



South Carolina Department of Transportation

2007

**STANDARD
SPECIFICATIONS
FOR
HIGHWAY
CONSTRUCTION**

The South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction is hereby approved for application on highway and related construction contracts as referenced in the Contract and the Plans, and applies as noted and amended by those documents.

Approved,



D. R. Shealy, P.E.
Director of Construction

I hereby certify that The South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction was prepared under my direct supervision and that I am a duly registered professional engineer under the laws of the State of South Carolina.



G. A. Peck, P.E.
Construction Specifications Engineer

COPIES OF THIS BOOK MAY BE OBTAINED FROM:

South Carolina Department of Transportation
Engineering Publications Office
955 Park Street
Columbia, South Carolina 29201
Telephone 803-737-4533
Fax 803-737-4530
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SECTION 816

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101.1 General

- 1 The titles or headings of the sections and subsections of these Standard Specifications are in bold type and are intended for convenience of reference and do not have any bearing on the interpretation. The number to the left of each paragraph is also for convenience of reference and does not have any bearing on the interpretation.
- 2 Cited publications, including the Office of Materials and Research (OMR) Standard Method of Tests, SCDOT Supplemental Specifications, SCDOT Supplemental Technical Specifications, and specification from other organizations or associations refer to the most recent issue or edition of the publication accepted or adopted by the Department, including interim publications, in effect at the time of advertisement of the proposal unless otherwise specified.
- 3 Action required of the Bidder or Contractor in these specifications is written as a command in the active voice, imperative mood to communicate the Bidder's or Contractor's responsibilities in a direct manner. The subject "the Bidder" or "the Contractor" is understood. Omission of words or phrases such as "the Contractor shall," "unless otherwise specified," or "unless otherwise directed" is intentional. Interpret the specifications as if they were included.
- 4 Sentences that define the Department's responsibility are written in the indicative mood, in either active or passive voice.

101.2 Abbreviations and Acronyms

- 1 Wherever the abbreviations and acronyms in the following tables are used in these specifications, the Supplemental Specifications, the Supplemental Technical Specification, the Special Provisions, or on the Plans, take them to represent the respective expressions in the following tables.

ORGANIZATIONS or PUBLICATIONS	
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AED	Associated Equipment Distributors
AGC	Associated General Contractors of America

(table continued on the next page)

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ORGANIZATIONS or PUBLICATIONS	
AISC	American Institute of Steel Construction
AMRL	AASHTO Materials Reference Laboratory
ANLA	American Nursery & Landscape Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASNS	<i>American Standard for Nursery Stock</i>
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWPA	American Wood Preserver Association
AWS	American Welding Society
CFR	<i>Code of Federal Regulations</i>
CRSI	Concrete Reinforcing Steel Institute
DBE	Disadvantaged Business Enterprise
ECTC	Erosion Control Technology Council
EPA	(U.S.) Environmental Protection Agency
FHWA	Federal Highway Administration
GSI	Geosynthetic Institute
ISEA	International Safety Equipment Association
ISO	International Organization for Standardization
MUTCD	<i>Manual of Uniform Traffic Control Devices</i>
NCHRP	National Cooperative Highway Research Program
NCMA	National Concrete Masonry Association
NEC	<i>National Electrical Code</i>
NESC	<i>National Electrical Safety Code</i>
NIST	National Institute of Standards and Technology

(table continued on the next page)

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ORGANIZATIONS or PUBLICATIONS	
NPDES	<i>National Pollutant Discharge Elimination System(General Permit)</i>
NRMCA	National Ready Mixed Concrete Association
NTPEP	National Transportation Product Evaluation Program
OSHA	Occupational Safety and Health Administration
PCI	Prestressed Concrete Institute
PUPS	Palmetto Utility Protection Service
SAE	Society of Automotive Engineers
SCDA	South Carolina Department of Agriculture
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SCDOI	South Carolina Department of Insurance
SCDOT	South Carolina Department of Transportation
SPIB	Southern Pine Inspection Bureau
SSPC	Steel Structures Painting Council
UL	Underwriters Laboratories
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USDOT	United State Department of Transportation

SCDOT OFFICIALS and OFFICES	
AME	Asphalt Materials Engineer
BCE	Bridge Construction Engineer
BDE	Bridge Design Engineer
BDGE	Bridge Design Geotechnical Engineer
DCE	District Construction Engineer
DEA	District Engineering Administrator

(table continued on the next page)

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SCDOT OFFICIALS and OFFICES	
DOC	Director of Construction
GME	Geotechnical Materials Engineer
MRE	Materials and Research Engineer
OMR	Office of Materials and Research
RCE	Resident Construction Engineer
RME	Resident Maintenance Engineer
SHE	State Highway Engineer
SME	Structural Materials Engineer

PAY UNITS	
ACRE	Acre
BALE	Bale
CF	Cubic Foot
CY	Cubic Yard
CYHM	Cubic Yard Half-Mile
EA	Each
LB	Pound
LF	Linear Foot
LS	Lump Sum
MI	Mile
MSY	One-Thousand Square Yards
SF	Square Foot
STA	Station (100 feet)
SY	Square Yard
TON	Ton (2000 pounds avoirdupois)

101.3 Terms and Definitions**101.3.1 General**

- ¹ Wherever in these specifications or in other contract documents the following terms and definitions are used, interpret the intent and meaning as set

forth in this section.

101.3.2 Acceleration and Deceleration Lanes

- 1 The Acceleration and Deceleration Lanes are the portions of the roadway adjoining the main traveled way consisting of tapers, widened areas or auxiliary lanes which function as speed change lanes, turning lanes, and segments of traffic interchange connections.

101.3.3 (the) Advertisement

- 1 The Advertisement is the official notice published publicly announcing a letting of highway construction projects, inviting bids, and carrying information concerning the date and time of the opening of bids and other pertinent information.

101.3.4 Award

- 1 The Award of a Contract is made by official letter from the DOC notifying the successful low bidder that the proposed work has been awarded to the Bidder, and authorizing work to begin upon the execution and approval of a satisfactory contract together with bonds to secure the performance of the work and assure the payment of all legal debts pertaining to the performance of the work, a certificate of insurance as proof of the required insurance, and such other conditions as specified or otherwise required by law.

101.3.5 Base Course

- 1 The Base Course is the layer or layers of specified material of designated thickness or rate of application placed on a subbase or subgrade to support subsequent layers of the pavement structure.

101.3.6 Bid Proposal

- 1 A Bid Proposal is the offer of the bidder, properly submitted and guaranteed in the prescribed manner, to perform the work at the prices quoted therein.

101.3.7 Bidder

- 1 A Bidder is an SCDOT prequalified individual, firm, corporation, or combination of same submitting a bid proposal for the work contemplated, acting directly or through a duly authorized representative.

101.3.8 Bridge

- 1 A Bridge is a structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway; having a track or passageway for carrying traffic or other moving loads; and having a length measured along the center of roadway of more than 20 feet.
- 2 The length of a Bridge is the overall length measured along the longitudinal centerline between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening. The width is the clear width between the bot-

toms of curbs measured at right angles to the longitudinal centerline.

101.3.9 Calendar Day

- 1 A Calendar Day is every day shown on the calendar, Saturdays, Sundays, and holidays included.

101.3.10 Change Order

- 1 A Change Order is a written order to the Contractor, signed by the authorized SCDOT representative, directing changes in the work within the provisions of the Contract.

- 2 A Change Order is used to change contract quantities for items with unit prices, provide for incentives, penalties, and adjustments for unit price items as provided in the original Contract, delete contract items, and revise contract time.

- 3 A Change Order may include written agreement made and entered into by and between the Contractor and the Department, covering alterations and unforeseen work incidental to the proper completion of the project, when such work is paid for at an agreed unit or lump sum price. Such Change Order becomes a part of the Contract when approved and properly executed.

101.3.11 Channel

- 1 A Channel is a natural or artificial watercourse.

101.3.12 (the) Commission

- 1 The Commission refers to the Commission of the South Carolina Department of Transportation.

101.3.13 Construction Estimate

- 1 A Construction Estimate is an official written itemization of the value of materials in-place and work performed according to which the Contractor is paid. A Construction Estimate may also be referred to as a Progress Estimate or the Final Estimate.

101.3.14 (SCDOT) Construction Manual

- 1 The *SCDOT Construction Manual* is the operational manual prepared by the South Carolina Department of Transportation that defines the criteria and procedures used by engineering personnel in the administration of construction contracts.

101.3.15 (the) Contract

- 1 The Contract is the executed agreement between the Department and the successful bidder, setting forth the obligations of the parties thereunder, including but not limited to the furnishing of materials, labor, equipment, and tools, the performance of the work, the method of measurement, and the basis of payment.

- 2 The Contract includes the proposal and contract form, payment bond, performance and indemnity bond, these Standard Specifications and Standard Drawings by reference, Supplemental Specifications, Special Provisions, general and detailed Plans and Strip Maps, Award Letter, and Notice to Proceed. Also, any subsequent Change Orders and Force Account Work Orders required to complete the construction of the work in an acceptable manner, including authorized Extensions thereof, all of which constitute one instrument.

101.3.16 Contract Bond

- 1 A Contract Bond is the approved form of security, executed by the Contractor and its surety or sureties, guaranteeing complete execution of the Contract and all Change Orders pertaining thereto, and the payment of all legal debts pertaining to the performance of the work.

101.3.17 Contract Item (or Pay Item or Bid Item)

- 1 A Contract Item may be referred to as a Pay Item or Bid Item and is an item of specifically described work for which a price, either unit or lump sum, is provided in the contract. It includes the performance of all work and the furnishing of all materials, labor, equipment, tools, supplies, and fuel described in the text of a specified item included in the contract.
- 2 Contract Items have a unique 7 digit Item Number. Generally, the first 3 digits correspond to a section of these Standard Specifications. The remaining 4 digits are for individual identification of each contract item.

101.3.18 Contract Time

- 1 Contract Time is the time in calendar days allowed for the substantial completion of the work specified in the Contract, including authorized time extensions. Contract Time is the number of calendar days between the Notice to Proceed and date of Substantial Completion of Work.

101.3.19 Contract Completion Date

- 1 The Contract Completion Date is the date specified in the Contract for substantial completion of the work. This date may be adjusted when justified in the opinion of the RCE. The adjusted date is the Adjusted Completion Date.

101.3.20 (the) Contractor

- 1 The Contractor is the individual, firm, corporation, or combination thereof undertaking the execution of the work under the terms of the contract and acting directly or through his, her, their, or its agents, employees or subcontractors. The term Contractor refers to the prime contractor.

101.3.21 (the) County

- 1 A County is one of the 46 counties in the State of South Carolina.

101.3.22 Crossover

- 1 A Crossover is a travelway connecting two travelways of a divided highway and provides for the movement of traffic across or between the travelways.

101.3.23 Culvert

- 1 A Culvert is structure that provides an opening or conduit under a roadway or fill, generally for the passage of water, and includes pipe culverts and any structure so named on the Plans.

101.3.24 (the) Department

- 1 The Department is the South Carolina Department of Transportation (SCDOT).

101.3.25 (the) Designer (of Record)

- 1 The Designer or Designer of Record is the Professional Engineer or Engineering Firm registered in South Carolina that performs the engineering design and analysis and is responsible for the plans and specifications for the project. The Designer or Designer of Record may be the Department's in-house staff or a consultant retained by the Department.
- 2 The terms Designer and Designer of Record are interchangeable with the term Engineer of Record.

101.3.26 (the) Director

- 1 The Director is the Executive Director of the South Carolina Department of Transportation.

101.3.27 (the) Engineer

- 1 The Engineer is the State Highway Engineer of the South Carolina Department of Transportation, acting directly or through a duly authorized representative, such representative acting within the scope of particular assigned duties or authority.

101.3.28 Engineering District

- 1 An Engineering District refers to one of the seven SCDOT Engineering Districts.

101.3.29 Equipment

- 1 Equipment includes all machinery, together with the necessary supplies for upkeep and maintenance, and all tools and apparatus necessary for the proper construction and acceptable completion of the work.

101.3.30 Extension

- 1 An Extension or Contract Extension is additional work added to a contract outside of the limits of the original contract.

101.3.31 Extra Work

- 1 Extra Work is additional work performed and/or additional material furnished beyond the original scope of the contract, and is duly authorized and necessary for proper completion of the improvement, but is not covered by any item in the contract, and for which, there is no means of payment, direct or indirect, provided in the contract. Such Extra Work is performed at duly

negotiated prices in a Change Order or Force Account Work Order.

101.3.32 Force Account Work Order

- 1 A Force Account Work Order is a written order of the State Highway Engineer directing the Contractor to perform additional work or furnish additional materials.

101.3.33 Highway

- 1 Highway is a general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way. In general, this term is synonymous with "road" and "street."

101.3.34 (the) Inspector

- 1 The Inspector is the authorized representative of the RCE or OMR assigned to make detailed inspections of materials and/or contract performance.

101.3.35 Laboratory

- 1 A Laboratory is an accredited materials and testing laboratory acceptable to the Department. The Office of Materials and Research (OMR) is the SCDOT materials and testing laboratory.

101.3.36 Letting

- 1 The Letting is the public opening of sealed bids for highway construction work.

101.3.37 Lump Sum

- 1 A Lump Sum is a bidding unit that includes the total cost to complete all work described under a single contract item (pay item). It includes all material, labor, equipment, tools, supplies and fuel costs plus all overhead, profit, and any other direct or indirect cost or expense necessary for the satisfactory performance and completion the work for that bid item.

101.3.38 Materials

- 1 Materials include all the substances or products specified for use in the construction of the project and its appurtenances.

101.3.39 Median

- 1 The Median is the portion of a divided highway between the travelways of traffic in opposite directions.

101.3.40 Optimum Moisture Content for Compaction

- 1 The Optimum Moisture Content for Compaction of soil is the dry weight of soil at which the soil can be compacted to the approximate maximum density under a specified standard method of compaction.

101.3.41 Parking Lane

- 1 A Parking Lane is an auxiliary lane adjoining the travelway intended for parking vehicles.

101.3.42 Pavement

- 1 Pavement is the uppermost layer of material placed on the travelway, shoulder, or both, usually placed as the wearing or riding surface. This term is used interchangeably with surface or surfacing.

101.3.43 Pavement Structure

- 1 The Pavement Structure is the combination of the subbase, base, pavement, or other specified layer placed on the subgrade to support the traffic load and distribute it to the roadbed.

101.3.44 Payment Bond

- 1 The Payment Bond is the security or bond furnished in the approved form by the contractor to guarantee the payment to all persons supplying labor and materials in the prosecution of the work in accordance with the terms of the contract. The penal sum of the bond is 100% of the contract amount.

101.3.45 Performance and Indemnity Bond

- 1 The Performance and Indemnity Bond is the security or bond furnished in the approved form by the contractor to guarantee the completion of the work in accordance with the terms of the Contract. The penal sum of the bond is the full value (100%) of the contract.

101.3.46 (the) Plans (or Design Plans)

- 1 The Plans or Design Plans are the official approved engineering drawings including profiles, cross-sections, strip maps, and supplemental drawings, or exact reproductions thereof that show the location, character, dimensions, and details of the work to be done; and are a part of the Contract supplementary to the Specifications.

101.3.47 Preconstruction Conference

- 1 A Preconstruction Conference is a conference held following the award and before the start of construction to be attended by a duly authorized representative of the Department and by the responsible officials of the prime contractor and other affected parties.

101.3.48 Prequalification

- 1 Prequalification of prime contractors is the procedure established and administered by the Department by virtue of which prospective bidders (prime contractors) are required to establish their responsibility and competence in advance of submitting bid proposals. By statute, only properly prequalified prime contractors may submit bids on Department highway construction contracts.

101.3.49 (the) Project

- 1 The Project refers to the work on a specific section or sections of highway together with all appurtenances to be performed under the contract.

101.3.50 Proposal (or Contract Proposal)

- 1 The Proposal or Contract Proposal is the package of documents made available to the public prior to the letting and contains the contractual obligations and pertinent information about the work, such as the time and date of the letting, the location and description of the proposed work, the required completion date, and the Disadvantaged Business Enterprise (DBE) goal. The Proposal includes Special Provisions, applicable Supplemental Specifications, a list of the pay items and quantities, and other documents necessary for a Bidder to prepare a bid for the contract.

101.3.51 Proposal Guaranty (or Bid Bond)

- 1 The Proposal Guaranty, also referred to as the Bid Bond, is the security or bond furnished in the approved form by the bidder with the bid proposal for a project, as guaranty that the bidder will enter into a contract for the work if the bid proposal is accepted. The penal sum of the bid bond is at least 5% of the bid amount.

101.3.52 Ramp

- 1 A Ramp is a connecting travelway between two intersecting highways, usually at a highway grade separation. Entrances to properties may also be referred to as ramps.

101.3.53 Right-of-Way

- 1 The Right-of-Way refers to the land secured and reserved by the Department for the construction, improvement, and maintenance of the highway.

101.3.54 Road

- 1 Road is a general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way. In general, this term is synonymous with "highway" and "street."

101.3.55 Roadbed

- 1 The Roadbed is the graded portion of a highway between the outside shoulder lines, prepared as a foundation for the pavement structure, median, and shoulders. Extensive areas between the roadbeds of divided highways will not be considered roadbed.

101.3.56 Roadside

- 1 The Roadside is the portion of the highway outside the roadway.

101.3.57 Roadway

- 1 The Roadway is that portion of the highway lying within the limits of construction.

101.3.58 SC-T-XXX

- 1 **SC-T-XXX** is the form of designation of an OMR Standard Method of Tests. The OMR Standard Method of Tests are SCDOT specifications for sampling

and testing methods and procedures. Consider the OMR Standard Method of Tests included in the Specifications and a part of the contract whenever applicable. They are available at the following website:

http://www.scdot.org/doing/rm_lab.asp

101.3.59 SC-M-XXX(MMY)

- 1 **SC-M-XXX(MMY)** is the form of designation of a Supplemental Technical Specification to these specifications. For example, **SC-M-401(0507)** is the Supplemental Technical Specification Number 401 issued in May of 2007. Consider the Supplemental Technical Specifications included in the Specifications and a part of the contract whenever applicable. They prevail over the Supplemental Specifications and these Standard Specifications when in conflict therewith. They are available at the following website:

<http://www.scdot.org/doing/>

101.3.60 Shop Plans

- 1 Shop Plans are plans or drawings prepared by the manufacturer showing fabrication details of specified items or components that will become a permanent part of the project and its appurtenances. Shop Plans include bending diagrams for reinforcing steel, structural steel fabrication drawings, prestressing steel strand layout drawings, or any other supplementary plans or similar data that the contractor is required to submit to the designer for review and acceptance before fabrication of specified items. The review and acceptance of the Shop Plans does not relieve the contractor of the sole responsibility for the materials, size, accuracy, and fit of the items in the Shop Plans.

101.3.61 Shoulder

- 1 The Shoulder is that portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

101.3.62 Sidewalk

- 1 The Sidewalk is that portion of the roadway primarily constructed for the use of pedestrians.

101.3.63 Skew or Skew Angle

- 1 The Skew or Skew Angle is the acute angle formed by the intersection of a line normal to the centerline of the roadway with a line parallel to the centerline of bents, piers, or abutments of a bridge, or in the case of a culvert, with the centerline of the culvert barrel(s).

101.3.64 (the) Special Provisions

- 1 The Special Provisions are the specifications in the contract revising or supplementing these Standard Specifications, the Supplemental Specifications, and Supplemental Technical Specifications for conditions peculiar to the individual project. The Special Provisions are included in the Specifications.

The Special Provisions prevail over the Supplemental Technical Specifications, the Supplemental Specifications, and the Standard Specifications and when in conflict therewith.

101.3.65 (the) Specifications

- 1 The Specifications is the general term that includes these Standard Specifications, the Supplemental Specifications, Supplemental Technical Specifications, Special Provisions, and all documents of any description including notes on the Plans that provide directions, provisions, and requirements pertaining to the method and manner of performing the work, the quality and quantity of materials to be furnished, and the measurement and payment of work required to satisfactorily complete the project.

101.3.66 Specified Completion Date

- 1 The Specified Completion Date is the date specified in the contract on which the work is required to be completed.

101.3.67 (SCDOT) Standard Drawings

- 1 The *SCDOT Standard Drawings for Roadway Construction* also referred to as the *SCDOT Standard Drawings* are issued by the Department and are considered part of the contract documents. The Design Plans prevail over the *SCDOT Standard Drawings* when in conflict therewith.

101.3.68 (these) Standard Specifications

- 1 These Standard Specifications is a reference to this document entitled the *SCDOT Standard Specifications for Highway Construction*. Consider these Standard Specifications included in the general term the Specifications.

101.3.69 (the) State

- 1 The State refers to the State of South Carolina.

101.3.70 State Highway Engineer

- 1 The State Highway Engineer refers to the State Highway Engineer of the South Carolina Department of Transportation.

101.3.71 Street

- 1 Street is a general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way. In general, this term is synonymous with "highway" and "road."

101.3.72 Structure

- 1 A Structure includes bridges, culverts, catch basins, drop inlets, manholes, retaining walls, cribbing, end walls, buildings, sewers, service pipes, underdrains, foundation drains, and other miscellaneous items that may be encountered in the work and that are not otherwise classified herein.

101.3.73 Subbase

- 1 The Subbase is the layer or layers of specified or selected material of designated thickness or rate of application placed on the subgrade to support the base course and surface course of the pavement structure.

101.3.74 Subcontractor

- 1 A Subcontractor is an individual, company, or corporation to whom the prime contractor sublets any part of the contract work.

101.3.75 Subgrade

- 1 The Subgrade is the top 18 inches of roadbed upon which the pavement structure and shoulders are constructed.

101.3.76 Substantial Completion of Work

- 1 Substantial Completion of Work is the point in the project when the work has been constructed to the typical sections in the Plans over the entire length of the project, including tie-ins to adjacent projects or existing roads, all travel lanes are open to the public, all safety features are installed and are being properly maintained, and no lanes will have to be closed to complete any remaining work.
- 2 Except for a project where the major item of work is installation of pavement markings or markers, the final pavement marking scheme must be in place with at least temporary markings, this would include temporary paint and RPMs, but the final pavement markings (thermoplastic and permanent RPMs) do not have to be in place, for the work to be substantially complete.

101.3.77 Substructure

- 1 The Substructure of a bridge is that part of the structure below the bridge seats or below the springlines of concrete arches. Backwalls and wingwalls of abutments are considered parts of the Substructure.

101.3.78 Superintendent

- 1 The Superintendent is the contractor's authorized representative in responsible charge of the work regardless of the company's title for this individual.

101.3.79 Superstructure

- 1 The Superstructure is that part of the bridge above the substructure or above the springlines of concrete arches.

101.3.80 Supplemental Specifications

- 1 Supplemental Specifications are specifications adopted by the SCDOT after the publication of the Standard Specifications and constitute a part thereof and of the Contract. Supplemental Specifications prevail over the Standard Specifications when in conflict therewith.

101.3.81 (the) Surety

- 1 The Surety is the corporation, partnership, or individual bound with and for the Prime Contractor for the full and complete performance of the contract and for the payment of all debts pertaining to the work.

101.3.82 Temporary Structure

- 1 A Temporary Structure is a structure required for the use of traffic while construction is in progress and is not to be retained as part of the permanent improvement.

101.3.83 Traffic Lane

- 1 A Traffic Lane is that portion of a travelway for the movement of a single line of vehicles.

101.3.84 Travelway or Traveled Way

- 1 The Travelway or Traveled Way is that portion of the roadway for the movement of vehicles exclusive of the shoulders.

101.3.85 Unit Price

- 1 A Unit Price is the costs for a unit of measure of a contract item (pay item). It includes all materials, labor, equipment, tools, and supply costs plus all overhead, profit, and any other direct or indirect costs or expenses necessary to satisfactorily perform and complete the work.

101.3.86 (the) Work

- 1 The Work includes the furnishing of all materials, labor, equipment, tools, supplies, fuel, services, and other incidentals necessary to the successful completion of the project or the portion of the project involved and the carrying out of all the duties and obligations imposed by the contract. The scope of the work is defined in the contract.

101.3.87 Working Drawings

- 1 Working Drawings include erection plans, falsework plans, cofferdam plans, temporary structure plans, or any other supplementary plans, or similar data that the contractor is required to submit to the BCE, BDE, BDGE, Consultant Designer, or Railway Company representative for acceptance before assembly of erection of the subject of the drawings on the project site. Acceptance of the Working Drawings does not relieve the contractor of sole responsibility for the implementation methods or procedures contained in the Working Drawings.

SECTION 102

BIDDING REQUIREMENTS AND CONDITIONS

102.1 Prequalification

- 1 Before submitting a bid on work let to contract by the Department, all bidders must be prequalified in accordance with South Carolina Code of Regulations, Section 63.300.
- 2 To become prequalified, submit a *Prime Contractor Prequalification Questionnaire* for consideration by the Department. Upon approval of prequalification, a *Certificate of Prequalification* will be issued to the Contractor. Submission of an updated *Prime Contractor Prequalification Questionnaire* is required annually within one month of the renewal thereafter to renew the certificate. A copy of the *Prime Contractor Prequalification Questionnaire* is available on the SCDOT website:

<http://www.scdot.org/doing/prequalified.shtml>
- 3 Providing false or misleading information on the *Prime Contractor Prequalification Questionnaire* is cause for prequalification to be denied or a previously granted prequalification to be revoked.
- 4 As part of the prequalification process, Contractors will receive a Contractor Performance Score (CPS) in accordance with the SCDOT Contract Performance System (CPES) as specified in the *Prime Contractor Prequalification Questionnaire*.
- 5 A Minimum Required CPS may be placed on an advertised project, and only Contractors with a CPS at or above that minimum required score would be allowed to submit a bid on that project. Prequalified Contractors that have not been issued a score or do not have a current score will be allowed to bid on that project. If a project does not have a Minimum Required CPS assigned to it, then all prequalified Contractors in good standing may submit a bid on that project.

102.2 Proposal

- 1 A Proposal is available for each Contract in a letting and contains the contractual obligations and pertinent information about the work, such as the time and date of the letting, the location and description of the proposed work, the required completion date, the Disadvantaged Business Enterprise (DBE) goal, the Special Provisions, the applicable Supplemental Specifications, and a list of pay items and estimated quantities for the project. Although the Proposal is intended as the basis of the Contract, it is not submitted as part of the electronic bid, but is included by reference.
- 2 Plans, Specifications, and other documents designated in the Proposal are considered a part of the Proposal whether attached or not.

102.3 Interpretation of Quantities

- 1 The quantities listed in the Proposal and the electronic bid form are approximate estimates and are prepared solely for the comparison of bids. Payment to the Contractor is made only for the actual quantities of work performed and accepted or materials furnished in accordance with the Contract. The quantities of work to be done and materials to be furnished may be increased, decreased, or omitted as hereinafter provided, without in any way invalidating the prices bid.

102.4 Examination of Plans, Specifications, Work Site, etc

- 1 It is the Bidder's responsibility to carefully examine the site of the proposed work, the Proposal, the Plans, the Standard Drawings, these Standard Specifications, and other pertinent documents before submitting a bid. The submission of a bid is considered prima facie evidence that the Bidder has made such examination and is satisfied as to the conditions to be encountered in performance of the work and as to the requirements of the Plans, the Standard Drawings, the Specifications, and other pertinent documents.
- 2 It is the Contractors responsibility to understand the relationship between the intended work, provisions in the proposal, and the pay items. If there is no pay item for work specified in the proposal, the cost of the performance of such work is considered included in the contract unit bid price of the various pay items in the proposal.

102.5 Electronic Bidding

- 1 Unless otherwise specified, only electronic bids are accepted for highway construction projects. The electronic bidding process is conducted in accordance with *The Policies and Procedures for Electronic Bidding*, which is available from the SCDOT Contracts Administration office and appears on the SCDOT Internet web site at the following website:

<http://www.scdot.org/>

102.6 Counterproposals

- 1 Do not offer any counterproposal linking a bid on one project with a bid on another project or projects. Such counterproposals will not be accepted.

102.7 Qualifying Letters Prohibited

- 1 Do not file any letters with the bid that limit the number of projects for which an award will be accepted. Bidders are awarded all projects on which their low bid is responsive and satisfactory to the Department, provided they are qualified for such projects.

102.8 Irregular Bids

- 1 A bid is considered irregular and may be rejected for any of the following reasons:
 - A. The electronic bid file is altered in any way except to input the required information.

- B. The bid is thought to contain unbalanced bid prices.
 - C. There is reason to believe that the Bidder has an economic interest in more than one bid on the same project or that there has been collusion among the bidders.
 - D. When it is required to supply information for a committal to meet or exceed the Disadvantaged Business Enterprise goal set for the Contract or to submit acceptable evidence of a "good faith effort," but the bidder fails to do so.
- 2 A bid is considered irregular and will be rejected for any of the following reasons:
- A. There are unauthorized additions, conditional or alternate bids, or irregularities of any kind which make the bid indefinite or ambiguous as to its meaning.
 - B. The Bidder adds any provisions reserving the right to accept or reject an award, or to enter into a Contract pursuant to an award.
 - C. The bid does not contain a unit price for each pay item listed except in the case of authorized alternate bid items.
 - D. The Bidder fails to indicate on the electronic bid form that it has read, understood, accepted, and acknowledged all the statements in the proposal form.
 - E. When the it is required to submit a proposal guaranty (Bid Bond) acceptable to the Department as outlined in **Subsection 102.9**, but the bidder fails to do so.

102.9 Proposal Guaranty

- 1 Unless otherwise stated in the proposal, provide a proposal guaranty with each bid using SCDOT Form 674, for 5% of the submitted bid. Make certain that the proposal guaranty is written by a company licensed for surety authority by the Chief Insurance Commissioner of the South Carolina Department of Insurance and has a rating of "A" or better assigned by A.M. Best Company on its most recent *Best's Key Rating Guide*; otherwise, the bond will not be accepted. Ensure that the proposal guaranty is fully executed and indicates the name of the Bidder, the name of the Surety, the project for which the bond is issued, the penal amount of the bond, and that the bond guaranties and names the South Carolina Department of Transportation as the obligee. Electronic bid bonds are accepted from SCDOT approved electronic bonding services. Proposal guarantees must be submitted to the SCDOT before the letting or along with the electronic bid at the time of the letting.

102.10 Withdrawal of Bids

- 1 A Bidder may, without prejudice, withdraw or revise a bid after it has been submitted to the electronic bidding service provided this is done before the date and time set for the opening of bids.

102.11 Public Opening of Bids

- 1 Electronic bids will be opened and read publicly at the time and place indicated in the Proposal and in the Advertisement. Bidders or their authorized agents are invited to be present.

102.12 Disqualification of Bidders

- 1 Contractors may be disqualified as bidders in accordance with the provisions of the South Carolina Code of Regulations, Sections 63-304 through 306.
- 2 Not more than one bid from an individual, a firm or partnership, a corporation, or any association, under the same or different names, will be considered for any single project. Reasonable grounds for believing that a Bidder has an interest as a principal in more than one bid proposal for a single project is cause for the rejection of all bids in which such bidder is believed to have an interest.
- 3 Any or all bids are rejected if there is reason to believe that collusion exists among the bidders, and no participant in such collusion will receive recognition as a bidder for any future work for the Department until the participant has been reinstated as a qualified bidder. Contracts are awarded only to responsible bidders capable of performing the work contemplated, within the time specified, and having sufficient resources and finances to carry on the work properly.

SECTION 103

AWARD AND EXECUTION OF CONTRACTS

103.1 Consideration of Proposals

- 1 After the proposals are opened and read, they are compared based on the summation of the extensions of the approximate quantities shown in the bid schedule multiplied by the unit bid prices. The results of such comparisons are available to the public only after the Contract has been awarded. In case of a discrepancy between unit bid prices and extensions, the unit bid price governs.
- 2 The right is reserved to reject any or all proposals, to waive technicalities, or to advertise for new bids, if in the judgment of the Director, the best interest of the Department is promoted thereby.

103.2 Award of a Contract

- 1 If awarded, the Contract will be awarded to the lowest responsible and qualified bidder whose bid complies with all the requirements prescribed. The award of the Contract will be made within 30 calendar days after the opening of bid proposals unless otherwise specified in the Special Provisions. The successful Bidder is notified by letter to the address provided in prequalification that its bid has been accepted and that it has been awarded the Contract. An award is not made until all information required by the Department has been received from the Bidder, and the Bidder's responsibility has been established.

103.3 Cancellation of Award

- 1 The Department reserves the right to rescind or cancel the award of any Contract at any time before the execution of said Contract by all parties and without any liability against the Department.

103.4 Return of Proposal Guaranty

- 1 All proposal guaranties are retained by the Department until the Contract is executed by the successful Bidder, after which all such proposal guaranties are destroyed unless the guaranty form contains a note requesting it be returned to the Bidder or the Surety.

103.5 Bond Requirements

- 1 Unless otherwise specified, provide the following bonds acceptable to the Department with the executed Contract:
- Performance and Indemnity Bond from a surety or sureties satisfactory to the Department in the full amount (100%) of the Contract bid amount, but in no case less than \$10,000.00 for the protection of the Department, and
 - Payment Bond from a surety or sureties satisfactory to the Department in the full amount (100%) of the Contract bid amount for the

protection of all persons supplying labor and materials in the prosecution of work provided for the Contract for the use of each such person.

- 2 Provide these bonds in accordance with the requirements of South Carolina Code of Laws, Sections 57-5-1660 and 29-6-250, as amended.
- 3 Only a Performance and Indemnity Bond written on SCDOT Form 672A and a Payment Bond written on SCDOT Form 673 are acceptable to the Department. Bond forms are available through the Contracts Administration office.
- 4 Criteria that is necessary in order for a surety or sureties to be satisfactory to the Department, include, but not limited to the following:
 - A. The surety or sureties are licensed for surety authority by the Chief Insurance Commissioner of the South Carolina Department of Insurance.
 - B. The surety or sureties are assigned a rating of "A" or better by A.M. Best Company in its most recent *Best's Key Rating Guide*.

103.6 Execution of the Contract

- 1 After receiving the Contract prepared by the Department, sign and return it, together with an acceptable Payment Bond, Performance and Indemnity Bond, and acceptable Certificates of Insurance to the Contracts Administrator within 20 calendar days from the date it was mailed by the Department. No Contract will be executed by the Department without the acceptable bonds and insurance certificates. No Contract will be considered effective until it has been fully executed by all parties thereto.

103.7 Failure to Execute the Contract and Provide Bonds and Insurance Certificates

- 1 Failure of the Contractor to execute the Contract and provide acceptable bonds and insurance certificates within 20 calendar days after the Contract is mailed by the Department is just cause for the annulment of the award and forfeiture of the proposal guaranty. If the award is annulled, the proposal guaranty becomes the property of the Department, not as a penalty, but as liquidated damages.

103.8 Contractor's Liability Insurance

- 1 Purchase and maintain, in a company or companies acceptable to the Department, such insurance as protects the Contractor from claims indicated below that may arise out of or result from the Contractor's operations under the Contract, whether such operations are performed by the Contractor or by a subcontractor or by anyone directly or indirectly employed by any of them or by anyone for whose acts any of them may be liable:
 - Claims under workers' or workmen's compensation, disability benefit and other similar employee benefit acts that are applicable to be performed;

- Claims for damages because of bodily injury, occupational sickness or disease, or death of the Contractor's employees;
- Claims for damages because of bodily injury, sickness or disease, or death of any person other than the Contractor's employees;
- Claims for damages insured by usual personal injury liability coverage that are sustained by any person as a result of an offense directly or indirectly related to the employment of such person by the Contractor or by any other person;
- Claims for damages, other than to the work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom;
- Claims for damages because of bodily injury, death of any person, or property damage arising out of the ownership, maintenance, or use of any motor vehicle; and
- Claims involving contractual liability insurance applicable to the Contractor's obligations under the indemnity provisions of the Contract.

2 To be acceptable to the Department, the insurer must be duly qualified to transact business under the laws of this State and conform to the requirements of Section 38-1-10 of the South Carolina Code of Laws.

3 Obtain insurance with the minimum limits of liability for the types of insurance indicated in the following table or otherwise required by statute, whichever is greater:

Type of Insurance	Limits of Liability
Worker's Compensation Insurance:	
Coverage A	Statutory
Coverage B -Employer's Liability:	
Per Accident	\$100,000
Disease, Policy Limit	\$500,000
Disease, Each Employee	\$100,000
Comprehensive General Liability:	
Each Occurrence	\$1,000,000
General Aggregate	\$2,000,000
Completed Operations	\$2,000,000
Business Automobile Liability:	\$1,000,000 per occurrence
Coverage includes: All Owned, Hired and Non-Owned Automobiles	
Umbrella Liability Coverage	\$5,000,000

4 Ensure that all policies contain the Per Project endorsement and name the SCDOT as an additional insured including coverage for Completed Opera-

tions as evidenced by endorsement CG 20 37(10 01) or its equivalent. The endorsement must be submitted to the Department as part of the Certificate of Insurance. Ensure that all policies waive rights of subrogation against the SCDOT, and that the Contractor's deductibles do not exceed \$250,000 without written consent of the SCDOT.

- 5 Provide Certificates of Insurance acceptable to the Department as verification that the required insurance has been obtained. Contracts will not be executed by the Department until such certificates are furnished. Ensure that these certificates contain a provision that coverage afforded under the policies cannot be cancelled or reduced until at least 30 days prior written notice has been given to the Department and that the certificates show the deductible amounts. Make certain that the policies are endorsed to reflect this requirement.

103.9 Deferral and Cancellation of Contract

- 1 If before the Department receives a bid, awards a Contract, or executes contract documents, the low bidder is indicted (directly or through its officers, directors, employees, subsidiaries, affiliates, or parent corporation) for activities that if convicted, may result in its disqualification as a bidder pursuant to Department regulations; the Department reserves the right to pursue any or all of the following actions:

- Defer the award and execution of the Contract until the criminal charges have been resolved.
- Cancel the award without forfeiture of the proposal guaranty.
- Re-bid the project upon any conviction or plea of guilty or nolo contendere.

If the criminal charges have not been resolved within 90 days of the indictment, the Department reserves the right to cancel the award without forfeiture of the proposal guaranty and to re-bid the project.

- 2 A low bidder indicted (directly or through its officers, directors, employees, subsidiaries, affiliates, or parent corporation) after the letting, but before either award or execution of the Contract, is entitled to promptly withdraw its bid without forfeiture of the proposal guaranty provided that such indicted Contractor is not eligible to re-bid the project before resolution of the criminal indictment should the Department elect to reject all other initial bids and re-advertise the project.

103.10 Mobilization

- 1 Mobilization consists of the preparatory operations including: moving personnel and equipment to the project site; paying bond and insurance premiums; establishing offices, buildings, and other facilities necessary for work on the project; and all other preparatory work or costs incurred before beginning work on the project.

103.11 Measurement and Payment

- 1 Mobilization is paid at the lump sum price bid, which price and payment is full compensation for organizing and moving all forces, supplies, equipment and incidentals to the project site, regardless of the number of times such moves are made, and all preconstruction costs incurred after award of the Contract. The price and payment also includes costs for demobilization.
- 2 Payments for mobilization are included on the first and second construction estimates. Each payment is for 1/2 of the lump sum price for Mobilization, subject to the limits shown in the following table:

Contract Amount (CA)			Max. Payment in First Estimate	Max. Payment in Second Estimate
\$0	-	\$100,000	CA × 0.05	CA × 0.05
\$100,000 and above			CA × 0.025	CA × 0.025

- 3 If there is a remaining amount of the lump sum price for Mobilization after payments are made according to the table above, then the remaining amount is paid after all work on the project has been completed and accepted.
- 4 Completion of erection of materials processing plants, if any, is not required as a condition for the release of the second payment.
- 5 Partial payment for this item in no way acts to preclude or limit any of the provisions of partial payments otherwise provided for by the Contract or these specifications.
- 6 Payment for this item includes all direct and indirect costs and expenses required to complete the work.
- 7 Pay items under this section include the following:

Item No.	Pay Item	Unit
1031000	Mobilization	LS

SECTION 104

SCOPE OF WORK

104.1 Intent of Contract

- 1 The intent of the Contract is to provide for the construction and completion, in every detail, of the work described and contemplated. Furnish all materials, labor, equipment, tools, supplies, transportation, and fuel required to complete the work in accordance with the Plans, the Specifications, and terms of the Contract.

104.2 Alteration of Plans or Character of Work

- 1 The Department reserves the right, at any time, to make increases or decreases in quantities and alterations to the Plans or character of the work including, but not limited to, alterations in the grade or alignment of the roadway or structure(s) or both, as may be found necessary or desirable by the Department. Such alterations are neither a waiver of any conditions of the Contract, nor a release of the Surety. Treat altered work as if it were part of the original Contract.
- 2 The right is reserved to increase or decrease the quantity of any contract item. If the quantity increase or decrease is less than 25% of the original quantity, there is no change in the unit price. If the quantity increase or decrease is more than 25% of the original quantity, the RCE will determine if unit prices may be adjusted because of the increases or decreases.
- 3 Alterations of Plans or of the nature of the work will not involve or require work beyond the termini of the original proposed construction except as may be necessary for drainage, transitions in alignment and grade or otherwise necessary to satisfactorily complete the work contemplated unless the Contract is extended in accordance with the provisions of **Subsection 104.4**.
- 4 An increase or decrease in the quantities of work in no way invalidates the unit bid or contract prices except as stated in paragraph 2 above. No claim is allowed for any loss of anticipated profits or for any other type of damages because of any such alteration or because of any variation between the approximate quantities and the actual quantities of work performed.
- 5 Payment for work occasioned by changes or alterations will be made in accordance with the provisions set forth in **Subsection 109.4**. If the RCE determines that the altered or added work is of sufficient magnitude as to require additional time in which to complete the project, then such time adjustment is made in accordance with the provisions of **Subsection 108.6**.
- 6 If during the progress of work, subsurface or latent physical conditions at the site differing substantially from those contemplated in the Contract or unknown physical conditions at the site are of an unusual nature and differ materially from those ordinarily encountered and generally recognized as inherent in work of the character in the Contract, promptly notify the RCE in writing

of such conditions. If the RCE finds that the conditions differ substantially and cause a substantial increase or decrease in the cost and/or time required to perform the work, an equitable adjustment will be negotiated and a Change Order will be executed in accordance with **Subsection 109.4**. If the Contractor and the Department are unable to reach an agreement concerning prices, then the work will be performed in accordance with the provisions of **Subsection 109.5**.

- 7 Submit a notice of differing site condition to the RCE before performing additional work resulting from the alleged differing site condition. Submit notification on SCDOT Form No. 100.04, *Contractor Notice of Claim*. If the issue cannot be resolved by the methods specified in this subsection, then submit to the Department at the appropriate time a fully detailed request (claim) for additional time and/or compensation. Submit the claim in accordance with **Subsection 105.16**.
- 8 Do not begin work until a Change Order is executed or a Force Account order is issued for the affected work. Revised contract unit prices are applicable only to that portion of the work created because of the changed conditions.
- 9 Whenever alterations are made in Plans, or within the contract provisions, and such alterations result in leaving the Contractor, either on hand or in transit, with materials that were ordered prior to the notice of the alterations being given to the Contractor, the Department may take over the surplus materials and pay the Contractor the actual cost of these materials including transportation, but in no case will the Contractor be paid for anticipated profits. The Contractor is responsible for the surplus materials until delivered to a point designated by the RCE. The Department will not take over or be responsible for any materials purchased in advance of the apparent need for such materials, or assume any responsibility for losses by the Contractor for furnishing an excess of materials except where the excess has been brought about by alterations of the Plans that the Contractor could not reasonably foresee.
- 10 The above provisions do not apply to materials left over due to changes in substructures caused by foundation conditions being at variances from those assumed or shown.

104.3 Value Engineering

- 1 This specification provides an incentive to initiate, develop, and present to the Department for consideration any proposal by the Contractor for reduction in time and costs involving changes in the drawings, concepts, designs, specifications, or other requirements of the Contract. This specification does not apply unless the proposal submitted is specifically identified as being presented for consideration as a Value Engineering Proposal.
- 2 Value Engineering Proposals considered are those that would result in a net savings to the Department by providing a decrease in the total cost of construction or reduce the construction time without increasing the cost to construct the project. The affects the proposal may involve the following

items, but not limited to these items, and will be considered by the Department when evaluating the Value Engineering Proposal:

- Service life,
- Safety,
- Reliability,
- Economy of Operation,
- Ease of Maintenance,
- Desired Aesthetics,
- Design, and
- Standardized Features.

- 3 The Department reserves the right to reject the proposal or deduct from the savings identified in the proposal to compensate for any adverse effects to these items that may result from implementation of the proposal.
- 4 The Department reserves the right to reject, at its discretion, any Value Engineering Proposal submitted that would require additional right-of-way. Substitution of a design alternate that is detailed in the Plans for the one on which the Contractor bid is not allowed. Plan errors that are identified by the Contractor and result in a cost reduction do not qualify for submittal as a Value Engineering Proposal. No time extension will be granted due to the time required to review a Value Engineering Proposal.
- 5 The Contractor is encouraged to include this specification in contracts with its subcontractors. Encourage submissions of Value Engineering Proposals from subcontractors; however, it is not mandatory that the Contractor accepts or transmits to the Department proposals by its subcontractors. The Contractor may choose any arrangement for the subcontractor's Value Engineering payments provided these payments do not reduce the Department's share of the savings resulting from the Value Engineering Proposal. If the Contractor desires a preliminary review of a possible Value Engineering Proposal before expending considerable time and expense in full development, submit a copy of the preliminary proposal to the RCE. Entitle the submittal: Preliminary Value Engineering Proposal Review Request, and ensure that it contains sufficient drawings, cost estimates, and written information that can be clearly understood and interpreted. Also, include the identity of any private engineering firms intended to prepare plans and designs or revisions to the Plans and designs. The Department will review the preliminary submittal only to the extent necessary to determine if it has a possible merit as a Value Engineering Proposal. If its preliminary review finds that the preliminary proposal has possible merit, this does not obligate the Department to approve the final proposal. The Department is under no obligation to consider any preliminary or final Value Engineering Proposal that is submitted.

- 6 If a final Value Engineering Proposal is submitted to the RCE, ensure that it contains, as a minimum, the following:
 - A. Statement that the request for the modification is being made as a Value Engineering Proposal.
 - B. Description of the difference between the existing contract requirements and the proposed modifications along with the comparative advantages and disadvantages of each.
 - C. Complete and accurate drawings of the details involved in the proposed modifications and the supporting design computations. Make certain that new designs, revisions, or modifications are prepared and sealed by a South Carolina registered Professional Engineer. Further, the Department may require a review and possibly the re-design to be done by the project's original designer or an approved equal. When needed, the Department may contract with private engineering firms for design reviews as requested by the Department. When required to do so by the Department, contract with the original project designer or an approved equal for any work needed to prepare new or revised, accurate, and complete contract documents. The Department may waive the requirements to have the preparation of contract documents accomplished by a Professional Engineer or the project's original designer based on the extent, detail, and complexity of the design needed to implement the Value Engineering Proposal.
 - D. Itemized list of the contract requirements that would be modified and a recommendation of how to make each modification.
 - E. Detailed estimate of the cost of performing the work involved in the proposed modification.
 - F. Statement of the time by which approval of the Value Engineering Proposal must be issued by the Department to obtain the total estimated cost reduction during the remainder of the Contract, noting any effect on the contract completion or delivery schedule.
- 7 To facilitate the preparation of revisions to the contract drawings, the Contractor may purchase reproducible copies of drawings through the Department. Coordinate the preparation of new design drawings with the appropriate Department Division. Provide, at no charge to the Department, one set of reproducible drawings needed to implement the proposal.
- 8 The DOC will be the sole judge of the acceptability of a Value Engineering Proposal requested in accordance with these provisions and of the estimated net savings resulting from the approval of all or any part of the proposal. The Contractor has the right to withdraw, in whole or in part, any proposal not yet accepted by the Department within the period to be specified in the proposal as indicated in item F in paragraph 6 above.
- 9 If a Value Engineering Proposal is approved, then the necessary changes are effected by a Change Order. Included as a part of the Change Order are

provisions for price adjustment giving the Contractor 50% of the net savings to the project resulting from the modifications.

- 10 The Department reserves the right to include in the Change Order any conditions it deems appropriate for consideration, approval, and implementation of the proposal. Acceptance of the Change Order by the Contractor constitutes acceptance of such conditions.
- 11 The final net savings distributed will be the difference in cost between the existing contract cost for the involved bid items and the actual final cost occurring because of the modification. Only those unit price items directly affected by the Change Order are considered in making the final determination of net savings. In determining the estimated net savings, the Department reserves the right to disregard the contract prices if in the judgment of the Department, such prices do not represent a fair measure of the value of the work to be performed or to be deleted.
- 12 Subsequent change documents affecting the modified bid items, but not related to the Value Engineering Proposal, are excluded from the determination of net savings. The Department will bear the cost of its review and administrative costs for the Value Engineering Proposal. The Contractor bears the costs for designs and/or revisions to designs and the preparation of design drawings. The costs to either party will not be considered in determining the net saving obtained by implementing the Value Engineering Proposal. The Contractor's portion of the net savings is full compensation for effecting all changes pursuant to the agreement.
- 13 Upon execution of the Change Order, the Department thereafter has the right to use, duplicate, or disclose in whole or in part any data necessary for utilization of the modification on other projects without obligation or compensation of any kind to the Contractor. Restrictions or conditions imposed by the Contractor for use of proposal on other projects are not valid.
- 14 Except as otherwise precluded by this specification, the Contractor may submit a previously approved Value Engineering Proposal from another project.
- 15 Unless and until a Change Order is executed and issued by the Department, the Contractor remains obligated to perform the work in accordance with the terms of the existing Contract.
- 16 Acceptance of the modification and its implementation does not modify the completion date of the Contract unless specifically provided for in the Change Order.
- 17 The Contractor is entitled to additional compensation for alterations in the Plans or in the details of construction pursuant to the Value Engineering Proposal.
- 18 The Department is not liable to the Contractor for failure to accept or act upon any Value Engineering Proposal submitted pursuant to this provision, nor for any delays to the work attributable to any such proposal.

19 The Department reserves the right to negotiate desired changes with the Contractor under the provisions of the Contract even though the changes are the result of a Value Engineering Proposal submitted on another contract. In this instance, the savings are prorated in accordance with the terms of the negotiated agreement.

20 Pay items under this subsection include the following:

Item No.	Pay Item	Unit
1040010	Value Engineering (Contractor's Portion)	LS

104.4 Extension of the Contract

1 Upon written agreement with the Contractor, the Department may extend the work beyond the limits of the Contract or add an additional road or roads as agreed. Such extension may not exceed 50% of the total amount of the original Contract being extended, nor exceed \$150,000.00, whichever is the lesser amount except as approved in advance by the Commission. Perform extended work at the same unit price as in the original Contract. If there is no unit price for an item in the original Contract, the unit price of such item is agreed upon, and a Change Order will be executed before beginning work.

104.5 Extra Work

1 If there is unforeseen work for which there is no bid price included in the Contract and the Department deems it necessary or desirable to complete the work as contemplated and to perform such extra work in accordance with the specifications and as directed, a Change Order will be entered into or a Force Account Work Order will be issued before any extra work is started.

2 In a Change Order, the Prime Contractor's markup for the cost of work performed by subcontractors may not exceed 10.0%. At the request of the RCE, make cost records available to the extent necessary to determine the validity and amount of each item claimed.

104.6 Detours and Haul Roads

1 When the Plans indicate that traffic is to be maintained on detour roads or structures, the pay items for construction and maintenance of such detours are included in the Contract or the work will be performed by the Department's forces. If detour roads or structures are not shown on the Plans or provided for in the Contract, the Contractor is responsible to provide adequate maintenance of traffic without extra compensation.

2 If roads provided by the Department are used to haul materials or equipment, the Contractor bears a proportionate part of the construction and maintenance costs of such roads as determined by the RCE. The Contractor bears all costs of constructing and maintaining new roads that are necessary to enable hauling materials over the shortest practicable route. If the RCE so directs, restore, without extra compensation, the premises over which a haul road has been constructed to a condition similar to or equal to that existing

before the haul road was constructed.

104.7 Maintenance and Maintaining Traffic

- 1 Unless otherwise provided, keep an existing road that is undergoing improvements open to all traffic. Maintain in a condition satisfactory to the RCE and, without direct compensation, the entire section or sections of highway within the limits of the work being performed, from the time the work begins until all the work is completed and accepted. When requested by the Contractor, the Department may assist in removing ice and snow from portions of the project that are open to traffic. Do not construe that such work by Department forces is in any way a waiver of the Contractor's responsibility as set forth herein or elsewhere in the Contract. The Contractor is not required to maintain portions of the highway or roadway that are not within the limits of the Contract.
- 2 Where determined necessary by the RCE, provide and maintain temporary approaches, crossings, and intersections with trails, roads, streets, businesses, parking lots, residences, garages, and farms.
- 3 Provide satisfactory maintenance of the old roadway, wholly or in part, even though a section or sections of the old roadway may be outside the new right-of-way, until the new road is sufficiently completed to adequately accommodate traffic. Keep all roadway sections used by the traveling public well drained at all times. Pay special attention to keeping the subgrade, newly laid subbase, base course, and surfacing in a condition that is safe and comfortable for public travel. Keep all watercourses free from obstruction. Repair all defects promptly and in a manner that ensures durability. Do everything necessary to maintain the subgrade, subbase, base course, surface course, shoulders, slopes, and ditches to the required cross-section and grade.
- 4 Coordinate and perform the various phases or stages of the construction, paying attention to weather conditions, seasons of the year, etc. to afford the least inconvenience to the adjacent landowners and the traveling public.
- 5 The Contractor is relieved of maintenance of a section or sections of the project when all work on such section or sections covered by the Contract is satisfactorily completed, the final cleaning-up performed, the punch items completed, the final inspection made, and all exceptions cleared.

104.8 Removal and Disposal of Structures and Obstructions

- 1 Unless otherwise specified, remove without extra compensation existing structures or portions thereof, fences, buildings, or other encumbrances or obstructions upon or within the limits of the right-of-way that are not necessary to the improvement or that interfere in any way with the new construction. Remove them with sufficient care to preserve the salvage value of the materials therein. Unless otherwise provided, such materials, when not designated for use in the new construction, become the property of the owner or the Department as the case may be. Neatly pile in an acceptable manner all such materials belonging to owners of abutting property upon their property or otherwise dispose of as required. Remove all such materials reserved for use

by the Department without damage in sections that can be readily transported and pile neatly at accessible points. Whenever materials are stored upon the highway, the Contractor is responsible for its care and preservation until its authorized removal. Remove all material designated by the RCE as having no salvage value, all discarded materials, and rubbish or debris from the highway without extra compensation and dispose of it as directed by the RCE.

- 2 Remove an existing structure if any part of it conflicts with the installation of a new structure. Unless otherwise specified, include the cost of this removal work in the contract price for items in the new structure.
- 3 Whenever it is necessary to remove, reset, or rearrange any building or structure outside the limits of the roadway, which is not provided for in the Contract, the Contractor may be required by the RCE to perform this work as Extra Work; or the work may be performed by the Department's forces or by the owners under separate agreement.
- 4 Take every precaution to prevent interference with utilities. The Contractor is solely responsible for damage to or interference with the utilities and for the cost of protecting the utilities from such damage or interference.

104.9 Rights In and Use of Materials Found on the Work

- 1 Unless otherwise specified, the material from an existing structure may be used temporarily by the Contractor in the erection of the new structure. Do not cut or otherwise damage such material except with the approval of the RCE, and upon completion of the work, place it where it can be readily loaded on trucks. If the Contractor unnecessarily damages or impairs the salvage value of the material removed from an existing structure, the Contractor will be charged an amount determined by the RCE as sufficient to cover the loss, damage, or impairment of the salvage value.

104.10 Final Cleaning Up

- 1 Before acceptance and final payment is made, clear the highway structures and site of all obstructions placed by the Contractor without extra compensation. Remove from the right-of-way, borrow pits, and adjacent property all surplus or discarded materials, rubbish, and temporary buildings, structures, and equipment. Restore in an acceptable manner to the RCE all property, both public and private, which has been damaged during the prosecution of the work and leave the highway or bridge site, including stream banks, in a neat and presentable condition with waterways unobstructed and free of debris for the entire length of the section or sections of road under contract.

SECTION 105

CONTROL OF WORK

105.1 Authority of the RCE

- 1 Unless otherwise specified elsewhere in these specifications, the RCE will decide all questions that may arise regarding the quality and acceptability of materials furnished, the work performed, the rate of progress of the work; the interpretation of the Plans and Specifications; acceptable fulfillment of the Contract by the Contractor; disputes and mutual rights between Contractors; and compensation for the work. The RCE will determine the amount and quantity of the several kinds of work performed and materials furnished, which are to be paid for under the Contract.
- 2 The RCE has the authority to suspend the work, wholly or in part, or to withhold further payments to the Contractor for failure to correct unsafe conditions for its workers or the general public; for failure to carry out provisions of the Contract; for failure to carry out orders of the RCE; for periods as the RCE deems necessary due to unsuitable weather; for conditions considered unsuitable for the prosecution of the work; or for any other conditions or reason the RCE deems to be in the public interest. No additional compensation is paid to the Contractor because of such suspensions of work.
- 3 The RCE is not authorized to increase the obligation of the Department under the Contract except as herein provided.

105.2 The Design Plans, Shop Plans, and Working Drawings

- 1 The Design Plans (the Plans) are furnished by the Department and consist of drawings that show details necessary to provide a comprehensive idea of the construction work contemplated. Road Plans will normally show the roadway alignment, profile, grades, and typical cross-sections. In general, Structure Plans will show the general details and dimensions of the structure work contemplated. In cases where dimensions are not shown, the Structure Plans show general features and details necessary to provide a comprehensive idea of the structure. The drawings for bridges will show sufficient information to enable the Contractor to determine the work contemplated, but the RCE reserves the right to have the Plans supplemented with Construction Plans, Erection Plans, or Working Drawings by the Contractor.
- 2 The information contained upon the Plans regarding the results obtained from test piles or borings is a record of the conditions revealed by fieldwork and shows conditions that were encountered at the place where the test piles were driven or the borings made, as nearly as those conditions could be interpreted by the inspector observing the operations. The Contractor is not bound to accept or rely on this data. Interpret them in the light of experience, and make such additional borings and investigations, including test piles, as desired in order to determine or obtain satisfaction concerning the conditions affecting lengths of piles or entering into the construction of foundations.

- 3 The Plans show the foundation depths and dimensions on which the estimated quantities are based. However, these depths and foundation dimensions are subject to such variation as may be necessary to secure a foundation satisfactory to the RCE. The Department expressly reserves the right to increase or diminish the dimensions and depths of substructures as the RCE may determine. When it is necessary to increase or decrease the height of a substructure or part thereof, the change is generally made in that portion between the bottom of pier or bent cap and the top of footing.
- 4 Submit all essential or required Working Drawings, Shop Plans, and Erection Plans to the Department for review and acceptance, and do not perform any work on the items involved until said plans have been accepted. Any work done or materials ordered before the acceptance of such Working Drawings, Shop Plans, and Erection Plans is at the Contractor's risk.
- 5 Furnish Working Drawings and Shop Plans for items or work required in **Subsection 725.1.1** and **725.1.2**.
- 6 In the case of steel superstructures, furnish Shop Plans and Working Drawings as required in **Subsection 709.1.3**. Include in the Shop Plans details, dimensions, material specification, and other information necessary for the complete fabrication of the metalwork and any items attached to the metalwork. In the Working Drawings or Erection Plans, include details of falsework, temporary bracing, and the erection process for the metalwork.
- 7 In the case of concrete structures, furnish Working Drawings and Shop Plans for concrete structures that include details that are necessary for the successful prosecution of the work and are not in the Plans furnished by the Department. Include bending details and schedules for reinforcing steel, falsework, bracing, cribs, cofferdams, and deck formwork as required by the project.
- 8 In the case of prestressed concrete, furnish Working Drawings and Shop Plans as required in **Subsection 704.4.2**. Include formwork details and dimensions, strand sizes, strand patterns, location of hold-down points, method for applying the required tension in the strands, method of detensioning the strands, and method of lifting and handling the prestressed members.
- 9 Furnish such copies of Shop Plans and Working Drawings in accordance with the requirements of **Section 725**. It is expressly understood that the acceptance of the Contractor's Shop Plans and Working Drawings is general and such acceptance does not relieve the Contractor of any responsibility.
- 10 The contract price of an item includes the cost of furnishing Shop Plans and Working Drawings as required.

105.3 Conformity with Plans and Specifications

- 1 Perform the work and furnish materials in reasonably close conformity with the lines, grades, cross-sections, dimensions, and material requirements, including tolerances shown on the Plans or indicated in the Specifications. Any deviation from the Plans or the Specifications that may be required by the exi-

gencies of construction will be determined by the RCE and authorized in writing.

- 2 In the event the RCE finds the materials or the finished product in which the materials are used are not within reasonably close conformity with the Plans and the Specifications, but that reasonably acceptable work has been produced, the RCE will make a determination if the work can be accepted and remain in place. In this event, the RCE will document the basis of acceptance by Change Order, which will provide for an appropriate adjustment in the contract price for such work or materials in conformance with the determination of the quality of the work or materials
- 3 In the event the RCE finds the materials or the finished product in which the materials are used or the work performed are not in reasonably close conformity with the Plans and the Specifications and as such have resulted in an inferior or unsatisfactory product, remove and replace or otherwise correct the work or materials without additional compensation.

105.4 Coordination of Plans, Specifications, and Special Provisions

- 1 The Special Provisions, the Plans, the SCDOT Standard Drawings, the Supplemental Technical Specifications, the Supplemental Specifications, these Standard Specifications, and all supplementary documents are essential parts of the Contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In the event of any discrepancy, the order of precedence is as follows:
 - Special Provisions
 - Plans
 - Calculated dimensions unless obviously incorrect
 - Scaled dimensions
 - SCDOT Standard Drawings
 - Calculated dimensions unless obviously incorrect
 - Scaled dimensions
 - Supplemental Technical Specifications
 - Supplemental Specifications
 - Standard Specifications.

Take no advantage of any error or omission in the Plans or of any discrepancy between the Plans and the Specifications. The RCE will make such corrections and interpretations as deemed necessary for the fulfillment of the intent of the Plans and the Specifications as interpreted by the RCE.

105.5 Cooperation by Contractors

- 1 The Contractor will be supplied with a minimum of two copies of the Plans and the assembled Contract, including Special Provisions. Keep one set available on the work site at all times. Notify the RCE in writing as early as possible as to the time and place at which work is expected to begin, but, in

all cases, at least 7 days before beginning work, in order to provide sufficient time for the staking out of the work.

- 2 Give the work the constant attention necessary to facilitate the progress thereof, and cooperate with the RCE, the RCE's authorized representatives and inspectors, and other Contractors in every way possible. Make certain that a competent superintendent, acting as the Contractor's agent, is on the work site at all times. Ensure that the superintendent is capable of reading and thoroughly understanding the Plans and the Specifications, is thoroughly experienced in the type of work being performed, will receive instructions from the RCE or the RCE's authorized representative, and has full authority to execute such orders or directions without delay. Furnish such superintendence irrespective of the amount of work sublet.

105.6 Cooperation with Utilities

- 1 The Department will endeavor to notify all utility companies, all pipe line owners, or other parties affected by the work, and endeavor to have all necessary adjustments of the public or private utility fixtures, pipe lines, and other appurtenances within or adjacent to the limits of construction, made as soon as practicable. The Contractor acknowledges that the SCDOT is unable to definitely identify or locate all utilities that may be present and that the SCDOT is unable to control the timing or method of relocation. Accordingly, the Contractor accepts all risks associated with any utilities that may affect the work. If utility issues delay the critical path of the project, the Contractor may be entitled to a time extension, but under no circumstances shall THE Contractor be entitled to additional compensation.
- 2 Water lines, gas lines, wire lines, sewer lines, water and gas meter boxes, water and gas valve boxes, manholes, light standards, cableways, signals, and all other utility appurtenances within the limits of the proposed construction requiring relocation or adjustment will be moved or adjusted by the utility owners under separate Agreement except as otherwise indicated in the Special Provisions, on the Plans, or as otherwise specified in **Subsection 202.2**.
- 3 The Plans will endeavor to show all known utilities located within the limits of the project according to information obtained. The accuracy of the Plans in this respect is not guaranteed by the Department. In the bid, consider all of the permanent and temporary utility appurtenances in their present or relocated position. No additional compensation is allowed for any delays, inconveniences, or damage of any kind sustained by the Contractor due to any interference from utility appurtenances, delays in relocation of utilities, or the operation of moving them.
- 4 Unless otherwise provided, the cost of temporary rearrangement of utilities made only in order to facilitate the construction of the work is borne by the Contractor.

105.7 Cooperation between Contractors

- 1 Where work is being performed for the Department by a Contractor and is continuous to or within the limits covered by another contract, the respective

rights of the various interests involved is determined by the RCE to secure the earliest practicable completion of the work.

- 2 When the Department awards separate contracts for work within the same project limits, conduct work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. The Contractor assumes all liability, financial or otherwise, in connection with the Contract and protects and saves harmless the Department from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced because of the presence and operations of other Contractors working within the same project limits. The Contractor is responsible for all work not completed or accepted despite the presence and operations of the other Contractors.
- 3 Whenever road and bridge projects are let separately and the limits of one project are included within or adjacent to the limits of the other project, the bridge Contractor has prior rights at the bridge site or sites for a reasonable period. Such prior rights permit the bridge Contractor to store materials and equipment within reasonable spaces, and to do the necessary hauling and other incidental work as the RCE determines. This condition of priority does not serve to release the road Contractor from its obligation to construct or maintain the bridge approaches unless all other roadwork is completed before the bridgework has progressed to a stage where the approach work can be performed to the satisfaction of the RCE. If practicable in the opinion of the RCE, the bridge Contractor may be required, at its expense, to locate or relocate its materials and equipment in order to permit construction of the approaches.
- 4 Wherever the RCE considers it desirable to clear and grub the right-of-way at the bridge site, or to construct bridge approaches before the construction of the bridge ends, or to complete bridge ends before other parts of bridgework, do such work when directed by the RCE.

105.8 Construction Stakes, Lines, and Grades

105.8.1 Construction Stakes, Lines, and Grades Partially Provided by the Department

- 1 Unless otherwise specified, the RCE will set construction stakes as necessary to establish lines, slopes, continuous profile-grade, centerline of roadway, centerline of piers and abutments, a bench mark adjacent to the work, and vertical control elevations for flow lines, footings, caps, bridge seats, screed elevations, etc. In addition, the RCE will furnish the Contractor with all necessary information relating to lines, slopes, and grades. Using the control lines and grades established by the RCE, the Contractor is responsible for completing the layout and performing the work.
- 2 The Contractor is responsible for the accuracy of transfer from the control lines, grades, and layout of the work. The Contractor is also responsible for the preservation of all stakes and marks. If any of the construction stakes or marks are carelessly or willfully destroyed or disturbed by the Contractor or its

105.8.1

105.8.2

employees, the cost to the Department of replacing them is charged against the Contractor and is deducted from payment for the work.

- 3 Furnish, free of charge, all guard stakes, templates, straightedges and other devices necessary for checking, marking, and maintaining points, lines, and grades.
- 4 The Department is responsible for the accuracy of control lines and grades established by the RCE. In case of error in the establishment of the original construction or survey stakes set by the RCE, which is discovered after the work has been fully or partially completed in compliance with the erroneous stakes, the Contractor will be paid for such additional work as may be required because of such error at the contract unit price for the work involved.
- 5 When requested on bridge projects, furnish assistance to obtain points and elevations during construction of the project. Such assistance is that usually furnished by holding a survey rod.

105.8.2 Construction Stakes, Lines, and Grades Provided by the Contractor

- 1 Provide all the layouts necessary to construct the elements of the project and accommodate all utility relocations. The Department will provide adequate reference points to the centerline of survey and bench marks as shown on the Plans or as provided by the RCE. Any additional control points set by the Department will be identified in the field and documented in writing to the Contractor. Keep the field notes in the RCE's office.
- 2 Provide field personnel and set all additional stakes for the project, which are needed to establish offset stakes, reference points, and any other horizontal or vertical controls, including supplementary bench marks necessary to secure a correct layout of the work. Make certain that project stakes have the station number clearly visible. The Contractor is not required to determine the property line between properties.
- 3 Ensure that all computations of survey work required in the execution of this project are performed by a Land Surveyor or Professional Engineer registered in South Carolina. Make certain that these computations are accompanied by the designated LS or PE seal and signature.
- 4 The Contractor is responsible for ensuring that the finished work substantially conforms to the lines, grades, elevations, and dimensions called for in the Plans or as provided by the RCE. Any inspection or checking of the Contractor's layout by the RCE and the acceptance of all or part of it does not relieve the Contractor of the responsibility to secure the proper dimensions, grades, and elevations of the several parts of the work. Exercise care in the preservation of stakes and benchmarks and have them reset at no additional expense when any are damaged, lost, displaced, or prematurely removed. Use competent personnel and suitable equipment for the layout work required. Do not engage the services of any person or persons in the employ of the Department for the performance of any work covered by this item.

105.8.2

105.8.3

- 5 The RCE will make random checks of the Contractor's staking to determine if the work is in substantial conformance with the plans. Where the Contractor's work ties into work that is being done or will be done by others, checks will be made to determine if the work is in conformance with the proposed overall grade and horizontal alignment. For bridge projects, provide bridge deck grades to the RCE for review before placing deck forms.
- 6 If during the course of staking or construction work unforeseen utilities and/or field conditions arise, which conflict with construction as shown in the Plans, notify the RCE immediately. The RCE will review the Contractor's findings and adjust the lines and grades accordingly or arrange for the utility to relocate its facilities. The resulting adjustments will be provided to the Contractor so that its survey crew can adjust the staking. Adjusted staking as described above is considered a normal consequence of construction. No additional compensation is due to the Contractor for this work or for any delays due to adjustments to the staking.
- 7 The quantity for the item Construction Stakes, Lines, and Grades is measured by each (EA) project site where the layout work is complete and accepted by the RCE.
- 8 The payment for each portion of this item in the project is proportional to the amount of the relevant work completed. In no case will the sum of all payments for this item exceed the total bid amount for Construction Stakes, Lines, and Grades, which payment is full compensation for all material, labor, equipment, tools, supplies, transportation, and incidental work, including computations necessary to satisfactorily complete the work.
- 9 The payment includes all direct and indirect costs and expenses required to complete the work.
- 10 Pay items under this subsection include the following:

Item No.	Pay Item	Unit
105080X	Construction Stakes, Lines, and Grades	EA

105.8.3 Construction Stakes, Lines, and Grades Provided by the Contractor for Bridge(s) Only

- 1 Provide all the layouts necessary to construct the bridge elements of the project. The Department will provide adequate reference points to the centerline of survey and bench marks as shown in the Plans or as provided by the RCE. Any additional control points set by the Department will be identified in the field and documented in writing to the Contractor. Keep the field notes in the RCE's office.
- 2 Provide field personnel and set all additional stakes for the bridge elements of this project, which are needed to establish offset stakes, reference points, and any other horizontal or vertical controls, including supplementary benchmarks necessary to secure a correct layout of the work. The Contractor is not

required to determine the property line between properties.

- 3 Ensure that all computations of survey work required in the execution of this project are performed by a Land Surveyor or Professional Engineer registered in South Carolina. Make certain that these computations are accompanied by the designated LS or PE seal and signature.
- 4 The Contractor is responsible for ensuring that the finished work substantially conforms to the lines, grades, elevations, and dimensions called for in the Plans or as provided by the RCE. Any inspection or checking of the Contractor's layout by the RCE and the acceptance of all or part of it does not relieve the Contractor of the responsibility to secure the proper dimensions, grades, and elevations of the several parts of the work. Exercise care in the preservation of stakes and benchmarks and have them reset at no additional expense when any are damaged, lost, displaced, or prematurely removed. Use competent personnel and suitable equipment for the layout work required. Do not engage the services of any person or persons in the employ of the Department for the performance of any work covered by this item.
- 5 Verify that the minimum vertical and horizontal clearance as shown on the Plans will be met before bridge construction begins at the site. Also, for railroad crossings, verify to the RCE in writing that the tops of rail grades as shown on the Plans are correct. Further, take actual measurements and submit to the RCE in writing when bridge substructure and superstructure elements are in place to confirm minimum clearances have been met.
- 6 The RCE will make random checks of the Contractor's staking to determine if the work is in substantial conformance with the Plans. Where the Contractor's work ties into work that is being done or will be done by others, checks will be made to determine if the work is in conformance with the proposed overall grade and horizontal alignment. Provide bridge deck grades to the RCE for review before placing deck forms.
- 7 If during the course of staking or construction work unforeseen utilities and/or field conditions arise that conflict with construction as shown in the Plans, immediately notify the RCE. The RCE will review the Contractor's findings and adjust the lines and grades accordingly or arrange for the utility to relocate its facilities. The resulting adjustments will be provided to the Contractor so that its survey crew can adjust the staking. Adjusted staking as described above is considered a normal consequence of construction. No additional compensation is due to the Contractor for this work or for any delays due to adjustments to the staking.
- 8 The quantity for the item Construction Stakes, Lines, and Grades (For Bridge Only) is measured by each (EA) project site where the layout work is complete and accepted by the RCE.
- 9 The payment for this item is proportional to the amount of the relevant work completed. In no case will the sum of all payments for this item exceed the total bid amount for Construction Stakes, Lines, and Grades (For Bridge Only), which payment is full compensation for providing all material, labor,

equipment, tools, supplies, and incidental work, including computations, necessary to satisfactorily complete the work.

10 The payment includes all direct and indirect costs and expenses required to complete the work.

11 Pay items under this subsection include the following:

Item No.	Pay Item	Unit
105081X	Construction Stakes, Lines, And Grades (For Bridge Only)	EA

105.9 Authority and Duties of the RCE's Representatives

1 Authorized representatives of the RCE may inspect all work done and all materials furnished. Such inspection may extend to all or part of the work and to the preparation, fabrication, or manufacture of the material to be used. However, such inspection does not relieve the Contractor of any responsibility or obligation to perform the work strictly in accordance with the requirements of the Contract. The RCE's representative has the authority to reject defective material and to suspend any work that is being improperly performed subject to the final decision of the RCE. The RCE's representative is not authorized to alter or waive the provisions of the Contract, to approve or accept any portion of the work, or to issue instructions contrary to the Plans and the Specifications. In no case will the RCE's representative act as superintendent or perform other duties for the Contractor or interfere with the management of the work by the Contractor's superintendent. Do not construe advice given by the RCE's representative as in any way binding on the RCE or the Department or as releasing the Contractor from the fulfillment of the terms of the Contract.

105.10 Inspection of the Work

1 Furnish the RCE with every reasonable facility for ascertaining whether or not the work as performed and materials used are in accordance with the requirements and intent of the Contract. At any time before final acceptance of the work, remove or uncover such portions of the finished work as directed by the RCE. After examination by the RCE, restore said portions of the work to the standard required by the Specifications. Should the work thus exposed and examined prove acceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed will be paid for as Extra Work; but should the work so exposed and examined prove unacceptable, the uncovering or removing and replacing of the covering or making good the parts removed will be at the Contractor's expense. Any work done or materials used without the knowledge or inspection by the RCE or the RCE's representative may be ordered removed and replaced at the Contractor's expense. Failure to reject any defective work or material does not in any way prevent later rejection when such defect is discovered, nor does it obligate the Department to final acceptance.

- 2 When a unit of government or political subdivision, public utility company, or railroad company is to pay a portion of the cost of the work covered by the Contract, its respective representatives have the right to inspect the work. Such inspection does not make the unit of government or political subdivision, public utility company, or railroad company a part of the Contract and in no way interferes with the rights of the parties hereunder.

105.11 Removal of Unacceptable and Unauthorized Work

- 1 All work that does not conform to the requirements of the Contract is considered unacceptable unless otherwise determined to be acceptable under the provisions in **Subsection 105.3**.
- 2 Immediately remove unacceptable work, whether it is the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause found to exist before the final acceptance of the work and replace in an acceptable manner.
- 3 Where lines and grades are necessary, do no work without lines and grades given by the RCE. Work done contrary to the instructions of the RCE, work done beyond the lines shown on the Plans or as given except as herein specified or any Extra Work done without authority is considered as unauthorized and will not be paid for under the provisions of the Contract. Work so done may be ordered removed or replaced at the Contractor's expense.
- 4 Upon failure to comply immediately with any order of the RCE made under the provisions of this subsection, the RCE has the authority to cause unacceptable work to be corrected or removed and replaced, or unauthorized work to be removed and the cost of such work to be deducted from any monies due or that may become due to the Contractor. In case no monies are due or available, the expenses so incurred will be charged against the Contractor's Surety.

105.12 Load Restriction

- 1 Comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the project. Obtaining a special permit does not relieve the Contractor of liability for damage, which results from the moving of materials or equipment.
- 2 Do not operate equipment of such weight or so loaded as to cause damage to structures or the roadway or to any other type of construction. Hauling of materials over the base course or surface course under construction is limited as directed by the RCE to prevent damage to any portion of the pavement structure. Do not place any loads on a concrete pavement, base course, or structure before the expiration of the curing period. Do not place loads on a Portland cement stabilized base before the placing of the pavement unless otherwise directed by the RCE. Do not exceed legal load limits unless permitted in writing by the authority having jurisdiction over the road being used. Off-road equipment for hauling borrow or other material on the project will not be permitted on the road on which the public is traveling without written per-

mission from the RCE.

105.13 Failure to Maintain Roadway or Structure

- 1 If at any time the Contractor fails to comply with the provisions of **Subsection 104.7**, the RCE will immediately notify the Contractor of such non-compliance. If the Contractor fails to remedy the unsatisfactory maintenance within 24 hours after receipt of such notice, the RCE may immediately proceed to maintain the project, and the entire cost of this maintenance will be deducted from monies due or that may become due to the Contractor on the Contract.

105.14 Termination for Convenience

- 1 By written order, the Department may terminate the Contract or any portion thereof after determining that termination is in the public interest. Such reasons for termination include, but need not be limited to, the following:
 - Executive Orders of the President of the United States relating to prosecution of war or national defense;
 - National Emergency that creates a serious shortage of materials;
 - Insufficient funds by the Department due to extenuating circumstances;
 - Orders from duly constituted authorities relating to energy conservation; or
 - Restraining orders or injunctions obtained by third-party citizen action resulting from national or local environmental protection laws or where the issuance of such order or injunction is primarily caused by acts or omissions of persons or agencies other than the Contractor.
- 2 When the Department orders "Termination for Convenience" of a contract effective on a certain date, all completed items of work as of that date will be paid for at the contract bid price. Payment for partially completed work is made at agreed prices or by Force Account methods described elsewhere in these specifications. Items that are eliminated in their entirety by such termination are paid for as provided in **Subsection 109.6**.
- 3 Acceptable materials, obtained by the Contractor for the work, but which have not been incorporated therein, may, at the option of the Department, be purchased from the Contractor at actual cost delivered to a prescribed location or otherwise disposed of as mutually agreed.
- 4 After receipt of Notice of Termination for Convenience from the Department, submit, within 60 days of the effective termination date, a claim for additional damages or costs not covered above or elsewhere in these specifications. Such claim may include such cost items as:
 - Reasonable idle equipment time,
 - Mobilization efforts,
 - Bidding and project investigative costs,

- Overhead expenses attributable to the project termination,
- Actual idle labor cost if work is stopped in advance of termination date, and
- Guaranteed payments for private land usage as part of original Contract.

In no event will the loss of anticipated profits be allowed as damages.

5 Make cost records available to the extent necessary to determine the validity and amount of each item claimed.

6 Termination of a contract or portion thereof does not relieve the Contractor of its contractual responsibilities for the work completed, nor does it relieve the Surety of its obligation for and concerning any just claims arising out of the work performed.

105.15 Acceptance and Final Inspection

105.15.1 Partial Acceptance

1 If at any time during the prosecution of the Contract the Contractor completes a bridge, segment of the project, or section of such length that, in the opinion of the RCE, is sufficient to justify an inspection, a final inspection of that bridge, segment, or section may be made. If upon inspection the RCE finds that the work has been satisfactorily completed in compliance with the Contract, the RCE may accept that bridge, segment, or section as being completed, and the Contractor is relieved of further maintenance on that portion of the work in the Contract.

105.15.2 Final Acceptance

1 When the RCE deems that the project has reached substantial completion, the RCE will promptly make an inspection. If all construction provided for and contemplated by the Contract is found to be completed to the RCE's satisfaction, that inspection constitutes the final inspection, and the RCE notifies the Contractor in writing of final acceptance after all the provisions of paragraph 5 in **Subsection 104.7** have been completed.

2 If the work is not acceptable to the RCE at the time of such inspection, the Contractor is advised as to the particular corrective work to be performed before final acceptance.

105.16 Claims for Adjustment and Disputes

105.16.1 General

1 Whenever the Contractor believes that it is or will be entitled to additional compensation for any reason, follow the procedures set forth in this subsection.

105.16.2 Delay Claims

1 The term "*delay*" means any event, action, force, or factor that extends the Contractor's time of performance. This subsection is intended for all such

events, actions, forces, or factors, whether they be styled "delay," "disruption," "interference," "impedance," "hindrance," or otherwise. Do not compute delay damages on any basis other than the original contract completion date as properly adjusted for time extensions granted.

- 2 Within 15 days after determining that a delay has occurred, give the Department written notice of the intention to file a claim for delay damages. Submit notification to the Department on SCDOT Form No. 100.04, *Contractor Notice of Claim*.
- 3 The Department has no liability for any delay damages that accrued more than 15 days before the filing of such notice. Failure of the Contractor to give such written notice in a timely fashion is grounds for denial of the claim.
- 4 The Contractor agrees that the failure to give notice will prejudice the Department and further agrees that the Department's conduct does not constitute a waiver of this contractual notice requirement.
- 5 Compliance with the provisions of this subsection is a condition precedent to any recovery of delay damages by the Contractor.
- 6 After giving the Department notice of intention to file a claim for delay damages, keep separate daily records of all labor, material, and equipment costs incurred for operations affected by the delay. The daily records must identify each operation affected by the delay.
- 7 On a monthly basis after giving notice of intention to file a claim for delay damages, prepare and submit to the Department's representative, written reports providing the following information:
 - A. Potential effect to the schedule caused by the delay,
 - B. Identification of all operations that the Contractor claims have been delayed, or will be delayed,
 - C. Explanation of how the Department's act or omission delayed each operation and an estimation of how much time is required to complete the project, and
 - D. Itemization of all extra costs incurred, including:
 - An explanation as to how these extra costs relate to the delay and complete details of the Contractor's method of measurements, calculations, and resultant quantifications,
 - Identification of all project employees for whom the Contractor seeks additional compensation, and
 - Identification by make, model, and manufacturer's number of all items of equipment for which the Contractor seeks additional compensation.
- 8 When the status of the information or condition of Items A, B, C, or D above is unchanged from the previous report, it is sufficient for the Contractor to so state, in writing, "*The status is unchanged from the previous report,*" and specify the date of the previous report.

105.16.3 Claims for Acceleration

- 1 The Department has no liability for construction acceleration. If the Department gives express written direction to the Contractor to accelerate its effort, then both parties execute a Change Order as defined in **Subsection 101.3.10**.

105.16.4 Other Claims

- 1 If the Contractor believes that it is entitled to additional compensation for reasons other than delay or acceleration, notify the RCE in writing of its intent to claim such additional compensation before beginning or proceeding further with the work, out of which such claim arises. Submit notification to the Department on SCDOT Form No. 100.04, Contractor Notice of Claim. If such notification is not given, the Contractor waives its right to any additional compensation.
- 2 The liability of the Department for such claims is limited to those items of damages that are specifically identified as payable in connection with delay claims as set forth in **Subsection 105.16.5**. For such claims, the Department has no liability for those items of damages identified as not payable in connection with Delay Claims as set forth in **Subsection 105.16.6**.

105.16.5 Recoverable Damages

- 1 Only the following items may be recovered by the Contractor with respect to Delay Claims or other claims. The Department has no liability for damages beyond the following items:
 - A. Additional job site labor expenses.
 - B. Documented additional costs for materials.
 - C. Equipment costs, as determined in accordance with this subsection.
 - D. Documented costs of extended job site overhead.
 - E. An additional 10% of the total of items A, B, C, and D above, for home office overhead and profit; however, this amount will not exceed the anticipated margin for home office overhead and profit provided for in the Contractor's original bid. Additionally, home office overhead margins paid to the Contractor included in Change Orders are considered as partial or final compensation for these costs.
 - F. Bond costs.
 - G. Subcontractor costs determined by and limited to those items identified as payable under items A, B, C, D, E, and F above.
- 2 For purposes of computing extra equipment costs, rates used are based on the Contractor's actual costs for each piece of equipment. These rates must be supported by equipment cost records furnished by the Contractor. Equipment rates will not be allowed in excess of those in the *Rental Rate Blue Book* with the appropriate adjustments noted in **Subsection 109.5**. The stand-by rate is 50% of the operating rate.

105.16.6 Non-Recoverable Damages

- 1 The parties agree that, in any claim for damages, the Department has no liability for the following items of damages or expense:
- A. Profit in excess of that provided in item E of **Subsection 105.16.5**.
 - B. Loss of profit.
 - C. Labor inefficiencies.
 - D. Home office overhead in excess of that provided in item E of **Subsection 105.16.5**.
 - E. Consequential damages including, but not limited to, loss of bonding capacity, loss of bidding opportunities, and insolvency.
 - F. Interest and any other indirect costs or expenses of any nature other than those allowable under item D of **Subsection 105.16.5**.
 - G. Attorneys' fees, claims preparation expenses, or costs of litigation.
 - H. Prejudgment interest on any amounts the Contractor may be found to be entitled for any claim.

105.16.7 Required Contents of Claims

- 1 Submit all claims in writing and in sufficient detail to enable the RCE to ascertain the basis and the amount of each claim. All information submitted to the Department under this subsection is used solely for analyzing and resolving the claim. At a minimum, provide the information opposite a checkmark (✓) in the following table.

Documentation Required with Claims		
For Delay Claims	For Other Claims	Required Documentation
✓		A. A description of the operations that were delayed, the reasons for the delay, how they were delayed, including the report of all scheduling experts or other consultants, if any.
✓		B. An As-Built chart, CPM schedule or other diagram depicting in graphic form how the operations were adversely affected, and may be required to submit a full electronic version of the CPM.
	✓	C. A detailed factual statement of the claim providing all necessary dates, locations and items of work affected by the claim.
✓	✓	D. The date on which actions resulting in the claim occurred or conditions resulting in the claim became evident.

(table continued on the next page)

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Documentation Required with Claims		
✓	✓	E. A copy of the SCDOT Form 100.04, <i>Contractor Notice of Claim</i> filed for the specific claim by the Contractor.
✓	✓	F. The name, function, and activity of each Department official or employee, involved in, or knowledgeable about facts that give rise to such claim.
✓	✓	G. The name, function, and activity of each Contractor or subcontractor official or employee, involved in, or knowledgeable about facts that gave rise to such claim.
	✓	H. The specific provisions of the Contract that support the claim and a statement of the reasons why such provisions support the claim.
✓	✓	I. The identification of any pertinent documents, and the substance of any material oral communication relating to such claim.
✓	✓	J. A statement as to whether the additional compensation or extension of time sought is based on the provisions of the Contract or an alleged breach of contract.
✓	✓	K. The amount of additional compensation sought and a breakdown of that amount into the categories specified as payable under Subsection 105.16.5 above.
✓	✓	L. If an extension of time is also sought, the specific days for which it is sought and the basis for such claim as determined by an analysis of the construction schedule. If a schedule is not required for the Contract, the request for time is analyzed based on other documentation as required in this subsection.

105.16.8 Required Certification of Claims

- 1 When submitting the claim, certify in writing and under oath in accordance with the formalities required by South Carolina law as to the following:
 - A. The claim is made in good faith.
 - B. Supportive data is accurate and complete to the Contractor's best knowledge and belief.
 - C. The amount of the claim accurately reflects what the Contractor in good faith believes to be the Department's liability.

- 2 Use the CERTIFICATE OF CLAIM form, which can be obtained from the Department, in complying with these requirements.

105.16.9 Auditing of Claims

- 1 All claims filed against the Department are subject to audit at any time following the filing of such claim, whether or not such claim is part of a suit pending in the courts of this State. Further, the Department has the right to audit the Contractor's records at any time during the project and up to 3 years after final completion of the project regardless of whether or not a claim is pending. The audit may be performed by employees of the Department or by an independent auditor appointed by the Department. The audit may begin after 10 days notice to the Contractor, subcontractors, and suppliers. The Contractor, subcontractors, and suppliers shall cooperate with the auditors. Failure of the Contractor, subcontractors, and suppliers to maintain and retain sufficient records to allow the Department's auditor to verify the claim constitutes a waiver of that portion of such claim that cannot be verified and bars recovery thereunder. If the Contractor fails to make all documents requested by the Department or its Consultants available within 10 days of request, then the Contractor shall be responsible for all of the Department's audit costs.
- 2 Without limiting the generality of the foregoing, and as a minimum, make the following documents available to the auditors:
- A. Daily time sheets and superintendent's daily reports;
 - B. Union agreements, if any;
 - C. Insurance, welfare, and benefits records;
 - D. Payroll Register;
 - E. Earnings records;
 - F. Payroll tax returns;
 - G. Material invoices, purchase orders, and all material and supply acquisition contracts;
 - H. Material cost distribution worksheet;
 - I. Equipment records (list of company equipment, rates, etc.);
 - J. Vendor rental agreements and subcontractor invoices;
 - K. Subcontractor payment certificates;
 - L. Canceled checks (payroll and to vendors);
 - M. Job Cost Report;
 - N. Job Payroll Ledger;
 - O. General Ledger, General Journal, (if used) and all subsidiary ledgers and journals together with all supporting documentation pertinent to entries made in these ledgers and journals;
 - P. Cash Disbursements Journal;
 - Q. Financial statements for all years reflecting the operations on this project;

- R. Income tax returns for all years reflecting the operations on this project;
- S. Depreciation records on all company equipment whether such records are maintained by the company, its accountant, or others;
- T. If a source other than depreciation records is used to develop costs for the Contractor's internal purposes in establishing the actual cost of owning and operating equipment, all such source documents;
- U. All documents which reflect the Contractor's actual profit and overhead during the years this project was being performed and for each of the 5 years before the commencement of this project;
- V. All documents related to the preparation of the Contractor's bid including the final calculations on which the bid was based unless such documents are placed in escrow under other provisions of the Contract;
- W. All documents that relate to each and every claim together with all documents that support the amount of damages as to each claim;
- X. Worksheets used to prepare the claim and establishing the cost components for items of the claim including, but not limited to, labor, benefits and insurance, materials, equipment, subcontractors, and all documents, which establish the time periods, individuals involved, the hours, and the rates for the individuals;
- Y. All documents relating to project schedules including, but not limited to, all electronic scheduling data, data bases, updates, interim schedules, look ahead schedules, and scheduling programs; and
- Z. Any and all electronic data relating in any way to the project.

105.16.10 Remedies Exclusive

- 1 The parties agree that the Department has no liability to the Contractor for expenses, costs, or items of damage other than those that are specifically identified as payable under this subsection. In the event any legal action is instituted against the Department by the Contractor because of any claim for additional compensation, whether because of delay, acceleration, breach of contract, or otherwise the Contractor agrees that the Department's liability is limited to those items that are specifically identified as payable in this subsection. The statute of limitations for any legal action against the Department commences on the date of Final Acceptance by the RCE or one year after substantial completion of work, whichever comes first.

105.17 General Design Features

- 1 Whenever the Contractor is called upon to furnish details of the design not shown on the Plans, or otherwise specifically covered herein and whenever any requirements of the Plans or the Specifications are in any way ambiguous or uncertain as to meaning, it is mutually understood and agreed that the standards of good practices as set forth in the specifications of AASHTO govern.

SECTION 106

CONTROL OF MATERIAL

106.1 Source of Supply and Quality of Materials

- 1 The source of supply of the materials specified may be required to be approved by the RCE before delivery is started. Submit preliminary, representative samples as directed by the RCE. Use only materials in the work conforming to the requirements of these specifications and approved by the RCE. In some cases, the RCE or the OMR authorized representative may approve material at the source before delivery is started. If it is found that sources of supply previously approved do not furnish a uniform or satisfactory product or if the product from any source proves unacceptable at any time, furnish approved materials from other approved sources and immediately remove any and all rejected materials from the job site. Do not use in the work any material that has become unfit for use in any way.
- 2 All policy sheets and approval sheets referenced to hereinafter are available from the Department's website at the following website:

http://www.scdot.org/doing/rm_lab.asp

or from the OMR at the following address:

Office of Materials and Research
South Carolina Department of Transportation
Post Office Box 191
Columbia, SC 29202

- 3 When materials are required for the work, but are not specifically covered in the Specifications, ensure that such materials meet the requirements of the AASHTO specifications that were current on the date bid proposal was advertised. If the materials are not covered in the AASHTO specifications, ensure that such materials meet the requirements of the ASTM specifications that were current on the date bid proposal was advertised.

106.2 Local Material Sources

- 1 Sources of local materials, which the Department will acquire and make available to the Contractor, may be designated on the Plans or by the RCE. If the Contractor desires to use materials from sources other than those designated, acquire the necessary rights to take materials from those sources and pay all costs related thereto, including any that result from an increase in length of haul.

106.3 Samples and Tests

- 1 Provide materials samples for testing at no cost to the Department.
- 2 Ensure that all materials proposed for use in the construction of the work are properly examined, tested, and approved by the RCE before being incorporated into the work. Any work in which such materials are used without prior testing and approval or written permission of the RCE is performed at

the Contractor's risk and may be considered defective, unauthorized, and not accepted for payment. Testing is done by and at the expense of the Department unless otherwise noted in the Specifications or other contract documents. Tests are performed in accordance with the methods prescribed in the *AASHTO Standard Specifications for Highway Materials and Methods of Sampling and Testing* and interims that were current on the date that bid proposals were advertised. In cases where no method of testing is prescribed therein, the tests are performed in accordance with the methods prescribed by the applicable ASTM specifications, OMR Standard Method of Testing, or other specifications current on the date that bid proposals were advertised. Materials to be used in the work may be inspected or tested at any time during their manufacture, preparation, or use.

106.4 Plant Inspection

- 1 The RCE or the OMR authorized representative may undertake the inspection of materials at the source.
- 2 If plant inspection is undertaken by the RCE or the OMR authorized representative, ensure that the following conditions are met:
 - A. The Department's inspector has the cooperation and assistance of the Contractor and the producer, with whom the Contractor has contracted for materials, and furnishes, free of charge, all reasonable and required facilities to assist in determining if the materials meet the requirements of the Specifications.
 - B. The Department's inspector has full entry at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished.
 - C. Adequate safety measures are provided and maintained.
- 3 Materials tested and accepted at the source of supply may be re-tested at the Department's discretion. If materials are re-tested and they do not meet the requirements of the Specifications, they may be rejected.

106.5 Field Laboratory

- 1 If required, provide a field laboratory for the Department's inspector, and ensure that it is fully equipped in accordance with the applicable specifications at no expense to the Department.

106.6 Storage of Materials

- 1 Store materials to ensure the preservation of their quality and fitness for the work. When considered necessary, place materials on wooden platforms or other hard, clean surfaces, but not directly on the ground, and place under cover when directed. Locate stored materials to facilitate proper inspection. Keep different kinds and sizes of aggregates separate during transportation, handling, and storage until used. If necessary, construct partitions of suitable height and strength between stockpiles to prevent different materials from becoming mixed. Do not permit the inclusion of any foreign material.

- 2 Subject to the approval of the RCE, portions of the right-of-way may be used for storage purposes and for the placing of the Contractor's plant and equipment. Provide any additional space required at the Contractor's expense. Do not use private property for storage purposes without written permission of the owner or lessee and furnish copies of such written permission to the RCE. Restore all storage sites to their original condition without additional compensation.

106.7 Handling Materials

- 1 Handle all materials in such manner to preserve their quality and fitness for the work. Transport aggregates from the storage site to the work in tight vehicles constructed to prevent loss or segregation of materials. Ensure that there are no inconsistencies in the quantities of materials intended for incorporation in work as loaded and measured, and in the quantities as actually received at the place of operations.

106.8 Unacceptable Material

- 1 Reject all materials not conforming to the requirements of these specifications that are deemed defective, whether in place or not. Immediately remove unacceptable material from the project unless otherwise instructed by the RCE.
- 2 If the defects of the rejected materials have been subsequently corrected, do not use this material until approved by the RCE. If the Contractor fails or refuses to remove and replace defective materials, whether in place or not, or to make any necessary corrections in an acceptable manner and in accordance with the requirements of the Specifications within the time indicated in writing, the RCE has the authority to cause the unacceptable or defective materials or work to be removed and replaced or corrected. Any expense incurred by the Department in making these removals, replacements, or corrections, which the Contractor failed or refused to make, will be deducted from monies due or that may become due to the Contractor. If no such monies are available, the expense will be charged against the Contractor's Surety.

106.9 Material Guaranty

- 1 When required by the Specifications, provide the OMR or RCE with material certifications, manufacturer's test reports, and the required samples for items and materials to be permanently incorporated into the work. The samples may be subject to the tests provided for in the Specifications to determine their quality and fitness for the work. Provide the material certificates to the RCE before incorporating material into the work.
- 2 The OMR will provide the RCE with a list of the required certifications and manufacturer's test reports based on the pay items and the specifications pertaining to the Contract.

106.10 Material Pit Acquisition and Testing

- 1 When the Contractor is required to furnish materials from pits, the Contractor is responsible for obtaining any samples necessary for evaluating the pit material. The Department may furnish the necessary equipment and operator for drilling test holes at locations and to depths designated by the Contractor. The Department's furnishing of the drilling service is generally limited to the lesser of 2 test holes and 2 sample tests per acre or 2 tests per 16,000 CY of the planned quantity of material.
- 2 Obtain the previously mentioned samples of the drilled material and submit the samples to the OMR for appropriate tests.
- 3 These tests are made in accordance with standard testing procedures, and the test results are furnished by the Department to the Contractor for its information in evaluating the proposed pit sites. The Department assumes no responsibility in the testing services other than the accuracy of the test of the material furnished by the Contractor for testing.

106.11 Source of Production of Iron and Steel Products

- 1 On all federal-aid projects where steel or iron materials are used, all manufacturing processes for iron and steel material, including tie wire for reinforcing steel, must occur in the United States in accordance with 23CFR Section 635.410(b)(1)(ii). This requirement includes the application of coating for these materials. Coating includes all processes that protect or enhance the value of the material to which the coating is applied.

SECTION 107

LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.1 Laws to be Observed

- 1 Keep fully informed of, and at all times observe and comply with, all federal, state, and local laws, ordinances, regulations, and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the work or that in any way affect the conduct of the work or the execution of any documents in connection therewith. Protect and indemnify the Department and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by the Contractor or the Contractor's employees.
- 2 Execute and file such documents, statements, and affidavits required under any applicable federal or state law or regulation affecting the Contract or the prosecution of the work thereunder. Permit the examination of any records made subject to such examination by any federal or state law or by regulations promulgated thereunder by any state or federal agency charged with the enforcement of such law.

107.2 Permits, Licenses, and Taxes

- 1 Unless otherwise specified, obtain all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incident to the due and lawful prosecution of the work.

107.3 Patented Devices, Materials, and Processes

- 1 If the Contractor desires to use any design, device, material, or process covered by letter of patent or copyright, provide for such use by suitable legal agreements with the patentee or owner. However, whether or not such agreement is made, together with the Surety, indemnify and save harmless the Department, any affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material, process, trademark, or copyright in connection with the work agreed to be performed under the Contract. Indemnify the Department for all costs, expenses, and damages, which it may be obligated to pay because of any such infringement at any time during the prosecution of or after the completion of the work.

107.4 Restoration of Surfaces Opened by Permit

- 1 Any individual, firm, or corporation wishing to make an opening in the highway must secure a permit from the Department. The right to make openings, construct or reconstruct any utility service in the highway, or grant permits for it at any time is expressly reserved by the Department. The Contractor is not entitled to any damages either for the making of openings in the highway or for any delay occasioned thereby.

- 2 Allow parties bearing such permits, and only those parties, to make openings in the highway. When ordered by the RCE or RME, make all necessary repairs due to such openings in an acceptable manner. Such necessary work is paid for as Extra Work as provided for in these specifications and is subject to the same conditions as original work performed.

107.5 Federal Participation

- 1 When the United States government is to pay all or a portion of the cost of a project, observe the federal laws authorizing such participation and rules and regulations made pursuant to such laws. When any federal laws, rules, or regulations are in conflict with provisions of a federally assisted Contract, the federal requirements prevail. These requirements take precedence and are in force over and against any such conflicting provisions. The work is under the supervision of the Department, but subject to the inspection of the appropriate federal agency. Such inspection does not make the federal government a party to the Contract and does not interfere with the rights of either party hereunder.

107.6 Sanitary Health and Safety Provisions

- 1 Provide and maintain in a neat and sanitary condition such accommodations for the use of employees as necessary to comply with the requirements and regulations of the SCDHEC or of other authorities having jurisdiction.
- 2 Attention is directed to federal, state, and local laws, rules, and regulations concerning safety and health standards. Do not require any worker to work in surroundings or under conditions that are unsanitary, hazardous, or dangerous to their health or safety.
- 3 Comply with requirements pertaining to noise controls on equipment.

107.7 Air Pollution Control

- 1 Comply with the South Carolina Air Pollution Control laws, regulations, and standards as they concern the related work included in the Contract. Copies of the requirements may be obtained from the SCDHEC Bureau of Air Quality Control. Comply with county, municipal, or other regulations pertaining to air pollution.

107.8 Quarantine Regulations

- 1 Comply with the quarantine regulations of the Clemson University Division of Regulatory and Public Service Programs and the USDA for plant and insect pest control as they pertain to Witchweed, Imported Fire Ant, or any other insect pest quarantine. Keep informed as to the counties or areas within the State in which quarantine is imposed.
- 2 Soil and soil moving equipment operating in regulated areas is subject to plant and insect quarantine regulations. In general, these regulations provide for cleaning soil from equipment before it is moved from regulated areas. Complete information may be secured from the Division of Regulatory and Public Service Programs at Clemson University and the USDA. Addresses

for the USDA are as follows:

- | | |
|--|--|
| <p>3</p> <p>USDA, APHIS, PPQ
Room 513 Federal Building
334 Meeting Street
Charleston, SC 29403</p> <p>USDA, APHIS, PPQ
1030 St. Andrews Road,
Suite A-1
P. O. Box 21792
Columbia, SC 29210</p> <p>USDA, APHIS, PPQ
2102 Airport Road
Greer, SC 29651</p> <p>USDA, APHIS, PPQ
180 Airport Road, Suite F
Mullins, SC 29574</p> | <p>USDA, APHIS, PPQ
9600 Two Notch Road,
Suite 10
Columbia, SC 29229</p> <p>USDA, APHIS, PPQ
1949 Industrial Park Road,
Room 153
P. O. Box 762
Conway, SC 29526</p> <p>USDA, APHIS, PPQ
P. O. Box 12212
Greenville, SC 29612</p> <p>USDA, APHIS, PPQ
I-95 & Hwy. 68
P. O. Box 707
Yemassee, SC 29945</p> |
|--|--|

107.9 Public Convenience and Safety

- 1 At all times, conduct the work in such a manner as to reasonably provide for the safety and convenience of the traveling public and of the residents along and adjacent to the highway and to offer the least practicable obstruction to the flow of traffic. This provision does not require the Contractor to provide for the safety and convenience of the traveling public for those portions of the highway or roadway that are not within the scope and the work being performed by the Contractor as defined by the Contract. Do not close any bridge or culvert or any portion of the road to traffic until permission has been granted by the RCE.
- 2 When materials and equipment are stored within the right-of-way, place them to cause the minimum obstruction to the traveling public. Conform to the requirements for storage of material equipment in **Subsection 601.2.1**.

107.10 Construction of Bridges Over or Adjacent to Navigable Waters

- 1 Conduct all work over, on, or adjacent to navigable waters so that free navigation of the waterways is not interfered with and that the existing navigable depths are not impaired except as allowed by permit issued by the U.S. Coast Guard and/or the U.S. Army Corps of Engineers as applicable.
- 2 Provide and maintain such temporary navigation lights and signals as may be required by U.S. Coast Guard regulations for the protection of navigation. When, in the judgment of the RCE, the construction has reached a point where such action should be taken, promptly clear the channel or channels through the structure of all falsework, piling, or other obstructions placed

therein to the satisfaction of the U.S. Coast Guard. Complete such clearing before the acceptance of the project.

107.11 Traffic Control

- 1 The *FHWA Manual on Uniform Traffic Control Devices (MUTCD)* has been adopted as the official source for traffic control guidelines for SCDOT policies and procedures on installing and maintaining signs, markings, and signals in South Carolina. The *MUTCD* may be viewed online at the FHWA website at <http://mutcd.fhwa.dot.gov>. Execute the item Traffic Control as required by the Specifications, the Plans, and the current edition of the *MUTCD* adopted by the Department. Provide, erect, and maintain all necessary barricades, warning signs, lights, temporary signals, temporary striping, and other traffic control devices as required by the Specifications, the Plans, and the *MUTCD*. Perform this work without compensation unless bid items for such work are included in the Contract. The Contractor is not required to provide traffic control on any portion of the highway outside the scope of its work.
- 2 The Department will erect and maintain signs on detours or temporary routes that the Contractor is not required to maintain. Provide and maintain such signs at and along all detours for which the Contractor is responsible. Maintain and relocate, where necessary, all regulatory, warning, and guide signs in place of those that may be erected by the Department within the limits of the project.
- 3 The work as defined in the Contract is considered to have begun with the placing of permanent construction signs by the Contractor. The work is considered completed when the RCE authorizes the Contractor to remove the permanent construction signs and the Contractor does so. The RCE may permit the Contractor to omit permanent construction signs on low volume roads or streets where the work will be completed within the daylight hours of a single day. However, if the permanent construction signs are omitted, install temporary signs while the work is in progress.
- 4 Ensure that all barricades, signs, and traffic control devices conform to the requirements of the *MUTCD*. All signs in the *MUTCD* have been given an identification number, and a full-scale drawing of each sign is available for sign fabricators from the Director of Traffic Engineering.

107.12 Measurement and Payment for Traffic Control

- 1 The item Traffic Control is paid on a lump sum (LS) basis; and therefore, there is no specific measurement for this item. Payment is made on a percentage complete basis as specified in **Subsection 601.6**.
- 2 The payment for Traffic Control does not include payment for permanent construction signs, temporary concrete barrier, portable terminal impact attenuators, changeable message signs, pavement markings, temporary pavement markers, or any item specified as a bid item with a contract unit bid price in the Contract.

3 The pay item for Traffic Control is as follows:

Item No.	Pay Item	Unit
1071000	Traffic Control	LS

107.13 Correcting Low Shoulder Conditions

107.13.1 Identifying Existing Low Shoulders Before the Commencement of Work

1 Before the placement of the permanent construction signs and before the work commences on a resurfacing project, together with the RCE inspect the roads within the project to identify existing low shoulder conditions. The Contractor is responsible for placing low shoulder signs at the identified locations and for correcting the existing low shoulder conditions where possible by bringing in and spreading borrow material before starting the resurfacing work. Agree with the RCE on the time allowed to perform work on correcting the existing low shoulder conditions. The RCE will provide the Contractor with a written list of the specific areas identified as requiring low shoulder signs and additional work to correct low shoulder conditions and will also specify the time allowed to complete the work. The Contractor is paid for this work at the contract unit bid price for Borrow Excavation and Permanent Construction Signs in accordance with the requirements of **Sections 203 and 605** respectively.

107.13.2 Maintenance of Low Shoulder Signs During the Project

1 Maintain all low shoulder signs within the termini of the project until the low shoulder conditions have been corrected to the satisfaction of the RCE.

107.13.3 Work Related to Existing Low Shoulders

1 Within 3 working days of completion of the low shoulder correction work, the RCE will inspect the prescribed work and, if necessary, direct in writing, the placement of additional low shoulder signs or borrow material before the Contractor can commence paving operations. Once this low shoulder work is complete, no further corrective action is required by the Contractor until the road surface is paved unless the Contractor is directed to do so by the RCE.

107.13.4 Correction of Low Shoulders Created by Resurfacing

1 Upon completion of the final riding surface on each road, begin correcting low shoulder conditions within 3 days. Make reasonable efforts, weather permitting, to continue the work until the low shoulder conditions are eliminated to the satisfaction of the RCE. When necessary, correct low shoulder conditions greater than 2 inches by placing borrow material against the edge of the pavement or by such other method as directed by RCE.

2 When within 3 days of completing shoulder work on a roadway, notify the RCE. Within 3 working days of such notification, the RCE will inspect the prescribed work and, if necessary, will direct in writing the placement of addi-

tional borrow material.

107.14 Railway/Highway Provisions

- 1 If the Plans require that materials be hauled across the tracks of any Railway Company, arrange with the Railway Company for new crossings if required or for the use of existing crossings not within the system of public roads.
- 2 Perform all work on the railroad right-of-way at such times and in such manner as not to interfere with the movement of trains or traffic upon the track of the Railway Company. Use all care and precaution in order to avoid accidents, damage, delay, or interference with the Railway Company's trains or other property.
- 3 Reimburse the Railway Company directly under terms arranged with them for all charges by the Railway Company for the construction or use of new or existing private crossing and their subsequent removal and all charges for services of railroad personnel at such crossings. Make certain that all such payment is made to the Railway Company before the acceptance of the project.
- 4 Conduct all operations that occur on or over the right-of-way of any Railway Company fully within the rules, regulation, and requirements of the Railway Company and in accordance with any agreement made between the Department and the Railway Company, which is made a part of the Contract.

107.15 Use of Explosives

- 1 When the use of explosives is necessary for the prosecution of the work, exercise the utmost care not to endanger life or property, including the new work. The Contractor is responsible for all damage resulting from the use of explosives. Store all explosives in a secure manner in compliance with all laws, ordinances, and regulations.
- 2 Comply with all laws and ordinances, as well as with Title 29CFR, Part 1926, Safety and Health Regulations for Construction (OSHA), whichever is the most restrictive with respect to the use, handling, loading, transportation, and storage of explosives and blasting agents.
- 3 Notify each public utility company having structures in proximity to the work site of the intention to use explosives and give such notice sufficiently in advance to enable the companies to take such steps as they deem necessary to protect their property from injury. Such notice does not relieve the Contractor of responsibility for any damage resulting from blasting operations.

107.16 Preservation and Restoration of Property, Trees, Monuments, etc.

- 1 Do not enter upon private property for any purpose without first obtaining permission. The Contractor is responsible for the preservation of all public and private property, trees, crops, monuments, highway signs and markers, fences, etc. along and adjacent to the roadway. Use every precaution neces-

sary to prevent damage or injury thereto. Use suitable precaution to prevent damage to pipes, conduits, underground structures, poles, wires, cables, and other overhead structures, whether shown on the Plans or not. Protect from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location and do not remove them until directed. When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work or in consequence of the non-execution thereof on the part of the Contractor, restore, at no additional expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as may be directed or make good such damage in an acceptable manner. If the Contractor fails to restore such property, or make good such damage or injury, the RCE may, upon 48 hours notice, proceed to repair, build, or otherwise restore such property as may be deemed necessary, and the cost thereof is deducted from any monies due, or that may become due the Contractor under the Contract. If no such monies are available, the expenses so incurred are charged against the Contractor's surety.

- 2 If it is necessary to disturb or rearrange utility service connections or other property belonging to others in order to adapt such property to the new work, cooperate with the property owners in effecting the rearrangement by giving advance notice of the necessity for such rearrangement to the owners, providing temporary supports during the rearrangement, installing utility supporting devices in concrete formwork, and permitting access by the owners' personnel.

107.17 Forest Protection

- 1 In carrying out work within or adjacent to state or national forests, comply with all the regulations of the state or federal authority having jurisdiction governing the protection of forests and the carrying out of work within forests. Observe all sanitary laws and regulations with respect to the performance of work in forest areas. Keep the areas in an orderly condition and dispose of all refuse in accordance with regulations. Obtain permits for the construction and maintenance of all construction camps, stores, warehouses, latrines, cesspools, septic tanks and other structures in accordance with the requirements of the forest supervisor. Take all reasonable precautions to prevent and suppress forest fires. Abide by such rules and instructions as the forest officers may prescribe as to the time and place for burning and for fire control generally. Do not cut roadside timber outside the roadway, nor mar the scenic values of the right-of-way for any purpose whatsoever without consent of the RCE, who must obtain permission from the proper forest authority. The responsibility of the Contractor for damages as provided for in **Subsection 107.16** applies in case of damages caused by the escape of fire.

107.18 Responsibility for Claims, etc.

- 1 Indemnify and save harmless the County, the State, the Department, its officers, agents, and employees, as well as the City, the Town or other mu-

nicipality in which the work is performed and all of their officers, agents, and employees from all suits or claims of any character brought because of any injuries or damage received or sustained by any person, persons, or property, in whole or in part, because of the operations of the Contractor or any subcontractor or sub-subcontractor; or because of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials or workmanship in constructing the work; or because of any act or omission, neglect, or misconduct of the Contractor or any subcontractor or sub-subcontractor; or because of any claims or amounts recovered from any infringements of patent, trademark or copyright; or for failing to pay, when and as due, all bills and other legitimate charges, including lawful claims for labor performed or materials, equipment, and supplies furnished for use in and about the construction of the work under the Contract; or from any claims or amounts arising or recovered under the Workmen's Compensation Act, or any other law, ordinance, or decree. This indemnity obligation is intended to apply even if the County, the State, the Department, and their officers, agents, and employees are negligent and in part responsible for the injuries or damages. This indemnity obligation is not intended to apply if the County, the State, the Department, and their officers, agents and employees are solely responsible for the injuries or damages. Money due the Contractor under and by virtue of the Contract and is considered necessary by the Department may be retained for the use of the Department, or in case no money is due, the Contractor's Surety is held responsible until such suit or suits, action or actions, or claim or claims for injuries or damages as aforesaid have been settled and suitable evidence to that effect has been furnished the Department; except that money due the Contractor is not withheld when the Contractor produces satisfactory evidence that it is adequately protected by public liability and property damage insurance.

107.19 Third Party Liability

- 1 It is not intended by any of the requirements of any part of these specifications to make the public or any member thereof a third party beneficiary hereunder, or to authorize anyone who is not a party to a contract entered into pursuant to these specifications to maintain a suit for personal injury or property damage otherwise than as authorized and provided by law.

107.20 Opening of Section of Highway to Traffic

- 1 When, in the opinion of the RCE, any bridge, roadway, or portion thereof is in acceptable condition for travel, open it to traffic as directed. Such opening is not held to be in any way an acceptance of the bridge, roadway, or any part of it, or as a waiver of any of the provisions of the Contract. Pending completion and final acceptance thereof, perform any necessary repairs or renewals due to any cause other than ordinary wear and tear at no additional expense. If the construction of the project has not been completed and weather conditions require suspension of the laying of the surface courses or other work, open the incomplete portions of the work to traffic when directed by the RCE, and carry on maintenance of such incomplete sections. Make any repairs

necessary to incomplete sections without any additional compensation.

107.21 Contractor's Responsibility for the Work

- 1 Until final acceptance of the work by the RCE as evidenced in writing, the Contractor has the charge and care thereof. Take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause whether arising from the execution or from the non-execution of the work. Unless otherwise provided in these specifications, rebuild, restore, and make good all injuries or damages to any portion of the work occasioned by any cause before final acceptance and bear the expense thereof.
- 2 The Contractor is responsible to the Department for the acts and omissions of its employees, subcontractors and their agents and employees, and all other persons performing work under a contract with the Contractor or any of its subcontractors.
- 3 In the case of suspension of work from any cause whatever, the Contractor is responsible for all materials and unfinished work. Properly store materials; provide suitable drainage of the roadway; continue the servicing of barricades, lights, signs, and other devices; and erect necessary temporary structures without additional compensation.

107.22 Contractor's Responsibility for Utility Property and Services

- 1 Before commencing work, arrange to protect the properties of railway, telegraph, telephone, power companies, or other utility property from damage.
- 2 Cooperate with the utility owners in the removal and rearrangement of any underground or overhead utility lines or facilities to minimize interruption to service and duplication of work by the utility owners.
- 3 If utility services are interrupted because of accidental breakage, promptly notify the proper authority and cooperate with them until service has been restored. Do not commence work around fire hydrants until provisions for continued service have been made and approved by the local fire authority.
- 4 If a permit is issued to a city, county, or other governmental unit for the installation of conduits, poles, or other appurtenances for artificial lighting of the structure, it may be necessary or desirable to revise the Plans or make structural changes as needed to accommodate such installation, and the provisions of **Subsection 104.2** apply to any changes in quantities of work.

107.23 Furnishing Right-of-Way

- 1 The Department is responsible for the securing of all rights-of-way that it deems necessary in advance of construction. Any exceptions are indicated in the Bid Proposal and Contract.

107.24 Personal Liability of Public Officials

- 1 In carrying out the provisions of these specifications or in exercising power or authority granted to them by or within the scope of the Contract, there is no liability upon the Director, RCE, or Department employees who are their au-

thorized representatives either personally or as officials of the State; it being understood that in all such matters, they act solely as agents and representatives of the State.

107.25 No Waiver of Legal Rights

- 1 Upon completion of the work, the Department will expeditiously make final inspection and notify the Contractor of acceptance. Such final acceptance, however, does not preclude or estop the Department from correcting any measurement, estimate, or certificate made before or after completion of the work; nor is the Department precluded or estopped from recovering any overpayments that may have been made; nor is the Department precluded from recovering from the Contractor or its Surety, liquidated damages because of failure to fulfill its obligations under the Contract. A waiver on the part of the Department of any breach of any part of the Contract is not held to be a waiver of any other subsequent breach. Neither the inspection, nor acceptance by the Department or representative of the Department, nor payment for or acceptance of the whole or part of the work, nor extension of time, nor possession taken by the Department, operates as a waiver of any portion of the Contract or of any power herein reserved, or of any right to damages.

107.26 Environmental Protection and Water Pollution Control

- 1 Comply with all federal, state, and local laws and regulations controlling pollution of the environment. Take the necessary precautions to prevent pollution of streams, lakes, ponds, and reservoirs with fuel, oils, bitumens, chemicals, soil sedimentation, or other harmful materials and prevent pollution of the atmosphere from particulate and gaseous matter.
- 2 At the Preconstruction Conference or before the start of construction, submit in writing to the RCE for approval the schedule for accomplishment of temporary and permanent erosion control work as is applicable for clearing and grubbing, grading, bridges and other structures in watercourses, and paving. Do not allow the amount of surface area of erodible earth material exposed at one time by clearing and grubbing, excavation, borrow, or fill, to exceed 750,000 square feet without prior approval by the RCE. Consider the location of the project, nature of the soil, topographic features, and proximity to watercourses when setting such limitations.
- 3 Conduct operations in a manner consistent with good erosion control practices to minimize soil erosion and to the extent practicable, prevent sediment from leaving the site. Take whatever measures necessary throughout the life of the project to control erosion and to prevent the deposition of sediment into adjacent rivers, streams, wetlands, and impoundments. Carry out temporary and permanent erosion control measures that control erosion and sedimentation in conjunction with clearing and grubbing and earthwork operations.
- 4 Provide temporary erosion and sediment control measures such as berms, dikes, slope drains, sedimentation basins, and temporary seeding until permanent drainage facilities and erosion control features are completed and operative.

- 5 Unless otherwise specified in the Contract, temporary erosion control devices or measures with the exception of sedimentation basins, fiberglass roving, sediment tubes, silt fence, fabric for slope protection, terraces, sectional drains, and temporary seeding are not paid for directly, but are considered as a subsidiary obligation of the Contractor under various items of contract work.
- 6 When included in the Contract, incorporate permanent erosion control devices or measures such as culvert pipe, terraces, gutters, asphalt curb, sectional drains, permanent slope drains, riprap, and the establishment of permanent vegetation (seeding) in the construction with the least possible delay. Seed cut and fill slopes as the excavation proceeds to the extent considered by the RCE as desirable or practicable in conformance with the applicable requirements of **Section 810**.
- 7 Once work begins on a cut or fill section, grade it to the typical section with the least amount of delay and promptly install all erosion control measures.
- 8 Conform to the following practices and controls:
- A. When the material is excavated from pits, control erosion of the pit site both during and after completion of the work such that erosion is minimized and sediment does not enter streams, wetlands, or other bodies of water. Locate and construct waste or disposal areas and haul roads in a manner that keeps sediment from entering streams.
 - B. Do not permit fording of live streams. Use temporary bridges or other structures whenever an appreciable number of stream crossings are necessary. Unless otherwise approved in writing by the RCE, do not operate mechanized equipment in live streams.
 - C. When work areas are located adjacent to live streams, perform the work in such a manner to prevent sediment from entering a flowing stream.
 - D. Clear all waterways of falsework, piling, debris, or other obstructions placed during construction operations and are not a part of the finished work as soon as practicable.
 - E. Do not discharge pollutants such as fuels, lubricants, bitumens, raw sewage, and other harmful materials into or near rivers, streams, impoundments, or natural or man-made channels leading thereto. Do not allow wash water or waste from concrete mixing operations to enter live streams.
 - F. Comply with applicable regulations of agencies and statutes relating to the prevention and abatement of pollution in the performance of the Contract.
- 9 In addition to the requirements set forth above, comply with specific project limitations and requirements included in the Contract.

107.27 Hazardous and/or Toxic Waste

- 1 If during construction operations any abnormal condition that may indicate the presence of a hazardous and/or toxic waste in the area is encountered or

exposed, immediately discontinue work and notify the RCE.

- 2 Abnormal conditions include, but are not limited to, the following:
 - presence of asbestos,
 - presence of barrels,
 - discolored earth, metal, wood, etc.,
 - obnoxious or unusual odors,
 - visible fumes,
 - excessively hot earth,
 - smoke, or
 - any other condition appearing abnormal could be a possible indication of hazardous and/or toxic waste.

Treat the conditions with extraordinary caution.

- 3 Do not resume operations until so directed by the RCE.
- 4 If a building is razed, the Contractor is responsible for securing the necessary permits in accordance with the SCDHEC requirements.
- 5 Where the Contractor performs necessary work required to dispose of these materials, payment is made at the contract unit price for items applicable to such work or payment is made in accordance with **Subsection 104.5** or **109.5**. Dispose of the hazardous and/or toxic waste in accordance with the requirements and regulations of the SCDHEC. Should the disposition of waste material require special procedures by certified personnel, the Department will arrange with qualified persons to dispose of the material.

SECTION 108

PROSECUTION AND PROGRESS

108.1 Subletting of Contract

- 1 Do not sublet, sell, transfer, assign, or otherwise dispose of the Contract or Contracts, or any portion thereof, or of its right, title, or interest therein; or either legally or equitably assign any of the monies payable under the Contract, or the claim thereto without written consent of the Bridge Construction Engineer for bridge projects or the Road Construction Engineer for all other projects.
- 2 On all projects, when acting as the Prime Contractor, perform with your own organization and with the assistance of workers under your immediate supervision work amounting to not less than 30% of the combined value of all items of work embraced in the Contract, exclusive of any items of work under the Contract that require highly specialized knowledge, craftsmanship, or equipment not ordinarily available in contracting organizations qualified to bid on the project. Such items are designated in the Contract as "*specialty items*."
- 3 Request for permission to sublet, transfer, assign, or otherwise dispose of any portion of the Contract in writing and accompany with documentation showing that the organization or organizations that will perform the work are particularly experienced and equipped for such work. In the request, state the name and mailing address of each proposed subcontractor and include the item of work to be subcontracted. On all federal-aid contracts, ensure that the request also contains a certification that all requirements for federal-aid construction contracts included in the prime Contract are physically included and are a part of the subcontracting agreement (contract) between the Prime Contractor and the subcontractor and lower tier subcontractors. In case of any conflict, the required Contract provisions prevail. On all federal-aid and state contracts, state in the request the amount of work involved for each item expressed both as a monetary value and as a percentage of the value of the entire Contract. When an agent performs work under a subcontractor, all requirements applicable to subcontractors apply. All pertinent contract requirements apply on all work sublet, assigned, or otherwise disposed of in any way. Approval to sublet, assign, or otherwise dispose of any portion of the Contract does not serve to release the Contractor or its Surety of any responsibility for the fulfillment of the Contract.
- 4 As a requirement of the NPDES General Permit, ensure that the NPDES certification statement and/or co-permittee status is made part of all subcontracts as specified in **Subsection 810.4.2**.

108.2 Preconstruction Conference

- 1 After receipt of the notice of award and before the beginning of construction, contact the DEA of the Engineering District in which the work will take

place and establish a mutually agreeable date for a Preconstruction Conference. Have present at the Preconstruction Conference the project superintendent and other representatives or responsible officials involved in the construction of the project, including representatives of the subcontractors. Officials of local county and municipal governments, representatives of affected utility companies and other affected agencies may be requested by the RCE to attend in order that a working understanding can be established, thus providing for the coordination of the work among the various parties and allowing the work to proceed with minimum delay.

- 2 The conference discussion of the project may include such matters as the Contractor's plans and schedules, where and when the prosecution of the work will begin, utilities, right-of-way, agreements affecting the construction, compliance with permits that have been issued, unusual conditions, compliance with all applicable requirements such as erosion control, pollution controls, and other pertinent items conducive to better progress and efficiency of operations. Construction pay items may be discussed so that all parties understand the type of materials required, the sampling and testing required, the method of construction, the Shop Plans and Working Drawings required, and the method of measuring and paying for the items of work.
- 3 Ensure that there is a discussion and thorough understanding and acceptance of the terms and conditions of the *Storm Water Pollution Prevention Plan (SWPPP)* as required by the NPDES General Permit as specified in **Subsection 810.4.2**.

108.3 Prosecution of the Work

- 1 Begin the work to be performed under the Contract on or before a date that enables completion within the period specified in the Contract. If the Contractor asks for and receives permission to begin work before the execution of the Contract, the Contractor is responsible for all claims and liabilities of third parties arising out of or connected with such interim work done prior to execution of the Contract. The Department is not responsible for payment to the Contractor for any work performed, costs, expenses, or damages of any kind or nature relative to or resulting from the Department's decision not to execute the Contract. Begin at such points as the RCE may direct and prosecute from as many different points in such part or parts and at such times as may be directed. Provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the Plans and the Specifications within the time set forth in the Contract. Should the prosecution of the work be discontinued for any reason, notify the RCE at least 72 hours in advance of resuming operations.

108.4 Limitation of Operation

- 1 Conduct the work at all times in such manner and in such sequence, to the extent practicable, that ensures the least interference with traffic. Have due regard to the location of detours and to the provisions for handling traffic. The use of detours and their locations are subject to approval of the RCE. Do not open work to the prejudice or detriment of work already started. The RCE

may require the Contractor to finish a section on which work is in progress before work is started on any additional sections if the opening of such section is essential to public convenience.

108.5 Character of Workers, Methods, and Equipment

- 1 Employ sufficient labor and equipment, at all times, for prosecuting the several classes of work to full completion in the manner and time required by the Specifications.
- 2 Ensure that all personnel have sufficient skill and experience to properly perform the work assigned to them. Make workers engaged in special work or skilled work have sufficient experience in such work and in the operation of the equipment required to perform the work properly and satisfactorily.
- 3 At the written request of the DOC, remove forthwith any person or persons employed by the Contractor or by any subcontractor who, in the opinion of the DOC, do not perform their work in a proper and skillful manner or are intemperate or disorderly. Do not employ or allow any subcontractor to employ such person or persons again in any portion of the work without the approval of the RCE.
- 4 Should the Contractor fail to remove such person or persons as required above or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the RCE may suspend the work by written notice until the Contractor remedies the situation. The Contractor is not entitled to any additional time or damages caused by the suspension.
- 5 Ensure that all equipment that is proposed for use on the work is of sufficient size and is in suitable mechanical condition to meet requirements of the work and to produce a satisfactory quality of work. Ensure that the equipment used on any portion of the project is such that no injury to the roadway, adjacent property, or other highways results from its use.
- 6 When these specifications require that the construction be performed by the use of certain methods or equipment, use such methods or equipment unless others are authorized by the RCE. Should the Contractor desire to use a method or type of equipment other than those specified, request in writing, approval from the RCE to do so. Before considering or granting a request, the RCE may require the Contractor to furnish, at its expense, evidence satisfactory to the RCE, that the equipment or method proposed for use by the Contractor is capable of producing work equal to or better than that which can be produced by the methods or equipment specified. If approval is given, it will be on the condition that the Contractor is fully responsible for producing work conforming to the requirements specified. If after trial use of the substituted methods or equipment the RCE determines that the work produced is not equal, in all respects, to that which can be produced by the methods or equipment specified, discontinue the use of substitute methods or equipment and complete the remaining work with the specified methods or equipment. Remove the deficient work and replace it with work of specified quality or take such other corrective action as the RCE may direct at no cost

to the Department. No change is made in basis of payment for the construction items involved or in the Contract because of approval of a change in methods or equipment as stipulated herein.

- 7 The approval for use of particular methods or equipment on any project is in no way considered as an approval of the use of such methods or equipment on any other project. When specific methods are prescribed in the special provisions or the Plans for a particular project, consideration will not be given to the use of alternate methods or equipment.

108.6 Determination and Extension of Contract Time

- 1 Unless otherwise specified, complete the work on or before the completion date stated in the Contract.
- 2 If the Contract is increased by extension of the Contract as set forth in **Subsection 104.4**, the contract time is agreed upon and is included in the agreement for the Contract Extension.
- 3 If satisfactory fulfillment of the Contract with deletions and decreases, authorized under **Subsections 104.2** and **104.4**, requires the performance of work in smaller quantities than those set forth in the Contract, the contract time will not be reduced.
- 4 Weather and seasonal limitations as set forth in the applicable sections of these specifications or other such limitations provided for in the special provisions do not affect the specified completion date. Under no circumstances is the Contractor entitled to compensation for weather related delays.
- 5 If the Contractor finds it impossible for reasons beyond its control to complete the work within the contract time as specified or as extended, it may, at any time before the expiration of the contract time as extended, make a written request to the RCE for an extension of time setting forth therein the reasons that the Contractor believes justify the granting of its request. That insufficient time was specified is not a valid reason for extension of time. If the RCE finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor, the RCE may extend the time for completion in an amount justified by the conditions based on a CPM schedule. The extended time for completion is then in full force and effect the same as though it was the original time for completion.

108.7 Temporary Suspension of Work

- 1 The RCE has the authority to suspend the work, wholly or in part, for such periods as the RCE deems necessary for the following reasons:
- Unsuitable weather conditions,
 - Unfavorable conditions for the suitable prosecution of the work,
 - Failure of the Contractor to correct conditions unsafe for its workers or the general public,
 - Failure of the Contractor to carry out orders given or to perform any provisions of the Contract,

- Failure of the Contractor to install or maintain erosion control devices,
- Failure of the Contractor to install or maintain proper traffic control, or
- For the convenience of the State.

Such suspensions do not constitute grounds for claims for damages or extra compensation by the Contractor except if the suspension is for the convenience of the State.

- 2 If it should become necessary to stop work for an indefinite period, make the necessary provisions to maintain accommodations for and safeguard traffic in as satisfactory a manner as is practicable. Store materials in such a manner that they do not obstruct or impede the traveling public or become damaged in any manner. Take every precaution to prevent damage or deterioration of the work performed, provide suitable drainage of the roadway by opening ditches, shoulder drains, etc., and erect temporary structures where necessary. Do not suspend work without written authority of the RCE.

108.8 Failure of Contractor to Maintain Satisfactory Progress

- 1 The Contractor may be declared delinquent in its work if, at any time, the percentage of the value of the Contract completed is not within a reasonable percentage of the contract time expired, and it is obvious that the work will not be completed by the specified completion date.
- 2 A Contractor disqualified under the provisions of this subsection is not permitted to bid as an individual, firm, partnership, or corporation under a different name. A Contractor or any contracting firm disqualified will be removed from delinquent status immediately upon evidence that progress as measured above is within a reasonable percentage.
- 3 A delinquency status check is made when determined necessary by the RCE. If it is evident that the Contractor is delinquent, the RCE will notify the DOC and a *Preliminary Notice of Delinquency* will be sent to the delinquent Contractor by registered mail.
- 4 If the Contractor does not remedy the situation or submit a plan to remedy the situation, then a *Notice of Delinquency* is sent to the Contractor via certified mail. The delinquency is not effective until 15 days after receipt of the *Notice of Delinquency* by the Contractor. During those 15 days, the Contractor is allowed to present information in opposition to the delinquency. After 15 days, the Contractor is declared delinquent unless the RCE or DOC decides otherwise based on information received during the 15-day period. The DOC will notify the Contractor via certified mail of the delinquency declaration. **Once declared delinquent, the Contractor is disqualified for further bidding and for approval as a subcontractor.**

108.9 Failure to Complete the Work on Time

- 1 If the Contractor fails to substantially complete the work by the contract specified completion date, then the Contractor is liable for liquidated damages for each calendar day past the contract specified completion date. The daily

liquidated damages rate is determined from the following schedule. The date of substantial completion is determined by the RCE.

Schedule of Liquidated Damages for Each Day Overrun in Contract Time		
Original Contract Amount		Daily Charge per Calendar Day at Fixed Rate
From More Than	To and Including	
\$0	\$50,000	\$100.00
\$50,000	\$100,000	\$200.00
\$100,000	\$500,000	\$400.00
\$500,000	\$1,000,000	\$600.00
\$1,000,000	\$2,000,000	\$800.00
\$2,000,000	\$5,000,000	\$1200.00
\$5,000,000	\$10,000,000	\$1400.00
\$10,000,000	and above	\$1800.00

108.10 Default and Termination of Contract

- 1 The Contractor is in default for any of the following:
 - Failure to perform the work with sufficient workers and equipment or with sufficient materials to assure the prompt completion of said work;
 - Failure to perform work in accordance with contract requirements and/or refuses to remove and replace rejected materials or unacceptable work;
 - Discontinues the prosecution of the work;
 - Failure to resume work that has been discontinued within a reasonable time after notice to do so;
 - Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency;
 - Allows any final judgment to remain unsatisfied for a period of 15 days;
 - Makes an assignment for the benefit of creditors; or
 - For any other cause whatsoever, fails to carry on the work in an acceptable manner.

- 2 If the Contractor or its Surety does not cure or make sufficient progress toward curing the default within 15 days of receipt of Notice of Default, then, at the discretion of the DOC, the Contract may be terminated and the Department will finish the work by whatever methods it deems reasonable and expedient, or the DOC, without violating the Contract, may take a portion of the work out of the hands of the Contractor. The Department may appropriate

or use any or all materials and equipment on the job site as may be suitable and acceptable for performing the work, and methods may be used that the RCE determines are required for the completion of the Contract in an acceptable manner.

- 3 All costs and charges incurred by the Department, including attorney's fees, together with the cost of completing the work under the Contract are deducted from any monies due or that may become due the Contractor. If such expense exceeds the sum that would have been payable under the Contract, the Contractor and its Surety are liable and shall pay to the Department the amount of such excess.
- 4 In all cases, the Surety company has the right to complete the Contract and is given 30 days from receipt of *Notice of Default* or longer, in the discretion of the RCE, in which to get the work underway. This procedure does not in any way serve to extend the contract time. All charges incident to negotiating with the Surety and arranging for work to be resumed, including attorney's fees, are charged against the Contractor or its Surety as part of the cost of the work.

SECTION 109**MEASUREMENT AND PAYMENT****109.1 Measurement of Quantities**

- 1 All work completed under the Contract will be measured by the RCE according to United States Standard Measures.
- 2 A station, when used as a definition or term of measurement, is 100 linear feet.
- 3 The appropriate method of measurement and computation set forth in the *SCDOT Construction Manual* will be used for the determination of quantities of materials furnished and of work performed under the Contract.
- 4 Unless otherwise specified, longitudinal measurements for area computations will be made along the actual surface of the roadway. No deductions will be made for individual fixtures having an area of 9 square feet or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the Plans or authorized by the RCE.
- 5 Structures are measured according to neat lines shown on the Plans or as altered to fit field conditions.
- 6 All items that are measured by the linear foot, such as curb and gutter, fence, pipe culverts, guardrail, etc., will be measured parallel to the base of foundation upon which the item is placed or attached unless otherwise specified.
- 7 In computing volumes of excavation, the average end area method or other acceptable methods will be used. Excavation performed beyond the neat lines or slope stakes, will not be measured for payment except when the material is utilized for borrow.
- 8 The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing are specified and will be measured in decimal fractions of inches.
- 9 When the term "gauge" or "gage" refers to the measurement of wire, it means the wire gauge specified in AASHTO M 279 or AASHTO M 280.
- 10 The term "Ton" means the short ton consisting of 2000 pounds avoirdupois. All materials that are measured and proportioned by weight will be weighed on accurate, approved scales by competent, qualified personnel at locations designated or approved by the OMR. Ensure that all platform scales are of sufficient size to permit the entire vehicle or combination of vehicles to rest on the scale platform while being weighed. Furnish the use of scales at no cost to the Department. Have scales tested by an approved firm or state agency as often as the OMR may deem necessary to ensure their accuracy. If material is shipped by rail, the proven railroad weights may be accepted with appropriate deductions to cover losses in shipment due to damaged cars, negligence

of the Contractor in handling material, or other circumstances as may be determined by the OMR. If the OMR determines that no other methods of determining weights for a material are feasible, railroad car weights or tank truck weights of material passed through mixing plants will be acceptable.

- 11 The tare weight of vehicles hauling material being paid for by weight is the empty weight of the vehicle with the driver aboard and the fuel tanks full. Have all vehicles weighed once each calendar week to determine their tare weights and, except as provided below, this tare weight will be used for the calendar week in computing net weights. During the course of the calendar week, vehicles will be spot checked for tare weight. If the spot check shows the tare weight of any vehicle exceeds, by 300 pounds or more, the tare weight determined at the regular weekly weighing, then the tare weight determined during the spot checking will be used to compute the net weights until the next weekly tare weights are determined. If the tare weight of the vehicle is less than the tare weight found at the weekly weighing, the tare weight determined at the weekly weighing will be used in computing net weights for the calendar week. Ensure that each vehicle bears a legible identification mark.
- 12 Haul materials measured by volume in approved vehicles will be measured therein at the point of delivery. Vehicles for this purpose may be of any size or type acceptable to the RCE if the body is of a shape such that the actual contents may be readily and accurately determined. Load all vehicles to at least their water level capacity and level all loads when the vehicles arrive at the point of delivery. No allowance will be made for the settlement of material in transit or material "coned" above the water level of the body.
- 13 When requested by the Contractor and approved by the RCE in writing, material specified measured by the cubic yard may be weighed and converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement are determined by the RCE and must be agreed to by the Contractor before such method of payment of quantities is used.
- 14 Asphalt material measured by volume will be measured in gallons in tank cars, distributor tanks, tanks, or drums. When requested, furnish the RCE certified calibration of tank cars, distributor tanks, tanks, and certified quantities in drums in which asphalt materials are delivered or stored. Volumes are measured at 60°F or are corrected to the volume at 60°F using ASTM D 1250. Asphalt material paid for directly will be weighed and paid for by the ton. If the RCE decides that weighing is not feasible, the asphalt material will be measured by volume as stipulated and converted to tons based on the unit weight determined by the OMR.
- 15 Cement will be measured by sack or bag or by the ton. The term "sack" or "bag" means the traditional 94 lb. bag size.
- 16 Timber will be measured by the thousand feet board measure (MFBM) actually incorporated in the structure. Measurement will be based on nominal widths and thickness and the extreme length of each piece. Timber piling will

be measured by the linear foot.

- 17 When lump sum is used as a unit of payment, there will be no direct measurement made. The unit includes all materials, labor, equipment, tools, supplies, fuel, and incidentals including all direct and indirect costs necessary to complete the item of work described in the Contract.
- 18 Rental of equipment will be measured in hours of actual working time and necessary traveling time of the equipment within the limits of the project. If special equipment is ordered by the RCE in connection with Force Account Work, transportation to the project will be in accordance with **Subsection 109.5**.
- 19 When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., these items will be identified by gauge, unit weight, section dimensions, etc., and such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerance established by the industries involved are acceptable.

109.2 Rounding of Quantities for Payment

- 1 The criteria for rounding of quantities for payment are set forth in **Section 109** of the *SCDOT Construction Manual*.

109.3 Scope of Payment

- 1 Receive and accept compensation provided for in the Contract as full payment for furnishing all materials and for performing all work specified in the Contract in a complete and acceptable manner and for all risk, loss, damage, or expense of whatever character arising out of the nature of the work or the prosecution thereof, subject to the provisions of **Subsection 107.25**.
- 2 If the "Payment" clause in the specifications relating to any unit price in the bid schedule requires that the said unit price cover and be considered full compensation for certain work or material essential to the item, this same work or material is not also measured and paid for under any other pay item which appears elsewhere in the Specifications.
- 3 When used as a unit of payment, the term "*lump sum*" means complete payment for the item of work specified in the Contract.
- 4 The payment of any progress or final estimate or of any retained percentage in no way affects the obligation of the Contractor to repair or renew, without additional compensation any defective parts of the construction or its responsibility for all damages due to such defects. The responsibility of the Contractor for all damages due to such defects is determined in accordance with **Subsection 107.21**.

109.4 Compensation for Underrun or Overrun of Quantities

- 1 When the accepted quantities of work vary from the quantities in the bid schedule or the quantities in a Change Order, accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices

and the Change Order unit prices for the accepted quantities of work done. No allowance will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting either directly from such alteration or indirectly from unbalanced allocation among the contract items of overhead expense and subsequent loss of expected reimbursements therefore or from any other cause.

109.5 Extra Work and Force Account Work

- 1 Extra Work performed in accordance with the requirements and provisions of **Subsection 104.5** is paid for at the unit prices or lump sum stipulated in a Change Order or the Department may require the Contractor to do such work on a Force Account basis and compensated in the following manner:
 - A. Labor. For all labor and personnel in direct charge of the specific operations, the Contractor will receive the current rate of wage (or scale) being paid by the Contractor for each hour that said labor and personnel are actually engaged in such work. Social Security taxes may be added to the rate or wage. An amount equal to 30% will be added to the total labor cost.
 - B. Materials. For materials accepted by the RCE and used, the Contractor will receive the actual cost of such materials delivered on the work site, including any transportation charges incurred (exclusive of machinery rentals as hereinafter set forth), to which cost 15% will be added.
 - C. Equipment. For all machinery or special equipment (other than small tools) the use of which has been authorized by the RCE, the Contractor will be allowed an hourly rental price based on published rental rates as shown in the *Rental Rate Blue Book* published by DATAQUEST, Inc., which are in effect on the date the Force Account Work is ordered. The hourly rate is the stated monthly rate divided by 176, after the monthly rate has been adjusted for (a) replacement cost allowances in machine depreciation and (b) contingency cost allowances. Steps to make these adjustments are shown in the *Blue Book*; however, the time of an operator will not be included. For any equipment not listed in the *Blue Book*, payment will be made at the prevailing rental rates being paid for such equipment in the area in which the project is located. In all cases, payment for equipment rental will include only those hours or portion of hours that the equipment is actually in use in the work. Payment will not be made for time spent in moving equipment to and from job sites or for idle time. Payment will be made for transportation costs for special equipment not needed in the normal prosecution of the other work, but which is necessary in the performance of work on a force account basis.
 - D. Miscellaneous. No additional compensation will be allowed for general superintendence, health and welfare benefits, insurance, taxes, bond, the use of small tools, or other costs for which no specific allowance is herein provided. However, the prime Contractor may be

entitled to a 10% markup for the cost of work performed by subcontractors.

- E. Compensation. The Contractor's representative and the RCE shall compare records of the cost of work done as ordered on a Force Account basis at the end of each day. Make records available in duplicate, and both representatives will sign both copies, and each retain a copy.
- F. Statements. No payment will be made for work performed on a Force Account basis until the Contractor furnishes the RCE duplicate itemized statements of the cost of such Force Account work detailed as follows:
- Name, classification, date, daily hours, total hours, rate, and extension for each laborer and foreman.
 - Designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and equipment.
 - Quantities of materials, prices, and extensions.
 - Transportation of materials. Furnish statements accompanied and supported by receipted invoices for all materials used and transportation charges. However, if materials used on the Force Account work are not specifically purchased for such work, but are taken from the Contractor's stock, then instead of the invoices, furnish an affidavit certifying that such materials were taken from stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

109.6 Eliminated Items

- ¹ If any items contained in the proposal are to be found unnecessary for the proper completion of the work, the RCE may eliminate such items from the Contract, and such action in no way invalidates the Contract. When a Contractor is notified of the elimination of items, it will be reimbursed for actual work done and all costs incurred, including mobilization of materials before said notification. Any such materials may be purchased by the Department in accordance with the provisions of **Subsection 104.2**.

109.7 Partial Payments

- ¹ Partial payments will be made at least once each month as the work progresses. Should the Contractor earn more than \$150,000 within a monthly pay period, the Contractor may request an intermediate estimate once earnings exceed \$150,000 for the month. The intermediate estimate is paid at the discretion of the RCE. Said payments will be based upon the RCE's estimate of the value of work performed and materials completed in place in accordance with the Contract and for materials delivered (stockpiled) in accordance with **Subsection 109.8**. Monthly partial payment periods end at the end of the day on the following dates for the respective Engineering Districts:

- Engineering District Nos. 2, 3, and 5 - Last day of each month.
- Engineering District Nos. 1, 4, 6, and 7 - 16th day of each month.

109.8 Payment for Material-on-Hand

- 1 Upon delivery of material for the project and satisfactory stockpiling or storing in approved areas, the materials listed below will be entered on the monthly construction estimate in accordance with the following tables:
 - A. Material tested and meeting the requirements of the Specifications.
 - B. Material for which the Contractor has furnished the RCE with verification of the quantity delivered.
 - C. Material for which the Contractor has furnished the RCE with paid invoices. Written consent of the Surety will be provisionally accepted instead of received invoices. However, if the paid invoices are not received by the RCE by the end of the next monthly partial payment period, payment for the materials will be removed from the monthly estimate.
 - D. Material that is stored or stockpiled on property other than the right-of-way and for which the Contractor has furnished the RCE with the right-of-entry onto the property for removing the material.

Partial Payment Schedule for Material Stored or Stockpiled	
Material	Percentage of Contract Unit Price of Item, %
Soil-Aggregate Subbase Courses (All Aggregates)	30
Macadam Base Course (All Aggregates)	30
Stabilized Aggregate Base Course (All Aggregates)	30
Asphalt Surfacing (All Aggregates)	30
Portland Cement Concrete Pavement (Coarse and Intermediate Aggregate)	17
Portland Cement Concrete Pavement (Coarse, Intermediate, and Fine Aggregates)	20

- 2 After the total specified thickness or rate of macadam, soil-aggregate sub-base, or stabilized aggregate base course has been placed on the roadbed, partial payment will be entered on the construction estimate at a unit price equal to 60% of the contract bid price
- 3 If the total thickness is not placed, the material will be converted to an equivalent area of total specified thickness and will be paid for as indicated above. The base course paid for in this manner will not be included in the quantity of materials paid for in stockpiles.

Partial Payment Schedule for Material for Structures Delivered to Job Site	
Material	Percentage of Contract Unit Price of Item, %
Fabricated Structural Steel	80
Fabricated Metal Hand Rail	80
Steel H-Piling	40
Reinforcing Steel	70
Prestressed or Precast Concrete Piling	50
Prestressed Concrete Beams	80
Precast Concrete Bridge Sections	75

Partial Payment Schedule for Material For Structures Cast or Fabricated and Stored, but Not Delivered to Job Site	
Material	Percentage of Contract Unit Price of Item, %
Fabricated Structural Steel	75
Prestressed or Precast Concrete Piling	45
Prestressed Concrete Beams	75
Precast Concrete Bridge Sections	70

- 4 When authorized by the RCE, payment for other durable materials requiring fabrication at an off-site location may be made provided the total invoice price of these materials is in excess of \$5,000.

109.9 Acceptance and Final Payment

- 1 When the final inspection and final acceptance have been duly made by the RCE, as provided in **Subsection 105.15**, the RCE will prepare the final estimate of the quantity of each class of work performed and the value thereof at the contract unit or lump sum price after which the Contractor will be paid the entire sum found to be due after deducting all previous payments and all amounts to be retained or deducted under the provisions of the Contract. All prior partial estimates and payments are subject to correction in the final estimate and payment.
- 2 Before the final payment is made, furnish a letter from the Surety company giving the Surety's approval and consent to the payment of the amount shown on the final estimate, and furnish satisfactory evidence that all bills, liens, or judgments have been satisfied; or in the absence of such proof, the Department may retain from the amount shown on the final estimate, an amount suf-

ficient to cover bills, liens, or judgments remaining unsatisfied. Also, before the final payment is made, furnish any other forms and documents required by the Department and the FHWA to closeout the Contract.

109.10 Audit of Contractor's Records

- 1 The Contractor is subject to audit at any time during the course of the project and up to three years after project closeout. The audit may be performed by SCDOT employees or an independent auditor retained by the SCDOT. The SCDOT will give 10 days written notice before conducting the audit. Include a similar audit clause in all subcontract agreements allowing the SCDOT to audit subcontractor's records. The Contractor and all subcontractors shall cooperate with the auditors in good faith. The Contractor and/or subcontractor shall make all records available as requested by the auditor. Upon receipt of audit notice, at a minimum, organize and make available to the auditors the document items listed in **Subsection 105.16.9**.

DIVISION 200

EARTHWORK

SECTION 201

CLEARING AND GRUBBING

201.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for clearing and grubbing of all vegetation, debris, and obstructions within the limits of the roadway, right-of-way, ditch and channel change areas, or other easement areas, except for such objects that are designated to remain, or are to be otherwise removed in accordance with the Plans or other sections of these specifications.

201.2 Materials

- 1 None specified.

201.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

201.4 Construction

201.4.1 General

- 1 Perform clearing and grubbing work before other construction work in the same general area is started. The RCE will establish right-of-way lines and construction lines and designates all trees, shrubs, plants, and other items to remain. Preserve from injury or defacement all natural terrain, vegetation, and objects designated to remain. Repair or replace, as directed by the RCE and at no cost to the Department, natural terrain, vegetation, and objects designated to remain that are damaged by the Contractor's operations or provide compensation as determined by the RCE for such damage.
- 2 Perform clearing and grubbing work by removing and disposing of all vegetation, trees, shrubs, stumps, rubbish, logs, roots, foundations, framework, utility connections not in service, fences, signs, posts, portions of structures not otherwise provided for, and other objectionable material indicated or considered necessary to satisfactorily complete the work. If trees are to remain, carefully trim trees that overhang the roadway to give a clear height of 18 feet over the roadway. In all cases, clear and grub the entire right-of-way at road intersections, traffic interchanges, and bridge sites indicated on the Plans. When the NPDES line is shown on the Plans, extend clearing and grubbing operations to that line.

- 3 On Contracts for Interstate grading projects, unless otherwise provided, clear and grub a minimum distance of 30 feet from each edge of the proposed pavement along both lanes and along the legs of interchanges. This is in addition to clearing and grubbing within the construction lines.
- 4 In areas to be cleared, remove trees that are considered merchantable timber. If required by the RCE, neatly saw trees of value that are designated for removal into merchantable lengths of not less than 5 feet and pile neatly at points within the right-of-way or in the vicinity of the project designated by the RCE. If the right-of-way agreement gives the owner the rights to the timber, the Contractor is responsible for the timber for 30 days after it is available for removal. If the owner does not claim and remove the cut timber from the project within this time, remove and dispose of the timber away from the site.
- 5 In areas to be excavated or where embankments are to be constructed, clear and grub the ground of all living or dead trees, brush, roots, weeds, leaves, and all other objectionable material. In areas where embankments are to be constructed to a height of 5 feet or less, clear and grub the area of all stumps, unless otherwise indicated on the Plans or allowed by the RCE. If stumps are allowed to remain under embankments, do not allow them to extend more than 8 inches above the ground line or low water level.
- 6 Except in areas to be excavated, backfill all stump holes and other holes from which obstructions are removed with suitable and thoroughly compacted material.
- 7 In areas designated for clearing, remove and dispose of (or salvage if required by the RCE) fences, posts, signs, structures, and other obstructions that interfere with the work and are not otherwise specified to be removed, adjusted, or relocated.

201.4.2 Clearing and Grubbing within Right-of-Way

- 1 Where clearing and grubbing within right-of-way is required, clear and grub the entire area within the right-of-way lines. Do not cut, damage, or destroy timber beyond the right-of-way lines unless the Plans or the Special Provisions provide for clearing such areas as necessary to complete the work. Do not remove or damage trees, plant specimens, or other objects considered valuable by adjacent property owners or that are aesthetically desirable and are designated by the RCE to remain.

201.4.3 Clearing and Grubbing within Roadway

- 1 Where clearing and grubbing within roadway is required, clear and grub the entire area inside of roadway construction lines. Where cut and fill slopes are shown on the Plans, extend clearing and grubbing beyond the roadway construction lines as necessary. Do not cut, damage, or destroy timber beyond the roadway construction lines unless the Plans or Special Provisions provide for clearing such areas as necessary to complete the work. Exercise care when clearing and grubbing within roadway to avoid cutting, damaging, or destroying any timber outside of the construction lines, except as directed by

the RCE.

- 2 Where clearing and grubbing within roadway is required, clearing of additional areas within the right-of-way may be directed by the RCE. Such work may include clearing and disposing of damaged limbs, trees, and other debris within the right-of-way.

201.4.4 Clearing and Grubbing at Bridge Sites

- 1 Where clearing and grubbing within the right-of-way is required at a bridge site, clear and grub the entire right-of-way at the bridge site.
- 2 Where clearing and grubbing within the roadway is indicated at a bridge site, clear by cutting all trees, stumps, etc., to within 8 inches of the ground or to low water in the full width of the right-of-way for a distance of 75 feet beyond the beginning and end of the proposed bridge. Grub the area at proposed bridge site by removing and disposing of all logs, vegetation, stumps, brush, rubbish, and other objectionable material within an area bounded by lines 5 feet beyond the outside edges of the proposed bridge and 10 feet beyond the beginning and end of the proposed bridge.
- 3 Clear, but do not grub the area to the Bridge Construction Access Line as designated on the Plans. Also, clear, but do not grub additional areas as needed for construction or safety reasons or as directed by the RCE.
- 4 Unless otherwise provided in the Contract or on the Plans, clearing and grubbing of the right-of-way is not required on bridge widening projects.

201.4.5 Clearing and Grubbing of Ditches

- 1 Where clearing and grubbing of ditches is indicated, clear and grub the entire area inside of the ditch or channel relocation construction lines or as indicated on the Plans or as directed by the RCE.

201.4.6 Removal and Disposal of Clearing and Grubbing Material

- 1 Remove all materials created by the clearing and grubbing operation from the project by burning or otherwise disposing of the removed materials as specified or directed. Perform all burning under constant care of competent guards and in accordance with applicable laws and ordinances and as provided in **Subsection 107.7**. Stumps and logs may be disposed of by depositing them off the right-of-way where they are not visible from any public road. Use only disposal sites approved by the RCE. At no cost to the Department, obtain disposal sites and secure any applicable federal, state, county, or municipal permits that are required. Certify in writing to the RCE that all permit requirements have been met before placing any material in a disposal area.
- 2 Re-cut any brush, weeds, and other designated vegetation immediately before final inspection if so instructed by the RCE.

201.5 Measurement

- 1 The quantity for the pay item Clearing and Grubbing within Roadway or Clearing and Grubbing within Right-of-Way is measured in accordance with

the pay unit specified in the Contract. If the pay unit specified is acre, the quantity is the actual surface area over which clearing or grubbing operations were performed and is measured by the acre (ACRE), complete, and accepted by the RCE. If the pay unit is lump sum (LS), no specific measurement is required or made.

- 2 The quantity for Clearing and Grubbing of Ditches is the actual area, based on field stakes, in ditches or channel changes outside the right-of-way on which the work was performed and is measured by the acre (ACRE), complete, and accepted by the RCE.
- 3 The removal of weeds, plant stalks regardless of size or density, loose rock, and small, scattered trees is not considered clearing and grubbing. No measurement or payment is made for such work.

201.6 Payment

- 1 Payment for the accepted quantity for Clearing and Grubbing within Roadway, Clearing and Grubbing within Right-of-Way, or Clearing and Grubbing Ditches, measured in accordance with **Subsection 201.5**, is determined using the contract unit bid price for the applicable item. Payment is full compensation for performing the clearing and grubbing work as specified or directed and includes proper removal and disposal of timber and debris and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 There is no payment for clearing and grubbing of pits furnished by the Contractor. The expense of clearing and grubbing the pits is considered included in the contract unit bid price for Unclassified Excavation or Borrow Excavation, etc., as applicable.
- 3 If the Contract does not include an item for clearing and grubbing work, all such work is considered incidental to the various items of work in the Contract. No separate or additional compensation is made for this work.
- 4 When obtaining rights-of-way for certain projects, the Department may acquire ownership of the timber on the property. In these instances, the Contract includes a credit for the value of the merchantable timber in the contract unit bid price for clearing and grubbing items, and the Contractor assumes the title to the timber and is responsible for removal of such timber.
- 5 Payment for each item includes all direct and indirect costs and expenses required to complete the work in an acceptable manner.

201.6

201.6

6 Pay items under this section include the following:

Item No.	Pay Item	Unit
2011000	Clearing and Grubbing within Right-of-Way	LS
2011001	Clearing and Grubbing within Right-of-Way	ACRE
2012000	Clearing and Grubbing within Roadway	LS
2012001	Clearing and Grubbing within Roadway	ACRE
2013050	Clearing and Grubbing Ditches	ACRE

SECTION 202

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

202.1 Description

- 1 This section contains specifications for the material, equipment, construction, measurement, and payment for the removal, wholly or in part, and satisfactory disposal of buildings, fences, guardrail, structures, old pavements, abandoned pipelines, underground storage tanks, and other obstructions that are not designated or permitted to remain, except for the obstructions removed and disposed of under other items in the Contract.
- 2 This subsection also contains specifications for the salvaging of all materials and backfilling of the trenches, holes, and pits.

202.2 Materials

- 1 None specified.

202.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

202.4 Construction

202.4.1 General

- 1 Raze and dispose of all buildings, foundations, structures, guardrail, fences, and any other obstructions that are on the right-of-way and are not designated to remain. Include structures (buildings) to be cut off at the right-of-way line and structures (buildings) and appurtenances located entirely outside the right-of-way limits when such items are indicated on the Plans as items to be demolished.
- 2 Due to the possibility of encountering asbestos, secure a permit in accordance with SCDHEC regulations anytime a structure is to be razed. Inspect the facilities identified in the Contract as a Removal and Demolition item for the presence of asbestos before the submission of the bid. If asbestos is located, the provisions of **Subsection 107.27** apply. Direct questions about the permit to the SCDHEC Bureau of Air Quality.
- 3 When structures (buildings) and obstructions are designated on the Plans to be cut off at a right-of-way line, produce a completed job of first class workmanship and remove and dispose of all debris and appurtenances, including utility connections from the portion of the structure within the right-of-way. Adequately support the portion of the structure remaining outside the right-of-way. Unless otherwise provided, re-facing is not required.

- 4 As directed by the RCE, remove, cap, or seal utility service connections such as sewers, water lines, electrical connections, gas lines, etc. left in place after the removal of the structure (buildings) and obstructions, at the right-of-way line, the edge of the existing pavement, or at the existing mains. Carefully store and protect utility materials unless the owner does not desire them. In this case, the material becomes the property of the Contractor.
- 5 When structures (buildings) and other obstructions are designated on the Plans to be cut off at the right-of-way or to be removed in their entirety, and unless otherwise provided, the structure (building) and all appurtenances and the material removed in performing this work becomes the property of the Contractor except utility materials as provided above. Take proper allowance for the value of the salvageable materials in the price bid for the item involved.
- 6 Destroy unusable perishable material. Unless otherwise permitted, dispose of non-perishable material outside the limits of view from the traveled roadway with written permission of the property owner on whose property the material is placed. Furnish copies of all agreements with property owners to the RCE. Without cost to the Department, obtain disposal sites and secure any applicable federal, state, county, or municipal permits as required. Certify in writing to the RCE that all permit requirements have been met before placing any material in a disposal area.
- 7 Remove unsuitable material from wells, cisterns, septic tanks, other tanks, basements, and cavities. Outside of construction limits, remove foundations left by structure removal to a depth of not less than 1 foot below natural ground. Within construction limits, remove foundations to a depth of not less than 2 feet below subgrade elevation. Break up basement floors to prevent them from holding water. Backfill basements or cavities left by structure removal as directed with material approved by the RCE and compact in accordance with the provisions of **Subsection 205.4.6** unless otherwise directed.
- 8 Where a structure or obstruction has been previously removed and the existing utility connections have not been terminated and capped, comply with the above provisions for utility service connections.
- 9 Comply with the requirements in the *SCDOT Construction Manual* including notifying the SCDOT Director of Communications before performing any blasting operations. Before blasting in any stream, river, or lake coordinate plans and operations with the local SCDNR District Fisheries Biologist and District Law Enforcement Captain.

202.4.2 Removal and Disposal of Bridges, Culverts, and Other Drainage Structures

- 1 Do not remove bridges, culverts, or other drainage structures in use by traffic until satisfactory arrangements have been made to accommodate traffic. Adequately shore any excavation adjacent to the structure or to its approaches to avoid damage to them or to traffic.

- 2 Before demolition of any bridge structure, coordinate with the RCE to complete SCDHEC form entitled: *Notification of Demolition and Renovation*. After the RCE and the Contractor have signed the completed form, attach a copy of the Asbestos Investigation Report and submit the completed form and report at least 10 working days before demolition begins to the following address:

Manager, Asbestos Section
SC Department of Health and
Environmental Control
2600 Bull Street
Columbia, SC 29201
- 3 Also, at least 10 working days before work begins, submit a *Demolition Plan* prepared by a Professional Engineer registered in South Carolina to the RCE for review and acceptance for structures over or adjacent to highways, navigable waters, railroads, and other public areas.
- 4 Unless otherwise directed, remove the substructures of existing structures within the stream down to the natural stream bottom. Remove those parts outside of the stream, including land structures, down 2 feet below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits of a new structure, remove them as necessary to accommodate the construction of the proposed structure.
- 5 Unless otherwise specified on the Plans and/or in the Contract, the material in the structure removed becomes the property of the Contractor. Remove this material from the work site before completion of the work, and take proper allowance for its salvage value in the price bid for the item involved. If the Plans or the Special Provisions provide for the material in the structure removed to remain the property of the Department, carefully dismantle steel or wood structures without unnecessary damage. Match-mark steel members and store all salvaged material as directed by the RCE.
- 6 Before placing any new work, complete blasting or other operations necessary for the removal of an existing structure or obstruction that may damage the new construction.
- 7 If the structural components designated for removal and disposal contain lead-based paints, comply with all applicable federal, state, and municipal requirements for lead as waste; for lead in the air, water, and soil; and for worker health and safety.
- 8 Remove and dispose of concrete or brick box culverts or arches that are designated on the Plans to be removed, but do not interfere or conflict with the placing of a new structure, to a point 2 feet below the bottom of the top slab or to a point where the sidewalls are a minimum of 3 feet below the sub-grade elevation. If culverts or arches interfere or conflict with the new structures, remove them in their entirety or to the limits shown in the Plans.
- 9 Unless otherwise provided, all concrete removed becomes the property of the Contractor.

202.4.3 Removal and Disposal of Pipe and Tile Drains

- 1 When noted on the Plans or when required by the RCE, remove existing pipes, pipe arches, tile drains, or other drainage devices located within the extreme limits of the project, including bridge sites. Remove pipe and tile in a careful manner and neatly store them at locations designated by the RCE unless it is to be re-laid as a part of the Contract. Any damage to pipe or tile during removal and storage because of negligence or improper handling or storing methods is the responsibility of the Contractor. Properly dispose of pipe removed and designated by the RCE as having no value.
- 2 Remove pipe or tile if any part of which conflicts with the installation of a new drainage structure. If not otherwise specified, include the cost of removal in the contract price bid for the new structure. Likewise, no direct payment will be made for the removal of pipe or tile that is to be re-laid at the same or other locations on the project.

202.4.4 Removal of Existing Guardrail

202.4.4.1 General

- 1 Remove bolts securing existing guardrail and remove guardrail elements. Remove all materials, including hardware, from the roadway immediately so that it does not create an obstacle for the traveling public. Place this material behind a completed section of guardrail or store it neatly in an area at least 30 feet from the travelway unless otherwise specified. The removed guardrail components become property of either the Department or the Contractor as stated in the Contract. Backfill postholes with suitable compacted material.

202.4.4.2 Guardrail that Remains the Property of the Department

- 1 If in accordance with the Contract the existing guardrail removed remains the property of the Department, store it within the limits of the project and protect it until it is removed from the project by the Department or for a period of 30 days, whichever comes first.

202.4.4.3 Guardrail that becomes the Property of the Contractor

- 1 If in accordance with the Contract the existing guardrail removed becomes the property of the Contractor, store it safely away from the traveling public until it is removed from the project.

202.4.5 Removal and Disposal of Pavements, Sidewalks, and Curbs

- 1 If so designated, remove and dispose of the following items unless such material is suitable for use in constructing embankments: existing Portland cement concrete, brick, or stone pavements with or without asphalt overlays, concrete, brick or stone sidewalks, concrete gutter or integral curb and gutter curb, asphalt concrete pavement, or asphalt curb. If suitable and approved by the RCE, this material may be used to construct embankments.
- 2 As directed by the RCE, sawcut pavement as necessary to produce a uniform line between the pavement to be retained and to be removed.

- 3 When the Plans indicate that concrete gutter is to be retained as a base and its integral curb removed, remove the curb to the top elevation of the gutter using methods approved by the RCE that prevents damage to or displacement of the retained gutter.

202.4.6 Removal and Disposal of Underground Storage Tank (UST)

- 1 When noted on the Plans or directed by the RCE, remove and dispose of all underground storage tanks and any associated contaminated soil. Conduct the work in accordance with the applicable SCDHEC regulations.
- 2 Secure the landowner's signature on the *Tank Ownership Closure Form* and submit it to the SCDHEC as required by the following regulation:
 Underground Storage Tank Control Regulations R.61-92, Part 280: promulgated pursuant to Section 44-2-50 of the 1976 South Carolina Code of Laws and enacted March 23, 1990.
- 3 Submit all paperwork involving the closure of an UST to SCDHEC within 30 days after the UST closure is complete. Visit the SCDHEC website to obtain the most current information on UST closure requirements. Provide acceptable means to assist the RCE in determining the quantity of the work items associated with all activities related to UST removal and remediation.

202.5 Measurement

- 1 Unless otherwise specified, the pay items Removal of Structures and Obstructions, Removal and Disposal Item No. *(number)*, and Removal and Disposal of Existing Bridge are paid for on a lump sum (LS) basis; and therefore, there is no specific measurement of quantities for these items.
- 2 The quantity of material used to backfill areas that is excavated as directed and approved by the RCE during the work for a removal item is measured by the cubic yard (CY) of Unclassified Excavation or Borrow Excavation as applicable in accordance with **Subsection 203.5**.
- 3 The quantity for the pay item Removal and Disposal of Existing Culvert (of the width and height specified) is measured by each (EA) reinforced concrete box culvert removed and disposed of as indicated on the Plans or directed by the RCE, regardless of the length of the culvert. If this item is not included in the Contract, the cost of the removal of concrete or brick culverts or arches is consider included in contract unit bid prices of the various other pay items in the Contract.
- 4 The removal and disposal of pipes, pipe arches, tile drains, and other drainage devices not otherwise specified is measured by the cubic yard (CY) as Unclassified Excavation in accordance with **Subsection 203.5**. No measurement is made for the removal of pipe that is replaced by new pipe or for the removal of pipe that is re-laid at any location. The cost of this removal is included in the new pipe or re-laid pipe items.
- 5 The quantity for the pay item Removal and Disposal of Existing Pavement is the actual horizontal surface area of the following material removed from

the project and is measured by the square yard (SY) of the pavement before removal, complete, and accepted:

- Existing brick pavement with or without asphalt overlay;
- Brick sidewalk;
- Cobblestone pavement with or without asphalt overlay;
- Portland cement concrete pavement with or without asphalt overlay;
- Portland cement concrete gutter;
- Portland cement concrete integral curb and gutter; or
- Portland cement stabilized base with asphalt concrete overlay.

- 6 The quantity for the pay item Removal and Disposal of Existing Asphalt Pavement is the actual horizontal surface area of asphalt concrete pavement with a total thickness of 2 inches or greater removed from the project, unless otherwise indicated, and is measured by the square yard (SY) of area before removal, complete, and accepted
- 7 Areas of asphalt pavement with a total thickness less than 2 inches or as otherwise indicated, such as aggregate bases, earth type bases, and other flexible pavement structure components are not included in the quantity for the pay item Removal and Disposal of Existing Asphalt Pavement because they are included in the quantity for the pay item Unclassified Excavation in accordance with **Subsection 203.5**.
- 8 The quantity for the pay item Removal and Disposal of Existing Curb is the length of existing stone, bituminous, or concrete curb removed from the project and is measured by the linear foot (LF) along the curb before removal, complete, and accepted.
- 9 When the Plans indicate that existing pavement or curb is to be removed, and the pay items Removal and Disposal of Existing Pavement, Removal of Existing Asphalt Pavement, or Removal and Disposal of Existing Curb are not included in the Contract, the removal and disposal of existing pavement or curb is included in quantity for the pay item Unclassified Excavation in accordance with **Subsection 203.5**.
- 10 The quantity for the pay item Removal of Existing Guardrail is the length of existing guardrail removed and is measured by the linear foot (LF) of existing guardrail removed as indicated in the Plans or directed by the RCE, complete, and accepted.
- 11 The quantity for the pay item Removal and Disposal of Tank Contents is the volume of the fluid removed from an underground storage tank and disposed of in accordance with SCDHEC regulations and is measured by the gallon (GAL), complete, and accepted.
- 12 The quantity for the pay item Removal and Disposal of Low-Level Contaminated Soil or Removal and Disposal of High-Level Contaminated Soil is the weight of the contaminated soil (as determined by SCDHEC regulations) removed from around an underground storage tank properly and disposed of in

accordance with SCDHEC regulations and is measured by the ton (TON), complete, and accepted.

202.6 Payment

- 1 Payment for the accepted quantity for each pay item, measured in accordance with **Subsection 202.5**, is determined using the contract unit bid price for the applicable item. Payment includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Payment for lump sum pay item Removal of Structures and Obstructions is full compensation for removing and disposing of structures and obstructions as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 If there is no pay item for the removal and disposal of a structure or obstruction indicated on the Plans, no direct payment is made for work necessary to remove and dispose of the structure or obstruction, and the cost for the work is considered included in the contract unit bid price of various other pay items of the Contract.
- 4 The removal and disposal of pipe, pipe arches, tile drains, or other drainage devices not otherwise specified is paid for as Unclassified Excavation in accordance with **Section 203**.
- 5 Any backfill required under this section is paid for as Unclassified Excavation or Borrow Excavation as applicable in accordance with **Section 203**.
- 6 Payment for the accepted quantity for Removal and Disposal of Existing Pavement is full compensation for removing and disposing of the existing brick pavement (with or without asphalt overlay), brick sidewalk, cobblestone pavement, Portland cement concrete pavement (with or without asphalt overlay), Portland cement concrete gutter, Portland cement concrete integral curb and gutter, and Portland cement stabilized base with asphalt concrete overlay as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 7 Payment for the accepted quantity for Removal and Disposal of Existing Asphalt Pavement is full compensation for removing and disposing of existing asphalt pavements with thickness of 2 inches or greater as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 8 Payment for the accepted quantity for Removal and Disposal of Existing Curb is full compensation for removing and disposing of existing concrete, asphalt, or stone curb as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to

complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.

- 9 Overhaul is paid in accordance with **Section 207**, except in conjunction with the following pay items:
- Removal and Disposal of Existing Pavement,
 - Removal and Disposal of Existing Asphalt Pavement,
 - Removal & Disposal of Existing Curb, and
 - Removal & Disposal of Existing Asphalt Curb.
- 10 Payment for the lump sum item Removal and Disposal Item No. (*schedule number*) is full compensation for removing and disposing of items designated by a *Schedule Number* on the Plans and includes the salvage of materials; their custody and preservation; storage on the right-of-way or as designated; and their disposal as specified or directed; and all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 11 Payment for the accepted quantity for Removal of Existing Guardrail is full compensation for removing of existing guardrail as specified or directed and includes dismantling and removing existing guardrail, posts, blockouts, end treatments, and other components; backfilling and compacting postholes; and all materials, labor, equipment, tools, supplies, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract. Payment also includes safely storing and protecting the material until the Department removes the material or until it is removed by the Contractor, whichever is specified in the Contract or directed by the RCE.
- 12 Payment for the accepted quantity for Removal and Disposal of Tank Contents is full compensation for removing and disposing of the fluid contents in underground storage tanks (UST) in accordance with SCDHEC regulations and as specified or directed and includes safely pumping or otherwise emptying the UST; hauling the fluid in approved vehicles; properly discharging it an approved disposal site; and all materials, labor, equipment, tools, supplies, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 13 Payment for the accepted quantity for Removal and Disposal of Low-Level Contaminated Soil or Removal and Disposal of High-Level Contaminated Soil is full compensation for removing and disposing of the material classified as Low-Level or High-Level contaminated soil from around underground storage tanks in accordance with SCDHEC regulations and as specified or directed and includes safely excavating the contaminated material; protecting uncontaminated material on the site; hauling the contaminated material in approved vehicles; disposing of it at an approved site; and all materials, labor, equipment, tools, supplies, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.

- 14 The removal and disposal of the underground storage tank including all piping associated with the UST system and the dispenser island, if applicable, is paid as a Removal and Disposal pay item.
- 15 If the Contract contains the lump sum pay item Clearing & Grubbing within Right-of-Way, then in addition to the work requirements of **Section 201**, payment includes the cost of removing and disposing of items within the clearing and grubbing area in accordance with **Section 202**, except for those items setout specifically as separate pay items in the Contract or as otherwise noted.
- 16 Pay items under this section include the following:

Item No.	Pay Item	Unit
2021000	Removal of Structures and Obstructions	LS
2021200	Removal and Disposal of Tank Contents	GAL
2021205	Removal and Disposal of Low-Level Contaminated Soil	TON
2021210	Removal and Disposal of High-Level Contaminated Soil	TON
2022000	Removal & Disposal Item No. <i>(number)</i>	LS
2023000	Removal & Disposal of Existing Pavement	SY
2024100	Removal & Disposal of Existing Curb	LF
2025000	Removal & Disposal of Existing Asphalt Pavement	SY
2027801	Removal of Existing Guardrail	LF
202810X	Removal & Disposal of Existing Bridge	LS
202850X	Removal & Disposal of Existing Culvert <i>(width)</i> ft. × <i>(height)</i> ft.	EA

SECTION 203

ROADWAY AND DRAINAGE EXCAVATION

203.1 Description

203.1.1 General

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the removal, placement, compaction, and satisfactory disposal of all materials encountered within the limits of the right-of-way and borrow pits necessary for the construction of the roadway. The limits of this work may include intersecting roads, driveways, ditches, channels, parking areas, ramps, and private entrances. This work also consists of the removal and replacement of unsuitable material in the subgrade or under structures, the stripping of the roadway and material pits, and the excavation work necessary for the formation, compaction, and shaping of embankments, subgrade, shoulders, slopes, and intersections.

203.2 Materials

203.2.1 Classification

203.2.1.1 Site Excavation

- 1 Site excavation consists of all excavation necessary to construct the roadway to the typical sections in the Plans. If excavation beyond the typical section line is required, it will be accomplished in accordance with **Subsection 109.4**. Unless otherwise provided, no separate payment is made for overhaul or for the removal and disposal of surplus material. It is the Contractor's responsibility to inspect the site and determine the quantities of material necessary to construct the roadway to the typical sections in the Plans.

203.2.1.2 Unclassified Excavation

- 1 Unclassified excavation consists of roadway and drainage excavation performed under this section regardless of the materials encountered or the manner in which they are removed and includes the work described in **Subsection 203.2.1.3** through **203.2.1.8** unless otherwise provided. When the item Unclassified Excavation is included in the Contract, the bid quantity is only an estimate. It is the Contractor's responsibility to inspect the site and determine the actual amount of unclassified excavation needed to complete the project.

203.2.1.3 Muck Excavation

- 1 Muck excavation consists of the removal and satisfactory disposal of unsuitable material that, in the opinion of the RCE, cannot be excavated using equipment normally utilized in the removal of Unclassified Excavation material. If the item Muck Excavation is not included in the Contract, the unsuitable material is considered Unclassified Excavation.

203.2.1.4 Stripping

- 1 Stripping consists of excavating and stockpiling of material from the ground surface within the roadway that, in the opinion of the RCE, is beneficial to the establishment of permanent vegetation called for later in the project. If Stripping is not a bid item in the Contract, excavation and replacement of this material is measured and paid for as Unclassified Excavation.

203.2.1.5 Surplus Material

- 1 Surplus material consists of the material excavated in order to complete the project and is not required or desired for use on the project. Surplus material may be designated on the Plans or referred to as "waste." Obtain disposal sites and dispose of any surplus material that cannot be accommodated by widening embankments and flattening slopes. Make certain that the disposal sites comply with all regulations governing the disposal of waste material. Secure the necessary permits if disposal sites are located in wetlands and/or floodplains of live streams and rivers. These permits include, but are not limited to, the Federal Water Pollution Control Act (Section 404), the Coastal Zone Management Act permits, and any other applicable federal, state, county, or municipal permits that may be required. Certify in writing to the RCE that all of these requirements have been met before placing any material in a disposal area. Seed disposal areas in accordance with **Section 810** or as required by permit provisions or other pertinent regulations. The contract unit bid price for the initial excavation of the material is full compensation for excavating, hauling, disposing, and seeding any surplus material.

203.2.1.6 Watercourse and Drainage Ditch Excavation

- 1 Watercourse and drainage ditch excavation consists of removing and disposing of material excavated from ditches or stream channels, inlets and outlets to drainage structures. If no item is specifically included in the Contract for excavation of this material, it is considered Unclassified Excavation.

203.2.1.7 Rock Excavation

- 1 Rock excavation consists of igneous, metamorphic, and sedimentary rock that cannot be excavated without blasting or using rippers, hoe-rams, or pavement breakers and also includes all boulders or other detached stones each having a volume of ½ cubic yard or more as determined by physical or visual measurement. If the item Rock Excavation is not included in the Contract, this excavation is measured and paid for as Unclassified Excavation.

203.2.1.8 Borrow Excavation

- 1 Borrow consists of material required for the construction of embankments or for other portions of the work where the elevation of the existing subgrade is less than the subgrade elevation required on the Plans or directed by the RCE. When sufficient borrow material is available entirely within the right-of-way, the work is covered by the item Unclassified Excavation and the material requirements of this subsection do not apply. When it is necessary to bring borrow material from outside of the right-of-way, the work is covered by the

item Borrow Excavation, and the material requirements of this subsection apply to all borrow material used in the work regardless of its origin. The requirements of this subsection are not applicable to in situ subgrade material.

- 2 Borrow Excavation includes hauling, clearing and grubbing pits, securing necessary permits, haul roads, and all other incidental related costs. Restore pits and haul roads to a condition satisfactory to property owners and in compliance with the South Carolina Mining Act.
- 3 A maximum of 25% (by weight) of recycled glass aggregate may be mixed with these materials in constructing the embankment. Use recycled glass that is free of organic and toxic materials, hypodermic needles, and hazardous materials. Ensure that the recycled glass aggregate meets SCDHEC regulations as a non-hazardous material. Do not allow the maximum particle size for recycled glass aggregate to exceed ½ inch. Ensure that the maximum lead content for the glass aggregate is not greater than 5 ppm, and the maximum silver content is less than 5 ppm. Use aggregate meeting the limits established by the EPA for the primary and secondary drinking water standards. Before any glass is incorporated into the work, obtain certified test results showing that the glass meets the requirements listed herein from the glass supplier and furnish this information to the RCE. Only test results that are less than 1 year old at the time they are furnished to the Department are acceptable. Use glass aggregate containing not more than 1% (by weight) of non-glassy material and does not contain any mirror glass.
- 4 Do not use glass aggregate in the top 18 inches of the embankment.
- 5 In order to accurately determine by cross-section the quantity of Borrow Excavation furnished, inform the RCE of the exact location and bounds of the borrow pit or the section of pit if material from the pit is being furnished to projects other than those included in this Contract. Reserve and protect the designated area(s) against use for any purpose other than furnishing the required borrow excavation for completing the project.
- 6 In the top 5 feet of the embankment, use borrow material with a loss on ignition of 1.0% or less when tested according to **SC-T-36**. For borrow material in the top 18 inches of embankment, use materials with a loss on ignition of 0.5% or less when tested according to **SC-T-36**.
- 7 Unless otherwise approved, use borrow material with a maximum dry density of not less than 100 lbs./ft.³ at optimum moisture when tested in accordance with **SC-T-29** in the top 5 feet of any embankment. Do not use any soil for embankment with optimum moisture content greater than 25.0% as defined in accordance with **SC-T-29**.
- 8 Before its use, ensure that the RCE has samples of material being considered for use for embankment or subgrade tested for maximum density and optimum moisture. The maximum density and moisture content will also be checked routinely during construction. At the sole discretion of the DCE, approval may be given to use borrow material that does not meet these loss on ignition, density, and/or moisture requirements. Approval to use such materi-

als in no way relieves the Contractor from any responsibility for meeting the requirements for proof rolling, compaction, or stability.

- 9 In addition to compaction tests, proof roll each layer of embankment material whose elevation is 5 feet or less below the finished subgrade elevation. Perform proof rolling as directed by the RCE in accordance with **Section 211**.
- 10 Soils that are acceptable for use in embankment and as subgrade vary by county. The Department will test soil in accordance with **SC-T-34** and classify it in accordance with AASHTO M 145 to determine suitability when required. Acceptable borrow material for embankment and subgrade is shown below. The acceptability of the material, as outlined below, is based on the county in which the project is located, regardless of the location of the borrow pit. Perform grading operations and sequence with selective grading and cross-hauling so that the best available soils are reserved for the top portions of the embankments.
- 11 The following counties are classified as Group A:
Abbeville, Anderson, Cherokee, Chester, Edgefield, Fairfield, Greenville, Greenwood, Lancaster, Laurens, McCormick, Newberry, Oconee, Pickens, Saluda, Spartanburg, Union, and York.
- 12 In addition to the general restrictions given above, the following restrictions apply to borrow material for work conducted in counties in Group A:
- A. Below the top 5 feet of embankment, any soil that does not meet the description of muck may be used to form embankments as long as it is stable when compacted to the required density.
- B. In the top 5 feet of embankment, only the following soil types are acceptable: A-1, A-2, A-3, A-4, A-5, and A-6
- 13 The following counties are classified as Group B:
Aiken, Allendale, Bamberg, Barnwell, Beaufort, Berkeley, Calhoun, Charleston, Chesterfield, Clarendon, Colleton, Darlington, Dillon, Dorchester, Florence, Georgetown, Hampton, Horry, Jasper, Kershaw, Lee, Lexington, Marion, Marlboro, Orangeburg, Richland, Sumter, and Williamsburg.
- 14 For counties classified as Group B, only the following soil types are acceptable for use as borrow material in the top 18 inches of the embankment:
A-1, A-2-4, A-2-5, A-3, A-4(0), and A-2-6(0).
- 15 For counties classified as Group B, only the following soil types are acceptable for use as borrow material below the top 18 inches of the embankment:
A-1, A-2, A-3, A-4, and A-5.
- 16 For counties classified as Group B, A-6 soil may be used below the top 5 feet of the embankment. Do not use A-7 soil.

203.2.1.9 Station Grading

- 1 When the Contract includes the item Station Grading, include the cost of all the excavation, embankment material, and work required for the construction of the road in the contract unit bid price for this item. Station Grading includes material excavation at intersections, driveways, private entrances, or other miscellaneous excavation necessary for the roadway construction.
- 2 If borrow material is necessary to bring embankments up to a required grade, such borrow material is paid for at the contract bid price for Unclassified Excavation with Overhaul as applicable. When it is necessary to remove unsuitable material in cut sections below the finished subgrade elevation, the material excavated below the finished subgrade is considered Unclassified Excavation with Overhaul as applicable. Likewise, when it is necessary to remove unsuitable material in fill sections before the embankment is constructed, the material excavated is measured and paid for as Unclassified Excavation with Overhaul as applicable. Excavation that is removed from inlet or outfall ditches, stream channels, or from inlets and outlets of structures is measured and paid for as Unclassified Excavation.

203.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

203.4 Construction

203.4.1 General

- 1 Perform all work under this section in conformance with the typical cross-sections shown on the Plans and with the lines and grades established by the RCE.
- 2 Perform all work under this section in a manner that complies with **Subsection 107.26**. Conduct all operations in a manner consistent with good erosion control practices to minimize soil erosion and to the greatest extent practicable to prevent sediment from leaving the site. During all phases of the work, take whatever measures are necessary to control erosion and to minimize the deposition of sediment into adjacent rivers, streams, wetlands, and impoundments.
- 3 The RCE may place limitations on the surface area of erodible material exposed. In order to limit the area of erodible material, the RCE may require that partially completed slopes be brought to the required slope and the seeding be performed at that time in accordance with **Section 810**.
- 4 Comply with the provisions of any required permits for the project that limit the surface area of exposed erodible material.

- 5 Unless otherwise provided, this work also includes the removal and disposal of old pavement, surfacing, curb, gutter, sidewalk, foundations, and structures necessary for the completion of the work.
- 6 Finish the excavation and embankments for the roadway, intersections, and entrances with a reasonably smooth and uniform surface. Do not disturb material outside of the limits of slopes when conducting excavation operations. Before beginning grading operations in any area, complete all necessary clearing and grubbing in that area in accordance with **Section 201**.
- 7 Notify the RCE a sufficient time before beginning excavation in order that the necessary cross-sections may be taken. Do not excavate beyond the dimensions and elevations established and do not remove any material before the staking and cross-sectioning of the site is complete.
- 8 After sufficient clearing and grubbing has been completed and the work has been cross-sectioned and staked, proceed with the excavation and placement of material at locations in a sequence approved by the RCE.
- 9 Use all suitable excavated materials to the greatest extent practicable in the formation of embankment, subgrade, shoulders, and at such other places as directed. Preserve the best materials for use in constructing the top portion of embankments to the greatest extent practicable. Where not practical or the material in the balance is unsuitable, the RCE may require the use of suitable material from other balances.
- 10 Use excavated rock in forming embankments wherever the depth of fill is sufficient to properly contain the rock. Place the rock in accordance with **Subsection 205.4.3**. No payment is made for any material that is excavated beyond the slope stakes set for construction unless such excavation is required in the formation of the embankment or is specifically ordered by the RCE. Unless otherwise directed by the RCE, dispose of surplus material or waste by widening the embankments uniformly and flattening the slopes. If additional areas are necessary to accommodate the surplus or waste material, dispose of the material in accordance with **Subsection 203.2.1**. Do not deposit excavated material above the grade of the finished road unless permitted by the RCE. Do not dispose of excavated material in a manner that causes damage to adjacent property. Do not impair the appearance or symmetry of the roadway.
- 11 When rock is encountered in the subgrade, excavate to a depth of 6 inches below subgrade for the entire width of the roadbed except where a cement modified subbase is specified. If a cement modified subbase is specified, excavate the rock to a depth of 1 foot below subgrade for the width specified on the Plans, or as directed by the RCE. Backfill the resulting excavated areas with suitable material specified by the RCE. Payment is made for both the material excavated and the material used for backfill. The excavated material is paid for as Unclassified Excavation, unless an item Rock Excavation is included, in which case, this material is paid for at the contract unit bid price for Rock Excavation. The backfill material is paid for at the contract unit bid price

of Unclassified Excavation, unless the item Borrow Excavation is included in the Contract, in which case, the backfill material may be paid for as Borrow Excavation if determined applicable by the RCE in accordance with **Subsection 203.2.1.8**.

- 12 Where unstable or other material that in the opinion of the RCE is unsuitable for foundation, subgrade, or other roadway purposes occurs within the limits of the roadway, remove and dispose of such material to the cross-section shown on the Plans or as directed by the RCE and backfill the excavation with suitable material.
- 13 Whenever it becomes necessary to obtain additional excavation to form embankments, the RCE may require that cuts be widened, cut slopes flattened, or grades in cuts lowered in lieu of obtaining material from borrow pits. The widening of cuts or flattening of cut slopes is carried to a uniform width throughout the cut to obtain a uniform and neat appearance. Obtain material from those borrow pits, cuts, backslopes, and ditches designated and previously cross-sectioned by the RCE. Trim borrow pits and leave them in a neat and suitable condition to facilitate the accurate measurement of the material excavated. Where practical, excavate them in a manner so that water does not collect or stand. After taking the final cross-sections, terrace the pits if so directed by the RCE.
- 14 Where suitable earth type base course material, selected material for shoulders, or materials suitable for stabilizing subgrade is encountered in excavation and on areas where embankment is to be placed, whether shown on the Plans or not, salvage and use this material accordingly if directed by the RCE. Materials that are stockpiled for later use in the work is measured and paid for as Unclassified Excavation in addition to payment under the appropriate item for which the material is used.
- 15 Construct watercourses as shown on the Plans or where directed and to the lines, grades, and cross-section established by the RCE. Remove all roots, stumps, rock, and other materials in the sides and bottom of watercourses to conform to the slope, grade, and shape of the required section. Where in the opinion of the RCE it is feasible, place all suitable material excavated from ditches and channels in the embankment. Where not feasible, place the material along the banks within 3 feet of the edge of the watercourse. Spread the excavation or spoil uniformly unless otherwise shown in the Plans or directed by the RCE. Construct ditches or gutters emptying from embankment cuts to avoid erosion of the embankment.
- 16 Ensure that all mail boxes, guide signs, traffic control signs, and traffic warning signs located in disturbed areas are left in a condition equal to or better than existed before excavating operations. Repair any damage caused by excavating operations at no expense to the Department.

203.4.2 Excavating Rock

- 1 If material encountered during roadway excavation appears to belong in the classification of rock excavation as set forth in **Subsection 203.2.1.7**, exca-

vate it according to this subsection. If the item Rock Excavation is not included in the Contract or unless otherwise provided, the material is measured and paid for as Unclassified Excavation.

- 2 Ensure that final breakage of rock excavation conforms with or closely approximates the slope lines shown on the Plans, unless different slope lines are established during construction. Leave the final slopes reasonably smooth and uniform with all loose and overhanging rock removed. Unless otherwise permitted, ensure that no rock projects more than 1 foot beyond the final established slopes.
- 3 Excavate rock to the required elevation for the full width of the roadway as shown on the Plans, or as directed by the RCE. When rock is excavated below the subgrade elevation, backfill to the subgrade elevation with material approved by the RCE. Properly compact and shape such material to the required elevation and cross-section.
- 4 Make certain that the final surfaces of rock excavation under the roadbed can drain sufficiently.
- 5 At any location or area to be pre-split, the RCE may require the firing of short test lines and exposure of the pre-split slope to see that the hole spacing, charge, and resulting blast give the desired results. The RCE reserves the right to require any changes in methods or procedures considered necessary to control the effectiveness of the pre-splitting operation.
- 6 Ensure that the pre-split face does not deviate more than 6 inches from the front line of the drill holes nor more than 12 inches from the back line except where, in the opinion of the RCE, the character of the rock being pre-split will unavoidably result in irregularities.

203.4.3 Maintenance of Excavation

- 1 Maintain the highway in accordance with the provisions of **Subsection 104.7**.

203.5 Measurement

- 1 When included in the Contract, the quantity for the pay item Unclassified Excavation, Rock Excavation, or Borrow Excavation is the volume of material excavated as prescribed and is measured by the cubic yard (CY). The quantity includes the material acceptably excavated and is measured in its original position and determined from cross-sections by the method of average-end-areas, complete, and accepted. The measurement includes:
 - Over-breakage or removal of slides not attributable to carelessness or negligence of the Contractor,
 - Authorized excavation of rock, unsuitable, or unstable materials below grade and the excavation necessary to replace such materials,
 - Excavation of selected materials required by the RCE to be stockpiled and reserved for later use in the project,
 - Material obtained from borrow pits, and

- Authorized excavation under bridges or box culverts exclusive of material classified as Excavation for Structures where bottom slabs have been omitted.
- 2 The volume measured for the construction of a watercourse (i.e. ditch or channel excavation) is the material removed from the end of the structure to the end of the watercourse. It does not include excavation necessary to construct the bridge foundations, but it does include excavation under structures where the RCE directs such work.
- 3 On all projects where the Plan quantity of Unclassified Excavation is computed from cross-sections included in the Plans, no field measurement is needed unless an error in the Plans or calculations is found, there are different site conditions, or a revision to the work is required. Revision to the computed Plan quantity is made in accordance with the following provisions:
- A. Where rock is removed from the subgrade as outlined in **Subsection 203.4.1**, measurements includes both the material excavated and the material used for backfill. However, payment is made only once for the backfill material.
 - B. Where rock is removed as outlined in **Subsection 203.4.2** and unless otherwise provided, the volume is computed from cross-section data taken in the field. Measurements are taken only in areas where rock removal was indicated on the Plans, where it was authorized by the RCE, or where unavoidable over-breakage occurred in accordance with the provisions of **Subsection 203.4.1**. The volume of over-breakage that, in the opinion of the RCE, was avoidable is not included.
 - C. Where the RCE directs the removal of unsuitable or unstable material, mucking, or stripping, as set forth in **Subsection 203.4.1**, the quantity is computed from cross-section data taken in the field. The quantity is computed only in areas where removal of unstable material is authorized by the RCE or indicated on the Plans. Where it is necessary to replace unstable material with borrow, the volume is computed for material removed and for the borrow material to replace it.
 - D. Where it is necessary to use borrow, the quantity of borrow material is computed from cross-section data taken in the field. Where cuts are widened, cut slopes are flattened, or grades in cuts are lowered to obtain borrow material as directed by the RCE, the quantity of borrow material is computed after first deducting the final cross-sectioned area shown on the Plans.
 - E. Where an estimated quantity is shown on the Plans for ditches or channels, the final quantity is computed from data taken in the field.
 - F. Plan quantities are used unless the final grade varies more than 0.3 foot from grade shown on the Plan. If the final grade changes are greater than 0.3 foot, or at the discretion of the RCE, revised quantities are obtained by the method outlined in item D. above.

- G. Aside from any of the reasons state above, the RCE may order a re-check of the Plan quantity for Unclassified Excavation before making final payment. The results of the re-checking may result in an increase or a decrease, but regardless, the results of the recheck are used as the final quantity of Unclassified Excavation.
- 4 The quantity for the pay item Muck Excavation is the volume of the material excavated as prescribed and is measured by the cubic yard (CY), complete, and accepted. The volume is calculated using the average-end-area method. The length for the computation is the actual length of the area along the excavation, and the cross-section areas are formed by the neat lines of the typical cross-section shown on the Plans or established by the RCE. No payment is made for material excavated outside of the neat lines shown on the Plans or as established by the RCE.
- 5 The quantity for the pay item Station Grading is length of the roadway where material excavation at intersections, driveways, private entrances, or other miscellaneous excavation is necessary for the roadway construction and is measured by the station (STA) along the length of the centerline of the road (a station is 100 feet), complete, and accepted. The measurement does not include the length of exceptions to the project, such as the length of bridges, railroads, etc., or as otherwise noted on the Plans.
- 6 When the Contract includes the pay item Site Excavation, the Contractor is responsible for inspecting the site to determine the quantities of material necessary to construct the roadway to the required typical section. No field measurement is made for this item because payment is made on a lump sum (LS) basis.

203.6 Payment

- 1 Unless otherwise specified, payment for the accepted quantity of material excavated as specified herein, measured in accordance with **Subsection 203.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for performing the earthwork prescribed and, if applicable, includes excavating of material; forming and compacting embankments; disposing of surplus or unsuitable material; stripping, preparing, and compacting of subgrade and shoulders; de-watering borrow pits (when necessary), terracing of borrow pits; removing and resetting of mail boxes, guide signs, etc.; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to satisfactorily complete the work in accordance with the Plans, the Specifications, and other terms of the Contract. The payment also includes hauling of the material within the free haul limit of 3000 feet. If the material is hauled beyond the free haul limit, payment for Overhaul as defined in **Section 207** applies in the case of Borrow Excavation furnished by the Department in accordance with **Subsection 203.2.1.8**.
- 2 Where the Contractor is required to furnish the borrow pits, payment for Borrow Excavation includes the cost of the borrow pit, clearing and grubbing of pits, necessary haul roads, hauling of the borrow material to the designated

location on the roadway and for all other pertinent stipulations stated above.

- 3 The accepted quantities for Muck Excavation are only paid for once. No addition payment is made for necessary re-excavation.
- 4 No payment is made for any excavated material used for purposes other than those designated, except material covered in **Subsection 104.9**.
- 5 No payment is made for excavation of rock performed for a depth greater than 6 inches below subgrade unless a Cement Modified Subbase is specified or the RCE specifically authorizes such work. No payment is made for the excavation of rock performed for a width greater than specified unless the RCE specifically authorizes such work.
- 6 Payment for the acceptable quantity for Station Grading includes excavation and embankment as specified or directed and includes all other work specified in **Subsection 203.2.1.9** required for the completion of the work, except for excavation that is specified in **Subsection 203.2.1.2** and paid for as Unclassified Excavation. No payment is made for Overhaul of material excavated on the roadway and used on the roadway.
- 7 Payment for the lump sum pay item Site Excavation includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract. No separate payment is made for any incidental costs associated with this work.
- 8 Pay items under this section include the following:

Item No.	Pay Item	Unit
2031000	Unclassified Excavation	CY
2031200	Site Excavation	LS
2032000	Rock Excavation	CY
2033000	Borrow Excavation	CY
2034000	Muck Excavation	CY
2035000	Station Grading	STA

SECTION 204

STRUCTURE EXCAVATION

204.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the removal and satisfactory disposal of all materials necessary for the construction of foundations and substructures for bridges, box culverts, and other structures when the Plans or the Contract indicate an item of structure excavation performed in conformity to the lines, grades, dimensions, and sections on the Plans or otherwise directed by the RCE.
- 2 This section includes specifications for the design and construction of temporary and permanent structures used to facilitate excavation, including shoring, sheeting, lagging, cribbing and cofferdams (when not itemized in the Contract) and for performing pumping, bailing, draining, backfilling, removal of all bracing, and the disposal of surplus or unsuitable materials.

204.2 Materials

204.2.1 Classification

204.2.1.1 General

- 1 Excavation for structures, except for box culverts and bridge foundations, is considered to be Unclassified Excavation. Unless otherwise provided for on the Plans or in the Special Provisions, excavation for structures performed in connection with foundations of box culverts and bridges are classified under the items in **Subsections 204.2.1.2 through 204.2.1.6.**

204.2.1.2 Structure Excavation for Culverts

- 1 The pay item Structure Excavation for Culverts includes all materials excavated as necessary for the construction of reinforced concrete box culverts within the limits given in **Subsection 204.4.**

204.2.1.3 Dry Excavation for Bridges

- 1 The item Dry Excavation for Bridges includes all materials excavated above the water elevation shown on the Plans, except as provided under **Subsection 204.2.1.6.**

204.2.1.4 Wet Excavation for Bridges

- 1 The item Wet Excavation for Bridges includes all materials excavated below the water elevation shown on the Plans and above the foundation, except as provided under **Subsection 204.2.1.6.**

204.2.1.5 Wet and Dry Excavation for Bridges

- 1 The item Wet and Dry Excavation for Bridges includes all materials excavated when the water elevation is not shown on the Plans, except as provided

under **Subsection 204.2.1.6**.

204.2.1.6 Rock Excavation for Bridges

- 1 The item Rock Excavation for Bridges includes the excavation of hard rock as specified in **Subsection 203.2.1.7**. When the pay item Rock Excavation is included in the Contract, the material meeting the specifications for Rock Excavation is classified as such wherever it is found. All other materials remain unclassified, except for Wet Excavation for Bridges, Dry Excavation for Bridges, and Wet and Dry Excavation for Bridges. In the event that Rock Excavation is not included in the Contract, all materials encountered are classified as Wet, Dry, or Wet and Dry Excavation.

204.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

204.4 Construction

204.4.1 General

- 1 Use all materials excavated for structures for backfilling around the structure and in the formation of embankments, as specified in these specifications wherever suitable or feasible. Otherwise, dispose of the material as directed by the RCE.
- 2 Notify the RCE sufficiently in advance of the beginning of structure excavation so that the cross-sectional elevations and measurements of the existing ground and structure may be taken. No compensation is made for any materials removed or excavated before such measurements are taken.
- 3 Do not start placing concrete or masonry in any foundation excavation until the RCE has examined and approved the depth of the excavation, the suitability of the foundation, and the control of the water and pumping operations.
- 4 Make changes in the elevation of footings or foundations for structures in accordance with the provisions of **Subsection 105.2**.

204.4.2 Preparation of Foundations

- 1 Where feasible, excavate foundations to the outline of the footings shown on the Plans and to sufficient size to permit the placing of the full width and length of the footings shown or indicated. Do not round or undercut corners and edges of footings.
- 2 When concrete is placed on rock, free loose rock or other loose material from the hard foundation. Clean and cut rock into a firm surface that is leveled, stepped, or serrated as directed by the RCE. Cleanout all rock seams and fill with concrete, cement mortar, or grout as directed by the RCE.

- 3 When concrete is placed on a foundation surface other than rock, take special care not to disturb the bottom of the excavation. Fine grade the bottom of the foundation just before placing the reinforcing steel and concrete.

204.4.3 Cofferdams or Cribs

204.4.3.1 General

- 1 When the project Plans require the use of cofferdams for construction of bridge substructure or other elements of work, make certain that the cofferdams comply with the following requirements:
- A. Construct the cofferdam of heavy structural timber and/or structural steel.
 - B. Materials used to construct a cofferdam remain the property of the Contractor. Remove the materials in accordance with **Subsection 204.4.3.3**.
 - C. Ensure that the design and inspection of cofferdams complies with **Subsection 702.4.1**.
 - D. The type of cofferdam (i.e. Type 1, Type 2, etc.) shown in the Contract is based on the theoretical plan volume of the cofferdam and is used by the Department for bidding purposes only. The unit price bid for each cofferdam is full compensation regardless of the actual volume of cofferdam constructed.

204.4.3.2 Construction of Cofferdams or Cribs

- 1 In general, carry cofferdams or cribs for foundation construction well below the bottom of the footings. Ensure that they are well-braced and constructed to permit them to be pumped free of water and kept free of water until all concrete below water has reached its initial set. Except where seals are called for on the Plans, ensure that the interior dimensions of cofferdams are sufficient to give clearance for the construction of forms, inspection of the exterior of forms, and pumping and handling of leakage from outside of the forms. Construct them to protect green concrete against damage from a sudden rising of water and to prevent damage to the foundation by erosion. Leave no bracing in cofferdams or cribs that extend into the substructure without the permission of the RCE.
- 2 Right or enlarge cofferdams or cribs that become tilted or moved laterally to provide ample clearance. No extra compensation is made for this work.

204.4.3.3 Removal of Cofferdams or Cribs

- 1 Unless otherwise provided, remove cofferdams or cribs with all falsework, sheeting, and bracing after completion of the substructure. Remove the cofferdams or cribs without disturbing or marring the finished structure.

204.4.3.4 Foundation Seal

- 1 When, in the opinion of the RCE, conditions are encountered that render it unfeasible to de-water the foundation before placing the concrete, the RCE

may allow the construction of a concrete foundation seal. Before placing the seal, remove all objectionable material from the foundation to the satisfaction of the RCE.

- 2 When foundation piles are to be driven, excavate the foundation for a concrete seal sufficiently below grade to take care of any "heave" in ground line due to the driving of foundation piles. If considered necessary by the RCE, excavate to sufficient depth and backfill with sand or aggregate to avoid contamination by mud. Prepare the elevation of the foundation within 6 inches of the grade shown on the Plans or as established by the RCE. Completely remove earth material in the arched web of the steel sheet piling so that the seal concrete is in full contact with the sheeting in all areas.
- 3 Level the foundation for a concrete seal without foundation piling to within a 5% grade in any direction from one edge to the opposite edge by blasting if necessary and permitted. Remove earth material, loose rock, and small boulders.
- 4 Construct the seal concrete as prescribed in **Subsection 702.4.2.6**. After it has cured sufficiently, de-water the cofferdam, and thoroughly clean the seal of all laitance and other objectionable materials. Place the balance of the foundation concrete in the dry. Unless the Plans or the Special Provisions provide for seals, place such concrete entirely at no expense to the Department.
- 5 When weighted cribs are employed and the weight is utilized to partially offset the hydrostatic pressure acting against the bottom of the foundation seal, provide special anchorage such as dowels or keys to transfer the entire weight of the crib into the foundation seal. When a foundation seal is placed underwater, take satisfactory steps to keep the water level the same on the outside and inside of the cofferdam to prevent pressure on fresh concrete due to a difference in head.

204.4.3.5 Pumping to De-water

- 1 Perform de-watering of a foundation enclosure using a method that prevents any portion of the concrete materials from being carried away. Do not pump water during the placing of concrete, nor for a period of at least 24 hours after placement is complete unless it is done from a suitable sump separated from the concrete work by a reasonably watertight wall.
- 2 Do not start pumping to de-water a sealed cofferdam until the seal has set sufficiently to withstand the hydrostatic pressure. Do not start pumping within 3 days after pouring seal concrete or longer as directed by the RCE.

204.4.4 Backfill

- 1 Ensure that the backfill for structures conforms to the requirements of **Subsection 205.4.2**.

204.4.5 Temporary and Permanent Shoring Wall

204.4.5.1 General

- 1 Design, furnish, install, maintain, and remove (if required by the RCE) the shoring walls at the locations shown on the Plans. A shoring wall may be, but is not limited to one of the following types unless otherwise specified on the Plans:
 - Steel sheet pile wall – braced or tieback,
 - Steel soldier piles with lagging – braced or tieback, or
 - Temporary Mechanically Stabilized Earth (MSE) wall with welded wire form facing and geosynthetic wrap for fill situations.
- 2 Shoring walls may be designated as "*temporary*" due to its limited service life that is typically until construction of a permanent structure (i.e. embankment, bridge abutment, etc.) is complete. Even though the shoring is temporary, it may remain in place at the end of construction due to the impracticality of removing the shoring components (i.e. tie backs, soil reinforcement, etc.) or the potential of damage to the permanent structure that may occur during extraction of the shoring components.

204.4.5.2 Design

- 1 Design shoring walls to resist all dead and live loadings including earth pressures, hydrostatic pressures, traffic loads, point loads, line loads, and surcharge loads that the retaining system may experience during the service life of the structure. Design the shoring walls in accordance with the latest edition of the AASHTO *Standard Specifications for Highway Bridges* with interims and the applicable requirements of **Subsection 702.4.1.2**. Only shoring walls designed, signed, and sealed by a South Carolina registered Professional Engineer are acceptable.
- 2 The Contractor is solely responsible for the external stability of all shoring walls. Include any geotechnical investigation necessary to verify the external stability in the unit price for Temporary Shoring Wall and Permanent Shoring Wall. Limit differential and absolute settlements of walls to ensure minimal detrimental effects.
- 3 Design all shoring walls in accordance with the following design criteria:
 - A. Design Methodology: Ensure all design methodology is in accordance with accepted AASHTO design methodology. Design temporary MSE walls using the Simplified Coherent Gravity method of determining the maximum reinforcement loads, T_{max} . Temporary shoring walls are not required to resist seismic forces from earthquake events.
 - B. Design Life: Design all temporary shoring walls for a minimum of 3 years design life. Design temporary shoring walls that will be in use for more than 5 years as permanent retaining wall structures.

- C. Soil Design Parameters: Design shoring walls using appropriate soil properties relative to the anticipated service life. Design shoring that will be in place for a period where excess pore pressures have not dissipated (typically less than 4 to 6 months) using total (undrained) soil shear strength parameters. Use effective (drained) soil shear strength parameters when temporary shoring walls are in service sufficiently long (typically more than 4 to 6 months) for excess pore pressures to dissipate.
- D. For MSE walls, use the following External Stability Minimum Safety Factors:
- Global Stability Factor of Safety,
 $FS_{Global} = 1.3$
 - Sliding Stability Factor of Safety @ Base,
 $FS_{Base} = 1.5$
 - Sliding Stability Factor of Safety @ Reinforcement,
 $FS_{Reinforcement} = 1.5$
 - Overturning Factor of Safety,
 $FS_{Overturning} = 2.0$
 - Eccentricity,
 $e < L/6$
 Where L = Reinforcement Length for Temporary MSE Walls
 - Bearing Capacity Factor of Safety,
 $FS_{Bearing} = 2.5$
- E. For MSE walls, use the following Internal Stability Minimum Safety Factors:
- Pullout Factor of Safety,
 $FS_{Pullout} = 1.5$
 - Reinforcement Rupture Factor of Safety,
 $FS_{Rupture} = 1.2$
- F. For MSE wall soil reinforcement, select the soil reinforcement length based on the longest soil reinforcement length required to meet the following design requirements:
1. Resist sliding along the wall base or at each soil reinforcement layer with the appropriate safety factor.
 2. The length, L, required for internal stability is the distance required to extend beyond the active zone, L_a , plus the length required to resist pullout in the resistant zone, L_e , with the appropriate safety factor. The minimum embedment in the resistant zone is 3 feet ($L_e \geq 3$ feet).
 3. AASHTO minimum soil reinforcement length requirements (8 feet or $0.7H$, where H is the wall design height). Use soil reinforcement that is the same length, L, for each soil reinforcement layer within a design section. Use a soil reinforcement coverage ratio, R_c , of 1.0 for all types of geosynthetic sheet reinforcement. AASHTO specifications for soil reinforcement performance (pull-out coefficients, degradation, etc.) are based on using AASHTO reinforced backfill specifications. Any deviation in backfill speci-

cations may require additional testing at the Contractor's expense or use of previous test results on similar materials.

- G. For MSE wall geosynthetic reinforcement: The default geosynthetic soil reinforcement total reduction factor, $RF_{Default}$, of 3.5, may be used provided that the geosynthetic manufacturer certifies that the geosynthetic reinforcement meets the requirements of AASHTO Table 11.10.6.4.2b-1. Ensure that geosynthetic reinforcements not meeting the requirements of AASHTO Table 11.10.6.4.2b-1 use a default total reduction factor, $RF_{Default}$, of 5. Use of total reduction factors, RF , less than default reduction factor, $RF_{Default}$, will require that the geosynthetic manufacturer certify and provide supporting documentation (field and laboratory test results), in accordance with AASHTO specifications, of individual reduction factors for installation damage, RF_{ID} , creep strength reduction, RF_{CR} , and material durability, RF_D , for the design life of the wall structure. Provide the geosynthetic soil reinforcement manufacturer's certification of the ultimate tensile strength, T_{Ult} . Ensure that all strength values certified are the minimum average roll value (MARV) for that product. Ensure that all certifications consider the performance of the geosynthetic soil reinforcement in the actual or similar type of reinforced backfill being used.
- H. For Temporary MSE wall facing, design temporary facing with welded wire form and geosynthetic wrap in a manner that prevents the occurrence of bulging in excess of 2 inches when backfill behind the facing elements is compressed due to compaction stresses or self weight of the backfill. Measure bulging as the maximum displacement from the theoretical vertical or sloped face of the temporary MSE wall that extends over a section of 1 foot or more along the theoretical wall face. Design the temporary facing to the same structural requirements as the other components of the temporary MSE wall.
- 4 Submit design calculations, including soil design parameters used, methods of construction, and detailed drawings for all design cases.
- 5 If permanent embankments are to be constructed against the temporary shoring walls, submit a method to prevent reflective cracking at the top of the embankment that may occur at the interface between the two construction phases. This may be accomplished by constructing a soil-reinforced mat below the pavement structure or approach slab that crosses over the two construction phases for sheet pile walls. Horizontal layers of soil reinforcement that crosses the interface between both construction phases at various elevations along the wall may be used for temporary MSE walls with welded wire form facing and geosynthetic wrap.
- 6 Provide all submittals for approval to the RCE at least 30 days prior to construction of the wall. Only submittals that have the seal and signature of the Design Engineer of record, who is a South Carolina registered Professional

Engineer are acceptable.

- 7 Ensure that MSE backfill and wall components (i.e. soil reinforcements, tie backs, etc.) are in conformance with the design of the shoring wall. Include any wall material or wall performance testing (i.e. anchor load testing, etc.) required by the design in the unit price bid for the Permanent and Temporary Shoring Wall.

204.4.5.3 Construction of Shoring Walls

- 1 Construct the shoring wall in a manner that protects adjacent buildings, bridges, roadways, railway, and existing traffic, while allowing construction access for new bridge and roadway embankment construction. Perform backfilling operations around existing piles so that only minimal lateral loads are exerted on existing piles. The Contractor is responsible for any damages or retrofit to adjacent structures that result from the construction of the shoring wall.
- 2 Use wood meeting the requirements of **Section 706** for lagging.
- 3 Use bracing, tiebacks, or other wall components that provide access for new bridge substructure and superstructure construction, while maintaining the existing traffic flow without interruption.

204.5 Measurement

- 1 The pay items involving structural excavation for bridge foundations are determined by the classification of the material excavated as set forth in **Subsection 204.2.1**. The quantities are the volumes of materials actually removed and are measured by the cubic yard (CY), complete, and accepted. The volumes are measured between the original elevation of the ground surface and the bottom of the footings. Material removed outside of an area that is bounded by vertical planes 18 inches outside of and parallel to the neat dimensions of the footings is not included in the quantity, except where specifically authorized in writing by the RCE. Where the excavation begins below the waterline, measurement is from the bottom of the watercourse to the bottom of the foundation, excluding any measurement of water.
- 2 In the case of a permanent structural member such as a strut, diaphragm, beam, or other structural element where it is necessary to excavate in order to place forms, such excavation is included in the volume of structure excavation. However, the limit of structural excavation measurement does not extend more than 12 inches horizontally beyond the sides of the members, nor more than 12 inches below the bottom of the members.
- 3 Where a foundation seal is indicated in the Contract, the quantity for the pay item Wet Excavation for Bridges is the volume of the excavation of material other than water between the bottom of the watercourse and the actual bottom of seal concrete as poured and within the vertical planes of the neat lines of the seal shown on the Plans and is measured by the cubic yard (CY) of excavated material, complete, and accepted.

- 4 The quantity for the pay Structure Excavation for Culverts is the volume of material removed for the construction of the culvert and is measured by the cubic yard (CY) of material, complete, and accepted. The volume is measured between the original elevation of the ground surface and the bottom of the bottom slab, bound by vertical planes located 2 feet outside of and parallel to the outside neat lines of the culvert barrel and extending to 2 feet beyond the ends of the wingwalls. This measurement excludes the material excavated for the wings that are outside the area described above. Measurement of unstable material removed as directed by the RCE as provided in **Subsection 203.4** is not limited to the area described above. Measurement does not include water or other liquid removed.
- 5 If material for backfill is required because of the removal of unstable material below grade is obtained from the roadway or material pits, it is included in the measurement for Unclassified Excavation. Material necessary for backfill obtained from sources other than the roadway and material pits is considered as being equal to the volume of the unstable material removed and is measured as provided in **Subsection 203.5**. No direct allowance is made for overhaul or shrinkage for material to backfill undercut areas.
- 6 The quantity for the pay Structure Excavation for Retaining Walls is the volume of material removed between the original elevation of the ground surface and the bottom of the footing and enclosed by vertical planes located 12 inches outside of and parallel to the neat lines of the footings and is measured by the cubic yard (CY), complete, and accepted.
- 7 The quantity for the pay item Cofferdam or Cofferdam – Type (1, 2, 3, 4, 5, or 6) is measured by each (EA) cofferdam constructed and de-watered in accordance with the Plans, complete, and accepted. The type is based on a theoretical range of the volume contained in the cofferdam. No adjustment is made for differences between theoretical and actual volume of the cofferdam constructed.
- 8 The quantity for the pay item Permanent Shoring Wall or Temporary Shoring Wall is the length of the shoring wall and is measured by the linear foot (LF) along the actual horizontal length of the shoring wall, complete, and accepted.

204.6 Payment

- 1 Payment for the accepted quantity of each pay item, measured or determined as provided in **Subsection 204.5**, is determined using the contract unit bid price for the applicable pay item. The payment is full compensation for all direct and indirect costs and expenses necessary for the successful completion of excavation to the depth indicated on the Plans, in the Specifications, or directed by the RCE.
- 2 If it is necessary and approved by the RCE to carry a foundation more than 5 feet, but not more than 10 feet below the Plan elevation for any individual footing, payment for the excavation work performed below the elevation of the waterline within these limits is determined using an adjusted unit price equal

to 150% of the contract unit bid price for the applicable classification of excavation.

- 3 If it is necessary and approved by the RCE to carry a foundation more than 10 feet below Plan elevation for any individual footing, payment for the excavation work performed below the elevation of the waterline is made at a adjusted unit price equal to 200% of the contract unit bid price for the applicable excavation. The payment includes the cost of removing cofferdams, cribs, sheeting, backfill, and disposing of surplus material. Excavation is paid under one classification only once and no allowance is made for necessary re-excavation.
- 4 Payment for Structure Excavation for Culverts is full compensation for excavating of material necessary for the construction of box culverts as specified or directed and includes removing and disposing of unstable material and backfill material obtained from sources outside the limits of the roadway, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 5 Payment for Cofferdam or Cofferdam – Type (1, 2, 3, 4, 5, or 6) is full compensation for the design and construction of the cofferdam as specified or directed and includes installation of cribs, caissons, or sheetpiling; de-watering; underwater inspection; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract. Cofferdams are paid at 100% of the contract unit bid price after the cofferdam is de-watered.
- 6 Payment for the accepted quantity for Temporary Shoring Wall or Permanent Shoring Wall is full compensation for constructing of shoring walls as specified or directed and includes preparing the design and necessary drawings; providing and installing sheetpiling, soldier piles and lagging, bracing, shoring, tie-backs, or MSE wall backfill and components (if required); installation, maintenance, removing the temporary shoring; and all other material, labor, equipment, tools, supplies and other items or incidental work necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 7 Pay items under this section include the following:

Item No.	Pay Item	Unit
2041000	Structure Excavation for Culverts	CY
2041005	Structure Excavation for Retaining Wall	CY
2042000	Dry Excavation for Bridges	CY
2043000	Wet Excavation for Bridges	CY

(table continued on next page)

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Item No.	Pay Item	Unit
2043500	Wet & Dry Excavation for Bridges	CY
2044000	Rock Excavation for Bridges	CY
2045000	Cofferdam	EA
2045010	Cofferdam - Type 1 (0 – 10,000 CF)	EA
2045020	Cofferdam - Type 2 (10,001 – 20,000 CF)	EA
2045030	Cofferdam - Type 3 (20,001 – 30,000 CF)	EA
2045040	Cofferdam - Type 4 (30,001 – 40,000 CF)	EA
2045050	Cofferdam - Type 5 (40,001 – 50,000 CF)	EA
2045060	Cofferdam - Type 6 (>50,000 CF)	EA
2047000	Temporary Shoring Wall	LF
2047210	Permanent Shoring Wall	LF

SECTION 205

EMBANKMENT CONSTRUCTION

205.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the formation of embankments in accordance with these specifications and in conformance with the lines, grades, and cross-sections on the Plans or established by the RCE. This work also includes preparation of the areas on which they are placed; the construction of dikes or other necessary embankment formations within or outside the right-of-way; the placement and compaction of approved material within roadway areas where unsuitable material has been removed; and the placement and compaction of embankment material in holes, pits and other depressions within the roadway area. Embankment construction also includes restoration, compaction, stabilization of the embankment, and the disposition of surplus and unsuitable material.

205.2 Materials

- 1 Unless otherwise provided, construct embankments of materials meeting the requirements of **Sections 203** and **204**.

205.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

205.4 Construction

205.4.1 General

- 1 Comply with the provisions of permits for the project that limit the surface area of exposed erodible material.
- 2 Perform work under this section in a manner that ensures compliance with **Subsection 107.26**. Conduct operations in a manner consistent with good erosion control practices that minimizes soil erosion and to the extent feasible that prevents sediment from leaving the site. Take all measures necessary to control erosion and to minimize the transportation of sediment into adjacent watercourses, wetlands, and impoundments throughout the life of the project.
- 3 To limit the surface area of erodible material exposed, the RCE may require that partially completed slopes be brought to the required slope and the seeding be performed at that time in accordance with **Section 810**.
- 4 Do not place rocks, broken concrete, or other solid materials in embankment areas where piling is to be driven. Likewise, do not construct the top 6 inches of embankments with any material larger than can pass a 3-inch sieve.

205.4.1

205.4.2

- 5 Use all suitable site-excavated material for the formation of embankments, subgrade, shoulders, approaches, intersections, and drives and for backfilling around structures. Perform the work in a manner and sequence with selective grading and necessary cross-hauling so that the most suitable soil is reserved for topping the embankments to the extent practicable.
- 6 Maintain the embankment as provided in **Subsections 104.7** and **205.4.7**.
- 7 Complete all clearing and grubbing in accordance with **Section 201**. Fill and compact stump holes and depressions before proceeding with the embankment construction.
- 8 Construct embankment by placing, spreading, and compacting the material in successive, uniform, horizontal layers of not more than 8 inches in depth (loose measurement) for the full width of the cross-section except as specified in **Subsection 205.4.3** where the depth may exceed 8 inches. Perform compaction in accordance with **Subsection 205.4.6**. Keep each layer of the embankment material uniform and shaped to drain for the full width of the cross-section by the use of blade graders, bulldozers, or other suitable equipment.
- 9 Where the embankment is constructed in low, undrained areas or where the earth material on which the embankment is constructed has a low support value, the RCE may permit the depth of the first layer to exceed 8 inches. Unless otherwise provided, do not use dragline casting in constructing embankments unless the material so handled can be placed in layers and compacted as specified.

205.4.2 Embankment Over and Around Structures

- 1 Do not place fill against a new masonry, abutment, wingwall, retaining wall, or culvert or over a box culvert, pipe culvert, bridge, or arch, until permission is given by the RCE. Do not backfill to full height behind new structures that causes unbalanced earth pressure until the concrete has cured for at least 14 days. If not subject to unbalanced earth pressure, backfill around piers or bents may be placed after the concrete has cured for at least 3 days. Do not place embankment around and over concrete box culverts or retaining walls until the concrete has cured for at least 14 days unless tests of field cured cylinders indicate that the concrete has obtained the required strength. When backfilling around box culverts, once the backfill is brought higher than one-half of the height of the box continue backfill immediately to provide a cover of not less than 12 inches over the top slab. Use thoroughly tamped select material or flowable fill for backfilling over and around pipes, culverts, arches, bridges, or other structures.
- 2 Deposit fill around culverts, bents, and piers, and fill below the natural ground surface at abutments, wings, and retaining walls on both sides to approximately the same elevation at the same time. As the work progresses, check piers or bents for proper location. Do not allow displacement of piers or bents. If displacement occurs, take corrective measures as required and approved by the RCE at no additional cost to the Department.

- 3 Place fill at arch structures in horizontal layers, symmetrically from haunch to crown, and simultaneously over and against all piers, abutments, and arch rings.
- 4 Take special precaution to prevent wedging action of filling material against structures. If directed, modify back slopes of excavation by stepping or serration.

205.4.3 Rock Embankment

- 1 Where rock is used for embankment, do not allow large stones to nest, and ensure that they are distributed over the area to avoid pockets. Fill voids carefully with small stones. Compose the final 2 feet of the embankment just below the subgrade elevation of suitable material placed in layers not exceeding 8 inches (loose measurement) and compacted to the required density.
- 2 Where the depth of an embankment exceeds 5 feet and consists entirely of rock, deposit the rock in lifts not to exceed the maximum size of the material being placed, but in any event, do not exceed 4 feet. For any particular lift, deposit the rock on the lift being constructed and push over the end of the lift by means of bulldozers or other approved equipment. Do not dump rock over the end of any lift directly from hauling equipment. If the voids of the last lift are not sufficiently closed, choke the material with small broken stone or other suitable material and compact as directed.
- 3 Where the depth of embankment is 5 feet or less, or where the material being placed does not consist entirely of rock, place the material in lifts not to exceed the maximum size of the rock being placed, but in any event, do not exceed 2 feet. Choke each layer thoroughly with broken stone or other suitable material and compact to the required density or as directed.
- 4 When a rock fill is placed over a structure, first cover the structure with a minimum of 2 feet of properly compacted earth or other approved material before the rock is placed. Place this covering in accordance with **Subsection 205.4.2**.

205.4.4 Embankment on Hillsides and Slopes

- 1 Before the embankment is placed on hillsides or against existing embankments, plow, deeply scarify, or bench the existing ground surface depending upon the slope of the existing ground or embankment. When the existing slope is steeper than 3:1 measured at right angles to the roadway, bench the area continuously in not less than 12-inch rises. Ensure that the benching is of sufficient width that the embankment may be brought up in layers. Begin each horizontal cut at the intersection of the ground line and the vertical face of the previous bench. Perform all such precautionary work as directed. No direct payment is made for the plowing, scarifying, or benching. Include those costs in the various pay items of the Contract.

205.4.5 Embankment over Existing Roadbeds

- 1 If the embankment for a new pavement is placed over an existing rigid pavement or over a pavement having a concrete base (or in other cases when required) and the top of the existing pavement is less than 12 inches below the subgrade elevation of the proposed new pavement, remove the existing pavement, including any concrete base, in accordance with the requirements of **Section 202**.
- 2 If embankment for a new pavement is placed over an existing rigid pavement, such as concrete pavement, concrete base with asphaltic concrete overlay, cement stabilized bases with asphaltic concrete pavement, or brick or cobblestone pavement with or without asphaltic concrete overlay and the top of the existing pavement is more than 12 inches, but less than 2 feet below the subgrade elevation of the proposed new pavement (or in other cases, when required), break, plow, and re-compact the old pavement when so directed. When directed, break the pavement so that the area of any individual unbroken slab or section does not exceed 1 square yard. No direct payment is made for this breaking, plowing and compacting of existing pavement. Include these costs in the various pay items of the Contract.
- 3 If embankment for new pavement is being placed over an existing flexible type base and pavement, and the top of the existing pavement 12 inches or less below the subgrade elevation of the proposed new pavement, remove the existing pavement in accordance with the requirements of **Section 202**.
- 4 If embankment is being placed over a flexible type base and pavement, and the top of the existing pavement is more than 12 inches, but less than 2 feet, below the subgrade elevation of the proposed new pavement, when directed, loosen (scarify) and re-compact the existing pavement for its full depth to prevent the possible trapping of water above the existing surface and to eliminate cleavage planes. No direct payment is made for this loosening and compacting. Include these costs in the various pay items in the Contract.

205.4.6 Embankment Compaction

- 1 Compact each layer of embankment to not less than 95.0% of maximum density before successive layers are applied unless otherwise provided. Accomplish the compaction by using suitable construction procedures while the material is at suitable moisture content. **SC-T-29** is used to determine the maximum densities.
- 2 On projects where the base and pavement are scheduled for construction under a later contract, compact each layer of embankment specified above.

205.4.7 Maintenance and Stability

- 1 Maintain embankments to the grade and cross-section shown on the Plans or as established by the RCE until the completion and acceptance of the project.

- 2 Until final acceptance, maintain the stability of all embankments made under the Contract and replace any portion that, in the opinion of the RCE, has become displaced or damaged. If in the opinion of the RCE the displacement or damage is due to negligent work on the part of the Contractor, perform all replacement and other approved remedial work without additional compensation. If the work has been properly constructed, completely drained, and properly protected, and damage to the embankment occurs due to unusual natural causes such as storms greater than a 10 year event, payment is made at the contract unit bid price for the items necessary in making the repairs or replacement.

205.5 Measurement

- 1 Unless otherwise included in the Contract, embankments themselves are not measured for payment directly and are considered a result of the work for pay items included in **Sections 203 and 204**.

205.6 Payment

- 1 Unless otherwise included in the Contract, there is no direct payment for embankments. Payment is made for items in **Sections 203 and 204**, which are used in the construction of embankments in accordance with this specification. The payment for such items is full compensation for providing all material, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.

SECTION 206

EMBANKMENT IN-PLACE

206.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the construction of embankments by dredging and pumping acceptable material from rivers, canals, or other areas or by excavating, loading, and hauling acceptable material from pits and depositing such material at locations shown on the Plans in accordance with these specifications and in conformity with the lines, grades and cross-sections indicated on the Plans or as established by the RCE.

206.2 Materials

206.2.1 Hydraulic Construction Material

- 1 When hydraulically constructing embankments, excavate the materials used in the embankment by dredging from nearby areas if so designated on the Plans or in the Special Provisions. Form the embankment using a material consisting of sand, marl, or clay marl with a maximum of 25% by weight of the materials passing the No. 200 sieve. Place no muck or other objectionable material in the embankment that exceeds the maximum allowable percentage stated above. Determine the quantity of material passing the No. 200 sieve by the wash method. Dispose of all unsuitable material in a manner and at a location satisfactory to all parties concerned.

206.2.2 Hauling-In Construction Material

- 1 When using hauled-in material to construct embankments, submit the proposed material for this work to the RCE for review prior to use. Take samples for approval of hauled-in material from the roadway after mixing and shaping has been completed but before initial compaction. Any samples submitted to the OMR that are obtained at a borrow pit will be tested for potential use on the project, and the results will be furnished to the Contractor for information only. The Department will not accept borrow material based on samples obtained from pits. Locating and obtaining suitable soils for hauled-in material is the sole responsibility of the Contractor.
- 2 In all aspects, ensure that material in this work conforms to the requirements of **Subsection 203.2.1.8**.

206.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

206.4 Construction

206.4.1 General

- 1 Unless otherwise provided, construct embankment in-place by hydraulic means or by using material hauled in from pits.
- 2 Without additional compensation, furnish the necessary borrow pits and haul roads; restore the premises over which a haul road has been constructed; procure necessary dredging permits and other necessary permits; comply with the laws and regulations pertaining to dredging and pollution; and remove and dispose of the stripping from pits.
- 3 Perform all work under this section in a manner compliant with **Subsection 707.26**. Conduct all operations in a manner consistent with good erosion control practices to minimize soil erosion and, to the extent feasible, prevent sediment from leaving the site. Throughout the life of the project, take all necessary measures to control erosion and to minimize the deposition of sediment into adjacent watercourses, wetlands, and impoundments.
- 4 Comply with the provisions of any required permits for the project, which limit the surface area of exposed erodible material.
- 5 In order to limit the area of erodible material, the RCE may require that partially completed slopes be brought to the required slope, and the seeding work be performed at that time in accordance with **Section 810**.

206.4.2 Hydraulic Construction

- 1 When the embankment is hydraulically constructed, the RCE may, in order to prevent possible slides and maintain a buffer zone, limit the distance between the pit furnished by the Contractor and the right-of-way line. The RCE will approve the location of the pit. In general, do not excavate or dredge material within 300 feet of the toe of the proposed embankment.
- 2 Carry embankment ahead in a continuous section to the greatest extent practicable. In order to obtain a compact fill of acceptable material throughout the embankment volume, use every precaution to prevent muck from being trapped within the fill section.
- 3 Remove unstable material well in advance of placing the embankment material. Move the unstable material a sufficient distance away from the excavation site to permit taking final cross-sections outlining the limits of the removed unstable material, and ensure that the embankment material does not come in contact with the unstable material.
- 4 Use a method of construction that does not produce slopes steeper than indicated on the Plans. After a method such as baffles is used, remove all retaining devices and fill and thoroughly compact any holes left in embankment.
- 5 Provide earth dams, timber baffles, or other means necessary to prevent damage to property beyond the right-of-way.

- 6 The use of a reasonable amount of the excess material placed outside of the prescribed slopes is allowed for raising the fill and dressing slopes. When such excess material is used to raise the embankment 2 feet or more, form and compact the raised portion as specified in **Section 205**.
- 7 Remove any material that is allowed to invade channel openings left in the embankment for structures without extra compensation to provide the same depth of channel as existed before the construction of the embankment.
- 8 If dredge material is stockpiled and later hauled to the site, perform the construction of the embankment in accordance with **Section 205** and **Subsection 206.4.3**.

206.4.3 Construction Using Hauled-in Material

- 1 When constructing embankment in-place using hauled-in material, construct the embankment in accordance with the requirements of **Section 205**. After the embankment is constructed to an elevation that is not subject to the action of ground water, compact the hauled-in material in layers to not less than 95.0% of maximum density determined in accordance with **SC-T-29**. When the embankment being constructed is subject to ground water, do not use a material that is not stable under such conditions.
- 2 Remove unstable material well in advance of placing the embankment material. Move the unstable material a sufficient distance away from the excavation site to permit the taking of final cross-sections outlining the limits of the removed unstable material, and ensure that the embankment material does not come in contact with the unstable material.
- 3 When using glass aggregate in embankment material, spread the glass aggregate uniformly on the uncompacted layer of hauled-in material. Perform the spreading in such a manner so that the finished embankment conforms to the lines, grades, dimensions, and typical cross-sections shown on the Plans or as directed by the RCE. Then, thoroughly mix the glass aggregate material with the hauled-in material to a depth specified by the RCE. During the mixing operation, add sufficient water as necessary to bring the moisture content to the optimum level to ensure proper compaction. Spread and shape the mixture of the soil and the glass aggregate to a uniform thickness. While at optimum moisture content, consolidate the material until the glass aggregate is bonded and the embankment thoroughly and satisfactorily compacted. Ensure that the result of the work is a uniform, dense surface, free from loose material.

206.4.4 Maintenance and Stability

- 1 Adhere to maintenance and stability requirements in **Subsection 205.4.7**.

206.5 Measurement

- 1 The quantity for the pay item Embankment In-Place is the volume of the fill material used to construct the embankment as prescribed and is measured by the cubic yard (CY), complete, and accepted. The volume is calculated by

the average-end-area method. The length for computation is the actual length of the embankment accepted and the cross-section area for the calculation is the neat area of the cross-section shown on the Plans, which is the area above the original ground line determined before the placing of any fill material and below the subgrade elevation and slopes. If the Plans or the Special Provisions require or the RCE so directs, the cross-section area of unstable or unsuitable material removed from underneath the roadbed (i.e. the trapezoidal area below the original ground line shown on the Plans or stated in the Special Provisions) is included in the cross-section area for the calculation. Embankment material used to replace material excavated beyond the lines and grades shown on the Plans or directed by the RCE is not measured or considered in the quantities unless the RCE specifically authorizes the placing of such material in writing.

- 2 When required, the removal of unstable material is measured and paid under items provided and as specified in **Section 203**.
- 3 It is the Contractor's responsibility to estimate the volume of material actually necessary for constructing the embankment to the cross-section shown or designated on the Plans. No payment is made for materials that may be deposited or flow outside the neat lines as described above.

206.6 Payment

- 1 Payment for the accepted quantity of Embankment In-Place, determined in accordance with **Subsection 206.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for constructing the embankment as specified or directed and includes acquiring borrow pits; obtaining permits; stripping borrow pits; haul roads; excavating, hauling, dredging, pumping, and placing of material; subsidence and maintenance of the embankment (complete); disposing of all unsuitable material and effluent water from the embankment area; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for Overhaul is not made for material used in the construction of embankments under this section.
- 3 Unless otherwise indicated in the Contract, no payment is made for any clearing and grubbing of the pit areas involved in the construction of embankments. If the items Clearing and Grubbing within the Right-of-Way or Roadway are not included in the Contract, include the cost of clearing and grubbing in the contract unit bid price for Embankment In-Place.
- 4 Payment for this item includes all direct and indirect costs and expenses required to complete the work.

206.6

206.6

5 Pay items under this section include the following:

Item No.	Pay Item	Unit
2061000	Embankment In-Place	CY

SECTION 207

OVERHAUL

207.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for Overhaul, which is the hauling of locally excavated material more than 3000 feet in performance of the work in the Contract.

207.2 Materials

- 1 None specified.

207.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

207.4 Construction

- 1 None specified.

207.5 Measurement

- 1 The quantity for the pay item Overhaul is the product of the volume of the material, in cubic yards, multiplied by the distance, in half-mile units, that the material was moved as determined below and is measured by cubic yard half-mile (CYHM), complete, and accepted.
- 2 There is a free haul distance of 3000 feet in which no overhaul is measured or paid. The distance is measured for payment is the distance between the centers of the material volume moved from its original location to its final location minus the free haul limit of 3000 feet. In other words, the first half-mile unit of overhaul applies to material hauled more than 3000 feet, but less than 5640 feet. The second half-mile unit of overhaul applies to material hauled more than 5640 feet, but less than 8280 feet, etc. The overhaul distance is based on the shortest feasible route. Any part of the overhaul distance not regarded by the RCE as reasonably necessary is disregarded in computing the overhaul quantity.
- 3 The measurement of the volume of material in the Overhaul quantity is calculated by the same method prescribed in these specifications for measuring the volume of earthwork material for payment.
- 4 When the Plan quantity for Overhaul of roadway excavation have been computed and are shown on the Plans, the final pay quantity for the roadway overhaul is an adjusted amount based on the original Plan quantity. The adjusted quantity is computed by multiplying the original Plan quantity of road-

way overhaul by the final roadway excavation, and then dividing this result by the original roadway excavation. When the Contract contains more than one road, each is considered separately. See the formula below.

$$\text{Adjusted Overhaul (CYHM)} = \frac{\text{Original Roadway Overhaul (CYHM)} \times \text{Final Roadway Excavation (CY)}}{\text{Original Roadway Excavation (CY)}}$$

- 5 On projects where the excavation within the roadway is not sufficient to construct the project, the additional material that is excavated from areas other than the roadway is not considered in the determination of the adjusted overhaul quantity. If the additional material is excavated from within the roadway area, measurement of the Overhaul for the additional material is made as provided above.

207.6 Payment

- 1 Payment for the accepted quantity of Overhaul, as determined in **Subsection 207.5**, is determined using the contract unit bid price for Overhaul. The payment is full compensation for all costs for hauling designated material beyond the free haul limit of 3000 feet and includes all direct and indirect costs and expenses required to satisfactorily complete the work.
- 2 On secondary road projects where Plan quantities are paid as Unclassified Excavation, the quantity of Overhaul is the quantity shown in the balances on the Plans where such quantity is obtained by balancing excavation. Where it is necessary to borrow or to raise or lower the grade more than 0.3 foot from Plan grade, the adjusted quantity of Overhaul is computed in accordance with **Subsection 207.5**.
- 3 Payment is not made for haul of material excavated by dredge, material excavated from pits or fields where the Contract requires that the Contractor furnish the material pits, or material placed in an embankment for which payment is made under the item of Embankment In-Place.
- 4 Pay items under this section include the following:

Item No.	Pay Item	Unit
2071000	Overhaul	CYHM

SECTION 208

SUBGRADE

208.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the construction and preparation of the subgrade intended to receive the pavement structure, sidewalk, curb, curb and gutter, and shoulders.

208.2 Materials

- 1 None specified.

208.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

208.4 Construction

208.4.1 General

- 1 Remove all soft, unstable, or unsuitable material that does not compact readily. Replace this material with satisfactory material as directed by the RCE. Remove or break off all objectionable loose rock or boulders to a depth of not less than 6 inches below the surface of the subgrade. Fill all holes, ruts, or depressions that develop in the subgrade with approved material, bring the subgrade to line and grade, and properly compact. Perform this work without any additional compensation. If the subgrade is too dry to compact properly, sprinkle with water to wet it, if deemed desirable by the RCE, to secure proper compaction.
- 2 Compact the subgrade between lines 18 inches outside the area occupied by the pavement structure, including curb and gutter and sidewalk as applicable, to not less than 95.0% of maximum density. Accomplish the compaction by using suitable construction procedures while the subgrade is at suitable moisture content. Maximum densities are determined by either **SC-T-25** (Method A or C as applicable) or **SC-T-29**.
- 3 On projects where the base and pavement are constructed under a later contract, compact the subgrade as specified above to not less than 95.0% density.
- 4 When any portion of the subgrade is constructed on an old roadbed that conforms to or approximates the elevation of the subgrade, scarify and grade the existing surface as directed by the RCE so that the subgrade has a uniform density when compacted.

208.4.2 Protection and Maintenance

- 1 Maintain the subgrade in a smooth and fully compacted condition, free from ruts and depressions, and adequately drained. Storing or stockpiling of materials directly on the subgrade is not permitted without the prior approval of the RCE.
- 2 Never, under any circumstances, place any base, surface course, or pavement before the subgrade is checked and approved by the RCE.
- 3 Never, under any circumstances, place any base, surface course, or pavement on frozen, muddy, or unstable subgrade.

208.4.3 Fine Grading

- 1 After all earthwork is substantially complete and all drains and structures completed and backfilled and the subgrade compacted to the satisfaction of the DCE, make certain that the subgrade conforms to the lines, grades and cross-sections shown on the Plans or as established by the RCE.
- 2 Ordinarily the costs necessary to complete fine grading of the subgrade are included in other items of work. Typically, these costs are included in excavation items or other items that may be subject to increases or decreases from the plan quantities as field conditions dictate. In order to alleviate this issue, an item, Fine Grading, has been established and may be included in the Contract at the discretion of the Department.
- 3 Fine Grading is defined as the work necessary to bring the in-place earth material into the final shape and compacted condition prescribed in the Contract documents. The area considered for Fine Grading is the area described in **Subsection 208.4.1**, which extends laterally 18 inches beyond the pavement structure.

208.5 Measurement

- 1 The quantity for the pay item Fine Grading is the surface area of the subgrade that is constructed and prepared for the intended pavement structure, sidewalk, and shoulders and is measured by the square yard (SY), complete, and accepted.
- 2 If the pay item Fine Grading is not included in the Contract, the grading work is not measured for payment directly and is considered included in contract unit bid price of the various other items of work.

208.6 Payment

- 1 Payment for the accepted quantity for Fine Grading, measured in accordance with **Subsection 208.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for grading and forming the subgrade as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.

208.6

208.6

2 Payment for this item includes all direct and indirect costs and expenses necessary to complete the work.

3 Pay items under this section include the following:

Item No.	Pay Item	Unit
2081001	Fine Grading	SY

SECTION 209

SHOULDERS AND SLOPES

209.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the excavating, hauling, placing, and maintaining of approved materials on shoulders in accordance with these specifications and in conformity with the lines, grades, and typical cross-sections shown on the Plans or as specified. It also includes excavating, hauling, placing, and maintaining approved material on cut and fill slopes or other designated areas.
- 2 It is the intent of this specification that the best available materials be utilized in the construction of shoulders and slopes in order to enhance the establishment of permanent vegetation and minimize the effects of erosion on the project.

209.2 Materials

- 1 Obtain the material used in the construction of shoulders and slopes from the following locations:
 - Stockpiles of material stripped from within the right-of-way in the grading operation,
 - Areas outside of the cut or fill slopes in the right-of-way,
 - Stockpiles of material stripped from borrow pits,
 - Select material pits, or
 - Areas of roadway and drainage excavation.
- 2 Selected material for shoulders or slopes consists of a friable material such as topsoil, etc. containing grass roots and having the properties of being comparatively porous, capable of growing grass, and of a stable nature in that when compacted resists erosion and is capable of supporting vehicles when relatively wet.
- 3 Salvage material from the roadway to the extent that it is available. Furnishing material from outside of the right-of-way for this purpose is not required unless otherwise specified. The provisions of **Subsection 104.9** that require the replacement of material removed and used on the project are not applicable for this construction operation.
- 4 Use material available from cut sections before considering material from fill sections. However, removal of material from fill sections is allowed if additional material is needed. If material is removed from fill sections, notify the RCE in sufficient time before beginning excavation in order that the necessary cross-sections may be taken.

- 5 When an item of Borrow Excavation is included in the Contract, strip the borrow pit and stockpile the suitable material for future use if this does not contradict any agreement with the property owner, affect the restoration of the pit site, or affect compliance with the South Carolina Mining Act.
- 6 When required by the Contract, provide the material pits and necessary haul roads. No payment for haul is made in this instance.
- 7 When the quality of material described above is not available, use suitable material from ordinary roadway and drainage excavation for shoulders and slopes. However, no compensation under this item of work is allowed.

209.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

209.4 Construction

209.4.1 General

- 1 Shape, trim, and compact the shoulders and slopes in proper sequence for the type of base or surfacing being constructed. Perform this work so that the shoulders, adjacent ditches, and slopes are adequately drained at all times.
- 2 Compact all shoulders on earth-type base courses for a width of 18 inches adjacent to the base or surface course along with the base course.
- 3 In the case of concrete base or concrete pavement, construct the shoulders immediately upon the expiration of the curing period. For other types of base or surface courses, perform the shoulder work prior to or during the construction of these courses or as soon thereafter as directed by the RCE.
- 4 Scarify and terrace selected material pits as directed by the RCE as soon as feasible after the material is removed. Perform all terracing work in accordance with the standard practices as recommended by the USDA Natural Resources Conservation Service (NRCS).

209.4.2 Maintenance

- 1 Maintain the shoulders, slopes and other designated areas by preserving, protecting, replacing and doing such other work as may be necessary to keep the work in a satisfactory condition until the project is accepted.

209.5 Measurement

- 1 The quantity for the pay item Select Material for Shoulders and Slopes is the volume of the approved materials placed and compacted to bring the shoulders and slopes up to the required lines, grades, and cross-section and is measured by the cubic yard (CY) of material, complete in-place, and accepted.

- 2 In cases where it is not feasible to measure the compacted in-place volume, it is measured on the cubic yard basis in loose volume at the point of delivery on the road by scaling and counting the loads, with a 25% deduction for shrinkage.
- 3 When selected material for shoulders and slopes is placed on irregular areas where it is not feasible to determine the volume of the soil compacted in place, in lieu of scaling and counting the loads, the RCE may designate pit areas from which to obtain selected material for shoulders and slopes and take measurements in accordance with **Subsection 203.5**. When measurement is made of the material in its original position, no deduction is made for shrinkage. This method of measurement is not allowed when the depth of the pit excavation is less than 18 inches.
- 4 Material used in the construction of shoulders, other than that obtained from sources specified in **Subsection 209.2**, is not measured or paid under the item Select Material for Shoulders and Slopes. When the material used in the shoulders and slopes consists of ordinary roadway or drainage excavation the material is measured as Unclassified Excavation.

209.6 Payment

- 1 Material in shoulders and slopes is paid under this item only when the selected material placed consists of material described and measured as provided in **Subsection 209.5**.
- 2 Payment for the accepted quantity for Select Material for Shoulders and Slopes, measured in accordance with **Subsection 209.5**, is determined using the contract unit bid price for the pay item. When the pay item is not included in the Contract or the material is not as specified, payment is determined using the contract unit bid price for Unclassified Excavation or Borrow Excavation, as applicable. Payment is full compensation for furnishing and placing approved material on shoulders and slopes as specified or directed and includes scarifying and terracing material pits; excavating, hauling within free haul limit, spreading, shaping, compacting, and maintaining the approved material in its final position; and for all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract. Overhaul, if applicable, is paid as specified in **Section 207**.
- 3 When the Contract requires the Contractor to furnish the shoulder material, the payment also includes the cost of material pits, haul roads and hauling of materials.
- 4 Payment for this item includes all direct and indirect costs and expenses necessary to complete the work.
- 5 Pay items under this section include the following:

Item No.	Pay Item	Unit
2091000	Select Material for Shoulders and Slopes	CY

SECTION 210

FLOWABLE FILL

210.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for the use of flowable fill, its application, materials, proportioning, handling, maintenance, and protection. Flowable fill is a controlled low strength material (CLSM) that can be placed in a self-leveling consistency or in a less flowable state to reduce the fluid pressures exerted by the material. The ultimate unconfined compressive strengths are controlled at specified low levels to maintain the ability to re-excavate and the hardened flowable fill should not exhibit settlement.
- 2 Flowable fill is typically used for routine backfilling for bridge abutments, utility trenches, pipes, catch basins, drop inlets, manholes, etc., bedding and encasement of pipes, filling the voids of abandoned below ground structures including pipelines, culverts, and storage tanks; structural backfilling beneath foundations; and other applications specified by the Plans or by the RCE.

210.2 Materials

- 1 Refer to **SC-M-210** for material requirements.
- 2 If a Foaming Agent is used as an additive to the concrete mix for flowable fill, ensure that it is in conformance with the requirements of ASTM C 869 when tested using ASTM C 796 and is obtained from a source appearing on the most recent edition of *SCDOT Qualified Product List 31*.

210.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.
- 2 Use equipment specified in **SC-M-210** to transport and place flowable fill.

210.4 Construction

210.4.1 Proportioning of Mixture

- 1 Select mixture proportions given in **SC-M-210**.

210.4.2 Preparation and Placement

- 1 Properly prepare the site before placing flowable fill. Place pipe joints or other utility as normal. Provide at least 6-inch cover of flowable fill above any utility line.

- 2 The RCE will select the appropriate type of mix, as defined in **SC-M-210** for the application at the site. If covering pipes or other items, ensure that the item is sufficiently anchored to prevent floating.
- 3 Protect flowable fill from freezing for a period of 36 hours after placement. Do not place flowable fill when ambient air temperature is below 40°F. Make certain that the temperature of the flowable fill is at least 50°F at the time of delivery.
- 4 Discharge the flowable fill directly from the mixer truck into the space to be filled or by other methods approved by the RCE. Place the mix either in lifts or in full depth as conditions at the site dictate. Compaction of individual layers of flowable fill is not necessary. Construct formed walls or other bulkheads to withstand the hydrostatic pressure exerted by the flowable fill. Block trench ends outside the roadway with sandbags or mounded soil rather than wood or metal forms. When backfilling utilities such as pipe culverts, distribute the flowable fill evenly to prevent any movement of the line.
- 5 The routine use of vibrators is prohibited. If the mix does not self-consolidate, cease placement of the flowable fill material until an acceptable product is provided. Under some conditions, the RCE may allow placement of flowable fill under conditions of rain or standing water. Do not place flowable fill under these conditions without prior approval of the RCE. If the flowable fill placement is not proceeding satisfactorily, the RCE may rescind such approval at any time.
- 6 Once the flowable fill is in the trench, make provision for bleed water that is displaced during the consolidation process to run off and away from the surface of the hardening flowable fill. Do not use plastic sheets as vapor barriers.
- 7 An initial subsidence of $\frac{1}{8}$ inch per vertical foot of depth of flowable fill is allowed as excess water is displaced. Once the flowable fill hardens, shape the material the following day to allow the patch thickness required by the RCE. Placement of the patch directly on top of the flowable fill is allowed.
- 8 The RCE will determine when full traffic may be allowed on the flowable fill. If it is necessary to return traffic in less than 8 hours, or if there is concern that traffic flow will cause damage to the fill or any structure below, use steel plates to bridge over the hardening flowable fill. If the filled cavity is too wide to bridge, place steel plates on the surface of the hardening flowable fill as soon as it is able to support foot traffic.

210.5 Measurement

- 1 The quantity for Flowable Fill is the volume of flowable fill furnished and placed as prescribed and is measured by the cubic yard (CY) of flowable fill delivered to the job site and incorporated into the work as shown on the Plans or otherwise directed by the RCE, complete, and accepted.

210.6 Payment

- 1 Payment for the accepted quantity for Flowable Fill, measured or determined in accordance with **Subsection 210.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for furnishing and placing the flowable fill material as specified or directed and includes proportioning, mixing, handling, hauling, placing, maintenance, and protection of the flowable fill; providing admixtures, shoring, and steel plates; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for this item includes all direct and indirect costs and expenses necessary to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
2103000	Flowable Fill	CY

SECTION 211

PROOF ROLLING

211.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for furnishing and operating, at the direction of the RCE, heavy, pneumatic-tired equipment for testing the roadway embankment and subgrade for stability and uniformity of compaction.

211.2 Materials

- 1 None specified.

211.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.
- 2 Use equipment for proof rolling that consists of a fully loaded tandem axle dump truck or an equivalent approved by the RCE. Use only equipment with air-filled pneumatic tires. Do not use liquid-filled tires. Ensure that the tires have a pressure between 70 and 90 psi while proof rolling. Use equipment with tires mounted on articulated axles so that all wheels on the same axle carry approximately equal loads when operated over uneven surfaces.

211.4 Construction

- 1 Proof roll each lift of embankment and subgrade that has an elevation of 5 feet or less below the finished subgrade elevation before placement of subsequent lifts. Perform proof rolling in the presence of the RCE or the RCE's certified earthwork, drainage, and base inspector. Operate proof rolling equipment at a speed between 200 and 300 feet per minute. Make a minimum of 5 passes over each area proof rolled. Correct areas shown by the proof rolling operation to be unstable or non-uniform. After correction of these deficient areas, repeat the proof rolling operation.

211.5 Measurement

- 1 No specific measurement is made for the work involved in proof rolling.

211.6 Payment

- 1 This work includes furnishing all labor, equipment, fuel, and ballast for loading; loading and unloading ballast as directed; and increasing and decreasing tire pressure as directed. This work is considered incidental to embankment and subgrade compaction and no direct payment is made for this work.

DIVISION 300
BASES AND SUBBASES
SECTION 301
CEMENT MODIFIED SUBBASE

301.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the modification of an existing subgrade by pulverizing the in-place soil, adding Portland cement, mixing, wetting, compacting, shaping, and finishing the mixed material to form a subbase for a pavement structure in conformance with the lines, grades, dimensions, and cross-sections shown on the Plans or as directed by the RCE.

301.2 Materials

301.2.1 Portland Cement

- 1 Use Portland cement that conforms to the requirements of **Subsection 701.2.1** with the allowable maximum alkali content ($\text{Na}_2\text{O}+0.658\text{K}_2\text{O}$) increased to 1.0%.

301.2.2 Water

- 1 Use water conforming to the requirements of **Subsection 701.2.11**.

301.2.3 Soil

- 1 Use soil consisting of the material in the existing subgrade prepared in accordance with **Section 280**.

301.2.4 Asphalt Material

- 1 For the asphalt curing coat, use RC-70, RS-2, CRS-2, or EA-P Special meeting the requirements set forth for asphalt materials in **Section 407**.

301.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.
- 2 Accomplish the work by using either a multiple-pass traveling mixing plant or a single-pass traveling mixing plant. Construct the cement modified subbase with a machine or combination of machines and auxiliary equipment necessary to meet the requirements of this specification. Use only experienced and capable workers to operate the mixing equipment.

301.4 Construction**301.4.1 General**

- 1 The Contractor's responsibilities include, but are not limited to, the following:
 - Regulation of the sequence of work to process the necessary quantity of material to provide the full depth of modification as shown on the Plans,
 - Use of the proper amount of Portland cement,
 - Maintenance of the work, and
 - Rework of the base and subbase courses as necessary to meet the requirements of this specification.

301.4.2 Preparation of Roadbed

- 1 Grade and shape the roadbed as required to construct the cement modified subbase using material in-place in conformance with the lines, grades, thickness, and typical cross-sections shown on the Plans. Remove unsuitable soil or material and replace it with acceptable soil.

301.4.3 Pulverization and Scarification

- 1 Pulverize the soil so that, at the completion of moist-mixing, 100% of the soil (by weight) passes a 2-inch sieve and a minimum of 65% passes a No. 4 sieve, exclusive of gravel or stone. Pulverize old asphalt wearing surface so that 100% passes a 2-inch sieve. Carefully control the depth of the scarification and conduct blading operations in a manner to ensure that the surface of the roadbed below the scarified and pulverized material remains undisturbed and conforms to the required cross-section.

301.4.4 Application of Cement (Road Mix)

- 1 Spread Portland cement uniformly on the pulverized soil at a rate (in pounds per square yard) established by the GME at the OMR. This rate is established in the laboratory using samples representative of the soils to be modified. Spread the cement with equipment that can be calibrated and adjusted so that the established rate is attained uniformly throughout the length and width of the roadway. Use spreading equipment that has adjustable openings or gate headers and that is not solely dependent on vehicle speed to obtain the required spread rate. A tolerance of $\pm 5\%$ will be allowed in the spread rate for individual sections of roadway; however, adjustments should be made in order to keep the actual spread rate as close as possible to that established by the GME. Only apply cement to such an area that all the operations can be continuous and completed in daylight, unless adequate artificial light is provided, and within 6 hours of such application.
- 2 Do not allow the percentage of moisture in the soil at the time of cement application to exceed the quantity that permits uniform and intimate mixture of soil and cement during dry mixing operations and do not exceed the specified optimum moisture content for the soil-cement mixture. Do not allow equip-

ment, except that used in spreading and mixing, to pass over the freshly spread cement until it is mixed with the soil.

- 3 Apply cement only when the temperature is above 40°F in the shade and rising. Do not perform the work on a frozen or excessively wet subgrade.

301.4.5 Mixing and Processing

- 1 Unless otherwise provided in the Special Provisions or shown on the Plans, optionally use either Method A or B specified in **Subsections 301.4.5.1** and **301.4.5.2**, respectively.

301.4.5.1 Method A (Multiple-Pass Traveling Mixing Plant)

- 1 After the cement has been applied, dry-mix it with the soil. Continue mixing until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied. Allow no mixture of soil and cement that has not been compacted and finished to remain undisturbed for more than 30 minutes. Immediately after the dry mixing of soil and cement is complete, uniformly apply and incorporate water as necessary into the mixture. Use adequate equipment and provide a sufficient supply of water to ensure continuous application of the required amount of water to sections being processed within 3 hours of application of the cement. Exercise care to ensure proper moisture distribution at all times. After the last increment of water has been added, continue mixing until a thorough and uniform mix has been obtained.

301.4.5.2 Method B (Single-Pass Traveling Mixing Plant)

- 1 After cement is spread, perform mixing in one continuous operation as follows:
 - Mix the air-dry soil and cement full depth using the mixer,
 - Add the required moisture uniformly,
 - Thoroughly moist-mix the soil, cement, and water,
 - Spread the completed soil and cement mixture evenly over the machine processed width of the subgrade, and
 - Leave it in a loose condition ready for immediate compaction.
- 2 Ensure that the mixing plant provides a sufficient period of dry mixing to prevent the formation of cement balls when water is applied. Do not allow unpulverized dry soil lumps in the soil-cement mixture immediately behind the mixer. If this condition prevails, "pre-wet" the raw soil as necessary to correct this condition. Ensure that the mixer operator has a means to gauge the water application visibly and accurately. Apply the water uniformly through a pressure spray bar. Do not allow the soil-cement mixture to remain undisturbed after mixing and before compacting for more than 30 minutes.

301.4.6 Compacting

- 1 At the start of compaction, ensure that the percentage of moisture in the mixture is not below, nor more than 2% above, the specified optimum mois-

ture content, and that it is not less than the amount that will cause the soil and cement mixture to become unstable during compaction and finishing. Before the beginning of the compaction, ensure that the mixture is in a loose condition for its full depth and then, uniformly compact. Continue the compaction operation until the entire depth of the mixture is uniformly compacted to not less than 95.0% of the maximum density. **SC-T-29** determines the maximum density of the composite mix. Should tests show that the 95.0% requirement is not being met, adjust construction operations to obtain the required density. Complete compaction work within a period of 2 hours from the initial rolling. After the mixture is compacted, reshape the surface as necessary to conform to the required lines, grades, and cross-section. If necessary, or if instructed by the RCE, perform light scarification to obtain a uniform surface and prevent scaling. Thoroughly compact the surface and finish it by rolling with an approved smooth wheel tandem roller, pneumatic-tired roller or other means satisfactory to the RCE. Supplement rolling with broom dragging when required. Compact and finish producing a smooth, closely-knit surface, free from equipment imprints, cracks, ridges, or loose material. Maintain the moisture content of the surface material within 2 percentage points of the specified optimum moisture content during finishing operations.

301.4.7 Reconstruction

- 1 If the construction is proceeding with the approval of the RCE and the uncompacted soil and cement mixture is wetted by rain so that the moisture content exceeds the allowable, the Department will pay for additional cement used in reconstructing the section, but will not pay for the reconstruction work. If the reconstruction of any section is necessary because of the Contractor's negligence, omission, or unsatisfactory performance of equipment, or if any section does not comply with the allowable variation in thickness, reconstruct the section without additional compensation.

301.4.8 Curing

- 1 After finishing the cement modified subbase as specified, protect the surface against rapid drying by applying an asphalt membrane to the modified subbase. Apply this membrane immediately after finishing operations are complete and ensure that it remains in place until the subsequent course is placed. Use an asphalt membrane material consisting of RC-70, RS-2, CRS-2, or EA-P Special applied at a minimum rate of 0.15 gallons per square yard of asphalt and completely covering and sealing the total surface of the modified subbase and filling all voids. Protect the asphalt membrane from being picked up by traffic by either sanding or dusting the surface. Allow the cement modified subbase to cure for not less than 3 days before subsequent base courses are applied.

301.4.9 Construction Joints

- 1 At the end of each day's construction, form a straight transverse construction joint by cutting back into the completed work to form a true vertical face, free of loose or shattered materials. Construct the base course for large, wide areas in a series of parallel lanes of convenient length and width meeting the

approval of the RCE. Form straight longitudinal joints at the edge of each day's construction by cutting back into the completed work to form a true vertical face, free of loose or shattered materials.

301.4.10 Surface Smoothness

- 1 Ensure that the finished surface of the modified subbase varies from a straight edge 10 feet long neither more than $\frac{3}{8}$ inch when applied parallel to the centerline of the road, nor more than $\frac{1}{2}$ inch from the typical cross-section shown on the Plans. Do not disturb the finished surface of the modified subbase after the final finishing and compaction. Perform no removal of random knots after the modified subbase has hardened unless directed by the RCE. Where low areas or depressions in the finished surface of the subbase occur, level and true the surface using the same material that the modified subbase is to receive as the next component of the pavement structure. If the material specified as the next component in the pavement structure is considered unsatisfactory by the RCE, the RCE will specify what material to use. Provide necessary materials and perform such corrective work without any additional compensation.

301.4.11 Thickness Tolerance of Subbase

- 1 The thickness of the completed cement modified subbase is measured at staggered intervals not to exceed 500 feet in length for two-lane roads. The depth measurement is made by test holes through the subbase course. Where the modified subbase is less than the specified thickness by more than 1 inch, correct such areas.
- 2 Where the measured thickness is more than 1 inch thicker than the specified thickness, it is considered as the specified thickness plus 1 inch. The average job thickness is the average of the depth measurements determined as specified above. If the average job thickness is less than the specified thickness by more than $\frac{1}{2}$ inch, an adjusted unit price is used for calculating payment. This adjusted unit price bears the same ratio to the contract unit price bid as the average job thickness bears to the specified thickness.
- 3 When the Contract includes more than one road, each road is considered separately.
- 4 No additional payment over the contract unit price is made for modified subbase where the average job thickness, determined as provided, exceeds the specified thickness.

301.4.12 Traffic

- 1 Local traffic may use completed portions of the cement modified subbase provided the subbase has hardened sufficiently to prevent marring or damaging of the surface by such usage. After the curing period, traffic may use the subbase as long as no damage to the subbase or curing coat results. Use the subgrade shoulders or completed pavement, when available, in transporting materials, workers, and equipment throughout the project. Construction equipment is not permitted on the subbase without the approval of the RCE,

unless it is being used in the subsequent construction operation.

301.4.13 Maintenance

- 1 Within the limits of the Contract, maintain the cement modified subbase in good condition until all work has been completed and accepted. This maintenance includes immediate repairs of any defects that may occur. Perform this work without any additional compensation and repeat as often as may be necessary to keep the area continuously intact. Replace faulty work for the full depth of subbase. Construct the plan depth of cement modification in one homogenous mass. Do not attempt to provide the minimum specified depth by the addition of thin stabilized layers.

301.5 Measurement

- 1 The quantity for the pay item Cement Modified Subbase (of the uniform thickness required) is the surface area of a uniform subbase constructed by applying and mixing cement with the subgrade as specified and is measured by the square yard (SY) of the modified subbase in-place, complete and accepted. Modified subbase constructed outside the designated area is not measured for payment.
- 2 The quantity for the pay item Portland Cement for Cement Modified Subbase is the weight of cement incorporated into the subbase at the percentage established by the OMR and is measured by the ton (TON), complete and accepted. Portland cement incorporated in excess of 5% of the amount established by the GME is not included in the measurement. Furnish the RCE with invoices of all cement received to verify weight.

301.6 Payment

- 1 Payment for the accepted quantity of Cement Modified Subbase (of the uniform thickness required), or Portland Cement for Cement Modified Subbase, measured in accordance **Subsection 301.5**, is determined using the contract unit bid price for the applicable item
- 2 Payment for Cement Modified Subbase (of the uniform thickness required) is full compensation for constructing the cement modified subbase as specified or directed and includes pulverizing and scarifying the subgrade; processing and mixing cement; applying cement and water; spreading; maintaining proper moisture content; compacting; finishing; applying an asphalt curing membrane; cutting construction joints; protecting cement modified subbase; reconstructing subbase (if necessary); and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract. Subbase that is deficient in thickness is paid at the adjusted unit price determined in accordance with **Subsection 301.4.11**.
- 3 Payment for Portland Cement for Cement Modified Subbase is full compensation for furnishing and weighing the cement as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans,

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301.6

the Specifications, and other terms of the Contract.

4 Payment for each item includes all direct and indirect costs or expenses required to complete the work.

5 Pay items under this section include the following:

Item No.	Pay Item	Unit
3011040	Cement Modified Subbase (4" Uniform)	SY
3011060	Cement Modified Subbase (6" Uniform)	SY
3011080	Cement Modified Subbase (8" Uniform)	SY
3011090	Cement Modified Subbase (9" Uniform)	SY
3011120	Cement Modified Subbase (12" Uniform)	SY
3013000	Portland Cement for Cement Modified Subbase	TON

SECTION 302

SOIL-AGGREGATE SUBBASE

302.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for increasing the strength of the subgrade or subbase by the addition of crushed stone, gravel, or slag and the construction of a soil-aggregate subbase on a properly prepared foundation course (subgrade or subbase) for pavement structure in conformance with the lines, grades, dimensions, and cross-sections shown on the Plans or as directed by the RCE.

302.2 Materials

302.2.1 Aggregate

302.2.1.1 Crushed Stone

- 1 Produce crushed stone from tough, durable parent rock, free from soft, thin, elongated, or laminated pieces, disintegrated particles, vegetable matter, or other deleterious substances. Do not use shale or shale-like aggregates unless approved by the RCE. Use crushed stone meeting the grading requirements of Aggregate No. CR-14. When subjected to the Los Angeles Abrasion Test, AASHTO T 96, the maximum allowable abrasion loss for this material is 65%. Use crushed stone obtained from sources listed on the most recent edition of *SCDOT Qualified Product List 2*.

302.2.1.2 Gravel

- 1 Use gravel composed of hard durable particles of clean stone, free from an excess of thin or elongated pieces, vegetable matter, or other deleterious substances. Use gravel meeting the grading requirements of Aggregate No. CR-14. When subjected to the Los Angeles Abrasion Test, AASHTO T 96, the maximum allowable abrasion loss for this material is 65%. Use gravel obtained from sources listed on the most recent edition of *SCDOT Qualified Product List 2*.

302.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

302.4 Construction

302.4.1 Placing, Mixing, and Compacting

- 1 Place the aggregate upon the approved foundation. Accomplish the spreading in such a manner that the finished subbase conforms to the lines, grades, dimensions, and the typical cross-sections shown on the Plans or as

directed by the RCE. Then, thoroughly mix the aggregate subbase material with the subbase or subgrade material to the depth specified by the RCE. During the mixing operation, add sufficient water as necessary to bring the optimum moisture of content of the mixture required for proper compaction.

- 2 Spread and shape the mixture of soil and aggregate to a uniform thickness and while at optimum moisture content, consolidate it until the aggregates are bonded and the subbase compacted to at least 95.0% of the maximum dry density as determined by **SC-T-140**. Continue operations until a uniform, dense surface, free from loose material, is produced. Take care during the shaping and rolling operations to retain the material within the limits indicated on the Plans. If during the mixing and shaping operations, the material becomes segregated, then re-mix the material until a uniform mixture is obtained.
- 3 The Department reserves the right to increase or decrease the length of road on which the aggregate is to be used from that shown on the Plans or stated in the proposal and also, to increase or decrease the quantity of materials to be used per square yard. Material used in excess of the authorized amount is not measured for payment.

302.4.2 Weight Tickets

- 1 Record in duplicate the net weight of each load of aggregate and the accumulated net weight of the loads for the day upon forms suitable to the RCE. Perform the weighing in accordance with **Subsection 109.1**. With each load of materials delivered to the worksite, present one copy of the weight ticket to the RCE or designated agent.
- 2 At any time during the delivery of material and for the purpose of checking the weighing equipment, the RCE may direct the weighing on tested and approved platform scales of any truckload of material delivered to the worksite. When so directed, comply with these directives without additional compensation.

302.4.3 Maintenance

- 1 Machine, water, roll, and perform other operations necessary to condition and preserve the aggregate subbase course until the base course is applied.

302.5 Measurement

- 1 The quantity for the pay item Soil Aggregate Subbase - Aggregate No. CR-14 is the weight of the aggregate incorporated into the subgrade or subbase to produce a subbase course as specified and measured by the ton (TON) of the material as weighed in trucks on approved platform scales and incorporated into the finished work, complete and accepted.

When aggregate meeting the requirements of **Subsection 302.2.1** is used alone, the quantity for the pay item Aggregate No. CR-14 is the weight of the aggregate placed to produce a subbase course as specified and measured by the ton (TON) of the material as weighed in trucks on approved platform

scales and incorporated into the finished work, complete and accepted.

- 2 No deduction is made for normal moisture in the aggregate.

302.6 Payment

- 1 Payment for the accepted quantity of Soil Aggregate Subbase - Aggregate No. CR-14, measured in accordance with Subsection 302.5, is determined using the contract unit bid price for the item. Payment is full compensation for constructing the subbase as specified or directed and includes preparing the subgrade or subbase; furnishing, handling, weighing, hauling, placing and mixing materials; watering, compacting, shaping, maintaining, and reconstruction (if necessary) of the subbase; and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 When CR-14 aggregate is used alone, payment for Aggregate No. CR-14, measured in accordance with **Subsection 302.5**, is determined using the contract unit bid price for the item. Payment is full compensation for furnishing aggregate conforming to the requirements of **Subsection 302.2.1** as specified or directed and includes handling, weighing, hauling, and placing aggregate, and all other material, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for each item includes all direct and indirect costs or expenses required to complete the work.
- 4 Pay items under this section include the following:

Item No.	Pay Item	Unit
3021000	Soil Aggregate Subbase Course - Aggregate No. CR-14	TON
3022000	Aggregate No. CR-14	TON

SECTION 303

SAND-CLAY BASE

303.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the construction of a base course composed of sand-clay material on a properly prepared foundation (subgrade or subbase) in conformance with the lines, grades, dimensions, and cross-sections shown on the Plans or as directed by the RCE.

303.2 Materials

303.2.1 Sand-Clay

- 1 Use material for sand-clay base course that consists of naturally or artificially proportioned sand-clay conforming to the requirements below. Naturally proportioned sand clay is a naturally proportioned soil composed of sand and clay suitable for the proposed purpose and usually occurring in a layer of considerable depth. Artificially proportioned sand-clay is an artificially proportioned combination of sand and clay soil suitable for the proposed purpose. Where feasible, excavate material pits so that water will not collect or stand within.
- 2 Provide sand-clay conforming to the following requirements:

Sand-Clay Base Course Requirements	Min.	Max.
Passing 1½-inch sieve, % by weight	100	--
Material passing No. 10 sieve		
Material passing No. 10 sieve and retained by No. 60 sieve, % by weight	35	80
Silt, % by weight	--	10
Clay, % by weight	5	23
Material passing No. 40 sieve		
Liquid Limit	--	28
Plasticity Index	--	9

303.2.2 Source of Supply

- 1 Furnish all material necessary for constructing the sand-clay base course. Locate suitable material pits and secure the necessary permits for the material pits and haul roads, including permits from railroads, utilities, property owners, and other interested parties. Restore material pits and haul roads to a condition satisfactory to the property owners after the pits and haul roads are no longer required by the Contractor. Restore pits in accordance with the South Carolina Mining Act.

- 2 If determined to be necessary by the RCE, scarify and terrace sand-clay base course material pit as soon as feasible after the material is removed. Accomplish terracing work in accordance with the standard practice as recommended by the USDA Natural Resources Conservation Service.

303.2.3 Asphalt Materials

- 1 Use EA-P Special for priming the base course. Use material meeting the requirements as specified in **Section 407**.

303.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

303.4 Construction

303.4.1 Naturally Proportioned Base Material

- 1 When using an approved naturally proportioned material, spread the material on the subgrade to such a depth that, when compacted, it has the thickness and width shown on the Plans. Perform placement, mixing, and shaping as specified.

303.4.2 Artificially Proportioned Base

- 1 If a naturally proportioned base material meeting the above requirements is not available within a reasonable haul distance, two classes of approved pit material may optionally be proposed to the Department. Proportion materials selected for use and approved by the RCE to meet the requirements specified in **Subsection 303.2**. Spread the layers evenly and mix until a homogeneous mixture is obtained. Perform placement, mixing, and shaping as specified.

303.4.3 Placing Material

- 1 Spread base material evenly on the approved foundation that has been prepared as prescribed. If the foundation initially approved subsequently becomes unstable or unsatisfactory, make such corrections as are necessary to obtain a satisfactory foundation without additional compensation. Wetting may be required to recondition a foundation that has become too dry.
- 2 In removing and hauling material from pits, ensure that objectionable material is not mixed with the approved pit material being placed on the road. Remove any soil containing an excessive amount of such objectionable material.
- 3 Start placement of base materials at a point farthest from the material pit unless otherwise permitted or directed by the RCE. Do not haul material over material previously placed until it has been mixed and shaped as required. Hauling over material previously placed is allowed if the material is to be placed in successive layers, or if at the discretion of the RCE, other conditions make it advisable.

303.4.3

303.4.5

- 4 If the base material is dumped on the foundation in windrows, spread it uniformly over the foundation not later than the following day or as soon as conditions permit.
- 5 When using artificially proportioned materials, place the materials in proper order so that the mixing operation is performed as specified.
- 6 If the base course is to have a compacted thickness in excess of 10 inches, construct it in approximately equal courses not to exceed 10 inches in compacted thickness. Spread, mix, shape, and compact each course as specified.

303.4.4 Scarifying, Mixing, Re-mixing, Shaping, and Reshaping

- 1 Mix the base course material as soon as feasible after placement on the foundation. Accomplish the mixing by methods that provide a homogenous mass throughout the width and depth of the base course. Immediately shape the material to the cross-section and grade shown on the Plans. If the base is to be constructed in more than one course, mix the top inch of the previous course with the next course to ensure an adequate bond between the courses.
- 2 Apply water to the base material or aerate the material as necessary to provide a moisture content as near as possible to the optimum moisture content during mixing and compaction operations.
- 3 Remix and reshape all or any part of the base material as many times as necessary to secure a homogeneous mixture of the component material conforming to the requirements of these specifications. If the base course loses its shape, reshape it as directed. Whenever unsuitable material appears, remove and replace it with suitable material.
- 4 During the process of mixing and shaping, remove from the base course all stones having a dimension greater than 2½ inches as well as all roots, sod, weeds, and other deleterious substances.

303.4.5 Application of Prime Coat

- 1 When hot mix asphalt or asphalt surface treatment is specified as the subsequent layer on a sand-clay base course, prime the base course in accordance with **Subsection 401.4.18**. Before placing the prime coat, repair all irregularities in the base course. Delay prime coat application as necessary to achieve uniform penetration of the base course and until the RCE approves the density of the base course.
- 2 Apply the prime coat at a rate of 0.25 to 0.28 gallons per square yard of asphalt. The method of application is prescribed in pertinent sections of **Section 406**.
- 3 When it is necessary to maintain traffic on a road or a section of road before the prime coat has time to sufficiently dry to prevent pickup, apply sand or some approved granular material as a cover as directed by the RCE. The cost of furnishing this material and performing this work is included in the

price of the base course or other items of work, and no direct payment for this operation is made.

303.4.6 Compaction

- 1 After mixing and shaping while at proper moisture, compact the base by using suitable construction procedures. Blade and roll the material until the base has been thoroughly compacted.
- 2 When the total compacted thickness of the base course is greater than 10 inches, place, mix, and shape it in approximately equal layers. The maximum allowable compacted thickness of any individual layer is 10 inches. Compact each layer of the base course to not less than 100.0% of the maximum density. **SC-T-25** or **SC-T-29** determines maximum densities for all base thicknesses. If these tests show that the 100.0% requirement is not being met, adjust the moisture or construction operations to obtain the required density.

303.4.7 Thickness Tolerance of Base Course

- 1 Unless otherwise provided, the RCE will measure the thickness of the completed base course, before surfacing is applied, at staggered intervals not to exceed 250 feet for two-lane roads. The depth measurements are made by test holes through the base course. Where the base course is less than the specified thickness by more than ½ inch, correct such areas by scarifying, adding base material, and re-compacting as directed by the RCE.
- 2 When the base course is paid on a square yard basis, any measurement that exceeds the specified thickness by more than ½ inch is considered as the specified thickness plus ½ inch. The average of these depth measurements is the average job thickness. When the average job thickness is less than the specified thickness by more than ¼ inch and payment is by the square yard, an adjusted unit price is used for calculating payment. This adjusted unit price bears the same ratio to the contract unit price bid as the average job thickness bears to the specified thickness.
- 3 When the Contract includes more than one road, each road is considered separately.
- 4 No additional payment over the contract unit price is made for any base course where the average job thickness, determined as provided, exceeds the specified thickness.

303.4.8 Maintenance

- 1 Maintain the base course by repeated machining throughout its entire length for such length of time as necessary to provide an adequate base course conforming to the required cross-section, grade, thickness, and proper compaction. Such maintenance includes the correction of any defects or damage that may develop due to traffic, erosion, or other cause as well as any watering, machining, rolling, and other operations necessary to condition and preserve the base course. Correct any lack of uniformity in the base course mixture, unevenness in the surface, or other irregularities by adding or replacing base materials and re-mixing, reshaping, and re-compacting as necessary

and required. Ensure that the base is properly drained at all times.

303.5 Measurement

- 1 The quantity for the pay item Sand-Clay Base Course (of the uniform thickness specified) is the surface area of the base course constructed as specified and measured by the square yard (SY) of base course in-place, complete and accepted. Base course constructed outside of the area designated is not included in the measurement.
- 2 Base course of variable thickness or base course of thickness for which there is no unit bid price is converted to square yards of equivalent areas of a base course of a thickness for which there is a unit bid price. The conversion is based on the base course item that has a thickness nearest to that of the base course in question.
- 3 Measurement and payment of Prime Coat is in accordance with **Subsections 401.5 and 401.6.**

303.6 Payment

- 1 Payment for the accepted quantity of Sand-Clay Base Course (of the uniform thickness specified), measured in accordance with **Subsection 303.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for constructing the base course as specified or directed and includes furnishing all materials; the cost of pits and necessary haul roads; clearing and grubbing of pits; excavating, loading, hauling, placing, spreading, watering, mixing, and compacting the base course materials; scarifying, re-mixing, and reshaping the base course materials when necessary; priming as directed; maintaining the base course; and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Base course that is deficient in thickness is paid at the adjusted unit price in accordance with **Subsection 303.4.8.**
- 3 Payment for each item includes all direct and indirect costs or expenses required to complete the work.
- 4 Pay items under this section include the following:

Item No.	Pay Item	Unit
3031006	Sand-Clay Base Course (6" Uniform)	SY
3031008	Sand-Clay Base Course (8" Uniform)	SY
3031010	Sand-Clay Base Course (10" Uniform)	SY
3031012	Sand-Clay Base Course (12" Uniform)	SY

SECTION 304

COQUINA SHELL BASE

304.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for construction of a base course composed of coquina shell material on a properly prepared subgrade in conformance with the lines, grades, dimensions, and cross-sections shown on the Plans or as directed by the RCE.

304.2 Materials

304.2.1 General

- 1 Compose the coquina shell base course from a mixture of aggregated shells, shell fragments, and varying amounts of sand and clay obtained from naturally existing deposits.

304.2.2 Source of Supply

- 1 Unless otherwise specified, obtain coquina shell material from sources currently listed on the most recent edition of *SCDOT Qualified Product List 4*. Unapproved or new sources of coquina shell material must apply and be approved for inclusion on this approval sheet by following the procedures given in the most recent edition of *SCDOT Qualified Product Policy 4* before they may supply the work.

304.2.3 Coquina Shell Base

- 1 Use coquina shell base course material that has a California Bearing Ratio (CBR) of not less than 55 when tested in accordance with AASHTO T 193 at 100.0% of **SC-T-140** density. Use material that has a calcium carbonate equivalent of not less than 45% when tested according to **SC-T-6**; however, the OMR may waive the calcium carbonate equivalent requirement provided the material is determined to be equally suitable for its intended use and complies with the CBR requirement. Make certain that the coquina shell base course also meets the requirements in the following table.

Coquina Shell Base Course Requirements	Min.	Max.
Passing 3½-inch sieve, % by weight	100	--
Passing No. 200 sieve, % by weight	5	30
Liquid Limit	--	30
Plasticity Index	--	6

- 2 Determine the amount passing the No. 200 sieve in accordance with AASHTO T 11.

304.2.4 Asphalt Materials

- 1 For prime coat, use EA-P Special meeting the requirements specified in **Section 407**.

304.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

304.4 Construction**304.4.1 Placing of Material**

- 1 Place coquina shell base course on the approved subgrade and uniformly spread it in layers not exceeding 10 inches in compacted thickness. Perform the spreading operation in such a manner that the finished base will conform to the lines, grades, dimensions, and the typical cross-sections shown on the Plans or as directed by the RCE. Take care to prevent segregation of fine particles from the coarse particles during placing and spreading. Correct all areas of segregation. Ensure that objectionable material and debris are removed and are not mixed with the coquina shell base course material.
- 2 If the subgrade becomes unstable after the base course has been placed, repair the affected section by removing the base course material and the unsatisfactory subgrade material, replace the unsatisfactory material with suitable material, and re-compact and re-shape. Replace the base course to the required cross-section, grade, and required compaction.

304.4.2 Mixing and Shaping

- 1 After the base material has been placed and spread, mix the material while at proper moisture content and with proper equipment to provide a homogeneous mass throughout the width and depth of the base course. Shape the coquina shell base course to the specified grade and cross-section. Remove all particles of material having a dimension greater than 3½ inches during mixing and shaping operations.

304.4.3 Compaction

- 1 After mixing and shaping, compact the base course by suitable construction procedures. Roll each layer of material, while as near optimum moisture content as possible, until the base has been thoroughly compacted. Continue rolling operations until the base is thoroughly bonded. Perform the final rolling with pneumatic-tired rollers and continue until the entire base course is compacted to not less than 100.0% of maximum laboratory density as determined by **SC-T-140**.

304.4.4 Thickness Tolerance of Base Course

- 1 The thickness of the completed base course is measured at staggered intervals not exceeding 250 feet for two-lane roads. Where the base course is less than the specified thickness by more than $\frac{1}{2}$ inch, correct such areas by scarifying, adding base material, and re-compacting as directed by the RCE.
- 2 Where a measured thickness is more than $\frac{1}{2}$ inch greater than the specified thickness, it is considered as the specified thickness plus $\frac{1}{2}$ inch. The average job thickness is the average of the depth measurements determined as specified above. If the average job thickness is less than the specified thickness by more than $\frac{1}{4}$ inch, an adjusted unit price is used for calculating payment. This adjusted unit price bears the same ratio to the contract unit price bid as the average job thickness bears to the specified thickness.
- 3 When the Contract includes more than one road, each road is considered separately.
- 4 No additional payment over the contract unit price is made for any base course where the average job thickness, determined as provided, exceeds the specified thickness.

304.4.5 Application of Prime Coat

- 1 When hot mix asphalt or an asphalt surface treatment is specified as the subsequent layer on a Coquina Base Course, prime the base course in accordance with **Subsection 401.4.18**. Before placing the prime coat, repair all irregularities in the base course, allow the base course to season sufficiently to permit a uniform penetration, and obtain approval of the density of the base course from the RCE.
- 2 Apply the prime coat as prescribed in pertinent sections of **Section 406** at a rate of 0.25 to 0.28 gallons per square yard.
- 3 When it is necessary to maintain traffic on a road or a section of road before the prime coat has time to sufficiently dry to prevent pickup, apply sand or some approved granular material as a cover as directed by the RCE. The cost of furnishing this material and performing this work is included in the price of the base course or other items of work and no direct payment for this operation is made.

304.4.6 Maintenance

- 1 Maintain the base course throughout its entire length for such length of time as necessary to provide an adequate base course conforming to the required cross-section, grade, thickness, and proper compaction. Such maintenance includes the correction of any defects or damage that may develop due to traffic, erosion, or other cause as well as any watering, machining, rolling, and other operations necessary to condition and preserve the base course. Correct any lack of uniformity in the base course mixture, unevenness in the surface, or other irregularities by adding or replacing base materials and re-mixing, reshaping, and re-compacting as necessary and required. Ensure

that the base is properly drained at all times.

304.5 Measurement

- 1 The quantity for the pay item Coquina Shell Base Course (of the uniform thickness specified) is the surface area of the base course constructed as specified, measured by the square yard (SY) of base course in-place, complete and accepted. Base course constructed outside of the area designated is not included in the measurement.
- 2 Base course of variable thickness or base course of thickness for which there is no unit bid price is converted to square yards of equivalent area of a base course of a thickness for which there is a unit bid price. The conversion is based on the base course item that has a thickness nearest to that of the base course in question.
- 3 Measurement and payment of Prime Coat is in accordance with **Subsections 401.5 and 401.6.**

304.6 Payment

- 1 Payment of the accepted quantity of Coquina Shell Base Course (of the uniform thickness specified), measured in accordance with **Subsection 303.5**, is determined with the contract unit bid price for the pay item. The payment is full compensation for the constructing the base course as specified or directed and includes furnishing, hauling, placing, spreading, mixing, and compacting the base course materials; priming and maintaining the base course; and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Base course that is deficient in thickness is paid at the adjusted unit price in accordance with in **Subsection 304.4.4.**
- 3 Payment for each item includes all direct and indirect costs or expenses required to complete the work.
- 4 Pay items under this section include the following:

Item No.	Pay Item	Unit
3041104	Coquina Shell Base Course (4" Uniform)	SY
3041105	Coquina Shell Base Course (5" Uniform)	SY
3041106	Coquina Shell Base Course (6" Uniform)	SY
3041108	Coquina Shell Base Course (8" Uniform)	SY
3041109	Coquina Shell Base Course (9" Uniform)	SY
3041112	Coquina Shell Base Course (12" Uniform)	SY

SECTION 305

GRADED AGGREGATE BASE

305.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for construction of a base course composed of the graded aggregate materials specified herein on a properly prepared foundation (subgrade or subbase) in conformance with the lines, grades, dimensions, and cross-sections shown on the Plans or as directed by the RCE.
- 2 When the Contract specifies a graded aggregate base course, the following base courses listed below may appear on the proposal as alternates:
 - Macadam Base Course,
 - Marine Limestone Base Course, or
 - Recycled Portland Cement Concrete Base Course.
- 3 When alternates appear in the proposal, select the intended bid alternate and provide unit bid prices only on that alternate.
- 4 Marine limestone aggregate is generally found in the coastal plain area of the state and is defined as any limestone aggregate not meeting the classification of dolomitic limestone. Fossiliferous limestone aggregate and recrystallized limestone aggregate are considered marine limestone aggregates.

305.2 Materials

305.2.1 Macadam Base Course

- 1 Use base course material composed of crushed stone, excluding marine limestone, filled and bound with screenings. Ensure that the aggregate is free from vegetable matter, sand, lumps or balls of clay, or other deleterious matter.

305.2.2 Marine Limestone Base Course

- 1 Use limestone base course materials produced from a single source or deposit that yields a satisfactory mixture conforming to all requirements of these specifications. Ensure that the Limestone Base Course does not contain clay, sand, organics, or other materials in sufficient quantity to be considered detrimental to the proper bonding, finishing, or strength of the base course.

305.2.3 Recycled Portland Cement Concrete Base Course

- 1 Use aggregate in the base course consisting of coarse aggregate of crushed, graded, recycled Portland cement concrete mixed together with sand, sand-gravel, soil or other approved materials having similar characteristics and combined as necessary to give a mixture conforming to the requirements given below.
- 2 Use aggregate that is free from lumps or balls of clay or other objectionable matter and does not contain metals, wood, brick, plastics, or other unaccept-

able debris.

- 3 When Recycled Portland Cement Concrete Base Course is selected, have the source inspected, sampled and tested, and approved by the MRE and RCE before any material is used in the work. Allow a minimum of 4 weeks for this sampling, testing, and approval.

305.2.4 Coarse Aggregate

305.2.4.1 General

- 1 Use material retained on the No. 4 sieve consisting of hard, durable aggregate particles that are reasonably free from thin or elongated pieces, disintegrated particles, vegetable matter, or other deleterious substances. Ensure that the maximum abrasion loss for coarse aggregate is 65% when subjected to the Los Angeles Abrasion Test (AASHTO T 96).

305.2.4.2 Coarse Aggregate for Macadam Base Course

- 1 Use coarse aggregate for Macadam Base Course consisting of hard, durable particles of crushed slag or stone, excluding marine limestone. Ensure that the aggregate is free from vegetable matter, sand, lumps or balls of clay, or other deleterious matter.
- 2 Ensure minimum weight for crushed slag used in Macadam Base Course, when dry and rodded, is 70 pounds per cubic foot. Use crushed slag that consists of angular fragments, reasonably uniform in density and quality, and reasonably free from glassy, thin or elongated pieces, dirt, or other objectionable material.

305.2.4.3 Coarse Aggregate for Marine Limestone Base Course

- 1 Use coarse aggregate for Marine Limestone Base Course consisting of sound, durable particles of marine limestone aggregate.

305.2.4.4 Coarse Aggregate for Recycled Portland Cement Concrete Base Course

- 1 Use coarse aggregate for Recycled Portland Cement Concrete Base Course consisting of sound, durable particles of recycled Portland cement concrete aggregate, excluding crushed concrete block or pipe.

305.2.5 Fine Aggregate

305.2.5.1 General

- 1 Use fine aggregate or binder material passing the No. 4 sieve subject to the requirements in this subsection.

305.2.5.2 Fine Aggregate for Macadam Base Course

- 1 Use fine aggregate for Macadam Base Course consisting of material produced by crushing operations, excluding marine limestone.

305.2.5.3 Fine Aggregate for Marine Limestone Base Course

- 1 Use fine aggregate for Marine Limestone Base Course consisting of marine limestone produced by mining or crushing operation. Sand will not be permitted as fine aggregate.

305.2.5.4 Fine Aggregate for Recycled Portland Cement Concrete Base Course

- 1 Use fine aggregate for Recycled Portland Cement Concrete Base Course consisting of material produced by the crushing operation, sand, soil, or other acceptable material. Ensure that these materials are obtained from sources approved by the MRE.

305.2.5.5 Composite Mixture

- 1 After the base course material is spread on the subgrade, mixed, and shaped, but prior to the beginning of compaction operations, make certain that the composite mixture conforms to the requirements in the following table.

Macadam Base Course	
Sieve Designation	Percentage by Weight Passing
2-inch	100
1½-inch	95 – 100
1-inch	70 – 100
½-inch	48 – 75
No. 4	30 – 60
No. 30	11 – 30
No. 200*	0 – 12
Liquid Limit	25 Max.
Plasticity Index	6 Max.

Marine Limestone Base Course	
Sieve Designation	Percentage by Weight Passing
2- inch	100
1½-inch	95 – 100
1-inch	70 – 100
½-inch	50 – 85

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Marine Limestone Base Course	
Sieve Designation	Percentage by Weight Passing
No. 4	30 – 60
No. 30	17 – 38
No. 200*	0 – 20
Liquid Limit	25 Max.
Plasticity Index	6 Max.

*AASHTO T 11 is used to determine the amount passing the No. 200 sieve.

Recycled Portland Cement Concrete Base Course	
Sieve Designation	Percentage by Weight Passing
2-inch	100
1½-inch	95 - 100
1-inch	70 - 100
½-inch	48 - 75
No. 4	30 - 60
No. 30	11 - 30
No. 200*	0 - 12
Liquid Limit	25 Max.
Plasticity Index	6 Max.

*AASHTO T 11 is used to determine the amount passing the No. 200 sieve.

305.2.5.6 Asphalt Materials

- 1 Use EA-P Special for priming the base course conforming to the requirements specified in **Section 407**.

305.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.
- 2 Use a steel wheel roller capable of developing a pressure of 250 to 350 pounds per inch of roller width in the compression wheel for compaction. If necessary, use other rollers in conjunction with the steel wheel roller. Ac-

ceptable additional rollers are self-propelled or tractor drawn pneumatic tired rollers or vibratory rollers. Use a combination of the above rollers as necessary to produce a finished product that complies with these specifications.

305.4 Construction

305.4.1 Preparation of Subgrade

- 1 Construct the foundation for the graded aggregate base course in accordance with the requirements as specified in **Section 208**. Roll and compact the subgrade for at least 500 feet ahead of the placing of base course materials where feasible.
- 2 Construct shoulders in accordance with the requirements of **Section 209**, accurately trimmed to the alignment and grade of the base course to form a trench or channeled section as prescribed on the Plans.

305.4.2 Placing of Base Course Material

- 1 Deliver base course materials to the project with the necessary fines already included. Alternatively, add fines if necessary to obtain the desired density and stability. However, in any case provide material whose final gradation meets the requirements shown in **Subsection 305.2.5**.
- 2 Place the base course aggregate on the prepared foundation. Perform the spreading so that the finished base course conforms to the lines, grades, dimensions, and the typical cross-sections shown on the Plans or as directed by the RCE.
- 3 When the required compacted thickness is 10 inches or less, construct the base course in one layer. Where the required thickness is more than 10 inches, construct the base course in two or more layers of approximately equal thickness, and ensure that the maximum compacted thickness of any one layer does not to exceed 10 inches. Construct and compact each layer as specified before placing the succeeding layer.
- 4 Take care to prevent segregation of the fines from the coarse aggregates during the handling, spreading, or shaping of the materials. Correct all areas of segregated fine or coarse material before subsequent placement of overlying lifts.
- 5 If the foundation becomes unstable after the base course has been placed, repair the affected section. Repair the section by removing the base course material and unsatisfactory foundation material and replacing it with approved foundation material. Reconstruct the foundation to the required compaction and shape and then replace the base course at the required cross-section, grade, and compaction.

305.4.3 Compaction, Rolling, and Finishing

- 1 After the base course material is spread, continually machine it with motor graders or other suitable equipment and maintain the required section until the base course is thoroughly compacted. Compact each layer by the use of equipment specified in **Subsection 305.3**. If the foundation becomes unsta-

ble after the base course has been placed, repair the affected section. After removing the base course material and the unsatisfactory foundation material, place suitable subgrade material at the required compaction and shape and then, replace the base course material to the required cross-section, grade and compaction.

- 2 Start rolling the base course at the edge and proceed toward the center, except on superelevated curves where rolling operations proceed from the lower to the upper side. On areas not accessible for the operation of standard rollers, perform compaction using RCE approved rollers. Continue rolling until the layer is satisfactorily compacted for the full width and depth. Wet the base course when necessary. Extend rolling over the edges of each layer of base course materials for a distance of 2 feet on the shoulders. Continue blading and rolling until a dense, smooth, unyielding, and well-bonded base course is obtained.
- 3 If initial compaction has been performed and the voids are not filled, place fine aggregate on the base course in an amount only sufficient to fill the voids. Broom, wet, and roll the base course until the coarse aggregate is firmly set, bonded, and the base course is thoroughly compacted for the full width and depth. Compact each layer of the macadam base course while near optimum moisture with equipment capable of obtaining the required density for the full depth. Continue the rolling until the entire base course is compacted to not less than 100.0% of maximum laboratory density as determined by **SC-T-140**. When the total compacted thickness of the graded aggregate base course is more than 10 inches, place the materials in layers as specified in **Subsection 305.4.2** and compact each layer to the density specified above, regardless of layer thickness.
- 4 Determine the in-place density and moisture content of the graded aggregate base course with a nuclear moisture-density gauge or by other approved means.
- 5 On shoulder work or other applicable construction, do not use steel wheel rollers on the finished pavement, except at locations necessary for turning around. During all phases of the work, take extreme care to protect structures.

305.4.4 Surface Smoothness

- 1 Ensure that the finished surface of the base course varies neither more than $\frac{3}{8}$ inch from a straight edge 10 feet long when applied parallel to the centerline of the road, nor more than $\frac{1}{2}$ inch from the typical cross-section shown on the Plans. Provide necessary materials and perform such corrective work to repair any deviations exceeding the limits given above without additional compensation.

305.4.5 Thickness Tolerance of Base Course

- 1 The thickness of the completed base course is measured at staggered intervals not to exceed 250 feet for two-lane roads. Depth measurements are made by test holes through the base course. Where the base course is less

305.4.5

305.4.6

than the specified thickness by more than ½ inch, correct such areas by scari-fying, adding base course material, and re-compacting as directed by the RCE.

- 2 When the base course is paid for on a square yard basis, any measurement that exceeds the specified thickness by more than ½ inch is considered as the specified thickness plus ½ inch. The average job thickness is the average of the depth measurements. When the average job thickness is less than the specified thickness by more than ¼ inch and payment is by the square yard, an adjusted unit price is used for calculating payment. This adjusted unit price bears the same ratio to the contract unit price bid as the average job thickness bears to the specified thickness.
- 3 When the Contract includes more than one road, each road is considered separately.
- 4 No additional payment over the contract unit price is made for any base course where the average job thickness, determined as provided, exceeds the specified thickness.

305.4.6 Application of Prime Coat

- 1 When hot mix asphalt or an asphalt surface treatment is specified as the subsequent layer on a Graded Aggregate Base Course, apply a prime coat to the base course in accordance with **Subsection 401.4.18**. Before applying the prime coat, repair all irregularities in the base course and ensure that the base course has seasoned sufficiently to permit a uniform penetration and that the RCE has approved the density of the base course. Clean the base course of all mud, dirt, dust, and caked or loose material of any description by brooming, blowing, or other methods to expose the coarse aggregate in the base course.
- 2 When, in the opinion of the RCE, the asphalt material used to prime coat the base course may present a hazard to adjacent properties, the RCE may opt to delete the prime coat from a section of roadway.
- 3 Ensure that the rate of application of the prime coat material conforms to the application rates in the following table.

Base Course Material	Application Rate in Gallons per Square Yard of Asphalt (gal/yd ²)	
	Min.	Max.
Macadam Base Course	0.25	0.30
Marine Limestone Base Course	0.10	0.15
Recycled Portland Cement Concrete Base Course	0.25	0.30

- 4 Perform the application using the methods and requirements prescribed in pertinent portions of **Section 406**.

- 5 When it is necessary to maintain traffic on a road or a section of road before the prime coat has had time to sufficiently dry to prevent pickup, apply sand or some other approved granular material as a cover as directed by the RCE. The cost of furnishing this material and performing this work is included in the price of the base course or other items of work and no direct payment is made.

305.4.7 Weight Tickets

- 1 When the base course is measured by the ton, the requirements set forth in **Subsection 302.4.2** regarding weight tickets apply in all respects.

305.4.8 Maintenance

- 1 Machine the base course as often as is necessary to maintain it smooth and true to grade and cross-section and apply water as required to prevent raveling and keep the base course tightly bound until the prime coat is applied. Repair any defects or damage that develops.

305.5 Measurement

- 1 The quantity for the pay item Graded Aggregate Base Course is measured by the pay unit, either square yard or ton, specified in the Contract.
- 2 When paid by the square yard, the quantity for the pay item Graded Aggregate Base Course (of the required uniform thickness) is the surface area of the base constructed as specified and measured by the square yard (SY) of base course in-place, complete and accepted. The area of base course constructed outside the area designated is disregarded in computing the quantity.
- 3 Base course of variable thickness or base course of thickness for which there is no unit bid price bid is converted to square yards of equivalent area of a base course of a thickness for which there is a contract unit bid price. The conversion is based on the base course whose thickness is nearest to that of the base course without a unit price.
- 4 When paid for by the ton, the quantity for Graded Aggregate Base Course is the weight of the base course constructed as specified, measured by the ton (TON), including water contained in the delivered base course material, weighed on approved scales and actually incorporated in the work, complete and accepted. If a visual inspection indicates excessive moisture in the base course, a deduction is made for the weight of water applied in excess of 2% above optimum moisture as determined by the RCE. The weight of base course constructed outside the area designated, wasted or lost due to the negligence of the Contractor, and applied in excess of the rate specified or directed in writing is disregarded in computing the quantity.

- 5 Measurement of Prime Coat is in accordance with **Subsection 401.5**.

305.6 Payment

- 1 Payment for the accepted quantity of Graded Aggregate Base Course, measured in accordance with **Subsection 305.5**, is determined using the

contract unit price for the item. Payment is full compensation for constructing the graded aggregate base course as specified or directed and includes preparing the foundation, furnishing, hauling, placing, spreading, mixing, adding water, shaping compacting, finishing, applying prime coat, maintenance, reconstruction (if necessary) of the base course, and all other materials, labor, equipment, tools, supplies, maintenance, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.

- 2 Base course specified on a square yard basis and is deficient in thickness is paid for at the adjusted unit price in accordance with **Subsection 305.4.5**.
- 3 Payment for Prime Coat is in accordance **Subsection 401.6**.
- 4 Payment for each item includes all direct and indirect costs or expenses required to complete the work.
- 5 Pay items under this section include the following:

Item No.	Pay Item	Unit
3050104	Graded Aggregate Base Course (4" Uniform)	SY
3050105	Graded Aggregate Base Course (5" Uniform)	SY
3050106	Graded Aggregate Base Course (6" Uniform)	SY
3050107	Graded Aggregate Base Course (7" Uniform)	SY
3050108	Graded Aggregate Base Course (8" Uniform)	SY
3050110	Graded Aggregate Base Course (10" Uniform)	SY
3050112	Graded Aggregate Base Course (12" Uniform)	SY
3050199	Graded Aggregate Base Course	TON

SECTION 306

CEMENT MODIFIED RECYCLED BASE

306.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the modification of an existing paved roadway or shoulder by scarifying the existing pavement structure, mixing it with Portland cement, and construction of an base course in conformance with the lines, grades, dimensions, and cross-sections shown on the Plans or as directed by the RCE.

306.2 Materials

306.2.1 Portland Cement

- 1 Use Portland cement that conforms to the requirements of **Subsection 301.2.1**.

306.2.2 Water

- 1 Use water conforming to the requirements of **Subsection 701.2.11**.

306.2.3 Asphalt Material

- 1 Use asphalt material conforming to the requirements of **Subsection 301.2.4**.

306.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.
- 2 Accomplish the work by using a single-pass traveling mixing plant meeting the requirements of **Subsection 301.4.5**. Construct the base with any machine or combination of machines and auxiliary equipment that will produce results as outlined in this specification. Use only experienced and capable workers to operate the mixing equipment.

306.4 Construction

306.4.1 General

- 1 Regulate the sequence of work to process the necessary quantity of material to provide the full depth of modification as shown on the Plans:
- Use the proper amount of Portland cement.
 - Maintain the work.
 - Rework the courses as necessary to meet the requirements of this specification.

306.4.2 Pulverization and Scarification

- 1 Pulverize the pavement so that at the completion of moist-mixing 100% (by weight) passes a 1½-inch sieve. Carefully control the depth of scarification and conduct blading operations in a manner to ensure that the surface of the roadbed below the scarified and pulverized material remains undisturbed and conforms to the required cross-section.

306.4.3 Application of Cement

- 1 Spread Portland cement uniformly on the pulverized pavement as specified in **Subsection 301.4.4**.

306.4.4 Mixing and Processing

- 1 Unless otherwise provided in the Special Provisions or shown on the Plans, mix and process the soil-pavement material as specified in **Subsection 301.4.5**.

306.4.5 Compaction

- 1 Compact the base as specified in **Subsection 307.4.5**.

306.4.6 Construction Limitations

- 1 Perform work in daylight hours unless adequate artificial light is provided. Limit the area over which the cement-pavement mixture is spread so that all operations specified in **Subsections 306.4.3** and **306.4.4** are performed continuously until completion of a section. Complete all work on a section within 2 hours after the application of water to the aggregate and cement mixture unless the RCE approves a longer period.
- 2 If operations are interrupted for a continuous period of greater than 1 hour after the cement has been mixed with the aggregate, reconstruct the entire affected section in accordance with these specifications. When the uncompacted mixture of aggregate and cement is wetted so that the moisture content exceeds that specified, manipulate and aerate the mixture to reduce the moisture to the specified content provided the base course is completed within the time limits of these specifications.

306.4.7 Weather Limitations

- 1 Apply cement only when the temperature is 40°F in the shade and rising. Do not perform work on frozen or excessively wet subgrade.

306.4.8 Curing

- 1 After the cement modified recycled base has been finished as specified, protect the surface from rapid drying by immediately applying a curing membrane. For sections where extended closure to traffic is not feasible, keep the base continuously moist until the subsequent layer of pavement is placed. For sections where extended closure is planned, the requirements of **Subsection 301.4.8** apply.

306.4.9 Construction Joints

- 1 At the end of each day's construction, form a straight construction joint as specified in **Subsection 301.4.9**.

306.4.10 Surface Smoothness

- 1 Ensure that the finished surface of the recycled base meets the requirements of **Subsection 301.4.10**.

306.4.11 Thickness Tolerance of Base Course

- 1 Measure and calculate the thickness of the recycled base in accordance with **Subsection 301.4.11**.

306.4.12 Opening to Traffic

- 1 After the 3-day curing period, traffic may use the base as long as no damage to the base results. Local traffic may use completed portions of the recycled base before the 3 days provided the base has hardened sufficiently to prevent marring or damaging of the surface by such usage. Use the subgrade shoulders or completed pavement, when available, for transporting materials, workers, and equipment throughout the project. Do not place construction equipment on the base without the approval of the RCE unless it is being used in the subsequent construction operation.

306.4.13 Maintenance

- 1 Maintain the cement modified recycled base in accordance with **Subsection 301.4.13**.

306.5 Measurement

- 1 Measurement of quantity for Cement Modified Recycled Base (of the uniform required thickness) or Portland Cement for Cement Modified Recycled Base is made using the methods specified in **Subsection 301.5** for the applicable items.

306.6 Payment

- 1 Payment for the accepted quantity of Cement Modified Recycled Base (of the uniform required thickness) or Portland Cement for Cement Recycled Base, measured in accordance with **Subsection 306.5**, is determined using the contract unit bid price for the applicable item.
- 2 Payment for Cement Modified Recycled Base (of the uniform required thickness) is full compensation for constructing the cement modified recycled base course as specified or directed and includes pulverizing and scarifying the existing pavement; applying and spreading cement; watering and maintaining proper moisture content; processing and mixing base course material; compacting, finishing, and curing base course (unless asphalt surfacing is used); forming construction joints; and all other materials, labor, equipment, tools, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.

- 3 Base course that is deficient in thickness is paid for at the adjusted unit price specified in **Subsection 306.4.12**.
- 4 Payment for Portland Cement for Cement Modified Recycled Base is full compensation for furnishing and weighing the cement as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 5 Payment for each item includes all direct and indirect costs or expenses required to complete the work.
- 6 Pay items under this section include the following:

Item No.	Pay Item	Unit
3063304	Cement Modified Recycled Base (4" Uniform)	SY
3063306	Cement Modified Recycled Base (6" Uniform)	SY
3063308	Cement Modified Recycled Base (8" Uniform)	SY
3063312	Cement Modified Recycled Base (12" Uniform)	SY
3064000	Portland Cement for Cement Modified Recycled Base	TON

SECTION 307

CEMENT STABILIZED EARTH BASE

307.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for construction of a base course composed of a combination of local soil and Portland cement, uniformly mixed, moistened, shaped, compacted, applied with an asphalt curing coat on a prepared roadbed and in conformance with the lines, grades, dimensions, and cross-sections shown on the Plans or as directed by the RCE.

307.2 Materials

307.2.1 Portland Cement

- 1 Use Portland cement that conforms to the requirements of **Subsection 301.2.1**.

307.2.2 Water

- 1 Use water that meets the requirements as specified in **Subsection 701.2.11**.

307.2.3 Soil

- 1 Utilize the soil for the cement stabilized earth base course from natural material in the roadbed, hauled-in material, or a combination of these materials proportioned as directed. Ensure that hauled-in material meets the requirements for sand-clay in **Section 303**, unless otherwise provided. Unless otherwise specified in the Special Provisions, furnishing of soil is not measured for payment; and there is no payment for overhaul. Provide soil that is free of roots, sod, weeds, or other deleterious materials. Submit samples to the OMR for approval of materials and for determining the correct cement content at least 30 days prior to beginning construction of the cement stabilized earth base course.

307.2.4 Asphalt Material

- 1 Use RS-2, CRS-2, or EA-P Special for the asphalt curing coat. Use materials that meet the requirements specified for asphalt materials in **Section 407** for this work.

307.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

307.4 Construction

307.4.1 Weather Limitations

- 1 Apply cement only when the temperature is above 40°F in the shade and rising. Do not perform any work on frozen or excessively wet subgrade.

307.4.2 Preparation of the Existing Roadbed

- 1 Before any stabilizing operations are started, grade and shape the existing roadway to conform to the lines, grades, and cross-sections required. Place additional soil as the RCE may direct and remove any unsuitable material and replace with suitable material.
- 2 Before placing the base course, ensure that the subgrade is firm and can support the construction equipment without displacement. Ensure that the subgrade is compacted as specified at the time of base placement. Correct soft or yielding subgrade and stabilize it before construction proceeds.
- 3 When the stationary plant method of mixing is specified, construct the subgrade in accordance with the requirements of **Section 208**.

307.4.3 Conditioning of Base Course Materials

- 1 Pulverize the base course material so that at the completion of the moist mixing 100% (by dry weight) passes the 1½-inch sieve and a minimum of 80% passes the No. 4 sieve, exclusive of gravel and stone retained on the sieve.
- 2 During mixing operations, ensure that the moisture content of the soil does not exceed the amount that permits a uniform and intimate mixture of the soil and cement. Do not exceed the optimum moisture content of the mixture by more than 2%.

307.4.4 Mixing and Placing Materials

- 1 Unless otherwise specified, mix the base course by the stationary plant method. Use the road mix method only when specified in the Special Provisions. Use the quantity of Portland cement added to the soil as a percentage by weight of the dry soil and at the rate established by the GME of the OMR with the tolerance specified in **Subsections 307.4.4.1** and **307.4.4.2**.

307.4.4.1 Stationary Plant Method

- 1 Mix the soil, cement, and water in a pugmill, either of the batch or continuous-flow type. Use a plant equipped with feeding and metering devices that add soil, cement, and water into the mixer in the specified quantities. In all plants, use only equipment capable of controlling the weight or rate of feed of the cement within 5.0% of the amount designated above. Continue mixing until a uniform, homogeneous mixture is obtained. The RCE may require an increase in the mixing time when necessary to secure a proper blend of the different materials.
- 2 Haul the mixture to the site in trucks with protective covers. Place the mixture on a moist subgrade in a uniform layer using an approved spreader. En-

sure that the layers are of a contour and thickness that the completed base course conforms to the required grade and cross-section. Dumping of the mixture in piles or windrows is not permitted.

- 3 Do not allow more than 30 minutes to elapse between the placement of the base course mixture in adjacent lanes except at longitudinal construction joints. Do not allow more than 60 minutes to elapse between the start of moist mixing and the start of compaction.

307.4.4.2 Road Mix Method

- 1 To achieve the compacted thickness shown on the Plans, loosen the roadway being stabilized and pulverize it to the required base course width and to sufficient depth before the application of Portland cement. Shape the loosened soil to the approximate line and grade shown on the Plans.
- 2 Spread Portland cement over the loosened roadway at the rate established by the GME of the OMR. This rate is established in the laboratory using samples representative of the material being stabilized.
- 3 Spread the Portland cement with equipment that can be calibrated and adjusted so that the established rate is attained uniformly throughout the length and width of the roadway.
- 4 Use spreading equipment with adjustable openings or gate headers and that are not solely dependent on vehicle speed to obtain the required spread rate. A tolerance of $\pm 5\%$ is allowed in the spread rate for individual sections of roadway; however, make adjustments to keep the actual spread rate as close as possible to that established by the GME. Equipment other than that used in the spreading and mixing are not allowed to pass over the freshly spread cement.
- 5 Immediately after the cement is spread, mix it with the loosened soil for the full depth of the stabilization. Exercise care to avoid mixing below the desired depth. Accomplish mixing by the use of an approved road-mixing machine. Only use disc harrows, road graders, and other equipment to supplement the mixing done by the approved road-mixer. Make sufficient passes of the mixing equipment to ensure a homogeneous mixture that is uniform in appearance.
- 6 Determine the moisture content of the soil and cement mixture upon completion of the mixing operation and if required, add water as directed. Ensure that water supply and distribution equipment are available to permit the continuous application within 3 hours of all the water required on the section of base course being processed. Add the water into the mix in a manner that avoids a concentration of water near the surface.
- 7 After all necessary water is added, continue mixing until the water is uniformly distributed throughout the base course. Exercise particular care to ensure satisfactory moisture distribution along the edges of the section. When the moist mixing is complete, ensure that the percentage of moisture in the mixture is not below nor more than 2 percentage points above the specified

optimum moisture. In any case, do not allow the moist mixture to remain undisturbed for more than 30 minutes before compaction is started.

307.4.5 Compaction

- 1 Before beginning the compaction, ensure that the mixture is in a loose condition for its full depth and uniformly compacted. Continue compaction until the entire depth of the base course mixture is uniformly compacted to not less than 95.0% of the maximum density. **SC-T-25**, or **SC-T-29** are used to determine the maximum density of the composite mix. If tests show that the 95.0% requirement is not being met, adjust construction operations to obtain the required density. Complete the compaction work within 2 hours from the initial rolling.
- 2 After the mixture is compacted, reshape the surface of the base course as necessary to conform to the required lines, grades, and cross-section. Perform light scarifying as required to obtain a uniform surface and to prevent scaling.
- 3 Thoroughly compact and finish the surface by rolling with an approved smooth wheel tandem roller, pneumatic-tired roller, or other means satisfactory to the RCE. Supplement rolling by broom dragging when required. Perform compacting and finishing in a manner that produces a smooth, closely knit surface, free from equipment imprints, cracks, ridges, or loose material. Maintain the moisture content of the surface material within 2% of the specified optimum moisture content during finishing operations.

307.4.6 Construction Joints

- 1 At the end of each day's construction, form a straight transverse construction joint by cutting back into the completed work to form a true vertical face, free of loose or shattered materials. Construct the base course for large, wide areas in a series of parallel lanes of convenient length and width and meeting the approval of the RCE. Form straight longitudinal joints at the edge of each day's construction by cutting back into the completed work to form a true vertical face, free of loose or shattered materials.

307.4.7 Construction Limitations

- 1 Limit the area over which the cement or soil and cement mixture is spread so that all operations specified in **Subsections 307.4.4** and **307.4.5** are continuous and all work is completed within daylight hours unless adequate artificial light is provided and within 6 hours after the application of water to the soil and cement mixture when scarifying is required. Otherwise, complete all work within 3 hours.
- 2 If operations are interrupted for a continuous period of greater than 2 hours after the cement has been mixed with the soil, reconstruct all affected sections in accordance with these specifications. When the uncompacted mixture of soil and cement is wetted so that the moisture content exceeds that specified, manipulate and aerate the affected material to reduce the moisture to the specified content if the base course can be completed within the time

limits of these specifications.

307.4.8 Reconstruction

- 1 If the construction of the base course is proceeding with the approval of the RCE and the un-compacted soil and cement mixture is wetted by rain so that the moisture exceeds that allowed and cannot be reduced to the specified moisture within the time limits of these specifications, the Department will pay for additional cement used in reconstructing the section but will not pay for the reconstruction work. If the reconstruction of any section is necessary because of negligence or omission by the Contractor, unsatisfactory equipment performance, or the section does not comply with the allowable variation in thickness, reconstruct the section without additional compensation.

307.4.9 Surface Smoothness

- 1 Ensure that the finished surface of the base varies neither more than $\frac{3}{8}$ inch from a straight edge 10 feet long when applied parallel to the centerline of the road, nor more than $\frac{1}{2}$ inch from the typical cross-section shown on the Plans.
- 2 Do not disturb the finished surface of the base course after the final finishing and compaction. Do not attempt remove random knots after the base course has hardened. Where low areas or depressions in the finished surface of the base occur, level and true the surface using the same material as the next component of the pavement structure. If the material specified as the next component in the pavement structure is considered unsatisfactory by the RCE, the RCE will specify what material to use. Provide the necessary materials and perform such corrective work without any additional compensation.

307.4.10 Thickness Tolerance of Base Course

- 1 The thickness of the completed modified base is measured at staggered intervals not to exceed 250 feet in length for two-lane roads. The depth measurement is made by test holes through the base course. Where the base course is less than the specified thickness by more than $\frac{1}{2}$ inch, correct such areas by scarifying, adding base material, and re-compacting as directed by the RCE.
- 2 Where the measured thickness is more than $\frac{1}{2}$ inch greater than the specified thickness, it is considered as the specified thickness plus $\frac{1}{2}$ inch. The average job thickness is the average of the depth measurements determined as specified above. If this average job thickness is less than the specified thickness by more than $\frac{1}{4}$ inch, an adjusted unit price is used for calculating payment. This adjusted unit price bears the same ratio to the contract unit price bid as the average job thickness bears to the specified thickness.
- 3 When the Contract includes more than one road, each road is considered separately.
- 4 No additional payment over the contract unit price is made for any base course where the average job thickness, determined as provided, exceeds

the specified thickness.

307.4.11 Curing Coat

- 1 After the base course has hardened but not later than 12 hours after the completion of finishing operations, apply an asphalt curing coat, as specified in **Subsection 307.2.4**, at a rate of 0.15 to 0.20 gallons per square yard of asphalt. Keep the finished soil-cement continuously moist until the curing coat is applied. At the time the asphalt material is applied, ensure that the base course surface is dense, free of all loose and extraneous material, and contains sufficient moisture to prevent penetration by the asphalt material.
- 2 Depending upon temperature and weather conditions, the RCE may allow deferral of the application of the curing coat on base course that is placed and completed during the latter portion of a day until the early part of the following day.

307.4.12 Opening to Traffic

- 1 Unless otherwise directed by the RCE, furnish such personnel and barricades along with other devices necessary to prevent construction equipment or other traffic, regardless of the type vehicle or its reason for being on the project, from using the finished base course. Use the subgrade shoulders or completed pavement for transporting materials, workers and equipment throughout the length of the project. Cross the finished base course at locations designated by the RCE only after the 7-day curing period has elapsed. Cover such designated crossings with at least 8 inches of earth as protection for the completed base course. When the paving operation is commenced, the completed section of the base course may be opened to light construction equipment for a distance not to exceed 1000 feet in advance of the paving work after the 7-day curing period has elapsed. When necessary to provide for normal traffic, the RCE may permit use of the base course for such purposes. Should the asphalt material for the curing coat not be sufficiently dry to prevent pickup when the base course is opened to traffic as outlined above, apply a granular cover before opening.

307.4.13 Maintenance

- 1 Maintain the entire base course within the limits of the project, during and after the curing period, in a good and satisfactory condition from the time the work starts until the work is complete and accepted. Maintenance includes the immediate repairs of any defects or damage that develops. If repair or patching is necessary, extend it to the full depth of the base course and in a manner that ensures the restoration to a uniform and durable base course.

307.5 Measurement

- 1 The quantity for the pay item Cement Stabilized Earth Base Course is the area of the cement stabilized earth base course constructed as specified and measured by the square yard (SY) on the surface of the base course, complete and accepted. Base course constructed outside the designated area is not measured for payment.

- 2 Base course of variable thickness or base course of thickness for which there is no unit bid price is converted to square yards of equivalent area of a base course of a thickness for which there is a unit bid price. The conversion is based on the base course with thickness nearest to that of the base course in question.
- 3 The quantity for the pay item Portland Cement for Cement Stabilized Earth Base Course is the weight of Portland cement incorporated into the work and is measured by the ton (TON), complete and accepted. Portland cement used in excess of 5% of the amount specified is not measured for payment.
- 4 The quantity of cement is determined by scale weights or by delivered weights. Furnish to the RCE invoices of all cement received to verify the weight.
- 5 When the stationary plant method of mixing is used, the weight of Portland cement is determined by calculating the weight of the composite mix using the actual dry density of the mix for a given area, the depth of the base course specified in the Plans, constructed within the tolerance specified in **Subsection 307.4.10**, and the percent cement placed in the mix not in excess of 5% of the amount specified.
- 6 Any unsuitable soil removed and replaced and any additional soil required for the base course in accordance with **Subsection 307.4.2** is measured and paid as Unclassified Excavation in accordance with **Section 203**.

307.6 Payment

- 1 Payment for the accepted quantity of Cement Stabilized Earth Base Course (of the uniform thickness specified) or Portland Cement for Cement Stabilized Earth Base Course, measured in accordance with **Subsection 307.5**, is determined using the contract unit bid price for the pay item.
- 2 Payment for Cement Stabilized Earth Base Course (of the uniform thickness specified) is full compensation for constructing the cement stabilized base course as specified or directed and includes pulverizing and scarifying the subgrade; mixing cement with soil and water; spreading base course material; maintaining proper moisture content; compacting, finishing, and curing base course; forming construction joints; and all other materials, labor, equipment, tools, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Base course that is deficient in thickness is paid for at the adjusted unit price specified in **Subsection 307.4.10**.
- 4 Payment for Portland Cement for Cement Stabilized Earth Base Course is full compensation for furnishing and weighing the cement as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.

307.6

307.6

5 Payment for each item includes all direct and indirect costs or expenses required to complete the work.

6 Pay items under this section include the following:

Item No.	Pay Item	Unit
3071040	Cement Stabilized Earth Base Course (4" Uniform)	SY
3071060	Cement Stabilized Earth Base Course (6" Uniform)	SY
3071080	Cement Stabilized Earth Base Course (8" Uniform)	SY
3071100	Cement Stabilized Earth Base Course (10" Uniform)	SY
3071120	Cement Stabilized Earth Base Course (12" Uniform)	SY
3071160	Cement Stabilized Earth Base Course (16" Uniform)	SY
3072000	Portland Cement for Cement Stabilized Earth Base Course	TON

SECTION 308

CEMENT STABILIZED AGGREGATE BASE

308.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for construction of a base course composed of aggregate and Portland cement, uniformly mixed, moistened, shaped, compacted, applied with a curing coat, and in conformance with the lines, grades, dimensions, and cross-sections shown on the Plans or as directed by the RCE.

308.2 Materials

- 1 Refer to **SC-M-308** for materials requirements.

308.3 Equipment

- 1 Refer to **SC-M-308** for equipment requirements.

308.4 Construction

- 1 Refer to **SC-M-308** for construction requirements.

308.5 Measurement

- 1 The quantity for the pay item Cement Stabilized Aggregate Base Course (of the uniform thickness specified) is the surface area of the cement stabilized aggregate base course in-place measured by the square yard (SY), complete and accepted. Base course constructed outside the designated area is not measured for payment.
- 2 Base course of variable thickness or base course of a thickness for which there is no contract unit bid price is converted to square yards of equivalent area of a cement stabilized aggregate base course of a thickness for which there is a contract unit bid price. The conversion is based on the cement stabilized aggregate base course that has a thickness nearest to that of the base course thickness in question.
- 3 The quantity for Portland Cement for Cement Stabilized Aggregate Base Course is measured by the ton (TON) of Portland cement incorporated into the work, complete and accepted. Cement used in excess of 5% of the amount specified is not measured for payment.
- 4 The measurement of Portland cement is by scale weights or by delivered weights. Furnish to the RCE invoices of all cement received to verify the weight.
- 5 Aggregate is considered included in unit price for the base course. No separate measurement or payment for aggregate or haul is made.

308.6 Payment

- 1 Payment for the accepted quantity of Cement Stabilized Aggregate Base Course (of the uniform thickness specified) or Portland Cement for Cement Stabilized Aggregate Base Course, measured as provided in **Subsection 308.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for the constructing the stabilized aggregate base course as specified or directed and includes furnishing all materials (except Portland cement); preparing, pulverizing, and scarifying the subgrade; processing, mixing, watering, and spreading base course material; maintaining proper moisture content; compacting, finishing, and curing base course; forming construction joints; and all other materials, labor, equipment, tools, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Base course that is deficient in thickness is paid for at the adjusted unit price specified in **SC-M-308**.
- 3 Payment for Portland Cement for Cement Stabilized Aggregate Base Course is full compensation for furnishing and weighing the cement as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Payment for each item includes all direct and indirect costs or expenses required to complete the work.
- 5 Pay items under this section include the following:

Item No.	Pay Item	Unit
3081060	Cement Stabilized Aggregate Base Course (6" Uniform)	SY
3081070	Cement Stabilized Aggregate Base Course (7" Uniform)	SY
3081080	Cement Stabilized Aggregate Base Course (8" Uniform)	SY
3081090	Cement Stabilized Aggregate Base Course (9" Uniform)	SY
3081100	Cement Stabilized Aggregate Base Course (10" Uniform)	SY
3081180	Cement Stabilized Aggregate Base Course (18" Uniform)	SY
3082000	Portland Cement for Cement Stabilized Aggregate Base Course	TON

SECTION 309

ASPHALT BASE COURSE - TYPE C AND D

309.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for construction of an asphalt base course composed of fine aggregate and asphalt binder, mixed in an approved hot mix asphalt plant, constructed on a prepared subgrade, base course, or other surface, applied with a tack coat when specified, and in conformance with the lines, grades, dimensions, and cross-sections shown on the Plans or as directed by the RCE.

309.2 Materials

309.2.1 Asphalt Binder

- 1 Use asphalt binder that meets the requirements of **Subsection 401.2.1**. Use performance grade PG64-22 unless otherwise specified.

309.2.2 Aggregate

309.2.2.1 General

- 1 Use aggregate material conforming to the requirements of **Subsection 401.2.2**. When Asphalt Base Course Type C is specified, use fine aggregate consisting of screenings as specified herein.

309.2.2.2 Screenings

- 1 In order to determine compliance with the material requirements, the RCE may sample the aggregate at any point before its introduction into the dryer. Obtain aggregate that passes a ½-inch sieve with a minimum of 90% of the material passing the No. 4 sieve.
- 2 At least 30 days before the beginning of any base course work, obtain samples of the aggregate intended for use in the construction of the base course. Use standard sampling methods to obtain these samples. Submit the local material to the OMR. Laboratory analysis and tests will be made to determine the suitability of the aggregate and the percentage of asphalt binder to be used.
- 3 Conduct excavation from pits so that a homogeneous material of uniform appearance is produced. When more than one material is used, keep the materials separated until blended from gates at the cold elevator feeders.

309.2.3 Composition of Mixture

- 1 Combine the constituents of the base course in such proportions so that after mixing, the resultant mixture is homogeneous and all particles are coated with asphalt binder. Use hydrated lime in all base courses as an anti-stripping additive.

- 2 Apply the quantity of asphalt binder to the dry aggregate necessary to provide a complete mixture, compacted in place, and meeting the properties specified in the following table.

Property	Type C	Type D
Asphalt Binder, % of Total Mixture	4.3 – 5.7	3.8 - 5.2
Minimum Stability, lbs.	2500	1500

- 3 The exact percentage of asphalt binder in the mixture is set between the above limits after laboratory tests have been made. The above composition limits are not master ranges of tolerance for asphalt binder content. Permitted tolerance for asphalt binder content is outlined in **Subsection 310.2.4**.
- 4 The RCE may direct that the quantity of asphalt material be increased or decreased from the limits specified above in order to secure a more stable mixture.

309.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.
- 2 The equipment requirements specified in **Subsection 401.3** also apply to Asphalt Base Course.

309.4 Construction

309.4.1 General

- 1 The construction requirements specified in **Subsection 401.4** apply to Asphalt Base Course, except as modified herein.
- 2 If desired, the material may be placed in one hot bin.
- 3 Perform the compaction of the asphalt base course using any combination of approved rollers while the mixture is still at a temperature that results in maximum density. Under normal conditions, perform the initial rolling with the tandem roller or a vibratory roller with the vibratory mechanism disengaged.

309.4.2 Preparation of Subgrade

- 1 Before placing the asphalt base course, prepare the subgrade in accordance with the requirements specified in **Section 208**.

309.4.3 Thickness Tolerance of Base Course

- 1 Where the Plans require a uniform thickness of the asphalt base course and the Contract provides for payment on a square yard basis, the thickness of the base course is determined from measurements taken of the completed base course at intervals not exceeding 500 feet for two-lane roads. Where the base course is less than the specified thickness by more than ½ inch, cor-

rect such areas by scarifying, adding base material, and re-compacting as directed by the RCE.

- 2 Where the measured thickness exceeds the specified thickness by more than $\frac{1}{2}$ inch, this thickness is considered as the specified thickness plus $\frac{1}{2}$ inch. The average job thickness is the average of the depth measurements determined as specified above. When the average job thickness is less than the specified thickness by more than $\frac{1}{4}$ inch, an adjusted unit price is used for calculating payment. This adjusted price bears the same ratio to the contract unit price bid as the average job thickness of the base course bears to the thickness specified.
- 3 When the project includes more than one road, each road is considered separately.
- 4 No additional payment over the contract unit price is made for any base course where the average thickness, determined as provided, exceeds the specified thickness.

309.4.4 Application of Tack Coat

- 1 When multiple lifts of asphalt base course are required, apply a tack coat conforming to the requirements of **Subsection 401.4.18**. No direct payment is made for the necessary tack coat.

309.5 Measurement

- 1 The quantity for the pay item Asphalt Base Course Type (*C or D*) (of uniform thickness required) is measured by the pay unit called for in the Contract.
- 2 When paid for by the square yard, the quantity for Asphalt Base Course is the surface area of the asphalt base course of uniform thickness measured by the square yard (SY) in-place, complete and accepted. Asphalt base course constructed outside of the area designated is not measured.
- 3 Asphalt base course of variable thickness or base course of thickness for which there is no contract unit bid price is converted to square yards of equivalent area of an asphalt base course of a uniform thickness for which there is a contract unit bid price. The conversion is based on the asphalt base course with the thickness nearest to that of the base course in question.
- 4 When paid for by the ton (TON), Asphalt Base Course is measured in accordance with **Subsection 401.5**.
- 5 When the base course is measured and paid for by the ton, the quantity for Liquid Asphalt Binder is measured by the ton (TON) in accordance with **Subsection 401.5**.
- 6 No measurement is made for the liquid asphalt binder when the asphalt base course is paid on a square yard basis, except when the quantity of asphalt binder is increased or decreased from the limits as specified in **Subsection 309.2.3**. The increase or decrease in asphalt binder used is the difference in tons between the quantity specified in **Subsection 309.2.3** and the quantity actually used in the compacted asphalt base course in accor-

dance with written instructions of the RCE.

- 7 All work and cost incidental to the preparation of the subgrade is included in the item Asphalt Base Course and is not measured for payment, except where such work is indicated on the Plans as Unclassified Excavation, in which case, it is measured and paid for in accordance with **Section 201**.

309.6 Payment

- 1 Payment for the accepted quantity of Asphalt Base Course Type (*C or D*) (of uniform thickness required), measured as provided in **Subsection 309.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for the construction of the asphalt base course as specified or directed and includes furnishing and clearing and grubbing the material pits; excavating and hauling materials, excluding the asphalt cement in paving mixture; preparing the subgrade; mixing, spreading and compacting the base course materials; applying tack coat (if necessary); and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to satisfactorily complete the work as specified.
- 2 Base course that is deficient in thickness is paid for at the adjusted unit price specified in **Subsection 309.4.3**.
- 3 Payment for Liquid Asphalt Binder PG64-22A is paid in accordance with **Subsection 401.6**.
- 4 Payment for the increase or decrease in the asphalt binder authorized in writing by the RCE and determined as provided in **Sub-section 309.5**, is paid for at the delivered cash price. Payment is not made for asphalt binder used in excess of that authorized in writing by the RCE.
- 5 Payment for each item includes all direct and indirect costs or expenses required to complete the work.
- 6 Pay items under this section include the following:

Item No.	Pay Item	Unit
3091040	Asphalt Base Course Type C (4" Uniform)	SY
3091060	Asphalt Base Course Type C (6" Uniform)	SY
3091100	Asphalt Base Course Type C	TON
3092040	Asphalt Base Course Type D (4" Uniform)	SY
3092060	Asphalt Base Course Type D (6" Uniform)	SY
3092100	Asphalt Base Course Type D	TON

SECTION 310

ASPHALT BASE COURSE - TYPE A AND B

310.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for construction of an asphalt aggregate base course composed of crushed stone, crushed slag, or gravel and an asphalt binder, mixed in an approved asphalt plant, constructed on a prepared subgrade, base course, or other surface, applied with a tack coat when specified, and in conformance with the lines, grades, dimensions, thickness, and typical cross-sections shown on the Plans or as otherwise directed by the RCE.

310.2 Materials

310.2.1 Asphalt Binder

- 1 Use asphalt binder meeting the requirements of **Subsection 401.2.1**. Use performance grade PG64-22 unless otherwise specified.

310.2.2 Aggregates

- 1 Use aggregate material conforming to the requirements of **Subsection 401.2.2**. When Asphalt Base Course Type A is specified, use coarse aggregates consisting of crushed stone and fine aggregate consisting of screenings.

310.2.3 Additives

- 1 Use hydrated lime in all base courses as an anti-stripping additive.

310.2.4 Composition of Mixture

- 1 Combine the coarse and fine aggregate with asphalt binder in such proportions that the composition by weight of the aggregate is within the limits specified in the following table.

Sieve Designation	Percentage By Weight Passing, %
1½-inch	100
1-inch	85 - 100
½-inch	60 - 80
No. 4	40 - 55
No. 8	30 - 45

- 2 The percent of asphalt binder in the total mixture usually ranges from 4.0% to 5.5%. Submit the coarse and fine aggregates to the OMR to determine the exact asphalt binder content used in the asphalt base course.

310.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.
- 2 The equipment requirements specified in **Subsection 401.3** also apply to equipment for construction of an asphalt base course.

310.4 Construction

- 1 The construction requirements specified in **Subsection 401.4** also apply to construction of an asphalt base course.

310.5 Measurement

- 1 Measurement for the quantity of Asphalt Base Course Type (*A or B*) or Liquid Asphalt Binder PG64-22 is made in accordance with methods in **Subsection 401.5**.

310.6 Payment

- 1 Payment for the accepted quantity of Asphalt Base Course Type (*A or B*) or Liquid Asphalt Binder PG64-22 is made in accordance with methods in **Subsection 401.6**.
- 2 Payment for each item includes all direct and indirect costs or expenses required to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
3100310	Asphalt Base Course Type A	TON
3100320	Asphalt Base Course Type B	TON

DIVISION 400
ASPHALT PAVEMENTS
SECTION 401

HOT MIXED ASPHALT (HMA) PAVEMENT

401.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for hot mixed asphalt (HMA) base courses, intermediate courses, and surface courses, regardless of gradation of mineral aggregates or the kind, type, and amount of binder or additives.
- 2 Also included in this section are the operations carried out on new and existing asphalt pavements such as milling, surface planing, and full depth HMA patching of asphalt pavement. These operations are performed to repair deteriorated pavement or segregated pavement, remove wheel ruts and other surface irregularities, and provide or restore the appropriate cross-slope to the pavement indicated in the Plans or as instructed by the RCE. Installation of milled-in rumble strips is also included in this section.

401.2 Materials

401.2.1 Binder and Additives

401.2.1.1 General

- 1 Use binder conforming to all of the requirements of AASHTO M 320 and meeting the performance grading within the following table unless otherwise noted in the Contract. Use binder from sources listed on the most recent edition of *SCDOT Qualified Product List 37*. When required, use polymer modified binder consisting of a neat binder modified with an elastomer polymer producing a binder complying with the requirements of a PG76-22 as specified in AASHTO M 320 with the addition of a maximum phase angle of 75 degrees when testing unaged binder in accordance with AASHTO T 320. Use neat binder meeting the requirements for PG64-22 or PG76-22 consisting of production "straight-run" materials that have not been "air-blown" or blended with acid. Use elastomer polymer consisting of a styrene-butadiene (SB), styrene-butadiene-styrene (SBS), or styrene-butadiene-rubber (SBR). Thoroughly blend the composite materials at the asphalt refinery or terminal before being loaded into the transport vehicle. Use polymer modified binder that is heat and storage stable.

Performance Graded Binder		
Type Facility	Intermediate	Surface
Interstates	PG64-22	PG76-22
Primary and Secondary Routes	PG64-22	PG64-22
Critical Areas	PG76-22	PG76-22

401.2.1.2 Liquid Anti-Stripping Agent

- 1 When permitted and used, use liquid anti-stripping agents (ASA) as an asphalt anti-stripping additive in HMA mixes according to the requirements of **SC-M-402**. Use a liquid ASA that has been blended at the binder supplier's terminal at the percentage recommended by the supplier of the liquid ASA and verified during the SCDOT mix design approval process.

401.2.1.3 Hydrated Lime

- 1 Use hydrated lime as an asphalt anti-stripping additive in HMA mixes according to the requirements of **SC-M-402** unless a liquid ASA is permitted and used in accordance with **Subsection 401.2.1.2**. Use hydrated lime conforming to the requirements of AASHTO M 303, Type 1 from suppliers listed on the most recent edition of *SCDOT Qualified Product List 39*.

401.2.2 Aggregates

401.2.2.1 Mineral Aggregates

- 1 Use mineral aggregate that is composed of fine aggregate or a combination of coarse and fine aggregate. Meet the gradation requirements for coarse and fine aggregates that are specified in the tables entitled Gradation of Coarse Aggregates and Gradation of Fine Aggregates located in the Appendix of these specifications. Blend aggregates through separate bins at the cold elevator feeders and not in the stockpile. Coarse aggregate is defined as the portion of the total aggregate retained on a No. 4 sieve, and fine aggregate is the portion passing a No. 4 sieve. Before Department approval may be given for their individual use, provide fine aggregate, coarse aggregate, and any additives in combination with the specified percentage of binder meeting the requirements of the tests specified. In any mix, use aggregates with a combined effective specific gravity of 2.90 or less. Marine limestone use is restricted for surface and intermediate courses as outlined under **Sections 402 and 403**.

401.2.2.2 Mineral Filler

- 1 Use mineral filler that conforms to the requirements of AASHTO M 17.

401.2.2.3 Fine Aggregates

- 1 Use fine aggregate consisting of sand, stone, slag, gravel, screenings, or a combination of sand and screenings from sources listed on the most recent edition of *SCDOT Qualified Product List 1*. Use fine aggregate that is uni-

formly graded from coarse to fine, is free of lumps of clay, loam, or other foreign matter and does not have a coating of an injurious material. The RCE will sample the stockpiled materials at the plant site to ensure compliance with these requirements.

401.2.2.3.1 Sand

- 1 Use sand consisting of hard, sharp, angular grains of quartz or other durable rock, free from excessive quantities of clay or other deleterious substances, and containing not more than 10.0% total material passing the No. 200 sieve with a maximum of 6.0% clay, except as indicated below. Determine the amount of material passing the No. 200 sieve using **SC-T-5**. Determine the percent of clay using **SC-T-34**. Use sand that is free of clay balls, and if it has any clay contained within it, the clay is uniformly dispersed throughout the material. Excavate, blend, and stockpile the sand so that a uniform product is provided. When sands are blended, one of the sands may contain a maximum of 12.0% minus No. 200 material; however, do not exceed 10.0% total material passing the No. 200 sieve with a maximum of 6.0% clay in the composite blend.

401.2.2.3.2 Screenings

- 1 Use screenings consisting of hard, sharp, angular grains of durable materials produced from stone, slag, or gravel meeting the quality requirements of coarse aggregate under **Subsection 401.2.2.4**. When 15.0% or less screenings are used in a mix, do not use screenings containing more than 35% passing the No. 200 sieve as determined by **SC-T-5**. When more than 15.0% screenings are used in a mix, do not use screenings containing more than 15.0% passing the No. 200 sieve as determined by **SC-T-5**. Do not use screenings containing an excessive amount of flaky, micaceous, or other injurious particles. Use regular screenings having a sand equivalent value greater than 40 as determined by AASHTO T 176. When used, ensure that marine limestone screenings or fines contained in a crusher-run material produced from marine limestone material have a sand equivalent of 28 or greater as determined by AASHTO T 176.

401.2.2.4 Coarse Aggregate

- 1 Use coarse aggregate from sources that appear on the most recent edition of *SCDOT Qualified Product List 2* and are shown as approved for HMA or are otherwise approved by the MRE. Use coarse aggregate consisting of clean, washed, tough, durable particles of crushed stone, gravel, or approved crushed slag free from an excess of soft or laminated pieces, disintegrated particles, and vegetable or other deleterious substances and free from aggregate coated with soil or other objectionable matter. Where slag is used, use dry slag having a weight of not less than 75 pounds per cubic foot.
- 2 Unless otherwise specified in **SC-M-402**, the following aggregate requirements apply. Use crushed stone or gravel having an abrasion loss of not more than 60.0% determined by AASHTO T 96 unless otherwise noted. Use slag that has an abrasion loss of not more than 45.0% as determined by

AASHTO T 96. Use aggregates with not more than 10% flat and elongated particles based on a 5:1 ratio following **SC-T-77**.

- 3 Before use in an HMA mixture, test stockpiled slag for expansion following ASTM D 4792 and use material with an average total volumetric expansion of less than 0.50% at the completion of the curing period. Cure stockpiles not meeting the expansion criterion for an additional 2 months minimum before re-testing.
- 4 When the stockpiled material has been aged and passes the volumetric expansion requirements, provide the AME with a certification stating that the material has been cured according to specifications and an HMA mix design for verification. The AME will assign a stockpile number to the stockpile after reviewing the required certification. Age all steel slag used for mix designs in accordance with this specification.

401.2.2.5 Crusher-Run Material

- 1 When using crusher-run material in HMA, use material produced from areas in the quarry that does not allow the possibility of intrusion of overburden, dirt, sap rock, or any other deleterious material.
- 2 The AME will review for approval the process for manufacturing the crusher-run material and the quality control program for controlling production. Utilize a manufacturing process that ensures that a consistent gradation is maintained. Verify this consistent gradation using quality control tests performed by the producer on a daily basis. Make available to the AME all test results upon request.
- 3 Use coarse aggregate in the crusher-run material that is free of clay coatings or other harmful films. Use fines in the crusher-run that meet the quality requirements specified for screenings, including the sand equivalent requirement. Crusher-run material does not require screening before entering the cold feed bin(s) provided a uniform mixture is being produced. If segregation of the finished mixture is evident, the AME may require the crusher-run material to be screened into a coarse and a fine size before entering the cold feed bin(s).

401.2.2.6 Recycled Asphalt Pavement (RAP)

401.2.2.6.1 General

- 1 Ensure that the RAP meets one of the following categories:
 - Category 1: Milled RAP - asphalt material milled from Interstate, US Highway or Primary routes.
 - Category 2: Production Returns – material generated from plant waste, i.e., start-up / shut down material or Random RAP – crushed and screened material removed from secondary routes, private paving projects and/or plant overruns / rejected loads.

401.2.2.6.2 Stockpile Approval

- 1 Perform extraction tests at a rate of 1 per 1000 tons of RAP, with a minimum of 3 tests per stockpile. Process the RAP in such a manner that all particles pass a 2-inch screen before entering the plant, and are free of foreign matter or other contaminations. RAP particles retained on the 2-inch screen may be re-crushed in a manner that does not result in further degradation of the aggregates. Separate stockpiles of RAP material by categories. Erect and maintain a sign satisfactory to the AME on each stockpile to identify the category. Assure that no deleterious material is allowed in any stockpile.

401.2.2.6.3 Records

- 1 Maintain at the plant site a record system for all RAP stockpiles. Include at a minimum the following:
 - Stockpile identification and a sketch of all stockpile areas at the plant site.
 - RAP category (project, state route, plant waste, rejected loads).
 - Origin, dates milled, and the approximate number of tons in the stockpile.
 - All extraction test results.
- 2 At the plant site, make available to the RCE and AME the RAP stockpile records. The RCE or AME may reject by visual inspection any stockpiles that are not kept clean and free of foreign materials.

401.2.2.6.4 Composition of Recycled Mixture

- 1 Use recycled HMA meeting all applicable requirements contained in the specifications, except as indicated herein. Submit samples of RAP and additives proposed for use in the recycled HMA to the AME at least 30 days prior to the beginning of the work. Submit a minimum of 50 pounds of representative milled/processed material along with the RAP stockpile records and the asphalt mix design approval request on forms approved by the AME.
- 2 If milled material from a project is not available, submit at least 10 cores that are between 6 and 8 inches in diameter, sliced at the proposed milling depth that is representative of the material to be milled. In addition, perform a minimum of 6 extraction tests on cored roadway samples from random locations before submitting an asphalt mix design approval request. Submit extraction test results and cores representing the material to be milled with the asphalt mix design request. Ensure that the number of roadway cores obtained is sufficient to represent the entire length of roadway to be milled taking into consideration the length of the project, changing roadway conditions, etc. Conform all HMA to the job mix formulas approved by the MRE within the tolerance range specified.
- 3 Use a final product with a maximum calculated recovered combined absolute viscosity at 140°F of 8,000 poises as determined by **SC-T-95** and AASHTO T 202.

401.2.2.6.4

401.2.2.6.6

- 4 Do not use softening agents, asphalt modifiers, rejuvenators, or recycling agents. Do not use RAP in any HMA mixture that requires or otherwise uses polymer-modified binder.
- 5 The AME will make random project inspections so that samples of recycled HMA can be obtained for checking the recovered absolute viscosity of the binder. For the maximum absolute viscosity at 140°F of the binder recovered from the field samples, do not exceed 14,000 poises.

401.2.2.6.5 Non-Fractionated RAP

- 1 In addition to the limits below, further limit RAP to 15% maximum when introduced in the hot elevator.
- 2 RAP stockpiles may contain RAP from sources indicated by the category and cannot be replenished once approved.
- 3 When used in HMA, do not exceed the maximum amounts of RAP in mixes shown in the following table.

Type Mix	Maximum % RAP	
	Category 1	Category 2
Surface Type B	10	10
Surface Types CM, C, and D	20	10
Intermediate Type B	15	10
Intermediate Type C	25	10
Asphalt Base Types A & B	30	10

401.2.2.6.6 Fractionated RAP

- 1 Mechanically separate RAP materials into appropriate sizes using a high frequency separation device.
- 2 Provide a QC plan approved by the AME, a fractionation device approved by the AME, and sufficient cold feed bins (one per RAP fractionation size) to handle the fine (passing No. 4 or ¼-inch sieve) and coarse material(s) generated during the fractionation process.
- 3 In addition to the limits in the table below, further limit RAP to 15% maximum when introduced in the hot elevator.
- 4 RAP stockpiles may contain RAP from sources as indicated by the category and may be replenished with RAP from sources of that same category.
- 5 When used in HMA, do not exceed the maximum amounts of RAP in mixes shown in the following table.

Type Mix	Maximum % RAP	
	Category 1	Category 2
Surface Type E Asphalt Base Types C & D	15 *	10 *
Surface Type B	15	10
Surface Types CM, C, and D	20	20
Intermediate Type B	25	10
Intermediate Type C (Binder Type 2)	25	25
Asphalt Base Types A & B	30	30

* Fine RAP only

401.2.2.7 Crushed Glass

- Crushed glass is permitted for use as an aggregate in HMA Aggregate Base Types A and B and Intermediate Type C. When used in these mixes, limit crushed glass to a maximum of 15% by weight of total aggregate. Do not exceed the limits of crushed glass in the following table.

Sieve	% Passing
3/8-inch	100.0
No. 200	8.0 max.

- When the stockpiled material is included in an HMA mix design, present a certification to the AME, along with the mix design for verification, stating that the material meets the required specifications. A stockpile number will be assigned to the stockpile after receiving the proper certification documents

401.2.2.8 Shingles

401.2.2.8.1 General

- Shingles are permitted in HMA Aggregate Base Types A and B, Intermediate Type C, and Surface Types C and D.
- If shingles are used, produce a uniform and reacted asphalt mixture of compatible paving grade binder, quality fine and coarse aggregates, anti-strip additive, and shredded shingles.

401.2.2.8.2 Amount of Shingles in the Mixture

- Limit the amount of the shingles used in each mix in accordance of the job mix formula requirements for that mix. When used, utilize 3% to 8% shingles by the total weight of the aggregate.

401.2.2.8.3 Shredded Shingles

- 1 Utilize shredded shingles that are produced primarily from the processing of shingles at a processing facility or during delivery to a landfill. Use shingles that are produced by ambient temperature grinding processes only. Optionally, use shingles of multiple types from multiple sources if the overall blend of shingles meets the gradation requirements. Ensure that the manufacturer of the roofing shingles has removed all debris such as nails, wood, metal, dirt, large stones, etc. and has rendered the materials to a particle size of less than ½ inch. Provide delivered material 99.7% (by weight) free of any debris.

401.2.2.8.4 Gradation

- 1 Use shingles that meet the requirements in the following table when tested in accordance with AASHTO T 27.

Sieve Size	% Passing
1/2-inch	100.0
No. 4	70.0 – 95.0
No. 100	15.0 max.
No. 200	7.00 max.

- 2 Do not exceed ½ inch for the length of the individual shingle particles. Use shingles that are sufficiently dry to be free flowing and to prevent foaming when blended with the hot binder. Ensure that the shingles are free of all chemicals, oils, or any other hazardous materials (e.g., asbestos). Only accept shredded shingles with a certification from the shingle supplier that the material conforms to these specifications.

401.2.2.8.5 Mix Design

- 1 Use the method of mix design described in **SC-T-80** for the design of HMA containing shingles. After heating the aggregates to the proper temperatures and approximately 1 hour before the addition of the binder, add the proper amount of the shingles (e.g., 8% of total weight of the aggregate or 0.080 x total weight of aggregate), mix thoroughly, and place the mix back in the oven. After approximately an additional 1-hour, add the required amount of the binder and mix. Check the temperature of the mixture to ensure that it has reached the compaction temperature before applying the compactive effort.
- 2 During the mix design verification, approval of the mixture will be based on the calculated absolute viscosity of the mixture. Use material with a recovered absolute viscosity at 140°F less than 12,000 poises as determined by **SC-T-95** and AASHTO T 202.

401.2.2.8.6 Extraction

- 1 Perform the extraction process in accordance with requirements described in these specifications. Follow the testing procedures described in **SC-T-75** to

obtain the binder content of the mixture.

401.2.3 Composition of Mixture

401.2.3.1 Submission of Materials and Job Mix Formula

- 1 Provide all asphalt mix designs for approval by the MRE. Prepare the mix designs in a laboratory approved by the AME following **SC-T-82**. Ensure that technicians designing mixes are certified as a Level 2S, HMA Mix Design Technician. Use a mix with the appropriate materials that complies with all specifications. Prepare mix designs following **SC-T-80** and AASHTO T 312.
- 2 In the job mix formula, indicate a single definite percentage of aggregate passing each required sieve and a single definite percentage of binder contained in the mixture. This percentage of binder is the percentage recovered by **SC-T-64** or **SC-T-75** and does not include any binder that may be absorbed in the aggregates. If an anti-stripping agent or other additives are required, in the job mix formula, indicate the percent of each to be incorporated in the mixture.
- 3 Submit the proposed mix design formula in writing and obtain the approval of MRE for the intended source of materials before starting any work or producing any mixture for acceptance.
- 4 The AME may make adjustments in the submitted job mix formula and if so, will provide advice as to the job mix formula to be used.

401.2.3.2 Gradation Test Method

- 1 Determine the gradation of HMA indicated in **SC-M-400**.

401.2.3.3 Tolerances

- 1 Conform mixtures controlled and accepted according to the standard procedure to the tolerances listed in the table below. Do not use any job mix formula, with or without the tolerances, outside of the master range provided in **SC-M-402** unless otherwise stated.

Sieve Size % Passing	Intermediate Courses	Surface Courses
3/8-inch & larger	± 7.0%	± 7.0%
No. 4	± 6.0%	± 7.0%
No. 8	± 6.0%	± 6.0%
No. 30	± 5.0%	± 5.0%
No. 100	± 4.0%	± 4.0%
No. 200	± 2.0%	± 2.0%

401.2.3.4 Moisture Susceptibility

- 1 Subject all intermediate and surface courses to the indirect tensile strength (ITS) test during the mix design and during actual production of the mix.

Conduct the test in accordance with **SC-T-70**.

- 2 Use intermediate and surface courses with a minimum wet conditioned strength of 65.0 psi and a minimum tensile strength ratio (TSR) of 85.0% during mix design.
- 3 Resubmit the HMA job mix request for mixtures that do not meet the minimum wet conditioned strength or minimum TSR requirements.
- 4 Specimens may be molded in the field anytime during construction to determine the moisture susceptibility of an asphalt mix. Produce HMA having a minimum wet conditioned strength of 60.0 psi and a minimum TSR of 80.0% after plant mixing.

401.2.3.5 Dust to Asphalt Ratio

- 1 Maintain the dust to asphalt ratio for all intermediate and surface courses, except for Surface Type E, in the limits of 0.60 to 1.20. The dust to asphalt ratio is defined as the percentage of material passing the No. 200 sieve divided by the percentage of binder. Determine the total amount passing the No. 200 sieve on mix designs by AASHTO T 11. Determine the amount passing the No. 200 sieve in the field by **SC-T-64**, **SC-T-76**, or **SC-T-92**.

401.2.3.6 Wash Gradations

- 1 Use wash gradations on coarse and fine aggregates to determine the combined blend of aggregates in the total mixture during mix designs. Determine aggregate washed gradations by AASHTO T 11. Submit washed gradations on forms approved by the AME when requesting a job mix formula.

401.2.3.7 Aggregate Selection

- 1 Use a combination of aggregates so that mix adjustments can be readily performed to correct mix design and field problems related to air voids, dust to asphalt ratio, and gradation. Use at least 3 uniformly graded aggregated types to compose an asphalt mix design: fine, intermediate, and coarse aggregates. Do not use less than 8% of any given aggregate type in any mix.

401.2.3.8 Rutting Susceptibility

- 1 HMA used for Interstate and high volume routes will be subjected to the Asphalt Pavement Analyzer (APA) procedure during the mix design process and may be subjected to testing during actual production of the mixture, as deemed necessary by the AME. Perform the testing in accordance with AASHTO TP 63 in a testing laboratory approved by the AME. Fabricate and test 6 cylindrical samples with the interior temperature of the APA set at 64°C. Set the downward force at 100 pounds with the hoses pressurized to 100 psi. Compact each specimen to 4 ±1% air voids. Meet the requirements for the specimen's average rut depth as listed in **SC-M-402**.

401.2.4 Mix and Pavement Samples

- 1 Samples of the HMA in use will be taken and tested as many times daily as deemed necessary by the RCE and the mixture must be maintained uniform

throughout the project within the applicable tolerances.

- 2 Furnish samples of HMA for testing from trucks at the asphalt plant site, trucks at the roadway site, or samples cut from the completed pavement structure. When areas of the pavement are so removed, replace with new HMA and refinish. No additional compensation is allowed for furnishing test samples and replacing the areas with new HMA.

401.2.5 Material for Full Depth Patching

- 1 Select the patch material from the HMA mixes approved for use in the project. Provide patch material that meets all requirements established for those mixes.

401.3 Equipment

401.3.1 General

- 1 The method employed in performing the work and all equipment, plants, machinery, tools, etc., used in handling the materials and performing any part of the work is subject to the approval of the RCE before work is started. The method will be changed or improved as required when found unsatisfactory. Maintain all equipment, tools, machinery, and plants used in a satisfactory working condition. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

401.3.2 Mixing Plants

- 1 Use either a batch mixing plant or a drum mixing plant that is designed, equipped and operated so that the weighing, proportioning, and mixing of the materials results in a uniform and satisfactory asphalt mixture meeting the requirements of these specifications. At the plant site, provide sufficient storage space for separate stockpiles, bins, or stalls for each size of aggregate. Keep the different sizes separated until they are delivered, without segregation, by the feeder or feeders to the boot of the cold elevator or elevators in their proper proportions. Maintain the storage yard in a neat and orderly condition with separated stockpiles readily accessible for sampling. Provide separate dry storage of adequate capacity for mineral filler when used. During production of mixes for Department projects, provide full access to the control room and other areas of the plant.
- 2 Use mixing plants of sufficient capacity and that are coordinated to adequately handle the proposed construction. Unless otherwise specified, ensure that mixing plants comply with the requirements contained in **SC-M-401**.
- 3 Ensure that mixing plants for RAP conform to the requirements of **Subsection 401.3.6**.

401.3.3 Hydrated Lime Systems

- 1 Use a lime proportioning system meeting the requirements of **SC-M-401**.

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- 2 Obtain approval by the AME for all lime systems, including the continuous premixing pugmill, before any mix is produced.

401.3.4 Shingle Blending Equipment

- 1 If a mechanical system is used to add the required amount of shingles to the HMA, utilize a system that is fully integrated with controls for mineral aggregate, binder, and anti-strip additive. During the pre-construction meeting, discuss and determine the system and methods of adding the shingles to the mix. The AME will inspect the system (manual or mechanical) for approval.

401.3.5 Shingle Storage Area and Silos

- 1 Provide a storage area for storing the shredded shingles that is kept free and clear of all debris such as dirt, wood, paper, stones, etc.
- 2 If the mixture is discharged from the mixer into a hot mix surge or storage silo, operate the bin so that segregation of the mixture is minimized and mixture is not stored overnight.

401.3.6 Mixing Plants for Recycled Asphalt Pavement (RAP)

401.3.6.1 General

- 1 Produce the recycled HMA in a batch plant or drum mix plant meeting all applicable requirements of the specifications and that is modified in a manner satisfactory to the AME to accomplish the hot recycling process. Ensure that the plant is capable of producing uniform mixtures meeting the requirements in **Subsection 401.2.2.6** at the temperatures specified.
- 2 Use a plant capable of meeting all applicable local, state, and federal pollution control requirements. Be familiar with all regulations and be aware that plant emissions resulting from the recycling process may be monitored.

401.3.6.2 Batch Plants for RAP

- 1 Introduce RAP into the plant at the hot elevator or in the weigh hopper.
- 2 When RAP is introduced into the weigh hopper, accurately weigh and proportion the RAP using an automatic proportioning system. Ensure that the RAP weight tolerance is $\pm 1.5\%$ of the total batch weight. Print the RAP weight for each batch on the weight ticket along with the weight of the other batched materials.
- 3 In addition to the maximum limits in the tables provided in **Subsection 401.2.2.6**, further limit the amount of RAP to 15% maximum when RAP is introduced in the hot elevator. Continuously weigh, control, and monitor the RAP cold feed rate and virgin aggregate cold feed rate. Ensure that the weighing system is accurate to 0.5%. Provide a means for conveniently diverting RAP and virgin aggregates into trucks or other containers for checking the accuracy of the cold feed delivery systems. Calibrate the plant before starting production.

- 4 Make provisions electronically for introducing the determined moisture content of the cold feed materials (RAP and virgin aggregates) in the belt weighing system and automatically correcting wet material weights to dry material weights. Determine the moisture content of the RAP and virgin aggregates twice a day during production or when the AME deems necessary. Record the moisture test results on the daily plant report.
- 5 Equip the hot elevator RAP introduction systems so that the dry RAP and dry virgin aggregate rates, in tons per hour, are printed on a cold feed ticket at a time interval prescribed by the AME. Submit the cold feed tickets to the RCE at the end of each day's production.

401.3.6.3 Drum Mixing Plants for RAP

- 1 Continuously weigh, control, and monitor the interlocked RAP cold feed rate and virgin aggregate cold feed rate. Utilize a weighing system with an accuracy of 0.5%. Provide a means for conveniently diverting RAP and virgin aggregates into trucks or other containers for checking the accuracy of the cold feed delivery systems. Calibrate the plant before starting production.
- 2 Make provisions to electronically introduce the determined moisture content of the cold feed materials (RAP and virgin aggregates) in the belt weighing systems and automatically correct wet material weights to dry material weights. Determine the moisture content of the RAP and virgin aggregates twice a day during production or when the AME deems necessary. Record the moisture test results on the approved daily plant report.
- 3 Introduce the RAP in the plant at a location far enough down-stream from the burner away from the flame and extremely hot gases.
- 4 Equip the drum mixing plant with a printer to print the following plant information:
 - Dry virgin aggregate rate in tons per hour.
 - Dry RAP rate in tons per hour.
 - Binder in tons per hour.
 - Total virgin aggregates, RAP, and binder in tons per hour.
- 5 Print the above mentioned plant information on a ticket at a time interval prescribed by the AME. Submit the plant information tickets to the RCE at the end of each day's production.

401.3.7 Hauling Equipment

- 1 Use trucks for hauling asphalt mixture that have tight, clean, smooth metal beds and, to prevent the mixture from adhering to the bed, have been thinly coated with an asphalt release agent listed on the most recent edition of *SCDOT Qualified Product List 17*. Do not use petroleum-based products to prevent asphalt mixtures from adhering to the beds. In all cases, after spraying with solution, raise truck beds so that excess material drains before placing mixture in the truck. Place a hole at a suitable location in the truck bed for checking the temperature of the mixture. Provide and have installed on vehi-

cles a cover made of canvas or suitable material that provides an essentially weather-tight enclosure to completely cover and protect the mixture from inclement weather or where there is evidence of a crust forming. Do not use mesh tarps for covers.

401.3.8 Batch and Truck Scales

- 1 Provide truck scales at the plant site to obtain the net weight of each load of finished mixture and that meet the requirements of **SC-M-401**.

401.3.9 Silos for Storage of HMA

- 1 Ensure that silos used for storage of HMA conform to the requirements of **SC-M-401**.

401.3.10 Pavers

- 1 Unless otherwise permitted or directed by the RCE, spread the asphalt mixture by means of a mechanical self-powered paver capable of spreading and finishing the asphalt mixture without segregation to the depth and width required, true to line, grade, and crown set by the RCE. Equip the paver with hoppers and distributing screws or satisfactory devices for placing the mixture uniformly in front of the screed. When extendable screeds are used, sufficiently extend the distributing screws or augers to provide uniform distribution of the mixture for the full width of the screed. Use a screed or strike-off assembly that operates by cutting, crowding, or other practical action that is effective on the mixture at workable temperatures without tearing, shoving, or gouging and that produces a finished surface of the smoothness and texture required. Use a screed that is adjustable as to level and has an indicating level attached.
- 2 Use a paver that is capable of operating at variable speeds consistent with uniform and continuous laying of the mixture. Avoid stop and go operations of the paver.
- 3 On projects of sufficient length, in addition to the above requirements, equip the paver with a system for automatically controlling the pavement cross-slope and for automatically controlling the longitudinal profile. As the paver moves forward, ensure that the system causes the paver to automatically anticipate and make adjustments for undulations encountered on the existing surface.
- 4 Attach to the paver a 40-foot mobile stringline, a 40-foot long ski, or an approved electronic leveling device with the mobile stringline or ski reference used to establish the longitudinal profile. Use a grade-following sensor that is capable of following the taut string, wire, or other reasonable rigid grade reference produced by the leveling device. Use an automatic cross-slope device that is adjustable and is able to obtain the proper super-elevation going into curves and able to maintain the maximum super-elevation within curves once reaching the maximum super-elevation. For tying into an existing layer of material, use the existing material as the grade reference for the grade following sensor.

- 5 If desired, use manual operation for constructing irregularly shaped and minor areas. If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained. If the specified surface tolerance is not obtained and maintained, suspend the paving operations until satisfactory corrections, repairs, or equipment replacements are made.

401.3.11 Rollers

401.3.11.1 General

- 1 At the job site, provide the RCE with the manufacturer's literature for the rollers being used, in order that the RCE can determine that the rollers conform to the specifications. Check the tire pressure in the pneumatic-tired rollers upon request and without additional compensation. Check the weight of any roller in use in the presence of the RCE.
- 2 Maintain roller speeds that give maximum compaction and a smooth pavement.

401.3.11.2 Steel-Wheel Rollers

- 1 Use steel wheel rollers that are between 8 and 12 tons in weight. Develop a minimum pressure of 250 pounds per inch of roller width in the compression wheel for these rollers under working conditions. Use rollers in good working condition and capable of reversing without backlash. Equip rollers with adjustable scrapers to keep the rollers clean and with efficient means of keeping the wheels wet to prevent mixes from sticking to the rollers.
- 2 Keep the surface of the rollers free of flat areas, openings, or projections that could mar the surface of the pavement.

401.3.11.3 Pneumatic-Tire Rollers

- 1 Use pneumatic-tire rollers that are self-propelled and have an effective rolling width of not less than 60 inches. Equip the rollers with pneumatic tires of equal size and diameter that are capable of exerting uniform contact pressures. Pressures varying from 60 psi to 80 psi are recommended. Adjust contact pressure by adjusting the ballast or tire inflation pressures. Place the wheels of the rollers so that one pass accomplishes complete coverage equal to the rolling width of the machine. Ensure a minimum of a ¼-inch overlap of the tracking wheels and ensure that the wheels do not wobble. Construct the roller so that the contact pressure is uniform for all wheels, and the tire pressure of the several tires does not vary more than 5 pounds per square inch. Use pneumatic-tire rollers that are constructed with enough ballast space to provide the uniform wheel loading required. Vary the total operating weight and tire pressure of the roller directed by the RCE to obtain contact pressures that results in adequate compaction.

401.3.11.4 Vibratory Rollers

- 1 Use vibratory rollers that weigh at least 8 tons and have either 1 or 2 vibrating wheels. Operate the roller at a speed, frequency, and amplitude that

yields maximum compaction and a smooth pavement.

401.3.12 Field Laboratory and Equipment

- 1 Provide and maintain in good condition a fully equipped field laboratory, meeting the requirements of **SC-T-81** and furnish all supplies necessary for performing the quality control inspection and testing at the asphalt plant. Furnish all the necessary electricity, fuel, and gas and furnish and maintain all necessary piping and valves. Provide full and ready access for the RCE and MRE during all production and testing. Make immediately available all records to the RCE and MRE at the asphalt plant upon request. Permit the RCE and AME to perform quality control or other tests as deemed necessary. Provide a substantial platform, constructed to the proper height, for use by the RCE and AME in obtaining HMA samples and inspecting mixtures in truck beds. All testing equipment and supplies will be inspected for approval by the AME.

401.3.13 Cutting Equipment for Milled-In Rumble Strips (MIRS)

- 1 Use a rotary type cutting head for MIRS. Use a head with a maximum outside diameter of 24 inches and a minimum length of 16 inches. Equip the cutting head with the cutting tips arranged in such a pattern that provide a relatively smooth cut. Ensure that the cutting head(s) is mounted on its own independent suspension from that of the power unit to allow the tool to self-align with the slope of the shoulder and/or any irregularities in the shoulder surface. Equip the cutting tool with guides to provide consistent alignment of each cut in relation to the roadway and provide uniformity and consistency throughout the project.

401.3.14 Equipment for Milling Existing Asphalt Pavement

- 1 Use a milling machine capable of performing the work to the specified width, depth, and cross-slope as shown in the Plans or as directed by the RCE.

401.3.15 Equipment for Planing Existing Asphalt Pavement

- 1 Use a planing or milling machine equipped with a cutting mandrel with carbide-tipped cutting teeth designed specifically for planing asphalt pavement to close tolerances. Make certain that the equipment accurately establishes slope elevations and profile grade controls. Ensure that a vacuum-equipped street sweeper, capable of removing all loose material from the roadway without causing dust to escape into the air, follows immediately behind the grinding machine. Provide necessary vehicles and equipment for loading and hauling away milled material and cleaning the road surface after planing.

401.4 Construction

401.4.1 General

- 1 Construct the base, intermediate, or surface course consisting of one or more courses of binder coated mineral aggregates on the prepared surface in accordance with these specifications and the specific requirements of the type

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specified. Conform the courses to the required lines, dimensions, thickness, and typical cross-section or specified rate of application.

- 2 Conform the production, spreading, compaction, etc. to the applicable requirements of the Specifications.

401.4.2 Plant Production

- 1 Conform HMA production to the requirements of **SC-M-400** unless otherwise specified.
- 2 If it is believed that the HMA is not accurately represented by the field laboratory results, the RCE may contact the AME to investigate the mixture. This investigation may involve the testing of additional HMA material from the paver, delivery truck, or roadway cores.

401.4.3 Paving from Multiple Plants

- 1 To avoid intermixing HMA, do not pave the same lane using mix from more than one plant during a day's production.

401.4.4 Weather and Surface Temperature Restrictions

- 1 Do not apply HMA when the existing surface is wet or frozen. Place HMA in accordance with the following table.

Lift Thickness (inches)	Minimum Ambient Temperature (°F)*
1.0 or less	55.0
1.1 to 2.0	45.0
2.1 to 3.0	40.0
3.1 to 4.5	35.0
* Measure ambient air temperature in the shade with a calibrated thermometer away from artificial heat following SC-T-84 .	

- 2 Do not place HMA surface courses, including Surface Type E, during the months of December, January, and February, except with written permission of the DOC.

401.4.5 Plant Calibration

401.4.5.1 General

- 1 Calibrate the asphalt plant before production so that the mix conforms to the job mix formula and field criteria. Keep stockpile aggregate gradation test results and calibration charts or graphs immediately available to the RCE at the plant upon request.

401.4.5.2 Batch Plant

- 1 When a batch plant is used, calibrate the cold feed bins to the correct proportions on the job mix information sheet. Develop calibration charts or

graphs for each individual cold feed bin. Sample each hot bin and perform gradation tests on each hot bin sample. Determine the percentage of material weighed from each hot bin. Immediately correct the automatic proportioning system when it does not consistently deliver materials within the full range of batch sizes within the tolerances stated in **SC-M-401**. Ensure that the automatic proportioning system can be corrected when the binder content does not reasonably compare with the extraction test results.

401.4.5.3 Drum Mixer Plants

- 1 When a drum mixer plant is used, calibrate the cold feed bins to the correct proportions on the job mix information sheet. Develop calibration charts or graphs for each individual cold feed bin. Recalibrate binder systems when there is variance in the binder content or when the RCE deems necessary. Determine the moisture content of the aggregates before entering the drum at least two times a day or when the RCE or AME deems necessary. Keep calibration charts or graphs and aggregate moisture content test results immediately available to the RCE and AME in the field laboratory upon request.

401.4.5.4 Contractors Monitoring Operations

- 1 Monitor the gradation and quality of materials that are delivered to the asphalt plant. When one or more aggregate gradations do not reasonably conform to the gradation on the job mix information sheet, resubmit another job mix design request.

401.4.5.5 Failing Samples

- 1 Adjust plant production and address samples that are out of tolerance as indicated in **SC-M-400**.

401.4.6 Use of HMA Stored in Silos and Surge Bins

- 1 Ensure that storage of HMA in silos is conducted following the requirements stated in **SC-M-401**.
- 2 The RCE is not obligated to purchase any HMA stored in a silo or surge bin that does not comply with the job mix formula and/or mixture field criteria. HMA that the RCE determines is segregated or contains too much binder due to migration will be rejected.

401.4.7 Preparation of Binder

- 1 Heat the binder to a temperature range recommended by the binder supplier in tanks designed to provide uniform heating of the entire content and to provide a continuous supply of the binder to the mixer at a uniform temperature. Do not heat the unmodified binder to more than 325°F or greater than the temperature recommended by the binder supplier at any time before or after shipment to the plant site.

401.4.8 Preparation of Aggregate

- 1 At the plant, dry and heat the aggregate for the mixture. Heat the aggregate to a temperature between 250°F and 325°F or within the temperature

range recommended by the binder supplier.

401.4.9 Preparation of Mixture

- 1 Heat and prepare the ingredients in a manner that produces a mixture that, when discharged, is at a temperature recommended by the binder supplier, except for HMA Base Type C and D, which requires a temperature to provide complete coating of all particles (typically 240°F to 275°F).
- 2 Whenever possible, devote the full production of the plant to the project in order that the work is performed as continuously as practical. Do not intermix different job mixes in a silo.

401.4.10 Mixing: Batch, Drum, and Continuous Mix Plants

- 1 In order to give the correct individual proportions, follow the HMA job mix formula at all asphalt plants. Dry the aggregates to a consistent mixing temperature before introducing the binder into the HMA. Mix the correct proportions of aggregate, mineral filler, lime, and binder to produce a homogenous asphalt mix in which all particles are thoroughly coated. Use asphalt plants meeting **SC-M-401**, with lime systems checked initially by the AME before producing HMA for Department projects. Use a plant that is able to produce a consistent asphalt mix, without problems with segregation, mix temperature, and varying binder content to meet requirements of the Specifications.

401.4.11 Blending of Hydrated Lime

- 1 Uniformly blend hydrated lime with the damp aggregate at a rate of 1% by weight of dry aggregate. Use damp aggregate containing a minimum of 3% moisture. Use a water spray delivery system if aggregate moisture is less than 3% or when the RCE deems it necessary to prevent lime from becoming airborne. Adjust the production rate so that there is not any retained moisture in the finished mix.
- 2 Perform aggregate moisture tests at least two times a day or when deemed necessary by the RCE. Obtain the aggregate moisture samples at a location between the water spray delivery system and the lime feed system. Keep a record of the test results in an easily accessible location at the asphalt plant for review by the RCE and MRE.
- 3 Determine the percentage of hydrated lime being introduced into the HMA in accordance with **SC-T-71** or **SC-T-78**. Check the percentage of hydrated lime at least two times a day or when the RCE deems necessary. Additionally, when **SC-T-78** is used, verify the weighing system accuracy at least one time per week or as often as the RCE deems necessary.
- 4 Maintain a daily record of aggregate moisture tests and lime percentage determinations on a form approved by the AME. Maintain the amount of hydrated lime by dry aggregate weight in the range of 0.90% to 1.10%. Upon request, make all records immediately available to Department personnel at the asphalt plant.

401.4.12 Milling Existing Asphalt Pavement

- 1 Mill the existing asphalt pavement to the specified width, depth, and cross-slope at locations shown on the Plans or as directed by the RCE. Monitor the milled surface to ensure smoothness and to reduce excess scarification marks or other damage as determined by the RCE. Establish the longitudinal profile of the milled surface by using a skid sensor on the side of the cut. Dispose of the milled material. Thoroughly clean the milled surface of all loose particles.
- 2 Tie milled surfaces to existing drives and intersections. Conduct additional milling in these areas as necessary.

401.4.13 Planing Existing Asphalt Surfaces

- 1 Conduct planing operations in a manner that produces a uniform finished surface of the required texture, grade, and cross-slope. Conduct planing operations in a continuous manner to ensure uniformity. It is not acceptable to conduct frequent halting of the planing operations to load and unload trucks.
- 2 Substantially plane and texture all of the surface area indicated. Extra planing to eliminate small depressed areas is not required if the cumulative total of these un-textured areas does not exceed 5% of the total treated area. It is critical that the planed surface does not allow water to accumulate at the edges of the pavement. Extend planing operations into the paved shoulders or other adjacent pavement a sufficient distance to prevent the construction of a "lip" or other area that retains water on the roadway surface.
- 3 Before commencing work, construct a test section of at least 500 feet in length. The purpose of the test section is to determine the appropriate forward speed for the planing equipment and to demonstrate that the equipment is providing a surface texture, cross-slope, and lane/shoulder configuration satisfactory to the RCE and consistent with this specification.
- 4 Create a "corduroy" texture consisting of a transverse pattern with grooves spaced no greater than 0.2 inches center to center and running generally parallel to the pavement centerline. Ensure that the maximum depth from high to low points on the planed surface is $\frac{1}{8}$ inch.
- 5 After completion of the planing process, test the ground pavement surface transversely and longitudinally with a 10-foot straightedge. Conduct the straightedge testing at no additional cost to the Department. Conduct testing parallel and normal to the pavement centerline. The RCE will determine the minimum frequency of testing and may require additional testing. Perform additional planing at no additional expense to the Department on all areas with high or low spots in excess of $\frac{1}{8}$ inch or in areas where the RCE determines that the appropriate cross slope and grades are not met.
- 6 Before allowing traffic on the planed pavement, clean the pavement of dust and debris using appropriate equipment. Use a vacuum sweeper if instructed to do so by the RCE.

401.4.14 Removal of Existing Asphalt Pavement before Patching

- 1 Remove the deteriorated pavement to the width and length as determined by the RCE, with the face of the cut being straight and vertical. Construct patches with a minimum patch size of 6 feet X 6 feet with at least 25 feet between patches. Remove the pavement to the depth indicated in the Plans. If unstable material is encountered at this point, remove additional material as directed by the RCE. Backfill the volume of material removed below the patch with material meeting the requirements of **Section 305**, Graded Aggregate Base and thoroughly compact in layers not exceeding 4 inches with vibratory compactors. Thoroughly tack the sides of the existing asphalt pavement before placing the asphalt patch material in the hole. Place the patch material in layers not exceeding 3 inches. Thoroughly compact each layer with a vibratory compactor and pneumatic roller. Conduct the work so that patches are opened and filled the same day, with the roadway being opened to traffic by late that same day. Ensure that the finished patch is smooth riding. Do not apply asphalt mixture when the existing surface is wet or frozen.

401.4.15 Conditioning of Subgrade

- 1 Before placing any HMA base course mixture, prepare the subgrade in accordance with the requirements specified in **Section 208**.

401.4.16 Surface Preparation and Leveling

- 1 Prepare base courses as specified in the applicable sections of Division 300.
- 2 Thoroughly sweep the base course, old pavement, or existing surface so that it is clean and free from dust and foreign material. Maintain it until the HMA is placed.
- 3 Bring irregularities in the surface of the existing pavement or old base (including widened shoulders where settled) to uniform contour by leveling with HMA. Place the leveling HMA in a separate operation from the specified depth of surface course. Thoroughly compact the leveling HMA until it conforms to the surrounding surface. Where necessary, perform the leveling with a motor grader or paver.

401.4.17 Transportation and Delivery of Mixes

- 1 Transport the HMA from the plant to the point of use in vehicles meeting the requirements of **Subsection 401.3.7**. Do not permit any load of HMA to leave the plant so late in the day that it cannot be spread, finished, and compacted during daylight of that same day unless an approved artificial lighting system is provided.
- 2 Deliver the HMA to the spreader at a temperature within 20°F of the temperature set at the plant.

401.4.18 Application of Prime or Tack Coat

- 1 Where the Plans call for HMA to be placed directly on a sand clay base course, coquina shell base, or graded aggregate base course and the priming of which is not otherwise provided, apply a prime coat meeting the requirements of **Section 303, 304, 305, or 306** as applicable. A prime coat is not required when HMA is placed directly on the subgrade.
- 2 Before laying any HMA on existing pavements or on unsealed asphalt surface treatment course, uniformly apply a tack coat by use of the distributor spray bars at the rate of 0.05 to 0.15 gallons per square yard as measured by **SC-T-86**. Ensure that all nozzles on the distributor are fully open and operational and are turned at the same angle to the spray bar, which is approximately 30 degrees. In addition, place the spray bar at the proper height above the pavement and apply the proper pressure to provide a uniform double or triple lap of the liquid asphalt material. Place lesser amounts on new pavements and greater amounts on older pavements to ensure a bond between the surface being paved and the overlying course. In areas where it is impractical to use distributor spray bars, such as crossovers, small areas, etc., it is permissible to apply the material by the use of the handheld nozzle. In both cases, apply the actual rate of application as directed by the RCE. Provide a tack coat consisting of binder or emulsified asphalt from a supplier listed on the most recent edition of *SCDOT Qualified Product List 37 or 38*. The acceptable grades of emulsified asphalt are RS-1, MS-1, MS-2, HFMS-1, HFMS-2, SS-1, CRS-1, CRS-2, CMS-2, and CSS-1. Emulsified asphalt, with the exception of grades RS-1 and CRS-1, may be diluted with up to 50% with water provided the dilution is performed at the manufacturing plant by the manufacturer using acceptable procedures. Do not dilute any of the emulsions at the point of use.
- 3 In all cases, regardless of the type tack material used, ensure that the existing pavement or unsealed asphalt surface treatment course is dry and thoroughly cleaned before applying the tack material.
- 4 When HMA sand base course is constructed in layers, clean and scarify the compacted layer as directed by the RCE before placing the next successive layer. When considered necessary by the RCE, apply a tack coat between layers as stipulated above.
- 5 Coat contact surfaces of headers, curbs, gutters, edges of existing pavement, manholes, catch basins, etc. with a thin uniform coating of asphalt tack coat material just before the HMA is placed against them.
- 6 Apply the tack coat as outlined above in a sufficient length of time in advance of the laying of the HMA to permit drying but not so far in advance or over such an area to cause it to lose its adhesiveness.
- 7 No additional compensation is provided for furnishing and applying the tack coats as specified in this subsection.

401.4.19 Spreading and Finishing

- 1 Upon arrival at the point of use, dump the HMA into the mechanical spreader and immediately spread and strike off true to the line, grade, and cross-section stipulated and to such appropriate loose depth for each successive course that when the work is completed, the specified thickness or weight per square yard is achieved. Determine HMA placement rates using **SC-T-85**. Deliver and spread all HMA while in a thoroughly workable condition and free from lumps. Handle material in such a manner to reduce segregation. Dump the HMA in the center of the hoppers and take care to avoid overloading and spilling material on the base.
- 2 If during construction it is found that the spreading and finishing equipment leaves tracks or indented areas in the new course that are not satisfactorily corrected by the scheduled operations, or which produce other permanent blemishes, discontinue the use of such equipment and provide other satisfactory spreading and finishing equipment.
- 3 Provide competent personnel who are capable of performing the work for the correction of all pavement irregularities. Correct irregularities in HMA courses while the mixture is still hot. Give special attention to the straight edging of construction joints immediately following the final rolling. Provide a qualified employee to perform the straight edging.
- 4 Immediately after a course is placed and before roller compaction is started, check the surface and adjust any inequalities. Remove all fat spots and irregular areas and replace them with satisfactory material. Correct irregularities in alignment and grade along the outside edge by the addition or removal of HMA before the edge is rolled.
- 5 Unless otherwise directed by the RCE, do not allow the compacted thickness of any single constructed course to exceed the following thicknesses:
 - 4½ inches for HMA Aggregate Base Course,
 - 3 inches for HMA Sand Base Course,
 - 3 inches for HMA Intermediate Course, or
 - 2 inches for HMA Surface Course.
- 6 Place each layer to such thickness as instructed by the RCE. Overlap the joints in the layers a minimum of 6 inches where practical.
- 7 When multiple lifts are being placed in a single day, ensure that the interior mat temperature of the previous lift is less than 175°F when measured at the mid-point of the depth of mat with a calibrated thermometer following **SC-T-84**.
- 8 If desired, in ditch paving, narrow widening, deep or irregular sections, intersections, turnouts, driveways, or at other locations where it is impractical to spread and finish the HMA by standard methods, use approved spreading equipment or acceptable hand methods. When it is considered necessary to improve the profile and cross-section of an existing pavement before placing the additional normal layer of HMA, the RCE may require that the material be

spread with a blade grader or other type of construction equipment that will give the desired results. Do not dump the loads faster than the material can be properly handled. Perform the raking carefully and skillfully to avoid segregation and so that after the first pass of the roller over the raked HMA, minimal back-patching is required.

- 9 Provide approved means for keeping all small tools clean and free from accumulations of asphalt material.
- 10 Locate the finished surface of surface courses placed adjacent to curbs, gutter, manholes, etc., approximately ¼ inch above the edges of these structures.

401.4.20 Compaction (Standard)

- 1 Ensure that compaction is obtained following the requirements stated in **SC-M-400**.
- 2 Ensure that the intermediate rolling is completed before the mat temperature drops below 175°F.
- 3 To prevent adhesion of HMA to the steel-wheel roller, keep the wheels moistened, without using excess water. Do not use oil.
- 4 In areas such as ditches or along forms, curbs, headers, and walls not accessible for the operation of rollers as specified herein, perform compaction with hand or mechanical tampers, hand-drawn steel wheel rollers, or self-propelled tandem steel wheel rollers as directed by the RCE.
- 5 Ensure that the surface of the HMA after compaction is smooth and true to the established crown and grade. Remove any mixture that becomes loose and broken, mixed with dirt, or in any way defective and replace it with fresh HMA. Immediately compact the fresh HMA to conform to the surrounding area.

401.4.21 Compaction Monitoring

- 1 Monitor the compaction process and make adjustments in equipment or roller patterns so that the finished HMA pavement meets the specified in-place density requirement. Conduct in-place density tests at least every 500 feet per paving lane width by conducting density-gauge tests at randomly selected locations approved by the RCE and at least 1 foot from any unsupported edge. Determine randomly selected locations by **SC-T-101**.
- 2 Do not start production in a lot until the roadway cores from the previous day's production have been obtained unless permission is given by the RCE. Obtain all density tests and cores required for compaction determination using equipment and procedures approved by the RCE.

401.4.22 Weak Base or Poor Surface Conditions

- 1 If in the judgment of the RCE a weak base or poor surface condition results in a density lower than the minimum specified, the RCE may establish a "maximum practical density" lower than that specified.

401.4.23 Joints

- 1 Roll longitudinal joints directly behind the paver. Position the paver so that in spreading, the material overlaps the edge of the lane previously placed by 1 to 2 inches. Leave the loose material high enough to allow for compaction to the depth of the previously rolled lane. Push back the overlapped material by means of lutes or other suitable tools to the edge of the "cold" joint. Perform this work in a manner that provides a uniform joint when rolled.
- 2 Carefully construct and thoroughly compact transverse joints to provide a smooth riding surface. Straightedge or stringline joints to ensure true alignments.
- 3 Construct longitudinal and transverse joints in a careful manner and present the same texture, density, and smoothness as other sections of the course.
- 4 Make joints between old and new pavements, or between successive strips, in a manner that ensures proper bond between the old and new surface for the full depth of the course. Thoroughly coat the joints, transverse and longitudinal, with an approved asphalt tack coat material before placing adjacent material. If necessary, form joints by cutting back on the course. Include the cost of cutting back and coating joints in the contract unit price for the HMA.
- 5 On projects containing multiple courses, arrange the width of the lanes so that the longitudinal joints of each successive course are offset from the joints of the previous course at least 6 inches where practicable. Construct the width of each lane in the top layer the same as the width of the design travel lanes, unless directed otherwise by the RCE.

401.4.24 Milled-in Rumble Strips (MIRS)

- 1 If MIRS are called for in the Plans, place them in the mainline paved shoulder only. Do not place MIRS on ramp shoulders.
- 2 Construct MIRS with finished dimensions of 7 inches ($\pm \frac{1}{2}$ inch) wide in the direction of travel and a minimum of 16 inches long measured perpendicular to the direction of travel. Construct the depressions with a concave circular shape with a minimum $\frac{1}{2}$ -inch depth at center. Place the MIRS perpendicular to the roadway on 12-inch centers. Begin the MIRS on the shoulder, 10 inches from the right edge of the travelway.
- 3 Do not construct MIRS on the median paved shoulder unless specified in the Plans. If the median shoulder is specified, construct the milled area 4 inches from the left edge of the travelway on the shoulder.
- 4 If desired, use removed pavement material suitable for recycling on the project or for other operations at no additional expense to the Department.
- 5 At the end of each working day, remove all equipment to a location where it does not present a hazard to traffic. Clean the pavement by sweeping or flushing; and reopen the work area to traffic each day.

401.4.25 Requirements for Recycled Asphalt Pavement (RAP)

- 1 Conform the production, spreading, compaction, etc. of the RAP to the applicable requirements of the **Subsection 401.3.6**.

401.4.26 Protection of Surface

- 1 Protect the newly constructed surface from traffic until the mixture has hardened sufficiently to prevent distortion. Keep the surface clean and free from foreign material when the shoulders are being constructed.

401.4.27 Finished Surface Requirements**401.4.27.1 General**

- 1 After compaction, ensure that the finished surface of the intermediate or surface course is smooth, of uniform texture, and true to the specified crown and grade.

401.4.27.2 Variability

- 1 When checked with a 10-foot straightedge applied parallel to the centerline of the pavement, ensure that the finished surface of the intermediate course does not vary more than $\frac{1}{4}$ inch and the finished surface course does not vary more than $\frac{1}{8}$ inch as measured from the bottom of the straightedge to the top of the finished surface. Correct intermediate or surface courses not meeting these finished surface requirements by repairing or if necessary, by removing and replacing subject to the approval of the RCE.

401.4.27.3 Ride Quality

- 1 In addition to meeting any specified requirements for surface tolerances, ensure that the intermediate and surface courses meet the satisfactory riding qualities for the HMA placed as determined by the RCE.

401.4.28 Segregation Identification and Correction

- 1 Segregation is defined as areas of non-uniform distribution of coarse and fine aggregate particles in a compacted HMA pavement.
- 2 Conduct necessary production, storage, loading, placing, and handling procedures to prevent segregation. Prevent placement of a segregated HMA mat by making plant modifications or providing auxiliary equipment.
- 4 Correct segregated areas in HMA courses at no additional expense to the Department. Meet all compaction and rideability requirements on roads with corrected segregated areas.
- 5 Correct segregated HMA courses that are not considered riding courses by removing and replacing segregated areas for the full depth of the course and extend at least 10 feet on either side of the segregated areas for the full width of the paving lane.
- 6 Correct all segregated HMA riding courses and segregated courses placed immediately below open graded friction courses by removing and replacing these segregated areas for the full depth of the riding course and extend at

least 300 feet on either side of the segregated areas.

- 7 Overlay the entire roadway with an open grade friction course when more than 25% of the final roadway surface area is corrected due to segregation. Place the open graded friction course at no additional expense to the Department.
- 8 Meet all compaction and rideability requirements on roads with corrected segregated areas.

401.4.29 Rideability

- 1 Ensure that pavement rideability meets the requirements of **SC-M-403**.

401.4.30 Plant Tickets

- 1 Record in triplicate on forms approved by the RCE the net weight of each load of HMA, the accumulated net weight of the loads for the day, and if loaded from a silo, the silo identification number.
- 2 When each load of HMA is delivered to the work, present the original copy of the plant ticket for the load to the RCE. Maintain the stub copy until the completion of the work. Deliver copies to the RCE at the end of the project.
- 3 Note any changes in the amounts designated on all copies of the tickets necessitated by the rejection of material and the reason stated for rejection.
- 4 At any time during the delivery of material and for the purpose of checking the weighing equipment at the plant, the RCE may request that any truckload of HMA delivered to the work be weighed on tested and approved platform scales at no additional expense to the Department.

401.5 Measurement

- 1 The quantity for HMA Intermediate Course and HMA Surface Course is the weight of the material placed determined by using approved scales with no deduction made for the weight of asphalt materials, hydrated lime, liquid anti-stripping agent, or any other admixtures and is measured by the ton (TON) of material, complete in place, and accepted,
- 2 The quantity for HMA base course is measured by the unit specified in the Contract. When measurement is specified by the ton (TON), measurement is in accordance with the requirements of this subsection. When measurement is specified by the square yard (SY), measurement is in accordance with the requirements of **Section 309** or **310** for Asphalt Base Course.
- 3 The quantity for Liquid Binder (of the performance grade specified) in the HMA is measured by the ton (TON) of liquid asphalt binder contained in the work and accepted. The amount of binder in the HMA is determined by **SC-T-63**, **SC-T-64**, or **SC-T-75** or, at the option of the RCE, from the amounts printed on the load tickets using an approved ticket printer. In order to check scale accuracy when using a ticket printer for measurement of binder, perform periodic extraction tests (not for pay purposes) on HMA other than those that contain marine limestone or slag.

- 4 Weight of binder that may be absorbed by the aggregate is not included in the quantity of binder.
- 5 When the binder content is not being measured by ticket printout, the quantity of binder in the HMA is the percentage of binder determined at the field laboratory unless otherwise directed by the RCE.
- 6 HMA wasted or lost due to negligence, HMA or binder applied in excess of the rate specified or directed in writing, or HMA applied beyond the limits of the work is deducted from pay quantity.
- 7 The quantity for Milling Existing Asphalt Pavement is surface area of asphalt pavement milled to the specified depth measured and is measured by the square yard (SY), complete in-place, and accepted. The measurement is made on the surface of the road or area designated for milling. No additional measurement is made for variable milling needed to tie in to existing drives and intersections unless specifically directed by the RCE.
- 8 The quantity for Surface Plane Asphalt Pavement is the surface area of the road planed to the specified texture and is measured by the square yard (SY), complete, and accepted. Surface planing conducted outside of the area designated for planing is disregarded in the quantity, except where necessary to provide acceptable cross-slope and lane/shoulder transition as directed by the RCE.
- 9 The quantity for Full Depth Asphalt Pavement Patching is surface area of full depth asphalt pavement patched to a uniform depth and is measured by the square yard (SY), complete, and accepted. Base course material used in the patching work is measured by the ton (TON) of Graded Aggregate Base in accordance with **Subsection 305.5**.
- 10 The quantity for Milled-In Rumble Strip is the sum of the length of the segments of rumble strips milled into the asphalt pavement as indicated on the Plans or as directed by the RCE and is measured by the mile (MI), complete, and accepted. The length of a segment is measured along the inside edge of the shoulder from the center of the first rumble strip in a segment to the center of the last rumble strip in that segment. Where MIRS are provided on more than one shoulder, the segments on each shoulder are measured separately and then, added together.

401.6 Payment

- 1 Adjustments in the contract unit bid prices for HMA courses are determined in accordance with **SC-M-400**. The unit bid prices of HMA courses may be adjusted due to fluctuations in the Monthly Asphalt Price Index or the Monthly Fuel Price Index only if specified as applicable in the Special Provisions.
- 2 Payment for the accepted quantity for HMA Intermediate Course or HMA Surface Course (of the type specified), measured in accordance with **Subsection 401.5**, is determined using the contract (or adjusted) unit price for the applicable pay item. For specific requirements and listing of pay items for the HMA Intermediate Courses and HMA Surface Courses, refer to

Sections 402 and 403, respectively.

- 3 Payment for the accepted quantity for Asphalt Base Course (of the type specified), measured in accordance with **Subsection 401.5**, is determined using the contract (or adjusted) unit price for the applicable pay item. For specific requirements and listing of pay items for the asphalt base courses, refer to **Sections 309 and 310**.
- 4 The above mentioned contract (or adjusted) unit prices and payments for all HMA courses are full compensation for constructing the HMA base course, intermediate course, or surface course as specified or directed and includes furnishing, mixing, hauling, placing, and compacting the HMA course; furnishing and applying a tack coat; determining the compaction of the course; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 5 Unless otherwise specified in the Contract, hydrated lime and any other admixtures are not paid for separately. Include all costs for furnishing and incorporating the hydrated lime and any other admixtures into the HMA in the contract (or adjusted) unit price of the HMA course.
- 6 Payment the accepted quantity for Liquid Asphalt Binder (of the performance grade specified), measured in accordance with **Subsection 401.5**, is determined using the contract (or adjusted) unit price for the applicable pay item. Payment is full compensation for providing the required liquid asphalt binder as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 7 Payment for the accepted quantity for full depth Full Depth Asphalt Pavement Patching (of the specified uniform depth), measured in accordance with **Subsection 401.5**, is determined using the contract (or adjusted) unit price for the applicable pay item. Payment is full compensation for patching deteriorated asphalt pavement as specified or directed and includes cleaning, removing, and disposing of debris from the patching work, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 8 Base course material used in the full depth asphalt pavement patching work is paid for as Graded Aggregate base in accordance with **Subsection 305.6**.
- 9 Payment for the accepted quantity for Milling Existing Asphalt Pavement (for the depth specified), measured in accordance with **Subsection 401.5**, is determined using the contract unit price for the applicable pay item. Payment is full compensation for milling the existing asphalt pavement as specified or directed and includes cleaning, removing, and disposing of debris from the milling work, and all other materials, labor, equipment, tools, supplies, trans-

portation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

10 Payment for the accepted quantity for Surface Plane Asphalt Pavement, measured in accordance with **Subsection 401.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for surfacing planing asphalt pavement as specified or directed and includes straightedge testing of planed surface; cleaning, removing, and disposing debris from planing work; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

11 Payment for the accepted quantity for Milled-In Rumble Strip measured in accordance with **Subsection 401.5**, is determined using the contract unit price for the applicable pay item. Payment is full compensation for milling the rumble strips into asphalt pavement as specified or directed and includes cleaning, removing, and disposing of debris from the work, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

12 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.

13 Pay items under this section includes the following:

Item No.	Pay Item	Unit
4011004	Liquid Asphalt Binder PG64-22	TON
4011008	Liquid Asphalt Binder PG76-22	TON
4011010	Liquid Asphalt Binder PG82-22	TON
4012030	Full Depth Asphalt Pavement Patching 3" Uniform	SY
4012040	Full Depth Asphalt Pavement Patching 4" Uniform	SY
4012060	Full Depth Asphalt Pavement Patching 6" Uniform	SY
4012080	Full Depth Asphalt Pavement Patching 8" Uniform	SY
4012100	Full Depth Asphalt Pavement Patching 10" Uniform	SY
4012120	Full Depth Asphalt Pavement Patching 12" Uniform	SY
4013001	Surface Plane Asphalt Pavement	SY
4013XXX	Milling Existing Asphalt Pavement (X)"	SY
4013990	Milling Existing Asphalt Pavement (Variable)	SY
4019000	Milled-In Rumble Strip	MI

SECTION 402

HMA INTERMEDIATE COURSE

402.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for hot mixed asphalt (HMA) intermediate courses composed of mineral aggregate and binder, mixed in an approved asphalt plant, constructed on a prepared surface, and in conformance with the lines, grades, dimensions, thickness, and typical cross-section shown on the Plans or as otherwise specified.

402.2 Materials

402.2.1 General

- 1 Provide and use materials that meet the applicable requirements of **Subsection 401.2** and **SC-M-402**.

402.2.2 Composition of Mixture

- 1 Combine the mineral aggregates and binder in such proportions so that the composition by weight of the finished HMA is within the composition limits shown in **Subsection 401.2.3** and **SC-M-402**.

402.3 Equipment

- 1 Provide equipment meeting the requirements of **Subsection 401.3**.

402.4 Construction

- 1 Construction HMA intermediate courses in accordance with the requirements specified in **Subsection 401.4**.

402.5 Measurement

- 1 Measurement of the quantity for HMA Intermediate Course Type (A, B, or C) is performed in accordance with **Subsection 401.5**.

402.6 Payment

- 1 Payment for the accepted quantity for HMA Intermediate Course Type (A, B, or C) is determined in accordance with **Subsection 401.6**.
- 2 Payment for each item includes all direct and indirect costs and expenses required to complete the work.

402.6

402.6

3 Pay items under this section include the following:

Item No.	Pay Item	Unit
4020310	HMA Intermediate Course Type A	TON
4020320	HMA Intermediate Course Type B	TON
4020330	HMA Intermediate Course Type C	TON

SECTION 403

HMA SURFACE COURSE

403.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for HMA surface courses composed of mineral aggregate and binder, mixed in an approved plant, constructed on a prepared surface, and in conformance with the lines, grades, dimensions, thickness, and typical cross-section shown on the Plans or as otherwise specified.

403.2 Materials

403.2.1 General

- 1 Use materials that meet the applicable requirements of **Subsection 401.2** and **SC-M-402**.

403.2.2 Composition of Mixture

- 1 Combine the mineral aggregates and binder in such proportions that the composition by weight of the finished HMA is within the limits set forth in **SC-M-402**.
- 2 A job mix formula is not required for the HMA Surface Course Type E; however, maintain a binder content within an allowable variation $\pm 0.4\%$ of the content approved by the MRE.
- 3 If included in the Contract, use HMA Surface Course Type C or D for Ditch Paving.

403.3 Equipment

- 1 Provide equipment meeting the requirements of **Subsection 401.3**.

403.4 Construction

- 1 Construct HMA surface courses in accordance with the requirements specified in **Subsection 401.4**.

403.5 Measurement

- 1 Measurement of the quantity for HMA Intermediate Course Type (A, B, CM, C, D, or E) is determined in accordance with **Subsection 401.5** with the following addition:
- When the item of HMA Surface Course for Ditch Paving is included in the Contract, the binder in the ditch paving mixture is not measured for separate payment.

403.6 Payment

- 1 Payment for the accepted quantity for HMA Intermediate Course Type (A, B, CM, C, D, or E) is determined in accordance with **Subsection 401.6** with the following addition:

- When the item HMA Surface Course for Ditch Paving is included in the Contract, the cost of the binder material in the ditch paving mixture is considered included in the contract unit price for the work and is not paid for separately.
- 2 Payment for each item includes all direct and indirect costs and expenses required to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
4030310	HMA Surface Course Type A	TON
4030320	HMA Surface Course Type B	TON
4030330	HMA Surface Course Type CM	TON
4030340	HMA Surface Course Type C	TON
4030350	HMA Surface Course Type D	TON
4030360	HMA Surface Course Type E	TON
4037000	HMA Surface Course for Ditch Paving	TON

SECTION 404

COLD MIX ASPHALT INTERMEDIATE COURSE

404.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for a cold mix asphalt intermediate course composed of mineral aggregate and asphalt material, mixed in an approved plant, constructed on a prepared surface, and in conformance with the lines, grades, dimensions, thickness, and typical cross-section shown on the Plans or as otherwise directed by the RCE.

404.2 Materials

404.2.1 Asphalt Material

- 1 Provide asphalt material conforming to the requirements specified in **Subsection 405.2**.

404.2.2 Mineral Aggregate

- 1 Provide mineral aggregate that meets the requirements specified in **Subsection 401.2.2.1**.

404.2.3 Composition of Asphalt Intermediate Course

- 1 Combine the mineral aggregate and asphalt material in such proportions so that the composition by weight of the finished mixture is within the composition limits in the following tables.

Composition Limits for HMA Intermediate Courses	
Gradation Requirements	
Sieve Designation	Percentage by Weight Passing
¾-inch	100.0
½-inch	95.0 – 100.0
⅜-inch	60.0 – 98.0
No. 4	30.0 – 65.0
No. 8	17.0 – 36.0
Note: To avoid large, interconnected air voids, do not allow the difference between any 2 consecutive sieves smaller than the ½-inch sieve to be less than 5.0%.	

Percent of Total Mixture	
Binder, %	4.00 – 7.00

Marshall Properties	
Marshall Stability, lbs., Min.	800

- 2 The above composition limits are master ranges of tolerance. Conform to a closer control meeting the requirements of **Subsection 401.2.3**.
- 3 Use PG64-22 grade binder in the design of the mixture to check Marshall Stability on the approved job mix.

404.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

404.4 Construction

- 1 Adhere to the construction requirements specified in **Subsection 405.4** for cold mix asphalt intermediate course.

404.5 Measurement

- 1 Measurement for Cold Mix Asphalt Intermediate Course is similar to measurement specified in **Subsection 405.5**.

404.6 Payment

- 1 Payment for Cold Mix Asphalt Intermediate Courses is similar to payment specified in **Subsection 405.6**.
- 2 Payment for includes all direct and indirect costs and expenses required to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
4041000	Cold Mix Asphalt Intermediate Course	TON

SECTION 405

COLD MIX ASPHALT SURFACE COURSE

405.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for a surface course composed of mineral aggregate and asphalt material, mixed in an approved asphalt plant, constructed on a prepared surface, and in conformance with the lines, grades, dimensions, thickness, and typical cross-section shown on the Plans or as otherwise directed by the RCE.

405.2 Materials

405.2.1 Asphalt Material

- 1 Use asphalt material in the mix conforming to the following cited specifications.
 - RC 250, RC 800, or RC 3000 ----- AASHTO M 81
 - MC 250, MC 800, or MC 3000 ----- AASHTO M 82
- 2 If desired, PG64-22 binder may be blended with cutback asphalt or a liquefier but only if a quality mix is produced. Optionally, a cutback asphalt emulsion may be used but only if an excellent mix is obtained.

405.2.2 Mineral Aggregate

- 1 Use mineral aggregate that meets the requirements of **Subsection 401.2.2.2.**

405.2.3 Composition of Asphalt Surface Course

- 1 Combine the mineral aggregate and the asphalt material in proportions so that the composition by weight of the finished mixture is within the range limits shown in the following tables, except as noted.

Composition Limits of Cold Mix Asphalt Surface Courses			
Gradation Requirements			
Sieve	Percentage by Weight Passing		
Designation	Type 1	Type 2	Type 3
¾-inch	100	100	--
½-inch	97 - 100	97 - 100	--
¾-inch	75 - 95	80 - 100	100
No 4	60 - 80	50 - 75	90 - 100

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Composition Limits of Cold Mix Asphalt Surface Courses			
Gradation Requirements			
Sieve	Percentage by Weight Passing		
No. 8	43 - 63	40 - 63	70 - 100
No. 30	23 - 39	14 - 39	28 - 60
No. 100	8 - 17	2 - 22	4 - 26
No. 200	2 - 8	0 - 12	2 - 10
Percent of Total Mixture			
	Type 1	Type 2	Type 3
Binder, %	4.2 - 6.8	4.2 - 6.8	5.0 - 8.0
Marshall Properties			
	Type 1	Type 2	Type 3
Marshall Stability, lbs., Min.	600	600	--

- 2 Use PG64-22 binder in the design of the mix to check Marshall Stability on the approved job mix.
- 3 The above composition limits are master ranges of tolerance. Except for Type 3, maintain a closer control meeting the requirements specified in Subsection 401.2.3. Set a binder content for Type 3 within an allowable variation of $\pm 0.4\%$ of the set value.

405.3 Equipment

- 1 Conform the asphalt plant and all equipment used in the manufacture of the asphalt mixture to the applicable requirements specified in **Subsection 401.3**. Plants different from the types specified in **Subsection 401.3** may be approved for use but only if a uniform and satisfactory mixture is produced.
- 2 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

405.4 Construction

405.4.1 Plant Inspection

- 1 Ensure that the asphalt plant is in conformance with the requirements of

Subsection 401.4.2.**405.4.2 Weather Restrictions**

- 1 Adhere to the provision for weather restrictions of **Subsection 401.4.4.**

405.4.3 Preparation of Aggregate

- 1 If wet, surface-dry the aggregate in the asphalt plant dryer before mixing.

405.4.4 Preparation of Asphalt Mixture

- 1 Combine the dried aggregate in the mixer in the proportionate quantities of each fraction of aggregate required and thoroughly mix dry. The asphalt materials may be introduced into the mixture in several component parts only if the finished mixture and the resulting binder meet the requirements of these specifications. It is permissible to add a small percentage of liquefier when necessary to keep the mixture soft and workable until it is spread on the roadway.
- 2 Ensure that the asphalt mixture has uniform viscosity and is in a condition at the time of delivery at the destination that allows it to be handled satisfactorily without heating when the ambient temperature is 40°F or above. Ensure that the mixture does not harden when stored outside in a stockpile. Make certain that the asphalt mixture is capable of withstanding traffic without displacement or raveling immediately after being spread on the roadway and rolled.

405.4.5 Transportation and Delivery of Mixture

- 1 Transport the asphalt mixture from the plant to the point of use in tight vehicles that have been previously cleaned of all foreign materials.

405.4.6 Conditioning of Existing Surface

- 1 Perform the conditioning of the existing surface as specified in **Subsection 401.4.16.**

405.4.7 Application of Prime or Tack Coat

- 1 Perform the application of the prime coat or tack coat as specified in Subsection 401.4.18.

405.4.8 Spreading and Finishing

- 1 Perform the spreading and finishing operations as specified in **Subsection 401.4.19.**

405.4.9 Compaction

- 1 After spreading to the required cross-section, thoroughly and uniformly compact each lift.
- 2 Ensure that a competent experienced roller operator operates each roller, and while the work is underway, keeps it in continuous operation as nearly as practical.

405.4.9

405.4.11

- 3 Start the initial rolling soon after the mixture has been spread and progress at a rate that furnishes compaction to the satisfaction of the RCE.
- 4 Perform "straight-edging" and "back-patching" at any time after initial compaction is accomplished.
- 5 Start rolling longitudinally at the sides, proceed gradually to the center of the pavement, and overlap on successive trips approximately one-half of the width of the rear wheel. On superelevated sections, progress rolling from the lower to the upper edge of the pavement. Continue rolling until the entire surface is rolled and roller marks are eliminated. If the surface develops heat checking or other cracks while being rolled, consider postponing rolling to a later time when cracking will not occur.
- 6 The RCE may require the surface course to be re-rolled at any time within two weeks after it is constructed.
- 7 Make certain that the motion of the roller is slow enough at all times to avoid displacement of the mixture. Correct any displacement, occurring because of reversing the direction of the roller or from any other cause, at once by the use of rakes and the addition of fresh mixture if necessary.
- 8 To prevent adhesion of the mixture to the roller wheels, keep the wheels properly moistened, but do not use excess water. Do not use oil.
- 9 Along forms, curbs, headers, walls, and at other places not accessible to the roller, thoroughly compact the mixture with hand tamps or mechanical tampers that furnish equivalent compaction.
- 10 Under favorable conditions and when approved by the RCE, place public traffic on the newly constructed surface course.
- 11 Ensure that the surface of the mixture, after compaction, is smooth and true to the required crown and grade. Remove any mixture that becomes loose and broken, mixed with dirt, or in any way defective and replace it with fresh mixture. Immediately compact the fresh mixture to conform to the surrounding area.

405.4.10 Joints

- 1 Ensure that joints meet the requirements of **Subsection 401.4.23**.

405.4.11 Protection of Surface

- 1 Protect the newly constructed surface from traffic until the mixture has hardened sufficiently to not be distorted.
- 2 Do not permit parking on the surface until it hardens so that the weight of the vehicles does not cause displacement. When the shoulders are being constructed, keep the surface course clean and free from foreign material.

405.4.12 Surface Requirements

- 1 Ensure that finished surfaces meet the requirements of **Subsection 401.4.27**.

405.4.13 Plant Tickets

- 1 Use plant tickets that meet the requirements of **Subsection 401.4.30**.

405.5 Measurement

- 1 The quantity for pay item Cold Mix Asphalt Surface Course (Type *(1, 2, or 3)*) is the weight of the cold mix asphalt surface course weighed on approved scales and is measured by the ton (TON), complete, and accepted.
- 2 Deductions are made for all asphalt mixture wasted or lost due to negligence, asphalt mixture applied in excess of the rate specified or directed in writing, and asphalt mixture applied beyond the limits of the work.

405.6 Payment

- 1 Payment for the accepted quantity for Cold Mix Asphalt Surface Course (Type *(1, 2, or 3)*), measured as provided in **Subsection 405.5**, is determined using the contract unit bid price for applicable pay item. Payment is full compensation for constructing the cold mix asphalt surface course as specified or directed and includes furnishing, mixing, hauling, placing, and compacting the cold mix asphalt surface course; furnishing and application of tack and prime coats; conditioning the existing surface; removing and disposing of broken surface pieces; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for each item includes all direct and indirect costs and expenses required to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
4051000	Cold Mix Asphalt Surface Course (Type 1)	TON
4052000	Cold Mix Asphalt Surface Course (Type 2)	TON
4053000	Cold Mix Asphalt Surface Course (Type 3)	TON

SECTION 406

ASPHALT SURFACE TREATMENT - SINGLE TREATMENT

406.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for a wearing surface composed of an application of a modified cationic emulsion (CRS-2P) and an application of aggregate, constructed on a prepared base course, existing base or surface course, or the existing road surface, and in conformance with the typical cross-section shown on the Plans and to the lines and grades set by the RCE.

406.2 Materials

406.2.1 Asphalt Materials

406.2.1.1 Modified Emulsified Asphalt (Cationic)

- 1 Use a cationic emulsified asphalt of the grade designated as CRS-2P conforming to the requirements in AASHTO M 316 with the exclusion of Force Ratio and with the addition of the following:

Add either natural latex, a styrene-butadiene-styrene (SBS) polymer, or an unvulcanized styrene-butadiene rubber (SBR) in an emulsified latex form to a PG58-22 base asphalt at the necessary proportions to result in 3% polymer by weight of the asphalt residue. Do not perform any post blending or acid modification of the CRS-2P. The RCE will sample the asphalt at a frequency of not less than one sample per 25,000 gallons and will submit the sample to the OMR within 7 days of sampling.

406.2.2 Aggregate

- 1 Use aggregates consisting of clean, washed, tough, dry, durable particles of crushed stone, crushed gravel, or crushed slag; free from soft, thin, elongated or laminated pieces, disintegrated particles, vegetation, or other deleterious substances; and from a source listed on **SCDOT Qualified Product List 1** or **SCDOT Qualified Product List 2**, as applicable. Do not use marine limestone.
- 2 Make certain that aggregates are within the required gradation limits provided in the Appendix of these specifications.
- 3 Ensure that crushed stone or gravel has an abrasion loss of not more than 60.0% when subjected to the Los Angeles Abrasion Test (AASHTO T 96). Ensure that slag has an abrasion loss of not more than 45.0% when subjected to the Los Angeles Abrasion Test.
- 4 When slag is used, ensure that it has a dry weight of 75 pounds per cubic foot or greater.
- 5 When specified, lightweight aggregates may be used in surface treatment provided the aggregate comes from a source listed on *SCDOT Qualified*

Product List 2 and meets the requirements of AASHTO M 195, Lightweight Aggregates for Structural Concrete (with the exception of any references to concrete samples or concrete strength).

- 6 Conform lightweight aggregate to also meet the physical properties in the following table.

Physical Properties of Lightweight Aggregate		
Property	Test Procedure	Specification (Max.)
Dry Loose Weight	AASHTO T 19	60 lbs./ft ³ *
Sodium Sulfate Soundness	AASHTO T 104 (Loss at 5 cycles)	15.0%
Los Angeles Abrasion Resistance	AASHTO T 96	45.0%
Absorption	AASHTO T 19	6.0%
* This value supersedes the value given in AASHTO M 195		

- 7 Use lightweight aggregate that is non-corrosive and meets the gradation requirements within the ranges shown in the following table.

Gradation Range of Lightweight Aggregate	
Sieve	Percent Passing, %
½-inch	100.0
¾-inch	80.0 – 100.0
No. 4	5.0 – 40.0
No. 8	0.0 – 20.0
No. 16	0.0 – 10.0

- 8 The pounds of aggregate in this specification are based upon an apparent specific gravity of 2.65. If the apparent specific gravity of the aggregate used is other than 2.65, make appropriate adjustments in the number of pounds required per square yard to ensure a uniform coverage.
- 9 When slag is used as the aggregate, increase the amount of emulsion used in the mat and seal applications to 15% over that herein specified without additional compensation.
- 10 When other aggregates with high absorption characteristics are used, the RCE may increase the quantity of emulsion specified for each application to compensate for the absorbed material without additional compensation.
- 11 No tolerance below the specified minimum quantity per square yard of emulsion or aggregate is allowed, except if a satisfactory uniform cover with material applied at a rate less than that required by these specifications is

actually obtained. If for any reason the RCE should decide to raise the minimum limit, appropriate notice will be given in writing. Any increase in the minimum limit carries a corresponding increase in the maximum limit. The upper limit specified is intended to give some leeway in carrying on the work.

406.3 Equipment

406.3.1 Distributors

- 1 Make certain that all distributors are mounted on pneumatic tires of sufficient width to prevent cutting or breaking the surface bond when the tank is fully loaded. Ensure that the distributor is designed, equipped, maintained, and operated so that the emulsion is uniformly applied (without streaking) at the required constant temperature and pressure and at the specified rate. Ensure that the distributor equipment includes a tachometer, pressure gauges, and accurate volume measuring devices or calibrated tank, and a thermometer for determining the temperature of the contents. Make certain the distributor is equipped with a hose and nozzle attachment for spotting areas inaccessible to the distributor spray bars. Ensure that the distributor spray bars are adjustable both laterally and vertically. In order to prevent lapping at the junction of two applications, ensure that the distributor is equipped with a positive shut-off control. Calibrate distributors in accordance with **Subsection 406.4.3.1** immediately before use on the project.

406.3.2 Aggregate Spreaders

- 1 Use aggregate spreaders that are approved self-propelled aggregate spreaders, mechanical type spreaders hooked onto the supply truck, or tail-gate spreaders. Make certain the spreaders are constructed so that they are accurately controlled to distribute the aggregate uniformly and at the required rate. Calibrate the spreaders in accordance with **Subsection 406.4.3.2** immediately before use on the project.

406.3.3 Rollers

406.3.3.1 Steel Wheel Rollers

- 1 Use steel wheel rollers weighing a minimum of 8 tons and are in good working condition. Ensure that they are equipped with smooth tires to prevent tracking, adjustable scrapers to keep the rollers clean, and an efficient means of keeping the wheels wet to prevent mixes from sticking to the rollers.

406.3.3.2 Pneumatic-Tire Rollers

- 1 Use pneumatic-tire rollers that are self-propelled, have an effective rolling width of not less than 60 inches, and are equipped with pneumatic tires of equal size and diameter. Ensure that the minimum tire pressure is 90 pounds per square inch, not varying more than 5 pounds per square inch between tires. Make certain the wheels of the rollers are placed so that one pass will accomplish complete coverage equal to the rolling width of the machine. Ensure that there is a minimum of ¼-inch overlap of the tracking wheels. Make certain that the wheels do not wobble, and the contact pressure is uniform for all wheels. Ensure that the pneumatic-tire roller has enough ballast space to

provide a minimum gross weight of 5 tons. Use enough pneumatic-tire rollers to complete uniform coverage.

406.3.4 Determination of Truck Weights

- 1 If the truckloads of aggregates are not delivered to the work with weight tickets for each load, the RCE may require one round of trucks to be weighed on approved scales in order to determine the application rate. Weigh the trucks both loaded and empty. After the work begins, load the trucks with a similar load as when weighed. At any time, the RCE may require the aggregates in the truck-bed to be leveled in order that the volume of the aggregate may be determined. When the unit weight of the aggregates is known, the RCE may use this method for determining truck weights instead of weighing them. The cost of this work is considered included in the contract unit price for surface treatment.

406.3.5 Equipment on Site

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

406.4 Construction

406.4.1 Weather and Seasonal Limitations

- 1 Do not perform surface treatment work between October 15 and March 15 inclusive, except with the written permission of the RCE.
- 2 Do not apply surface treatment on a wet surface, when rain is imminent, when the ambient temperature is below 60°F, or when weather conditions are anticipated not to meet the above mentioned requirements within a 12-hour period.

406.4.2 Cleaning of Surface

- 1 Ensure that the surface of the roadbed to be treated is dry and clean of all dust, dirt, clay, and all deleterious matter at the time the surface treatment is applied. Clean the roadbed surface with power sweepers, hand brooms, mechanical brooms, or other equipment acceptable to the RCE.

406.4.3 Calibration of Equipment

406.4.3.1 Distributor

- 1 Within the first 1000 feet of the project and then once per week, calibrate the distributor by obtaining a dry weight of a 1 square yard piece of building paper or metal pan, placing it in the middle of the lane to be treated, passing the distributor over the test area, and obtaining a final weight. Use the following equation to calculate the application rate:

$$R = w/D$$

where:

R = asphalt emulsion application rate, (gal/sy)

w = weight of emulsion on paper, (lbs/sy)

D = density of emulsion at 60°F (lbs/gal)

- 2 Determine the rate at the spraying temperature by dividing R by the temperature-volume correction factor from *Temperature-Volume Corrections For Emulsified Asphalt* table in **SC-T-86**.

406.4.3.2 Aggregate Spreader

- 1 Within the first 1000 feet of the project and then once per week, calibrate the spreader by obtaining a dry weight of a 1 square yard metal pan, placing it in the middle of the lane to be treated, passing the spreader over the test area, and obtaining a final weight. Use the following equation to calculate the application rate:

$$R = w/A$$

where:

R = aggregate application rate, (lbs/sy)

w = weight of aggregate in pan, (lbs)

A = Area of pan (sy)

406.4.4 Sequence of Operations

- 1 Apply the surface treatment using quantities and sequence of operations as outlined in the following table.

Asphalt Surface Treatment - Single Treatment	
Sequence Of Operations	Quantities Per Square Yard
1. Clean surface	
2. Apply CRS-2P (gal.)	0.28 – 0.35
3. Immediately spread Aggregate No. 789 (lbs.)	15 – 20
OR immediately spread Aggregate No. 89M (lbs.)	12 – 15
OR immediately spread Lightweight Aggregate (lbs.)	6 – 12
4. Roll with pneumatic rollers in tandem	
5. Continue rolling with pneumatic rollers until aggregate is firmly seated.	
6. Remove excess aggregate.	

406.4.5 Application of Asphalt Materials

- 1 Do not apply the asphalt material until the base or surface on which the material is to be placed is properly cured, firm, intact, clean, dry, and compacted to the satisfaction of the RCE and conforms to the typical cross-section shown on the Plans and to the lines and grades established by the RCE.
- 2 Apply the asphalt material uniformly by means of a distributor at the rate specified and within the temperature limits stated herein. Apply the asphalt material for the full width to be treated in one application unless the RCE directs or permits otherwise. If the material is applied to a partial width at a time, provide suitable and adequate joints between adjacent treatments to ensure complete and uniform coverage. At the beginning and end of the distribution of each load, use building paper or other suitable paper to ensure a clean, straight line where the treatment begins and terminates. Take special precaution to have the distributing machine adjusted and operated so that an even and uniform distribution of the asphalt material is obtained. If streaking develops, stop the distributor immediately and correct the problem before proceeding. Immediately remove excessive deposits of asphalt material on the road surface and correct in a satisfactory manner. In applying the asphalt material, use effective means of protecting adjacent structures from discoloration. Determine the speed of the application of asphalt material in accordance with the number of rollers and the speed at which they are permitted to operate. Provide a means to verify the distributor's calibration.
- 2 Spray binder at a temperature between 300°F and 350°F, MC-30 at a temperature between 50°F and 120°F, and MC-70 at a temperature between 120°F and 180°F. Spray all emulsions at a temperature between 50°F and 160°F, except for CRS-2P, which is sprayed at a temperature between 140°F and 185°F. At the time of application, the RCE will set the exact temperature to satisfy current conditions.

406.4.6 Spreading of Aggregate

- 1 Ensure that the aggregate is available at the site of the work loaded in trucks or is delivered in manner so that the emulsion is immediately covered in a continuous operation. Make certain that the spreading of the aggregate takes place within 200 feet of the application of the emulsion. Shorten this distance due to low temperatures or high humidity. Uniformly spread the required amount of aggregate with approved spreaders. Operate trucks or spreaders so that the emulsion is covered with aggregate before the wheels pass over it. Use hand brooms as necessary. Ensure that the quantity of mat aggregate in place, after the completion of drag brooming and rolling, is no more and no less than that needed to give a complete cover. If determined necessary by RCE, have a spotter truck available to follow the spreader to fill in any non-covered areas.

406.4.7 Rolling

- 1 Use two pneumatic-tired rollers in tandem to ensure full coverage is completed before the emulsion "breaks." Complete a minimum of three passes within 30 minutes of the aggregate application. Stagger rollers and do not allow rollers to exceed 7 mph. Have the rolling speed determine the production speed. If necessary, use additional rollers to increase productivity. Ensure that rolling produces an even surface with thorough keying of the aggregate into the asphalt and is performed in a longitudinal direction, beginning at the outer edges of the treatment and working toward the center. If it is determined during the first calibration test section that a single pass of a steel wheel roller is needed to assist in the seating of the stone, one may be added if the rolling operation is completed within 30 minutes.

406.4.8 Sweeping and Cleaning

- 1 Do not sweep the loose aggregate until the emulsion is set. Determine the time frame for sweeping by the cure time of the emulsion, the temperature, the humidity, and other variables. Remove from the surface all loose aggregate that may be injurious to the finished road by means of a pick-up sweeper. Remove and dispose of this material away from the project. If material is clean and free of deleterious material and meets gradation limits, the Contractor may opt to reuse this material.

406.4.9 Opening to Traffic

- 1 After the surface treatment has been rolled, the emulsion has cured sufficiently to hold the aggregate, and the loose aggregate has been swept and removed, allow traffic on the road. Maintain "Loose Stone" and "25 MPH" signs until a pilot vehicle can test the surface treatment for loose aggregate. If it is determined by the RCE that loose stone is present, sweep and clean the area until no loose stone is detected. Once this is completed, allow traffic to resume normal operating speeds.
- 2 On sections where it is impracticable to close to traffic, the RCE may direct the Contractor to split the seal stone into two applications and allow traffic to use these sections.

406.4.10 Maintenance

- 1 In addition to the maintenance required as specified in **Subsection 104.7**, repair all spotty or bleeding places or any defects that occur during or after the surface treatment operations until no loss of stone is detected and traffic has resumed normal operating speeds. Make the necessary repairs in a manner that restores a uniform surface and ensures the durability of the portion repaired.

406.5 Measurement

- 1 The quantity for the pay item Asphalt Surface Treatment (Single Treatment) is the surface area of the road with asphalt surface treatment and is measured by the square yard (SY), complete in-place, and accepted. Material

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placed outside of the designated treatment area is disregarded in computing the quantity.

- 2 For the purpose of verifying rates of application and measuring materials authorized to be applied at a rate greater or lesser than that required by these specifications, the following rules apply:
 - A. Measurement in all cases is based on material actually and properly incorporated into the surface treatment and excludes loss due to the negligence of the Contractor or other circumstances as determined by the RCE.
 - B. The quantities of emulsion are based on the volume of the material at the temperature of 60°F. Correct volumes measured at higher or lower temperatures to the volume of the material at 60°F using the table entitled *Temperature-Volume Corrections for Emulsified Asphalt* in **SC-T-86**.

406.6 Payment

- 1 Payment for the accepted quantity for Asphalt Surface Treatment (Single Treatment), measured in accordance with **Subsection 406.5** is paid for at the contract unit bid price for the pay item. Payment is full compensation for constructing the asphalt surface treatment as specified or directed and includes furnishing, hauling, applying, spreading, and rolling the asphalt surface treatment; applying a prime coat when specified; surface preparation; removal of excess aggregate; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for this item includes all direct and indirect costs and expenses required to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
4060010	Asphalt Surface Treatment (Single Treatment)	SY

SECTION 407

ASPHALT SURFACE TREATMENT - DOUBLE TREATMENT

407.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for providing a wearing surface composed of a asphalt prime coat (when specified herein), an application of asphalt material and aggregate, covered with one or more applications of asphalt material and seal aggregate, constructed on a prepared base, and in conformance with the typical cross-section shown on the Plans and to the lines and grades set by the RCE.

407.2 Materials

407.2.1 Cut-back Asphalt (Rapid Curing Type)

- 1 Use Grade RC-30 material from suppliers listed on the most recent edition of *SCDOT Qualified Product List 38* and conforming to the properties in the following tables.

Property	Min.	Max.
Water, percent	--	0.2
Viscosity, Saybolt-Furol @77°F, seconds	75.0	150.0

Distillation Test		
Distillate as percent by volume of total distillate to 680°F	Min.	Max.
to 374°F	15	--
to 437°F	55	--
to 500°F	75	--
to 600°F	90	--

Residue from Distillation to 680°F:	Min.	Max.
Volume percentage of sample by difference	50	--

Tests on Residue from Distillation:	Min.	Max.
Penetration, 100 g, 5 sec, @77°F	60	120
Ductility, 5 cm/min @77°F, cm	100	--
Percent Solubility in Trichloroethylene	99	--

- 2 Saybolt-Furol viscosity applies.

407.2.2 Cut-Back Asphalt (Medium Curing Type)

- 1 Use Grade MC-30 or MC-70 material from suppliers listed on the most recent edition of *SCDOT Qualified Product List 38* and conforming to the requirements of AASHTO M 82, except the penetration of the residue must be in the range of 80 to 250. Saybolt-Furol viscosity applies.

407.2.3 Binder

- 1 Use binder conforming to the requirements of AASHTO M 320 for the grade of PG58-22 unless otherwise specified. Use material from suppliers listed on the most recent edition of *SCDOT Qualified Product List 37*.

407.2.4 Anionic Emulsified Asphalt

- 1 Use anionic emulsified asphalt of the grade designated meeting the requirements of AASHTO M 140 (with the exception of EA-P Special). Use emulsion from suppliers listed on the most recent edition of *SCDOT Qualified Product List 38*.
- 2 If grade EA-P Special is requested and approved, use emulsified asphalt meeting the requirements in the following table.

EA-P Special		
Test	Min.	Max.
Viscosity, Saybolt-Furol @77°F, sec	10.0	50.0
Sieve test @140°F, %	--	0.10
Oil Distillate, % by volume of emulsion	--	8.0
Binder as percentage by weight	40.0	--

407.2.5 Cationic Emulsified Asphalt

- 1 Use cationic emulsified asphalt of the grade designated conforming to the requirements of AASHTO M 208. When CRS-2P is specified in the Contract, use material conforming to AASHTO M 316, except omit the force ratio requirement. Use material from suppliers listed on the most recent edition of *SCDOT Qualified Product List 38*.

407.2.6 Aggregates

- 1 Use aggregates meeting the requirements specified in **Subsection 406.2.2**.

407.3 Equipment

- 1 Use equipment conforming to the requirements in **Subsection 406.3**.
- 2 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as

to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

407.4 Construction

407.4.1 Weather and Seasonal Limitations

- 1 Adhere to the weather and seasonal limitations specified in **Subsection 406.4.1**.

407.4.2 Cleaning of Surface

- 1 Perform cleaning of the surface in accordance with the requirements of **Subsection 406.4.2**.

407.4.3 Calibration of Equipment

- 1 Ensure that all equipment is calibrated in accordance with the requirements of **Subsection 406.4.3**.

407.4.4 Sequence of Operations

- 1 Apply Double Treatment using the quantities and sequence of operations outlined in the table entitled Asphalt Surface Treatment – Double Treatment, located in the **Appendix** of these specifications.

407.4.5 Application of Asphalt Materials

407.4.5.1 General

- 1 Apply asphalt material as specified in **Subsection 406.4.5**.

407.4.5.2 Prime Coat

- 1 Do not permit any traffic on the primed base until, in the opinion of the RCE, the asphalt material has penetrated and dried sufficiently so that it does not pick-up under traffic. On sections where it is impractical to detour traffic and if directed by the RCE, furnish and spread, without additional compensation, a minimum quantity of sandy material to avoid pick-up and then, allow traffic on these sections.
- 2 Maintain the prime coat and surface of the base course intact until it has been covered by superimposed construction. Place the asphalt surface treatment within 7 days of the base course being primed.
- 3 When directed to do so by the RCE, roll the primed base until the loose material is bonded.

407.4.6 Spreading of Aggregate

- 1 When binder is used as the asphalt material, ensure that sufficient aggregate to cover the application of binder is available before the application of binder. Ensure that the aggregate is available at the site of the work and loaded in trucks or is delivered in such a manner that the binder will be immediately covered in a continuous operation. Uniformly spread the required amount of aggregate with approved spreaders. Operate trucks or spreaders

so that the asphalt material is covered with aggregate before the wheels pass over it. The RCE may delay the application of mat stone when emulsion is used as the asphalt material. Ensure that any delay after application of the emulsion is only the time necessary for the emulsion to set sufficiently to prevent the aggregate from turning over under the wheels of the vehicles. After the aggregate has been spread, smooth it uniformly by light brooming with drag or rotary brooms along with the rolling operations. Use hand brooms as necessary.

- 2 Ensure that the quantity of mat aggregate in place, after the completion of brooming and rolling, is no more and no less than that needed to give a complete cover.

407.4.7 Rolling

- 1 Roll the aggregate applications for their entire width as specified in the table entitled Asphalt Surface Treatment – Double Treatment, located in the Appendix of these specifications. Repeat rolling and light brooming as often as, in the opinion of the RCE, is necessary to obtain smooth, even surface and to ensure thorough keying of the aggregate into the asphalt. Perform the rolling in a longitudinal direction, beginning at the outer edges of the treatment and working toward the center. On each trip of the roller, overlap the prior one by 1/2 the width of the roller. Permit traffic to use the road as soon as the mat aggregate is rolled.
- 2 When in the judgment of the RCE, the aggregate is sufficiently embedded in the asphalt material, remove all loose excess cover material from the surface.

407.4.8 Opening to Traffic

- 1 After the seal has been rolled and the asphalt material has cured sufficiently to hold the seal aggregate, open the surface to traffic. On sections that are impracticable to close to traffic, the RCE may direct that the seal stone be split into 2 applications and traffic allowed to use these sections.
- 2 Where the RCE directs the seal to be split, apply the seal aggregate specified herein for Asphalt Surface Treatment - Double Treatment - Types 1 and 2 as follows:
 - A. Immediately after the first application of asphalt material for the seal coat, uniformly spread 13 to 18 pounds of No. 789 aggregate per square yard.
 - B. Apply the second application of asphalt material.
 - C. Spread 6 to 9 pounds of No. 789 aggregate per square yard.
 - D. Roll as soon as possible with both the steel wheel and pneumatic roller.
- 3 Ensure that the total weight of both seal aggregate applications is 22 pounds per square yard or greater. Perform the additional work involved in placing the split seal without additional compensation.

407.4.9 Maintenance

- 1 Conform the maintenance to the requirements specified in **Subsection 406.4.10**.

407.4.10 Substitution of HMA Surface Courses for Asphalt Surface Treatment - Double Treatment

- 1 When requested in writing, the RCE may allow the substitution of 150 pounds (average) per square yard of HMA Surface Course Type C or D conforming to the requirements set forth in **Section 403** instead of the asphalt surface treatment specified herein at the same unit price for asphalt surface treatment. There is no substitution permitted when asphalt surface treatment is used on paved shoulders as a safety measure.
- 2 In computing the average rate in pounds per square yard, the total weight placed on each road is used to compute the average pounds per square yard for the road. Adhere to a tolerance range of minus 3% from the specified average rate. However, ensure that the depth of the HMA surface course is at least 0.8 inch at any point in the roadway. Correct any deficiencies without additional compensation. The RCE will set the amount of binder to be placed in the mix without separate or additional payment for this material.
- 3 Perform priming as required in **Subsection 401.4.18**.

407.5 Measurement

- 1 The quantity for the pay item Asphalt Surface Treatment (Double Treatment Type *(1, 2, 3, 4, or 5)*) the surface area of the roadway with double treatment asphalt surfacing and is measured by the square yard (SY), complete in-place, and accepted. Material placed outside of the area designated for treatment is disregarded when computing the quantity.
- 2 If the average rate per square yard of HMA surface course is less than the 3% tolerance allowed in **Subsection 407.4.10**, the quantity of square yards is reduced by the percentage that the actual average rate varies from 150 pounds per square yard. The actual rate per square yard is determined from field measurements and approved weight tickets.
- 3 Verify rates of applications as specified in **Subsection 406.5**.

407.6 Payment

- 1 Payment for the accepted quantity for Asphalt Surface Treatment (Double Treatment Type *(1, 2, 3, 4, or 5)*), measured in accordance with **Subsection 407.5**, is determined using the contract unit bid price per square yard for the applicable pay item. Payment is full compensation for constructing the asphalt surface treatment as specified or directed and includes furnishing, hauling, applying, spreading, and rolling the asphalt surface treatment; cleaning the existing surface; calibrating equipment; maintaining the surfacing; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with

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the Plans, the Specifications, and other terms of the Contract.

2 Payment for each item includes all direct and indirect costs and expenses required to complete the work.

3 Pay items under this section include the following:

Item No.	Pay Item	Unit
4070101	Asphalt Surface Treatment (Double Treatment Type 1)	SY
4070102	Asphalt Surface Treatment (Double Treatment Type 2)	SY
4070103	Asphalt Surface Treatment (Double Treatment Type 3)	SY
4070104	Asphalt Surface Treatment (Double Treatment Type 4)	SY
40750105	Asphalt Surface Treatment (Double Treatment Type 5)	SY

SECTION 408

ASPHALT SURFACE TREATMENT - TRIPLE TREATMENT

408.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for providing a wearing surface composed of an asphalt prime coat (when specified) and applications of asphalt material and spreading of aggregate, constructed on a prepared base, and in conformance with the typical cross-section shown on the Plans and to the lines and grades set by the RCE.

408.2 Materials

408.2.1 Asphalt Materials

408.2.1.1 Emulsified Asphalt

- 1 When used, use emulsified asphalt of grade CRS-2 conforming to the requirements specified in **Subsection 407.2.5**. If specified in the Contract, use CRS-2P conforming to the requirements of **Subsection 406.2.1.1**.

408.2.1.2 Prime Coat

- 1 When priming materials are required, use RC-70, MC-30, MC-70, or EA-P Special meeting the requirements specified in **Subsections 407.2.1, 407.2.2, and 407.2.4**.

408.2.2 Aggregate

- 1 Use Aggregate Nos. 5, No. 6M, No. 89M, and No. 789 conforming to the requirements specified in **Subsection 406.2.2**, including the provision concerning marine limestone.
- 2 Use Aggregate No. FA-13 consisting of crushed stone, crushed or uncrushed gravel, or sand. Ensure that the aggregate is free from clay balls and adherent films of clay.
- 3 Washed screenings may be used in lieu of Aggregate No. FA-13 in Asphalt Surface Treatment - Triple Treatment - Type 2, if they meet the gradation in the following table.

Washed Screenings	
Sieve Designation	Percentage by Weight Passing, %
3/8-inch	100.0
No. 4	90.0 – 100.0
No. 8	80.0 – 100.0

(table continued on the next page)

(table continued from the previous page)

Washed Screenings	
Sieve Designation	Percentage by Weight Passing, %
No. 30	25.0 – 55.0
No. 100	0.0 – 10.0
No. 200	0.00 – 4.00

408.2.3 Variation in Materials

- 1 Conform the variation in materials to the requirements specified in **Subsection 406.2.2**.

408.3 Equipment

- 1 Use equipment conforming to the requirements specified in **Subsection 406.3** and to the following:

When Aggregate No. FA-13 or washed screenings are used; utilize a spreader equipped with a mechanical device that spreads the Aggregate No. FA-13 or washed screenings at a uniform rate.

408.4 Construction

408.4.1 Weather and Seasonal Limitations

- 1 Adhere to the weather and seasonal limitations specified in **Subsection 406.4.1**.

408.4.2 Cleaning of Surface

- 1 Perform cleaning of the surface conforming to the requirements of **Subsection 406.4.2**.

408.4.3 Sequence of Operations

- 1 Apply Asphalt Surface Treatment using quantities and a sequence of operations as outlined in the table entitled Asphalt Surface Treatment - Triple Treatment, located in the **Appendix** of these specifications.

408.4.4 Applications of Asphalt Materials

- 1 Apply the asphalt material as specified in **Subsection 406.4.5** or **407.4.5**.

408.4.5 Weight of Aggregate

- 1 Determine truck weights as provided in **Subsection 407.4.5**.

408.4.6 Spreading of Aggregate

- 1 Conform the spreading of aggregate to the requirements specified in Subsection 407.4.6. Spread the Aggregate No. FA-13 using equipment specified in **Subsection 408.3**.

408.4.7 Brooming and Rolling

- 1 Except for the spreading of Aggregate Nos. 789 and No. 89M applied for second layer, roll each layer of aggregate following spreading as directed by the RCE. Perform rolling with a steel wheel tandem and pneumatic roller. Repeat rolling and light brooming with drag or rotary brooms as often as, in the opinion of the RCE, is necessary to obtain a smooth, even surface and to ensure thorough keying of the aggregate into the asphalt. Delay broom operations until the asphalt has set sufficiently to hold the stone and prevent the broom from turning the stone over. Permit traffic to use the road as soon as the mat aggregate is spread. When in the judgment of the RCE, the aggregate is sufficiently embedded in the asphalt, remove all loose excess material from the surface.
- 2 Start the rolling of the final layer as soon as sufficient aggregate is spread to prevent pickup and continue until the aggregate is worked into the surface. Perform the initial rolling of the final layer with the steel wheel roller. Begin light brooming with drag or a rotary broom as soon as possible after the rolling has started and the surface has set sufficiently to prevent excessive marking of the seal surface. Perform further light brooming as often as necessary to keep the cover aggregate uniformly distributed over the surface. Continue brooming, rolling and back-spotting until the top surface is compacted, bonded and cured to the satisfaction of the RCE. Sweep surplus aggregate off the surface before final acceptance.

408.4.8 Maintenance

- 1 Conform maintenance to the requirements specified in **Subsection 406.4.10**.

408.5 Measurement

- 1 The quantity for the pay item Asphalt Surface Treatment (Triple Treatment Type (*1 or 2*)) the surface area of the road with a triple treatment asphalt surface and is measured by the square yard (SY), complete in-place, and accepted. Material placed outside of the area designated for treatment is disregarded when computing the quantity
- 2 Rates of application are verified as provided in **Subsection 406.5**.

408.6 Payment

- 1 Payment for the accepted quantity for Asphalt Surface Treatment (Triple Treatment Type (*1 or 2*)), measured in accordance with **Subsection 408.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for the constructing the asphalt surface treatment as specified or directed and includes furnishing, hauling, applying, spreading, brooming, and rolling the asphalt surface treatment; cleaning existing surface; maintaining the new surface; applying prime coat when required; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the

408.6

408.6

Plans, the Specifications, and other terms of the Contract.

2 Payment for each item includes all direct and indirect costs and expenses required to complete the work.

3 Pay items under this section include the following:

Item No.	Pay Item	Unit
4080101	Asphalt Surface Treatment (Triple Treatment Type 1)	SY
4080102	Asphalt Surface Treatment (Triple Treatment Type 2)	SY

SECTION 409

OPEN-GRADED FRICTION COURSE

409.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for an open-graded friction course (OGFC) composed of crushed mineral aggregate, polymer modified binder, stabilizing fibers, and hydrated lime mixed in an approved HMA plant. Place the OGFC on a prepared surface and in conformity with the Plans or otherwise specified by the RCE.

409.2 Materials

409.2.1 General

- 1 Use materials meeting the applicable requirements of **Subsection 401.2** except as modified in this subsection. Do not use RAP, slag, or marine limestone in the OGFC. Use a polymer modified binder of grade PG76-22 and hydrated lime in all OGFC mixtures.

409.2.2 Aggregate

- 1 Use crushed coarse aggregate having an abrasion loss of not more than 52.0% when tested in accordance with AASHTO T 96 (C Grading). If the aggregate's abrasion loss is greater than 42.0%, but less than or equal to 52.0%, test the Micro-Deval abrasion value of the material in accordance with AASHTO T 327 and ensure it does not exceed a maximum of 15.0% loss. Use Crushed coarse aggregate with two or more freshly mechanically induced fractured faces on at least 90%, based on count, in accordance with AASHTO T 61, and a Sodium Sulfate Soundness loss not greater than 15.0% when subjected to five alterations in accordance with AASHTO T 104.

409.2.3 Stabilizing Fibers

409.2.3.1 Mineral Fibers

- 1 Use mineral fibers made from virgin basalt, diabase, or slag, which is treated with a cationic sizing agent to enhance disbursement of the fiber as well as increase adhesion of the fiber to the binder. Add the mineral fiber at a dosage rate of 0.2% to 0.4% by weight of the total mix as approved by the MRE. Use mineral fibers conforming to the properties in the following tables.

Size Analysis	
Average Fiber Length	6.35 mm Max.
Average Fiber Thickness	0.005 mm Max

Shot Content (ASTM C 612)	% Passing
Passing 250 μm sieve	90 - 100
Passing 67μm sieve	65 - 100

Degradation (GDT-124/McNett fraction)	30% Max.
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- 2 Obtain a letter from the mineral fiber supplier certifying that the mineral fiber has been tested and complies with the required properties. Submit the certification letter to the AME and the RCE when submitting the design for verification and approval.

409.2.3.2 Cellulose Fibers

- 1 Add cellulose fibers at a dosage rate of 0.2% to 0.4% by weight of the total mix as approved by the MRE. Use cellulose fibers conforming to the properties in the following tables.

Size Analysis	
Average Fiber Length	6.35 mm max.

Sieve Analysis (AASHTO T 27)	% Passing
No. 20	80.0 – 95.0
No. 40	45.0 – 85.0
No. 100	5.0 – 40.0

- 2 Obtain a letter from the cellulose fiber supplier certifying that the cellulose fiber has been tested and complies with the above properties. Submit the certification letter to the AME and the RCE when submitting the design for verification and approval.

409.2.3.3 Recycled Polyester Fibers

- 1 Add recycled polyester fibers at a dosage rate of 0.2% to 0.4% by weight of the total mix as approved by the MRE. Use recycled polyester fibers conforming to the properties in the following tables.

Size Analysis	
Average Fiber Length	6.35 mm max.

Sieve Analysis (AASHTO T 27)	% Passing
No. 20	80.0 – 95.0
No. 40	45.0 – 85.0
No. 100	5.0 – 40.0

409.2.4 Composition of Mixture

- 1 Conduct the OGFC mix design in accordance with **SC-T-91**. Submit the mix gradation, binder content, and mineral fiber dosage rate on a form approved by the AME. The AME will review the binder content and the stabilizing fiber dosage rate for approval. Ensure a minimum retention coating of 99.5% following **SC-T-90**. Ensure that the gradation and binder content comply with the ranges shown in following table.

Sieve	% Passing
¾-inch	100
½-inch	85.0 – 100.0
⅜-inch	55.0 – 75.0
No. 4	15.0 – 25.0
No.8	5.0 – 10.0
No.200	0.00 – 4.00
Range for % Binder	5.50 – 7.00

409.3 Equipment

- 1 Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.
- 2 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

409.4 Construction

409.4.1 Seasonal and Ambient Air Temperatures Limitations

- 1 Place the OGFC on a clean, dry, properly tacked surface only during favorable weather conditions between March 1 and October 31 inclusive. Assure that ambient air temperature during placement of OGFC is 60°F or above when measured in the shade away from artificial heat.

409.4.2 Production

- 1 Produce the OGFC mix within a temperature range of 325°F and 350°F at discharge from the plant. Measure all temperatures following **SC-T-84**. Do not produce other mixes during OGFC production for Department projects.

409.4.3 Fiber Supply System

- 1 Ensure that the fiber supply system conforms to the requirements stated in **SC-M-401**.

409.4.4 Placement

- 1 Ensure that the temperature of the mix when placed on the roadway is not less than 320°F. Do not allow long hauling distances or excessive waiting time to off-load. Unless otherwise permitted by the RCE, place OGFC mix within 1 hour of mixing at the plant.
- 2 Apply a tack coat of approved emulsified asphalt in accordance with Sub-section 401.4.18 to the surface on which the OGFC is placed. The tack rate may be reduced if the RCE deems necessary.
- 3 Spread the OGFC at the rate shown on the Plans and promptly roll with an 8 to 10 ton tandem steel-wheel roller conforming to the requirements of **Sub-section 401.3.11**. Cease rolling as soon as the OGFC is properly seated to the underlying surface. It is recommended that no more than three passes of the roller be applied to the OGFC. Regardless of the number of passes of the roller, if aggregate breakdown is observed, make adjustments to eliminate the breakdown.
- 4 Do not permit non-uniform distribution of binder (flushing) and raveling in the OGFC. Remove areas in the OGFC that are flushed or raveled to the full lane width 50 feet on each side and replace at no additional expense to the Department.

409.5 Measurement

- 1 The quantity for the pay item OGFC is measured in a similar manner as HMA courses specified in **Subsection 401.5**.

409.6 Payment

- 1 Payment for Open-Graded Friction Course is determined using the contract unit price for the pay item. Payment is full compensation for constructing the OGFC as specified or directed and includes furnishing, mixing, hauling, placing, and compacting OGFC; furnishing and applying tack coat; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for each item includes all direct and indirect cost and expenses necessary to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
4092000	Open-Graded Friction Course	TON

DIVISION 500
CONCRETE PAVEMENT
SECTION 501

PORTLAND CEMENT CONCRETE PAVEMENT

501.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for a rigid pavement composed of Portland cement concrete placed as a monolithic course on a prepared subbase or base course in conformity with the lines, grades, thickness, and typical cross-sections shown on the Plans or established by the RCE. Use a slipform paver to construct the concrete pavement; however, when approved by the RCE, stationary side forms may be used only where a slipform paver is not practical.

501.2 Materials

501.2.1 Portland Cement, Fly Ash, and Water-Granulated, Blast Furnace Slag

- 1 Use Portland cement, fly ash, and water-granulated, blast furnace slag meeting the requirements of **Subsections 701.2.1, 701.2.2, and 701.2.3**, respectively.
- 2 When fly ash or water-granulated, blast furnace slag is used, ensure that it conforms to the requirements of **Subsection 701.4.9**.

501.2.2 Air-Entraining Admixtures

- 1 Unless otherwise specified, use air entrainment in all concrete. Use air-entraining admixtures that comply with the requirements of **Subsection 701.2.5.1**.

501.2.3 Fine Aggregate

- 1 Use fine aggregate conforming to the requirements in **SC-M-501**.

501.2.4 Coarse Aggregate

- 1 Use coarse aggregate conforming to the requirements in **SC-M-501**.

501.2.5 Water

- 1 Use water meeting the requirements of **Subsection 701.2.11**.

501.2.6 Joint Fillers

- 1 Use filler for preformed or sawed joints of the type specified and placed in accordance with joint details shown in the Plans. Apply materials in accordance with the manufacturer's recommendations regarding preparation of

joint walls, application temperatures, and the necessary equipment to ensure proper placement of material.

501.2.6.1 Preformed Expansion Joint Filler

- 1 Use preformed joint filler that conforms to the requirements of AASHTO M 213. Provide preformed joint fillers with a thickness equal to the width of the joint required and furnish in lengths equal to the width of the slabs in which they are installed. Use preformed joint filler shaped so that, after installation, the upper and lower surfaces conform to the shape of the slab and subbase surfaces. Position the lower surface of the preformed joint filler on or below the surface of the base while the upper surface is ½ inch below the surface of the slab unless otherwise specified.
- 2 A preformed material composed of 100% scrap tire rubber, shredded and fused into cohesion with a non-toxic, odorless, polyurethane binder complying with the physical properties given in AASHTO M 153 (ASTM D 1752, Type I) is also allowed. Only shredded material treated to resist most types of microbes, oils, fungi, and biological growth is acceptable.

501.2.6.2 Silicone Sealant

- 1 Use silicone sealant of low modulus and furnished in a one-part silicone formulation. Make certain that the sealant is compatible with the surface to which it is applied. Use silicone sealants that do not require heat or primers in order to attain a bond to the joint walls. Do not use acid cure silicone sealants on Portland cement concrete. Use silicone sealants from approved sources listed on the most recent edition of *SCDOT Qualified Product List 8*. Fill all sawed joints (transverse and longitudinal) with a silicone sealant unless otherwise specified.
- 2 Provide the RCE with the manufacturer's installation instructions for each brand and type of sealant intended for use before incorporation into the work. With each shipment of materials, furnish to the RCE a manufacturer's certification showing the following information:
 - Brand Name,
 - Lot or Batch No.,
 - Shipping date,
 - To whom it is shipped, and
 - The quantity in the shipment.
- 3 Ensure that the certificate contains the manufacturer statement that the material meets the Department's specifications and is essentially the same as that on *SCDOT Qualified Product List 8*. Use containers that are plainly marked with the manufacturer's name, batch or lot number, trademark, type of silicone, and end of shelf life date. Furnish a materials safety data sheet with each shipment.

501.2.6.3 Bond Breaker

- 1 Install silicone sealant over a suitable bond breaker that prevents the sealant from bonding to the bottom of the joint. Provide bond breakers that are chemically inert and resistant to oils, gasoline, solvents, and that will not stain or adhere to the sealant. Use bond breakers in the form of a backer rod or tape as identified on the Plans or in other contract documents.
- 2 Provide properly sized backer rod of circular cross-section and consisting of closed cell polyethylene foam. Generally, the backer rod is 25% greater in diameter than the saw cut width.
- 3 Where specified, provide bond breaker tape with 0.005-inch minimum thickness made from extruded polyethylene with a pressure sensitive adhesive on one side.
- 4 Furnish a certification by the bond breaker manufacturer stating that the provided material complies with the Department specification for closed cell polyethylene foam and that the tape is polyethylene type.

501.2.6.4 Hot Poured Joint Sealant

- 1 When specified, use hot poured joint sealant conforming to the requirements of AASHTO M 324 or ASTM D 6690, Type II. Provide the RCE with a certification from the manufacturer of the sealant material stating that the material complies with AASHTO M 324 or ASTM D 6690, Type II. Unlike silicone sealant, no pre-certification or pre-approval of hot pour joint sealant material is necessary.

501.2.6.5 Preformed Neoprene (Polychloroprene) Joint Seal

- 1 Where required, use an open-cell compression-type preformed neoprene joint seal such as D. S. Brown Company Model E-686 Preformed Neoprene Seal or approved equivalent sized to work with a nominal $\frac{3}{8}$ -inch wide joint reservoir unless otherwise specified. Use seals manufactured from a vulcanized elastomeric material in which neoprene makes up at least 50% of the compound used in the manufacture of the seal. Use joint material that meets the requirements of ASTM D 2628.
- 2 Use lubricant-adhesive necessary for installation and follow the seal manufacturer's instructions. Submit a certification to the RCE before installation indicating that the seal manufacturer approves the lubricant-adhesive for use with the particular joint seal.
- 3 Use seal material that indicates the lot number and manufacturer and that is pre-marked on the top surface at 1-foot intervals for making length measurements after installation. Use material that is packaged in cardboard boxes or wooden cable reels. Protect the uninstalled seal material from moisture and outdoor exposure until placement of the material.
- 4 Provide the RCE with a certification from an independent laboratory stating that the material meets the requirements of ASTM D 2628 for each lot of seal material. A lot consists of the lesser of 60,000 linear feet or not more than

one manufacturer's production day.

501.2.7 Reinforcing Steel

- 1 Use steel reinforcing bars in concrete pavement of the type, length, size, spacing, and quantity shown on the Plans and meeting the requirements specified in **Section 703**, except as specified in this subsection.
- 2 For tie bars and steel reinforcing bars, use deformed steel bars conforming to AASHTO M 31, Grade 40. If desired, tie bars conforming to the requirements of AASHTO M 31 or ASTM A 706, Grade 60 are also allowed. For dowel bars, use plain round bars conforming to the requirements of AASHTO M 31, AASHTO M 322, or ASTM A 706, Grade 60. Ensure that dowel bars are free from burring or other deformation that may restrict slippage in concrete. Use dowel bars coated with an approved, factory applied material to break the bond between the steel and concrete. Where specified, use metal sleeves for dowel bars at expansion joints of an approved design to cover 2 inches ($\pm\frac{1}{4}$ inch) of the dowel, having a closed end, and having a suitable stop to hold the end of the sleeve at least 1 inch from the end of the dowel bar.
- 3 Where specified, use wire and wire mesh conforming to the requirements specified in **Section 703**.

501.2.8 Curing Materials

501.2.8.1 Burlap Cloth Made from Jute or Kenaf

- 1 Provide material conforming to the requirements of AASHTO M 182, Class 3 (10 ounces/yard) or Class 4 (12 ounces/yard).

501.2.8.2 Sheet Materials for Curing Concrete

- 1 Provide waterproof paper, polyethylene film, or white burlap-polyethylene sheet conforming to the requirements of AASHTO M 171.

501.2.8.3 Liquid Membrane-Forming Compounds

- 1 Provide liquid curing compounds that meet the requirements of **Subsection 702.2.2.10**.

501.2.9 Paving Concrete

501.2.9.1 General

- 1 Provide concrete composed of Portland cement, fine aggregate, coarse aggregate, fly ash, water-granulated blast-furnace slag, water, and chemical admixtures meeting the requirements of **Subsection 701.2** to produce concrete of the specified strength and workability.

501.2.9.2 Concrete Proportions, Strength, Workability, Sampling, and Testing

- 1 Conform to the requirements of **SC-M-501** for concrete strength, mix design submittals, trial batches, air entrainment, workability, field sampling and curing, and testing.

501.2.9.3 Re-tempering and Admixtures

- 1 Do not re-temper concrete by adding water or by any other means. Do not use concrete that is not within the specified slump limits at the time of placement. Admixtures for changing the workability or accelerating the set are permissible only when included in an acceptable mix design authorized by the SME.

501.3 Equipment**501.3.1 General**

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

501.3.2 Subbase Planer

- 1 Where required, provide a subbase planer with a cutting edge or edges, set to conform accurately to the specified subbase elevations. Provide a planer that is fully self-contained and designed for the specific purpose of planing the subbase to the true grade and cross-section. Scratch planers with spikes or teeth are not permitted.

501.3.3 Batching Plant and Equipment**501.3.3.1 General**

- 1 Provide a batching plant that includes bins, meters, weighing hoppers, and scales for weighing and measuring the fine aggregate, coarse aggregate, cement, fly ash, slag, water, and admixtures. Ensure that the cement weighing hoppers are properly sealed and vented to preclude dusting during operation. Utilize a batch plant equipped with a suitable batch counter that correctly indicates the number of batches proportioned. The batching plant may be manually controlled or automatically controlled.
- 2 Make certain that all batching equipment in automatic plants is interlocked so that a new weighing cycle cannot be started until the weigh hopper is empty; the scales are in balance; and the discharge gates and the supply valves in the system are closed. Ensure that automatic batching equipment is capable of conversion to manual operation if necessary.
- 3 Verify the designated batch weights for bulk cement and each separate aggregate component before the batch cycle starts as directed by the RCE. Make satisfactory provisions for batching other components of the mix at the batching plant or at the roadside paver as necessary.

501.3.3.2 Bins and Hoppers

- 1 Provide bins with adequate separate compartments for fine aggregate and coarse aggregate at the batching plant. Ensure that each compartment discharges efficiently and freely into the weighing hopper or hoppers and is

equipped to control the discharge at variable speeds and to shut off cleanly for proper proportioning. Provide means to enable the removal of overloads of the aggregates before being charged into the mixer. Ensure that weighing hoppers are constructed to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Provide partitions between compartments, both in bins and in hoppers that are sufficiently ample to prevent spilling under working conditions.

501.3.3.3 Scales, Meters, and Dispensers

- 1 Provide scales for weighing aggregates, water, and cement of beam type, springless dial type, or load cell type. The required accuracy of the scales is $\pm 0.5\%$ when used for cement and $\pm 1.0\%$ when used for aggregate and water under operational conditions throughout the range of use. When beam type scales are used, provide a device, such as a "tell-tale" dial, to alert the operator when the required load in the weighing hopper is being approached. Provide a device on the weighing beams to clearly indicate the critical position. Use poises designed to lock in any position to prevent accidental change of position. Make certain that the weigh beam and "tell-tale" device are in full view of the operator while charging the hopper and that the operator has convenient access to all controls. Provide clearance between scale parts, hoppers, and bin structure so that displacement of, or friction between, parts due to accumulations, vibration, or other causes is avoided. Provide pivot mountings designed to ensure that none of the parts jar loose and the spacing of knife-edges remains unchanged. Use scales designed so that all exposed fulcrums, clevises, and similar working parts may readily be kept clean. Ensure that weigh beams have leveling lugs and that the weighing parts of other type scales have a means for precision adjustment. Have the scales inspected, calibrated, and sealed at no cost to the Department at intervals not greater than 6 months or whenever calibration may be deemed necessary by the RCE to ensure their continued accuracy.
- 2 Measure Portland cement by weight on a separate scale and hopper. Provide a boot or other approved means to transfer the cement from the weighing hopper. Employ satisfactory methods of handling cement.
- 3 Weigh each material such that the batch weights required are within a tolerance of $\pm 1.0\%$ for cement and water and $\pm 2.0\%$ for aggregates. Use meters for measuring water that operate within a tolerance of $\pm 1.0\%$.
- 4 Provide separate devices in the system for measuring the amounts of chemical admixtures added to each batch that are accurate within $\pm 3.0\%$, easily adjustable, and satisfactory to the RCE.

501.3.4 Mixers

501.3.4.1 General

- 1 Mix concrete in central mix plants, except when the RCE authorizes the use of truck mixers and roadside pavers. Ensure that each mixer has a manufacturer's plate, attached in a prominent place, showing the capacity of the drum in terms of volume of mixed concrete and the recommended speed of rotation

of the mixing drum or blades.

- 2 Examine mixers daily for accumulation of hardened concrete or mortar and wear of the blades. At the job site, have a copy of the manufacturer's design available showing dimensions and arrangement of blades in reference to original height and depth. Repair or replace the blades when they are worn down 1 inch or more from their original dimension.

501.3.4.2 Central Mixing Plant

- 1 Provide central mixing plants meeting the requirements in **Subsection 701.3.3**. If the plant is a pre-existing ready-mix concrete producer, make sure it is listed on the most recent edition of *SCDOT Qualified Product List 28*. If the plant has been brought in to exclusively provide material for a paving project, approval sheet listing is not required; however, have the plant inspected by the OMR personnel before starting production.

501.3.4.3 Truck Mixers

- 1 Provide truck mixers meeting the requirements in **Subsection 701.3.3**.

501.3.4.4 Roadside Paver Mixers

- 1 If allowed by the RCE, use roadside mixers that are original in design and in good working condition. Do not start work until each mixer is inspected and approved by the RCE.

501.3.5 Transporting Vehicles

501.3.5.1 Non-Agitator Trucks

- 1 Use non-agitating hauling equipment for centrally mixed concrete whose bodies are metal with rounded internal corners. Use trucks equipped with vibrators and capable of discharging the concrete at a satisfactorily controlled rate without segregation.

501.3.5.2 Truck Mixers and Truck Agitators

- 1 Use truck mixers for mixing and hauling concrete meeting the requirements in **Subsection 701.3.4**.

501.3.5.3 Dry Batch Trucks

- 1 Use vehicles for transporting batched unmixed materials from the batching plant to the roadside paver mixer that are equipped with batch boxes, containers, or bodies of adequate capacity and construction to properly carry the dry volumes required. Ensure that partitions separating batches are constructed to prevent spilling of the weighed batches from one compartment into another while in transit or when being dumped.
- 2 Use transporting equipment and accessories in the proportioning and transportation of concrete materials to the roadside paver mixer that are designed and operated to ensure that the charging of the mixer with the previously weighed amounts of each material required for each batch is performed without over-spilling or intermixing of batches or wastage.

501.3.6 Slipform Paver

- 1 Use a slipform paving machine with the following characteristics and capabilities:
 - Fully self-contained, self-propelled, and requiring no external tractive force.
 - Designed for the specific purpose of placing concrete in one pass without the use of fixed side forms.
 - Capable of consolidating and finishing the concrete pavement true to grade and cross-section.
 - Equipped with trailing side forms, of dimensions, shape, and strength to support the concrete laterally for a sufficient length of time that no appreciable edge slumping occurs.
 - Capable of vibrating the concrete for the full width and depth of the layer being placed.
 - Equipped with the necessary electronic or hydraulic devices to control the finished elevation of the pavement from a stringline. The RCE may require the use of these controls on a part or all of the paving work.

501.3.7 Concrete Spreaders

- 1 Use spreaders that are self-propelled, equipped with a power-driven device for spreading the concrete uniformly between the forms without segregation, and have an adjustable blade or other approved means for striking off the concrete to the required height and crown. Ensure that spreaders are equipped with effective cleaning devices to provide proper contact at all times between the wheels and the contact surface. If using wheels that are supported by an adjacent slab, do not use wheels that have flanges in contact with the slab.

501.3.8 Forms

- 1 Use forms with the following characteristics:
 - Sides are straight with sufficient thickness to maintain the true cross-section.
 - Sections are not shorter than 10 feet in length.
 - Depth is equal to at least the prescribed edge thickness of the concrete pavement without horizontal joint and base width is not less than 8 inches.
 - For curves of 150-foot radius or less, forms are flexible or curved, of an acceptable design, and of the proper radius.
 - Adequate devices for secure setting and mounting so that when in place they withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment.
 - Flange braces that extend outward on the base not less than 2/3 the height of the form.

- Top surfaces are not battered.
- Not bent, twisted, or broken.
- Not repaired forms unless inspected and approved by the RCE.
- Not built-up forms except where the total area of pavement of any specified thickness on the project is less than 3000 square yards. Built-up forms may extend the form depth up to 25%. Make certain that the build-up is securely attached to the bottom of the form.
- Top face does not vary from a true plane by more than 1/8 inch in 10 feet.
- Upstanding leg does not vary more than 1/4 inch.
- Equipped to lock the ends of abutting form-sections together tightly for secure setting.

501.3.9 Finishing Equipment

501.3.9.1 Finishing Machine

- 1 Use finishing machines equipped with at least two oscillating type transverse screeds.

501.3.9.2 Vibrators

- 1 Use vibrators for full-width vibration of concrete paving slabs that are either the surface pan type or the internal type with immersed tube or multiple spuds. Either attach the vibrators to the spreader or the finishing machine or mount them on a separate carriage. Do not allow the vibrators to come in contact with load transfer devices, subgrade, or side forms. Ensure that the frequency of the surface vibrators is not less than 3500 impulses per minute and the frequency of the internal type is not less than 5000 impulses per minute for tube vibrators and 7000 impulses per minute for spud vibrators unless authorized by the RCE. When spud type internal vibrators, either hand-operated or attached to spreaders or finishing machines, are used adjacent to forms, ensure that they have a frequency of not less than 3500 impulses per minute. When vibrators are attached to a separate carriage, spreader, or finishing machine, ensure that they are equipped with a control to shut off the operation automatically when forward motion stops. Have and maintain necessary tachometers or other approved automated displays to verify the frequency of the vibrators.

501.3.9.3 Tube Finisher

- 1 Provide tube finishers that are self-propelled and are a type that produces a satisfactory finish to the concrete as determined by the RCE.

501.3.9.4 Hand Tools

- 1 Provide appropriate straight edge tools to complete the finishing of the slab.

501.3.10 Transverse Groover

- 1 When required, have available a mechanical device that is essentially a metal comb capable of spanning the width of the pavement to produce ac-

ceptable transverse grooves. Use a metal comb consisting of a single line of tempered spring rectangular steel tines or other approved material uniformly spaced at ½-inch centers and securely mounted in a suitable head. Use tines that produce transverse grooves in the hardened surface of the concrete that are 0.10 inch (± 0.02 inch) in width and ranging from 0.10 inch to 0.15 inch in depth. Attach the metal comb to a mechanical device capable of traversing the entire pavement width in a single pass at a uniform speed. Use a grooving device that is a separate independent unit and is not attached to equipment performing other functions, except that it may be part of the curing membrane spray unit. Small or irregular areas may be grooved by hand methods.

501.3.11 Curing Membrane Spray Equipment

- 1 Provide a mechanical device capable of spanning the width of the pavement for uniformly applying the white pigmented curing compound to the surface and sides of the slab at the rate specified. Use equipment that is self-propelled and equipped with proper pumps and nozzles to spray the slab while traveling at a uniform speed. If desired, apply curing compound by hand for small or irregular areas.

501.3.12 Rain Protection

- 1 In case of a rain shower during construction, have available at all times a mechanical device with an appropriate supply of rolled polyethylene capable of spanning the pavement along with the paving equipment. Ensure that the device is capable of mechanically unrolling the polyethylene over the portion of the slab that has not set enough to resist the rain.

501.3.13 Concrete Saws

- 1 Provide sawing equipment in adequate numbers and power to complete the sawing to the required dimensions and at the required rate. Ensure that the saws are equipped with water-cooled diamond edge saw blades or abrasive wheels. If desired, early entry saws may also be used with the prior approval of the RCE. Provide at least one standby saw that is in good working order. Maintain an ample supply of saw blades at the site of the work at all times during sawing operations. Provide adequate artificial lighting facilities for night sawing. Maintain all of this equipment on site in working order before beginning each workday and continuously during concrete placement.

501.3.14 Miscellaneous Equipment

- 1 Provide other tools and equipment of approved design as necessary for the satisfactory completion of the work.

501.3.15 Equipment to Install Joint Filler

501.3.15.1 Hot Pour Elastic Joint Filler

- 1 Provide a melter/applicator of conventional double boiler type with a bottom-sweeping agitator for the installation of hot pour elastic joint filler. Use melter/applicators equipped with at least a 16-horsepower engine, an agitator in good working condition, a reliable rotary pump with a 2-inch minimum port

size without an internal pressure relief valve, a full 2-inch manual bypass that allows circulation of the sealant from the pump back into the vat at the farthest possible point away from the pump intake, and a 15-foot high-pressure sealing hose with a 1-inch inside diameter coupled to a sealing wand with a $\frac{3}{4}$ - to 1-inch inside diameter with appropriate insulation to maintain the sealant temperature. Maintain temperature controls and indicators on the melter/applicator unit to a degree of accuracy that is very reliable. Provide a partition in the vat to hold the fresh unheated sealant at the farthest possible point away from the pump intake until the sealant is liquefied. Also, provide a recording thermometer for recording the temperature of the liquefied sealant in relation to time during melter operation.

501.3.15.2 Silicone Sealant

- 1 Provide equipment to place silicone sealant that is manually or power operated. Use an air compressor and air-powered extrusion pump for the transfer of the sealant from either drums or pails through high-pressure hoses to the joint. Maintain seals, hoses, and hose connections in a condition adequate to prevent moisture permeation from causing the sealant to cure prematurely before being installed in the joint. Use seals and packing made of Teflon® or equivalent and hoses lined with Teflon® or equivalent.
- 2 Use a wand that is made to install the sealant from the bottom up in the joint and stay below the top surface of the joint at all times. Have available the proper tooling device to shape the top surface of the sealant to the proper configuration at the proper time.
- 3 Ensure that all equipment capacities, hose diameter, pump pressures, etc. conforms to the sealant manufacturer's recommendations.

501.3.16 Field Office and Laboratory

- 1 Refer to **SC-M-501** for requirements pertaining to field offices and laboratories.

501.4 Construction

501.4.1 Preparation of Subgrade, Subbase, and Base

- 1 Construct the subgrade, subbase (if applicable), and base to the lines, grades, and typical sections shown on the Plans or as designated by the RCE. Complete base placement operations at least 2500 feet in advance of concrete placing operations when this distance is available unless otherwise directed by the RCE.
- 2 Construct the subbase and base beneath the concrete pavement to include an area 18 inches in width extending beyond the edges of the concrete pavement unless shown otherwise on the Plans to provide stability for the paver tracks. If desired, additional width may be added at no additional cost to the Department in order to facilitate construction. When curb and gutter is constructed contiguous with the pavement, include an area of base and subbase 2 feet in width extending beyond the back of the curb and gutter. Complete the base and subbase for at least 2500 feet in advance of concrete placing

operations when this distance is available.

501.4.2 Conditioning of Subgrade or Base Course

501.4.2.1 Compaction

- 1 Thoroughly compact the subgrade, subbase, and base as specified. Maintain all specified compaction levels until such time that the overlying pavement layer is applied. Compact any portion of the subbase that is not accessible to a roller with hand tampers to obtain the density requirements for the material.

501.4.2.2 Protection

- 1 Before placing any surfacing material on any section, ensure that all ditches and drains along that section are completed and are draining the subgrade effectively. In handling materials, tools, equipment, etc., protect the subbase or base from damage. If ruts are formed, reshape the subbase or base and re-compact to the specified levels. At all times, keep the subbase or base surface in such condition that it will drain readily. Do not place any overlying layer until the subbase or base has been tested and approved by the RCE.

501.4.2.3 Finish for Base

- 1 Before paving begins, bring the subbase to proper cross-section. Trim high areas to proper elevation. Either fill and compact low areas to a condition similar to that of surrounding grade or fill low areas with concrete integral with the pavement. No additional compensation is made for concrete used to correct low base. Maintain the finished grade in a smooth and compacted condition until the pavement is placed. Use an approved type of subbase or base grader that follows a chord line for grade or rides on the forms in forming the crown and shaping the subbase or base to ensure that the specified thickness of the finished pavement is secured. Ensure that the grader has the capacity of cutting the surface without reducing compaction. After grading, use rubber tired rollers as necessary to recondition the surface a sufficient distance ahead of the placement of concrete to allow necessary inspection and testing of the subgrade.

501.4.3 Slipform Concrete Paving

501.4.3.1 Slipform Method

- 1 Use a slipform-paving machine unless the area to be paved is inaccessible or as otherwise permitted by the RCE. Allow no wheeled equipment that disturbs the track line for other equipment or does not perform satisfactorily in the paving train.
- 2 Allow no vehicular traffic or mixing equipment on the completed base without the permission of the RCE.

501.4.3.2 Placing Concrete

- 1 Place the concrete with an approved slipform-paving train designed to spread, consolidate, screed, float-finish, texture, and place cure material in

one complete operation. Slumping of the concrete will not exceed $\frac{3}{8}$ inch from a typical cross-section. However, slump at longitudinal construction joints will not exceed $\frac{1}{4}$ inch from a typical cross-section.

- 2 Operate the slipform-paving machine with as much continuous forward movement as possible. Coordinate all mixing, delivering, and spreading operations to provide uniform progress with stopping and starting of the machine held to a minimum. If for any reason it is necessary to stop the forward movement of the machine, also stop the vibratory and tamping elements immediately. Except in an emergency, do not apply a tractive force to the machinery except that which is controlled from the machine.
- 3 Employ such devices and procedures as necessary to ensure proper consolidation of the concrete and proper positioning of reinforcement, tie bars, and dowels for joints to produce a monolithic slab.
- 4 Pave areas inaccessible to slipform-paving equipment in accordance with **Subsection 501.4.4.**

501.4.4 Fixed Form Concrete Paving

501.4.4.1 Base Support

- 1 Ensure that the base under the forms is compacted and true to grade so that the form, when set, is firmly in contact for its whole length and at the specified grade. Fill any base that is below established grade at the form line. Fill these areas to grade with granular material in lifts of $\frac{1}{2}$ inch or less for a distance of 18 inches on each side of the base of the form, and compact thoroughly. Correct imperfections or variations above grade by tamping or by cutting. Except in the case of cement-stabilized bases, the removal of random knots or high areas is not permissible. Treat imperfections in cement-stabilized bases as required in **Section 307** or **308** as applicable.

501.4.4.2 Form Setting

- 1 After the forms have been set to the correct grade, thoroughly tamp the subbase mechanically or by hand at both the inside and outside edges of the base of the forms. No settlement or springing of forms under the finishing machine is permissible.
- 2 Stake forms into place with not less than 3 pins for each 10-foot section. Place a pin at each side of every joint. Tightly lock form sections so that they are free from play or movement in any direction. Ensure that the forms do not deviate from true line by more than $\frac{1}{4}$ inch at any point. Ensure that forms are cleaned and oiled before the placing of concrete.
- 3 Set and maintain sufficient forms and conduct operations so that the final minor corrections, compaction of base, and checking and approval of forms is complete at least 800 feet in advance of the point of depositing concrete when that distance is available.

501.4.4.3 Removing Forms

- 1 Except for auxiliary forms used temporarily in widened areas, do not remove forms from freshly placed concrete until it has cured at least 8 hours. Removal of forms at the end of contraction joints to be sawed may occur as soon as joints can be sawed without raveling. Under no circumstance use form pullers that depend on the new pavement for support. As soon as the side forms have been removed, fill any minor honeycombed areas with mortar composed of 1-part Portland cement to 2-parts fine aggregate by weight. Major honeycombed areas are considered defective work requiring removal and replacement. Immediately after the forms have been removed, spray the sides of the slab with curing compound at the appropriate rate.

501.4.5 Handling, Measuring, and Batching Materials

- 1 In stockpiling aggregates, the location and preparation of the sites, the minimum size of the stockpile, and the method adopted to prevent coning or other segregation of component sizes is subject to the approval of the RCE. Build up stockpiles in layers of not more than 3 feet in thickness. Ensure that each layer is completely in place before beginning the next. Do not allow subsequent layers to cone down over the previous layer. Under no circumstances will coning of stockpiles be acceptable. Do not stockpile aggregates from different sources together unless previously approved by the RCE. Clear vegetation and other extraneous materials on the area on which materials are to be stockpiled and ensure that it is smooth, firm, and well drained.
- 2 Move aggregates from stockpiles or other sources to the batching plant in a manner to secure a uniform grading of the material. Do not use aggregates that have become segregated or mixed with earth or foreign material.
- 3 Stockpile or bin for draining at least 12 hours before batching aggregates that have been produced or handled by hydraulic methods and all washed aggregates. Rail shipments requiring more than 12 hours are acceptable as adequate binning only if the car bodies permit free drainage. In case the aggregate contains high or non-uniform moisture content, the RCE may require storage or stockpile periods in excess of 12 hours.
- 4 Separately weigh the fine aggregate and coarse aggregate into the hopper in the respective amounts set by the appropriate job mix. Measure cement, fly ash, and slag by weight in scales and hoppers separate from the aggregate scales and hoppers. Ensure that this equipment is equipped with devices to positively indicate the complete discharge of each batch of material into the mixer.
- 5 When mixing is done at the job site, transport materials from the batching plant to the mixer in vehicles conforming to the requirements specified in **Subsection 501.3.5.3**. Use a suitable method of handling the cement from the weighing hopper to the transporting container or into the batch itself for transportation to the mixer (with chute, boot, or other approved device) to prevent the loss of cement. Arrange to provide positive assurance of the actual presence in each batch of the entire cement content specified.

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- 6 In the dry batch process, transport bulk cement to the roadside paver in watertight compartments carrying the full amount of cement required for the batch or, if permitted, between the fine and coarse aggregate. Batches where cement is placed in contact with the aggregates are unacceptable unless mixed within 1½ hours of such contact.
- 7 Deliver dry batches to the mixer separately and intact. Dump each batch into the mixer without loss of cement and, when more than one batch is carried on the truck, without spilling of material from one batch compartment into another.
- 8 Measure water either by volume or by weight. Ensure that the water-measuring equipment is accurate to within ±1.0% and arranged so that the measurement is unaffected by variations of pressure in the water supply line and is accurate under all construction conditions encountered. Unless the water is weighed, ensure that the water-measuring equipment includes an auxiliary tank from which the measuring tank is filled. Ensure that the measuring tank is equipped with an outside tap and valve to provide for checking the setting unless other means are provided for determining the amount of water in the tank readily and accurately. Make certain that the volume of the auxiliary tank is at least equal to that of the measuring tank.
- 9 Use methods and equipment for adding the air-entraining agent or other admixtures into the batch meets the requirements of **Subsection 701.4.3.4**. Do not use equipment that does not accurately and continuously dispense the correct amount of admixture.

501.4.6 Weather and Lighting Conditions

- 1 Undertake no concrete operations until the air temperature in the shade and away from artificial heat is at least 35°F and rising and is predicted by the National Weather Service to exceed 40°F the same day. Cease concrete operations when the temperature is below 41°F and falling or when the temperature is expected to drop to 32°F within 4 hours. If the temperature falls unexpectedly below 32°F before the concrete has hardened sufficiently to resist injury from frost action during the early curing stages, provide sufficient insulated curing blankets to cover the vulnerable area. Regardless of the temperature at the time of placement, remove and replace any concrete injured by frost action without additional compensation. Under any circumstances, do not mix concrete when either the coarse or the fine aggregate contains frozen particles.
- 2 Mix concrete in such quantities that are required for immediate use. Concrete that has stood, after mixing and before placing, until its consistency is below the limits specified or is not plastic and workable is not acceptable for use in the work. Mix concrete in quantities that placement, finishing, and application of curing membrane are completed during daylight unless an adequate artificial lighting system is operating and approved by the RCE.

501.4.7 Mixing Concrete

- 1 Mix the concrete at the work site, in a central-mix plant, in truck mixers when allowed, or in a roadside paver.

501.4.7.1 Central Plant Mixing

- 1 Conduct plant operations in a manner that meets the requirements specified in **Subsection 701.4.4.4** and the additional requirements or changes as set forth below.

501.4.7.1.1 Mixing Time

- 1 When using a mixer having a rated capacity greater than 2 cubic yards, mix the concrete for at least 90 seconds. Add any charging time in excess of 20 seconds to the required 90 second mixing time. The RCE may require a longer mixing time, if necessary, to produce a homogeneous mass. The RCE, in consultation with the SME, may decrease the required mixing time to 60 seconds if shown that the decreased time produces a mixture that is thoroughly mixed and indistinguishable from satisfactory concrete mixed for 90 seconds or more.

501.4.7.1.2 Overload

- 1 The RCE may permit overloads up to 10% above the mixers' nominal capacity provided concrete strength test data, segregation, and uniform consistency is satisfactory and no spillage of concrete occurs.

501.4.7.1.3 Elapsed Time

- 1 Transport mixed concrete from the central-mixing plant in truck mixers, truck agitators, or non-agitating trucks. Do not allow the time elapsed from the addition of water to the mix to the deposition of concrete in place to exceed 30 minutes when the concrete is hauled in non-agitating trucks, or 60 minutes when hauled in truck mixers or truck agitators. Under unusual conditions and depending upon ambient temperature, the RCE may allow a slight increase in the elapsed times specified above provided the slump of the concrete, without re-tempering, is not less than the average slump for the concrete previously placed, and from visual inspection, the concrete is otherwise satisfactory.

501.4.7.2 Truck Mixing

- 1 Use truck mixers meeting the requirements specified in **Subsection 701.4.4.5**.

501.4.7.3 Roadside Paver Mixer

- 1 For concrete mixed at the work site in roadside pavers, the mixing time is measured from the time that all materials, except water, are in the drum. Ensure that the mixing time is not less than 60 seconds. Add 4 seconds to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is considered part of the mixing time. Ensure

that the contents of an individual mixer drum are removed before a succeeding batch is introduced. Unless otherwise permitted, operate the mixer outside the lane of pavement being placed.

- 2 Operate the roadside mixer at a drum speed as shown on the manufacturer's nameplate on the approved mixer. Discard and dispose of any concrete mixed less than the specified time. Do not allow the volume of concrete mixed per batch to exceed the mixer's nominal capacity in cubic feet shown on the manufacturer's AGC standard rating plate on the mixer; except that an overload up to 10% above the mixer's nominal capacity is permitted if the concrete strength test data and the segregation and uniform consistency are satisfactory and no spillage of concrete takes place.
- 3 Charge the batch into the drum such that a portion of the mixing water enters in advance of the cement and aggregates. Ensure that the flow of water is uniform and all water is in the drum by the end of the first 15 seconds of the mixing period. Keep the throat of the drum free of such accumulations that may restrict the free flow of materials into the drum.

501.4.8 Placing Reinforcing Steel

- 1 Provide load transfers shown on the Plans at bridge ends, for the two approach slabs at each bridge end, for successive slabs adjacent to the approach slabs at each bridge end, and at other locations indicated on the Plans. The spacing of the joints on the successive slabs adjacent to the reinforced approach slabs may be varied to compensate for any added distances to accommodate the reinforced approach slabs. The minimum width of any reinforced slab is 16 feet, and the maximum length is 20 feet unless shown otherwise on the Plans. Place other steel in accordance with the Plans.
- 2 When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement, or it may be placed by approved mechanical methods.
- 3 Ensure reinforcing steel and tie bars are free from dirt, harmful rust, scale, paint, grease, oil, or any other harmful material that could impair bond of the steel with the concrete.
- 4 Place dowel bars and tie bars as shown on the Plans.

501.4.9 Placing Concrete

- 1 Once the placing of concrete has begun, ensure that the amount of equipment and supply of materials is sufficient to allow continuous placement for the working period.
- 2 Deposit the batches in a manner requiring as little re-handling as possible. When necessary, perform re-handling with rakes. Do not allow workers to walk on the fresh concrete with footwear coated with earth or other foreign matter.
- 3 Take necessary precautions to prevent segregation of the concrete ingredients while being placed. Provide baffles or other satisfactory equipment in

the discharge end of depositing equipment if considered necessary by the RCE. Keep all conveying equipment clean.

- 4 Place concrete over and against the joints in such a manner to ensure that joints, dowel bars, and load transfer assemblies are retained in correct position.
- 5 Perform continuous placement between transverse joints without the use of intermediate bulkheads, except as provided below for construction joints.
- 6 Thoroughly consolidate concrete against the faces of all forms and joints, including concrete in a previously constructed lane of pavement, by means of vibrators inserted in the concrete. Do not permit vibrators to contact a joint assembly, the grade, or a side form. Do not operate the vibrator more than 15 seconds in any one location. Do not operate the vibrator in a way that brings excess mortar to the surface or causes segregation in the mix. Use vibrators that meet the requirements specified in **Subsection 501.3.9.2**.
- 7 Do not place concrete around a manhole or similar structure until it has been adjusted to proper grade and alignment and keep the casting surrounded by the preformed joint material required in **Subsection 501.2.6.1**.
- 8 Where concrete is placed adjacent to a previously constructed lane of concrete pavement, wait until the previously constructed concrete is at least 10 days old, has obtained a flexural strength of at least 500 psi shown by tests of standard specimens, or has obtained a compressive strength of 3000 psi shown by tests of 6 inch by 12 inch cylindrical specimens. On areas where hand methods of placing and finishing are allowed in **Subsection 501.4.10**, the fresh concrete may be placed when the previously constructed concrete is 5 days old. When calculating the age of the concrete, do not count the time that the air temperature is below 40°F. Repair or replace any damage caused by the operation of mechanical equipment on existing pavement lanes at no cost to the Department. If concrete material falls on or is worked into the surface of a completed slab, remove the material immediately by approved methods to the satisfaction of the RCE.
- 9 In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently set, have available at all times the necessary material for the protection of the surface and edges of the fresh concrete. When rain appears imminent, cease all paving operations and direct all available personnel to begin placing materials to protect the surface and edges of the fresh concrete. Immediately after the rain ceases, make all repairs to pavement damage caused by the rain, as directed by the RCE.

501.4.10 Final Strike-Off, Consolidation, and Finishing

501.4.10.1 Consolidation and Strike-Off

- 1 Construct main line pavement and interchange ramp pavement using one or more finishing machines meeting the requirements of **Subsection 501.3.9.1**. Use approved equipment designed to strike-off, consolidate, and finish the concrete pavement. As soon as it is placed and vibrated, strike-off

the concrete accurately and screed with approved equipment, so that when it is consolidated and finished, the surface of the pavement will have the required elevation and cross-section.

- 2 Carry a sufficient and uniform amount of concrete in front of the screed to fill all voids and depressions. Do not allow the rate of placement to exceed the finishing capacity of the single or multiple finishing machines being used.
- 3 Control the operations so that an excess of mortar and water is not worked to the top. Thoroughly hand-mix segregated particles of coarse aggregate that may have collected in front of the screed with the unfinished concrete already on the subgrade. Do not allow the finishing machine to carry aggregate particles forward and push onto the subgrade in front of the mass. Operate the finishing machine in a manner that prevents damage to joint installations or to an existing adjacent slab.
- 4 Do not use hand methods of placing, compacting and finishing except as follows:
 - When breakdowns of the finishing machine or other emergency occur, and then only for the concrete already mixed or in the process of mixing.
 - On widened portions at bridges, intersections, and portions widened beyond traffic lanes.
 - Where the dimensions of the work make the use of power-operated machinery impracticable.
 - At other places permitted by the RCE or these specifications.
- 5 Where hand methods are used, tamp the concrete to ensure maximum compaction and a minimum of voids. Level the concrete slightly above the required finished surface. Then, strike-off the concrete to the true surface using a strikeboard with a rigidly attached mechanical vibrator capable of imparting impulses at a rate of not less than 3500 per minute. Move the strikeboard forward with a combined longitudinal and transverse motion and with both ends resting on the forms. Cover the entire area a sufficient number of times, but not less than 2, and at intervals that produce the desired results. Carry a slight excess of concrete ahead of the cutting edge.

501.4.10.2 Floating

- 1 After the concrete has been struck-off and consolidated, further smooth and true the surface by means of an approved longitudinal float or an approved transverse smoothing float.

501.4.10.2.1 Hand Methods

- 1 Use hand methods only if specifically permitted by the RCE. Use hand-floats not less than 14 feet long and 6 inches wide, properly stiffened to prevent warping and flexibility, and reasonably light to prevent the float from working into the surface. Only use floats that are in good condition.

- 2 Perform floating in an approximately longitudinal direction from one edge to the other. Work the float along the surface with a sawing motion to each edge and with the forward operator slightly ahead. After each complete transverse operation, provide a 1/2 lap longitudinally. Support the operators handling the float by bridges that are entirely clear of the surface of the pavement.

501.4.10.2.2 Transverse Smoothing Float

- 1 Provide a machine-operated transverse smoothing float with a smoothing float suspended from and guided by a rigid frame. Make certain that the forms carry the frame and that it has a minimum effective wheelbase of 14 feet. Ensure that the length of the float is approximately 2 inches less than the normal width of the pavement and is adjusted to the required crown. Adjust the weight of the float and coordinate it with the finishing screed ahead so a small amount of mortar is carried ahead of the float at all times.
- 2 Adjust the forward speed of the float to minimize starting and stopping.
- 3 If necessary, following one of the preceding methods of floating, use long-handled floats having blades no less than 5 feet long and 6 inches wide to smooth and fill in open textured areas in the pavement. Do not use long-handled floats to float the entire surface of the mainline pavement instead of or supplementing one of the preceding methods of floating. On pavement other than mainline pavement, floating may be done with a long-handled 10-foot long by 4-inch to 6-inch wide float.

501.4.10.3 Checking and Surface Corrections

- 1 As soon as the longitudinal or final floating is complete, work all laitance, surplus water, and inert material off the surface. Make the surface smooth by a scraping or dragging motion with the long-handled 10-foot straightedge. Place this straightedge at the center of the pavement with the blade parallel to the centerline and then, pull slowly and uniformly to the edge. Next, move the blade forward 1/2 of its length and repeat the operations until the surface is free from irregularities and makes contact with the blades at all points.
- 2 During this checking operation, fill and strike-off with fresh concrete any remaining depressions. Remove projections and continue the checking and correcting until the surface has the required smoothness and contour. Take care to preserve the required crown.
- 3 In general, do not add superficial water to the surface of the concrete to assist in finishing operations. If the RCE permits the application of water to the surface, apply as a fog spray by means of approved equipment.

501.4.10.4 Final Finishing

- 1 Refer to **SC-M-502** for requirements on final finishing.

501.4.10.5 Edging at Forms and Joints

- 1 Before the concrete has taken its initial set, work the edge of the pavement along each side of each slab and on each side of formed joints with an ap-

proved tool rounded to the radius required by the Plans. Produce a well-defined and continuous radius and obtain a smooth dense mortar finish. Take care not to disturb the surface of the slab by tilting of the tool during use.

- 2 At all joints, eliminate any tool marks appearing on the slab adjacent to the joints by brooming the surface. In doing so, do not disturb the rounding of the corner of the slab. Completely remove all concrete on top of the joint filler.
- 3 Test all joints with a straightedge before the concrete has set and make correction if one side of the joint is higher than the other side is or if they are higher or lower than the adjacent slabs.

501.4.11 Curing

- 1 Immediately after the finishing operations have been completed and immediately after the surface water has disappeared, cure the entire surface of the concrete pavement by mechanically applying a uniform coating of white-pigmented curing compound.
- 2 If the compound is not applied immediately, keep the surface thoroughly wetted with water fog until the application of the compound is started. Protect joints by an approved method so that the compound does not enter the joint. Apply the white-pigmented compound in 1 or 2 applications as required by the manufacturer's recommendations or as directed by the RCE. When applied in two applications, make the second application within 30 minutes of the first.
- 3 Apply the compound in a continuous uniform film by means of a power-operated pressure spraying or distributing equipment at the approved rate, but not less than 0.06 gallon per square yard of surface. Ensure that the equipment for applying the compound provides adequate agitation of the compound during application and is approved before work is started. If the compound is too thick for satisfactory application during cold weather, warm the material in a water bath with a temperature not exceeding 100°F. Do not thin the compound with solvents. If the method of applying the compound produces a non-uniform film, make immediate corrections.
- 4 If rain should fall on the newly coated pavement before the film has dried sufficiently to resist damage or if the film is damaged in any other way, apply a new coat of material to the affected areas equal in curing value to that specified for the original coat. Protect the treated surface from damage until the expiration of the curing period. All vehicles and pedestrian traffic are considered injurious to the film of the applied compound and are prohibited from using the pavement. However, a minimum of walking is permitted on the dried film as necessary to carry on the work properly if damage to the film is repaired immediately by the application of a second coat of the compound. If there is a breakdown of the spraying equipment, provide protection of the uncoated pavement until coating is complete.

501.4.12 Protection of Pavement

- 1 Exclude all vehicle traffic from the newly constructed pavement for a period of not less than 14 days, unless the RCE directs that sections may be opened

to traffic at an earlier date. Do not count the time during the curing period when the atmospheric temperature is below 40°F. Count the time when the temperature is in the range of 40°F to 50°F at only 1/2 of the actual time.

- 2 When using concrete that contains Type III cement, cure for a period of 48 hours in the manner specified or until field-cured test specimens indicate a flexural strength of 450 psi or as otherwise specified, whichever is greater. The facility may then be opened to traffic unless weather or other conditions make it advisable to extend this time.
- 3 When required by the RCE, erect and maintain suitable barricades and furnish satisfactory and competent personnel to exclude traffic from the newly constructed pavement for the period prescribed. Arrange the barriers so that they do not interfere with or impede public traffic on any open lane. Maintain the signs, barricades, and lights necessary to clearly indicate the lanes open to traffic. If it becomes necessary to move traffic across a lane of pavement from which traffic must be temporarily prohibited, construct suitable and substantial crossings to bridge over the concrete at no additional cost to the Department. Ensure that these crossings are adequate for traffic and satisfactory to the RCE. Repair or replace, in a satisfactory manner, any part of the pavement damaged by traffic or other causes that occur before its final acceptance. Perform the crossing and pavement repair or replacement without cost to the Department.
- 4 Maintain all ditches and drains to provide effective drainage.
- 5 If directed by the RCE, place and maintain a berm of earth adjacent to the pavement edges to prevent underwash of the pavement slab.

501.4.13 Joints

501.4.13.1 General Requirements

- 1 Construct longitudinal and transverse joints at the locations and in accordance with the dimensions and other requirements shown on the Plans or in the Special Provisions. Cut all joints using a diamond-bladed saw; parting strips and tooling are not acceptable.
- 2 Construct longitudinal joints parallel to the pavement centerline unless otherwise required. Construct transverse joints at right angles to the pavement centerline and extending the full width of the pavement. Construct all joints true to line with their faces perpendicular to the pavement surface.
- 3 When the pavement is placed in lanes or partial width slabs, or when existing pavement is widened, place transverse joints in line with like joints in the adjacent pavement unless otherwise shown on the Plans.
- 4 When keyed construction joints are required, construct the key by fastening a wooden strip or a deformed metal plate to the form to produce a continuous keyway conforming to the dimensions shown on the Plans. When the adjacent slab of concrete is placed, carefully consolidate it by vibrating or spading along the edge to ensure the forming of the key portion of the joint without

pockets or honeycomb.

- 5 When deformed steel bars are used in keyed joints or in plain butt-type construction joints, they may be bent at right angles against the form of the first lane or portion constructed and straightened into final position before the concrete of the adjacent lane or section is placed.
- 6 Place dowel bars across transverse joints at locations and in accordance with details shown on the Plans. Hold dowels in position, parallel to the surface and centerline of the pavement, with an approved metal dowel support that will remain in the pavement. Automated dowel bar insertion may be used with the advance approval of the RCE in consultation with the SME. Ensure that the dowels are coated with a bond breaking coating as required in **Subsection 501.2.7** to permit free horizontal movement at the transverse joint.
- 7 When used in expansion joints, provide dowel assemblies with one end of each dowel treated and capped with a close fitting, closed end, metal sleeve as required in **Subsection 501.2.7**.
- 8 Use preformed expansion material in expansion joints that is prepared in accordance with **Subsection 501.2.6.1** and placed perpendicular to the pavement surface.

501.4.13.2 Longitudinal Joint

501.4.13.2.1 General

- 1 Construct longitudinal joints in all concrete pavement 16 feet or more in width. If a particular type is not specified, use a sawed joint.
- 2 Place tie bars of the specified length, size, spacing, and material in all longitudinal contraction and longitudinal construction joints. Place the bars perpendicular to the longitudinal joints. Place the bars using approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement.

501.4.13.2.2 Longitudinal Sawed Joints

- 1 Cut longitudinal sawed joints by means of approved concrete saws to the depth, width, and line shown on the Plans. Use suitable guides or devices to ensure cutting the longitudinal joint on the true line shown on the Plans. Saw the longitudinal joint before the end of the curing period, or immediately thereafter, and before any equipment or vehicles are allowed on the pavement. Seal the joint as required in **Subsection 501.4.14**.
- 2 When adjacent lanes are constructed separately, and where required by the Plans, secure a trapezoidal keyway of the dimensions shown on the Plans to the side forms along the longitudinal joint. Tie bars may be two-piece bolt assemblies of a type and size approved by the RCE or deformed bars bent at right angles against the form at the first lane constructed and bent back without breaking into final position before the concrete is placed in the adjacent lane. Ensure that longitudinal joints so constructed are free of surface fins

extending beyond the vertical face of the joint and are sawed and sealed as specified above.

501.4.13.2.3 Longitudinal Weakened Plane Joints

- 1 Weakened plane joints (parting strips) are not permitted.

501.4.13.3 Expansion Joints

- 1 Construct expansion joints of the types specified, at the locations shown on the Plans, or as directed by the RCE. Furnish and place dowel bars, if required, in accordance with the requirements specified in **Subsection 501.4.13.1** above. If using premolded joint filler, ensure that it is appropriately punched to admit the dowels.
- 2 Use expansion joint filler that is continuous from form to form and shaped to the subgrade and to the keyway along the form. Furnish preformed joint filler in lengths equal to the pavement width or equal to the width of one lane. Do not use damaged or repaired joint filler unless approved by the RCE.
- 3 Ensure that the expansion joint filler is held in a position normal to the surface. Use an approved installing bar or other device, if required, to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Allow finished joints to deviate not more than $\frac{1}{4}$ inch in the horizontal alignment from a straight line. If joint fillers are assembled in sections, do not allow offsets between adjacent units. Plugs of concrete are not permitted anywhere within the expansion space.
- 4 Transverse expansion joints are not required unless otherwise specified on the Plans. Ensure that transverse expansion joints have a thickness of 1 inch unless otherwise specified.

501.4.13.4 Transverse Contraction Joints

- 1 Construct transverse contraction joints to the dimensions, lines, and spacing shown on the Plans. Only sawed transverse contraction joints are permitted. The forming of joints by using preformed parting strips of any kind is prohibited. Construct sawed joints as follows:
 - Establish sawed contraction joints by sawing grooves in the surface of the pavement with an approved concrete saw. After each joint is sawed, thoroughly clean the saw cut and adjacent concrete.
 - Commence sawing of the joints as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually 4 to 6 hours. Some raveling of the green concrete is desired in order for the sawing process to prevent uncontrolled shrinkage cracking.
 - If sharp-edged joints are being obtained, expedite the sawing process to the point where some raveling is observed.
 - Continue this process during the day and night regardless of the weather conditions until all joints in the day's paving have been sawed.

- In case the sawing procedure is delayed due to emergency or equipment failure, saw every third transverse joint as a control system to prevent cracking until raveling is again observed. Complete the intermediate saw cuts immediately.
- If uncontrolled cracking is observed due to late sawing, replace the affected pavement at no cost to the Department and as instructed by the RCE.

501.4.13.5 Transverse Construction Joints

- 1 Make transverse construction joints whenever placing of concrete is suspended longer than 30 minutes. Position the joint at a point midway between transverse contraction joints unless directed by the RCE. To form the joint, accurately set a suitable and satisfactory header board, which is cut to the required cross-section and drilled at 12-inch intervals to receive tie bars of the same size and length used in the longitudinal contraction joint and securely held in a plane perpendicular to the surface. Install the tie bars in the drilled holes and thoroughly vibrate the concrete.
- 2 When the placing of concrete is resumed, carefully remove the header board and remove any surplus concrete on the subgrade. Deposit fresh concrete against the previously placed concrete and finish the surface across the joint true to grade and cross-section. The joint does not require sawing or joint sealant just neatly finish the joint.

501.4.14 Sealing Joints

501.4.14.1 Cleaning and Preparing Joints

- 1 After curing is completed, perform a second sawing operation to create an appropriate sealant reservoir and fill both longitudinal and transverse contraction joints with the specified sealant. Create the required joint configuration by a second sawing operation to receive the sealant as shown on the Plans. Unless otherwise specified or shown on the Plans, ensure that the final sealed surface width of all newly constructed longitudinal and transverse contraction joints is $\frac{3}{8}$ -inch. Immediately following the second sawing operation, flush the joint with a high-pressure water jet to remove the slurry and any loose material from the joint faces. Wash joint in one direction to prevent recontamination.
- 2 Once the joint is completely dry and before final cleaning begins, abrasion blast the joint to remove contaminants, including membrane-curing compound. Perform blasting in two passes, one for each face, with the nozzle held at an angle to the joint face and within 1 to 2 inches from the pavement. Conduct blasting the same day as the sealing operation and repeat if rain showers occur between initial blasting and sealing.
- 3 Blow the blast material as well as dust and dirt deposited by wind and traffic out of the joint and away from the area around it using a high-pressure air blast. Use an air compressor producing a pressure of at least 90 psi and

equipped with traps capable of removing moisture and oil from the compressed air. As with the water, move the air blast in only one direction to prevent recontamination of the joint.

- 4 Inspect joints for proper width, depth, alignment, and preparation and obtain approval from the RCE before installation of sealant. Ensure all joints to be sealed are sound, clean, dry, and frost free as proper joint preparation is essential to proper long-term sealant performance. Just before placement of the backer rod or neoprene sealant, judge the cleanliness of the joint walls by rubbing a finger or clean cloth across the dry joint face to ensure that residual cement and/or dust has been removed. Re-clean any joints that still contain dust or have become dirty or contaminated until no residue appears on a finger or clean cloth rubbed across the joint face.

501.4.14.2 Installation of Sealants

- 1 Unless otherwise shown on the Plans or indicated in the contract document, select a sealant type in accordance with **Subsection 504.2.1**. After cleaning has been completed, place the backer rod (where applicable) at the proper depth to form the bottom of the seal. Make certain that the backer rod or other bond-breaker is compatible with the sealant. Use installation methods and equipment in accordance with the manufacturer's recommendations. Make the backer rods leak proof where required by caulking with a silicone product compatible with the sealant used.
- 2 When using a liquid sealant, place the sealant in the joint in accordance with the Plan configuration by means of an appropriate pump equipped with a nozzle that is narrow enough to place the material in the joint from the bottom up. Place the material to establish a surface profile at the desired depth below the surface of the pavement. Ensure that all equipment for placing the seal and methods of placement are in accordance with the sealant manufacturer's recommendations.
- 3 Perform the final cleaning, placing of the backer rod, and placing of the sealant in a continuous operation. Once the final cleaning and sealing operation has begun on a section of pavement, do not allow traffic, construction vehicles, or other equipment on that section of pavement for a minimum of 2 hours or until the sealant material has cured.
- 4 If the RCE determines that a joint is not properly sealed, remove the sealant for the full sealant depth and thoroughly clean and reseal in accordance with this specification at no expense to the Department. Once all obvious defects have been corrected, the final acceptance of the joint sealants will be delayed for 180 days after the date of the final sealant installation to permit the RCE to observe the sealant performance. If, in the opinion of the RCE, any joints fail to perform properly during the 180-day period due to defects in workmanship or materials, repair the joints as specified above at no additional expense to the Department.
- 5 Immediately remove any material spilled on the pavement. Do not use solvents to remove spills.

501.4.14.3 Installation of Silicone Sealant

- 1 Connect the power extrusion pump to either the drum or pail of sealant. Properly connect all seals on the drum, pail, hoses, and hose connections to prevent moisture permeation. Clean all hoses and connections to ensure that blockage from prematurely cured sealant have not occurred. After the final cleaning of the joints, install the backer rod to the proper depth. The depth is measured from the pavement slab surface to the top of the backer rod. Install the sealant in a single continuous pass from the bottom to the top of the joint. Tool the sealant to the desired depth and joint configuration and cure to a tack free condition before allowing traffic on it.

501.4.14.4 Installation of Neoprene Compression Seals

- 1 When using preformed neoprene compression seals, install the joint seal in accordance with the manufacturer's recommendations. Provide a copy of the manufacturer's installation instructions to the RCE before any installation of joint seals. If the manufacturer's installation or joint preparation instructions conflict with these specifications, obtain approval from the RCE before commencing installation.

501.4.15 Requirements for Smoothness and Rideability

- 1 Ensure that smoothness and rideability conform to the requirements found in **SC-M-502**.

501.4.16 Repair of Random Cracking

- 1 Remove and replace areas of random cracking determined by the RCE to be detrimental to the concrete pavement. Perform this work at no additional cost to the Department.
- 2 When removal is required, remove the entire slab for the full width and length. Additional requirements for smoothness in the area of replaced slabs may be required.

501.4.17 Slabs Adjacent to Bridge Ends and Bar Mat

- 1 Construct the length of the first and second slab section from bridge ends to the length indicated on the Plans and containing bar mat reinforcement as shown on the Plans. The length of the slab adjacent to skewed bridge ends is measured along the centerline of the slab. Increase or decrease the left side or right side of this slab as necessary to conform to the bridge skew.
- 2 The thickness of the two approach slabs at each bridge end may exceed the slab thickness of the remainder of the road. Construct the thickness in accordance with the Plans. For measurement purposes, the additional thickness is converted to equivalent square yards of slab of the nominal plan thickness. No direct payment is made for furnishing and placing reinforcing steel mat reinforcement in approach slabs.

501.4.18 Tapers at Acceleration and Deceleration Lanes

- 1 Use the method of widening for tapers shown on the Plans or as approved by the RCE.

501.4.19 Adjacent Lane Construction

- 1 Unless otherwise shown on the Plans or in the Special Provisions, construct the pavement in double lanes, which means two adjacent lanes paved in a single operation. Whenever possible, operate the concrete transport vehicles or roadside pavers on the subbase or shoulder adjacent to the lanes being paved. If there is insufficient unpaved width adjacent to the last strip to be paved, operate the equipment on a newly paved strip with approval of the RCE. Make a written request and secure written approval for such operation. Include in the request the kind, size, and type of equipment; the proposed size of batch; and the safeguards to prevent damage to the existing pavement.

501.4.20 Pavement Thickness Tolerance

- 1 Refer to **SC-M-503** for requirements regarding pavement thickness tolerance.

501.5 Measurement

- 1 The quantity for the pay item Portland Cement Concrete Pavement (of the uniform thickness specified) is the surface area of Portland cement concrete pavement of normal the width of through-lane pavement constructed and is measured by the square yard (SY), complete in-place, and accepted. Pavement constructed outside the area designated for pavement is disregarded in computing the quantity for payment.
- 2 The quantity for the pay item Portland Cement Concrete Pavement for Ramps (of the uniform thickness specified) is the surface area of Portland cement concrete pavement of ramps, acceleration and deceleration lanes, tapers, widened areas, and configurations necessary for the interchange of traffic other than the normal width of the through lanes and is measured by the square yard (SY), complete in-place, and accepted.
- 3 Adjacent to bridge ends, over trenches, and at other places where the RCE authorizes the thickness to be other than that shown on the typical cross-section, the volume of concrete pavement authorized, actually placed, and accepted is converted into equivalent square yards of the typical pavement as shown on the Plans.
- 4 Wire mesh, bar mat reinforcing steel, tie bars, dowels, load transfer devices, joint sealant, other materials and labor are considered as an incidental part of the work for this item and are not measured separately. No direct payment is made for these items.

501.6 Payment

- 1 Payment for the accepted quantities for Portland Cement Concrete Pavement (of the uniform thickness specified) or Portland Cement Concrete Pavement for Ramps (of the uniform thickness specified), measured in accordance with **Subsection 501.5**, is determined using the contract unit bid price for the applicable pay item.
- 2 Payment is full compensation for constructing Portland cement concrete pavement as specified or directed and includes providing, batching, mixing, transporting, pouring, striking-off, floating, finishing, curing concrete pavement; providing formwork and admixtures; constructing joints and installing joint material; sawing and sealing joints; furnishing and placing of wire mesh, bar mat reinforcing steel, tie bars, load transfer devices, and dowels; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Pavement that is deficient in thickness, but permitted to be left in place, is paid at the reduced unit price or deducted as provided in **SC-M-503**. Reductions for deficient thickness are entered on the estimate after the information becomes available.
- 4 No compensation is made for the materials or labor involved in the removal, repair, or replacement of defective slabs.
- 5 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 6 Pay items under this section include the following:

Item No.	Pay Item	Unit
5011100	Portland Cement Concrete Pavement 8" Uniform	SY
5011200	Portland Cement Concrete Pavement 9" Uniform	SY
5011300	Portland Cement Concrete Pavement 10" Uniform	SY
5011400	Portland Cement Concrete Pavement 11" Uniform	SY
5011500	Portland Cement Concrete Pavement 12" Uniform	SY
5011600	Portland Cement Concrete Pavement 13" Uniform	SY

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Item No.	Pay Item	Unit
5011800	Portland Cement Concrete Pavement 16" Uniform	SY
5012100	Portland Cement Concrete Pavement for Ramps (8" Uniform)	SY
5012200	Portland Cement Concrete Pavement for Ramps (9" Uniform)	SY
5012300	Portland Cement Concrete Pavement for Ramps (10" Uniform)	SY
5012400	Portland Cement Concrete Pavement for Ramps (11" Uniform)	SY
5012500	Portland Cement Concrete Pavement for Ramps (12" Uniform)	SY

SECTION 502

CONCRETE PAVEMENT PATCHING

502.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for replacing full depth pavement slabs on a prepared subgrade or base course in accordance with the Plans and with the applicable requirements of the Special Provisions and **Sections 501, 701, and 702**. Place pavement replacement slabs where distressed concrete has been removed. The replacement slabs range in size from 12 feet wide by a minimum of 6 feet long up to the full slab length for jointed concrete pavements. Patches of continuously reinforced concrete pavements have a minimum dimension of 6 feet in length and width. In all cases, the depth is nominally equivalent to the depth of the existing pavement. See the Plans for additional details.
- 2 The RCE will locate and establish the areas to be replaced by marking on the surface of the existing pavement the boundaries of the area to be patched. The boundaries of the patch area will be of sufficient width and length to ensure that all of the distressed concrete is removed. Transverse boundaries are not necessarily perpendicular to the shoulder in all cases, but are at least 18 inches away from transverse cracks in the good concrete.

502.2 Materials

502.2.1 General

- 1 Use materials that meet the requirements of **Sections 302, 501, 701, or 703**, as applicable.

502.2.2 Portland Cement Concrete

- 1 Use Portland cement Type I or Type III from an approved source listed on the most recent edition of *SCDOT Qualified Product List 6*. Ensure that the minimum cement content for patching concrete is 800 pounds per cubic yard or more. Use a water-cementitious material ratio less than or equal to 0.38. Maintain the water-cementitious material ratio using normal or high range water reducing materials Type F or G from an approved source listed on the most recent edition of *SCDOT Qualified Product List 5*. Use non-chloride accelerators to achieve compressive strength and time of set desired. Use coarse aggregates meeting the gradation of Aggregate No. 56, 57, or 67. Provide an air content of 3% to 6% when tested in accordance with AASHTO T 152.
- 2 Provide a mix design to the SME at the OMR at least 14 days in advance of placement. The SME will review the mix design for compliance with these specifications and report to the RCE whether or not the mix meets the Specification. Uses concrete mixes that meet or exceed the Specifications. It is the responsibility of the Contractor to provide a mix design that gives satisfac-

tory performance as defined in the Specifications. Review of the mix design by the Department in no way relieves the Contractor of this responsibility.

- 3 Provide concrete for patching that develops sufficient strength such that the patch may be opened to traffic within 6 hours of placement. Replace any patch that develops cracking or deformation within 30 days after opening to traffic at no additional cost to the Department.

502.2.3 Reinforcing Steel

- 1 Provide bar mat reinforcing steel, wire mesh, tie bars, and dowel bars as specified in the patching detail included in the Plans and conform to **Subsection 501.2.7**.

502.2.4 Epoxy System

- 1 When an epoxy system is required to anchor dowel bars and tie bars, use a product that meets ASTM C 881, Type 4, Grade 3, Class B or Class C. Provide the RCE with a certification from the manufacturer for each lot number received at the job site. If requested by the RCE, verify that the proposed epoxy system provides adequate pullout resistance by demonstrating the epoxy with a No. 4 tie bar in a scrap section of pavement slab. Provide the equipment to test the pullout strength bearing labels indicating up-to-date calibration by an independent calibration service. Demonstrate that the proposed epoxy system develops an ultimate pullout strength of at least 12,000 pounds at no additional cost to the Department.

502.2.5 Maintenance Stone

- 1 Where maintenance stone is required, use aggregate that meets the requirements of Aggregate No. CR-14 as specified in **Subsection 302.2**. Use aggregates obtained from approved sources as listed on the most recent edition of *SCDOT Qualified Product List 2*.

502.3 Equipment

- 1 Use a water-cooled diamond- or carbide-tipped concrete saw to cut the concrete before any pavement removal to prevent damage to surrounding slabs that are being retained. Use any combination of equipment necessary to minimize damage to the base and subgrade.
- 2 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

502.4 Construction

502.4.1 General

- 1 Conduct the full depth concrete pavement patching work in one lane at a time and in a manner that offers minimum inconvenience to the traveling public. Provide a written *Traffic Control Plan* for approval by the RCE in advance

of starting work that interrupts the normal flow of traffic. Complete work on the inside (passing) lane before the outside (travel) lane work begins. Do not place concrete unless the air temperature meets the requirements of **Subsection 501.4.6**.

502.4.2 Removal of Existing Pavement

- 1 The RCE will locate and establish the areas to be replaced by marking on the surface of the existing pavement the boundaries of the area to be patched. Remove the existing pavement slab by sawing the pavement full depth with a diamond tipped blade, leaving vertical concrete edges. Carbide tipped wheel saws are permitted to within 3 inches of the transverse limits of the patch. Prepare the deteriorated pavement slab for removal by either of the following procedures:
- 2 Procedure 1. Make a ¼-inch wide sawcut the full depth of the pavement in the pavement/shoulder longitudinal joint. Do not damage the shoulder when removing the adjacent pavement slab.
- 3 Procedure 2. Make a sawcut in the shoulder at a distance of 12 inches parallel to the pavement/shoulder longitudinal joint. Sawcut the length of the required pavement patch plus enough distance to accommodate formwork.
- 4 Use Procedure 1 on patches 6 feet to 12 feet in length where the shoulder is not damaged. If the vertical edge of the shoulder is undamaged, the new concrete for the pavement slab may be placed against the undisturbed shoulder.
- 5 After Procedure 2, remove the shoulder material and set a form for a new shoulder pavement joint. When the form is removed and longitudinal drains are to be placed later, repair the shoulder area with temporary material that consists of thoroughly compacted Aggregate No. CR-14, conforming to the requirements of **Subsection 302.2** and topped with an asphalt surface course selected by the RCE. If no drains are required, repair the shoulder area as specified in **Subsection 502.4.9**.
- 6 Take care during the removal of the deteriorated pavement and the placement of new concrete to prevent damage to the vertical sawcut in the existing pavement or to the base material.
- 7 When it is necessary to repair continuously reinforced concrete (CRC) pavement in the areas at or near terminal ends, it is not necessary to remove the terminal end to its full depth. The pavement may be removed to the normal depth of the pavement, taking care to leave the shear steel. If the shear steel is inadvertently removed or damaged, re-establish it by drilling into the terminal end, and epoxy new shear steel equivalent in area to the old shear steel.
- 8 Dispose of the concrete pavement that has been removed in a proper manner.

502.4.3 Base Preparation

- 1 After the deteriorated pavement has been removed, prepare the base and compact it to the depth of the existing pavement. This may require removing some of the existing base material. If poor materials are encountered, remove additional material and establish a new grade depth as directed by the RCE. Use Aggregate No. CR-14 to backfill to the bottom of the existing pavement or use additional depth for the pavement patch as directed by the RCE. Thoroughly compact all materials on which the concrete pavement is placed using vibratory compactors. The saw-water from the pavement removal operations may deteriorate compacted base material in the replacement area. Correct any deterioration of the base before placing new concrete.

502.4.4 Faces of Existing Pavement

- 1 Before placing concrete, thoroughly clean and prepare the faces of the existing pavement to receive the concrete. Repair featheredge spalls by sawing a new face on the existing pavement.

502.4.5 Placing of Reinforcement

- 1 After removing the deteriorated concrete, establish new dowels and tie bars in the vertical faces of the remaining pavement slab by drilling and using epoxy to fix the steel. Establish tie bars and dowel bars as shown in the Plans.
- 2 Install bar mat reinforcing steel or wire mesh as specified on the Plans or in the Specifications. Ensure that reinforcement is securely anchored and held in place to avoid movement during concrete placement.
- 3 Ensure that the smooth dowel bars extending into the patch opening are entirely and uniformly coated with a bond-breaking agent to allow the patch concrete to expand and contract.

502.4.6 Concrete Finishing

- 1 Give the replacement concrete surface a medium broom texture finish to establish a surface similar to the existing pavement and spray with curing compound as specified in **Subsection 702.2.2.11**.

502.4.7 Curing

- 1 Cover freshly placed patches with insulated curing blankets during the curing period when necessary to protect the uncured concrete from low temperatures and to achieve sufficient strength to allow opening to traffic.

502.4.8 Joints

- 1 Seal joints in accordance with the Plans and the requirements of **Section 504**.

502.4.9 Repair of Shoulders

502.4.9.1 General

- 1 Where it is necessary to place side forms adjacent to the shoulder, repair the damaged shoulder. Use a repair method based on type of shoulder in

place and conforming to the following requirements for the type of shoulder material.

502.4.9.2 Asphalt Shoulder

- 1 Repair damaged shoulder with Aggregate No. CR-14 and Hot Mix Asphalt Surface Course - Type C overlay as directed by the RCE.

502.4.9.3 Portland Cement Concrete Shoulder

- 1 Repair Portland cement concrete shoulder with same mix as used in the mainline patching. Coat the surface of the set concrete with a moisture insensitive high-modulus epoxy recommended by the manufacturer for the purpose of bonding fresh concrete to old concrete and certified to meet ASTM C 881, Type V, Grade 1 or 2, Class B or Class C. Deposit concrete in the shoulder area to be patched after the epoxy coating becomes tacky but before it dries.

502.4.10 Opening Pavement to Traffic

- 1 Open the patched pavement to traffic when the concrete has developed sufficient strength. Determination and timing of sufficient strength for opening is the responsibility of the Contractor. If the concrete patch develops any distress or distortion within 45 days after opening to traffic, remove and replace the patched pavement at no additional cost to the Department.
- 2 No sooner than 14 days after the patch has been placed, grind and texture the patch as specified in **Section 503** to provide a smooth surface; however, the rideability of the ground area will not be tested for rideability. Begin grinding operations at a distance before the patch equal to the patch length or 25 feet, whichever is less, and continue the grinding beyond the patch for a like distance. Grind not less than 98% of the target area, with 100% coverage as the target. Perform all grinding at full lane width, regardless of the patch width. Individual patch grinding is not required if the entire roadway is subject to a rideability requirement under the same contract as the patching.

502.5 Measurement

- 1 The quantity for the pay item Full Depth Concrete Pavement Patching (of the thickness specified) is the surface area of full depth concrete pavement patching and is measured by the square yard (SY), complete in-place, and accepted. Patches constructed outside the area designated to be patched are disregarded in computing the quantity for payment

Wire mesh, bar mat reinforcing steel, dowels, tie bars, load transfer devices, and materials and labor used to anchor reinforcement and ties are not measured for payment separately and are considered incidental to complete the patching work and are not measure separately. The cost of this work is included in the contract unit bid price for the concrete patching pay item.

- 2 Adjacent to bridge ends, over trenches, and at other places where the RCE authorizes the thickness to be other than that specified in the Plans, the volume of concrete pavement authorized by the RCE, actually placed, and ac-

cepted is converted into equivalent square yards of the depth of patching as shown on the Plans.

- 3 The quantity for the pay item Portland Cement Concrete (Special Use), is the volume of concrete used to replace deteriorated base course, cement stabilized subbase, and/or subgrade removed as specified and directed by the RCE and is measured by the cubic yard (CY) to the level of the bottom of the concrete pavement, complete in-place, and accepted. If Aggregate No. CR-14 is used for this purpose, it is measured and paid for as specified in **Subsections 302.5 and 302.6.**
- 4 Unless a separate bid item is included in the Contract for temporary or permanent repairs in asphalt shoulders, work and materials for temporary or permanent repairs in asphalt shoulders are not measured for payment, but are considered as an incidental part of the concrete pavement patching work.

502.6 Payment

- 1 Payment for the accepted quantity for Full Depth Concrete Pavement Patching (of the thickness specified) or Portland Cement Concrete (Special), measured in accordance with **Subsection 502.5**, is determined using the contract unit bid price for the applicable pay item.
- 2 Payment for Full Depth Concrete Pavement Patching (of the thickness specified) is full compensation for full depth patching Portland cement concrete pavement as specified or directed and includes sawing patch perimeter; removing and disposing of the existing deteriorated pavement; temporary and permanent repairs to shoulders; reconstructing and sealing joints; providing and installing wire mesh, bar mat reinforcement, dowels, tie bars, and load transfer devices; restoring terminal ends in continuously reinforced pavement; drilling and grouting reinforcement; providing and applying epoxy bonding system for reinforcement anchorage and concrete bonding; preparing the base or subbase; furnishing, placing, finishing, curing, all texturing and diamond grinding, and testing concrete; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for Portland Cement Concrete (Special) is full compensation for replacing existing deteriorated base or subbase material under the removed slab with Portland cement concrete as specified and directed and includes removing and disposing of the deteriorated base or subbase material; compacting the remaining base or subbase as necessary; furnishing and placing the replacement concrete to the bottom of the concrete pavement; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.

502.6

502.6

5 Pay items under this section include the following:

Item No.	Pay Item	Unit
5021011	Full Depth Concrete Pavement Patch - 8"	SY
5021015	Full Depth Concrete Pavement Patch - 8.5"	SY
5021020	Full Depth Concrete Pavement Patch - 9"	SY
5021025	Full Depth Concrete Pavement Patch - 10"	SY
5021030	Full Depth Concrete Pavement Patch - 11"	SY
5021035	Full Depth Concrete Pavement Patch - 12"	SY
5029000	Portland Cement Concrete (Special Use)	CY

SECTION 503

GRINDING AND TEXTURING CONCRETE PAVEMENT

503.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for grinding and texturing Portland cement concrete pavement longitudinally as shown on the Plans or as directed by the RCE.

503.2 Materials

- 1 Conform to the material requirements pertaining to grinding and texturing concrete pavement found in **SC-M-502**.

503.3 Equipment

- 1 Conform to the equipment requirements pertaining to grinding and texturing concrete pavement found in **SC-M-502**.
- 2 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

503.4 Construction

- 1 Conform to the construction requirements pertaining to grinding and texturing concrete pavement found in **SC-M-502**.

503.5 Measurement

- 1 The quantity for the pay item Grinding and Texturing Existing Concrete Pavement is the surface area of grinding and texturing Portland cement concrete pavement and is measured by the square yard (SY, complete, and accepted). Grinding and texturing performed outside the areas designated is disregarded in computing the quantity for payment.

503.6 Payment

- 1 Payment for the accepted quantity for Grinding and Texturing Existing Concrete Pavement, measured in accordance with **Subsection 503.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for grinding and texturing concrete pavement as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for this item includes all direct and indirect costs and expenses necessary to complete the work.

503.6

503.6

3 Pay items under this section include the following:

Item No.	Pay Item	Unit
5031000	Grinding and Texturing Existing Concrete Pavement	SY

SECTION 504

CLEANING AND RESEALING OF JOINTS IN PORTLAND CEMENT CONCRETE PAVEMENT

504.1 Description

- ¹ This section contains specifications for the materials, equipment, construction, measurement, and payment for the rehabilitation of joints and cracks in Portland cement concrete pavements by cleaning, preparing, and placing the specified sealant in conformance with the Plans or as directed by the RCE.

504.2 Materials

504.2.1 General

- ¹ Use materials in this work that meet the requirements of **Section 501**. Select sealant material in accordance with the following table.

Application	ASTM D 6690, Type II Sealant	Silicone Sealants	
		Non-Sag	Self- Leveling
Old Concrete Pavement w/transverse and lane longitudinal joints ¹ , uniform joint widths ³ - no overlay		✓	✓
Old Concrete Pavement w/transverse and lane longitudinal joints ¹ , non-uniform joint widths ³ - no overlay		✓	
Old Concrete Pavement w/transverse and lane longitudinal joints ¹ , to be overlaid with hot mix asphalt	✓		
Concrete Shoulders (with Concrete Pavement) w/transverse and longitudinal joints, uniform joint widths ³ - no overlay		✓	✓
Concrete Shoulders (with Concrete Pavement) w/transverse and longitudinal joints, non-uniform joint widths ³ - no overlay		✓	
Concrete Shoulders (with Concrete Pavement) w/transverse and longitudinal joints, to be overlaid with hot mix asphalt	✓		
New HMA Shoulders (with Concrete Pavement) w/longitudinal joints ²	✓		✓

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Application	ASTM D 6690, Type II Sealant	Silicone Sealants	
		Non-Sag	Self-Leveling
Old HMA Shoulders (with Concrete Pavement) w/longitudinal joints ²	✓		
✓ Denotes acceptable sealant for indicated application 1 Not constructed with the plastic strip. 2 A bond breaker/backer rod is not required. 3 Consider all joints in service more than 10 years to be non-uniform unless otherwise instructed by the RCE.			

504.2.2 Silicone Sealant

- 1 When silicone sealant is used, use material conforming to the requirements of **Subsection 501.2.6.2**.

504.3 Equipment

- 1 When silicone sealant is required, use equipment conforming to the requirements of **Subsection 501.3.16**. When hot-poured sealant is required, use equipment conforming to the requirements of **Subsection 501.3.15**.
- 2 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

504.4 Construction

504.4.1 Preparation of Joints

- 1 Prepare joints by removing all joint material, including sealants, inserts, and any material that may have infiltrated the joint. Remove the existing sealant from the joint using a vertical edge-cutting tool. Use a power driven concrete saw with diamond or abrasive blades to remove all old sealant from the joint faces and expose clean concrete. The use of a plow, hook, or other tool is not acceptable for this operation. Cut the joints to the depth and width necessary to provide the specified dimensions of new joint sealant.
- 2 Immediately following the sawing operations, flush the joints thoroughly with a high-pressure water jet to remove the slurry and any loose material from the joint faces. Perform all joint washing in one direction to prevent recontamination of the joint. When replacing existing pre-formed joints, the sawing and cleaning step may be omitted if a sufficiently clean face can be obtained with abrasion blasting only.
- 3 Once the joint is dry and before final cleaning begins, abrasion blast the joint to remove contaminants. Perform abrasion blasting in two passes, one

for each face, with the nozzle held at an angle to the joint face and within 1 to 2 inches from the pavement. Perform as many abrasion blasting passes as necessary to remove all traces of old sealant or other irregularities that may interfere with the bonding of the new sealant. Perform abrasion blasting the same day as the sealing operation and repeat if rain showers occur between initial abrasion blasting and sealing so that the joint is absolutely dry and clean.

- 4 Blow all blast abrasive, as well as any dust and dirt deposited by wind and traffic, out of the joint and away from the surrounding area using a high-pressure air blast. Use an air compressor that produces a pressure of at least 90 psi and equipped with traps capable of removing moisture and oil from the compressed air. As with the water jet, perform air blast operations in one direction to prevent re-contamination of the joint. Continue air blast or other cleaning operations as necessary until a finger or clean cloth rubbed across the joint face displays no visible dust or contamination.
- 5 The RCE will inspect joints for proper width, depth, alignment, and preparation. Do not begin installing sealant before the joints are inspected and approved by the RCE. Ensure that all joints are sound, clean, dry, and frost free before sealing. Re-clean any joint found to contain dust or that has become dirty or contaminated.

504.4.2 Installation of Silicone Sealant

- 1 After joint cleaning has been completed, place the bond-breaker (bond-breaker tape or backer rod) at the proper depth to form the bottom of the seal. Use bond-breaker that is compatible with the sealant. Perform all installation methods and use equipment in accordance with the manufacturer's recommendations. Make backer rods leak proof where required by caulking with a silicone product compatible with the sealant used. Sealant may be applied with a caulking gun device or a power extrusion pump in accordance with **Subsection 501.4.14.3**.
- 2 Next, place the sealant in the joint in accordance with the plan configuration by means of an appropriate pump equipped with a nozzle that is narrow enough to place the material in the joint from the bottom up. Place the material to establish a surface profile at the desired depth below the surface of the pavement. Use equipment for placing the seal and methods of placement in accordance with the sealant manufacturer's recommendations.
- 3 Perform final cleaning, placing of the bond breaker, and placing of the sealant in a continuous operation. Once the final cleaning and sealing operation has begun on a section of pavement, do not allow construction vehicles or other equipment on the section of pavement for a minimum of 2 hours or until the seal material has cured.
- 4 If the RCE determines that a joint is not properly sealed, remove the sealant for the full sealant depth and thoroughly clean and reseal in accordance with this specification at no additional expense to the Department. Once all obvious defects have been corrected, the final acceptance of the joint seal-

ants will be delayed for 180 days after the date of the final sealant installation to permit the RCE to observe the sealant performance. If, in the opinion of the RCE, any joints fail to perform properly during the 180-day period due to defects in workmanship or materials, repair the joints as specified above at no additional cost to the Department.

- 5 Immediately remove any material spilled on the pavement. Do not use solvents to remove spills.

504.4.3 Installation of Hot Poured Sealants

504.4.3.1 General

- 1 When hot poured sealant, as specified in **Subsection 501.2.6.4** is used, handle and apply it as indicated in **Subsections 504.4.3.1** and **504.4.3.2**.
- 2 Do not store the sealant material in direct sunlight or in an ambient temperature over 100°F, such as under a tarp. Store the material under cover or roof with adequate ventilation. Optionally, the plastic wrap may be left on the as shipped when sealant material is placed into the melter vat.
- 3 Ensure that the melter system is thoroughly clean at the start of work and the pump and sealing hose are flushed out at the end of each day or work period. Material may be left in the vat overnight and used the next day if it has not exceeded the maximum heating time during the previous heating period.

504.4.3.2 Heating

- 1 During the sealing operation, operate the hot poured sealant melter as follows:
 - Initially charge the melter to half of the vat capacity. Once the initial charge has liquefied, the remaining charge may be added.
 - Maintain continuous agitation once the sealant is liquefied.
 - Begin circulation pumping after the sealant has initially liquefied.
 - Add fresh unheated sealant so that the temperature of the heated sealant in the vat does not fall below the recommended application temperature range while the sealant is being applied.
 - Do not heat the sealant beyond its safe heating temperature recommended by the sealant manufacturer.
 - Operate the temperature recorder at all times when the melter is being used. Date the permanent record chart and give it to the RCE each day or chart timing period as requested. The RCE may waive the requirement for continuous temperature recording on new technology pump systems that reasonably ensure low temperature material cannot be applied.
- 2 Do not begin sealing until the liquefied sealant in the melter is at the approximate mid-point of the recommended application temperature range and has been above the minimum working temperature range for 30 minutes or

more.

504.4.3.3 Application

- 1 During the sealing operation, handle and use the hot poured sealant material as follows:
 - Do not begin application until the ambient temperature and groove wall surface temperature is 45°F and rising.
 - Do not apply sealant material when cooler or hotter than the recommended application temperature range.
 - Continuously agitate and circulate the sealant once it is liquefied in the melter.
 - Use a wand tip of a size that will fit into the groove and then place the material from the bottom to the top of the groove. Use tips equipped with a depth gauge to prevent the wand from traveling in the bottom of the groove.
 - Consider the first gallon of material to flow out of the applicator wand at the beginning of the day as spoil, discharge it into a container and discard.
 - Re-heating or prolonged heating at or above the safe heating temperature will cause the sealant to gel in the application equipment. A rapid increase in viscosity and stringiness of the material indicates the approach of gelation. When these conditions occur, stop sealing operations, rapidly pump the remaining material from the kettle into a container and discard.
 - Immediately upon completion of each joint sealing, return the applicator wand to the machine and re-circulate the material.
 - Do not overfill the joints. Clean and reseal overfilled joints as directed by the RCE. The correct level for the top of the seal is ¼ inch below the lower top of joint surface unless otherwise shown on the Plans.

504.5 Measurement

- 1 The quantity for the pay item Clean & Seal Longitudinal Joints, Clean & Seal Longitudinal Shoulder Joints, Clean & Seal Transverse Joints, or Clean & Seal Transverse Joints at Bridge is the length of joint cleaned and resealed and is measured by the linear foot (LF) of joint in place along the surface of the roadway, complete, and accepted.

504.6 Payment

- 1 Payment for the accepted quantity for Clean & Seal Longitudinal Joints, Clean & Seal Longitudinal Shoulder Joints, Clean & Seal Transverse Joints, or Clean & Seal Transverse Joints at Bridge, measured in accordance with **Subsection 504.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for cleaning and resealing joints as specified or directed and includes preparing the joint; installing the proper sealant material; satisfactorily disposing of waste materials; and all

other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

- 2 Payment for each item includes all direct and indirect costs and expenses required to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
5041100	Clean & Seal Longitudinal Joints	LF
5041200	Clean & Seal Longitudinal Shoulder Joints	LF
5041300	Clean & Seal Transverse Joints	LF
5041400	Clean & Seal Transverse Joints at Bridge	LF

SECTION 505

ROUTING, CLEANING, AND SEALING OF RANDOM CRACKS IN PORTLAND CEMENT CONCRETE PAVEMENTS

505.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for routing, cleaning, and sealing cracks with silicone sealant in existing Portland cement concrete pavement. These cracks are random cracks other than the standard crack patterns in continuously reinforced concrete pavement or transverse cracks in jointed concrete pavement. In general, these cracks are usually opened $\frac{1}{8}$ inch or more and are greater than 10 feet in length. The RCE will identify and mark cracks to be rehabilitated.

505.2 Materials

- 1 Use hot-pour sealant and associated materials meeting the requirements of **Section 501**.
- 2 Use blocking medium or backer rod meeting the requirements of **Subsection 501.2.6.3**.

505.3 Equipment

- 1 Use sealing equipment in accordance with the requirements of **Subsection 501.3**. Use a concrete saw with a pivotal small diameter blade that follows the crack to provide a reservoir for sealant material.
- 2 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

505.4 Construction

505.4.1 General

- 1 Prepare cracks by removing any existing sealant, re-facing and cleaning the crack, installing blocking medium as needed, and sealing the crack.

505.4.2 Preparation of Cracks

- 1 Remove old sealant, re-face, and clean cracks in accordance with the applicable requirements in **Subsection 504.4.1**. Widen the cracks to the widths and depths shown in the Plans or as directed by the RCE.
- 2 For cracks $\frac{3}{8}$ inch or greater in width, install a backer rod in the crack at a uniform depth to prevent entrance of the sealant below the depth specified. Use backer rods that are compatible with the sealant and install using the sealant manufacturer's recommendation, taking care not to stretch the rods during installation.

505.4.2

505.6

- 3 For cracks less than $\frac{3}{8}$ inch wide, the use of a blocking medium is optional as long as the seals produced are satisfactory. Should the seals prove to be unsatisfactory, the RCE may require subsequent crack rehabilitation to include installation of blocking medium.

505.4.3 Installation of Sealant

- 1 Install sealant in accordance with **Section 504**.

505.5 Measurement

- 1 The quantity for the pay item Rout, Clean, and Seal Cracks is the sum of the length of rehabilitated and sealed cracks and is measured by the linear foot (LF) along the surface of the concrete pavement, complete, and accepted.

505.6 Payment

- 1 Payment for the accepted quantity for Rout, Clean, and Seal Cracks, measured in accordance with **Subsection 505.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for routing, cleaning, and sealing cracks as specified or directed and includes preparing the crack; installing the proper sealant material; satisfactorily disposing of waste materials; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for this item includes all direct and indirect costs and expenses required to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
5051000	Rout, Clean, and Seal Cracks	LF

DIVISION 600
MAINTENANCE AND CONTROL OF TRAFFIC
SECTION 601
WORK ZONE TRAFFIC CONTROL

601.1 Description

601.1.1 General

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for work zone traffic control conducted within the highway right-of-way in conformity with the Plans, the Specifications, or as directed by the RCE.
- 2 The sections in **Division 600** specify provision, fabrication, installation, performance, maintenance, relocation, and removal requirements of all traffic control devices, methods, and procedures as required by the Plans, the *SCDOT Standard Drawings*, the Special Provisions, the Supplemental Specifications, the manufacturer's requirements and specifications, the latest edition of the FHWA *Manual on Uniform Traffic Control Devices* adopted by the Department, hereinafter referred to as *MUTCD*, and the RCE.
- 3 The *MUTCD*, in effect when the Contract Proposal was advertised, provides the minimum requirements for installation, operation, and maintenance of all traffic control devices.
- 4 For all sections in **Division 600**, the term "the Specifications" includes these Standard Specifications, the Special Provisions, the Supplemental Specifications, the Supplemental Technical Specifications, *SCDOT Qualified Product Lists*, *SCDOT Qualified Product Policies*, all SCDOT Construction and Traffic Control Policies, and all documents of any description including notes on the Plans and the *SCDOT Standard Drawings* that provide directions, provisions, and requirements pertaining to the method and manner of performing the work, the quality and quantity of materials furnished, and the measurement and payment of work required to satisfactorily complete the project. All of these documents are the current edition in use by the Department.

601.1.2 Traffic Control Plan

- 1 Provide a *Traffic Control Plan* for the maintenance and control of traffic during work within the highway right-of-way. This includes work by the Contractor, subcontractor, sub-subcontractor, supplier, or anyone working within the highway right-of-way. Include in the *Traffic Control Plan* procedures and guidelines for providing for the safe passage of traffic through and/or around the project area with the intent of minimizing inconvenience to the traveling public. Ensure that the *Traffic Control Plan* is in conformity with the requirements of these specifications, the Plans, the *SCDOT Standard Drawings*, the

Special Provisions, the Supplemental Specifications, the manufacturer's requirements and specifications, the *MUTCD*, and the RCE.

- 2 Traffic control includes provision, installation, maintenance, repair, replacement, relocation, and removal of all traffic control devices used for regulating, warning, or directing traffic. All items remain the property of the Contractor unless otherwise indicated in the Specifications or on the Plans.
- 3 Obtain approval for any *Traffic Control Plan* revisions due to modifications of the Plans, the plan quantities, the Specifications, and the project staging as presented in the *Traffic Control Plan*. Final approval of such revisions will be pending upon review by the DCE. Provide the RCE with a written request for each revision to the *Traffic Control Plan* not less than two weeks before implementation of the proposed revision.
- 4 Do not use off-road construction equipment or vehicles on portions of roadways open to the public. Include details for the use of all construction equipment or vehicles on portions of the roadway that are open to the traveling public in accordance with the *Traffic Control Plan*.
- 5 When the Specifications or the Plans do not cover a necessary traffic control condition, obtain approval from the RCE for a plan of traffic control before beginning the work that requires traffic control.
- 6 The RCE is responsible for requesting the assistance of the South Carolina Highway Patrol or local law enforcement when necessary unless the Contract includes a specific bid item for providing law enforcement assistance.

601.1.3 Restrictions

- 1 The Department reserves the right to restrict the installation of lane closures on Interstate highways and high volume primary routes when the presence of a lane closure would hinder normal traffic flow during holidays, extended holiday periods, weekends, special events, or any time traffic is unusually heavy. The Department's right to restrict construction operations includes, but is not limited to, lane closures, road closures, shoulder closures, pacing operations, or any operation that would affect the efficient flow of traffic as determined by the RCE. Do not close travel lanes of high volume highways during peak traffic periods or at any time the traffic volume exceeds the numerical values determined to be acceptable by the RCE. Do not close lanes or streets with high volume commuter traffic in cities and urban areas during peak traffic periods unless otherwise specified and approved by the RCE.
- 2 As stated above, the Department reserves the right to restrict construction operations when the continuance of the work would hinder normal traffic flow during extended holiday periods. An extended holiday period is hereby defined as those days preceding and following a holiday that experience significant increases in the volume of traffic due to the holiday as determined by the Department. The Department reserves the right to increase an extended holiday period if excessive traffic volumes occur during the days before and after the established extended holiday period. Extended holiday periods in-

clude, but are not limited to, the week of Thanksgiving, the weeks before and after Christmas, and the weeks before and after the 4th of July. Submit inquiries to the RCE regarding specific days of an extended holiday period not less than two weeks before entering into an extended holiday period. Make inquiries annually due to the progressive nature of the calendar.

- 3 The Department prohibits lane closures on multilane primary routes and Interstate highways during holidays, holiday weekends, or special events unless otherwise directed by the Department. A holiday occurring on a weekday may require an extension of the holiday restrictions due to the proximity of the weekend as determined by the RCE. The Department defines most holiday weekends as from 12:00 noon of the Friday before the weekend or of the day before the holiday until 6:00 a.m. of the Monday after the weekend or the day after the holiday. The Thanksgiving holidays are defined as from 12:00 noon of the Wednesday before Thanksgiving Day until 6:00 a.m. of the Monday after Thanksgiving Day. The Christmas holidays are defined as from 6:00 a.m. of December 23rd through 6:00 a.m. of January 3rd. The RCE may extend Christmas holiday restrictions due to the proximity of the weekend. Easter holidays are defined as from 12:00 noon of the Thursday before Easter until 6:00 a.m. of the Tuesday after Easter. Special events are events generating excessive traffic as determined by the RCE.
- 4 Observe all time restrictions regarding lane closures, road closures, shoulder closures, or pacing operations. The RCE may extend these time restrictions as traffic conditions warrant. The Department reserves the right to suspend a lane closure or road closure if the RCE determines the resulting traffic backup is excessive. Observe and maintain all job specific time restrictions as specified by the Plans, the Specifications, and the RCE. Install and remove lane closures, including all relative traffic control devices and signs, within all time restrictions. Coordinate work activities requiring lane closures, road closures, shoulder closures, or pacing operations in accordance with all restrictions.

601.1.4 Contractor's Responsibility

- 1 These specifications set forth specific procedures and requirements and do not relieve the Contractor of any responsibilities incurred by the Plans, the *SCDOT Standard Drawings*, the Specifications, the manufacturer's specifications, the *MUTCD*, and the RCE.
- 2 The Contractor is responsible for maintaining the *Traffic Control Plan* as required by the Plans, the Specifications, the *MUTCD*, and the RCE. Observe all requirements of the *Traffic Control Plan*, and ensure that all subcontractors working on the project site observe all requirements of the *Traffic Control Plan*. Before beginning any work, submit a plan for constructing the project and maintaining traffic to the RCE and obtain the RCE's written approval for the submitted plan before beginning the work.
- 3 Schedule and arrange all work, equipment, and materials to ensure the least inconvenience and the utmost in safety to the traveling public and to the Contractor's and the Department's forces. In observance of all safety regula-

tions set forth by the Specifications, each Contractor, subcontractor, sub-subcontractor, or anyone working on contiguous and overlapping projects must coordinate work activities as determined by the RCE.

- 4 Maintain the travel patterns directed by the *Traffic Control Plan* and execute the construction schedules expeditiously. Provide the RCE with not less than a two-week prior written notification of any impending changes in the traffic patterns, including, but not limited to, lane closures, road closures, shoulder closures, and flagging operations and obtain RCE approval for each event that modifies the travel patterns, such as lane closures, road closures, shoulder closures, and flagging operations.
- 5 Provide individuals properly trained in traffic control practices in accordance with Department requirements. Ensure that these individuals provide quality assurance of the installation and maintenance of the *Traffic Control Plan*. Have a person in charge of the traffic control on the job site at all times when construction activities are in progress. Also, have a person available 24 hours a day in case of an emergency or failure of traffic control devices.
- 6 The *Traffic Control Plan* may require installation and maintenance of detour signs outside the immediate project limits. In such cases, the Contractor is responsible for installing and maintaining these detour signs as required by the Plans, the Specifications, and the RCE.
- 7 The Contractor is responsible for maintenance of the traffic from time the Contractor installs the permanent or initial temporary construction signs until the project reaches substantial completion of work. Conduct weekly daytime inspections of the project traffic control devices and configuration to determine the adequacy, effectiveness, and maintenance requirements of the *Traffic Control Plan*. Conduct a monthly nighttime inspection and an inspection whenever the traffic pattern is changed. Due to conditions uncharacteristic to a roadway without construction, prudent revisions may be necessary to provide for the protection of the traveling public and the safety of all personnel working on the project site.
- 8 The Contractor is responsible for installation, maintenance, and performance of all traffic control devices. Install, maintain, and ensure the performance of these traffic control devices as required by the Plans, the Specifications, and the device manufacturer's specifications.

601.2 Materials

601.2.1 Storage of Materials and Equipment

- 1 The Contractor and subcontractor are prohibited from storing material and equipment adjacent to a roadway in an unsafe manner. When the right-of-way and space is available, store material and equipment at the greatest possible distance from the near edge of the adjacent travel lane.
- 2 On urban roadways with limited right-of-way and on rural roadways, store material and equipment not closer than 15 feet from the near edge of the adjacent travel lane when space is available. Whenever space is limited and

the 15-foot clear distance is not available, store material and equipment at the greatest possible distance from the near edge of the adjacent travel lane and supplement the complete length of the storage area with portable plastic drums spaced at 5-foot intervals.

- 3 On Interstate highways, do not store material and equipment closer than 30 feet from the near edge of the adjacent travel lane.
- 4 Utilize areas protected by guardrail or temporary concrete barrier when available. See **Subsection 605.4.3.2** and **605.4.3.3** for restrictions on storing materials and equipment behind temporary barriers.
- 5 These requirements for storage of material and equipment also apply to parking of employee's personal vehicles and storage of portable sign supports and other traffic control devices when not in use.

601.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

601.4 Construction

601.4.1 General

- 1 Provide advance warning arrow panels during the closure of a travel lane of a multilane roadway. The taper section of a lane closure requires not less than two arrow panels. If the Plans do not provide locations for the arrow panels during a lane closure, place one arrow panel at the beginning of the taper and another arrow panel at the end of the taper. These locations are for normal traffic conditions.
- 2 Ensure adequate sight distance when selecting the location of the taper for a lane closure. These locations may require adjustments due to horizontal and vertical alignments or due to some other type of physical obstruction that may prevent attaining adequate sight distance.
- 3 Install a changeable message sign as specified herein when required in a lane closure setup. Utilize changeable message signs in all lane closures installed on high-volume, high-speed multilane roadways. Using changeable message signs in lane closures installed on low-volume, low-speed multilane roadways are optional unless otherwise indicated on the Plans or directed by the RCE. Install and use a changeable message sign within a lane closure setup in conformity with the *SCDOT Standard Drawings*. Make certain that the pre-programmed messages are in accordance with the *SCDOT Standard Drawings* when used as part of the traffic control setup for lane closures. Use only messages pertinent to the requirements of the traffic control situation and the traffic conditions for display on a changeable message sign. At no time should the messages displayed on a changeable message sign duplicate the

legends on the permanent construction signs.

- 4 When a recurring lane closure is not imposed for a period exceeding 24 hours, remove the changeable message sign from the roadway and place it in a predetermined area on the project site approved by the RCE where the sign is not visible to passing motorists.
- 5 On roadways with posted speed limits of 45 mph or less, where any work in the shoulder requires personnel, tools, equipment, materials, vehicles, etc., to encroach within 1 foot of the near edge of the adjacent travel lane, conduct the work under a lane closure setup instead of a shoulder closure.
- 6 On roadways with posted speed limits of 50 mph or greater, where any work in the shoulder requires personnel, tools, equipment, materials, vehicles, etc., to encroach within 1 foot of an adjacent travel lane on primary routes or within 10 feet on Interstate highways, conduct the work under a lane closure setup instead of a shoulder closure.
- 7 Properly delineate all travel lanes through construction zones to provide motorists with a clear and positive travel path. Reflectorize all traffic control devices in place on a project site during the hours of darkness. Portable plastic drums are the preferred traffic control devices for use at night; however, the Contractor may use reflectorized cones at night during emergencies. The Contractor may substitute oversized cones for plastic drums during nighttime lane closures; however, the oversized cones are prohibited for use in shoulder closures during the hours of darkness. Plastic drums are the only traffic control devices permitted for use during nighttime shoulder closures.
- 8 During, but not limited to, widening projects, whenever two-lane, two-way traffic is separated by a relocation of one direction of the traffic and results in a vacant travel lane adjacent to a travel lane open to traffic, install portable plastic drums within the vacated travel lane immediately upon the traffic relocation. Allowing multiple lanes of traffic to travel in the same direction on adjacent travel lanes separated by yellow centerline pavement markings is strictly prohibited. Install portable plastic drums in the same manner as required for a lane closure as indicated by the *SCDOT Standard Drawings* and directed by the RCE.
- 9 When working adjacent to or over travel lanes, ensure that dust, debris, tools, and equipment from the operation does not endanger motorists. When working over traffic, provide suitable safety platforms to catch falling materials, equipment, or objects. Arrange these safety platforms so that they do not encroach on the vertical clearance necessary in the areas as determined by the Department.
- 10 When not in use, remove portable sign supports and all other traffic control devices from within 15 feet of a travel lane of a primary route and from within 30 feet of a travel lane of an Interstate highway. Ensure that all portable sign supports lie flat with the legs in the retracted position when not in use.
- 11 Conduct inspections of the project specified in paragraph 7 of **Subsection 601.1.4** to determine the adequacy, effectiveness, and maintenance require-

ments of the traffic control devices. Repair or remove damaged traffic control devices from the job site. Immediately replace those traffic control devices removed from the job for repairs or due to failure with duplicated devices in proper operational condition. Maintain the required level of reflectivity and color by keeping all signs, barricades, drums, and cones clean and replacing damaged signs and traffic control devices. Take not more than 3 days to correct deficiencies and replace or repair traffic control devices that do not meet the Plans, *SCDOT Standard Drawings*, the Specifications, manufacturer's specifications, and the *MUTCD* unless otherwise directed.

601.4.2 Construction Vehicles

- 1 On roadways open to public travel, ensure that the Contractor's trucks and other construction related vehicles travel in the direction of normal roadway traffic. However, when these vehicles are operating within a closed travel lane, they may travel in either direction as necessary.
- 2 When working within the rights-of-way of access-controlled roadways such as Interstate highways, the Contractor's vehicles may only change direction of travel at interchanges. These vehicles are prohibited from crossing the entire roadway from right side to the median or vice versa. Use a flagger to control the Contractor's vehicles when these vehicles attempt to enter the roadway from a closed lane or the median area. Ensure that the flagger does not stop traffic, cause traffic to change lanes, or affect traffic in any manner. The Contractor's vehicles may not disrupt the normal flow of traffic or enter the travel lane of the roadway until a sufficient gap is present.

601.4.3 Daytime and Nighttime Work

- 1 The Department defines the conditions of daytime and nighttime in accordance with the level of natural light provided by the sun measured by a light meter. The terms "Daytime," "Hours of Daylight," or any similar term refers to a level of illumination greater than or equal to 54 Lx or 5 fc. The terms "Nighttime," "Hours of Darkness," or any similar term refers to a level of illumination less than 54 Lx or 5 fc.
- 2 In areas where work is being performed during the hours of darkness, furnish, place, and maintain lighting facilities capable of providing light of sufficient intensity to facilitate good workmanship and proper inspection at all times. Arrange the lighting so that it does not produce glare or diminish the motorist's visibility.
- 3 Illuminate the work area by any combination of portable lights, standard electric lights, existing streetlights, etc., that provides the necessary illumination indicated in the following table.

Area of Illumination	Work Activity	Minimum Illumination Level Lx (fc)
General	Cleaning, Sweeping, Tacking, Painting, etc.	54 (5)
Tasks Around Equipment (50 foot Ahead/Behind)	Milling, Paving, Rolling, etc.	108 (10)

601.4.4 Drop-offs and Changes in Elevation Adjacent to Travelway

- 1 Do not allow grade elevation differences and drop-offs greater than 1 inch adjacent to or between adjacent travel lanes open to traffic during surface planing and milling operations. If the grade difference exceeds 1 inch, either mill or surface plane the adjacent travel lanes or pave the milled travel lanes as necessary to eliminate the grade elevation differences before opening the travel lanes to traffic.
- 2 Do not allow drop-offs greater than 2 inches next to traffic or within 6 feet or less of the near edge of an adjacent travel lane; however, if the Contractor is actively working in the immediate vicinity, a drop-off of more than 2 inches is permitted. Eliminate these drop-offs at the end of each day's work and at the completion of the construction activities.
- 3 During the rough grading operations, provide for the safe movement of traffic by excavating the earth next to the travel lane open to traffic to a 6:1 slope until the fine grading begins. During the fine grading operations, provide for the safe movement of traffic by placing a material approved by the RCE next to the travel lane open to traffic at a 6:1 slope. Prepare the 6:1 slope at the end of each workday as necessary.
- 4 Do not allow drop-offs greater than 2 inches between adjacent travel lanes open to traffic during paving operations. Acceptable drop-offs on multi-lane facilities are limited to not more than one drop-off between adjacent travel lanes carrying traffic in the same direction. Begin the necessary work to eliminate acceptable drop-offs between adjacent travel lanes open to traffic within 3 working days of creating the drop-offs unless otherwise directed by the Plans or the RCE. Observe all restrictions regarding grade elevation differences and lane closures by maintaining an approved construction schedule. Obtain the RCE's approval of the schedule for all milling, paving, or any similar operations before beginning the work.

601.4.5 Excavations Adjacent to Travelway

- 1 On roadways with posted speed limits of 45 mph or less, do not sustain an open excavation within 15 feet of an adjacent travel lane during anytime the Contractor is not actively engaged in construction activities directly related to the excavation or present at the site of the excavation. Either close the adjacent travel lane or install and maintain temporary concrete barrier wall to protect these open excavations whenever not actively engaged in work activities directly related to the excavation or not present at the site of the excavation.

- 2 On roadways with posted speed limits of 45 mph or less, close both adjacent shoulders during excavation work in a grassed median area if the work is within 15 feet of both adjacent travel lanes.
- 3 On roadways with posted speed limits of 50 mph or greater, do not sustain an open excavation within 30 feet of an adjacent travel lane during anytime the Contractor is not actively engaged in construction activities directly related to the excavation or present at the site of the excavation. Either close the adjacent travel lane or install and maintain temporary concrete barrier wall to protect the open excavation whenever not actively engaged in work activities directly related to the excavation or not present at the site of the excavation.
- 4 On roadways with posted speed limits of 50 mph or greater, close both adjacent shoulders during excavation work in a grassed median area if the work is within 30 feet of both adjacent travel lanes.
- 5 Comply with all requirements for shoulder closures and lane closures as necessary when construction activities for catch basins or similar features are in progress.
- 6 During the construction of catch basins and other structures, the RCE will be the judge of which excavations or exposed structures within the construction limits are susceptible to contact with errant vehicles. Provide protective covers for excavations (i.e. catch basins) located within 6 feet or less of a travelway with metal plates capable of sustaining vehicular traffic unless otherwise directed by the RCE. Delineate, with two or more 3-foot Type II barricades or four or more portable plastic drums, excavations and structures (i.e. completed catch basins or any structure that can be an obstruction to a vehicle) located within 30 feet of a travel way as directed by the RCE. Utilize either the Type II barricades or the portable plastic drums for delineation purposes; however, do not mix Type II barricades and portable plastic drums for delineation purposes. Disregard the requirement for metal plates and delineation if guardrail or temporary concrete barrier protects the excavation or structure.

601.5 Measurement

- 1 The quantity for the pay item Traffic Control is paid for on a lump sum basis; and therefore, no specific measurements are made for this item.
- 2 Traffic control needed during repair or replacement of damaged or malfunctioning traffic control devices is considered incidental work for the item Traffic Control.
- 3 Traffic control needed during application of temporary or permanent pavement markings is considered incidental work for the item Traffic Control.

601.6 Payment

- 1 Work under this section is paid for in the lump sum pay item Traffic Control as specified in **Subsection 107.12** and includes traffic control devices and work necessary for the proper protection of the traveling public and the con-

struction work zone, except where the Contract includes other pay items for specific traffic control devices.

- 2 Payment for Traffic Control is made as indicated in the following schedule.

Percent of Contract Completion	Percent of Traffic Control Paid
1 - 5	20
6 - 15	40
16 - 29	60
30 - 49	70
50 - 69	80
70 - 89	90
90 - 100	100

- 3 Payment is made in accordance with the above schedule as long as the adequacy of the traffic control measures are satisfactory within the guidelines set forth by the Plans, the *SCDOT Standard Drawings*, the Specifications, and the *MUTCD* as determined by the RCE. The RCE may assess appropriate reductions in payment when the Contractor does not use or maintain traffic control devices as required by the Plans, the *SCDOT Standard Drawings*, the Specifications, and the *MUTCD*.
- 4 The RCE will notify the Contractor when the traffic control is not being provided as specified. If the Contractor fails to provide the appropriate traffic control, the RCE will immediately suspend all work activities until the Contractor corrects the conditions. The RCE has the authority to withhold partial payment for work on the Contract if the traffic control is not provided as required.
- 5 When the Contract requires payment for Traffic Control on more than one project, each project is considered separately.
- 6 Payment for Traffic Control is full compensation for providing the proper traffic control during all stages of construction and includes furnishing, preparing, fabricating, installing, maintaining, removing, relocating, repairing, or replacing traffic control devices and signs as necessary, and all other materials, labor, hardware, equipment, tools, supplies, incidentals, and miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 7 Payment for Traffic Control does not include payment for permanent construction signs, temporary concrete barrier, portable terminal impact attenuators, changeable message signs, temporary pavement markings or pavement markers, or any other item with a contract unit bid price.
- 8 Payment includes all direct and indirect costs and expenses required to complete the work.

SECTION 602

GENERAL REQUIREMENTS FOR PROVIDING AND MAINTAINING TRAFFIC CONTROL DEVICES IN THE WORK ZONE

602.1 Description

- 1 This section contains specifications for materials and construction for providing, installing, and maintaining work zone traffic control devices, including signs that delineate travel lanes, warn of obstructions and hazards, and provide safe maintenance of traffic during work within or adjacent to the highway rights-of-way in conformity with the Plans and the Specifications or as directed by the RCE.
- 2 Only those work zone traffic control devices included on the current SCDOT Traffic Engineering approved products list, entitled and hereafter referred to as the *Approved Products List for Traffic Control Devices in Work Zones*, are considered acceptable for use on highway construction work in South Carolina. The *Approved Products List for Traffic Control Devices in Work Zones* includes the implementation dates and any special conditions or restrictions for each device. The list is available on the Department website at:
http://www.scdot.org/doing/pdfs/NCHRP350List-_ALL2_.pdf.
- 3 Ensure that all work zone traffic control complies with the requirements of *NCHRP Report 350*, entitled *Recommended Procedures for the Safety Performance Evaluation of Highway Features*.
- 4 Considering the function and weight of each device, the FHWA has divided work zone traffic control devices into four categories for purposes of determining the level of effort needed to demonstrate crashworthiness in accordance with the requirements of *NCHRP Report 350*. Ensure that all Category I, II, and III devices comply with the requirements of *NCHRP Report 350*. The compliance date for Category IV devices will be determined at a later date.
- 5 Category I includes small and lightweight channelizing and delineating traffic control devices that include plastic cones, portable plastic drums, and tubular markers without attachments such as signs or warning lights.
- 6 Category II includes traffic control devices that are not expected to produce significant vehicular velocity changes to impacting vehicles. Acceptable devices in this category are not capable of penetrating a windshield or causing vehicular instability during a crash. Portable sign stands mounted with signs, Types I, II, and III barricades, vertical panels, intrusion alarms, and other such work zone traffic control devices that weigh 100 pounds or less are included in this category.
- 7 Category III includes traffic control devices that are expected to cause significant vehicular velocity changes to impacting vehicles. These devices weigh more than 100 pounds. Portable temporary barriers, portable terminal impact attenuators, truck-mounted attenuators, fixed sign supports, and other

work zone traffic control devices that do not meet the definitions of Category I or II are included in this category.

- 8 Category IV includes advanced warning arrow panels, changeable message signs, portable traffic signals, and portable lighting equipment.
- 9 Any traffic control device, including Category I devices, supplemented with a sign or warning light requires approval from the Office of Engineering of the FHWA to ensure crash worthiness of such a combination.
- 10 The Department reserves the right, as granted by the FHWA, to reject the design of a traffic control device or place limitations on its use. Manufacturer's certification or FHWA acceptance does not constitute or imply that the device is acceptable for use in South Carolina. The Department may reject or restrict the use of any traffic control device based on the following:
- A. Differing interpretation of the test results.
 - B. Insufficient test results, which may require additional testing.
 - C. Insufficient field data, which may require in-service evaluation.
- 11 Provide certification documents to confirm the compliance of Category II and III traffic control devices with *NCHRP Report 350* requirements to the RCE before installation. Certification for Category I devices is not required. Ensure that that the certification documents include the following:
- Letter from the Contractor certifying that all traffic control devices intended for use on the project are *NCHRP Report 350* compliant.
 - Copy of the portions of the *Approved Products List for Traffic Control Devices in Work Zones* that includes the subject devices.
 - List of all the traffic control devices, including the name of the devices, model numbers, descriptions, and manufacturers.
 - For those devices that require reflectorization, include the certification for the reflective sheeting.

602.2 Materials

602.2.1 General

- 1 Provide traffic control devices as specified by the Plans, the *SCDOT Standard Drawings*, the Specifications, the manufacturer's specifications, the *MUTCD*, and the RCE. Provide traffic control devices manufactured in compliance with the requirements of the Plans, the *SCDOT Standard Drawings*, the Specifications, the manufacturer's specifications, the *MUTCD*, the *Approved Products List for Traffic Control Devices in Work Zones*, and the RCE.

602.2.2 Reflectorization

- 1 Use approved reflectorizing materials on traffic control devices. Use reflectorizing materials listed on the most recent edition of *SCDOT Qualified Product List 20* in effect at the time the Contract was advertised.
- 2 When reflectorizing traffic control devices and signs, apply the sheeting material evenly to surfaces so that the sheeting is smooth and adheres firmly.

- 3 Reflecterize drums, barricades, and other traffic control devices requiring reflectorization, except signs, with Type III High Intensity Retroreflective Sheeting unless otherwise indicated on the Plans or in the Specifications.
- 4 Reflecterize rigid signs with Type VII, Type VIII, or Type IX Prismatic Retroreflective Sheeting unless otherwise specified in the Plans and the Specifications. Type III High Intensity Retroreflective Sheeting is not approved for reflectorization of rigid advance warning construction signs.
- 5 Reflecterize orange advance warning construction signs and any orange areas of a multi-colored advance warning construction sign with fluorescent orange colored prismatic retroreflective sheeting. Reflecterize white advance signs and any white areas of multi-colored advance warning construction sign with white colored prismatic retroreflective sheeting. Use retroreflective sheeting listed on the most recent edition of *SCDOT Qualified Product List 20*.
- 6 Do not splice retroreflective sheeting, except when the sign is too large to cover with a single piece of the widest material available from the sheeting manufacturer, and in this case, use only one splice per sign on the centerline of the sign or barricade. Overlap permitted splices not less than 3/16 inch except for butt splices, which may be used on signs processed with transparent colors, where a gap not greater than 1/32 inch is allowed. In horizontal overlapped splices, overlap the top portion over the bottom portion, as viewed when the sign is in an upright position. Do not use screening paints between the sheeting of overlapped splices. When splicing, match the retroreflective sheeting for color to provide uniform appearance in both daytime and nighttime conditions.

602.2.3 Work Zone Signs

- 1 Signs in the *MUTCD* and on the traffic control drawings in the *SCDOT Standard Drawings* each have an identification number. Detailed drawings of each sign are available from the Director of Traffic Engineering.
- 2 Provide certification from the sign manufacturer verifying that the retroreflective sheeting and aluminum sign blanks employed on the project comply with the Specifications. Include certifications for rollup signs and rigid signs fabricated from an aluminum composite material in the *NCHRP Report 350* compliance certification documents. Additional certification documents are not required unless otherwise specified.
- 3 Mark signs on the back with a label made of a durable material capable of retaining its legibility for the life of the sign. Imprint the name of the manufacturer of the sign sheeting and the date of fabrication on the label.
- 4 Provide rigid signs with a background material constructed of aluminum or an approved aluminum composite material unless otherwise required by the Plans and the Specifications. Ensure that aluminum sign blanks meet the requirements of **Section 651** of these specifications. Use approved aluminum composite materials included on the *Approved Products List For Traffic Control Devices in Work Zones* only with those traffic control devices that

specifically reference an approved use of aluminum composite material. However, a rigid sign fabricated from an approved aluminum laminate substrate may be utilized as an alternate for approved aluminum sign blanks mounted on a ground mounted sign assembly with 3-pound per foot U-section signposts. Ensure that the aluminum laminate substrate is fabricated from either of the approved aluminum composite materials Alpollic, Dibond, or Reynolite.

- 5 Provide reflective roll-up signs with a background material constructed of an approved reflective fabric material substratum attached to two or more fiberglass battens. Use approved reflective roll-up sign materials included on the *Approved Products List For Traffic Control Devices In Work Zones*.
- 6 Mount temporary "Exit" signs (M1025-00) located within temporary gore areas during lane closures on multi-lane roadways at a minimum height of 7 feet from the ground to the bottom edge of the sign in accordance with the requirements of the *MUTCD*. The minimum 7-foot mounting height for a temporary "Exit" sign applies to installation both on ground mounted U-section posts and portable sign supports.
- 7 Utilize 3-pound per foot galvanized U-section posts for ground-mounted sign assemblies as required by the *Traffic Control Plan*, including permanent construction signs, temporary construction signs, regulatory signs, warning signs, etc.
- 8 Ensure that U-section posts installations comply with the requirements for breakaway supports detailed in the 1985 AASHTO specification entitled *Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals*.

602.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

602.4 Construction

- 1 Install, remove, relocate as necessary, and maintain traffic control devices provided in conformance with **Subsection 602.2** throughout the duration of the project. Maintenance of traffic control devices includes, but not limited to, replacement of damaged traffic control devices and those that have completed their functional service life. When not in use, remove unnecessary traffic control devices in conflict with the roadway conditions to prevent confusion of the traveling public.
- 2 Maintain the performance level of work zone traffic control devices as required by the Specifications, the manufacturer's requirements and specifications, and the *MUTCD*. Do not allow a reduction of the performance level of a traffic control device in order to meet the requirements of the *NCHRP Report*

350. Any reduction of the required performance levels disqualifies a device for use in South Carolina.
- 3 Repair or replace damaged or failed traffic control devices in accordance with the Specifications and as directed by the RCE. Notify the RCE before repairing or replacing substandard traffic control devices and provide the RCE with indisputable evidence that repairs or replacements were in strict accordance with the manufacturer's and Department specifications. If the Contractor fails to provide the RCE with proper notification and evidence of conformity with the manufacturer's and Department specifications, the RCE will immediately suspend all work. The suspension of work continues until questions regarding the repairs or replacements are resolved. Without proper notification and evidence of conformity with the manufacturer's and Department specifications, the Contractor forfeits payment for those repair or replacement items in question.
 - 4 Mount signs on supports constructed to yield upon impact to minimize hazards to motorists as indicated in Sections 6F.01 through 6F.03 of the *MUTCD* and as required by the FHWA.
 - 5 Replace reflectorized traffic control devices or signs that fail to perform satisfactorily, day or night, due to deterioration or damage to the retroreflective material or any circumstances that prevent the retroreflective material from meeting the Department's retroreflectivity requirements.
 - 6 Before beginning work, conduct an inspection with the RCE of the project to determine the necessity for removal or relocation of existing signs and the number of these signs and their locations. Remove, relocate, or cover existing permanent signs in conflict with changes in the traffic patterns or speed limits because of the implementation of the *Traffic Control Plan*. Install the appropriate temporary signing to the satisfaction of the RCE. When the conflict is resolved, immediately remove the temporary signing and restore the permanent signing. The Contractor is responsible for the necessary removal, relocation, storage, protection, and re-erection of existing signs located within the scope of the project. Re-erect these signs as directed by the RCE. The Contractor is responsible for the storage of signs removed from the project site and for the prevention of corrosion, bending, defacing, or other damage to the signs during storage. Replace signs damaged due to improper protection during removal, storage, or re-installation. Consider removal, storage, and re-erection of the signs incidental to the item Traffic Control; and therefore, there is no separate payment for this work.
 - 7 Install work zone traffic control signing as specified. Do not omit or substitute for these signs unless otherwise allowed by the Specifications or directed by the RCE.
 - 8 Mount flat sheet signs straight and level and with the face of the signs perpendicular to the surface of the roadway. This requirement applies to flat sheet signs whether they are portable or have the embedded supports. Mount advance construction signs 2 feet from the edge of a paved shoulder or the face of a curb, or if no paved shoulder exists, 6 feet to 12 feet from the

edge of an adjacent travel lane to the nearest edge of the signs. Ensure that advance construction signs erected on ground mounted U-channel posts have a minimum mounting height of 7 feet from the ground to the bottom edge of the sign and any secondary sign on the same assembly has a minimum mounting height of 6 feet from the ground to the bottom edge of the secondary sign. Ensure that signs mounted on portable sign supports, including advance construction signs, regulatory signs, warning signs, etc., have a minimum mounting height of 5 feet from the ground to the bottom edge of the sign. Provide special sign mounting assemblies, when necessary, in areas of double-layered guardrail, concrete median barrier, or bridge parapet walls.

- 9 Cover signs in their entirety with an opaque material or remove them from the job site when not in use. Do not simply re-direct a sign. Cover the signs in their entirety to prevent any visualization of the sign background color or perception of the message by the motorist. Use weather resistant materials to cover signs to prevent any exposure of a covered sign due to adverse weather conditions or long periods.
- 10 When covering signs with opaque materials, do not attach a covering material to the face of the sign with tape or a similar product or any method that leaves a residue on the retroreflective sheeting because residue from tape or similar products, as well as many methods utilized to remove such residue, may damage the reflectivity of the sign. Therefore, contact with tape or a similar product with the retroreflective sheeting will require replacement of the damaged sign at no additional cost to the Department.
- 11 The Contractor has the option to use an electrical power source for various traffic control devices on long-term projects due to the extensive maintenance associated with diesel generators and batteries. A solar assisted power source for use as an alternative power source is recommended when practicable. Install and maintain alternative power sources as required by the Specifications and as directed by the RCE. When using an electrical power source, the Contractor is responsible for the arrangements and cost necessary to obtain and maintain electric current from the local power company and to maintain a safe operation. Safely secure all electrical power lines. Protect temporary power poles providing electric current to traffic control devices, installed within 30 feet of a travel lane, by an approved method such as guardrail or temporary concrete barrier when deemed necessary by the RCE. Equip electrical lines carrying a direct feed from high voltage power lines to traffic control devices with ground fault interrupter circuit (GFIC) breakers.
- 12 When an advance warning arrow panel, a changeable message sign, a temporary traffic signal, or a truck-mounted attenuator suffers a strike by an errant vehicle or a mechanical or electronic failure, eliminate the resulting hazardous condition immediately. Initiate replacement or repair operations of the defective or damaged equipment immediately upon discovery or notification of a failure.
- 13 When a portable terminal impact attenuator suffers a strike by an errant vehicle, eliminate the resulting hazardous conditions promptly. Initiate re-

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placement or repair operations of the damaged equipment within the first 2 hours upon discovery or notification of the damage.

602.5 Measurement

- 1 There are no measurements made of traffic control devices under this section. Measurements of specific traffic control devices are specified elsewhere in **Division 600**.

602.6 Payment

- 1 There is no payment made for traffic control devices under this section. Payments for specific traffic control devices are specified elsewhere in **Division 600**.

SECTION 603

CATEGORY I TRAFFIC CONTROL DEVICES

603.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for Category I Traffic Control Devices in conformity with the Plans and the Specifications or as directed by the RCE.
- 2 Category I includes small and lightweight channelizing and delineating traffic control devices such as standard traffic cones, oversized traffic cones, portable plastic drums, and tubular markers without attachments such as signs or warning lights.

603.2 Materials

603.2.1 Standard Traffic Cones

- 1 Use standard traffic cones included on the *Approved Products List For Traffic Control Devices In Work Zones*.
- 2 Ensure that standard sized cones are orange in color and have a minimum height of 28 inches and a maximum height of 36 inches. Use standard traffic cones on the Interstate system that have a minimum height of 36 inches. Reflectorize these cones for use during the hours of darkness.

603.2.2 Oversized Traffic Cones

- 1 Use oversized traffic cones included on the *Approved Products List For Traffic Control Devices In Work Zones*.
- 2 Ensure that oversized traffic cones are orange in color and have a minimum height of 42 inches and a maximum height of 50 inches. Provide, install, and maintain each oversized traffic cone as specified herein.
- 3 Ensure that each oversized traffic cone is a two-piece traffic control device with a breakaway design and consists of a cone and a rubber base.
- 4 Fabricate each oversized traffic cone from a low-density polyethylene plastic in a standard highway orange color. Ensure that the minimum diameter of the cone cylinder is 4 inches at the top of the cone and not less than 7½ inches at the bottom of the cone. Ensure that the bottom of each cone flares outward to form a flange for the rubber base to rest upon and provide stability. Make certain that the flange is no less than 10½ inches in diameter to prevent the bottom of the cone from easily passing through the rubber base.
- 5 Ensure that the minimum weight of the base, molded from recycled rubber, is not less than 15 pounds and that the maximum width of the base is not greater than 18 inches. Ensure that the diameter of the hole in the center of the base is ½ inch larger than the diameter of the cone cylinder at the bottom of the cone and not less than 2½ inches smaller than the cone flange.

- 6 Reflecterize each oversized traffic cone with 4 retroreflective bands: 2 orange and 2 white retroreflective bands. Alternate the orange and white retroreflective bands, with the top band always being orange. Make each retroreflective band not less than 6 inches wide. Utilize Type III High Intensity retroreflective sheeting for retroreflectorization unless otherwise specified. Separate each retroreflective band with not more than a 2-inch non-reflectorized area. Do not splice the retroreflective sheeting to create the 6-inch retroreflective bands. Apply the retroreflective sheeting directly to the cone surface. Do not apply the retroreflective sheeting over a pre-existing layer of retroreflective sheeting.
- 7 Ensure that the construction of the oversized traffic cone facilitates storage. Ensure that each cone has a handle type structure on top of the cone to facilitate relocation, installation, and removal operations.
- 8 Ensure that oversized traffic cone on a project are uniform in size. Use the same size of oversized traffic cones, including the height and width, throughout the project.

603.2.3 Portable Plastic Drums

- 1 Use portable plastic drums included on the *Approved Products List For Traffic Control Devices In Work Zones*.
- 2 Provide drums constructed of a lightweight plastic material. Do not use metal drums for traffic control purposes. Ensure that each drum has a minimum height of 36 inches and minimum width of 18 inches. Ensure that all drums have drain holes in the bottom to prevent accumulation of water and the creation of hazardous masses of ice due to freezing temperatures. Do not weight drums with loose sand, water, or any material to the extent that would make them hazardous to motorists. Do not place ballast on top of a drum. Use 1 or 2 sand bags for ballast placed at the bottom of the device when necessary. Obtain RCE approval for the use of any other devices as ballast.
- 3 Reflecterize each drum with Type III High Intensity retroreflective sheeting: 2 orange and 2 white retroreflective bands, 4 to 6 inches wide unless otherwise specified. Alternate the orange and white retroreflectorized bands with the top band always being orange. Ensure that any non-retroreflectorized area between the orange and white retroreflectorized bands does not exceed 3 inches. Do not splice the retroreflective sheeting to create the width of the retroreflectorized band. Apply the retroreflective sheeting directly to the drum surface. Do not apply the retroreflective sheeting over a pre-existing layer of retroreflective sheeting.

603.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

603.4 Construction

603.4.1 Standard Traffic Cones

- 1 Use standard traffic cones on the roadway to delineate travel lanes and to channelize traffic through the tangent section or activity area of lane closures and to mark specific hazards as directed by the Plans, the Specifications, or the *SCDOT Standard Drawings*. Replace all standard sized traffic cones with portable plastic drums when traffic control devices are necessary on or adjacent to a traveled way during the hours of darkness. Use standard traffic cones during the hours of darkness only during emergencies. Provide, install, and maintain each cone as specified herein.
- 2 Maintain standard traffic cones in good condition. Replace and do not use standard traffic cones that contain dents, cuts, scrapes, scratches, or are otherwise damaged and those that have completed their functional service life.

603.4.2 Oversized Traffic Cones

- 1 Use oversized traffic cones on multilane roadways during lane closures to aid in providing delineation for motorists and to channelize traffic through the tangent section or activity area of lane closures.
- 2 Only use oversized traffic cones in place of portable plastic drums during right, left, and center lane closures and daytime shoulder closures on existing multilane roadways. Do not use oversized traffic cones in any other manner or method other than as directed by the Specifications.
- 3 Use oversized traffic cones as a substitute for portable plastic drums within lane closures and daytime shoulder closures only. Do not use oversized traffic cones for any purpose other than as the traffic control devices within lane closures. Do not substitute oversized traffic cones for portable plastic drums required for delineation of the edge of a roadway, delineation of excavations or structures, nighttime shoulder closures, or delineation or channelization purposes on a two-lane, two-way roadway widening project.
- 4 Ensure that oversized traffic cones comply with all regulations and requirements of the *Typical Traffic Control Standard Drawings* that apply to portable plastic drums utilized within lane closures and daytime shoulder closures contained in the *SCDOT Standard Drawings*. Install and maintain oversized traffic cones in place of portable plastic drums or standard size cones only within lane closures and daytime shoulder closures in conformity with the Specifications and as illustrated on the *Typical Traffic Control* drawings for lane closures and daytime shoulder closures contained in the *SCDOT Standard Drawings*.
- 5 Ensure that oversized traffic cones and standard traffic cones that are 36 inches tall or less are not used interchangeably. Use oversized traffic cones for the standard traffic cones, but ensure that the standard traffic cones are not substituted for the oversized traffic cones or for portable plastic drums.

- 6 Maintain oversized traffic cones in good condition. Replace and do not use oversized traffic cones that contain dents, cuts, scrapes, scratches, faded plastic or reflective sheeting that is faded, peeling, or contaminated by any substance or material that reduces the required reflectivity or reflective area of the sheeting, or is otherwise damaged, and those that have completed their functional service life.

603.4.3 Portable Plastic Drums

- 1 Use portable plastic drums on the roadway to delineate travel lanes, to channelize traffic through the tangent section or activity areas of lane closures and shoulder closures, to delineate the edge of roadway, and to delineate excavations and structures. Reflectorize these drums with Type III High Intensity retroreflective sheeting unless otherwise specified by the Plans and the Specifications. Use drums as the preferred traffic control device adjacent to a traveled way during the hours of darkness. Provide, install, and maintain each drum as specified herein.
- 2 Maintain all drums in good condition. Replace and do not use drums that contain dents, faded plastic or reflective sheeting that is faded, peeling, contaminated by any substance or material that reduces the required reflectivity or reflective area of the sheeting, or cut, scratched, or damaged in any manner, and those that have completed their functional service life.

603.5 Measurement

- 1 Unless otherwise specified, Category I Traffic Control Devices, including standard traffic cones, oversized traffic cones, and portable plastic drums are not measured for separate payment, but are included in the contract lump sum bid price for the item Traffic Control as specified in **Subsections 107.12** and **601.5**.

603.6 Payment

- 1 Unless otherwise specified, payment for Category I traffic control devices including standard traffic cones and oversized traffic cones is included in the contract lump sum bid price for the item Traffic Control as specified in **Subsections 107.12** and **601.6**. The payment is full compensation for providing, installing, removing, relocating, and maintaining standard traffic cones and oversized traffic cones as specified or directed and includes furnishing and applying proper reflective materials; using an approved ballast; maintaining a clean and proper construction zone orange color; replacing damaged traffic cones and those that have completed their functional service life; providing traffic control necessary for installing and maintaining traffic cones; all other materials, labor, hardware, equipment, tools, supplies, transportation, incidentals, and miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Unless otherwise specified, payment for portable plastic drums is included in the contract lump sum bid price for the item Traffic Control as specified in

Subsections 107.12 and 601.6. The payment is full compensation for providing, installing, removing, relocating, and maintaining portable plastic drums as specified or directed and includes furnishing and applying a proper reflective materials; using of approved ballast; maintaining clean and proper construction zone orange and white colors; and replacing damaged drums and those that have completed their functional service life; providing traffic control necessary for satisfactorily installing and maintaining the drums; and all other materials, labor, hardware, equipment, tools, supplies, transportation, incidentals, and miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

SECTION 604

CATEGORY II TRAFFIC CONTROL DEVICES

604.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for Category II traffic control devices in conformity with the Plans and the Specifications or as directed by the RCE.
- 2 Category II includes traffic control devices that are not expected to produce significant vehicular velocity changes to impacting vehicles. Acceptable devices in this category are not capable of penetrating a windshield or causing vehicular instability during a crash. Portable sign stands mounted with signs, Types I, II, and III barricades, vertical panels, intrusion alarms, and other work zone traffic control devices that weigh 100 pounds or less are included in this category.
- 3 Type I, Type II, and Type III barricades are Category II devices.

604.2 Materials

604.2.1 Type I and Type II Barricades

- 1 Provide, install, and maintain Type I and Type II barricades as specified herein.
- 2 Use Type I and II Type barricades included on the *Approved Products List For Traffic Control Devices In Work Zones*.
- 3 Reflectorize these barricades with Type III High Intensity retroreflective sheeting unless otherwise specified by the Plans and the Special Provisions. Ensure that the retroreflective sheeting has alternate orange and white stripes sloping downward at a 45-degree angle in the direction of passing traffic.

604.2.2 Type III Barricade

- 1 Provide, install, and maintain each Type III barricade as specified herein.
- 2 Use Type III barricades included on the *Approved Products List For Traffic Control Devices In Work Zones*.
- 3 Reflectorize the barricades with a Type III High Intensity retroreflective sheeting unless otherwise specified by the Plans and the Specifications. Ensure that the retroreflective sheeting has alternate orange and white stripes sloping downward at 45-degree angles. Apply the sloping orange and white stripes in accordance with the requirements of the Plans, *SCDOT Standard Drawings*, and the *MUTCD*.

604.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide

sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

604.4 Construction

604.4.1 Type I and Type II Barricades

- 1 Use Type I and Type II barricades to develop taper sections and channelize traffic into lane closures, delineate travel lanes, and delineate excavations and structures.
- 2 Use Type II barricades not less than 3 feet wide as the traffic control device for the taper sections of lane closures.
- 3 Use Type II barricades as the traffic control devices for delineation of excavations and structures (i.e., catch basins, completed drop inlets, or any structure that can be an obstruction to a vehicle).

604.4.2 Type III Barricade

- 1 Erect Type III barricades to close the roadway to traffic and to prevent traffic from entering a construction area.
- 2 Only mount supplementary signs intended for attachment to the Type III barricades fabricated from either an approved retroreflective fabric material or an approved aluminum laminate substrate. Refer to the *Approved Products List For Traffic Control Devices in Work Zones* for Type III barricades approved to support signs with aluminum composite substrates fabricated from an approved aluminum composite material such as Alpolic, Dibond, or Reynolite. Do not attach any other type of rigid sign substratum to a Type III barricade.

604.5 Measurement

- 1 Category II traffic control devices including Type I, Type II, and Type III barricades are included in the lump sum item Traffic Control as specified in **Subsections 107.12** and **601.5**. No separate measurement is made for Type I, Type II, or Type III barricades unless the Contract includes the specific pay item Barricade -Type (*I, II, or III*).
- 2 If the Contract includes the pay item for Barricade -Type (*I, II, or III*), the quantity is the length of the installed barricade and is measured by the linear foot (LF) along the width of each barricade in-place, complete and accepted.

604.6 Payment

- 1 Payment for the accepted quantity for each pay item, measured, or determined in accordance with **Subsection 604.5**, is determined using the contract unit bid price for the applicable item.
- 2 Payment for Category II traffic control devices, either included in the pay item Traffic Control as specified in **Subsections 107.12** and **601.6** or as the pay item Barricade -Type (*I, II, or III*), is full compensation for providing, installing, removing, relocating (as necessary), and maintaining the barricades as specified or directed and includes fabricating the barricades with proper ret-

roreflective sheeting; using proper supports; providing traffic control necessary for installing and maintaining the barricades; removing or replacing damaged or malfunctioning barricades; and all other materials, labor, hardware, equipment, tools, supplies, transportation, incidentals, and any miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

3 Payment for Category II traffic control devices includes all direct and indirect costs and expenses required to complete the work.

4 Pay items under this section include the following:

Item No.	Pay Item	Unit
6041100	Barricade – Type I	LF
6041150	Barricade – Type II	LF
6041200	Barricade – Type III	LF

SECTION 605

CATEGORY III TRAFFIC CONTROL DEVICES

605.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for Category III traffic control devices in conformity with the Plans and the Specifications or as directed by the RCE.
- 2 Category III includes traffic control devices expected to cause significant vehicular velocity changes to impacting vehicles. These devices weigh more than 100 pounds. Portable temporary barriers, portable terminal impact attenuators, truck-mounted attenuators, fixed sign supports, and other work zone traffic control devices that do not meet the definitions of Category I or II are included in this category.
- 3 The following Category III traffic control devices are covered in this section:
 - Construction sign mounted on a portable sign support or Type III barricade,
 - Construction sign ground-mounted on 3-pound per foot U-section posts,
 - Truck-mounted attenuator,
 - Portable terminal impact attenuator for a work zone,
 - Temporary concrete barrier wall, and
 - Temporary polyethylene water-filled barrier wall.

605.2 Materials

605.2.1 Construction Signs

- 1 Fabricate construction signs from sign materials included on the *Approved Products List For Traffic Control Devices in Work Zones* and in conformance with the requirements of **Subsection 602.2.3**.
- 2 Use sign substratum for construction signs from the following types of materials:
 - A. Aluminum sign blanks (0.10-inch thick),
 - B. Roll-up retroreflective fabric material, and
 - C. Aluminum composite material.
- 3 Reflectorize advance warning construction signs with approved reflective sheeting. Reflectorize orange advance warning construction signs and orange areas of a multi-colored advance warning construction sign with fluorescent orange colored prismatic retroreflective sheeting. Reflectorize white advance warning construction signs and white areas of a multi-colored advance warning construction sign with white colored prismatic retroreflective sheeting.

- 4 When mounting sign on bridges or permanent concrete barrier wall, provide customized mounting hardware where necessary. Customized mounting hardware is subject to RCE approval prior to installation.

605.2.2 Work Zone Attenuators

605.2.2.1 General

- 1 Ensure that each attenuator complies with requirements of the *NCHRP Report 350*. Use attenuators included on the *Approved Products List For Traffic Control Devices in Work Zones*.

605.2.2.2 Truck-Mounted Attenuators

605.2.2.2.1 General

- 1 Provide truck-mounted attenuators designed and constructed for controlled deceleration of an impacting vehicle and dissipation of the vehicle's kinetic energy. When struck on the front of the unit, ensure that the unit has the capability to bring the errant vehicle to a safe and controlled stop and functions within the requirements as detailed by the Specifications and the manufacturer's specifications.
- 2 Use the truck-mounted attenuators included on the *Approved Products List For Traffic Control Devices in Work Zones*.

605.2.2.2.2 Performance Requirements

605.2.2.2.2.1 General

- 1 Ensure that each truck-mounted attenuator complies with *NCHRP Report 350* requirements for Test Level 2 or Test Level 3.
- 2 When an attenuator mounted on a truck weighing 15,000 pounds or more is impacted by an errant vehicle, ensure that the truck-mounted attenuator performs as specified in **Subsection 605.2.2.2.2.2** or **605.2.2.2.2.3** according to the test level required.

605.2.2.2.2.2 Test Level 2

- 1 Ensure that the truck-mounted attenuator is capable of decelerating and stopping vehicles weighing 1800 pounds during head-on impacts at 43 mph. Make certain that the truck-mounted attenuator meets the occupant risk criteria during the impact of a small car into the unit as required by the *NCHRP Report 350*, Test 50.

605.2.2.2.2.3 Test Level 3

- 1 Ensure that the truck-mounted attenuator performs under Test 3 conditions in accordance with the following requirements:
- A. Decelerate and stop vehicles weighing 1800 pounds during head-on impacts at 62 mph. Meet the occupant risk criteria during the impact of a small car into the unit as required by the *NCHRP Report 350*, Test 50.

- B. Decelerate and stop vehicles weighing 4400 pounds during head-on impacts at 62 mph. Meet the structural adequacy requirements, the occupant risk criteria, and the criteria for an acceptable roll-ahead distance of the supporting truck during the impact of a heavy passenger vehicle into the unit as required by the *NCHRP Report 350*, Test 51.
- C. *NCHRP Report 350* Test 52 and Test 53 results are desirable. If requested by the Department, submit a detailed report of certified test data showing conformance to the requirements of Test Numbers 50 and 51 of *NCHRP Report 350*.

605.2.2.2.3 System Description

605.2.2.2.3.1 General

- 1 Ensure that each truck-mounted attenuator is new or in like-new condition. Furnish each unit with all equipment, options, and features as required by the Specifications.

605.2.2.2.3.2 Lights

- 1 Equip each truck-mounted attenuator with lights and reflectors in compliance with applicable South Carolina motor vehicle laws, including turn signals, dual tail lights, and brake lights. Ensure that lights are visible in both the raised and lowered positions of the attenuator.

605.2.2.2.3.3 Color

- 1 Stripe the rear face of the unit in the operating position with alternating 4-inch black and 4-inch safety yellow 45-degree striping. Ensure that the striping forms an inverted "V" at the center of the unit and will slope down and toward the outside of the unit, in both directions from the center. Use industrial grade enamel paint.

605.2.2.2.3.4 Types of Truck-Mounted Attenuators

605.2.2.2.3.4.1 Cartridge Type

- 1 Make certain that the major performance characteristic of this type of truck-mounted attenuator is an energy absorbing material surrounded with an aluminum shell. Ensure that each unit consists of an expendable (crushable) cartridge, a backup structure, and a mounting assembly.

605.2.2.2.3.4.2 Mechanical Type

- 1 Ensure that the major performance characteristic of this type of truck-mounted attenuator is a steel frame structure with a bracket assembly attached to a bumper assembly. Make certain that the steel frame has sufficient structural strength to compress evenly.

605.2.2.3 Portable Terminal Impact Attenuators

605.2.2.3.1 General

- 1 Use non-gating and re-directive portable terminal impact attenuators designed and constructed for controlled deceleration of impacting vehicles and dissipation of a vehicle's kinetic energy or redirection of an errant vehicle as necessary. When struck from the front, ensure that the unit brings the errant vehicle to a safe and controlled stop. When impacted from the side, ensure that the unit redirects the errant vehicle. Ensure that each attenuator functions within the requirements as detailed by the Specifications and the manufacturer's specifications.
- 2 Use gating and non-redirective portable terminal impact attenuators only when directed by the Department.
- 3 Use portable terminal impact attenuators included on the *Approved Products List For Traffic Control Devices In Work Zones*.
- 4 Provide attenuators with nosepieces that are either fabricated in a solid yellow color or covered in its entirety with Type III high intensity solid yellow reflective sheeting.
- 5 Supplement the nosepiece of each unit with specific road signs for delineation. Install road sign W18-2-24, W18-2R-24, or W18-2L-24 complying with the requirements of the location of the installation. Provide roads signs in conformance with sign drawings in the *SCDOT Standard Drawings*.

605.2.2.3.2 Performance Requirements

605.2.2.3.2.1 Performance Criteria

- 1 Ensure that each attenuator functions within the criteria reported in industry publications.
- 2 Provide attenuators meeting the test requirements for the *NCHRP Report 350* for re-directive, non-gating terminals and crash cushions as directed by the FHWA. Ensure that all attenuators meet either Test Level 2 or Test Level 3 requirements. Require units installed on roadways with legal posted speed limits of 65 mph and 70 mph have FHWA acceptance for Test Level 3 requirements for 70 mph. Base determination for speed requirements for Test Level 3 units upon the legal posted speed limit prior to beginning construction.
- 3 Ensure that the design, selection, and placement of an attenuator conforms to and utilize devices described in:
 - AASHTO publication, *Roadside Design Guide*, and
 - FHWA Report N5040.16, *Crash Cushions, Selection Criteria and Design*.

605.2.2.3.2.2 Performance Regulations

- 1 Ensure that each attenuator functions within regulations regarding the performance of attenuators.

- 2 Ensure that each attenuator has the capability to decelerate and stop vehicles weighing 1800 to 4400 pounds during head-on impacts. Make certain that each attenuator meets the occupant risk and vehicle trajectory criteria as required by the *NCHRP Report 350*, Tests 30, 31, 32, and 33. Ensure that each attenuator passed Test 31, which evaluates the capacity of the unit to absorb the energy of the 4400-pound standard 3/4-ton pickup truck.
- 3 Ensure that each attenuator has the capability to redirect vehicles weighing 1800 to 4400 pounds that impact the unit along the side at angles of 20 degrees or less for both right-way and wrong-way impacts. All angles are measured from the longitudinal centerline of the unit for impact angle determination. Ensure that each attenuator meets the requirements of the *NCHRP Report 350*, Tests 36, 37, 38, and 39, which are used to evaluate the occupant risk and vehicle trajectory criteria, re-directional capability, the structural adequacy of the attenuator, the potential for snagging, and performance during a reverse hit.
- 4 Ensure that all test result data for 4400-pound vehicles includes the standard 3/4-ton pickup truck.
- 5 Ensure that each attenuator contains the debris from an impact within design parameters to prevent posing a potential hazard to the vehicle occupants, other traffic, pedestrians, or workers present in the immediate area.
- 6 The last 4 feet of the attenuator in front of the hazard is referred to as the "coffin corner." Ensure that the attenuator prevents penetration of the "coffin corner" in all impacts from 0 miles per hour up to the maximum design speeds of the unit for vehicles in the weight range of 1800 to 4400 pounds. Ensure that the attenuator prevents lateral penetration with a subsequent impact against the stationary hazard at or near the "coffin corner."

605.2.2.3.2.3 Types of Portable Terminal Impact Attenuators

605.2.2.3.2.3.1 Cartridge Type

- 1 Provide an attenuator in which the major performance components are expendable individual cartridge units. Provide cartridge units that are new or in like-new condition. Do not use cartridges exhibiting improper openings, gaps or wrinkles in the plastic container package, creases in the plastic, exposed internal material or attempt to repair the defective cartridges with rivets, screws, etc.; and furthermore, do not allow such defective cartridges on the project site. Replace all defective cartridges prior to installation of the unit.

605.2.2.3.2.3.2 Mechanical Type

- 1 Provide an attenuator in which the major performance components are mechanical parts, pieces, and systems working together to absorb and dissipate the energy. Provide energy-absorbing units that are in acceptable condition for proper operation as required by the manufacturer's specifications. Use units with working parts in new or like-new condition and are properly aligned. Replace all defective parts prior to installation of the unit.

605.2.3 Temporary Longitudinal Barriers

605.2.3.1 General

- 1 Provide temporary longitudinal barrier walls that comply with the requirements of the *NCHRP Report 350* and provide an acceptance letter from the FHWA verifying *NCHRP Report 350* compliance.

605.2.3.2 Temporary Concrete Barrier

- 1 Provide temporary concrete barriers included on the *Approved Products List For Traffic Control Devices in Work Zones*.
- 2 Use temporary concrete barrier walls fabricated by fabricators or producers included on the most recent *SCDOT Qualified Product List 54*.
- 3 Make certain that the design and shape of the concrete barrier wall meet all requirements as specified by the *SCDOT Standard Drawings*.
- 4 Ensure that the fabrication facilities of an approved barrier are inspected by a representative of the OMR. Repeat this process every 24 months. Require the fabricator to place a recessed approval stamp on each section of barrier wall in accordance with the *SCDOT Standard Drawings*. Ensure that these approval stamps are recessed; painted on stamps are not acceptable.
- 5 Prior to initiation of the current requirements for the recessed approval stamp, *NCHRP Report 350* compliant temporary concrete barrier walls were fabricated in accordance with the standard drawing for temporary concrete barriers with the J-J hook connection. Some of these barrier walls have a recessed stamp that reads "SCDOT 350," but some may not have a recessed stamp. The barrier walls with the "SCDOT 350" recessed stamp will continue to be acceptable on all projects as will the *NCHRP Report 350* compliant SCDOT approved safety shape with the J-J hook connection without the "SCDOT 350" recessed stamp. However, other than the *NCHRP Report 350* compliant SCDOT approved safety shape with the J-J hook connection, barrier walls that do not have a recessed approval stamp will not be acceptable on projects let after October 1, 2007.
- 6 Previously used temporary concrete barrier walls are subject to inspection and approval by the RCE before use. Ensure that previously used temporary concrete barrier walls are in good condition. Do not use any sections of barrier with excessive damage such as cracks, top corners with broken or chipped areas greater than 1 inch, bottom corners with broken or chipped more than 2 inches, or any edge with broken or chipped areas more than 1 inch.
- 7 Color all temporary concrete barrier walls "bright white" in conformance with the Plans and the Specifications. Obtain the coloration by either coating or painting. Ensure that the finish on each section of barrier wall is new with no chips, peel areas, or discoloration, and is smooth to prevent retention of roadway particles. If the finish chips, peels, or becomes discolored, remove and replace, re-coat, or repaint previously coated or painted barrier walls prior

to placement on the job site. Maintain the location and length of the barrier wall in conformity with the Plans, the Specifications, and direction of the RCE.

605.2.3.3 Temporary Polyethylene Water-Filled Barrier

605.2.3.3.1 General

- 1 Provide temporary polyethylene water-filled barriers included on the *Approved Products List For Traffic Control Devices in Work Zones*.
- 2 Provide temporary polyethylene water-filled barrier walls fabricated from a lightweight, recyclable, polyethylene plastic with each section of barrier wall designed to hold water as ballast. Ensure that the water-filled barrier walls interconnect and function as a temporary polyethylene water-filled barrier wall system. Provide a water-filled barrier with sections fabricated in white and orange colors and install in sections with alternating colors.
- 3 Ensure that the fabrication, installation, and maintenance of each temporary polyethylene water-filled barrier wall system conform to the requirements of the Plans, the Specifications, the manufacturer's specifications, and the RCE.
- 4 Supplement the top of the water-filled barrier with large delineators. Ensure that these large delineators have a minimum reflective area of not less than 50 square inches. Install these large delineators in accordance with the requirements of the *SCDOT Standard Drawings*. Due to the polyethylene material of the water-filled barrier, utilize an alternate system other than the mechanical anchors for anchoring the large delineators.

605.2.3.3.2 Performance Requirements

- 1 Ensure that the temporary polyethylene water-filled barrier wall system meets the recommended structural adequacy, occupant risk, and vehicle trajectory criteria specified by the *NCHRP Report 350*. Ensure that the design and construction of a water-filled barrier wall system prevents penetration, vaulting, and under riding of impacting vehicles within the Length Of Need (LON) and the Minimum Length of Need (MLON) of the water-filled barrier as determined by *NCHRP Report 350* guidelines.
- 2 Provide a temporary barrier wall system that satisfies the Operational Length of Need (OLON), which is that portion of the temporary polyethylene water-filled barrier wall system that deflects and prevents intrusion of an errant vehicle. To function properly, ensure that the OLON is flanked by an approach area of barrier and a downstream area of barrier. Ensure that each line of water-filled barrier contains an approach area, an OLON area, and a downstream area. Do not install the water-filled barrier adjacent to a work area in a manner that allows the approach and downstream areas to encroach onto the vicinity where the OLON area is required. If requested, provide the RCE with information regarding the determination of the required lengths of the approach and downstream areas.
- 3 Provide a temporary barrier wall system that satisfies the LON, which is the overall length of the temporary polyethylene water-filled barrier wall system

required to protect the work area. The LON is necessary to maintain acceptable deflection values and prevent the intrusion of an errant vehicle or the water-filled barrier wall into the work area. The LON provides the system with the capacity to redirect an errant vehicle or bring it to a controlled stop. The LON is comprised of an approach area, the OLON area, and a downstream area. The capacity for redirection of an errant vehicle is not likely in the approach and in downstream areas.

- 4 Ensure that the MLON, which is the minimum length of the temporary polyethylene water-filled barrier wall system required to perform within all *NCHRP Report 350* requirements, is installed properly. The MLON is the minimum length of water-filled barrier installation required to maintain acceptable deflection values and to prevent the intrusion of an errant vehicle or the water-filled barrier into the work area. The MLON is the minimum length of water-filled barrier that allows the system to maintain the capacity to redirect an errant vehicle or bring it to a controlled stop. Provide the MLON in the product description column of the *Approved Products List For Traffic Control Devices in Work Zones* for the approved water-filled barrier.
- 5 Ensure each installation of a temporary polyethylene water-filled barrier wall system consists of an approach area, an OLON area, and a downstream area to yield the LON for the system. The distances for these specific areas are unique to each approved product and the information must be acquired from the manufacturer.

605.2.3.3.3 Performance Regulations

- 1 Ensure that the temporary polyethylene water-filled barrier wall system provided has the capability to prevent vehicle penetration, vaulting, and under riding during impacts from errant vehicles within the OLON. Ensure that vehicles impacting the barrier wall within the OLON are brought to a controlled stop near the impact area or redirected during shallow angle impacts. Ensure that lateral deflection of the barrier wall conforms to design criteria during impacts when the barrier wall is installed on clean asphalt or concrete with less than a 5% cross slope.
- 2 Ensure that the temporary polyethylene water-filled barrier wall system has the capability to bring an errant vehicle impacting with the OLON at angles of 25 degrees or less to a controlled stop or redirected at a shallow angle.

605.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

605.4 Construction

605.4.1 Construction Signs

605.4.1.1 General

- 1 Use construction, regulatory, warning, and guide signs erected on the roadway for construction and maintenance projects to advise motorists of potential hazards and provide construction, regulatory, warning, and guide information as necessary. Install and maintain these signs as specified herein.
- 2 Mount these signs on either ground-mounted 3-pound per foot U-section posts, approved temporary sign supports, or approved Type III barricades. Ensure that construction signs erected on ground-mounted U-section posts have a minimum mounting height of 7 feet from the ground to the bottom edge of the sign and any secondary sign on the same assembly has a minimum mounting height of 6 feet from the ground to the bottom edge of the secondary sign. Ensure that construction signs mounted on approved portable sign supports have a minimum mounting height of 5 feet from the ground to the bottom edge of the sign. However, make certain that temporary "Exit" signs (M1025-00) located within temporary gore areas during lane closures mounted on approved portable sign supports have a minimum mounting height of 7 feet from the ground or pavement surface to the bottom edge of the sign as specified in **Subsection 602.2.3**.
- 3 When ground-mounting the construction signs, install signs on galvanized 3-pound per foot U-section posts per the Specifications. Utilize either a single direct driven or spliced post with an approved breakaway assembly for each individual sign support of a sign assembly installation. On spliced post installations, ensure that post lengths, stub heights, and breakaway assemblies comply with the manufacturer's requirements of each breakaway assembly. Use approved breakaway assemblies found on the *Approved Products List For Traffic Control Devices in Work Zones*. Do not combine a direct driven post and a spliced post for a single sign assembly installation that contains two or more sign supports.
- 4 Ensure that construction signs fabricated from an approved roll-up retroreflective fabric material or an approved aluminum composite material are mounted on portable sign supports or Type III barricades. Use portable sign support and Type III barricade included on the *Approved Products List For Traffic Control Devices in Work Zones* to support construction signs fabricated from an approved roll-up retroreflective fabric material. Use portable sign supports and Type III barricades that specifically reference an approved aluminum composite substrate material to support sign substrates fabricated from these materials. Refer to the *Approved Products List For Traffic Control Devices in Work Zones* for those portable sign supports and Type III barricades approved to support signs with aluminum composite substrates fabricated from an approved aluminum composite material such as Alpolite, Dibond, or Reynolite.

605.4.1.2 Temporary Construction Signs

- 1 Use construction, regulatory, warning, and guide signs installed on a temporary basis during construction or maintenance projects. Use these sign assemblies in place for various stages or durations during the life of the project.

605.4.1.3 Permanent Construction Signs

- 1 Erect these signs at the termini of a project before work begins and maintain in place until the project is complete. However, remove these signs when the project reaches substantial completion of work or omit selected signs in a case of contiguous projects as directed by the RCE. Consider all other signs temporary.
- 2 Use these signs attached to the Type III barricades during bridge closures and the closure of existing roads as illustrated on the *SCDOT Standard Drawings* designated for extended road closures for bridge construction and for existing roadways. Consider all other signs attached to Type III barricades as temporary. Ensure that these signs have sign substratum constructed of either an approved roll-up retroreflective fabric material or an approved aluminum composite material.

605.4.1.4 Application

- 1 Due to conditions unique to lane closures such as overlapping the permanent construction signs with the advance warning signs for lane closures, cover either some or all the permanent construction signs at the project termini when work activities that require lane closures are being conducted near or at the project termini with no adjustment in compensation.
- 2 Remove the permanent construction signs when the project reaches substantial completion of work. Remove or cover the signs when the project appears complete to the traveling public and only minor work is being conducted sporadically (i.e. such as touchup of grassing and adding nutrients to the grass). Re-erect or uncover the permanent construction signs if major work resumes. The Contractor has the option to replace the removed sign assemblies with proper temporary signing mounted on approved portable sign supports as directed by the RCE.
- 3 Do not overlap permanent construction signs on contiguous projects. If a contiguous project is initiated prior to completion of an existing project, install the new permanent construction signs and maintain the existing permanent construction signs at the remote termini of each project. Remove the signs at the contiguous terminus of the existing project. Upon completion of the existing project, remove the signs at the remote terminus of the existing project and install the signs at the contiguous terminus of the subsequent project.
- 4 Due to conditions unique to contiguous projects, remove or delay installation of certain permanent construction signs as directed by the RCE with no adjustment in compensation.

- 5 Installation, relocation, and removal of permanent construction signs are the responsibility of the Contractor. Coordinate installation, relocation, and removal of the signs at the adjoining termini of contiguous projects as directed by the RCE.

605.4.2 Work Zone Attenuators

605.4.2.1 General

- 1 Use attenuators on or adjacent to roadways to aid in providing protection of work areas and hazards in work zones.
- 2 Install, maintain, repair or replace as necessary, and relocate each attenuator as directed by the Plans, the Specifications, the manufacturer's specifications, the *SCDOT Standard Drawings*, and the RCE.

605.4.2.2 Truck-Mounted Attenuators

- 1 Use truck-mounted attenuators in lane closures, shoulder closures, mobile operations, and similar scenarios to aid in providing protection of work zones.
- 2 Use a *NCHRP Report 350* Test Level 2 or Test Level 3 truck-mounted attenuator based upon the legal posted regulatory speed limit of the roadway prior to the presence of construction zones, temporary speed limits, or unforeseen roadway hazards.
- 3 Restrict the use of a Test Level 2 truck-mounted attenuator, rated for 43 mph, on roadways with legal posted speed limits of 45 mph or less. Do not use truck-mounted attenuators on Interstate highways or roadways with posted speed limits of 50 mph or greater.
- 4 The Contractor may use a Test Level 3 truck-mounted attenuator, rated for 62 mph, on all roadways. Use only Test Level 3 truck-mounted attenuators on Interstate highways or roadways with posted speed limits of 50 mph or greater.
- 5 Always provide a clear zone of 100 feet in advance of the truck-mounted attenuator for roll ahead during an impact from an errant vehicle. Do not place the unit in front of a stationary hazard such as a temporary concrete barrier wall that may restrict roll ahead and reduce or eliminate the unit's capacity to function properly.
- 6 Attach each truck-mounted attenuator to the rear of a truck with a minimum gross vehicular weight (GVW) of 15,000 pounds (actual weight). If the addition of supplemental weight to the vehicle as ballast is necessary, use only dry loose sand for ballast.

605.4.2.3 Portable Terminal Impact Attenuators

605.4.2.3.1 Operational Regulations

- 1 Use the portable terminal impact attenuators on or adjacent to roadways to protect the ends of concrete barrier walls and other similar hazards in work zones.

- 2 Ensure that the speed functionality of an attenuator complies with the legal posted speed limit of the roadway prior to the presence or initiation of a work zone or temporary speed limit within a work zone. Require each attenuator to have FHWA acceptance for the test speeds equivalent to the speed requirements of the location intended for installation. For an attenuator to be considered acceptable at a specific rate of speed, ensure that the unit has FHWA acceptance for *NCHRP Report 350* at that rate of speed. Do not accept mathematical computations as alternatives to actual test results. Acceptable parameters for speed functionality of attenuators are as follows:
- A. Portable Terminal Impact Attenuator - Test Level 2 are units tested at 45 mph on roadways with permanent speed limits of 45 mph or less in place prior to the initiation of a work zone or any temporary reduced speed limits. Do not use Test Level 2 units on roadways with speed limits greater than 45 mph.
 - B. Portable Terminal Impact Attenuator - Test Level 3 - 60 MPH are units tested at 62.5 mph on roadways with permanent speed limits of 60 mph or less in place prior to the initiation of a work zone or any temporary reduced speed limits. Do not use Test Level 3 – 60 mph units on roadways with speed limits greater than 60 mph.
 - C. Portable Terminal Impact Attenuator – Test Level 3 – 70 MPH are units tested at 70 mph on roadways with permanent speed limits of 70 mph or less in place prior to the initiation of work zone or any temporary reduced speed limits. Test Level 3 – 70 mph units are acceptable on all roadways.
- 3 Ensure that all corresponding Shop Plans and detailed specifications including design, installation, and maintenance from the manufacturer are available for inspection by the RCE before installation of the attenuator. Ensure that the Shop Plans and specifications include performance criteria, installation drawings, and instructions that completely describe the attenuator system.

605.4.2.3.2 Field Installations

605.4.2.3.2.1 General

- 1 Install each attenuator as detailed by the Specifications, the manufacturer's specifications, the Plans, and the RCE.
- 2 Ensure that the personnel responsible for and actively engaged in installation of an attenuator have training and instruction from the manufacturer of the attenuator for correct installation and maintenance of the unit.
- 3 The RCE will inspect each attenuator, including all parts and materials, before and immediately after installation to ensure conformance with the Department and manufacturer's specifications.

605.4.2.3.3.2 Site Location

- 1 Install an attenuator not closer than 2 feet from the edge of an adjacent travel lane and preferably not closer than 6 feet. Install the attenuator parallel

to the adjacent traffic flow, unless otherwise specified by the Special Provisions and the Plans. When a unit is placed in a gore area, install the unit parallel to the mainline traffic flow.

- 2 If required for proper installation of the attenuator, perform site preparations such as grading, slope flattening, paving, installation of a concrete leveling pad, and excavation at the immediate site location of the attenuator. If the cross-slope exceeds 8% or has a variance in excess of 2%, perform site preparations to bring the immediate site location to within acceptable limits. Pave each site location in accordance with the manufacturer's specifications for installation for specific anchoring options.
- 3 Determine the length of the immediate site location by the length of the attenuator. Prepare the immediate site location to coincide with the length of the unit by 8 to 10 feet wide (perpendicular to the roadway). Excavate and clear all obstructions from the immediate site location as necessary. Remove obstructions within 3 feet of either side of the unit. Dress and clear the immediate surrounding area and the approach area 50 feet in advance of the system of curbs, islands, elevated objects, and depressions where possible. Grade unpaved approach areas where necessary to provide for smooth and flat surfaces. Make all approach areas in advance of the site location reasonably smooth and flat for not less than 100 feet. Ensure that the immediate site location places the attenuator at the same grade elevation, including adjustments necessary for superelevation, as the adjacent travel lane or paved shoulder.
- 4 Require an approved transition panel for the attenuator whenever the site location is within a two-way traffic situation. Place the attenuator on the site location to minimize exposure of the rear of the unit to opposing traffic and the possibility of a vehicle snagging the rear of the unit. Prepare each transition panel for attachment to the hazard and the attenuator, and attach the panel to the attenuator to permit the unit to function properly during an impact from the front. Install the panel flat and securely against the side of the hazard to prevent snagging of vehicles. Make all attachments of the transition panel in accordance with manufacturer's specifications.
- 5 Ensure that each site location selected for placement of an attenuator meets all requirements of the Specifications, the manufacturer's specifications, the Plans, and the RCE.

605.4.2.3.3.3 Foundation and Anchoring

- 1 Construct each foundation for anchoring of an attenuator in accordance with the manufacturer's specifications. Ensure that the top of each foundation is constructed or installed at the same grade elevation as the near edge of the adjacent travel lane or paved shoulder.
- 2 Construct each foundation of Portland cement concrete or asphalt concrete or a combination of the two as directed by the manufacturer's specifications. Do not use soil as a foundation.

- 3 If using asphalt concrete, ensure that approved asphalt concrete surface or intermediate courses are used for the foundation of an attenuator.
- 4 Match the correct anchors with a corresponding foundation as directed by the manufacturer's specifications. Ensure that the anchors placed into any portion of foundation containing asphalt concrete have a minimum length of 18 inches with a minimum embedment of 16.5 inches unless otherwise specified by the manufacturer. Ensure that the anchors placed into Portland cement concrete have a length of 6.5 inches to 7.5 inches with a minimum embedment of 5.5 inches to 6 inches in accordance with the manufacturer's specifications for concrete anchorage.
- 5 A reinforced portable concrete pad is an additional option for a foundation. Construct the portable pad with Class 4000 Portland cement concrete and No. 5 rebar spaced on a grid not greater than 12 inches X 24 inches. Ensure that the pad has a minimum thickness of 8 inches and has a minimum width of 4 feet and a minimum length of not less than 2 feet greater than the length of the attenuator the pad is to support. Ensure that the anchors used with the portable pad have a length of 6.5 inches to 7.5 inches with a minimum embedment of 5.5 inches to 6 inches in accordance with the manufacturer's specifications for concrete anchorage.
- 6 When utilizing a reinforced portable concrete pad, excavate the location as necessary to ensure that the top of the pad is at the same grade elevation as the adjacent roadway or shoulder. Backfill all areas surrounding the pad and compact this fill to stabilize the unit.
- 7 Ensure that anchors and anchor system components are new or in like-new condition for each installation or relocation of an attenuator when the reinforced portable concrete pad is not used. All new and like-new anchors and anchor system components are subject to RCE approval prior to installation.
- 8 Correctly match the grout and anchors to the intended foundation as required by the manufacturer's specifications for each installation or reinstallation. Reinstallation is considered the relocation of an attenuator from one location to another on the same project after an initial installation.
- 9 Install the correct number of anchors for the installation of each attenuator as specified by the manufacturer's specifications.
- 10 Utilize a two-part polyester epoxy or resin for grouting the anchors in accordance with the manufacturer's specifications.

605.4.2.3.4 Maintenance

- 1 Maintain all attenuators in a good, functional condition at all times. Repair or replace any unit that has sustained damage and is unable to function within the requirements of the Department specifications and the manufacturer's specifications. Initiate refurbishment or total replacement of a damaged unit within 2 hours after discovery or notification of an impact. Complete repairs or replace a damaged unit within 24 hours of discovery or notification of an impact.

- 2 Closely examine all parts of an attenuator, including the anchors and foundation, for damages after any incident. If on site repair without replacement of the unit is feasible, replace the damaged parts. If on-site repair is not feasible, replace the entire unit. Provide the replacement unit when an impact is severe enough to require complete replacement of an attenuator.
- 3 Closely examine all anchors after an impact. Replace all anchors that exhibit evidence of being moved or if the area surrounding an anchor contains cracks. If damage to the area surrounding an anchor appears too excessive to permit proper reattachment of the anchor, relocate the attenuator and reinstall all anchors.

605.4.3 Temporary Longitudinal Barriers

605.4.3.1 General

- 1 Use temporary longitudinal barrier walls on or adjacent to roadways to provide protection of work areas and hazards in work zones by preventing traffic from entering the work area.
- 2 Install, maintain, repair or replace as necessary, and relocate the barrier walls as directed by the Specifications, the manufacturer's specifications, the *SCDOT Standard Drawings*, the Plans, and the RCE.

605.4.3.2 Temporary Concrete Barrier

- 1 Use portable temporary concrete barrier walls on the roadway to prevent traffic from entering the work area, to separate two-way traffic, or to act as a temporary bridge parapet wall. Install, maintain, repair or replace as necessary, and relocate the barrier wall as specified herein.
- 2 Do not store material or equipment within 3 feet of the back of a temporary concrete barrier wall. Do not brace, attach, or rest material or equipment on or against a temporary concrete barrier wall.
- 3 Upon completion of the project, the concrete barrier wall remains the property of the Contractor unless otherwise specified.

605.4.3.3 Temporary Polyethylene Water-Filled Barrier

605.4.3.3.1 General

- 1 Use temporary polyethylene water-filled barrier walls on the roadway to prevent traffic from entering the work area. Install, maintain, repair or replace as necessary, and relocate the barrier wall as specified herein.
- 2 A temporary polyethylene water-filled barrier wall system has a much greater deflection than temporary concrete barrier wall; therefore, obtain all information from the manufacturer regarding the deflection values of the water-filled barrier and furnish this information to the RCE prior to installation of the water-filled barrier. Do not store material or equipment within the manufacturer's specified deflection zone of a water-filled barrier wall. Do not brace, attach, or rest material or equipment on or against a temporary polyethylene water-filled barrier wall.

605.4.3.3.2 Field Installations

- 1 Deploy the temporary polyethylene water-filled barrier wall system as directed by the manufacturer's specifications, the Specifications, the Plans, and the RCE.
- 2 Due to the amount of deflection characteristic of water-filled barrier, place the water-filled barrier to accommodate the projected amount of deflection in the event of an impact. Provide an adequate buffer space between the water-filled barrier and the work area based on the location, the roadway geometry, and the normal travel speed of the traffic.
- 3 Offset the approach area of the water-filled barrier away from the work area at a distance greater than or equal to the amount of lateral deflection likely to occur during an impact. Consider the roadway geometry and speeds when considering the angles of impact most likely to occur in the area where the water-filled barrier is deployed.
- 4 Install the temporary polyethylene water-filled barrier wall system to prevent the approach end of the line of water-filled barrier from becoming a hazard when placed adjacent to a travel lane. If space is available, taper the approach area of the water-filled barrier away from traffic. In those areas where the posted speed limit prior to installation of the work zone is 40 mph or less, taper the approach area of the water-filled barrier away from traffic at a rate of 8:1 to a point where the approach end of the water-filled barrier is 15 feet away from the near edge of the adjacent travel lane. In those areas where the posted speed limit prior to installation of the work zone is 45 mph or greater, taper the approach area of the water-filled barrier away from traffic at a rate of 10:1 to a point where the approach end of the water-filled barrier is 30 feet away from the near edge of the adjacent travel lane.
- 5 When tapering the approach end of the temporary polyethylene water-filled barrier wall system is not an option, supplement the approach end of the water-filled barrier with a portable terminal impact attenuator. Ensure that all portable terminal impact attenuators comply with **Subsection 605.2.2.3**. Use portable terminal impact attenuators appearing on the current *Approved Products List For Traffic Control Devices in Work Zones*.
- 6 When tapering the end of the temporary polyethylene water-filled barrier wall system or utilization of a portable terminal impact attenuator is impracticable as an option, usually due to space limitations or business and residential access requirements, utilization of a water-filled barrier capable of acting as its own crashworthy end treatment against head-on collisions is an option. Ensure that those sections of the plastic barrier wall system acting as crashworthy end treatment meet the criteria for a Test Level 2 Non-Redirective Crash Cushion for impact conditions of 1800 to 4400 pound vehicles with impact speeds up to 43 mph. As its own crashworthy end treatment, ensure that the impacting vehicles can be decelerated to a safe stop, permitted a limited controlled penetration of the barrier wall system, contained and redirected, or a combination of these possible scenarios. Use temporary polyeth-

ylene water-filled barrier wall systems acting as their own crashworthy end treatments appearing on the *Approved Products List For Traffic Control Devices in Work Zones*.

605.5 Measurement

- 1 The quantity for Permanent Construction Signs (mounted as required) is the area of the sign installed and is measured by the square foot (SF) using outside dimensions of sign, complete and accepted. No deduction is made for corner radii of the sign.
- 2 Temporary construction signs are included in the lump sum item Traffic Control as specified in **Subsections 107.12, 601.5, and 601.6**. No separate measurement is made for temporary construction signs unless otherwise specified and included in the Contract.
- 3 The quantity for the pay item Portable Terminal Impact Attenuator (of the test level and speed specified) is measured by each (EA) unit installed during the stage of work that requires the greatest number of attenuators, complete and accepted. Revision to the quantity and locations of the attenuators, from that required by the Plans, Plan quantities, or the Specifications, requires RCE approval before installation. If revision to the work reduces the required number of attenuators, only the units actually installed and eligible for measurement are measured for payment.
- 4 No pre-event measurement is made of spare parts for repair purposes in the event an attenuator is struck by an errant vehicle. Measurement and payment for spare parts required to repair an attenuator is made by a Supplemental Agreement as necessary.
- 5 No pre-event measurement is made for spare attenuators for replacement purposes in the event an attenuator is struck by an errant vehicle. Measurement of each (EA) replacement attenuator at the contract unit bid price is made only if repair of a unit struck and damaged by an errant vehicle is not possible or practical and total replacement of the unit is required.
- 6 No measurement is made of anchor kits used for the initial installation of an attenuator. The quantity for the pay item Anchor Kit – Portable Attenuator (of the test level and speed specified) required for the reinstallation of an attenuator after relocation from one location to another on the same project site are measure by each (EA) anchor kit installed, complete and accepted. Anchor kits used to anchor attenuators to portable reinforced concrete pads are not measured for payment.
- 7 The quantity for Temporary Concrete Barrier or Temporary Concrete Barrier Moveable is the length of function barrier essential for traffic control and is measured by the linear foot (LF) along the centerline of each section of barrier wall in-place during the stage of work that requires the greatest length of barrier wall as directed in the Plans, the *SCDOT Standard Drawings*, the Specifications, and the RCE, complete and accepted. Revision of the quantity or the location of the barrier wall, from that required by the Plans, Plan quantity, or the Specifications, requires RCE approval before installation. If the scope of

work is reduced, only the length of barrier wall installed and eligible for measurement is measured for payment. No separate measurement is made for the work, including the moving equipment and miscellaneous hardware, for the relocation of the barrier wall included in the Plan quantity and indicated on the Plans or in the Specifications. Such work is considered incidental to the work for the barrier wall item.

- 8 The quantity for the pay item Temporary Polyethylene Water-Filled Barrier is the length of functional water-filled barrier essential to the traffic control and is measured by the linear foot (LF) along the centerline of the barrier in-place during the stage of construction that requires the greatest length of the water-filled barrier as directed in the Plans, the *SCDOT Standard Drawings*, the Specifications, and the RCE, complete and accepted. Revision of the quantity or the location of the water-filled barrier, from that required by the Plans and the Specifications, requires RCE approval before installation. If the scope of work is reduced, only the length of water-filled barrier actually installed and eligible for measurement is measured for payment. No separate measurement is made for the work, including the equipment and miscellaneous hardware, for the relocation of the barrier included in the Plan quantity and indicated on the Plans or in the Specifications. Such work is considered incidental to the work for the water-filled barrier item. No measurement is made of spare parts, manuals, water, equipment for dispensing and removing water, vehicles and equipment for conveying water, antifreeze, repair or replacement of damaged units, or miscellaneous hardware. Such items and work are considered incidental to the water-filled barrier.
- 9 Measurement of additional or relocated temporary barrier is made only if all the following conditions are met:
- A. Only those sections of barrier provided are in addition to the original Plan quantity.
 - B. The additional quantity is provided as directed by the RCE.
 - C. Placement of the additional barrier is not illustrated in the Plans or directed by the Plans and the Specifications.
- 10 Truck-mounted attenuators are included in the lump sum item Traffic Control as specified in **Subsections 107.12** and **601.5**. No separate measure or payment is made for truck-mounted attenuators unless otherwise specified and included in the Contract.
- 11 Other Category III traffic control devices not herein specified for measurement are included in the lump sum item Traffic Control. No separate measure or payment is made for these items unless the Contract includes specific bid items for such devices.

605.6 Payment

- 1 Payment for the accepted quantity for each pay item measured or determined in accordance with **Subsection 605.5**, is determined using at the contract unit bid price of the applicable item.

- 2 Payment for Permanent Construction Signs (mounted as required) is full compensation for installing permanent construction signs as specified or directed and includes providing, storing, installing, relocating as necessary, maintaining, and removing the signs. Payment includes providing an approved sign substratum with the proper sheeting and legend; erecting the signs on ground-mounted 3-pound per foot U-section posts, providing approved temporary sign supports, Type III barricades, or customized mounting hardware; providing approved breakaway assemblies and necessary customized mounting hardware; installing and removing the signs on contiguous projects as directed by the RCE; and all other materials, labor, hardware, equipment, tools, supplies, transportation, incidentals; miscellaneous items, and traffic control necessary for installation and maintenance of the signs until completion of the work in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for Portable Impact Attenuators (of the test level and speed specified) is full compensation for the installation of the portable attenuator as specified or directed and includes providing, installing, removing, relocating, and reinstalling the attenuator. Payment includes preparing and excavating the site location as necessary; providing a reinforced concrete leveling pad as necessary; furnishing and installing the initial anchor kit, providing delineation treatments and rear transition panels; installing concrete and asphalt paving in conjunction with the attenuator; initiating and completing the repair or replacement of damaged units within the time limits specified; providing traffic control for installation and maintenance of attenuators; and all other materials, labor, equipment, tools, supplies, transportation, incidentals, and miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 No pre-event payment is made for spare parts for repair purposes in the event an attenuator is struck by an errant vehicle. Payment for replacement spare parts used to repair the attenuator on site will be made by a Supplemental Agreement. Payment for replacement of the spare parts utilized is made at the manufacturer's invoice purchase price up to 80% of the contract unit bid price for the attenuator if the unit is repaired on site and also includes shipping and handling of the replacement parts up to 20% of the contract unit bid price for the attenuator.
- 5 No pre-event payment is made for a spare attenuator for replacement purposes of an attenuator struck by an errant vehicle. If repair of the unit damaged is not possible or practical and total replacement of the unit is required, payment for a replacement attenuator is made using the contract unit bid price bid for Portable Impact Attenuator (of the test level and speed required).
- 6 Payment for the initial installation of a terminal impact attenuator includes the anchor kit. No separate payment is made for the anchor kit unless used for the reinstallation of an attenuator when relocated from one location to another on the same project site. If relocation is required, payment is determined using the contract unit bid price for Anchor Kit – Portable Attenuator (of

the test level and speed specified). Payment is full compensation for providing and installing the correct anchor kit for the corresponding foundation and attenuator as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation and incidentals required for each anchor kit specified. Anchor kits used to anchor attenuators to portable reinforced concrete pads are not eligible for separate payment.

- 7 Payment for Temporary Concrete Barrier Wall or Temporary Concrete Barrier Wall (Moveable) is full compensation for providing, installing, removing, relocating as necessary, and maintaining the temporary concrete barrier wall as specified or directed and includes painting or coating new barrier wall; re-coating, repainting, or cleaning previously used or discolored barrier wall or barrier wall discolored during the life of the project as determined necessary by the RCE; removing and replacing discolored barrier walls; relocating and reinstalling throughout the stages of construction; repairing or replacing damaged barrier walls; providing and installing anchors for anchoring barrier walls when necessary; providing hardware, concrete pads, and all incidentals required to connect the barrier wall to Thrie beam guardrail sections, permanent barrier walls, and bridge rails; providing traffic control for the installation and maintenance of the temporary barrier wall; and all other materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 8 Payment for relocation of temporary concrete barrier walls is made only for those sections of barrier installed in addition to original plan quantities upon request of the RCE.
- 9 Payment for Temporary Polyethylene Water-Filled Barrier is full compensation for providing, installing, removing, relocating as necessary, and maintaining the water-filled barrier as specified or directed and includes furnishing all materials, hardware, equipment, water, water dispensing equipment, and antifreeze; relocating and reinstalling the temporary barrier (as necessary) throughout all stages of construction; repairing or replacing damaged barrier units; providing traffic control for the installation and maintenance of the temporary barrier; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 10 Payment for Category III traffic control devices not herein specified for payment are included in the lump sum bid price for the item Traffic Control as specified in **Subsections 107.12** and **601.6**. Payment is full compensation for providing, installing, relocating (as necessary), removing, and maintaining the device as specified or directed and includes furnishing the truck for truck-mounted attenuators; replacing a damaged device before continuing or resuming work after damage causing incident; installing and removing traffic control required during replacement of malfunction or damaged devices; providing an approved sign substratum with the proper sheeting and legend for temporary construction signs; erecting temporary construction signs on either

ground-mounted 3-pound per foot U-section posts, approved temporary sign supports, or approved Type III barricades including customized mounting hardware; and all other materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

11 Payment for each item includes all direct and indirect costs and expenses required to complete the work.

12 Pay items under this section include the following:

Item No.	Pay Item	Unit
6051120	Permanent Construction Signs (Ground Mounted)	SF
6051125	Permanent Construction Signs (Barricade Mounted)	SF
6052120	Portable Terminal Impact Attenuator	EA
6052121	Portable Terminal Impact Attenuator – Test Level 2	EA
6052122	Portable Terminal Impact Attenuator – Test Level 3 (60 mph)	EA
6052123	Portable Terminal Impact Attenuator – Test Level 3 (70 mph)	EA
6052124	Absorb 350 – Portable Attenuator - Moveable Barrier	EA
605212A	Anchor Kit – Portable Attenuator (Test Level 2)	EA
605212B	Anchor Kit – Portable Attenuator (Test Level 3) 60 mph	EA
605212C	Anchor Kit – Portable Attenuator (Test Level 3) 70 mph	EA
6053110	Temporary Concrete Barrier	LF
6053115	Temporary Concrete Barrier (Moveable)w/Non- Textured White Coating (Including TTV)	LF
6053120	Temporary Water Filled Polyethylene Barrier	LF

SECTION 606

CATEGORY IV TRAFFIC CONTROL DEVICES

606.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for Category IV traffic control devices in conformity with the Plans and the Specifications or as directed by the RCE.
- 2 Category IV traffic control devices include trailer-mounted traffic control devices such as advance warning arrow panels, changeable message signs, portable traffic signals, and portable lighting equipment. The FHWA and AASHTO are evaluating methods for making these devices crashworthy. No Category IV devices were *NCHRP Report 350* approved at the time of printing of these specifications.

606.2 Materials

- 1 None specified.

606.3 Equipment

606.3.1 Trailer-Mounted Advance Warning Arrow Panels

606.3.1.1 Panel Face

- 1 Ensure that each advance warning arrow panel has a rectangular shaped panel face, not less than 48 inches high by 96 inches wide, and finished with a black non-reflectorized surface. Equip each panel with 5-inch minimum sized yellow or amber lamps (15 or 25 lamps). Supplement each lamp with a visor encompassing not less than 180 degrees of the lamp circumference. Ensure that these lamps provide legible message modes at a minimum distance of 1 mile. Ensure that the panels are able to produce the message modes specified when operating.

606.3.1.2 15-Lamp Arrow Panel Message Modes

- 1 Ensure that the advance warning arrow panel has the following 15 lamp arrow panel message modes:
 - Left Arrow Mode: 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.
 - Right Arrow Mode: 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.
 - Double Arrow Mode: 5 lamps in each arrowhead and 3 lamps in a shaft flashing simultaneously.
 - Caution Mode: 4 outermost corner lamps flashing simultaneously.

606.3.1.3 25-Lamp Arrow Panel Message Modes

- 1 Ensure that the advance warning arrow panel has the following 25 lamp arrow panel message modes:

606.3.1.4

606.3.1.5

- Left Arrow Mode: 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.
- Right Arrow Mode: 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.
- Double Arrow Mode: 5 lamps in each arrowhead and 3 lamps in a shaft flashing simultaneously.
- Caution Mode: 4 outermost corner lamps flashing simultaneously.
- Left Sequencing Chevrons Mode: 3 chevrons of 5 lamps each, a 3 step sequential action of 5 lamps, 10 lamps, and 15 lamps sequencing from right to left.
- Right Sequencing Chevrons Mode: 3 chevrons of 5 lamps each, a 3 step sequential action of 5 lamps, 10 lamps, and 15 lamps sequencing from left to right.

606.3.1.4 Rear of Panel

- 1 Ensure that each arrow panel is equipped with 3 lamps located on the rear of the panel that will indicate message mode being displayed.

606.3.1.5 Power System, Illumination, and Intensity

- 1 Provide a 12-volt electrical system powered from a 12-volt DC power source or an adaptable 110- or 120-volt AC power source to operate the arrow panel. Equip each arrow panel that utilizes a DC electrical power source with an automatic lamp intensity regulator that maintains a constant output with a varying battery voltage and a voltage indicator or warning device that indicates when the batteries need recharging. Place the lamp intensity regulator and the voltage indicator in a convenient location for easy reading.
- 2 Ensure that the system provides between 25 and 40 complete operating cycles or flashes per minute in each of the operational modes specified. Ensure that the lamp illumination or "ON" time is not less than 50% during flashing modes and not less than 25% during sequential modes. Ensure that the system has the capability to track ambient light 24 hours a day and make the required adjustments to lamp intensity. Adjust the system for nighttime lamp intensity through a voltage reduction of not greater than 50% and ensure that it maintains lamp intensity at a constant and even intensity level throughout all lamps operating in unison.
- 3 Provide electrical power from a power source mounted on the same trailer as the arrow panel or from an adaptable 110- or 120-volt AC power source. Regardless of the source, ensure that the supply of electrical energy is capable of operating the arrow panel as required by the Plans, the Specifications, and the *MUTCD*.
- 4 Provide electrical power for the arrow panel from one of the power sources specified in **Subsection 606.3.1.6**.

606.3.1.6 Power Sources**606.3.1.6.1 Solar Assisted Power Source**

- 1 Power the arrow panel with a battery bank charged by photovoltaic solar panels and supplemented with a built-in 110-volt, 20-amp battery charger. Ensure that the battery bank is housed in a lockable, heavy-duty, steel, weatherproof box. Ensure that the power control unit contains two current meters, one to indicate amperage generated by the battery charger and the other for amperage generated by the solar panels.

606.3.1.6.2 AC Power Source

- 1 Power the arrow panel with an adaptable 110- or 120-volt AC power source and equip the unit with ground fault interrupting circuit (GFIC) breakers. Ensure that all AC power adaptations are made in compliance with UL approved equipment and methods. Make all power attachments in accordance with all OSHA regulations and the *National Electrical Code* in effect at the time the Contract Proposal was advertised.

606.3.1.6.3 Diesel Power Source

- 1 An air-cooled variable speed diesel engine is an acceptable power source, in some isolated areas with prior RCE approval. Do not use a diesel power source in or near residential or business areas where the engine noise could be considered a nuisance. Equip the engine with a minimum 25-gallon capacity fuel tank with a fuel cut-off valve at the tank, a muffled exhaust system, and a steel fabricated security cage that encloses both the engine and the alternator.
- 2 When utilizing a diesel powered trailer-mounted arrow panel, equip the unit with a fuel tank capacity to operate not less than 24 hours without refueling. Design the fuel tank to minimize the danger of rupture or explosion in case of impact. Do not store additional fuel on or near the trailer.

606.3.1.7 Trailers

- 1 Ensure that each trailer-mounted arrow panel is in total compliance with South Carolina laws governing motor vehicles. Satisfy the minimum requirement for lights and reflectors including turn signals, dual taillights, and brake lights. Equip the trailer with safety chains meeting SAE J-697 standards. Paint both the trailer and the sign support Federal Standard No. 595, Orange Color No. 12246.
- 2 Ensure that the trailer-mounted arrow panel can remain stable in winds up to 80 miles per hour when in the operating position.

606.3.2 Trailer-Mounted Changeable Message Sign**606.3.2.1 General**

- 1 Provide changeable message signs that have either three lines or full matrix three-line capability and the capability to provide clear and legible messages from a distance of 1000 feet.

606.3.2.2 Sign Panel

- 1 Ensure that the sign panel is approximately 76 inches vertically by 113 inches horizontally. Specific measurements may vary from manufacturer to manufacturer. Ensure that the sign panel has the capability to provide message updates in less than 400 milliseconds.

606.3.2.3 Three-Line Display

- 1 Ensure that a three-line sign has not less than eight individual modules per line. Ensure that each module has a matrix size of not less than 5 x 7 message components and has the capacity to provide a character height of not less than 18 inches.

606.3.2.4 Full Matrix Three-Line Display

- 1 Ensure that a full matrix three-line sign has a full matrix with a matrix size of approximately 50 x 28 message components. The exact matrix size may vary from manufacturer to manufacturer not to exceed $\pm 5\%$.

606.3.2.5 LED Display

- 1 Ensure that message components are LED elements and each pixel contains no less than 4 LED elements.

606.3.2.6 LED/Flip Disk Hybrid Display

- 1 Ensure that message components are a combination of LED and flip disk elements and that the flip disk elements have a face area of not less than 3.75 square inches and are Saturn Yellow in color on the face and flat black on the backside. Ensure that a typical 5 x 7 matrix or an equivalent area contains 35 LED lamp pixels and 35 flip disk elements.

606.3.2.7 Controller

- 1 Ensure that the controller is an electronic unit housed in a weatherproof, rust resistant box with a keyed lock and a light for night operation. Provide the unit with a jack that allows direct communications between the on-board controller and an IBM compatible personal computer. Ensure that this unit has a LCD display screen that allows the operator to review messages prior to displaying the message on the sign.
- 2 Ensure that the controller has the capability of storing 199 factory preprogrammed messages and up to 199 additional messages created by the user. Ensure that the controller stores the messages in a manner that does not require a battery to recall the messages. Ensure that the operator of the computer has the ability to program the controller to display multiple messages in sequence. Ensure that the "LED/Flip Disk Hybrid" signs have a preprogrammed "default message" programmed for constant display in the event of a malfunction such as a power loss and total shut down of the sign.
- 3 Ensure that the controller has a selector switch that allows the operator to control the brightness of light source intensity of the sign panel. Use a selector that is capable of "bright," "dim," and "automatic" modes. When the selec-

tor switch is in the "automatic" mode, ensure that a photosensitive circuit controls the light source intensity in response to the changes such as from day to night and other various sources of ambient light.

- 4 Equip each sign with a cellular telephone to provide the operator the capability to revise or modify the message selection from the office or from another cellular telephone.

606.3.2.8 Power System

- 1 Provide a 12-volt electrical system powered from a 12-volt DC power source or an adaptable 110- or 120-volt AC power source to operate the sign panel. Equip each sign panel that utilizes a DC electrical power source with an automatic lamp intensity regulator that maintains a constant output with a varying battery voltage and a voltage indicator or warning device that indicates when the batteries need recharging. Place the lamp intensity regulator and the voltage indicator in a convenient location for easy reading.
- 2 Obtain the sign panel operating power from a power source mounted on the trailer on which the unit is mounted unless an adaptable 110- or 120-volt AC power source is available. Regardless of the source, ensure that the supply of electrical energy is capable of operating the changeable message sign as required by the Plans, the Specifications, and the *MUTCD*.
- 3 Provide electrical power for the sign panel from one of the power sources specified in **Subsection 606.3.2.9**.

606.3.2.9 Power Sources

606.3.2.9.1 Solar Assisted Power

- 1 Power the sign panel with a battery bank charged by photovoltaic solar panels and supplemented with a built-in 110-volt, 20-amp battery charger. Ensure that the battery bank is housed in a lockable heavy-duty, steel, weatherproof box. Ensure that the power control unit contains two current meters, one to indicate amperage generated by the battery charger and the other for amperage generated by the solar panels.

606.3.2.9.2 AC Power

- 1 Power the sign panel with an adaptable 110 or 120-volt AC power source and equip the unit with ground fault interrupting circuit breakers. Ensure that all AC power adaptations are made in compliance with UL approved equipment and methods. Ensure that all the power attachments are in accordance with all OSHA regulations and the *National Electrical Code*, in effect at the time the Contract was advertised.

606.3.2.10 Trailer and Accessories

- 1 Mount the sign panel on a trailer rated for not less than 2000-pound capacity. Ensure that the trailer is fabricated and equipped with a single axle, springs, sign support assembly, and four leveling or stabilizer jacks. Ensure that the sign rotates 360 degrees on a vertical axis to permit positioning for transport or for operation. Ensure that the sign has a manual crank or a hy-

draulic system to permit one person to raise the sign into its operating position.

- 2 Ensure that the sign panel provides a minimum height of 7 feet from the bottom of the sign to the surface of the roadway when raised into its operating position.
- 3 Make certain that each trailer-mounted sign panel is in total compliance with South Carolina laws governing motor vehicles. Satisfy the minimum requirement for lights and reflectors including turn signals, dual taillights, and brake lights. Equip the trailer with safety chains meeting SAE J-697 standards. Paint both the trailer and the sign support Federal Standard No. 595, Orange Color No. 12246.
- 4 Ensure that the trailer-mounted sign panels can remain stable in winds up to 80 miles per hour when in the operating position.

606.3.3 Equipment on Site

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

606.4 Construction

606.4.1 Trailer-Mounted Advance Warning Arrow Panels

606.4.1.1 General

- 1 Use trailer-mounted advance warning arrow panels to provide additional advance warning and directional information to assist motorists through a work zone. Make certain to provide these warning devices for advance directional information in lane closures. Install, maintain, and operate each arrow panel as specified herein.

606.4.1.2 Operational Regulations

- 1 Use trailer-mounted advance warning arrow panels for lane closures or work activities on high-density and high-speed roadways as well as low-density and low-speed roadways.
- 2 Mount advance warning arrow panels to provide a minimum height of 7 feet from the bottom of the sign to the surface of the roadway.
- 3 During lane closures, place one trailer-mounted arrow panel on the roadway shoulder at the beginning of the taper and a second within the closure at the downstream end of the taper. However, where the shoulders are narrow or site conditions restrict the use of the shoulder areas, place the first arrow panel in the closed lane behind the channelizing devices. Placement of the first arrow panel at the start of the taper is desirable.

- 4 Use a combination pattern of 4 lamps with 1 in each corner flashing simultaneously (referred to as the "4 Corners" pattern) as the required pattern during the Caution Mode.

606.4.1.3 Operational Restrictions

- 1 Use the trailer-mounted advance warning arrow panel as a supplemental traffic control device. Prohibit the use of a trailer-mounted arrow panel as a singular entity. Use an arrow panel along with other various traffic control devices as specified by the Plans, the Specifications, the *MUTCD*, and the RCE.
- 2 Do not use trailer-mounted arrow panels as a part of a flagging operation to direct vehicles into lanes used by opposing traffic.
- 3 Do not display Sequencing Arrow Modes due to staged and slow development of the intended message by the message modes. Use the Flashing Arrow Modes, the Sequencing Chevron Modes, or the Caution Mode.
- 4 Ensure that the "4 Corners" pattern does not indicate direction or resemble any other mode. Do not use advance warning arrow panels incapable of producing the "4 Corners" pattern. Do not display a "bar," "diamond," or any other symbol other than the required "4 Corners" during the Caution Mode.

606.4.1.4 Maintenance

- 1 Provide daily maintenance of each advance warning arrow panel. Ensure that all power source generators, including the photovoltaic solar panels on solar assisted units, undergo daily maintenance inspections. Replace an inoperative unit immediately upon discovery of the unit's failure. If replacement of the inoperative unit is not initiated immediately, the RCE will immediately suspend all work activities and require removal of all equipment from the roadway. If replacement of defective or burned out lamps is not initiated immediately upon discovery of the deficient lamps, the RCE will impose an immediate suspension of all work activities. Consider any unit with lamps producing inconsistent levels of intensity between messages or between the lamps to be in need of repair and requiring immediate replacement with a unit in good operating condition. Do not place a defective, deficient, or damaged unit on the roadway.

606.4.2 Trailer-Mounted Changeable Message Sign

606.4.2.1 General

- 1 Use trailer-mounted changeable message signs to provide additional advance warning and directional information to assist motorists through a work zone. Install, maintain, and operate each changeable message sign as specified herein.
- 2 Use changeable message signs to supplement all lane closures on Interstate highways and high volume primary routes as directed by the *SCDOT Standard Drawings*, the Specifications, and the Plans.

606.4.2.2 Operational Requirements

- 1 Install and utilize changeable message signs in all lane closures installed on high-volume, high-speed roadways. Use of changeable message signs in lane closures installed on low-volume, low-speed multilane roads is optional unless otherwise directed by the Plans, the Specifications, or the RCE. Install and use changeable message signs within a lane closure setup as indicated in the *SCDOT Standard Drawings*.
- 2 When a lane closure is non-operational for more than 24 hours, remove the changeable message sign from the roadway. Place the sign in a predetermined area on the project site, approved by the RCE, where the sign is not visible to passing motorists.
- 3 Use pre-programmed messages in accordance with the *SCDOT Standard Drawings* when changeable message signs are used as part of the traffic control setup for lane closures. Display only those messages pertinent to the traffic control situation and traffic conditions. Do not use messages on the changeable message sign that duplicate the legends on the permanent construction signs.
- 4 Place the changeable message sign on the shoulder of the roadway not less than 6 feet between the edge of the sign and the near edge of the adjacent travel lane. Supplement the sign location with not less than 5 portable plastic drums placed between the sign and the adjacent travel lane for delineation of the sign location. Install and maintain the drums not closer than 3 feet from the near edge of the adjacent travel lane. This requirement for delineation of the sign location applies at all times during which the sign is within 30 feet of the near edge of a travel lane open to traffic and includes both operation and non-operation times. Do not use oversized cones as a substitute for the portable plastic drums.

606.4.2.3 Maintenance

- 1 Provide daily maintenance of each changeable message sign. Ensure that all power source generators, including the photovoltaic solar panels on solar assisted units, undergo daily maintenance inspections. Replace an inoperative unit immediately upon discovery of the unit's failure. If replacement of the inoperative unit is not initiated immediately, the RCE will immediately suspend all work activities and require removal of all equipment from the roadway. If replacement of defective or burned out lamps is not initiated immediately upon discovery of the deficient lamps, the RCE will impose an immediate suspension of all work activities. Consider any unit with lamps producing inconsistent levels of intensity between messages or between the lamps to be in need of repair and requiring immediate replacement with a unit in good operating condition. Do not place a defective, deficient, or damaged unit on the roadway.

606.5 Measurement

- 1 Unless otherwise specified, Category IV traffic control devices, such as trailer-mounted advance warning arrow panels, are included in the lump sum item for Traffic Control in accordance with **Subsections 107.12** and **601.5** and if so included, there is no specific measurement made for such items.
- 2 Trailer-mounted changeable message signs are not included in the lump sum item Traffic Control. The quantity for the pay item Construction Zone Electric Changeable Message Sign (Trailer-Mounted) is measured by each (EA) message sign actually installed and operational on the project. RCE approval is required for any revisions to the quantities and locations of the changeable message signs required by the Plans, the Plan quantities, the *SCDOT Standard Drawings*, and the Specifications before installation. There is no separate payment for sign relocations or operational equipment unless the Contract includes specific pay items for these items.

606.6 Payment

- 1 Payment for accepted quantities, measured, or determined in accordance with **Subsection 606.5** is determined using the contract unit bid price for the item.
- 2 In addition to **Subsections 107.12** and **601.6**, the payment for Traffic Control is full compensation for providing, installing, removing, relocating, operating, and maintaining trailer-mounted advance warning arrow panels as specified or directed and includes providing the unit's primary power source; repairing or replacing damaged or malfunctioning units within the specified time; providing traffic control necessary for installing, operating, and maintaining the arrow panels; and all other materials, labor, hardware, equipment, tools, supplies, transportation, incidentals, and any miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for the accepted quantity for Construction Zone Electric Changeable Message Sign (Trailer-Mounted) is full compensation for providing, installing, removing, relocating, operating, and maintaining the trailer-mounted changeable message signs as specified or directed and includes providing the unit's primary power source; repairing or replacing damaged or malfunctioning units within the specified time; providing traffic control necessary for installing, operating, and maintaining the changeable message signs; and all other materials, labor, hardware, equipment, tools, supplies, transportation, incidentals, and any miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Payment for Category IV traffic control devices includes all direct and indirect costs and expenses necessary to fulfill the requirements of the pay item.

606.6

606.6

5 Pay items under this section include the following:

Item No.	Pay Item	Unit
6062000	Construction Zone Electric Changeable Message Sign (Trailer-Mounted)	EA

SECTION 607

TRUCK-MOUNTED TRAFFIC CONTROL DEVICES

607.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for truck-mounted traffic control devices including advance warning arrow panels and changeable message signs in conformity with the Plans and the Specifications or as directed by the RCE.
- 2 Truck-mounted advance warning arrow panels and truck-mounted changeable message signs are not included in any category as an individual traffic control devices since these devices are supplemental to the vehicles.
- 3 These truck-mounted devices are excluded from any of the categories as currently defined by *NCHRP Report 350*.

607.2 Materials

- 1 None specified.

607.3 Equipment

607.3.1 Truck-Mounted Advance Warning Arrow Panels

607.3.1.1 Panel Face

- 1 Ensure that each advance warning arrow panel has a rectangular shaped panel face, not less than 48 inches high by 96 inches wide, and is finished with a black non-reflectorized surface. Equip each panel with 5-inch minimum sized yellow or amber lamps (15 or 25 lamps). Supplement each lamp with a visor encompassing not less than 180 degrees of the lamp circumference. Ensure that these lamps provide legible message modes at a minimum distance of 1 mile. Ensure that the panels are able to produce the message modes specified when operating.

607.3.1.2 15-Lamp Arrow Panel Message Modes

- 1 Ensure that the advance warning arrow panel has the following 15 lamp arrow panel message modes:
 - Left Arrow Mode: 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.
 - Right Arrow Mode: 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.
 - Double Arrow Mode: 5 lamps in each arrowhead and 3 lamps in a shaft flashing simultaneously.
 - Caution Mode: 4 outermost corner lamps flashing simultaneously.

607.3.1.3 25-Lamp Arrow Panel Message Modes

- 1 Ensure that the advance warning arrow panel has the following 25 lamp arrow panel message modes:

- Left Arrow Mode: 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.
- Right Arrow Mode: 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.
- Double Arrow Mode: 5 lamps in each arrowhead and 3 lamps in a shaft flashing simultaneously.
- Caution Mode: 4 outermost corner lamps flashing simultaneously.
- Left Sequencing Chevrons Mode: 3 chevrons of 5 lamps each, a 3 step sequential action of 5 lamps, 10 lamps, and 15 lamps sequencing from right to left.
- Right Sequencing Chevrons Mode: 3 chevrons of 5 lamps each, a 3 step sequential action of 5 lamps, 10 lamps, and 15 lamps sequencing from left to right.

607.3.1.4 Rear of Panel

- 1 Equip each arrow panel with 3 lamps located on the rear of the panel that indicate the message mode being displayed.

607.3.1.5 Power System, Illumination, and Intensity

- 1 Use a 12-volt electrical system powered from a 12-volt DC power source or an adaptable 110- or 120-volt AC power source to operate the arrow panel. Equip each arrow panel that utilizes a DC electrical power source with an automatic lamp intensity regulator that maintains a constant output with a varying battery voltage and a voltage indicator or warning device that indicates when the batteries need recharging. Place the lamp intensity regulator and the voltage indicator in a convenient location for easy reading.
- 2 Ensure that the system provides between 25 and 40 complete operating cycles or flashes per minute in each of the operational modes specified. Ensure that the lamp illumination or "ON" time is not less than 50% during flashing modes and not less than 25% during sequential modes. Ensure that the system has the capability to track ambient light 24 hours a day and make required adjustments to lamp intensity. Adjust the system for nighttime lamp intensity through a voltage reduction of not greater than 50% and ensure that it maintains lamp intensity at a constant and even intensity level throughout all lamps operating in unison.
- 3 Obtain operating power for the truck-mounted arrow panel from the vehicle, solar assisted facilities, an adaptable 110- or 120-volt AC power source, or a truck-mounted generating plant. Regardless of the source, ensure that the supply of electrical energy is capable of operating the arrow panel as required by the Plans, the Specifications, and the *MUTCD*.
- 4 Provide electrical power for the advance warning arrow panel unit from one of the power sources specified in **Subsection 607.3.1.6**.

607.3.1.6 Power Sources**607.3.1.6.1 Solar Assisted Power**

- 1 Power the arrow panel with a battery bank charged by photovoltaic solar panels and supplemented with a built-in 110-volt, 20-amp battery charger. Ensure that the battery bank is housed in a lockable heavy-duty, steel, weatherproof box. Equip the battery bank with a charge indicator that gives readings on the amount of charge the battery bank is carrying.

607.3.1.6.2 AC Power

- 1 Power the arrow panel with an adaptable 110- or 120-volt AC power source and equip the unit with ground fault interrupting circuit (GFIC) breakers. Ensure that all AC power adaptations are made in compliance with UL approved equipment and methods. Make all power attachments in accordance with all OSHA regulations and the *National Electrical Code* in effect at the time the Contract Proposal was advertised.

607.3.1.6.3 Vehicle Based Power

- 1 Operating the arrow panel at an optimal voltage of 12-volt DC and obtaining the electrical power necessary for operation from the vehicle's alternator and battery system of a truck-mounted generating plant is an acceptable power source in some isolated areas with prior RCE approval. Do not use a portable generator for a power source. Do not use the vehicle as a power source in or near residential or business areas where the engine noise could be considered a nuisance.

607.3.2 Truck-Mounted Changeable Message Sign**607.3.2.1 Sign Panel**

- 1 Provide a sign display panel that is approximately 42 inches vertically by 76 inches horizontally. Specific measurements may vary from manufacturer to manufacturer. Ensure that the display panel has full matrix capability and provides two message lines with the capability to display 7 characters per line with a character height of 18 inches.
- 2 Ensure that the truck-mounted changeable message sign has the capability to provide clear and legible messages from a distance of 850 feet and the message update rate is less than 400 milliseconds.
- 3 Use truck-mounted changeable message signs with LED and LED/Flip Disk Hybrid sign display panels. Ensure that the LED and the LED/Flip Disk Hybrid sign display panels maintain legibility requirements at all times when operating. Ensure that the LED's within the sign display panels that utilize the LED/Flip Disk Hybrid elements for message components during daytime hours operate at all times to maintain legibility requirements during the hours of transition between night and day and during cloudy weather and severe weather.

607.3.2.2 LED Display

- 1 Ensure that message components are LED elements and that each display module has a density of not less than 35 pixels consisting of 140 LED elements.

607.3.2.3 LED/Flip Disk Hybrid Display

- 1 Ensure that message components are a combination of LED and flip disk elements and that the flip disk elements are Saturn Yellow in color on the face and flat black on the backside. Ensure that each display module contains no less than 35 pixels with 1 LED per pixel with not less than 1 flip disk element per pixel.

607.3.2.4 Controller

- 1 Ensure that the controller is an electronic unit housed in a weatherproof, rust resistant box with a keyed lock and a light, for night operation. Ensure that the unit has a jack that allows direct communications between the on-board controller and an IBM compatible personal computer. Ensure that this unit has a LCD display screen that allows the operator to review all messages prior to displaying the message on the sign.
- 2 Ensure that the controller stores a minimum of 100 factory-preprogrammed messages and a minimum of 50 additional user-defined messages created, edited, and stored for display by the user. Make certain that the controller stores the messages in a manner that does not require a battery to recall the messages. Ensure that the operator of the computer can program the controller to display multiple messages in sequence. Remove the sign from the roadway in the event of failure of the controller such as a power loss and total shut down of the sign.
- 3 Ensure that the controller has a selector switch to allow the operator to control the brightness of light source intensity of the sign panel. Ensure that the selector has "bright," "dim," and "automatic" modes. When the selector switch is in the "automatic" mode, ensure that a photosensitive circuit controls the light source intensity in response to the changes such as from day to night and other various sources of ambient light.
- 4 Equip each truck-mounted changeable message sign with a remote control unit to permit control of the sign from inside the cab of the vehicle.

607.3.2.5 Power System

- 1 Provide a 12-volt electrical system powered from a 12-volt DC power source or an adaptable 110- or 120-volt AC power source to operate the sign panel. Equip each sign panel that utilizes a DC electrical power source with an automatic lamp intensity regulator that maintains a constant output with a varying battery voltage and a voltage indicator or warning device that indicates when the batteries need recharging. Place the lamp intensity regulator and the voltage indicator in a convenient location for easy reading.

- 2 Obtain operating power for the truck-mounted sign panel from the vehicle, solar assisted facilities, an adaptable 110- or 120-volt AC power source, or a truck-mounted generating plant. Do not use a portable generator for a power source. Regardless of the source, ensure that the supply of electrical energy is capable of operating the sign panel as required by the Plans, the Specifications, and the *MUTCD*.
- 3 Provide electrical power for the changeable message sign from one of the power sources specified in **Subsection 607.3.2.6**.

607.3.2.6 Power Sources

607.3.2.6.1 Solar Assisted Power

- 1 Power the sign panel with a battery bank charged by photovoltaic solar panels and supplemented with a built-in 110-volt, 20-amp battery charger. Ensure that the battery bank is housed in a lockable heavy-duty, steel, weatherproof box. Ensure that the power control unit contains two current meters, one to indicate amperage generated by the battery charger and the other for amperage generated by the solar panels.

607.3.2.6.2 AC Power

- 1 Power the sign panel by an adaptable 110 or 120-VAC power source and equip the unit with ground fault interrupting circuit breakers. Ensure that all AC power adaptations in compliance with UL approved equipment and methods. Make the power attachments in accordance with all OSHA regulations and the *National Electrical Code*, in effect at the time the Contract was advertised.

607.3.2.6.3 Vehicle Based Power

- 1 Operating the sign panel at an optimal voltage of 12-VDC and obtaining the electrical power necessary for operation from the vehicle's alternator and battery system of a truck-mounted generating plant is an acceptable power source, in some isolated areas with prior RCE approval. Do not use a portable generator for a power source. Do not use the vehicle as a power source in or near residential areas where the engine noise could be considered a nuisance.

607.3.2.7 Truck and Accessories

- 1 Mount the sign panel unit on a truck with a gross vehicular weight (GVW) of 5000 pounds or less when utilizing the sign for "Prepare to Stop" notification during lane closures as specified in the *SCDOT Standard Drawings*.
- 2 When utilizing the sign in conjunction with mobile operations and for "Exit" notification during lane closures, mount the sign on a truck equipped with an approved truck-mounted attenuator with a gross vehicular weight of no less than 15,000 pounds. See **Subsection 605.4.2.2** for the requirements of the truck-mounted attenuator.

- 3 Mount the sign panel unit as a permanent fixture to the truck to provide a minimum height of 7 feet from the bottom of the sign to the surface of the roadway when in its operating position. Do not mount a trailer-mounted unit on a truck.

607.3.3 Equipment on Site

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

607.4 Construction

607.4.1 Truck-Mounted Advance Warning Arrow Panels

607.4.1.1 General

- 1 Use truck-mounted advance warning arrow panels to provide additional advance warning and directional information to assist motorists through a work zone. Make certain to provide these warning devices for advance directional information in lane closures. Install, operate, and maintain each arrow panel as specified herein.

607.4.1.2 Operational Regulations

- 1 Use a truck-mounted arrow panel that has the capability to operate while the vehicle is moving and produce all message modes as listed herein.
- 2 Use the truck-mounted advance warning arrow panel for lane closures, mobile operations, or work activities on high-density and high-speed roadways as well as low-density and low-speed roadways.
- 3 Ensure that the truck-mounted arrow panel has a minimum mounting height not less than 7 feet from the surface of the roadway to the bottom of the sign and at a sufficient height to afford visibility to traffic from a maximum distance practical. Mount the arrow panel as a permanent fixture on the truck. Do not mount a trailer-mounted arrow panel on a truck.
- 4 For stationary lane closures, supplement the truck-mounted attenuator placed beyond the end of the taper with an advance warning arrow panel. When the truck is advanced beyond the initial location 250 feet beyond the end of the taper, switch the arrow panel from a Flashing Arrow Mode to the Caution Mode.
- 5 For mobile lane closures, use truck-mounted arrow panels as required in the *Traffic Control Plan*. Operate these arrow panels in conformity with all requirements of the Specifications. Do not tow a trailer-mounted arrow panel instead of utilizing a truck-mounted arrow panel.
- 6 Use a combination pattern of 4 lamps with 1 in each corner flashing simultaneously (referred to as the "4 Corner" pattern) as the required pattern during the Caution Mode.

607.4.1.3 Operational Restrictions

- 1 Use the truck-mounted advance warning arrow panel as a supplemental traffic control device. Do not use a truck-mounted advance warning arrow panel as a singular entity. Use a truck-mounted advance warning arrow panel along with other various traffic control devices as specified by the Plans, the Specifications, the *SCDOT Standard Drawings*, the *MUTCD*, and the RCE.
- 2 Do not use a truck-mounted advance arrow warning panel as part of a flagging operation to direct vehicles into lanes used by opposing traffic.
- 3 Do not display the Sequencing Arrow Modes due to staged and slow development of the intended message by these message modes. Use only the Flashing Arrow Modes, the Sequencing Chevron Modes, or the Caution Mode.
- 4 Ensure that the "4 Corners" pattern does not indicate direction or resemble any other mode. Do not use advance warning arrow panels incapable of producing the "4 Corners" pattern. Do not display a "bar," "diamond," or any other symbol other than the required "4 Corners" during the Caution Mode.

607.4.1.4 Maintenance

- 1 Provide daily maintenance of each advance warning arrow panel. Ensure that all power source generators, including the photovoltaic solar panels on solar assisted units, undergo daily maintenance inspections. Replace an inoperative unit immediately upon discovery of the unit's failure. If replacement of the inoperative unit is not initiated immediately upon discovery, the RCE will immediately suspend all work activities and order the removal of all equipment from the roadway. If defective or burned out lamps are not replaced immediately upon discovery of the deficient lamps, the RCE will impose an immediate suspension of all work activities. Consider any unit with lamps producing inconsistent levels of intensity between messages or between the lamps to be in need of repair and requiring immediate replacement with a unit in good operating condition. Do not place a defective, deficient, or damaged unit on the roadway.

607.4.2 Truck-Mounted Changeable Message Sign**607.4.2.1 General**

- 1 Use truck-mounted changeable message signs on or adjacent to roadways to provide information to motorists. Use the truck-mounted changeable message sign to provide additional advance warning and directional information to assist motorists through a work zone. Provide, install, maintain, and operate each changeable message sign as specified herein.
- 2 Truck-mounted changeable message signs are not included in a category as an individual traffic control device because these devices are supplemental to vehicles on which they are mounted.

607.4.2.2 Operational Regulations

- 1 Utilize the truck-mounted changeable message sign for slow moving work activities. Install, maintain, and operate each truck-mounted sign as directed by the Plans, the Specifications, the *SCDOT Standard Drawings*, the *MUTCD*, and the RCE.
- 2 Utilize a truck-mounted changeable message sign for the initial shadow vehicle encountered by motorists during mobile operations. Position this vehicle on the right shoulder of the roadway as directed by the *SCDOT Standard Drawings* and the RCE. Ensure that the truck-mounted changeable message sign remains on the right shoulder during left lane closures unless otherwise directed by the RCE.
- 3 Use truck-mounted changeable message signs to supplement stationary lane closures on Interstate highways and high-volume, high-speed primary multilane facilities with paved shoulder as directed by the Specifications, the *SCDOT Standard Drawings*, and the RCE.
- 4 Ensure a truck-mounted changeable message sign is always mounted on a truck equipped with an approved truck-mounted attenuator when utilized during mobile operations, for "Exit" notification during lane closures, or whenever the sign is required within a travel lane open or closed to traffic.
- 5 Provide a truck-mounted changeable message to display the "Prepare To Stop" message in advance of traffic queues during static lane closures. When utilizing a truck-mounted changeable message sign to display the "Prepare To Stop" message, a truck-mounted attenuator is not required under the following specific conditions:
 - A. This sign is mounted on a vehicle with a gross vehicular weight (GVW) of 5000 pounds or less.
 - B. The truck remains on the shoulder and does not encroach onto a travel lane open to traffic or a closed travel lane adjacent to a travel lane open to traffic.

607.4.2.3 Operational Restrictions

- 1 Do not interchange truck-mounted changeable message signs and trailer-mounted changeable message signs when a specific type of unit is specified. Do not substitute truck-mounted changeable message sign with a trailer-mounted changeable message sign in a mobile operation. Do not substitute a trailer-mounted changeable message sign for a truck-mounted changeable message sign required in advance of a traffic queue.
- 2 Do not substitute a truck-mounted changeable message sign for an advance warning arrow panel within the taper area of a stationary lane closure.

607.4.2.4 Maintenance

- 1 Provide daily maintenance of each changeable message sign. Ensure that all power source generators, including the photovoltaic solar panels on solar assisted units, undergo daily maintenance inspections. Replace an inopera-

tive unit immediately upon discovery of the unit's failure. If replacement of the inoperative unit is not initiated immediately, the RCE will immediately suspend all work activities and require removal of all equipment from the roadway. If replacement of defective or burned out lamps is not initiated immediately upon discovery of the deficient lamps, the RCE will immediately suspend all work activities. Consider any unit with lamps producing inconsistent levels of intensity between messages or between the lamps to be in need of repair and requiring immediate replacement with a unit in good operating condition. Do not place a defective, deficient, or damaged unit on the roadway.

607.5 Measurement

- 1 Truck-mounted advance warning arrow panel and truck-mounted changeable message signs are included in the lump sum item Traffic Control as specified in **Subsections 107.12** and **601.5**. Therefore, there is no separate measurement for these devices unless the Contract includes specific bid items for truck-mounted advance warning arrow panels or truck-mounted changeable message signs.

607.6 Payment

- 1 Payment for truck-mounted advance warning arrow panel and truck-mounted changeable message signs is included in the lump sum bid price and payment for Traffic Control as specified in **Subsections 107.12** and **601.6**.
- 2 Payment for the pay item Traffic Control is full compensation for providing, installing, removing, relocating as necessary, operating, and maintaining truck-mounted advance warning arrow panels or truck-mounted changeable message signs as specified or directed and includes providing and maintaining the truck equipped with an approved attenuator; providing the mounted device's primary power source; providing traffic control necessary for installing, operating, and maintaining truck-mounted devices; repairing or replacing damaged or malfunctioning devices within the specified time; and all other materials, labor, hardware, equipment, tools, supplies, incidentals, and any miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

SECTION 608

SUPPLEMENTAL TRAFFIC CONTROL DEVICES

608.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for supplemental traffic control devices, which include warning lights and temporary glare shields in conformity with the Plans and the Specifications or as directed by the RCE.
- 2 These traffic control devices supplement other traffic control devices and are not intended to function as single entities but in conjunction with other devices.

608.2 Materials

608.2.1 Warning Lights

- 1 Provide warning lights that are yellow or amber, portable, lens directed, and enclosed. Operate Types A and B lights in the flashing mode and Type C lights in the steady burn mode. Ensure that these lights meet all requirements of the *MUTCD*. Ensure that all warning lights, including Types A, B, and C are lightweight and do not exceed 3.3 pounds in accordance with the requirements of *NCHRP Report 350*. Provide, install, and maintain each warning light as specified herein.
- 2 Do not include warning lights in a category as an individual traffic control device. However, a Category I device supplemented with a warning light becomes a Category II device and requires crash testing to determine the acceptability of the combination of the two traffic control devices. Provide an FHWA letter of acceptance for any Category I traffic control device supplemented with a warning light to ensure the crash worthiness of the combination of the traffic control device and a warning light.

608.2.2 Temporary Glare Shield System

- 1 Ensure that the temporary glare shield system is modular and consists of base rails, vertical blades, mounting brackets, and hardware. Fabricate the base rail and vertical blades from an impact resistant, non-warping, non-metallic, polymeric material resistant to ultraviolet radiation and temperature.
- 2 Provide blades that have a width not less than 3 inches or greater than 9 inches and a minimum height of 24 inches. Ensure that the blades used on any continuous run have a uniformed width and height. Attach the blades to the base rails with brackets to prevent unintentional blade rotation.
- 3 Provide a base rail containing not less than 3 holes/slots per rail section to provide for zinc plated mechanical anchoring system with a minimum shear strength of 3000 psi.

608.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

608.4 Construction

608.4.1 Warning Lights

- 1 Use Types A, B, and C warning lights as supplemental traffic control devices for signs and barricades as indicated in the Plans, the Specification, *SCDOT Standard Drawings*, *MUTCD*, and the *Traffic Control Plan*.

608.4.2 Temporary Glare Shields

- 1 Use temporary glare shields installed on top of temporary longitudinal barriers that separate two-way traffic. In most instances, these temporary longitudinal barriers are temporary concrete barrier walls. Provide, install, and maintain temporary glare shields as specified herein and by the Plans, the Specification, *SCDOT Standard Drawings*, *MUTCD*, and the *Traffic Control Plan*.
- 2 Ensure that the base rail does not extend or protrude beyond the edges of the temporary longitudinal barrier where the rail is attached. Ensure that no section of base rail spans the joint between sections of the longitudinal barrier wall.
- 3 Install all blades with spacing not less than a 22-degree angle from the X-axis perpendicular to the direction of traffic to provide adequate sight cutoff.

608.5 Measurement

- 1 If the Contract does not contain the pay item Type (A, B, or C) – (Flashing or Steady Burn) Light, the warning lights are included in the lump sum item Traffic Control as specified in **Subsections 107.12** and **601.5**. Therefore, there is no specific measurement for the lights.
- 2 If the Contract contains the pay item Type (A, B, or C) – (Flashing or Steady-Burn) Light, the quantity is measured by each (EA) light installed, complete and accepted.
- 3 The quantity for the pay item Temporary Glare Shields For Traffic Control is measured by the linear foot (LF) along the centerline of the base rail of the glare shields installed during the stage of work that requires the greatest length, complete and accepted. If the scope of the work is reduced and thereby reduces the length of temporary glare shields required, length of glare shields actually used and eligible for measurement are measured for payment. RCE approval is required before installation for any revisions to the quantities and locations of the temporary glare shields from that required by the Plans, the Plan quantities, and the Special Provisions. Equipment, tools,

or hardware required to install or relocate the glare shield are considered incidental to the temporary glare shield item and are not measured separately.

608.6 Payment

- 1 Payment for the accepted quantity for each pay item, measured in accordance with **Subsection 608.5**, is determined using the contract unit bid price of the applicable item.
- 2 Payment for traffic warning lights, either included in the pay item Traffic Control as specified in **Subsections 107.12** and **601.6** or as pay item Type *(A, B, or C) – (Flashing or Steady Burn)* Light is full compensation for providing, installing, relocating as necessary, operating, and maintaining the warning lights as specified or directed and includes providing traffic control for installing and maintaining the lights and all other materials, labor, equipment, tools, supplies, mounting hardware, transportation, incidentals, and any miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for the accepted quantity for Temporary Glare Shields For Traffic Control is full compensation for providing, installing, removing, relocating, and maintaining the temporary glare shields as specified or directed and includes cutting units to length; drilling for mounting holes and anchors; and attaching to barrier walls; replacing damaged blades or rails; providing traffic control for installing and maintaining the glare shields; and all other materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Payment for each item under this section includes all direct and indirect costs and expenses required to complete the work.
- 5 Pay items under this section include the following:

Item No.	Pay Item	Unit
6082000	Temporary Glare Shields For Traffic Control	LF
608100A	Type A – Flashing Light	EA
608100B	Type B – Flashing Light	EA
608100C	Type C – Steady-Burn Light	EA

SECTION 609

TEMPORARY PAVEMENT MARKINGS

609.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for temporary pavement markings (fast dry paint, thermoplastic, epoxy, tape, and temporary raised pavement markers) applied within the limits of a construction or maintenance project in conformity with the Plans and the Specifications or as directed by the RCE.
- 2 Use these pavement markings to provide delineation for travel lanes during all stages of the work.

609.2 Materials

609.2.1 Temporary Pavement Markings

609.2.1.1 General

- 1 Provide fast dry paint, thermoplastic, epoxy, or tape for temporary pavement markings that are white or yellow in color as required by the Plans and in conformance with the applicable Specifications, the *SCDOT Standard Drawings*, and the *MUTCD*. Ensure that temporary paint complies with the Specifications that apply to permanent paint in **Subsection 625.2**.
- 2 Provide temporary pavement markings as required by the Plans, the Specifications, the *MUTCD*, and the RCE.

609.2.1.2 Color and Retroreflectivity Requirements

- 1 Ensure that the colors of temporary pavement markings conform to the requirements of the *MUTCD*.
- 2 Ensure that retroreflectivity of temporary pavement markings are in conformance with Department requirements. Ensure that the glass beads applied to a temporary paint, a temporary thermoplastic, and a temporary epoxy, comply with those sections of the Specifications for the application of glass beads to permanent applications of waterborne fast dry paint, thermoplastic, and epoxy pavement markings.

609.2.2 Temporary Raised Pavement Markers

- 1 Ensure that raised pavement markers conform to the requirements in **Subsection 630.2**.

609.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

609.4 Construction**609.4.1 Temporary Pavement Markings****609.4.1.1 Application Requirements****609.4.1.1.1 General**

- 1 Use temporary pavement markings for temporary lane lines, no passing zone markings, pavement edge lines, transverse lines, arrows, words, and railroad crossing symbols.
- 2 Apply, maintain, relocate, and remove all temporary pavement markings as required during the stages of the project indicated in the Plans, the Specifications, the *MUTCD*, and the RCE. Apply new temporary pavement marking as pavement marking in-place become deficient due to time and wear as determined by the RCE.
- 3 Do not allow traffic onto travel lanes without temporary or permanent pavement markings where pavement markings existed prior to beginning work or where the width of the pavement is 24 feet or greater. Whenever existing pavement markings are removed or covered, such as by an overlay of an asphalt pavement course or an asphalt surfacing, apply new pavement markings before the end of each day's work. Apply temporary pavement markings to the travel lanes of a resurfaced multilane facility or any roadway with obliterated pavement markings prior to re-opening a closed travel lane to traffic.
- 4 Follow standard application practices to ensure straight lines with true edges, a clean cut, and no waviness. Ensure that the lateral deviations of finished line markings do not exceed 2 inches in 15 feet. Any greater deviation than that is sufficient cause for removal and correction of such markings at no additional cost to the Department. Remove and correct any symbol markings not meeting the dimensional requirements shown in the *MUTCD*.
- 5 Apply all temporary pavement markings to clean and dry pavement surfaces. Prior to the application of temporary pavement markings, clean the roadway surface by sweeping or high-pressure air to ensure a clean surface for proper adhesion of the markings.
- 6 Do not apply thermoplastic, epoxy, or tape to a pavement surface within the first 24 hours after a rainfall. Coordinate all traffic pattern revisions and construction operations to accommodate the restriction regarding rainfall.
- 7 Before beginning work on a project, perform an inspection of the project with the RCE to determine the condition of the existing pavement markings. Apply temporary pavement markings to roadways where the existing pavement markings are deficient as determined by the RCE.
- 8 Before beginning work on two-lane, two-way roadways, apply 4-inch double yellow lines for the centerlines and 4-inch white solid lines for the pavement edge lines within the work zone unless otherwise specified.

- 9 Apply all lines at the width and length prescribed by the Plans, the *MUTCD*, and the RCE. On primary and secondary routes, use 4-inch wide temporary solid lines on edge lines and center lines, and 4 inches wide by 10 feet long with a 30-foot gap for broken center lines unless otherwise specified. On Interstate highways, use temporary solid edge lines that are 6 inches wide and temporary broken center lines that are 6 inches wide by 10 feet long with a 30-foot gap unless otherwise specified. For all other solid lines, use 8-inch, 12-inch, or 24-inch wide pavement markings in conformity with the Plans.
- 10 Use Type 2 temporary removable preformed flexible retroreflective pavement markings on bridge decks and final surface courses for temporary pavement marking schemes that require modifications. Do not apply paint, thermoplastic, or epoxy pavement markings to a bridge deck or a final surface course in a temporary pavement marking scheme that requires modifications unless otherwise directed by the *Traffic Control Plans*. As the traffic control stages progress, tie each new temporary pavement marking scheme to the existing pavement markings.
- 11 Apply no passing zone markings as specified by the Plans, the Specifications, the *MUTCD*, and/or the RCE.
- 12 Apply the permanent pavement markings to the final surface course when the traffic pattern will no longer change. When resurfacing a road, apply pavement markings after each application of asphalt mix and bituminous surface treatment, including the final pavement course at the end of each day's work.

609.4.1.1.2 Waterborne Fast Dry Paint

- 1 Apply temporary paint pavement markings to pavement courses other than a final surface course unless otherwise directed by the Plans and the RCE. Apply a painted pavement marking at a wet film thickness of not less than 15 mils. When necessary, eradicate temporary markings by acceptable eradication methods or by overlaying the markings with a subsequent pavement course. Application of temporary paint may be applied to a final surface course if the markings are in conformance with the final pavement marking scheme and will be covered by the permanent pavement markings. These markings are considered non-removable due to scarring that results from the processes necessary for the eradication of these markings. Ensure that temporary paint complies with the Specifications that apply to permanent paint in **Section 625**.

609.4.1.1.3 Thermoplastic

- 1 Apply temporary thermoplastic pavement markings on an asphalt pavement course in areas that must maintain traffic patterns for 4 to 6 months or longer. Apply an alkyd based temporary thermoplastic pavement marking at a thickness not less than 60 mils. Do not use temporary thermoplastic pavement markings on a final surface course unless otherwise directed by the Plans. When necessary, eradicate these markings by acceptable eradication methods or by overlaying these markings with a subsequent pavement course.

These markings are considered non-removable due to scarring that results from the processes necessary for the eradication of these markings.

609.4.1.1.4 Epoxy

- 1 Apply temporary epoxy pavement markings on a concrete pavement course in areas that must maintain traffic patterns for 4 to 6 months or longer. Apply temporary epoxy pavement markings at a thickness of not less than 20 mils. Do not use temporary epoxy pavement markings on a final concrete surface course in a temporary pavement marking scheme unless otherwise directed by the Plans. When necessary, eradicate these markings by acceptable eradication methods or by paving over these markings with a subsequent pavement course. These markings are considered non-removable due to scarring that results from the processes necessary for the eradication of these markings.

609.4.1.1.5 Tape

- 1 Apply temporary tape pavement markings in areas where the traffic patterns will be modified, but must maintain traffic on an existing pavement course or a final surface course. Use Type 2 Temporary – Removable Preformed Flexible Retroreflective Pavement Markings. When necessary, remove these markings without any residual effects or scarring of the pavement surface.

609.4.1.2 Removal of Pavement Markings

- 1 Do not allow conflicting pavement marking schemes on any roadway open to traffic. Remove conflicting pavement markings as necessary and pavement markings designated by the Plans and the RCE prior to revising the traffic patterns.
- 2 Remove obsolete pavement markings and any residue resembling a previous pavement marking scheme. If the pavement marking removal process damages the roadway, repair the damage or resurface the roadway as directed by the RCE with no additional compensation.
- 3 Use the following acceptable methods for removal of pavement markings from a concrete pavement course:
 - Sand blasting using air or water,
 - High pressure water,
 - Steam of superheated water, or
 - Shot blasting.
- 4 Use the following acceptable methods for removal of pavement markings from an asphalt pavement course:
 - Sand blasting using air or water,
 - High pressure water,
 - Steam of superheated water,
 - Shot blasting, and

- Grinding.
- 5 Use grinding for pavement marking removal on asphalt pavement courses only. Do not use grinding for removal of pavement markings from a concrete pavement course.
 - 6 Do not apply a black paint or any other color of paint or type of paint over pavement markings designated for removal as a singular method of removal of pavement markings.
 - 7 Remove the residue from a blast cleaning method, including the components of the blast method including sand, water, or shot. When operating within 10 feet of a travel lane open to traffic or in an area that the residue may encroach onto the adjacent travel lane, remove the residue immediately after contact between the blast component and the treated surface. Use a vacuum attachment operating concurrently with the blast operation or by an alternate method approved by the RCE. Provide all safety and protective measures required by the Department and federal, state, and local laws.

609.4.2 Temporary Raised Pavement Markers

609.4.2.1 Installation Requirements

- 1 Use temporary raised pavement markers installed during stage construction as a supplement to the pavement markings. Apply the pavement markers for each traffic control scheme, traffic relocation, or each asphalt concrete course application as directed. Do not install temporary raised pavement markers on new asphalt concrete surface course or any other final surface course unless otherwise directed by the Plans, the Special Provisions, or the RCE. Provide, install, and maintain the temporary raised pavement markers as required by the Specifications, the Plans, the *MUTCD*, and the RCE. Ensure that temporary raised pavement markers installed during stage construction comply with the requirements for permanent raised pavement markers in **Section 630**.
- 2 On two-lane, two-way roadways, install the temporary pavement markers at 80-foot intervals to supplement the yellow center line pavement markings. On primary and secondary multilane roadways, install the temporary pavement markers at 40-foot intervals to supplement the yellow center line pavement markings. On all multilane roadways including Interstate highways, install the temporary pavement markers at 80-foot intervals to supplement the broken white lane line pavement markings. On roadways where turn lanes, acceleration lanes, and deceleration lanes are present, install the temporary pavement markers at 40-foot intervals to supplement the broken white auxiliary line.
- 3 At the beginning of a project, install temporary pavement markers on the existing pavement in conformity with the *Pavement Marking Plans* if the existing pavement markers are deficient or no pavement markers are present. Install temporary pavement markers within 7 days of the application of an asphalt concrete course to any two adjacent travel lanes, unless a subsequent asphalt concrete course is scheduled to be placed within 30 days. Apply temporary pavement markers in conformity with the *Pavement Marking*

Plans each time the traffic control scheme or the traffic patterns change. The RCE may waive the 30-calendar day period for application of temporary raised pavement markers.

- 4 Do not allow the time between completion of the asphalt concrete surface course application to all travel lanes and beginning the application of the permanent pavement markings to exceed 30-calendar days on jobs with permanent pavement markers. Apply the permanent pavement markers to the roadway in conformity with the *Pavement Marking Plans*.

609.5 Measurement

- 1 The quantity for Pavement Marking(Temporary - *of the specific material*) – (*width, color, and line type*) is the length of the temporary pavement marking line excluding spaces between broken lines and is measured by the linear foot (LF) along the center of the pavement marking line in-place, complete and accepted.
- 2 The quantity for Pavement Markings (Temporary - *of the specific material*) - White Single Arrow (or Combination Arrows, Word "ONLY," or Railroad Crossing Symbol is measured by each (EA) symbol or word in-place, complete and accepted. A railroad-crossing symbol consists of "X RR".
- 3 No separate measurement is made for the removal of pavement markings unless the Contract includes the pay item Removal of Pavement Markings or Removal of Pavement Markings (High Pressure Water). In the absence of such a pay item, the cost of pavement marking removal is considered incidental to the pavement marking items.
- 4 No separate measurement is made for pavement marking for traffic control during application and removal of pavement markings. The costs of such markings for traffic control is includes in the contract lump sum item Traffic Control. In the absence of a pay item Traffic Control, traffic control for application and removal of pavement markings is considered incidental to the pavement marking bid items.
- 5 The quantity of temporary raised pavement markers is measured by the each (EA) temporary raised pavement marker installed, complete and accepted.

609.6 Payment

- 1 Payment for the accepted quantities, measured in accordance with **Subsection 609.5**, is determined using the contract unit bid price for the applicable pay item and includes all direct and indirect costs and expenses necessary to fulfill the requirements of the pay item.
- 2 Payment for Pavement Marking (Temporary - *of the specific material*) – (*width, color, and line type*) or Pavement Markings (Temporary - *of the specific material*) – White Single Arrow (or Combination Arrows, Word "ONLY," or Railroad Crossing Symbol is full compensation furnishing, installing, and replacing (if necessary) pavement markings meeting the reflectivity requirements as specified or directed and includes removing of temporary and exist-

ing pavement markings unless a separate bid item for removal of pavement markings is included in the Contract; preparing the pavement surface; applying marking at the correct thickness; applying glass beads at correct amounts; maintaining the temporary pavement markings until they are removed, replaced, or covered by the permanent pavement markings; and all other materials, labor, hardware, equipment, tools, supplies, transportation, incidentals, and any miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

- 3 Payment for Temporary Raised Pavement Markers (of the specific color, type, and size) is full compensation for providing, installing, and maintaining temporary raised pavement markers as specified or directed and includes preparing the pavement surface, removing existing pavement markers prior to beginning the construction project due to traffic pattern changes; removing unacceptable pavement markers, removing temporary pavement markers applied to a final surface course or an open-graded friction course prior to application of the permanent pavement markers; and all other materials, labor, hardware, equipment, tools, supplies, incidentals, and miscellaneous items necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

- 4 Pay items for under this section include the following:

Item No.	Pay Item	Unit
609105X	Pavement Markings (Temporary <i>-(material)</i>) - 4" <i>(color)</i> Broken Lines	LF
609110X	Pavement Markings (Temporary <i>-(material)</i>) - 6" <i>(color)</i> Broken Lines	LF
609115X	Pavement Markings (Temporary <i>-(material)</i>) - 4" <i>(color)</i> Solid Lines	LF
609120X	Pavement Markings (Temporary <i>-(material)</i>) - 6" <i>(color)</i> Solid Lines	LF
609125X	Pavement Markings (Temporary <i>-(material)</i>) - 8" <i>(color)</i> Solid Lines	LF
609130X	Pavement Markings (Temporary <i>-(material)</i>) - 12" <i>(color)</i> Solid Lines	LF
609135X	Pavement Markings (Temporary <i>-(material)</i>) - 24" <i>(color)</i> Solid Lines	LF
609160X	Pavement Markings (Temporary <i>-(material)</i>) - White Single Arrow	EA

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Item No.	Pay Item	Unit
609165X	Pavement Markings (Temporary - <i>(material)</i>) - White Combination Arrows	EA
609180X	Pavement Markings (Temporary - <i>(material)</i>) - White Word 'Only'	EA
609185X	Pavement Markings (Temporary - <i>(material)</i>) - Railroad Crossing Symbols	EA
6092100	Temporary Clear Pavement Markers Mono-Directional - 4"X 4"	EA
6092150	Temporary Yellow Pavement Markers Mono-Directional - 4"X 4"	EA
6092155	Temporary Yellow Pavement Markers Bi-Directional - 4"X 4"	EA

SECTION 610

WORK ZONE TRAFFIC CONTROL PROCEDURES

610.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for work zone traffic control procedures provided for the maintenance of traffic during construction of the project in conformity with the Plans and the Specification or as directed by the RCE.
- 2 All traffic control procedures include providing, installing, maintaining, relocating, and removing the traffic control devices used for regulating, warning, and directing traffic and providing for delineation of travel lanes, warning of obstructions and hazards, and maintenance and control of traffic during the work. Install and conduct all work zone traffic control procedures in conformity with the *SCDOT Standard Drawings*, the applicable Supplemental Specifications, the Special Provisions, the Plans, the RCE, and as specified herein.
- 3 For each of the following work zone traffic control procedures, the Department will determine the specific requirements for each procedure with regard to conditions such as the hours permitted for the procedure according to traffic volumes, the physical characteristics and conditions unique to the roadway, and the work activities.

610.2 Materials

- 1 None specified.

610.3 Equipment

- 1 Ensure that background color of personal protective apparel is fluorescent Orange-Red.
- 2 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

610.4 Construction

610.4.1 Flagging Operations

610.4.1.1 General

- 1 Use a flagging operation to control the flow of traffic when two opposing directions of traffic must share a common travel lane. A flagging operation may be necessary during a lane closure on a two-lane, two-way roadway, an intermittent ramp closure, or an intermittent encroachment of equipment onto a portion of the roadway. Utilize flagging operations to direct traffic around work activities and maintain continuous traffic at reduced speeds on low-volume, low-speed roadways when determined to be appropriate by the RCE.

610.4.1.2 Requirements

- 1 Ensure that flagging operations have the appropriate signing, equipment, and trained personnel. Install all essential signs, including the "Flagger" sign (W20-7a-48), in advance of each flagger station. Ensure that flaggers conduct themselves and the operation as directed by the Specifications, the *MUTCD*, *SCDOT Flaggers Handbook*, and the RCE. Failure by the flaggers to conduct the operation properly or without the flagger signs is considered as failure to provide traffic control as required.
- 2 Erect all signs relative to the operation before initiation of the operation and immediately remove or cover such signs upon termination of the operation. Station each flagger not further than 300 feet from the end of the lane closure that requires a flagging operation. Equip each flagger with a Stop/Slow paddle. Do not use flags except during emergency situations. Failure to conduct the operation properly within all requirements as set forth by the Specifications, the *MUTCD* and the *SCDOT Flaggers Handbook* is deemed as failure to provide the traffic control as required and shall result in immediate suspension of all work activities requiring the flagging operation until the condition is corrected.
- 3 During flagging operations, maintain the proper array of advance warning signs in-place for each approach at all times that a flagging operation is in place and active. When necessary to relocate the flagger station while actively maintaining the flagging operation, install an additional array of advance warning signs at the new location for the flagger station and complete the relocation of the flagger station prior to removing the existing array of advance warning signs. Always maintain the flagger station within 500 feet of the "Flagger" (W20-7a-48) symbol sign of the array of advance warning signs.
- 4 During nighttime flagging operations, supplement the array of advance warning signs with a trailer-mounted changeable message sign for each approach. These changeable message signs are not required during daytime flagging operations. Install the changeable message signs 500 feet in advance of the advance warning sign arrays. Messages should be "Flagger Ahead" and "Prepare To Stop."
- 5 During nighttime flagging operations, ensure that flaggers wear safety apparel that meet the requirements of **Subsection 610.3** and ANSI/ISEA 107, *Standard Performance for Class 3 Risk Exposure*, latest revision, and a fluorescent hardhat.
- 6 During nighttime flagging operations, illuminate each flagger station with any combination of portable lights, standard electric lights, existing street lights, etc., that provide a minimum illumination level of 108 Lx or 10 fc.

610.4.2 Lane Closures

610.4.2.1 General

- 1 Provide and install a specific array of traffic control devices to channelize traffic during closure of a travel lane of a multilane roadway and to delineate

the travel lanes open to traffic.

610.4.2.2 Requirements

- 1 Traffic control setups differ for daytime and nighttime lane closures. Do not use daytime lane closure setups during the hours of darkness or for the duration of weekends and holidays. Install nighttime lane closure setups when lane closures are required during the hours of darkness or for the duration of weekends and holidays. Observe all time restrictions for lane closures as required by the Department.
- 2 Install Type II barricades, not less than 3 feet wide, for the taper sections and drums or cones for the tangent sections of lane closures. Ensure that standard traffic cones installed on Interstate highways have a minimum height of 36 inches.
- 3 Use standard traffic cones within the tangent sections of daytime lane closure setups and use portable plastic drums or oversized traffic cones in the tangent sections of nighttime lane closure setups. Do not use standard traffic cones during nighttime lane closures.
- 4 Convert a daytime lane closure setup to a nighttime lane closure setup whenever circumstances prohibit removal of a daytime lane closure before entering nighttime conditions. Replace the standard traffic cones with portable plastic drums or oversized traffic cones.
- 5 Always supplement lane closures on multilane facilities with advance warning arrow panels. Install, maintain, and operate the arrow panels as specified by these specifications. Display the Caution Mode on arrow panels operating beyond 250 feet from the end of the taper within the tangent section of a closed lane. Always display the Caution Code on arrow panels operating within shoulder closures.
- 6 Use a truck equipped with a truck-mounted changeable message sign when reducing the number of travel lanes during each lane closure on Interstate highways and high-volume, high-speed primary multilane facilities with paved shoulders. Ensure that the truck-mounted changeable message sign displays the message "Prepare To Stop". In the event traffic backs up, place the truck, manned with an operator, on the shoulder, which remains not less than 2000 feet in advance of the traffic queue. When the development of a traffic queue is not evident or the traffic queue has dissipated, locate the truck in a predetermined area on the project site approved by the RCE, where the truck is not visible to passing motorist. Do not place the truck on the shoulder of the roadway without an operator. Failure to provide the truck-mounted changeable message sign for lane closures is considered as failure to provide traffic control required.
- 7 If work is being conducted at two different locations at the same time in the same travel lane, separate the two locations by not less than 2 miles from the end of the first lane closure to the beginning of the taper of the second lane closure.

- 8 When work is being conducted at two different locations at the same time, do not close one travel lane at one location and a different travel lane at the other location unless the locations are more than 4 miles apart. Whenever separate work locations are less than 4 miles apart, conduct work at the two locations in the same travel lane unless otherwise directed by the Special Provisions and/or the RCE.
- 9 On an Interstate highways, use a lane closure procedure to conduct work or to place equipment in the shoulder within 10 feet of the near edge of the adjacent travel way.
- 10 On primary and secondary roads, use a lane closure procedure to conduct work or to place equipment in the shoulder within 1 foot of the near edge of the adjacent travel way.
- 11 These interval restrictions between lane closures apply to lane closures on the same project, contiguous projects, and projects that overlap in any manner and apply to all entities, including the Department, the Contractor, sub-contractors, utility companies, municipalities, etc. Failure to observe these interval restrictions is considered as failure to provide traffic control as required.
- 12 Coordinate lane closure installations on contiguous projects or projects that overlap in any manner as directed by the RCE unless otherwise directed by the Plans and the Special Provisions.
- 13 Restrict the length of a lane closure to a maximum distance of 2 miles unless otherwise directed by the Plans, the Special Provisions, and the RCE.
- 14 Do not use lane closures on high-volume roadways during peak traffic periods unless otherwise directed. Before installing a lane closure on a roadway with high-volume commuter traffic, acquire RCE approval of the proposed hours for the lane closure.

610.4.3 Shoulder Closures

610.4.3.1 General

- 1 Provide and install the specific array of traffic control devices to close the shoulder area of a roadway to traffic.

610.4.3.2 Requirements

- 1 Comply with specific shoulder closure requirements according to traffic volumes in the adjacent travel lanes, physical characteristics, and conditions unique to the roadway, and the work activities. If traffic backups develop and deemed excessive by the RCE, suspend work conducted under a shoulder closure. The hourly restrictions for lane closures also apply to work activities conducted under a shoulder closure within 15 feet of the near edge of an adjacent travel lane. Adhere to all shoulder closure restrictions as directed by the Specifications, the Plans, and the RCE.

- 2 On Interstate highways, do not conduct work within the limits of a paved shoulder or within 10 feet of the near edge of an adjacent travel lane under a shoulder closure. Conduct work that may require the presence of personnel, tools, equipment, materials, vehicles, etc., within the limits of a paved shoulder or within 10 feet of the near edge of an adjacent travel lane under a lane closure setup.
- 3 On primary and secondary roadways, do not conduct work within one foot or less of the near edge of an adjacent travel lane under a shoulder closure. Conduct work that may require the presence of personnel, tools, equipment, materials, vehicles, etc., within one foot of the near edge of an adjacent travel lane under a lane closure setup.
- 4 Do not substitute oversized traffic cones for portable plastic drums during nighttime shoulder closures.
- 5 When working in an outside shoulder area within 30 feet of an adjacent travel lane, close the adjacent shoulder as directed by the *Typical Traffic Control Standard Drawings*. Use "Case 1" whenever conducting work or occupying the shoulder beyond the restricted area, which is 1 foot (for primary and secondary roads) or 10 feet (for Interstate highways) from the near edge of the adjacent travel lane, but within 15 feet of the near edge of the adjacent travel lane. Use "Case 2" whenever conducting work between 15 to 30 feet of the near edge of the adjacent travel lane. Install a lane closure instead of a shoulder closure, unless otherwise directed by the RCE, when any work requires encroaching within the restrictive area, 1 foot or 10 feet from the near edge of the adjacent travel lane as specified above.
- 6 When working in a grassed median area within 30 feet of a travel lane, close the adjacent shoulder as directed by the *Typical Traffic Control Standard Drawings*. If the median area work is within 30 feet of both adjacent travel lanes, close both adjacent shoulders. Use "Case 1" whenever conducting work or occupying the area beyond the restrictive area, 1 foot or 10 feet of the near edge of the adjacent travel lane as specified above, but within 15 feet of the near edge of the adjacent travel lane. Use "Case 2" whenever conducting work between 15 to 30 feet of the near edge of the adjacent travel lane. Apply the "Case 1" and "Case 2" requirements to each adjacent travel lane flanking the median area work. Install a lane closure instead of a shoulder closure, unless otherwise directed by the RCE, when any work requires encroaching within the restrictive area, 1 foot or 10 feet of the near edge of the adjacent travel lane as specified above.

610.4.4 Mobile Operations

610.4.4.1 General

- 1 Use specific traffic control devices and specifically equipped vehicles specified herein during mobile operations on roadways open to traffic. Maintain the minimum requirements for traffic control devices and equipment on two-lane, two-way routes, multilane primary routes, and Interstate highways as specified herein.

- 2 Use traffic control setups for mobile operations during the application and removal operations for pavement markings and raised pavement markers.

610.4.4.2 Requirements

610.4.4.2.1 General

- 1 Install, operate, and maintain all advance warning arrow panels, truck-mounted attenuators, and truck-mounted changeable message signs as required by these specifications, the manufacturer's specifications, the *SCDOT Standard Drawings*, the Plans, and the RCE.
- 2 Maintain functional two-way radio communications between all vehicles in the mobile operation train.

610.4.4.2.2 Two-Lane, Two-Way Roadways

- 1 Ensure that the lead vehicle maintains a distance of 100 to 500 feet ahead of the work vehicle. Ensure that the lead vehicle has an amber revolving flashing dome light and a 48-inch X 48-inch "One Lane Road Ahead" sign (W20-4-48-A) mounted on top of the vehicle. During the hours of darkness, ensure that the lead vehicle also has an approved advance warning arrow panel operating in the Caution Mode mounted on top of the vehicle. Use of the advance warning arrow panel is not required during daytime operations. Ensure that the sign and the advance warning arrow panel face oncoming traffic.
- 2 Ensure that the work vehicle has an approved advance warning arrow panel operating in the Caution Mode and may be supplemented with an approved truck-mounted attenuator.
- 3 Ensure that a shadow vehicle maintains a distance of 150 to 300 feet behind the work vehicle and has an approved advance warning arrow panel operating in the Caution Mode and an approved truck-mounted attenuator.
- 4 Use of an optional second shadow vehicle may be provided. Operate the second shadow vehicle 500 to 1000 feet behind the initial shadow vehicle. Ensure that the second shadow vehicle has an approved advance warning arrow panel operating in the Caution Mode and an approved truck-mounted attenuator.
- 5 Ensure that the distances between vehicles are within the ranges specified above at all times.

610.4.4.2.3 Multilane Primary Routes

- 1 Ensure that the work vehicle has an approved advance warning arrow panel displaying a flashing arrow and may be supplemented with an approved truck-mounted attenuator.
- 2 Ensure that the first shadow vehicle maintains a distance of 150 to 300 feet behind the work vehicle and has an approved advance warning arrow panel displaying a flashing arrow and an approved truck-mounted attenuator. Adjust the distance intervals between the first shadow vehicle and the work ve-

hicle to compensate for horizontal and vertical curves and any other conditions that may hinder or obstruct the sight distance between the vehicles.

- 3 Ensure that a second shadow vehicle maintains a distance interval of 500 to 1000 feet behind the first shadow vehicle in accordance with the parameters provided below, has an approved truck-mounted changeable message sign, and has an approved truck-mounted attenuator. Ensure that the truck-mounted changeable message sign flashes alternately to read "Right (Left) Lane," "Closed Ahead." Operate the second shadow vehicle on the shoulder adjacent to the travel lane with the work train where paved shoulders or earth shoulders wide enough to accommodate vehicles. Operate the second shadow vehicle within the same travel lane as the work train when the shoulders are too narrow to accommodate vehicles, the shoulders are structurally inadequate, or curb and gutter is present. During operations in the left travel lane, avoid placing the second shadow vehicle in a paved median where opposing left turn traffic may be encountered. The truck-mounted changeable message sign may display a flashing arrow when the second shadow vehicle must operate in the travel lane. The flashing arrow display on the truck-mounted changeable message sign is permissible only when the second shadow vehicle must operate in the travel lane. Do not use the flashing arrow display on the truck-mounted changeable message sign when the second shadow vehicle operates on the shoulder.
- 4 Adjust the distance intervals between the second shadow vehicle and the first shadow vehicle to compensate for horizontal and vertical curves and any other conditions that may hinder or obstruct the sight distance between the vehicles. Restrict any adjustments between the second shadow vehicle and the first shadow vehicle to a designated range of variable distances. These variable distances are 250 to 500 feet in areas where the speed limit is 45 mph or less, and 500 to 1000 feet in areas where the speed limit is 50 mph or greater.
- 5 Ensure that the distances between vehicles are within the ranges specified at all times.

610.4.4.2.4 Interstate Highways

- 1 Ensure that the work vehicle has an approved advance warning arrow panel displaying a flashing arrow and may be supplemented with an approved truck-mounted attenuator.
- 2 Ensure that the first shadow vehicle maintains a distance of 250 to 500 feet behind the work vehicle and has an approved advance warning arrow panel displaying a flashing arrow and an approved truck-mounted attenuator. Adjust the distance intervals between the first shadow vehicle and the work vehicle to compensate for horizontal and vertical curves and any other conditions that may hinder or obstruct the sight distance between the vehicles.
- 3 Ensure that a second shadow vehicle maintains a distance interval of 750 to 1500 feet behind the first shadow vehicle. Ensure that the second shadow vehicle has an approved advance warning arrow panel displaying a flashing

arrow and an approved truck-mounted attenuator. Adjust the distance intervals between the second shadow vehicle and the first shadow vehicle to compensate for horizontal and vertical curves and any other conditions that may hinder or obstruct the sight distance between the vehicles.

- 4 Ensure that a third shadow vehicle maintains a distance of 750 to 1500 feet behind the second shadow vehicle. Ensure that the second shadow vehicle has an approved truck-mounted changeable message sign and an approved truck-mounted attenuator. Ensure that the truck-mounted changeable message sign flashes alternately to read "Right (Left) Lane," "Closed Ahead." Operate the third shadow vehicle on the right shoulder where paved shoulders wide enough to accommodate vehicles or within the same travel lane as the work train when the shoulders are too narrow to accommodate vehicles, the shoulders are structurally inadequate, or curb and gutter is present. Ensure that the truck-mounted changeable message sign displays a flashing arrow when the third shadow vehicle must operate in the travel lane. The flashing arrow display on the truck-mounted changeable message sign is permissible only when the third shadow vehicle must operate in the travel lane. Do not use the flashing arrow display on the truck-mounted changeable message sign when the third shadow vehicle operates on the shoulder. Adjust the distance intervals between the third shadow vehicle and the second shadow vehicle to compensate for horizontal and vertical curves and any other conditions that may hinder or obstruct the sight distance between the vehicles.
- 5 Ensure that the distances between vehicles are within the ranges specified at all times.

610.4.5 Road Closures

610.4.5.1 General

- 1 Use the specific array of traffic control devices specified herein to close a roadway for a period ranging from 20 minutes to a long term or permanent closure. Apply the requirements specified herein whenever a road closure is necessary.

610.4.5.2 Extended Road Closures

610.4.5.2.1 General

- 1 Use the specific array of traffic control devices specified herein to close a roadway for a period ranging from days to a permanent closure. Install the appropriate array of traffic control devices on each approach as necessary to ensure complete closure of the specific area to traffic.
- 2 Install and maintain all traffic control devices as required by these specifications, the manufacturer's specifications, *SCDOT Standard Drawings*, the *MUTCD*, the Plans, and the RCE.

610.4.5.2.2 Extended Road Closure of Existing Roadway

- 1 Use this specific array of traffic control devices to close an existing roadway that has been open to traffic. Provide and install traffic control devices that include Type III barricades supplemented with appropriate signs placed at the nearest intersection that provides an alternate route, but not necessarily the intended detour, advanced warning signs, and Type III barricades installed across the entire roadway at the point of closure. Supplement the advance warning signs and the Type III barricades at the point of closure with approved Type B high intensity flashing warning lights.

610.4.5.2.3 Extended Road Closure of New Roadway Alignment

610.4.5.2.3.1 General

- 1 Use the specific array of traffic control devices specified herein to close a new roadway alignment that has not been open to traffic. Provide and install traffic control devices that include Type III barricades supplemented with the appropriate signs installed across the roadway at the beginning of the new roadway alignment. No warning lights are required to supplement these barricades.

610.4.5.2.3.2 Requirements

- 1 In areas where an existing roadway alignment is being relocated, install portable plastic drums adjacent to the edge of the existing roadway at intervals not to exceed 35 feet at the beginning of the rough grading of the new roadway alignment. Maintain the drums in-place until Type III barricades are installed across the new roadway alignment. However, depending upon field conditions such as the roadway geometry, it may be prudent to maintain the drums in-place until the new roadway alignment is opened to traffic. The RCE will determine when the drums may be removed.
- 2 Upon beginning the fine grading of the new roadway alignment in the area adjacent to the existing roadway alignment, install Type III barricades supplemented with the appropriate signing. The traffic control setups for these barricades require a minimum number of 3 to 5 Type III barricades as necessary to cross the entire new roadway alignment as illustrated in the *SCDOT Standard Drawings*. Field conditions may require additional barricades to completely close the new roadway alignment. Maintain these barricades until the new roadway alignment is opened to traffic.

610.4.6 Temporary Road Closures

610.4.6.1 General

- 1 Use the array of traffic control devices specified herein and law enforcement officers to temporarily close a roadway for brief periods not to exceed 20 minutes and preferably shorter. Whenever temporary road closures are necessary, apply all the requirements specified herein.

610.4.5.2 Requirements

- 1 Arrange all equipment and crews to keep each temporary road closure limited to no longer than 20 minutes. Allow stopped traffic to proceed and clear the area after each temporary closure before stopping traffic again and make all reasonable efforts to expedite the work and minimize interference with traffic.
- 2 Use the assistance of the South Carolina Highway Patrol when it is necessary to stop traffic. Coordinate the traffic control with the RCE and the Highway Patrol.
- 3 Conduct temporary road closures as directed by these specifications, the Special Provisions, and the RCE. Permit temporary road closures at times of the lowest traffic volumes as determined by the Special Provisions and the RCE. The hourly restrictions for lane closures at the location intended for closure also apply to any temporary road closures. Prohibit temporary road closures during holidays, holiday weekends, or special events unless otherwise specified.
- 4 Provide a truck equipped with a truck-mounted changeable message sign and an approved truck-mounted attenuator when temporarily closing the mainline roadway on Interstate highways and high-volume, high-speed multi-lane facilities with paved shoulders. Ensure that the truck-mounted changeable message sign displays a message to read "Prepare To Stop." Immediately upon development of a traffic queue, place the truck, manned with an operator, on the shoulder, to remain not less than 2000 feet in advance of the traffic queue. Do not place the truck on the shoulder of the roadway without an operator. Failure to provide the truck-mounted changeable message sign is considered as failure to provide the required traffic control.
- 5 Provide notice to the RCE not less than 2 weeks prior to any major traffic interruption such as temporary road closure.

610.4.7 Pacing Operations**610.4.7.1 General**

- 1 Use the array of traffic control devices specified herein, law enforcement officers, and law enforcement vehicles to temporary control the flow of traffic through a defined area without creating a complete cessation of the traffic flow. Obtain prior approval from the RCE before using a pacing operation as an alternative to a complete cessation of traffic operations. Whenever pacing operations are implemented, apply all the requirements specified herein.

610.4.7.2 Requirements

- 1 Arrange all equipment and crews to conduct and complete the necessary work tasks prior to the arrival of the controlled traffic flow. Ensure that the time frame to conduct the necessary work is limited to not longer than 20 minutes. Allow the controlled traffic flow to proceed, clear the area after each event, and resume normal traffic flow for the location prior to initiating a sub-

sequent pacing operation. Make all reasonable efforts to expedite the work and minimize interference with traffic.

- 2 Use the assistance from the South Carolina Highway Patrol when it is necessary to implement a pacing operation. Coordinate the traffic control with the RCE and the Highway Patrol.
- 3 Assistance from the Highway Patrol is required when a pacing operation is implemented. Have Highway Patrol troopers intercept traffic in advance of the project site at a distance sufficient to provide a work period of 20 minutes or less. Close all on-ramps within the effected area in advance of the project site until the queue of controlled traffic has passed. Station Highway Patrol troopers at the point of closure of each ramp.
- 4 Conduct all pacing operations as directed by these specifications, the Special Provisions, and the RCE. Use pacing operations at times of the lowest traffic volumes as determined by the Special Provisions and the RCE. The hourly restrictions for lane closures at the subject location also apply to pacing operations. Do not use pacing operations during holidays, holiday weekends, or special events unless otherwise specified.
- 5 Provide a truck equipped with a truck-mounted changeable message sign and an approved truck-mounted attenuator when pacing traffic on Interstate highways and high-volume, high-speed multilane facilities with paved shoulders. Ensure that the truck-mounted changeable message sign displays a message to read "Prepare To Stop." If a traffic queue develops, immediately place the truck, manned with a sign operator, on the shoulder to stay not less than 2000 feet in advance of the traffic queue. Prohibit placing the truck on the shoulder of the roadway without an operator. Failure to provide the truck-mounted changeable message sign is considered as failure to provide the required traffic control.
- 6 Notify the RCE not less than 2 weeks prior to any major traffic interruption such as a pacing operation.

610.4.8 Detours

610.4.8.1 General

- 1 Use the array of signs installed to direct and guide traffic around a closed portion of an Interstate, primary, or secondary route. Conduct the detour by relocating traffic onto an alternate route and returning the traffic to the closed route beyond the closed portion of the roadway.

610.4.8.2 Requirements

- 1 If the detour route is not specified in the Plans or special provision, select roads for the detour that have a structure and geometry to safely sustain the type and amount of detoured traffic. Ensure that the route has adequate sight distances at intersections, no bridges with posted weight limitations, 12-foot travel lanes, adequate pavement markings, and a good pavement surface. Minimize the length of the detour meeting the aforementioned requirements. Depending on the type and amount of detoured traffic, consider other factors

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for route selection such as school locations, areas of reduced speed limits, and traffic control at intersections that would be impacted by the detour.

610.5 Measurement

- 1 Unless otherwise specified, flagging operations, lane closures, shoulder closures, mobile operations, temporary road closures, extended road closures, pacing operations, and detours are included in the lump sum pay item Traffic Control. No specific measurements are made for items required for these traffic control operations unless the Contract includes specific pay items for such work.
- 2 In the case of an extended road closure of an existing roadway, as specified in **Subsection 610.4.5.2.2**, separate measurements are made of quantities for Type III barricades, permanent construction signs, and Type B flashing warning lights. Type III barricades installed and accepted are measured in accordance with **Subsection 604.5**. Only the length of the actual barricade is measured. The spaced between the barricades is excluded. Permanent construction signs both ground and barricade mounted (regardless of the type of sign stratum) installed and accepted are measured in accordance with **Subsection 605.5**. Type B flashing warning lights installed and accepted are measured in accordance with **Subsection 608.5**.

610.6 Payment

- 1 Payment for accepted quantity for each pay item, measured in accordance with **Subsection 610.5**, is determined using the contract unit bid price for the applicable item.
- 2 Payment for Traffic Control is full compensation for providing, installing, and maintaining flagging operations, lane closures, shoulder closures, mobile operations, temporary road closures, extended road closures, pacing operations, and detours as specified or directed and includes and all materials, labor, hardware, equipment, tools, supplies, transportation, incidentals, and miscellaneous items necessary to conduct the operations as specified by the Plans, the Specifications, the manufacturer's specifications, the *SCDOT Standard Drawings* or as directed by the RCE.
- 3 Payment for Traffic Control also includes providing, installing, removing, relocating signs, vehicles, truck-mounted advance warning arrow panels, truck-mounted attenuators, truck-mounted changeable message signs, proper safety attire, Stop/Slow paddles, trained personnel and other traffic control devices required to protect traffic and the work zone.
- 4 In the case of an extended road closure of an existing roadway, as specified in **Subsection 610.4.5.2.2**, a separate payment is made for accepted quantities for Type III barricades, permanent construction sign, and Type B flashing warning lights. Type III barricades are paid for in accordance with **Subsection 604.6**. Permanent construction signs both ground and barricade mounted (regardless of the type of sign stratum) are paid for in accordance with **Subsection 605.6**. Type B flashing warning lights are paid for in accor-

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dance with **Subsection 608.6**.

- 5 Payment for each pay item includes all direct and indirect costs and expenses required to complete the work.
- 6 There are no pay items included under this section.

SECTION 611

WORK ZONE TRAFFIC CONTROL PROCEDURES FOR SPECIFIC OPERATIONS

611.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for work zone traffic control procedures for the maintenance of traffic during specific work operations of paving and resurfacing operations; milling and surface planing operations; guardrail replacement operations; removal and placement of permanent ground mounted signs and supports; and installation and removal of overhead signs and structures in conformity with the Plans, the Specifications, and as directed by the RCE.
- 2 All traffic control procedures consist of providing, installing, maintaining, relocating, and removing of the traffic control devices used for regulating, warning, and directing traffic and providing for delineation of travel lanes, warning of obstructions and hazards, and maintenance and control of traffic during the work. Conduct these work procedures within the requirements for work zone traffic control as specified herein.

611.2 Materials

- 1 None specified.

611.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

611.4 Construction

611.4.1 Paving and Resurfacing Operations

611.4.1.1 General

- 1 Use the appropriate traffic control procedures and setups during paving and resurfacing operations. The specific traffic control procedures for these operations include flagging operations for two-lane, two-way roadways and lane closures for multilane roadways provided in accordance with **Subsections 610.4.1** and **610.4.2**.

611.4.1.2 Requirements

- 1 Provide and maintain the proper traffic control procedure to close the travel lane in which the resurfacing operations are conducted. Use flagging operations on two-lane, two-way facilities and lane closures on multilane facilities. Provide and maintain all flagging operations and lane closures as specified in these specifications, the *MUTCD*, the *SCDOT Standard Drawings*, unless

otherwise specified on the Plans, in the Special Provisions, or by the RCE. Relocate the traffic control setups for flagging operations or lane closures upon completion of each section as specified on the Plans, in the Special Provisions, and by the RCE.

- 2 Ensure that grade elevation differences do not exceed 2 inches between adjacent travel lanes opened to traffic during resurfacing operations. Do not allow more than one acceptable drop-off of less than or equal to 2 inches between adjacent travel lanes carrying traffic in the same direction on multi-lane facilities with three or more travel lanes. Observe all restrictions during resurfacing or any similar operations.
- 3 During paving operations, provide lane closures at all times where grade elevation differences and drop-offs greater than 2 inches exist adjacent to or between travel lanes, unless otherwise directed by the RCE.
- 4 When the grade elevation difference between adjacent travel lanes exceeds 2 inches, pave the adjacent travel lane to eliminate the grade elevation difference prior to opening the travel lane to traffic.
- 5 In addition to lane closure restrictions regarding drop-offs greater than 2 inches, adhere to any travel and time restrictions as specified herein, on the Plans, in the Special Provisions, and by the RCE. Maintain the construction schedule approved by the RCE.
- 6 During paving operations, ensure that the length of roadway that may remain open to traffic with an acceptable grade elevation difference of less than or equal to 2 inches between adjacent travel lanes does not exceed 4 miles, unless otherwise directed by the RCE.
- 7 Do not allow traffic onto travel lanes without pavement markings where pavement markings existed before beginning the paving operations. Apply pavement markings to the travel lanes of a resurfaced roadway before re-opening the closed travel lanes to traffic.
- 8 Whenever travel lanes with acceptable grade elevation differences are open to traffic, provide "Uneven Lanes" signs (W8-11-48). Reflectorize these signs with a fluorescent orange colored prismatic retroreflective sheeting unless otherwise specified. Install these signs adjacent to the uneven travel lanes at intervals no greater than 2600 feet. Do not use temporary construction sign with the "Uneven Pavement" legend
- 9 Upon completion of the final riding surface on any road without paved shoulders, begin eliminating shoulder drop-offs greater than 2 inches within 3 working days and continue the work until these drop-offs are eliminated.

611.4.2 Milling and Surface Planing Operations

611.4.2.1 General

- 1 Use the appropriate traffic control procedures and setups during milling and surface planing operations. The traffic control procedures for these operations include flagging operations for two-lane, two-way roadways and lane

closures for multilane roadways provided in accordance with **Subsections 610.4.1 and 610.4.2.**

611.4.2.2 Requirements

- 1 Provide and maintain the proper traffic control devices and procedure to close the travel lane in which the milling and surface planing operations are conducted. Use flagging operations on two-lane, two-way facilities and lane closures on multilane facilities. Provide and maintain all flagging operations and lane closures as specified in these specifications, in the *MUTCD*, and on the *SCDOT Standard Drawings*, unless otherwise specified on the Plans, in the Special Provisions, or by the RCE. Relocate traffic control setups for flagging operations or lane closures upon completion of each section as directed on the Plans, in the Special Provisions, and by the RCE.
- 2 Ensure that grade elevation differences do not exceed 1 inch between adjacent travel lanes opened to traffic in milled areas. The 1-inch grade elevation difference restriction applies to any milled travel lane opened to traffic regardless of the condition of the adjacent travel lane.
- 3 During milling and surface planing operations, maintain lane closures at all times where grade elevation differences and drop-offs greater than 1 inch exist adjacent to or between travel lanes unless otherwise directed by the RCE.
- 4 When the grade elevation difference exceeds 1 inch, mill or pave the adjacent travel lane to eliminate the grade elevation difference prior to opening the travel lane to traffic.
- 5 In addition to lane closure restrictions regarding drop-offs greater than 1 inch, adhere to any travel and time restrictions on milled surfaces as specified in these specifications, on the Plans, in the Special Provisions, and by the RCE.
- 6 In those areas that have time and travel restrictions, mill only the amount of roadway that can be replaced with an asphalt concrete course to eliminate the grade elevation difference greater than 1 inch prior to removal of the lane closure.
- 7 During milling and surface planing operations, ensure that the length of roadway that may remain open to traffic with an acceptable grade elevation difference less than or equal to 1 inch does not exceed 4 miles, unless otherwise directed by the RCE.
- 8 Sweep milled lanes clean of debris and mark with temporary pavement markings before reopening the travel lanes to traffic.
- 9 Whenever travel lanes with acceptable grade elevation differences are open to traffic, provide "Uneven Lanes" signs (W8-11-48). Reflectorize these signs with a fluorescent orange colored prismatic retroreflective sheeting unless otherwise specified. Install these signs adjacent to the uneven travel lanes at intervals no greater than 2600 feet. Do not use of the temporary

construction sign with the "Uneven Pavement" legend.

611.4.3 Guardrail Replacement Operations

611.4.3.1 General

- 1 Use appropriate traffic control procedures and setups during guardrail replacement operations. The traffic control procedures for these operations include lane closures and shoulder closures installed and maintained in accordance with **Subsections 610.4.2** and **610.4.3**.

611.4.3.2 Requirements

- 1 Determine the necessity for lane or shoulder closures relative to the construction requirements to accomplish the work. Provide and maintain lane closures and shoulder closures as specified in these specifications, in the *MUTCD*, and on the *SCDOT Standard Drawings*, unless otherwise specified on the Plans, in the Special Provisions, or by the RCE. Relocate the traffic control upon completion of each section as directed on the Plans, in the Special Provisions, and by the RCE.
- 2 Do not remove more guardrail than can be replaced in the same day. Upon removal of the guardrail, maintain not less than a shoulder closure in place at each guardrail replacement location until the guardrail replacement operation is completed for that location.

611.4.4 Installation or Removal of Permanent Ground Mounted Signs and Supports

611.4.4.1 General

- 1 Use the appropriate traffic control procedures and setups during installation and removal of permanent ground mounted signs and supports. The specific traffic control procedures for these operations include lane closures and shoulder closures installed and maintained in accordance with **Subsections 610.4.2** and **610.4.3**.

611.4.4.2 Requirements

- 1 Determine the necessity for lane closures or shoulder closures relative to the construction and encroachment requirements necessary to accomplish the work.
- 2 Provide and maintain all lane closures and shoulder closures in accordance with these specifications, the *MUTCD*, and the *SCDOT Standard Drawings*, unless otherwise specified on the Plans, in the Special Provisions, or by the RCE.

611.4.5 Installation and Removal of Overhead Signs and Structures

611.4.5.1 General

- 1 Provide the appropriate traffic control procedures and setups during installation and removal of overhead signs and structures. The specific traffic control procedures for these operations include lane and shoulder closures, temporary road closures, pacing operations, and detours installed and maintained

in accordance with **Subsection 610.4.2, 610.4.3, 610.4.6, 610.4.7, or 610.4.8.**

611.4.5.2 Requirements

- 1 Determine the necessity for lane or shoulder closures, temporary or short-term road closure, pacing operation, or detour relative to the construction requirements to accomplish the work based on the location, type of traffic, traffic volumes, time of day, time of year, and closure restrictions. Provide and maintain the proper traffic control procedure to close the travel lanes and shoulders that pass beneath the sign or the structure being installed or removed. Maintain access to ramps at all times where feasible.
- 2 Provide and maintain all traffic control procedures as required by these specifications, the *MUTCD*, the *SCDOT Standard Drawings*, unless otherwise specified on the Plans, in the Special Provisions, or by the RCE.
- 3 When the installation or removal of bridge beams or overhead sign structures can be accomplished in 20 minutes or less, protect the traveling public by stopping or controlling the flow of traffic in the immediate vicinity of the intended work for short periods of time necessary to hoist and set into place or remove each bridge beam or overhead sign structure. Arrange equipment and crews to conduct and complete the necessary work tasks within a time frame limited to no longer than 20 minutes and preferably shorter. Allow stopped or controlled traffic to proceed and clear the area after each installation or removal operation before interrupting the traffic flow again to hoist the next bridge beam or overhead sign structure. Keep interference with traffic to a minimum.
- 4 Use assistance from the South Carolina Highway Patrol when it is necessary to stop or pace traffic. Coordinate the traffic control procedure with the RCE and the Highway Patrol as necessary.
- 5 Road closures, pacing operations, and detours may be used pending approval of the proposed plan by the RCE. Provide at least 2 weeks notice prior to any major traffic interruption such as road closure, pacing operation, or detour.

611.5 Measurement

- 1 Providing and maintaining work zone traffic control procedures and setups for the maintenance and protection of traffic and the work zone during the work operations of paving and resurfacing operations; milling and surface planing operations; guardrail replacement operations; removal and placement of permanent ground mounted signs and supports; and installation and removal of overhead signs and structures is included in the lump sum pay item Traffic Control as specified in and 601.5. Unless otherwise specified and included in the Contract, there is no separate measurement for providing and maintaining the work zone traffic control procedures and setups for the specific construction operations.

611.6 Payment

- 1 Providing and maintaining the work zone traffic control procedures and setups for the maintenance and protection of traffic and the work zone during the work operations specified in this section are included in the price and payment for item Traffic Control as specified in **Subsections 107.12 and 601.6**. Payment is full compensation for providing, installing, removing, relocating (as necessary), and maintaining the necessary work zone traffic control procedures and setups for the maintenance of traffic to provide a safe construction zone and for the protection of the traveling public.
- 2 Unless otherwise specified and included in the Contract, payment for Traffic Control includes providing, maintaining, removing, and relocating signs, vehicles, truck-mounted advance warning arrow panels, truck-mounted attenuators, and truck-mounted changeable message signs and other traffic control devices as necessary; providing proper safety attire; trained personnel; and all other materials, equipment, labor, hardware, tools, supplies, transportation, incidentals, and miscellaneous items necessary to satisfactorily install and relocate the traffic control procedures as specified by the Plans, the Specifications, or directed by the RCE.
- 3 Payment for Traffic Control includes all direct and indirect costs and expenses required to complete the work.
- 4 Unless otherwise specified and included in the Contract, there are no pay items for work under this section.

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SECTION 612 THROUGH SECTION 624

SECTIONS NOT USED

SECTION 625

PERMANENT PAVEMENT MARKINGS FAST DRY WATERBORNE PAINT

625.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for furnishing and applying reflectorized, heavy metals free, fast drying, waterborne paint for pavement markings.
- 2 Use markings that are the color (white or yellow) and pattern indicated in the *Pavement Marking Plans*, *Pavement Marking Typical*s, or the *MUTCD*, as applicable. This work includes supplying all necessary equipment and materials for the correct application of the marking material to the pavement surface, protecting pavement markings during installation, determining no passing zones for two-lane facilities in accordance with the *MUTCD*, and providing the Department data used in establishing no passing zones on two-lane facilities.

625.2 Materials

625.2.1 General

- 1 Use pavement marking that consists of traffic paint, meeting the requirements given herein, upon which spherical glass beads are applied by dropping immediately following paint application. If required, clean the pavement surface in an appropriate manner as described herein immediately prior to application.

625.2.2 Paint

- 1 Use paint conforming to the requirements of this specification for this work. Do not use paint that is more than 12 months old. Use paint that is in conformance with all applicable specifications and has been tested by the OMR before commencement of work. Upon satisfactory completion of testing, the OMR will assign a unique Laboratory Number to each paint batch. Stencil the Laboratory Test Number on the side of each paint container to indicate OMR approval. Provide documentation to the RCE with each batch containing the information specified in **Subsection 625.2.2.7**. The RCE will forward a copy of this information to the OMR in order to track usage of each paint batch tested.

625.2.2.1 General Requirements

- 1 Provide white and yellow paint that meets the following general requirements:
 - A. Formulated and manufactured from top grade materials and free from defects and imperfections that might adversely affect the serviceability of the finished product.
 - B. Formulated and processed specifically for service as a suitable binder for glass beads for use on traffic-carrying pavements, includ-

ing Portland cement concrete, asphalt pavement, and brick.

- C. Dries to an elastic adherent finish that does not darken after exposure to sunlight, does not show appreciable discoloration with age, or darken under service such that the color or visibility to the reflectorized marking is impaired. Ease and uniformity of application and covering properties.
- D. Free of heavy metals as defined in **Subsection 625.2.2.4.11**.
- E. Provides the proper anchorage and refraction for glass beads when both binder and spheres are applied in the stipulated quantities with specialized equipment using pressurized bead guns.
- F. Manufactured and sealed in containers in such manner that during normal shelf life does not show evidence of settling or livering that causes the paint to be unusable or is detrimental to the specialized equipment used in application.
- G. Does not show evidence of skinning when received in sealed containers.

625.2.2.2 Vehicle

- 1 Use a vehicle portion that has a combination of 100% acrylic emulsion resins and sufficient surfactants, dispersants, defoamers, water, and coalescing agents that produce a pigmented binder meeting the requirements of these specifications.

625.2.2.3 Testing and Production Variation

- 1 When minimum or maximum values are given in these specifications, they represent values that are reliably obtained from testing. They do not represent acceptable mean production values. It is the responsibility of the manufacturer to consider variations in production and between testing laboratories when setting manufacturing tolerances.

625.2.2.4 Detailed Requirements

625.2.2.4.1 Viscosity

- 1 Use paint with a viscosity of 80 to 95 K.U. when tested at 77°F in accordance with ASTM D 562.

625.2.2.4.2 Drying Time

625.2.2.4.2.1 Laboratory Drying Time

- 1 Test paint in accordance with ASTM D 711 at a wet film thickness of 15 mils (± 1 mil) to determine time to "no-pickup" condition. Conduct the test in a standard laboratory atmosphere during which the relative humidity is maintained at 50% ($\pm 5\%$), and the temperature is maintained at 73.5°F ($\pm 3.5^\circ\text{F}$) and air flow is maintained at a rate of 2.2 mph (± 0.45 mph). Use paint that will dry to a "no-pickup" condition in 8 minutes or less.

625.2.2.4.2.2 Field Drying Time

- 1 Provide paint that when applied at a wet film thickness of 15 mils and a bead application rate of 6 pounds/gallon, dries to a "no-track" condition in the following times under the stipulated conditions:

Relative Humidity \leq 85%, Surface Temperature \geq 54°F	
Paint Temperature at Tip	Maximum "No-Track" Time
77°F	4 minutes
122°F – 131°F	90 seconds
131°F – 140°F	60 seconds

- 2 Consider paint to have reached a "no-track" condition when the marking is traversed by a standard automobile simulating a passing maneuver at a speed of approximately 40 mph without visible tracking of the reflectorized line. Tracking is defined to be visible if it is discernable when viewed at a distance of 50 feet.

625.2.2.4.3 Flexibility

- 1 Cast a 5 mil wet film of the paint on a clean 30-gauge tin panel approximately 3 inches by 6 inches. Air-dry the panel at room temperature for 18 hours (\pm 2 hours), and then, bake at 122°F (\pm 4°F) for 2 hours (\pm 0.25 hour). Allow the panel to cool at room temperature for 30 minutes (\pm 10 minutes), and then, bend around a 0.5-inch metal rod. Use paint that withstands this test with no sign of film failure or loss of adhesion when viewed without the use of magnification.

625.2.2.4.4 Dry Opacity

- 1 Provide white and yellow paint that has a minimum contrast ratio of 0.965 when tested at a wet film thickness of 10 mils in accordance with ASTM D 2805.

625.2.2.4.5 Directional Reflectance

- 1 Use paint that has daylight reflectance, without drop-on glass spheres, of not less than 86% for white paint, and not less than 50% for yellow paint relative to magnesium oxide when tested in accordance with ASTM E 1347.

625.2.2.4.6 Abrasion Resistance

- 1 Provide paint that passes the following abrasion resistance test:
 Prepare 4 plate samples for each lot to be tested on the Taber Abrader. Apply paint with a drawdown blade having a clearance of 26 mils. Dry the paint abrasion samples at room temperature for approximately 30 minutes, and then, dry at 105°C for 18 hours (\pm 0.2 hour). After this time, clean, dress, weigh, and abrade the paint for 1000 cycles. After abrading, clean the samples with a soft brush and weigh again. Provide a corresponding loss for the 4 plates that does not ex-

ceed 50mg per plate. Operate the Taber Abrader with a weight of 500g and CS-10 wheels.

625.2.2.4.7 Glass Bead Adhesion

- 1 Use paint that is formulated and processed as both white and yellow colors specifically for service as a binder of drop-on beads to produce maximum adhesion, refraction, and reflection during the life of the marking applied at 15 mils wet film thickness.

625.2.2.4.8 Bleeding

- 1 Use a paint that has a minimum bleeding ratio of 0.98 when tested in accordance with the method given in Federal Specification TT-P-1952B, paragraph 4.5.13.

625.2.2.4.9 Total Non-Volatile, Vehicle Solids, and Flash Point

- 1 Provide paint with volatile organic compounds (VOC) that does not exceed 100 grams/liter. Use a non-volatile vehicle that is greater than or equal to 42.00%, reported to the nearest one hundredth of a percent, when the whole paint is ashed for one hour at 877°F (± 45°F). Use white and yellow paints that have 75.00% to 80.00% total non-volatiles, reported to the nearest one hundredth of a percent, when tested in accordance with ASTM D 3723. Provide paint that has a closed cup flash point that is greater than or equal to 140°F.

625.2.2.4.10 Composition

- 1 Use a white paint that contains a minimum of 1.0 pound/gallon of titanium dioxide in the white pigment. For all colors, conform the titanium dioxide to ASTM D 476, Types II, III, or IV.

625.2.2.4.11 Lead Content

- 1 For yellow heavy metals free binder, use a finished binder that does not exceed the legal limit of 6% maximum when tested for lead content. Use yellow pigments that are organic yellows containing no lead, chromium, or other heavy metal containing pigments. Establish the color using a blend of Color Index PY 75 and Rutile Titanium Dioxide Type II or blends of CI PY 75, CI PY 65, and Rutile Titanium Dioxide Type II. Use only small quantities of tinting aids if needed to establish an acceptable color.

625.2.2.4.12 Color

- 1 Use paint that is capable of maintaining its original color throughout the life of the line (approximately 2 years). Use paint with color that meets the requirements of 23CFR, Part 655, Table 1. The following CIE chromaticity coordinates describe the instrumental boundaries of the required color match:

Chromaticity Coordinates				
	White		Yellow	
	x	y	x	y
1	0.303	0.300	0.498	0.412
2	0.368	0.366	0.557	0.442
3	03.93	0.340	0.520	0.479
4	0.274	0.329	0.438	0.472

625.2.2.4.13 Distinguishable Color

- 1 Use yellow color that is very distinguishable from white markings under day or night conditions when applied on the roadway and is capable of remaining distinguishable during the life of the marking.

625.2.2.4.14 Grind and Freedom from Lumps

- 1 Use pigmented binder that has a grind of not less than 3 on the Hegman Grind Gauge and that passes a No. 50 mesh sieve at the time of packaging.

625.2.2.4.15 Settling

- 1 Test the pigmented binder for settling by the following method:
1. Use full pint, triple-sealed, friction top paint cans lined with an appropriate material designed to be non-reactive with waterborne paints.
 2. Fill the cans to the bottom of the friction seal lip and place in an inverted position for one hour to ensure a complete seal between the cover and the body of the can.
 3. At the end of one hour, place the filled can in an upright position for at least one hour before being placed in an air temperature of 122°F (± 2°F). Place the can or cans in a single tier.
 4. Store these cans free of vibration at an air temperature of 122°F (± 2°F) for a period of 5 days.
 5. After a heating period of 5 days, cool the cans at room temperature for 4 to 5 hours and evaluate the degree of settling in accordance with ASTM D 869.

Provide paint that exhibits no dense or hard settling and has a degree of settling rating of 6 or better when evaluated in accordance with ASTM D 869.

625.2.2.4.16 pH Factor

- 1 Provide a pigmented binder that has a pH factor of 9.5 minimum as packaged without thinning or diluting. Use the following resins: Rohm and Haas E-2706 Resin, Rohm and Haas Rhoplex Fastrack 3427, Dow DT211, or an approved equal for enhancing the time to "no-track." Request approval by the RCE of any substitute resin other those expressly mentioned here before its

use. Inform the OMR of the resin intended for use when supplying samples. Ensure that the supplier does not change resins during the life of the Contract without prior approval from the RCE. In the event that low pH water is used to manufacture the finished binder, pH buffers may be used to obtain the minimum pH factor.

625.2.2.4.17 Solvents

- 1 Use potable water from a public water supply as the solvent for the binder manufactured by these specifications.

625.2.2.5 Control Tolerances

625.2.2.5.1 Percent Pigment

- 1 Use total pigment solids that are 58.00 to 63.00 percent by weight, reported to the nearest one hundredth of a percent, when tested in accordance with ASTM D 3723.

625.2.2.5.2 Volumetric Weight

- 1 Use pigmented binders that have a density of 14.0 pounds/gallon (± 0.3 pound/gallon) for white and 13.7 pounds/gallon (± 0.3 pound/gallon) for yellow. Determine weight per gallon in accordance with ASTM D 1475.

625.2.2.5.3 Vehicle Solids and Total Non-Volatile

- 1 Provide paint that meets the requirements given in **Subsection 625.2.2.4.9** of these specifications.
- 2 As noted in **Subsection 625.2.2.3**, it is the manufacturer's responsibility to consider testing and production variation when selecting mean production values. It is strongly recommended that the vehicle solids be one to two percent higher than the specified minimum values.

625.2.2.5.4 Viscosity

- 1 Use paint that meets the requirements given in **Subsection 625.2.2.4.1** of these specifications.

625.2.2.5.5 Drying Time

- 1 Use paint that meets the requirements for Laboratory Drying time given in **Subsection 625.2.2.4.2** of these specifications.

625.2.2.6 Samples and Tests Required

625.2.2.6.1 Qualification of Samples

- 1 Before shipment or use, submit the following items for each type and color of paint supplied:
 - Two samples consisting of one-quart cans of paint that the manufacturer proposes to furnish.
 - Manufacturer's testing results for the samples. Provide testing results that minimally include the items given in **Subsection 625.2.2.5** of these specifications and the brand and type of resin used.

625.2.2.6.1

625.2.2.7.1

- Manufacturer's statement of compliance with all requirements of these specifications. This statement explicitly states that the paint provided is essentially free of lead, cadmium, and other heavy metals.
- *Material Safety Data Sheets*, essentially similar to *Form OSHA-20*, for the material provided.

2 Furnish the items above to the following address:

SCDOT Office of Materials and Research
1406 Shop Road
Columbia, SC 29201

3 Do not ship or use paint until testing indicates that the material proposed is in conformance with these specifications.

625.2.2.6.2 Production Control Tests

1 Perform laboratory tests on each batch of paint produced under these specifications to ensure compliance with these specifications. Include the results of these tests with samples provided as specified in **Subsection 625.2.2.6.1**.

625.2.2.6.3 Department Samples

1 After award of the contract, the Department reserves the right to perform in-plant sampling of the finished paint during packaging operations and/or sampling of the packaged paint after it is received. During packaging operations for each batch and at the time the manufacturer obtains samples for each batch, obtain two one-quart samples, sealed properly, and forwarded along with the results of the manufacturer's production control tests and a certification of compliance with these specifications to the OMR at the address shown in **Subsection 625.2.2.6.1** of these specifications. The samples are tested by the Department in whatever manner is deemed necessary. Department inspectors or their designated agents observe the performance of all sampling. Samples taken by the manufacturer without supervision are not acceptable without permission of the RCE. The inspectors will designate at random two containers from each batch to be sampled for testing and enclose a copy of the sampling inspection with the samples.

625.2.2.7 Materials Acceptance Criteria

625.2.2.7.1 Shipping Records

1 Once a batch of paint has been approved for shipment, send a form with the following information to the RCE for each shipment:

- Date
- Consignee
- Shipped To
- Type of Paint
- No. of Gallons Shipped

- Batch Number
- Laboratory Number furnished by OMR for approved batch(es).

625.2.2.8 Packing and Marking

625.2.2.8.1 Bulk Containers

- 1 Supply paint in an intermediate bulk container capable of holding 250 gallons. Provide a container that is new or reconditioned, stainless steel, and conforms to Federal DOT Specification 57 from 49 CFR, Part 178.251, or 49 CFR, Part 178 Subpart O and all other appropriate rules and regulations. Provide a container that has a certificate of construction compliance with 49 CFR, Part 178.2(C), (1), (i) and (ii) or Part 178 Subpart O regarding drop test requirements. Use a container that is equipped with disposable airtight bladders (not liners), minimum 5-mil thickness, constructed of polyethylene or similar flexible materials that will not react with the specified waterborne paint. Provide a bladder that has a minimum working volume of 250 gallons. Use a bladder that is designed to allow for valve access and proper drainage of the container contents, while minimizing air space around the paint during storage and use. Use a bladder that completely encapsulates the paint within the container and that can be easily opened for field sampling and easily closed to remain airtight. Do not allow direct air to contact paint between the bladder and the container. Reuse of the bladder is prohibited.
- 2 Use containers that comply with the following specifications:

 - A. Capable of holding approximately 250 gallons.
 - B. Designed to accommodate their lifting and transporting with forklift or front-end loader.
 - C. Stackable, at least two high.
 - D. Has either a hinged or bolted hatch and/or screw top opening that is at least 16 inches in diameter. Use containers with a bolt-down hatch that have an additional screw top opening of 6-inch minimum diameter.
 - E. Has a 2-inch ball valve fitted with a male quick disconnect and valves that are 100% compatible with waterborne paint. Has a valve that no portion, including the in-place cap assembly, extends beyond the vertical plane of the forklift. No galvanized, copper, chrome, or brass valves allowed.
 - F. Has a security feature that protects the valve from being opened by accident or by vandals.
 - G. 100% compatible with waterborne paint.
 - H. Has proper venting of the tank by either a vacuum relief valve or an access port that can be opened. Opening the container for vacuum relief will not cause the paint to come in direct contact with air.

625.2.2.8.2 Fill Level for Bulk Containers

- 1 Fill each bulk container with 250 gallons of paint to provide an air space at the top. This space is to reduce spillage when stirring is required. Add several liters of an appropriate floating ammonia solution to the top of the paint to retard evaporation and skinning.

625.2.2.8.3 Five Gallon Containers

- 1 When 5-gallon containers are used, use buckets that are USDOT hazmat certified containers for shipping liquids conforming to this specification. Ensure that they are made of not less than 26-gauge steel or plastic buckets with 90-mil minimum wall thickness, a 26-gauge metal lid, and are open-head design with lug cover and flowed-in gasket. Ensure that metal pails have at least one reinforcing bead at the upper end.
- 2 If a tapered design is used, provide two beads; one above and one below the point at which the handle is attached to the side of the metal buckets. Provide a suitable wire bail-type handle.

625.2.2.8.4 Fifty-Five Gallon Containers

- 1 Use open-head type 55-gallon drums conforming to USDOT 1A1 hazmat approved containers, as amended by this specification. Ensure that they are constructed of not less than 18-gauge steel and have a removable head that is solid and contains no bungs. Use a $\frac{5}{8}$ " bolt to secure the ring clamp that secures the removable head. Tighten the ring clamp to prevent spillage when the drum is tilted during unloading.

625.2.2.8.5 Container Marking

- 1 Plainly mark or label all containers to show the following information as appropriate: "Waterborne Lead Free - White," or "Waterborne Lead Free - Yellow." Also, show the following:
 - Net gallons and/or liters,
 - Name of manufacturer,
 - Batch number,
 - Date of manufacture (month and year), and
 - Type of resin used.
- 2 Use containers that are labeled with the information listed above in a method that is able to withstand exposure to elements for up to one year and retain all of the required information. The Department reserves the right to require an improved marking/labeling method in the event that the identifying information is not retained on the container during the storage period to the satisfaction of the RCE.

625.2.2.8.6 Container Color

- 1 Use containers provided under these specifications that are painted or otherwise colored blue. Other colors may be used with prior approval of the

RCE. Yellow, white, and black are not acceptable container colors.

625.2.2.8.7 Container Lining

- 1 Ensure that each drum or metal pail has a baked-on epoxy lining on the inside of the container. Provide containers with a coating of phenolic epoxy or equal coating.

625.2.2.8.8 Alternative Method of Packaging

625.2.2.8.8.1 General

- 1 At the Contractors option, an alternative method of packaging may be used. This alternative packing consists of caged bottle paint totes also known as composite intermediate bulk containers (IBCs). If totes are used, make certain that containers consist of blow-molded, high molecular, high density polyethylene (HDPE) enclosed by a galvanized square tubular steel cage and have a capacity of 275 gallons.

625.2.2.8.8.2 Materials

- 1 Ensure that the HDPE resin is certified by the tote manufacturer to contain a U.V. stabilizer compounded by the resin manufacturer. Make certain that the frame is zinc-galvanized tubular steel and the pallet is either plastic (HDPE) or zinc-galvanized tubular steel.
- 2 Make certain totes are equipped with disposable airtight bladders (not liners), minimum 127-micron (5-mil) thickness, constructed of polyethylene or similar flexible materials that will not react with the specified waterborne traffic paint.

625.2.2.8.8.3 Requirements

- 1 Use reusable HDPE totes capable of handling bulk liquids with 1.9 specific gravity. Make certain containers have a footprint dimensions that does not exceed 48 inches for either width or depth.
- 2 Ensure that totes are UN/DOT certified for shipping and handling of bulk liquids with a maximum of 1.9 specific gravity as required by 49 CFR, Part 178.
- 3 Use totes that have a base that allows four-way forklift and pallet jack handling. Make certain that the totes are capable of being stacked a minimum of two high when completely filled with paint.
- 4 Ensure that the minimum working volume of the bladder is 275 gallons and that the bladder is designed to allow for valve access and proper drainage of the container contents, while minimizing air space around the paint during storage and use. Ensure that the bladder completely encapsulates the paint within the container and does not allow any direct air to paint contact between the bladder and the container. Reuse of the bladder is prohibited.
- 5 Ensure that the finished tank wall is as free, as commercially practicable, of visual defects such as foreign inclusions, dried paint, air bubbles, pinholes, pimples, crazing, cracking and delaminations that will impair the serviceability

of the vessel. Fine bubbles are acceptable with tanks to the degree in which they do not interfere with proper fusion of the resin melt.

625.2.2.8.8.4 Tank Fittings and Attachments

- 1 Make certain that a bottom drain ball valve is recessed 2 inches with has a 2-inch male quick disconnect fitting. Ensure that the fill port and disconnect are leak free and compatible with waterborne paint. No galvanized, copper, chrome, or brass valves are allowed. Make certain that no portion of the valve, including the in-place cap assembly, extends beyond the vertical plane of the forklift.
- 2 Ensure that the top lid is a 6-inch screw cap style lid, and is easily opened by hand, and the screw cap has a 2-inch bung incorporated into it to provide a vacuum vent.

625.2.2.8.8.5 Markings and Certifications

- 1 Use totes that have a molded-in gallon marker for at-a-glance monitoring.
- 2 Make certain that totes that have the following markings required by 49 CFR, Part 178.703:
 - UN/DOT shipping classification,
 - Capacity,
 - Tare mass,
 - Month, day and year of manufacture, and
 - Manufacturer's name, city and state.
- 3 Use totes that have either a document holder attached or direct stenciling to the side that clearly convey the following information:
 - Company name,
 - Color of paint,
 - Quantity of paint contained,
 - Batch number,
 - Formula code, and
 - Other information as may be specified/requested by the Department.

625.2.2.9 Supplier Qualification

625.2.2.9.1 Supplier Experience

- 1 The firm or corporation that supplies paint is required to have a history of production and sales of the material furnished under these specifications. If requested by the Department and before use, have the supplier meet in person and/or furnish a statement to the satisfaction of the Department of the above history along with the names of other government agencies that have successfully used its products.

625.2.2.9.2 Laboratory Facilities

- 1 Ensure that the supplier possesses or has sufficient access to laboratory facilities capable of assuring accuracy and quality of formulation by performing laboratory tests as required in these specifications.

625.2.2.9.3 Service Technician

- 1 Proper application is deemed essential to the success of this process. To ensure proper usage of material provided under these specifications, provide at least one technician to instruct in the application of materials when requested by the Department. Provide a technician that is familiar with marking application equipment and has had successful experience in the placing of reflective markings and the use of reflective marking materials.

625.2.3 Glass Beads

- 1 Use glass beads meeting the requirements of this specification in the performance of this work. Use beads manufactured from 100% recycled cullet glass. This may include windowpane glass, architectural glass, automotive glass, or other glass sources.
- 2 Ensure that the beads meet all the requirements of AASHTO M 247, Type 1 with moisture resistant coating, with the following exceptions:
- 3 Replace Section 5.1 of AASHTO M 247, Type 1 with the following:

Package the beads in 50 or 55 pound waterproof multiple-layer type treated paper bags with a sheet of plastic moisture barrier between paper layers. Ensure that the bags are not less than five-ply construction, including the plastic moisture barrier. Furnish all pallets with the same quantity of bags and secure each pallet with shrink-wrap.

Mark each package with the following information:

 - Name and address of manufacturer,
 - Shipping point,
 - Trademark or name,
 - Wording: "Glass Beads",
 - Number of pounds,
 - Lot or batch number, and
 - Month and year of manufacture.
- 4 Other larger containers may be used subject to approval by the RCE.
- 5 The Department reserves the right to perform sampling of the packaged or unpackaged material at the point of manufacture, the Contractor's facilities, or at the job site. These samples will be tested in the manner deemed appropriate by the RCE. Before commencement of the work, provide a Certification of Compliance to the RCE for the glass beads as specified herein. At least one 50 or 55 pound bag of beads will be sampled by the RCE at random for each 44,000 pounds of beads used. Forward the bead samples and a copy of the

certification information to the OMR in Columbia for testing.

625.3 Equipment

625.3.1 Traveling Applicator

- 1 Use a traveling pavement marking applicator that is adaptable to traveling at a uniform, predetermined rate of speed both uphill and downhill in order to produce a uniform application of paint. Use a spray-type paint machine that is capable of satisfactorily applying the paint under pressure with a uniformity of feed through nozzles spraying directly upon the pavement. Use a machine that is capable of applying at least two separate stripes, either solid or skip, in any specified pattern by using at least two adjacent spray nozzles simultaneously. Use paint tanks equipped with satisfactory cutoff valves, which can apply broken, or skip lines automatically. Make certain that the controls allow the operator to override set automatic cycles to extend a line or to begin a new cycle at any selected point. Use nozzles with a mechanical bead dispenser that operates simultaneously and in coordination with the spray nozzle and distributes the beads in a uniform pattern at the rate specified. Ensure each nozzle is equipped with suitable line guides. Use a traveling applicator equipped with paint meters that will indicate the amount of paint dispensed from each tank.

625.3.2 Cleaning Equipment

- 1 Use pavement cleaning equipment consisting of the necessary brushes, brooms, scrapers, grinders, high-pressure water jets, and air blast equipment required to satisfactorily remove all foreign matter from the surfaces to be painted. Conduct cleaning in such a manner so that the underlying pavement is not damaged.

625.3.3 Hand Painting Equipment

- 1 Use hand painting equipment consisting of suitable applicators, templates, and guides necessary to produce satisfactory results. Limit the use of this equipment to smaller areas such as traverse lines and stenciled symbols.

625.3.4 Equipment on Site

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

625.4 Construction

625.4.1 Use and Coordination of Traffic Control

- 1 It is the Contractor's responsibility to use and coordinate the proper traffic control indicated in the Contract, the *SCDOT Standard Drawings*, the *MUTCD*, or as directed by the RCE to allow for the safe removal of existing pavement markings, surface preparation, and installation of new pavement markings.

625.4.2 Surface Preparation

- 1 Ensure that the pavement is dry and free of glaze, oil, dirt, grease, or other foreign contaminants. Where directed by the RCE, remove any existing markings that conflict with the *Pavement Marking Plans* by an approved method before the application of painted pavement marking. Use approved removal methods, which are shot blast, sand blast, or grinding.
- 2 In cases where the existing symbol markings (i.e. arrows, ONLY, etc.) differ from or are in conflict with the Plans, the *MUTCD*, or *the SCDOT Standard Drawings*, the RCE will determine which governs. For symbol marking relocation or replacement, remove 95% of the conflicting markings by buffing, water blasting, sand blasting, or otherwise ensuring that the pavement surface is in proper condition for adequate bonding of the new pavement markings. Include the cost of removal in the bid prices for placement of the new symbol markings.
- 3 On Portland cement concrete surfaces including bridge decks, remove at least 95% of any existing markings by an approved method to provide for adequate bonding of the pavement marking. Make the width of the removal 2 inches wider than the line to be applied.
- 4 When removing existing markings from the pavement surface, provide a positive means to control dust and accumulation of debris resulting from the removal operation. Capture the removed material utilizing a separate vacuum equipped vehicle or other approved system, to prevent its dispersal, and to properly dispose of this material. Do not allow any visible marking material debris to remain on the pavement shoulders. Ensure that the clean-up operations include removal and disposal of the excess or waste materials away from the project site.
- 5 Ensure that the removal or dust and debris collection operations do not damage the existing pavement surfaces (concrete or asphalt) or damage the pavement joint materials. Repair any significant damage occurring from the removal operations to the satisfaction of the RCE at no expense to the Department.
- 6 Immediately before application of the new marking material, clean all surfaces to be marked with a jet of compressed air. At the time of marking application, ensure that the pavement surface is free of dust, dirt, oil, grease, and any remaining loose or flaking existing marking material.

625.4.3 Application of Markings

625.4.3.1 Maximum Temperature and Heat Exchanger Dwell Time (Waterborne Paint)

- 1 When waterborne paint is utilized, do not allow the temperature at the heat exchanger of the paint truck to exceed 150°F. Do not allow paint to dwell in the exchanger for more than 2 hours.

- 2 It is strongly recommended that the exchanger temperature be reduced to 120°F or that heat to the exchanger and lines be turned off if the material is not to be applied within one hour.

625.4.3.2 Alignment of Markings

- 1 Ensure that the markings are straight or uniform in curvature and conform uniformly to tangents, curves, and transitions. Make certain that symbols are of dimensions shown in the Plans and the *SCDOT Standard Drawings*. Ensure that markings are the dimensions shown on the *Pavement Marking Plans* and the *SCDOT Standard Drawings* or as directed by the RCE. Provide sufficient control points to serve as guides for the application of markings.
- 2 Ensure that the finished line markings are free from waviness and the lateral deviations do not exceed 2 inches in 15 feet. Any greater deviation will be sufficient cause for requiring the removal and correction of the markings. Remove and correct any symbol markings not meeting the dimensional requirements shown on the Plans, the *Pavement Marking Plans*, and the *SCDOT Standard Drawings*.

625.4.3.3 Applicator Type

- 1 Place all longitudinal markings with a truck-mounted applicator except when approved by the RCE. Such an exception may occur where the length of a particular marking is too short or the curvature too great to permit efficient use of a truck-mounted applicator. Transverse markings may be applied with a portable unit.

625.4.3.4 Application Restrictions

- 1 Unless otherwise permitted by the RCE, no markings may be applied to areas of pavement when any of the following conditions are present:
1. Moisture or foreign matter is present on the surface.
 2. The air temperature is below 50°F.
 3. The relative humidity is above 85%.
- 2 The RCE may waive the temperature and humidity requirements on newly placed pavement when markings are immediately required for safe conduct of traffic.

625.4.3.5 Hours of Operation

- 1 Conduct marking operations only during daylight hours unless nighttime operations are required by the Contract or by the RCE. Ensure that all markings are sufficiently dry before opening to traffic.

625.4.3.6 Rate of Application

- 1 Provide all markings with a wet film thickness of 15 mils. Place glass beads at a minimum rate of 6 pounds per gallon of paint.

625.4.3.7 Protective Measures

- 1 When marking operations are conducted under traffic, take protective measures as outlined in the *Traffic Control Plan*. At the discretion of the RCE, repair and correct markings damaged by traffic, or markings tracked by crossing traffic as specified in **Subsection 625.4.3.9**.

625.4.3.8 Tolerance and Appearance

- 1 Ensure that markings are applied at the dimensions shown on the Plans, the *Pavement Marking Plans*, and the *SCDOT Standard Drawings*. Markings less than the specified width will not be accepted. Lengths of painted segment of skip lines less than 10 feet will not be accepted. Gaps between the painted segments that vary more than ± 6 inches from the specified dimensions will not be accepted. Ensure that all markings present a clean-cut, uniform, and workmanlike appearance. Correct all markings that fail to have a uniform, satisfactory appearance during day or night. Continued deviation from required dimensions will be cause for stopping the work and correcting the non-conforming markings as specified in **Subsection 625.4.3.9**.

625.4.3.9 Corrective Measures

- 1 All work will be subject to checks of dimensions and application rates for beads and paint. Correct all traffic markings that fail to meet the requirements given herein. Remove all areas of misted, dripped, and/or splattered paint to the satisfaction of the RCE. In all instances, when it is necessary to remove paint, remove it by means that are satisfactory to the RCE and which does not damage the underlying pavement.

625.5 Measurement

- 1 The quantities for fast dry painted pavement marking for lines are measured by the linear foot (LF) along the center of the pavement marking lines for each width and color of pavement marking line in-place, complete and accepted. The measurement includes the length of the painted marking only and excludes spaces between broken lines.
- 2 The quantities for fast dry painted pavement marking symbols (arrow, word, railroad crossing, handicap, and biking symbol, etc.) are measured by each (EA) symbol in-place, complete and accepted. A railroad crossing symbol consists of "X RR".
- 3 Traffic control utilized during the performance of painted pavement marking work is not measured under items covered by this section, but is included in the item Traffic Control in accordance with **Subsections 107.12** and **601.5**.
- 4 Unless included in other pay items in the Contract, the work required to remove existing pavement markings is considered incidental to the work under this section and is not measured separately.
- 5 Unless included in other pay items in the Contract, determination of the no passing zones for two-lane facilities and providing the Department with the data used in establishing the zones is considered incidental work for the

painted pavement marking items and is not measured for payment.

625.6 Payment

- 1 Payment for the accepted quantity for each type of pavement marking, measured in accordance with **Subsection 625.5**, is determined using the contract unit bid price for the applicable item. Payment is full compensation for applying painted pavement markings as specified or directed and includes preparing the pavement surface; removing unacceptable pavement markings; and all other materials, labor, equipment, supplies, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Removal of existing pavement markings is considered incidental to the other items of work and no separate payment is made for this work unless separate pay items are included in the Contract.
- 3 Unless otherwise included in the proposal, traffic control for surface preparation and the application and/or removal of pavement markings is included in the item Traffic Control in accordance with **Subsections 104.7** and **601.6**
- 4 Determination of the no passing zones for two-lane facilities and providing the Department with the data is considered incidental to the other various items of work, and no separate payment is made for this work.
- 5 Payment for each item includes all direct and indirect costs and expenses required to complete the work.
- 6 Pay items under this section include the following:

Item No.	Pay item	Unit
6250005	4" White Broken Lines (Gaps Excluded) - Fast Dry Paint	LF
6250007	6" White Broken Lines (Gaps Excluded) - Fast Dry Paint	LF
6250008	6" Black Broken Lines (Gaps Excluded) - Fast Dry Paint	LF
6250010	4" White Solid Lines (Pavement Edge Lines) - Fast Dry Paint	LF
6250012	6" White Solid Lines (Pavement Edge Lines) - Fast Dry Paint	LF
6250015	8" White Solid Lines (Crosswalk & Channelization) - Fast Dry Paint	LF
6250020	12" White Solid Lines - Fast Dry Paint	LF
6250025	24" White Solid Lines - (Stop/Diagonal Lines) - Fast Dry Paint	LF
6250030	White Single Arrow (Left, Straight, Right) - Fast Dry Paint	EA

(table continued on the next page)

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Item No.	Pay item	Unit
6250031	White Single Bike Lane Arrow (Left, Straight, Right) - Fast Dry Paint	EA
6250035	White Word Message "Only" - Fast Dry Paint	EA
6250040	White Combination Arrow (Straight & Right or Straight & Left) - Fast Dry Paint	EA
6250043	White Lane Drop Arrow (Left or Right) - Fast Dry Paint	EA
6250045	Railroad Crossing Symbols - Fast Dry Paint	EA
6250050	Handicap Symbol - Fast Dry Paint	EA
6250055	Bike Lane Symbol - Fast Dry Paint	EA
6250105	4" Yellow Broken Lines - (Gaps Excluded) - Fast Dry Paint	LF
6250107	6" Yellow Broken Lines - (Gaps Excluded) - Fast Dry Paint	LF
6250110	4" Yellow Solid Line - (Pavement Edge & No Passing Zone) - Fast Dry Paint	LF
6250111	6" Yellow Solid Line - (Pavement Edge & No Passing Zone) - Fast Dry Paint	LF
6250112	6" Yellow Solid Line on Curb/Median - Fast Dry Paint	LF
6250113	6" Yellow Solid Lines on 6" Concrete Curb (Top & Side) - Fast Dry Paint	LF
6250115	24" Yellow Diagonal Lines - Fast Dry Paint	LF

SECTION 626

EPOXY PAVEMENT MARKINGS

626.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for furnishing and applying permanent epoxy pavement markings within the limits of the project to delineate the travel lanes and channelize traffic.
- 2 This work includes protection of pavement markings during installation, determination of no passing zones for two-lane facilities in accordance with the *MUTCD*, and providing the Department data used in establishing no passing zones on two-lane facilities.

626.2 Materials

626.2.1 Epoxy Pavement Marking Material

- 1 Provide epoxy pavement markings that are permanent retro-reflective (white or yellow) and non-retroreflective (black) pavement marking materials of the color and pattern indicated on the Plans or Special Provisions. Supply all the necessary equipment and materials for proper surface preparation and correct application of the pavement marking material.
- 2 Provide markings consisting of a two-component, 100%-solids epoxy coating material capable of being applied by truck-mounted spray equipment. Ensure the material is capable of being applied at a minimum ambient air temperature of 40°F. Provide markings that are capable of retaining glass spheres and are suitable for application on all types of asphalt and concrete pavement surfaces.

626.2.1.1 Epoxy Coating Material

626.2.1.1.1 Formulation

- 1 Provide epoxy material consisting of a two-part system formulated and designed to provide a simple volumetric mixing ratio of two components (such as two volumes of Part A and one volume of Part B). Part B must be common to all colors.

626.2.1.1.2 Composition

- 1 Ensure Part A material is within the following limits:

Pigments:	White	Yellow	Non Lead Yellow	Black
Titanium Dioxide [*]	18-25%	----	14-17%	----
Chrome Yellow ^{**}	----	23-30%	----	----

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Pigments:	White	Yellow	Non Lead Yellow	Black
Organic Yellow	-----	-----	7-8%	-----
Black	-----	-----	-----	18-25%
Binder:				
Epoxy Resin	75-82%	70-77%	75-79%	75-82%
Notes: * ASTM D 476, Type II & III ** ASTM D 211, Type III				

626.2.1.1.3 Color

- 1 Ensure that the epoxy marking materials, without drop-on beads, visually match the color chips that correspond to the Federal Standard Number 595B for the following colors:

White	17925
Yellow	3538
Black	37038

- 2 Apply the mixed epoxy compound, white, yellow and black, to 2 sets of 3-inch x 6-inch steel plates at 20 mils (± 1 mil) in thickness, one set with glass beads and one set without glass beads as specified. Expose the prepared samples in accordance with ASTM G 53. Conduct the test for 75 hours at 122°F, 4 hours of humidity, and 4 hours of UV in alternating cycles. Ensure that the color of the epoxy materials is within 5 units of the Federal Standards shown above.

626.2.1.1.4 Yellowness Index (ASTM D 1925)

- 1 Check for compliance as follows:
- Cure 72 hours after sample preparation.
 - Take yellow index reading, XYZ C/2 degrees, following the 72-hour cure and preceding QUV (ASTM G 53).
 - Maximum before QUV, 10.0.
 - Place sample in QUV for 72 hours.
 - Maximum after QUV, 15.0

2

Typical White Standard	Typical Yellow Standard
X 78.5	X 52.7
Y 81.8	Y 48.1
Z 90.4	Z 7.6
YI 4.7	---

626.2.1.1.5 Directional Reflectance (ASTM E 97)

- 1 The Directional Reflectance after QUV using XYZ Scale D65/10 degrees is as follows:

White	75 Minimum
Yellow	38 Minimum

626.2.1.1.6 Epoxide Number

- 1 Ensure that the WPE of the epoxy resin is 250 (\pm 50) as determined by ASTM D 1652 for white, yellow, and black Component A on a pigment free basis.

626.2.1.1.7 Amine Number

- 1 Ensure that the amine number of the curing agent (Component B) is 450 (\pm 50) per ASTM D 2074.

626.2.1.1.8 Toxicity

- 1 Provide material that does not exude fumes that are toxic or injurious to persons or property when heating to application temperature.

626.2.1.1.9 Viscosity

- 1 Ensure that formulations of each component are such that the viscosity of both components coincides (within 10%) at the spray temperature recommended by the manufacturer. Ensure that Component B is formulated to have a steady and constant viscosity at temperatures recommended for spray application.

626.2.1.1.10 Drying Time

- 1 Ensure that the epoxy marking material, when mixed in the proper ratio and applied at 20 mils (\pm 0.5 mil) wet film thickness at 75°F (\pm 2°F) and with the proper saturation of glass spheres, exhibits "no tracking" time less than 15 minutes when tested in accordance with ASTM D 711.

626.2.1.1.11 Curing

- 1 Ensure that the epoxy materials are capable of fully curing under a constant pavement surface temperature of 32°F or above.

626.2.1.1.12 Adhesion to Concrete

- 1 Ensure that the catalyzed epoxy pavement marking materials, when tested according to ACI Method 503, have such a higher degree of adhesion to the specified concrete (4000 psi minimum) surface that it results in a 100% concrete failure in the performance of this test. Condition the prepared specimens at room temperature for a minimum of 24 hours and a maximum of 72 hours before the performance of the tests indicated.

626.2.1.1.13 Hardness

- 1 Ensure that the epoxy pavement marking materials, when tested according to ASTM D 2240, have a Shore D Hardness greater than 80. Cure samples

at room temperature for a minimum of 24 hours and a maximum of 72 hours before performing the tests indicated.

626.2.1.1.14 Abrasion Resistance

- 1 Evaluated the abrasion resistance on a Taber Abrader with a 1000-gram load and CS-17 wheels at duration of 1000 cycles. Calculate wear index based on ASTM C 501. Make certain that the wear index for the catalyzed material is not more than 80. Run the tests on cured samples of material, which have been applied at a film thickness of 15 mils (± 0.5 mil) to code S-16 stainless steel plates (to be run without glass spheres). Cure the samples at room temperature for a minimum of 24 hours and a maximum of 72 hours before performing the tests indicated.

626.2.1.1.15 Tensile Strength

- 1 Ensure that the epoxy pavement marking materials have an average tensile strength of not less than 6000 psi, when tested according to ASTM D 638. Cast the Type IV in a suitable mold and pull at a rate of 0.25 inch per minute with a suitable dynamic testing machine. Allow samples to cure at room temperature for a minimum of 24 hours and a maximum of 72 hours before performing the tests indicated.

626.2.1.1.16 Compressive Strength

- 1 Ensure that the catalyzed epoxy pavement marking materials, when tested according to ASTM D 695, have a compressive strength of not less than 12,000 psi. Condition the cast sample at room temperature for a minimum of 72 hours before performing the indicated tests. Make certain the rate of compression of these samples is not more than 0.25 inch per minute.

626.2.2 Glass Beads

626.2.2.1 Composition

- 1 Ensure that the silica content of the beads is not less than 60%.

626.2.2.2 Physical Characteristics

- 1 Ensure that the glass spheres are colorless, clean, transparent, and free from milkiness or excessive air bubbles. Ensure that the glass beads have a minimum refractive index of 1.5 when tested by the liquid immersion method at 77°F. Use beads that are essentially free of sharp angular particles and particles showing surface scarring or scratching.

626.2.2.3 Gradation

- 1 Ensure that Type 1, Type 4, and Type 5 glass beads meet the requirements of AASHTO M 247 with the following exceptions:

Glass beads are a minimum of 80% true spheres when tested according to ASTM D 1155 and meet the gradation requirements when tested in accordance with ASTM D 1214 shown in the following table.

Sieve Size	Percent by Mass Passing Designated Sieve (ASTM D 1214)		
	Grading Designation		
	Type 1 (AASHTO)	Type 4 (FP-96)	Type 5 (FP-96)
No. 8	---	---	100
No. 10	---	100	95 - 100
No. 12	---	95 - 100	80 - 95
No. 14	---	80 - 95	10 - 40
No. 16	100	10 - 40	0 - 5
No. 18	---	0 - 5	0 - 2
No. 20	95 - 100	0 - 2	---
No. 25	---	---	---
No. 30	75 - 95	---	---
No. 40	---	---	---
No. 50	15 - 35	---	---
No. 80	---	---	---
No. 100	0 - 5	---	---

626.2.2.4 Bead Coating

1. Ensure that all beads are embedded and moisture proof coated with Pot-ers Industries AC-100 series or an equivalent performance ensuring coating. Test the embedment coating by the Dansyl Chloride Method. Test the moisture proof coating by the following method:

A. Equipment:

1. Teaspoon
2. 500 ml Beaker

B. Procedure:

1. Put about 400 ml of cold water in the beaker.
2. Fill a spoon with the coated beads and gently immerse them into the water.
3. Tap the spoon to force the mass of beads to fall to the bottom to the beaker. The material should maintain its initial shape for at least one hour. Some beads may fall from the agglomerated mass; however, there should not be considerable dropping of beads before one hour.

626.2.3 Certification

- 1 Obtain from the manufacturer of the epoxy material, final certification that each batch of material furnished meets the requirements of these specifications. Also, obtain from the manufacturer of the glass beads, certifications that each batch of material furnished meets the requirements of these specifications. Ensure that the certifications provided for the marking material or glass beads indicate the batch numbers utilized and include the manufacturer's production control tests for each batch. Make certain that certifications also include the manufacturer's material safety data sheets. Furnish copies of the certifications to the RCE before the work commences.

626.2.4 Department Samples

- 1 The Department reserves the right to perform in-plant sampling of the finished epoxy paint components or glass beads during packaging operations and/or sampling of the packaged epoxy paint components or glass beads after they are received. The Department, in whatever manner it deems necessary, may test the samples. Department inspectors or their designated agents will observe performance of all sampling. The inspectors will designate at random two containers from each batch to be sampled for testing and enclose a copy of the sampling inspection with the samples.

626.2.5 Marking and Packaging

- 1 Provide all materials utilized in the performance of this work in the manufacturer's original, undamaged packaging. Ensure that this packaging clearly shows the following information:
 - Name of the manufacturer,
 - Type of material packaged,
 - Weight or volume of the material enclosed
 - Batch or lot numbers,
 - Date of manufacture and,
 - Color, if applicable.

626.3 Equipment**626.3.1 Equipment for Epoxy Pavement Markings**

- 1 Use equipment for applying the epoxy material that is truck-mounted and capable of mixing the two material components in the proportions recommended by the manufacturer and applying the material at the manufacturer's recommended application temperature. Ensure that the equipment is capable of automatically dispensing beads immediately following application of the epoxy material using a double drop system.
- 2 Use marking equipment that is capable of applying the epoxy material at a uniform thickness up to 25 mils, and in addition, is capable of dispensing beads at a constant rate of 25 pounds per gallon of marking material.

- 3 Make certain that the application equipment can distribute glass beads as required in **Subsection 626.4.3.1**.
- 4 Ensure the application equipment is mobile and maneuverable, can follow straight lines, and can make normal curves in a true arc. Use equipment that is constructed to ensure continuous uniformity in the dimensions of the applied markings.
- 5 Ensure the equipment is capable of cleanly cutting off square stripe ends and provides a method of automatically applying "skip" or longitudinal lines, including right and left edge-lines, or any combination of single or double line configurations (color and pattern) as illustrated in the *MUTCD*. In addition, ensure that the controls are such that the operator can override set automatic cycles in order to extend a line or to begin a new cycle at any selected point.
- 6 Use equipment that is capable of producing markings of varying widths as indicated in the *Pavement Marking Plans*, the *MUTCD*, the *Standard Drawings*, or the Contract specifications.
- 7 Make certain that the equipment travels only in the direction of normal traffic flow during marking operations.
- 8 Ensure that the equipment is configured to allow the operator to see the pressure gauges for each type of proportioning pump at all times so that any fluctuation or pressure difference can be detected immediately.
- 9 Make certain that 6 digit electrical foot counters with a reset feature are installed on the marking equipment to individually tabulate the amount of footage applied by each striping gun.
- 10 Equip the marking equipment with a pressure regulated air jet that spray all debris from the pavement in advance of the applicator guns that operate when marking material is applied. Synchronize the jets with marking material application or remain "on" at all times.

626.3.2 Equipment on Site

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

626.4 Construction

626.4.1 Preparation of Surface

- 1 Ensure that the pavement is dry and free of glaze, oil, dirt, grease, or other foreign contaminants. Where directed by the RCE, remove any existing markings that conflict with the *Pavement Marking Plans* by an approved method before the application of epoxy material. Use approved removal methods, which are shot blast, sand blast, or grinding.

- 2 In cases where the existing symbol markings (arrows, words, etc.) differ from or are in conflict with the Plans, the *MUTCD*, or the *Standard Drawings*, the judgment of the RCE will determine which to follow. For symbol marking relocation or replacement, remove 95% of the conflicting markings by buffing, water blasting, sand blasting, or otherwise ensuring that the pavement surface is in proper condition for adequate bonding of the new epoxy markings. Include the cost of removal in the bid prices for placement of the new symbol markings.
- 3 On Portland cement concrete surfaces including bridge decks, remove at least 95% of any existing markings by an approved method to provide for adequate bonding of the epoxy material. Make the width of the removal 2 inches wider than the line to be applied. Apply a primer sealer, recommended by the epoxy manufacturer, to the prepared surface before the application of the epoxy material.
- 4 When removing existing markings from the pavement surface, provide a positive means to control dust and accumulation of debris resulting from the removal operation. Capture the removed material utilizing a separate vacuum equipped vehicle or other approved system to prevent its dispersal. Properly dispose of this captured material. Do not allow visible marking material debris to remain on the pavement shoulders. Clean up, remove, and dispose of excess or waste materials away from the project site.
- 5 Ensure that the removal of dust and debris collection operations does not damage the existing pavement surfaces (concrete or asphalt) or damage the pavement joint materials. Repair any significant damage occurring from the removal operations to the satisfaction of the RCE no expense to the Department.
- 6 Immediately before the application of the new marking material, clean all surfaces to be marked with a jet of compressed air. At the time of marking application, the pavement surface must be free of dust, dirt, oil, grease and any remaining loose or flaking marking material.

626.4.2 Application of Markings

626.4.2.1 General

- 1 Place all longitudinal markings with a truck-mounted applicator except where approved by the RCE. Such an exception may occur where the length of a particular marking is too short or the curvature too great to permit efficient use of a truck-mounted applicator. Such markings, as well as transverse markings, may be applied with a portable unit.
- 2 Make certain markings are sharp, well defined, uniformly retroreflective (except black markings), and are free of uneven edges, overspray, or other readily visible defects, which in the opinion of the RCE detract from the appearance or function of the pavement markings. Non-retroreflective lines are unacceptable with the exception of black pavement markings. Remove and reapply pavement markings that are improperly applied or are not of uniform

retroreflectivity at no additional expense to the Department, including furnishing of materials. Remove and reapply improperly located markings in the correct location at no additional expense to the Department, including furnishing of materials.

- 3 Make certain that the markings are straight or uniform in curvature and conform uniformly to tangents, curves, and transitions. Apply symbols of dimensions shown in the *SCDOT Standard Drawings*. Ensure that line markings are of the dimensions shown on the *Pavement Marking Plans* or as directed by the RCE. Provide sufficient control points to serve as guides for the application of markings.
- 4 Ensure that the finished line markings are free from waviness and that lateral deviations do not exceed 2 inches in 100 feet. Remove and correct line markings with deviation greater than 2 inches in 100 feet at no additional expense to the Department. Remove and correct any symbol markings not meeting the dimensional requirements of the *Pavement Marking Plans* and the *SCDOT Standard Drawings* at no additional expense to the Department.
- 5 Protect the markings until dry by placing guarding or warning devices as necessary. In the event any vehicle should cross the wet marking, re-apply the marking and remove any tracking lines made by the moving vehicle to the satisfaction of the RCE.
- 6 In the event that the contract includes sections of roadway where raised pavement markers are installed on the surface, do not apply marking material onto the reflective surface of the raised markers. If marking material is applied to the reflective marker surface, the RCE will suspend the work and all marking material must be removed from the reflector unit or the damaged marker removed and replaced.

626.4.2.2 Rate of Application

- 1 Provide an adequate number of personnel experienced in the handling and application of this type of material to ensure that the work is done properly.
- 2 Apply the epoxy marking materials at the rate specified in the following table to produce a uniform 20 mil wet film thickness, calculated without drop-on beads.

Gallons of Material per Mile of Line		
Line Width (inches)	Material for Solid Line (gallons)	Material for Broken Line (gallons)
4	22	5.5
6	33	8.25
8	44	---
12	66	---
24	132	---

- 3 Ensure that application rates for solid lines in gore areas are not be less than one gallon per 80 square foot of marking surface (20 mil thickness). The following table gives the application rate on a linear foot basis for shorter lengths of markings (gore markings and stop bars.)

4

Linear Foot of Line per Gallon of Material	
Line Width (inches)	Solid Line Length (feet)
8	120
12	80
24	40

- 5 Heat the epoxy to the manufacturer's recommended temperature before application to the pavement surface.

626.4.3 Glass Beads

626.4.3.1 Application of Glass Beads

- 1 Apply two sizes of glass beads by the double drop method. This method requires that the large and small glass spheres be injected into or dropped onto the liquid epoxy marking immediately after the material is applied to the pavement surface while the pavement marking material is still wet to ensure that the beads are held by and mechanically embedded in the surface of the epoxy material. Ensure that the beads are uniformly distributed over the entire surface of the marking material in accordance with **Subsection 626.4.3.2**.
- 2 Apply the large beads first and immediately followed by the application of the small beads. Ensure that the beads adhere to the cured epoxy or cease all marking operations until corrections are made.

626.4.3.2 Double Drop Method

- 1 Use small glass beads meeting the gradation for Type 1 required in **Subsection 626.2.2.3**.
- 2 Use large glass beads meeting the gradation for Type 3 or 4 required in **Subsection 626.2.2.3** and are a minimum of 80% true spheres.
- 3 Apply large beads uniformly to the surface of the epoxy material so that they are embedded at 60% of their diameter at a rate of 12 lbs per gallon of material. Immediately follow the application of the large beads with application of the smaller spheres at a rate of 12 lbs per gallon of material.
- 4 Make certain that the beads are properly imbedded and adhered to the cured epoxy line; if not, cease all marking operations until corrections are made.
- 5 Make certain that the marking is uniformly retroreflectorized upon cooling.

626.4.4 Weather, Seasonal, and other Limitations

- 1 Place epoxy pavement markings only when the pavement is dry as determined by visual inspection or other approved method, the pavement temperature is a 45°F or greater, and the air temperature is 40°F or greater. No work is allowed when any moisture is visible on the pavement surface or pavement is wet.
- 2 Provide each work crew with a hand-held infrared non-contact thermometer with a temperature range of 0°F to 1000°F to verify the minimum surface temperature and a pocket thermometer capable of accurately measuring air temperature. Measure air temperature away from heat generating equipment.
- 3 Application of markings may be disallowed on any day when, in the opinion of the RCE, moisture or temperature conditions are not satisfactory for obtaining quality pavement markings.
- 4 Do not apply epoxy pavement markings between December 15 and March 15, inclusive.
- 5 Ensure that new asphalt concrete surfaces are in place a minimum of 2 weeks before marking application. Remove the curing compound on new Portland cement concrete surfaces before application.

626.4.5 Inspection and Acceptance

- 1 All epoxy markings will be inspected for proper line thickness and width, proper adhesion, and proper cycle length. The markings will also be observed during both daytime and nighttime conditions to determine whether all the requirements of these specifications have been met. Remove and replace markings that fail to have satisfactory appearance in either daytime or nighttime conditions at no additional expense to the Department.
- 2 The final acceptance of the epoxy pavement markings will be delayed for a period of 180 days after the last date of marking on the project to permit observation of performance.
- 3 Traffic must be operating on the facility during the entire 180-day observation period unless otherwise directed.
- 4 Replace markings that, in the opinion of the RCE, have not performed satisfactorily during this 180-day period due to defective materials and/or workmanship.
- 5 Ensure that the pavement marking material shows no signs of failure due to blistering, excessive cracking, chipping, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, or gasoline drippings, spilling, poor adhesion to the pavement materials, loss of retroreflectivity, and normal wear.

626.5 Measurement

- 1 The quantities for epoxy pavement markings for lines are measured by the linear foot (LF) along the center of the pavement marking lines for each width and color of epoxy pavement marking in-place, complete and accepted. The measurement is the length of the epoxy pavement marking only and excludes spaces between broken lines.
- 2 The quantities for epoxy pavement marking symbols (arrows, word, and railroad crossing symbol) are measured by each (EA) symbol in-place, complete and accepted. A railroad-crossing symbol consists of "X RR".
- 3 Traffic control utilized during the performance of epoxy pavement marking work is not measured under items covered by this section, but is included in the item Traffic Control in accordance with **Subsections 107.12** and **601.5**.
- 4 Unless included in other bid items in the Contract, the work required to remove existing pavement markings is considered incidental work for epoxy pavement marking work and is not measured separately.
- 5 Unless included in other bid items in the Contract, the work required to determine the no passing zones for two-lane facilities and to provide the Department with the data used in establishing the zones is considered incidental to the work under this section and is not measured for payment.

626.6 Payment

- 1 Payment for the accepted quantity for each type of epoxy pavement markings measured in accordance with **Subsection 626.5**, is determined with the contract unit bid price for the applicable item. Payment is full compensation for applying epoxy pavement markings as specified or directed and includes preparing the pavement surface; removing unacceptable pavement markings; and all other materials, labor, equipment, supplies, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Removal of existing pavement markings is considered incidental to the other items of work and no separate payment is made for this work unless separate pay items are included in the Contract.
- 3 Unless otherwise included in the Contract, traffic control for application and/or removal of pavement markings is included in the pay item Traffic Control in accordance with **Subsections 107.12** and **601.6**.
- 4 Determination of the no passing zones for two-lane facilities and providing the Department with the data is considered incidental to the other various items of work, and no separate payment is made for this work.
- 5 Payment for each item includes all direct and indirect costs and expenses required to complete the work.

6 Pay items under this section include the following:

Item No.	Pay Item	Unit
6262005	4" White Broken Lines - (Gaps Excluded) - Epoxy Paint	LF
6262007	6" White Broken Lines - (Gaps Excluded) - Epoxy Paint	LF
6262008	6" Black Broken Lines - (Gaps Excluded) - Epoxy Paint	LF
6262010	4" White Solid Lines - (Pavement Edge Lines) - Epoxy Paint	LF
6262012	6" White Solid Lines - (Pavement Edge Lines) - Epoxy Paint	LF
6262015	8" White Solid Lines - (Crosswalk & Channelization) - Epoxy Paint	LF
6262020	12" White Solid Lines (Gore Markings) Epoxy Paint	LF
6262021	12 " White Solid Lines (Diagonal Lines) - Epoxy Paint	LF
6262025	24" White Solid Lines (Stop Lines/Diagonal Lines) - Epoxy Paint	LF
6262030	White Single Arrows (Left, Straight, Right) - Epoxy Paint	EA
6262035	White Word Message "Only" - Epoxy Paint	EA
6262040	White Combination Arrow (Straight & Right or Straight & Left) - Epoxy Paint	EA
6262043	White Lane Drop Arrow (Left or Right) - Epoxy Paint	EA
6262045	Railroad Crossing Symbols - Epoxy Paint	EA
6262105	4" Yellow Broken Lines (Gaps Excluded) Epoxy Paint	LF
6262110	4" Yellow Solid Lines (Pavement Edge & No Passing Zone) - Epoxy Paint	LF
6262112	6" Yellow Solid Lines (Pavement Edge & No Passing Zone) - Epoxy Paint	LF
6262114	12" Yellow Solid Lines (Diagonal Line) - Epoxy Paint	LF
6262115	24" Yellow Diagonal Line - Epoxy Paint	LF

SECTION 627

THERMOPLASTIC PAVEMENT MARKINGS

627.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for furnishing and applying permanent thermoplastic pavement markings within the limits of the project to delineate the travel lanes and channelize traffic.
- 2 This work includes protection of pavement markings during installation, determination of no passing zones for two-lane facilities in accordance with the *MUTCD*, and providing the Department data used in establishing no passing zones on two-lane facilities.

627.2 Materials

627.2.1 General

- 1 Provide thermoplastic pavement marking material that is a reflectorized mixture of a thermoplastic binder and spherical glass beads upon which additional glass beads are applied by dropping immediately following application. Coat Portland concrete pavement surfaces, including bridge decks, with a primer-sealer material before application of the thermoplastic binder material. Coat other surfaces as well if recommended by the thermoplastic manufacturer.

627.2.2 Thermoplastic Binder Compound

627.2.2.1 General

- 1 Ensure that the thermoplastic binder compound meets all requirements of AASHTO M 249 as modified herein.
- 2 The material may be shipped in the granulated form or the block form. Use alkyd based thermoplastic pavement markings. Apply alkyd/maleic thermoplastic pavement markings by extrusion methods only. Extrusion may be accomplished using either conventional extrusion equipment or ribbon gun extrusion devices.
- 3 Ensure that the alkyd/maleic binder consists of a mixture of synthetic resins containing high boiling point plasticizers and at least one synthetic resin that is solid at room temperature. Use a binder with at least one-half of its composition consisting of 100% maleic-modified glycerol of resin and not less than 15% by weight of the entire material formulation. Make certain that the binder does not contain petroleum hydrocarbon resins. Ensure that resins/rosins used are maleic-modified glycerol esters.
- 4 Ensure that the thermoplastic material dissolves immediately in diacetone alcohol. Slow dissolution is evidence of the presence of hydrocarbon binder components, which are not allowed.

627.2.2.2 Yellow Thermoplastic

- 1 Use a yellow thermoplastic that is lead-free (L/F). Ensure that it does not contain more than 3ppm of lead by weight in a cured state and not more than 100ppm of total Heavy Metals as defined by Resource Conservation and Recovery Act (RCRA) including lead and hexavalent chromium when tested in accordance with Environmental Protection Agency (EPA) Methods 3050 and 6010. Ensure that the yellow thermoplastic contains proper amounts of pigment to produce a material that is weather-fast, heat stable, and meets the Yellow Color, Reflectance, Color Stability (Accelerated Weathering), and Retroreflectivity requirements specified herein. Make certain that the lead-free yellow thermoplastic material appears yellow during both daytime and nighttime conditions when applied with drop-on beads. Ensure that the thermoplastic does not contain any hazardous materials at levels that would cause the thermoplastic to be classified as a hazardous waste as defined by RCRA Subarticle C rules and Table 1 of 40 CFR 261.24 Toxicity Characteristic.
- 2 Ensure that the yellow color of unbeaded material matches Federal Standard Designation No. 595b, color No. 33538 and is within the following chromaticity limits (color box) defined by plotting the following four (x, y) pairs on a C.I.E. 1931 Chromaticity diagram:

(x1, y1) (.5300, .4560)

(x2, y2) (.5100, .4850)

(x3, y3) (.4550, .4440)

(x4, y4) (.4720, .4000)

Reflectance (Y) between 45 and 55

Measurement conditions = 2 degrees observer/illuminant D65

Instrument: BYK – Gardner “Color-Guide” Spectrophotometer

627.2.2.3 Accelerated Color Stability

- 1 Ensure that the accelerated weathering of white and yellow (L/F) thermoplastic meets the requirements of ASTM G 155, Table X3.1, Cycle I for 1500 hours total exposure time. Prepare sample by dipping a sheet aluminum panel into the molten thermoplastic and removing it to obtain a 1.5 to 3.0 mm coating thickness of thermoplastic on the panel. Place the panel in the weathering apparatus for 1500 hrs.
- 2 After accelerated weathering, measure the Yellow Color or Yellowness Index of the unbeaded material as stated in AASHTO M 249, Section 4.3.1 or 4.3.7. Material must meet the color stability requirements below after this exposure:
 - White – ASTM E 313 – Yellowness Index, max. 20
 - Yellow – Measured chromaticity coordinates falls within a “color box” defined by the following four (x, y) pairs on a C.I.E. 1931 Chromaticity diagram:

(x1, y1) (.5300, .4560)
 (x2, y2) (.5100, .4850)
 (x3, y3) (.4350, .4290)
 (x4, y4) (.4490, .3770)

627.2.2.4 Color Stability of In-Service White and Yellow Thermoplastic

- The daytime color of the applied white and yellow thermoplastic pavement marking material (with drop-on beads) must meet the color requirements shown in **Subsection 627.2.2.3** (Accelerated Color Stability). The color may be measured within 60 days of application using a portable BYK-Gardner "Color-Guide" Spectrophotometer (see **Subsections 627.2.2.2** and **627.2.2.3**) and must remain within the "color-box" as noted in **Subsection 627.2.2.3**.

627.2.2.5 Hardness and Indentation Resistance

- Measure the hardness according to ASTM D 2240, except condition the sample for 2 hours in a 115°F water bath, before measuring the hardness. Condition the Durometer at 115°F in a forced air oven. Remove the sample from the water bath and quickly place the Durometer on the sample while starting a stopwatch. Record the hardness after 15 seconds. Ensure that the total weight of the Durometer is 2000 grams. Make certain the hardness is a minimum of 40 and a maximum of 70.

627.2.2.6 Flash Point

- Ensure that the flash point of the thermoplastic pavement marking is a minimum of 475°F (245°C) when tested in accordance with ASTM D 92.

627.2.3 Glass Beads

- Ensure that Type 1, Type 3, and Type 4 glass beads meet the requirements of AASHTO M 247 with the following exceptions:

Glass beads are a minimum of 80% true spheres when tested according to ASTM D 1155 and meet the following gradation requirements when tested in accordance with ASTM D 1214:

Sieve Size	Percent by Mass Passing Designated Sieve (ASTM D 1214)		
	Grading Designation		
	Type 1 (AASHTO)	Type 3 (FP 96)	Type 4 (FP 96)
No. 8	---	---	---
No. 10	---	---	100
No. 12	---	100	95 - 100
No. 14	---	95 - 100	80 - 95

(table continued on the next page)

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Sieve Size	Percent by Mass Passing Designated Sieve (ASTM D 1214)		
	Grading Designation		
	Type 1 (AASHTO)	Type 3 (FP 96)	Type 4 (FP 96)
No. 16	100	80 - 95	10 - 40
No. 18	---	10 - 40	0 - 5
No. 20	95 - 100	0 - 5	0 - 2
No. 25	---	0 - 2	---
No. 30	75 - 95	---	---
No. 40	---	---	---
No. 50	15 - 35	---	---
No. 80	---	---	---
No.100	0 - 5	---	---

- 2 Ensure that the intermixed glass beads meet the requirements for Type I with the following exception:

The intermixed glass beads are incorporated into the thermoplastic binder at a minimum of 35% and a maximum of 40% by mass weight.

627.2.4 Primer-Sealer

- 1 Use a two-part epoxy primer-sealer recommended by the manufacturer of the thermoplastic pavement marking material on Portland cement pavement surfaces and bridge surfaces that have not been overlaid with asphalt. Use the primer-sealer on any type of pavement before the placing of any pavement symbols. Use the primer-sealer on asphalt concrete pavement surfaces if recommended by the manufacturer of the thermoplastic pavement marking material. Ensure that the primer-sealer forms a continuous film that will mechanically adhere to the pavement and neither discolor nor cause any noticeable change in the pavement outside of the finished pavement markings. Apply the primer-sealer in accordance with the manufacturer's recommendations.

627.2.5 Quality Assurance Provisions And Certification

- 1 Obtain actual laboratory test results from the manufacturer of the thermoplastic binder indicating compliance with all requirements of AASHTO M 249 for each batch or lot of material furnished, along with a final certification that the material furnished meets the requirements of the Department's specifications. Also, obtain from the manufacturer of the drop-on glass beads a certification stating that the material furnished meets all the requirements of the

Contract specifications. Furnish copies of the above-described affidavits to the RCE.

627.3 Equipment

627.3.1 Application Equipment

- 1 Use equipment that enables the installation of thermoplastic pavement markings by methods in accordance with AASHTO M 249 with the addition of the following requirements.
- 2 Applicators may be either a truck-mounted liner or a portable unit. A truck-mounted unit is defined as a self-propelled vehicle with six or more wheels and an enclosed cab for housing a driver. Make certain that the operator has controls that allow override of pre-set automatic cycles in order to extend a line or to begin a new cycle at any selected point.
- 3 Prepare material with an insulated batching machine recommended or furnished by the manufacturer and consists of a special kettle for melting and heating the composition. Ensure that heating of kettles and melters is done by controlled heat transfer systems that are oil jacketed or indirect flame air jacketed. Do not use direct flame heating equipment. Make certain that all kettles and melters are equipped with an automatic thermostatic control device and proper thermometers to control the temperature of the material at the manufacturer's recommended application temperature range. Ensure that all mixing and conveying parts up to the final dispensing nozzle/shaping die maintain the material at the appropriate temperature. Ensure that the applicator and kettle are equipped and arranged to satisfy the requirements of all state and local requirements.
- 4 Ensure that the batching machine provides continuous mixing and agitation of the material. Make certain that all parts of the equipment that come in contact with the material are easily accessed and exposed for cleaning and maintenance and are designed to prevent accumulation and clogging.
- 5 Apply thermoplastic pavement markings by extrusion methods. Extrusion may be accomplished either with a conventional extrusion equipment, wherein one side of the shaping die is the pavement surface and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material, or with ribbon gun extrusion devices. Make certain that the applicators have a means for cleanly cutting off square ends.
- 6 Ensure that the applicators are capable of producing the various widths of traffic markings required in the *MUTCD* and/or on the Plans. Make certain that the applicators are mobile and maneuverable so that it can follow straight lines and make normal curves in a true arc. Use a truck-mounted liner with a method of automatically applying "skip" or solid longitudinal lines, including right and left edge lines, or any combination of single or double line configurations (color and pattern) as illustrated in the *MUTCD*. Adjust application equipment to prevent nozzle/shaping die overruns without the use of pans,

aprons, or other devices.

- 7 Apply glass beads to the surface of the completed marking with an automatic bead dispenser attached to the applicator so that the beads are dispensed almost instantly following application of the marking material.

627.3.2 Equipment on Site

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

627.4 Construction

627.4.1 Use and Coordination of Traffic Control

- 1 It is the Contractor's responsibility to use and coordinate the proper traffic control indicated in the Specification, on the Plans and the *SCDOT Standard Drawings*, in the *MUTCD*, or as directed by the RCE to allow for the safe removal of existing pavement markings if required, surface preparation, and installation of new pavement markings.

627.4.2 Surface Preparation

- 1 Ensure that the pavement is dry and free of glaze, oil, dirt, grease, or other foreign contaminants. Where directed by the RCE, remove any existing markings that conflict with the *Pavement Marking Plans* by an approved method before the application of thermoplastic material. Use approved removal methods, which are shot blast, sand blast, or grinding.
- 2 In cases where the existing symbol markings (i.e. arrows, ONLY, etc.) differ from or are in conflict with the Plans, the *MUTCD*, or the *SCDOT Standard Drawings* the RCE will determine which governs. For symbol marking relocation or replacement, remove 95% of the conflicting markings by buffing, water blasting, sand blasting, or otherwise ensuring that the pavement surface is in proper condition for adequate bonding of the new thermoplastic markings. Include the cost of removal in the bid prices for placement of the new symbol markings.
- 3 On Portland cement concrete surfaces including bridge decks, remove at least 95% of any existing markings by an approved method to provide for adequate bonding of the thermoplastic material. Make the width of the removal 2 inches wider than the line to be applied. Apply a primer sealer, recommended by the thermoplastic manufacturer, to the prepared surface before the application of the thermoplastic material.
- 4 When removing existing markings from the pavement surface, provide a positive means to control dust and accumulation of debris resulting from the removal operation. Capture the removed material utilizing a separate vacuum equipped vehicle or other approved system, to prevent its dispersal, and to properly dispose of this material. Do not allow visible marking material debris

to remain on the pavement shoulders. Ensure that the clean-up operations include removal and disposal of the excess or waste materials away from the project site.

- 5 Ensure that the removal or dust and debris collection operations do not damage the existing pavement surfaces (concrete or asphalt) or damage the pavement joint materials. Repair any significant damage occurring from the removal operations to the satisfaction of the RCE and at no expense to the Department.
- 6 Immediately before application of the new marking material, clean all surfaces to be marked with a jet of compressed air. At the time of marking application, ensure that the pavement surface is free of dust, dirt, oil, grease, and any remaining loose or flaking existing marking material.

627.4.3 Application of Primer-Sealer

- 1 Where required, spray the primer-sealer on the pavement surface where the lines are to be applied. Follow the recommendations of the manufacturer of the primer sealer and/or thermoplastic material for the application thickness and curing time before application of the thermoplastic material.

627.4.4 Application of the Thermoplastic Pavement Marking Material

- 1 Except when directed or approved by the RCE, place all longitudinal markings with a truck-mounted applicator in conformance with the requirements of **Subsection 627.3**. Such an exception may occur where the length of a particular marking is too short or the curvature too great to permit efficient use of the truck-mounted liner. Transverse markings may be applied with a portable unit.
- 2 Ensure that the markings are straight or uniform in curvature and conform uniformly to tangents, curves, and transitions. Make certain that symbols are of the dimensions shown in the *SCDOT Standard Drawings*. Ensure that markings are of the dimensions and are placed as shown on the *Pavement Marking Plans* or as directed by the RCE. Provide sufficient control points to serve as guides for the application of markings at no additional expense to the Department.
- 3 Ensure that the finished line pavement markings are free from waviness and lateral deviation does not exceed 2 inches in 15 feet. Any greater deviation is sufficient cause for removal and correction of such markings at no additional expense to the Department. Remove and correct symbol pavement markings not meeting the dimensional requirements shown in the *SCDOT Standard Drawings*. Protect the pavement markings until dry by placing guarding or warning devices as necessary. If a vehicle crosses the wet marking, remove the pavement marking and any tracking lines made by the moving vehicle and apply new markings at no additional expense to the Department.
- 4 Place pavement markings only when the pavement is dry as determined by visual inspection or other approved method and the pavement temperature is

a 55°F or greater and the air temperature is 50°F or greater. No work is allowed when any moisture is visible on the pavement surface or pavement is wet. Provide each work crew with a hand-held infrared non-contact thermometer with a temperature range of 0°F to 1000°F to verify the minimum surface temperature and a pocket thermometer capable of accurately measuring air temperature. Measure air temperature away from heat generating equipment.

- 5 Do not apply thermoplastic pavement markings between December 15 and March 15, inclusive. Additionally, the RCE may disallow application on any days when the weather is cold and/or rainy and there is some question as to whether the surface temperature will be above 55°F for a period adequate to obtain quality pavement markings. Application may also be disallowed on any day when, in the opinion of the RCE, moisture conditions are not satisfactory for obtaining quality pavement markings.
- 6 Ensure that new asphalt concrete surfaces are in place a minimum of 7 days before application of thermoplastic pavement markings. Remove the curing compound on new Portland cement concrete surfaces before application of pavement markings.
- 7 Have on hand an adequate number of personnel experienced in the handling and application of this type of material to ensure that the work is done properly. Run the marking machine only in the direction of normal traffic flow during marking operations.
- 8 Perform work only during daylight hours unless specified otherwise. Ensure that all markings are sufficiently dry before sunset to permit crossing by traffic. Remove all protective devices before sunset to allow free movement of traffic at night.
- 9 Apply the thermoplastic pavement marking material at a temperature between 390°F and 420°F that provides the best adhesion to the pavement as recommended by the manufacturer. Heat the material uniformly throughout, and ensure that it has a uniform disbursement of binder, pigment, and glass beads when applied to the surface of the pavement.
- 10 Apply extruded lines 12 inches or less in width with a die that equals the width of the line. Extruded lines greater than 12 inches may be applied with two dies whose combined width is equal to the width of the line.

627.4.5 Rate of Application of Thermoplastic Material

- 1 Apply the thermoplastic material at the specified widths and at the rate of new dry material thickness as specified as follows.
 - 90 mils for edge lines and median lines including:
 - 4-inch solid white lines,
 - 4-inch solid yellow lines,
 - 4-inch broken yellow lines,
 - 6-inch solid white lines, and

- 6-inch solid yellow lines.
- 90 mils for lane lines including:
 - 4-inch broken white lines and
 - 6 inch broken white lines.
- 90 mils for center lines on two-lane roads including:
 - 4-inch broken yellow lines and
 - 4-inch solid yellow lines.
- 125 mils for all symbols, words, or other lines not listed above.

627.4.6 Application of Glass Beads

627.4.6.1 General

- 1 Mechanically apply drop-on glass beads to the surface of the pavement marking material immediately after the material is applied to the pavement surface while the pavement marking material is still molten. Ensure that the beads are held by, and mechanically embedded in, the surface of the material. Make certain that the beads are uniformly distributed over the entire surface of the marking utilizing the single-drop or double-drop method specified below.
- 2 Uniformly apply drop-on glass beads to the surface of the molten thermoplastic material using either Single-Drop or Double-Drop method as required. Make certain that beads are embedded at 60% of their diameter and at a rate of 8 to 10 lbs per 100 square feet. Ensure that Type I glass spheres used for Single-Drop applications have a dual coating for adhesion promotion and moisture resistance.

627.4.6.1 Double Drop Method

- 1 Use the double-drop method of applying glass beads for all Interstate highways and for other roadways when specified or required by the plans.
- 2 Use small glass beads meeting the gradation for Type 1 required in **Subsection 627.2.3**.
- 3 Use large glass beads meeting the gradation for Type 3 or 4 required in **Subsection 627.2.3** and are a minimum of 80% true spheres.
- 4 Apply large beads uniformly to the surface of the thermoplastic material so that they are embedded at 60% of their diameter at a rate of 8 to 10 lbs. per 100 square feet of material. Immediately follow the application of the large beads with application of the smaller spheres at a rate of 8 to 10 lbs. per 100 square feet of material.
- 5 Ensure that the beads are properly embedded and adhered to the thermoplastic line; if not, cease all marking operations until corrections are made.
- 6 Make certain that the marking is uniformly retroreflectorized upon cooling.

627.4.7 Reflectance Requirements

- 1 Ensure that the markings have the minimum retroreflectance values shown in the following table at the time of installation as obtained with a LTL 2000 Retroreflectometer. Make certain these values are maintained for a minimum of 30 days from the time the markings are placed. Make certain that each marking is uniformly retroreflectorized upon cooling.

Retroreflectivity (mcd/lux/m ²)		
	White	Yellow
Single-Drop	375	250
Double-Drop	450	350

627.4.8 Inspection and Departmental Sampling

- 1 In addition to initial acceptance, thermoplastic material may be required to be sampled, tested, and approved by the OMR or their designated representative before shipment.
- 2 At the discretion of the Department, additional sampling and testing at the job site may be performed. Submit to the RCE a certification from the manufacturer for each shipment, certifying through actual laboratory test results that the thermoplastic meets the requirements of AASHTO M 249 as amended herein for each type of thermoplastic material. No thermoplastic material may be used or be paid for until the thermoplastic certification is received and accepted by the RCE. The Department reserves the right to sample and test any thermoplastic material supplied for any SCDOT project at any time.
- 3 A lot consists of a batch or consecutive batches of thermoplastic manufactured on the same day using the same formulation. A lot must be more than 2000 lbs and less than 44,000 lbs of thermoplastic material. A batch is that amount of thermoplastic that was manufactured and packaged in a single operation. Make certain thermoplastic material from the same lot is palletized, stretch-wrapped, labeled with the manufacturer's lot and batch numbers (on each pallet) and batch number (on each bag) and stored in a common area to facilitate random sampling of the entire lot by the Department's Inspector.
- 4 Ensure that the following information is included on the manufacturer's certification:
- State Specification No.,
 - Manufacturer's Product No.,
 - Color (White or Lead-Free Yellow),
 - Weight of the sample,
 - Identification numbers of batches comprising the lot and lot number,
 - Date of Manufacture,

- Form (block or granular),
 - Binder Type – Alkyd,
 - Sampling Method (splitting, thieving, quartering, random bag, etc.), and
 - SC File No. or Contract No.
- 5 Submit to the OMR or their designee a manufacturer's test report showing actual laboratory test results on each lot of thermoplastic material. Include the following information in the manufacturer's test report:
- Binder Content,
 - Pigment Content,
 - Glass Bead Content,
 - Daylight Luminous Reflectance,
 - 4 Hour Daylight Luminous Reflectance after 4 hrs at 425°F,
 - Yellow Color – Chromaticity Coordinates (for yellow only),
 - Yellowness Index (for white only),
 - Ring and Ball Softening Point,
 - Hardness,
 - Flowability,
 - Extended Flowability, and
 - Flash Point.
- 6 The Department reserves the right to retest any batch/lot of thermoplastic material after delivery. Results from such retesting will prevail over all other tests and failure will be the basis of rejection. Remove material not meeting the specification from the project and replaced at no expense to the Department, including all costs for handling, retesting and shipping.

627.4.9 Testing

- 1 Perform tests according to the specified test methods. Qualitative and quantitative analysis may also be performed by other methods of analysis at the option of the Department. Ensure that the manufacturer maintains a laboratory sufficiently staffed and equipped to maintain the quality of the product called for in these specifications.
- 2 The Department may require the manufacturer to fully disclose details of the systems and processes in its QA/QC Program.

627.4.10 Inspection and Acceptance of Work

- 1 All thermoplastic pavement markings will be inspected for proper line thickness and width, adhesion, and cycle length. The markings will also be observed in both daytime and nighttime conditions to determine whether all requirements of the Contract have been met. Remove and replace markings that fail to have a satisfactory appearance during either daytime or nighttime conditions at no additional expense to the Department.

- 2 The final acceptance of the thermoplastic pavement markings will be delayed for a period of 90 days after the last date of marking on the project to permit observation of performance. The Contractor is responsible for the maintenance and performance of pavement markings during the 90-day observation period. The markings are guaranteed under the payment and performance bond. Traffic must be operating on the facility during the entire 180-day observation period unless otherwise directed.
- 3 Replace markings or markers that, in the opinion of the RCE, have not performed satisfactorily during this 90-day period due to defective materials and/or workmanship.
- 4 Ensure that the pavement marking material provided shows no signs of failure due to blistering, excessive cracking, chipping, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, or gasoline drippings, spilling, poor adhesion to the pavement materials, loss of retroreflectivity, and normal wear.
- 5 Ensure that the thermoplastic marking maintains minimum retroreflectance values shown in the following table throughout the observation period. These measurements will be taken within 30 days before the end of the observation period. The retroreflectance values will be taken using a LTL 2000 Retroreflectometer.

180-Day Retroreflectivity (mcd/lux/m ²)		
	White	Yellow
Single-Drop	325	200
Double-Drop	400	300

627.5 Measurement

- 1 The quantities for thermoplastic pavement markings for lines are measured by the linear foot (LF) along the center of the pavement marking lines for each type of line, width, color, and dry thickness of pavement marking line in-place, complete and accepted. Measurement is made of the pavement marking only and excludes the spaces between broken lines.
- 2 The quantities for thermoplastic pavement marking symbols (arrows, words, and railroad crossing symbols) are measured by each (EA) arrow (straight, right, left or combination), word or words, and railroad crossing symbol in-place, complete and accepted. A railroad-crossing symbol consists of "X RR".
- 3 Traffic control utilized during the performance of thermoplastic pavement marking work is not measured under items covered by this section, but is included in the item Traffic Control in accordance with **Subsections 107.12** and **601.5**.

- 4 Unless included in other pay items in the Contract, the work required to remove existing pavement markings is considered incidental work for the thermoplastic pavement marking items and is not measured separately.
- 5 Unless included in other pay items in the Contract, the work required to determine the no passing zones for two-lane facilities and to provide the Department with the data used in establishing the zones is considered incidental to the work under this section and is not measured for payment.

627.6 Payment

- 1 Payment for the accepted quantity for each type of thermoplastic pavement markings measured in accordance with **Subsection 627.5** is determined with the contract unit bid price for the applicable item. Payment is full compensation for applying thermoplastic pavement markings as specified or directed and includes preparing the pavement surface; removing unacceptable pavement markings; and all other materials, labor, equipment, supplies, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Removal of existing pavement markings is considered incidental to the other items of work and no separate payment is made for this work unless separate pay items are included in the Contract.
- 3 Unless otherwise included in the Contract, traffic control for application and/or removal of pavement markings is included in the pay item Traffic Control in accordance with **Subsections 107.12** and **601.6**.
- 4 Determination of the no passing zones for two-lane facilities and providing the Department with the data is considered incidental to the other various items of work, and no separate payment is made for this work.
- 5 Payment for each item includes all direct and indirect costs and expenses required to complete the work.
- 6 Pay items under this section include the following:

Item No.	Pay Item	Unit
6271005	4" White Broken Lines (Gaps Excluded) Thermoplastic - 90 mil.	LF
6271007	6" White Broken Lines (Gaps Excluded) Thermoplastic- 90 mil.	LF
6271010	4" White Solid Lines (Pavement Edge Lines) Thermoplastic - 90 mil.	LF
6271012	6" White Solid Lines (Pavement Edge Lines) Thermoplastic - 90 mil.	LF
6271015	8" White Solid Lines Thermoplastic - 125 Mil.	LF

(table continued on the next page)

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Item No.	Pay Item	Unit
6271020	12" White Solid Lines (Stop Lines) - Thermoplastic -125 mil.	LF
6271023	12" X 18" White Triangular Yield Bar (Gaps Excluded) Thermoplastic - 125 mil.	LF
6271025	24" White Solid Lines (Stop/Diagonal Lines) - Thermoplastic - 125 mil.	LF
6271030	White Single Arrows (Left, Straight, Right) - Thermoplastic - 125 mil.	EA
6271035	White Word Message "Only" - Thermoplastic - 125 mil.	EA
6271036	White Word Message "Stop Ahead" - Thermoplastic - 125 mil.	EA
6271037	White Word Message "School" - Thermoplastic - 125 mil.	EA
6271040	White Combination Arrows (Straight & Right or Straight & Left) Thermoplastic - 125 mil.	EA
6271043	White Lane Drop Arrow (Left or Right) Thermoplastic - 125 mil.	EA
6271045	Railroad Crossing Symbols - Thermoplastic - 125 mil.	EA
6271050	Handicap Symbol - Thermoplastic - 125 mil.	EA
6271064	4" Yellow Broken Lines (Gaps Excluded) Thermoplastic - 90 mil.	LF
6271066	6" Yellow Broken Lines (Gaps Excluded) Thermoplastic - 90 mil.	LF
6271074	4" Yellow Solid Lines (Pavement Edge Lines) Thermoplastic - 90 mil.	LF
6271076	6" Yellow Solid Lines (Pavement Edge Lines) Thermoplastic - 90 mil.	LF
6271078	8" Yellow Solid Lines (Pavement Edge Lines) Thermoplastic - 90 mil.	LF
6271080	24" Yellow Solid Lines - Thermoplastic - 125 mil.	LF

SECTION 628 THROUGH SECTION 629
SECTIONS NOT USED

SECTION 630

PERMANENT RAISED PAVEMENT MARKERS

630.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for furnishing and installing durable, abrasion-resistant retroreflective pavement markers (RPM) at locations designated on the Plans and as directed by the RCE. Also included is protection of the RPM during installation.

630.2 Materials

630.2.1 General

- 1 Ensure that the RPM meets the requirements of ASTM D 4280 and conform to the provisions in this section. Drawings of markers shown in the Plans are for illustrative purposes only and are not intended to specify any particular product.

630.2.2 Shape and Color

- 1 Provide RPM with a base approximately 4 inches x 4 inches or 5 inches X 2 inches both approximately $\frac{5}{8}$ inch in height with 30-degree sloping sides (nominal dimensions). Make certain that the outer surface of the marker is smooth and all corners and edges exposed to traffic are rounded. Provide RPM of the color(s) indicated on the Plans and with either one or two reflective faces as required on the Plans. When illuminated by automobile headlights, ensure that the reflective faces redirect light of the required color and as specified herein. Make certain that the color of the reflectors when illuminated and when not illuminated is similar. The color of RPM will be evaluated by the Department, and off-colors or non-similar color samples will constitute grounds for rejection.

630.2.3 Physical Requirements

- 1 Provide RPM with a smooth exterior surface of the shell and contain one (mono-directional) or two (bi-directional) prismatic reflector faces, as required on the Plans, molded to reflect incident light and having a minimum surface area of 2.50 square inches.
- 2 Ensure that the markers have a hard, durable, abrasion resistant surface (untempered glass or a special abrasion resistant coating), bonded to the reflective face surface of the marker. The red lenses on two color units are exempt from this requirement.
- 3 Make certain that the abrasion resistant surface of the reflector lens can withstand radial cracking and show only concentric cracks when damaged by impact of hard objects embedded in vehicle tires.

630.2.4 Samples

- 1 Twenty-five markers of each type selected at random from each shipment or lot will constitute a representative lot sample for testing by the OMR. Markers undamaged from testing by the OMR will be available for the Contractor to reclaim and use.
- 2 Ensure that 20 markers selected from the lot sample meet the requirements for the size and material for the reflective face surface for a lot or shipment to be accepted. However, if 19 markers meet this requirement, a resample may be allowed at the request of the Contractor. If all 20 markers of the resample meet the requirements for the size and material for the reflective face surface the lot or shipment will be accepted with the stipulation that if any deficient markers are detected during installation the remainder of the lot or shipment may be rejected.

630.2.5 Tests**630.2.5.1 General**

- 1 The OMR will test the RPM samples in accordance with ASTM D 4280.

630.2.5.2 Optical Test

- 1 Ten markers from each lot sample will be tested as prescribed in ASTM D 4280. If all pass the optical test, the lot will be accepted.
- 2 If any fail, 10 additional samples will be tested. If any of the second 10 markers fail the optical test, a resample may be allowed if requested; however, if more than 2 markers from the original sample fail the optical test, no resample will be allowed, and the lot or shipment will be rejected. If 19 of the 20 markers comprising the resample pass the optical test, the lot or shipment will be accepted.

630.2.5.3 Abrasion Test

- 1 Three markers picked at random from each lot sample will be tested as prescribed in ASTM D 4280. If all pass the abrasion test, the lot will be accepted.
- 2 If any marker fails the abrasion test, a resample may be allowed if requested. If any of the 3 markers tested from the resample fail the requirements, the lot or shipment will be rejected.

630.2.5.4 Impact Test

- 1 Three markers picked at random from the lot sample will be impact tested as prescribed in ASTM D 4280. If all pass the impact test, the lot will be accepted.
- 2 If any marker fails the impact test, a resample may be allowed if requested. If any of the three markers tested from the resample fail the requirements, the lot or shipment will be rejected.

630.2.5.5 Longitudinal Flexural Strength Test

- 1 Three markers picked at random from the sample lot will be load tested as prescribed in ASTM D 4280. Each marker must support a minimum load of 2000 pounds.
- 2 If only 2 of the 3 markers selected for strength testing meet the requirements of these specifications, the lot or shipment may still be accepted provided 6 additional markers selected from the sample lot for strength testing all meet the requirements. If 2 or more of the original 3 markers fail the strength test the lot or shipment will be rejected.

630.2.5.6 Compressive Strength Test

- 1 Three markers picked at random from the sample lot will be load tested as prescribed in ASTM D 4280. Each marker must support a minimum load of 6000 pounds.
- 2 If only 2 of the 3 markers selected for strength testing meet the requirements of these specifications, the lot or shipment may still be accepted provided 6 additional markers selected from the sample for strength testing all meet the requirements. If 2 or more of the original 3 markers fail the strength test the lot or shipment will be rejected.

630.2.5.7 Manufacturer's Q/C Test Report

- 1 Furnish the RCE 4 copies of a notarized certified report from the manufacturer of the markers showing the results of its quality control tests.

630.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

630.4 Construction**630.4.1 Installation of RPM****630.4.1.1 Restrictions**

- 1 No permanent raised markers may be installed between December 15 and March 15 inclusive, except with the written permission of the RCE.

630.4.1.2 Location of RPM

- 1 Locate the lane line markers, edge line markers, center line markers, entrance and exit ramp markers as shown in the Plans and typicals.

630.4.1.3 Method of Bonding RPM to Pavement**630.4.1.3.1 General**

- 1 Markers may be bonded to the pavement by using either the epoxy method or the bituminous adhesive method. Ensure that the ambient temperature

and road surface temperature during application is at least 50°F for use of the epoxy method or 40°F for use of the bituminous adhesive method of bonding.

- 2 If the epoxy method is used, furnish the RCE 4 copies of a certification stating that the epoxy meets the requirements of AASHTO M 237, Type 1. If the bituminous adhesive method is used, furnish the RCE 4 copies of a certification stating that the bituminous adhesive meets the requirements of these specifications.

630.4.1.3.2 Epoxy Method

- 1 If the epoxy method of bonding RPM to the pavement is elected, use an epoxy adhesive that meets the requirements of AASHTO M 237, Type 1. In addition to the manufacturer's recommendations, comply with the following requirements:
 - A. Maintain the temperature of the adhesive components at 60°F to 100°F before mixing.
 - B. Just before use, mix Components A and B in accordance with manufacturer's recommendations.
 - C. Clean the road surface by sandblasting the area to which the marker is to be bonded. Ensure that the sand is clean and dry. Make certain that the road surface where markers are to be placed is thoroughly dry before applying epoxy.
 - D. When markers are placed over existing traffic paint stripes, remove all old paint and primer down to bare concrete or asphalt.
 - E. Ensure that the machine mixer and applicator are capable of accurately and uniformly proportioning Component A to Component B in a volume ratio in accordance with the manufacturer's recommendations.
 - F. Ensure that the mixing chamber produces the mixed adhesive with a uniform gray color with no visible evidence of streaks of either black or white on the surface or within the mixed adhesive.
 - G. Make certain that voids in a cured undisturbed sample $\frac{1}{16}$ inch thick from the extrusion nozzle do not exceed 4%.
 - H. Make periodic checks of the proportioning equipment to determine the actual volume ratio of Component A to B. Do this by placing containers before the mixing chamber and measuring the actual volume of Components A and B dispensed.

630.4.1.3.3 Bituminous Adhesive Method

- 1 If the bituminous adhesive method of bonding the RPM to the pavement is elected, use a bituminous type hot-melt adhesive that meets the requirements of these specifications.
- 2 Ensure that the adhesive is suitable for bonding ceramic and plastic markers to Portland cement concrete, asphalt concrete, and chip-seal road surfaces and is applicable when road surface and marker temperatures are in

the approximate range of 40°F to 160°F. Make certain that the composition of the adhesive is such that its properties do not deteriorate when heated to and applied at temperatures up to 425°F using either air or oil-jacketed melters.

- 3 Use adhesive packaged in self-releasing cardboard containers with essentially flat and parallel top and bottom surfaces such that the packages stack properly. Ensure that each package has a net weight of either 50 or 60 pounds and weighs within 2 pounds of the stated weight. Make certain that the packaging has self-releasing cardboard dividers that separate each package into sections weighing not more than 15 pounds each. Make sure each package shows the following:
 - Manufacturer's Name,
 - Net Weight,
 - Lot or Batch Number, and
 - The words "Bituminous Adhesive for Pavement Markers" or similar wording identifying the contents.

630.4.1.3.4 Prequalification of Adhesive

- 1 Use adhesives from manufacturers that have had their adhesives successfully tested by the National Transportation Product Evaluation Program (NTPEP) in compliance with *SCDOT Qualified Product Policy 42* and listed on *SCDOT Qualified Product List 42*.

630.4.1.4 Observation and Acceptance

- 1 The RPM will be inspected during both daytime and nighttime conditions to determine whether the intent of this specification has been achieved. Remove and replace markers failing to have satisfactory appearance in either daytime or nighttime conditions at no additional expense to the Department.
- 2 The final acceptance of the RPM will be delayed for a period of 180 days after the last date of marker placement to permit observation of performance. Remove and replace any marker that, in the opinion of the RCE, has not performed satisfactorily during this 180-day period due to defective materials and workmanship in manufacture and application at no additional expense to the Department.

630.5 Measurement

- 1 The quantity for the pay item Permanent (*Clear, Yellow, or Red/Clear*) Pavement Markers (*Mono-Directional or Bi-Directional*) – (*4"X4" or 5"X2"*) is measured by each (EA) permanent raised mono-directional or bi-directional retroreflective pavement marker of each color, type, and size in-place, complete and accepted.
- 2 The quantity of clear replacement reflectors for existing raised pavement markers is measured by each (EA) clear mono-directional raised pavement marker reflector in place, complete and accepted.
- 3 Traffic control utilized during the performance of raised pavement marker work is not measured under items covered by this section, but is included in

the item Traffic Control in accordance with **Subsections 107.12** and **601.5**.

- 4 Unless included in other pay items in the Contract, the work required to remove existing raised pavement markers is considered incidental work for raised pavement marker items and is not measured separately.

630.6 Payment

- 1 Payment for the accepted quantity for Permanent (*Clear, Yellow, or Red/Clear*) Pavement Markers (*Mono-Directional or Bi-Directional*) – (*4"X4" or 5"X2"*), measured in accordance with **Subsection 630.5**, is determined using the contract unit bid price for the applicable item. Payment is full compensation for installing raised pavement markers as specified or directed and includes preparing pavement surface; providing and applying proper adhesive; removing existing markers where required; removing and replacing unaccepted markers; and all other materials, labor, equipment, tools, supplies, and incidentals to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for the accepted quantity for Clear Mono-Directional Replacement Reflectors, measured in accordance with **Subsection 630.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for furnishing and replacing raised pavement marker reflectors as specified or directed and includes providing an applying adhesive; removal of existing reflectors (where required); installation of reflectors; and all other material, labor, equipment, tools, supplies, and incidentals necessary to satisfactorily complete the work.
- 3 Traffic control for surface preparation and the application and/or removal of raised pavement markers or replacement reflectors is included in the item Traffic Control in accordance with **Subsections 107.12** and **601.6**
- 4 Payment for each item includes all direct and indirect costs and expenses required to complete the work.
- 5 Pay items under this section include the following:

Item No.	Pay Item	Unit
6300005	Permanent Clear Pavement Markers Mono-Dir.- 4"X 4"	EA
6300010	Permanent Clear Pavement Markers Mono-Dir.- 5"X 2"	EA
6300029	Clear Mono-Directional Replacement Reflector	EA
6301005	Permanent Yellow Pavement Markers Mono-Dir.- 4"X 4"	EA
6301010	Permanent Yellow Pavement Markers Mono-Dir.- 5"X 2"	EA
6301100	Permanent Yellow Pavement Markers Bi-Dir.- 4"X 4"	EA
6301110	Permanent Yellow Pavement Markers Bi-Dir.- 5"X 2"	EA
6302001	Permanent Red/Clear Pavement Markers Bi-Dir. - 4"X 4"	EA

SECTION 631

REMOVAL OF EXISTING PAVEMENT MARKINGS

631.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for removal of existing pavement markings before installation of new markings when specified. This work includes removal of existing markings, capture of removed material by an approved means and disposal of the captured material.

631.2 Materials

- 1 None specified.

631.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

631.4 Construction

- 1 Remove the existing long lines (edge lines, lane lines and gore markings) on the Interstate highway mainline and ramps by water blasting, sandblasting, grinding, or other method approved by the RCE. Do not use chemicals for removal of existing markings. Upon completion of the removal, make certain that the pavement surface is in proper condition for bonding of the new marking material.
- 2 On smooth surfaces, remove at least 95% of the existing lines. On open-graded asphalt or grooved concrete surfaces, remove the existing lines in a manner such that none of the marking material remains above the pavement surface (i.e. the existing marking is planed even with the pavement surface). Residual material may remain in the grooves or voids on such surfaces.
- 3 When removing existing markings from the pavement surface, provide a positive means to control dust and accumulation of debris resulting from the removal operation. Capture the removed material utilizing a separate vacuum equipped vehicle or other approved system, to prevent its dispersal, and properly dispose of this material. No visible marking material debris may remain on the pavement shoulders. Ensure that the recovery system is within a maximum of 75 feet behind the removal operation. If the recovery system fails, cease the removal operations until the recovery system is operating properly. Clean up, remove, and dispose of excess or waste materials from the project site.
- 4 Ensure that the removal operation and the dust and debris collection operation does not damage existing pavement surfaces (concrete or asphalt) or

damage pavement joint materials. Repair any significant damage occurring because of removal operations to the satisfaction of the RCE.

- 5 In cases where the existing symbol markings (arrows, words, etc.) differ from or are in conflict with the Plans or the *SCDOT Standard Drawings*, the RCE will determine which to follow. For symbol marking relocation or replacement, remove 95% of the conflicting markings by buffing, water blasting, sand blasting or otherwise assuring that the pavement surface is in proper condition for adequate bonding of the new thermoplastic markings.
- 6 Replace all mainline and ramp edge lines (white and yellow) and entrance and exit gore markings within 3-calendar days of removal. Replace all mainline lane lines the same day that the existing lines are removed. Immediately before application of the new marking material, clean all surfaces to be marked with a jet of compressed air. At the time of marking application, ensure that the pavement surface is free of dust, dirt, oil, grease, and any remaining loose or flaking marking material.

631.5 Measurement

- 1 The quantity for the pay item Removal of Pavement Markings is the length of existing pavement markings removed and is measured by the linear foot (LF) of a 6-inch width of pavement marking measured along the center of existing edge lines, lane lines, and gore markings removed excluding spaces between broken lines, complete and accepted.
- 2 For each lane line removed, the quantity is a minimum of 10 feet, regardless of the actual line length removed. The length of 12-inch gore markings is multiplied by a factor of 2 (i.e. 300 feet of 12 inch line = 600 LF of removal).
- 3 Removal of arrows, words, and symbols is considered incidental work for the replacement items and no separate measurement is made for this work.

631.6 Payment

- 1 Payment for the accepted quantity for Removal of Pavement Markings, measured in accordance with **Subsection 631.5**, is full compensation for the removal and disposal of existing pavement markings as specified or directed and includes dust control, debris removal, and all other materials, labor, equipment, tools, supplies, transportation and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 No payment is made for the removal of arrows, words, and symbols. This work is incidental to the in the unit bid price for placement of the new symbol markings.
- 3 Traffic control for removal of existing pavement markings is included in the pay item Traffic Control in accordance with **Subsections 107.12** and **601.6**
- 4 Payment for each item includes all direct and indirect costs and expenses required to complete the work.

631.6

631.6

⁵ Pay items under this section include the following:

Item No.	Pay Item	Unit
6319505	Removal of Pavement Markings	LF

SECTION 632 THROUGH SECTION 649

SECTIONS NOT USED

SECTION 650

GENERAL REGULATIONS FOR INSTALLATION OF PERMANENT TRAFFIC SIGNS

650.1 Description

650.1.1 General

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for fabricating and erecting a complete system of traffic signs within the highway right-of-way in conformity with the Plans, the Specifications, or as directed by the RCE.
- 2 The traffic signing system include signs, sign supports, structures, delineators, barricades, and lighting systems for a specific section of Interstate or primary highway, associated interchanges, frontage roads, and streets/roads affording access to such a highway or Interstate. Also included is the removal of existing traffic control devices being replaced or are in conflict with new devices and includes supports and/or hardware and restoration of the removal site.
- 3 Fabricate, install, and maintain traffic signs and supports as specified by these specifications, the *MUTCD*, the *SCDOT Standard Drawings*, the Special Provisions, the Plans, and the RCE. Do not deviate from the Plans and the Specifications without prior written approval from the Director of Traffic Engineering. Submit the specific details and reasons for any requested changes to the RCE for approval.

650.1.2 Availability of Right-of-Way

- 1 The Contractor is allowed to occupy any state owned right-of-way necessary to perform the work according to the terms of the Contract. If additional area is needed for the operation, plant, equipment, storage of materials, etc., obtain and pay for such area at no cost to the Department. Do not store materials or equipment within 30 feet of the near edge of the adjacent travel lane, except while performing work required by the Contract or when the material or equipment is protected by guardrail or concrete barrier.
- 2 If work under other contracts is in progress such as: grading, top-soiling, seeding, drainage, roadway pavement construction, bridge construction, erection of guardrail, installation of right-of-way fence, installation of area lighting systems, sign erection, and other work, coordinate the work accordingly with other contractors and the RCE and permit access for such work when necessary and practical.

650.1.3 Existing Appurtenances

- 1 The Contractor is responsible for continuity of any existing utility service and to maintain a safe and satisfactory operating condition for all overhead, surface, or subsurface utilities. Contact the Palmetto Utility Protection Service (PUPS) at 1-800-922-0983 three days before any excavation or driving of

- posts. Contact the District Mechanical Engineer to locate any Department owned service or fiber optic cable within the work zone.
- 2 Exercise precautions to avoid damage to existing highway installations such as inlets, storm drains, roadway and shoulder pavements, grassed areas, fences, monuments, etc.
 - 3 Maintain existing guide signs until new replacement signs are erected. Remove existing signs the same day the new signs are erected. Relocate signs that are in conflict with construction as necessary to maintain guidance until new signs are erected or relocated to new supports. Include the cost for relocating and erecting existing signs on temporary supports in the price bid for I-Beam Breakaway sign supports.
 - 4 Correct any direct or indirect damage to any utility, structure, other installation, or property caused by the work and any damages caused by the Contractor's agent, employees, or subcontractors.
 - 5 If it is necessary to remove a portion of fence or guardrail in order to erect a sign support or obtain proper sight distance for the sign, reset the fence or guardrail to its original condition with no adjustment in compensation.
 - 6 Do not remove more guardrail for sign replacement work than can be replaced in the same day. Upon removal of the guardrail, maintain required Traffic Control in place at each guardrail replacement location until the guardrail replacement operation is completed for that location.

650.2 Materials

650.2.1 General

- 1 Use new material for all signs and signing work. Obtain written approval from the RCE before the use of any non-conforming materials not specified herein or not included on the *Approval Sheets for Construction and Maintenance Materials*.
- 2 Use the sign face layouts, details, and general descriptions with specified background and finish legend as shown in the Plans, the drawing entitled *Standard Highway Signs* contained in the *SCDOT Standard Drawings*, or as otherwise provided.
- 3 Submit the names of manufacturers used to fabricate signs and/or supports to the Director of Traffic Engineering for approval. Include the names of the fabricators of flat sheet signs, multiple panel signs, steel I-beam breakaway supports, U-section posts, square tube posts, and overhead sign supports. Do not proceed with fabrication until after approval has been granted. If requested, furnish affidavits to the Director of Traffic Engineering summarizing the fabricator's qualifications and experience as well as samples of the items in question.
- 4 Ensure that retroreflective sheeting types meet the requirements of the Department's *Engineering Directive Memorandum No. 4*.

- 5 Use ready mix concrete from ready mix concrete plants listed on *SCDOT Qualified Product List 28*.

650.2.2 Special Brand Products

- 1 When a specific brand of material or equipment is mentioned herein or on the Plans, it indicates the required standard of quality, grade, or type for the material or equipment. Use of other material and equipment of equal quality, grade, or type may be allowed if they meet the requirements specified herein or on the Plans. Submit a written request for substitutions to the RCE who will coordinate with Traffic Engineering to determine if substitutes are acceptable. Determination of acceptability is solely determined by the Department.

650.2.3 Sign Supports

- 1 Use the specific posts and footing sizes for all signs mounted on break-away supports and U-section post as indicated on the Plans and the *SCDOT Standard Drawings*. Other supports may be designed by the Contractor if approval from the Director of Traffic Engineering is received before fabrication.

650.2.4 Mechanical Galvanized Zinc Coated Products

- 1 Use mechanically galvanized Type 1 bolts, nuts, Direct Tension Indicators (DTI), and washers meeting the requirements of the applicable requirements of **Section 709**.
- 2 Provide a zinc-galvanized coating on all exposed ferrous surfaces of overhead sign structures, breakaway posts, and U-section post prior to shipment to the project site. Coat any damaged surfaces with two applications of either a brush or a spray type cold galvanizing compound that contains a minimum 90% zinc dust. Clean all surfaces thoroughly before painting and apply the second coat after the first coat has thoroughly dried.

650.2.5 In-plant Inspections

- 1 In-plant inspection is required for fabrication of new overhead sign structures. Material and workmanship of other items may be inspected if it is deemed necessary by the OMR before being shipped to the project. Schedule the necessary inspections with the OMR before fabrication is started.

650.2.6 Storage

- 1 Store flat sheet signs, mounting hardware, delineators, and electrical material in an enclosed building, trailer, or similarly protected enclosure. Keep flat sheet signs completely dry during shipping and storage and do not allow sign faces to touch each other. If moisture is found upon delivery, separate the signs and remove the shipping material to avoid damage to the reflective sheeting. Damaged signs are not acceptable. Replace damaged signs at no additional cost to the Department.
- 2 Store multiple panel signs in a vertical position on skids to prevent the faces of the multiple panel signs from touching. Multiple panel signs may be

stored outside after removing all protective film, paper, and packaging. Do not place foreign material, such as plywood, etc. between the panels.

- 3 The Contractor is responsible for damaged or lost signs because of improper handling or shipping. Replace damaged or lost signs at no additional cost to the Department.

650.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

650.4 Construction

650.4.1 Clearing

- 1 Remove trees, limbs, underbrush, and debris at locations directed by the RCE to provide a 1200-foot sight distance for multiple panel signs or flat sheet signs erected on the mainline of Interstate highways, freeways, and expressways. When entire trees are removed, ensure that the tree is removed to an elevation of at least 2 inches below the ground line elevation. For details, see the drawing entitled *Detail of Sign Distance Clearing for Mainline Signs* contained in the *SCDOT Standard Drawings*.
- 2 Place signs above crossing routes at interchanges as determined by the RCE to provide for adequate sight distance for the signs.

650.4.2 Fabrication

- 1 Shear, blank, saw, mill, or thermal cut materials according to details and procedures in the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.
- 2 Install bolt holes as specified in **Section 709**.

650.4.3 Site Restoration

- 1 Restore all trenched and excavated areas to the original condition as described herein in a manner acceptable to the RCE. The work includes, but is not limited to; concrete pavement, sidewalks, curbs and gutters, bituminous pavement, paved or stabilized shoulders, final grading, seeding and mulching, and replacing shrubbery and trees in affected areas.

650.4.4 Final Clean Up

- 1 Clean exposed sign and support surfaces. Level and repair the site as deemed necessary by the RCE to provide a neat appearance of the project area. Remove and dispose of any cleared vegetation and construction materials to the satisfaction of the RCE.

650.5**650.6****650.5 Measurement**

- 1 There are no specific items measured for payment under this section.

650.6 Payment

- 1 There no specific items paid for under this section. Payments for specific permanent traffic signs and supports are made under other sections of these specifications.
- 2 Unless otherwise specified, the clearing of vegetation in the area of a new sign installation is included in the payment for the new sign.

SECTION 651

FLAT SHEET SIGNS

651.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the fabrication and installation of flat sheet signs, either singly or as assemblies, in conformance with the Plans, the Specifications, the *MUTCD*, or as directed by the RCE.

651.2 Materials

651.2.1 Sign Blanks

- 1 Fabricate sign blanks from aluminum that meets the requirements of ASTM B 209, Alloys 6061-T6, 5052-H38 or 5154-H38. Comply with the following aluminum thickness requirements:

Sign Width	Blank Thickness
Less than 48 inches	0.080 inch
48 or more inches	0.100 inch

- 2 Measure the width of signs along the horizontal edge. Measure width of diamond shape and pennant shape signs along the sloped edge of the sign.

651.2.2 Mounting Hardware

- 1 Use $\frac{5}{16}$ -inch stainless steel or galvanized steel bolts of the proper length with a nylon washer between the bolt head and sign face and a lock washer and flat washer between the support and the nut to attach the sign proper to the supports. Attach flat sheet signs to U-section posts, square tubing posts, I-beam breakaway posts, or other supports as indicated on the Plans and *SCDOT Standard Drawings*.
- 2 When attaching signs to an overhead structure upright or a bridge column, use a mounting system consisting of two sign braces attached to the sign and held onto the column or upright with a stainless steel banding system. Use a minimum of two bands per sign. Use a system with a bracket or screw type adjustment so that it can be removed from the upright or column if necessary without damage to the sign, braces or bracket, or the upright or column.

651.2.3 Reflective Sheeting Materials

- 1 Use reflective sheeting that meets the requirements of AASHTO M 268, *Specifications for Reflective Sheeting for Traffic Control*.
- 2 In addition to the requirements of AASHTO M 268, ensure that reflective sheeting conforms to the following provisions.
- 3 Use reflective sheeting material obtained from manufacturers prequalified in accordance with *SCDOT Qualified Product Policy 20* and who appear on

the current edition of *SCDOT Qualified Product List 20*.

- 4 Ensure that each delivery of material is accompanied by a certificate signed by an officer of the reflective sheeting manufacturer certifying that the material fully complies with the requirements of this specification and the provisions of the performance warranty. The Department, at its option, may require testing by an independent commercial laboratory approved by the Department. The cost of testing is borne by the Contractor.
- 5 Upon delivery to the Department, provide a warranty from the reflective sheeting manufacturer covering the full replacement cost of roll-up signs or signs that have sheeting installed according to the recommended procedure on aluminum, aluminum composite sign blanks, or aluminum extruded panels that fail to meet the following performance requirements. Full replacement cost includes sign blanks, sheeting, and fabrication costs.
- 6 Ensure that sheeting shall maintain the following reflective intensity values for the indicated number of years:
 - Type I – 50% of minimum retroreflective values for Type I sheeting given in AASHTO M 268 for a service life of 7 years with the exception of orange sheeting, which shall have a service life of 3 years.
 - Type II - 50% minimum retroreflective values for Type II sheeting given in AASHTO M 268 for a service life of 10 years with the exception of orange sheeting, which shall have a service life of 3 years.
 - Type III – 80% of minimum retroreflective values for Type III sheeting given in AASHTO M 268 for a service life of 10 years with the exception of orange sheeting, which shall have a service life of 3 years.
 - Type IV – 80% of minimum retroreflective values given for Type IV sheeting in AASHTO M 268 for a service life of 10 years with the exception of orange sheeting, which shall have a service life of 3 years.
 - Type V – 80% of minimum retroreflective values for Type V sheeting given in AASHTO M 268 for a service life of 3 years.
 - Type VI – 80% of minimum retroreflective values for Type VI sheeting given in AASHTO M 268 for a service life of 3 years.
 - Type VII – 80% of minimum reflective values for Type VII sheeting given in AASHTO M 268 for a service life of 10 years with the exception of orange sheeting, which shall have a service life of 3 years.
 - Type VIII – 80% of minimum reflective values for Type VIII sheeting given in AASHTO M 268 for a service life of 10 years with the exception of orange sheeting, which shall have a service life of 3 years.
 - Type IX – 80% of minimum retroreflective values for Type IX sheeting given in AASHTO M 268 for a service life of 10 years with the exception of orange sheeting, which shall have a service life of 3 years.
 - Type X – 80% of minimum retroreflective values for Type X sheeting given in AASHTO M 268 for a service life of 10 years with the exception of orange sheeting, which shall have a service life of 3 years.

- 7 Ensure that sheeting will remain free of cracks, scaling, blisters, or delaminations for the service life of each type specified in above.
- 8 Ensure that sheeting will not show any appreciable change in color when compared to unexposed sheeting specimens.
- 9 Ensure that sheeting will remain free of any form of deterioration that would render the sign ineffective for its intended purpose for the specified service life.
- 10 Replace any traffic control device that fails to perform satisfactorily for either its daytime or nighttime purpose, due to deterioration of the reflective material.

651.2.4 Inks

651.2.4.1 Inks for Screening

- 1 Use inks that are produced or recommended by the sheeting manufacturer and are compatible with the sheeting. Upon request, have the manufacturer provide a color match formula from their ink series at no charge to the Department.

Make certain screening inks are warranted for the same period as the reflective sheeting on which they are applied as outlined in **Subsection 651.2.3**.

651.2.4.2 Black Inks

- 1 For non-reflectorized message application, use black inks of high quality opaque process paste made with synthetic resin as manufactured or recommended by the manufacturer of the reflective sheeting.

651.2.4.3 Transparent Inks

- 1 Use manufacturer recommended transparent ink and thinner for application on signs with reflective sheeting. Use colors that match the standard colors listed in the *MUTCD* when compared in natural daylight after thoroughly drying. Use colored inks with durability equal to that of the reflective sheeting.

651.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

651.4 Construction

651.4.1 Fabrication

651.4.1.1 Dimensions

- 1 Use the general design and dimensions as specified in the Plans, the *MUTCD*, the *FHWA Standard Highway Signs*, and the *SCDOT Special Highway Signs Drawings*. Make the corner radii and hole placement of each indi-

vidual sign in accordance with the FHWA *Standard Highway Signs* or the scale drawings maintained and distributed by the Director of Traffic Engineering. Locate the holes for destination and mileage flat sheet signs as indicated in the Plans and the Department's standards.

651.4.1.2 Sign Blanks and Surface Preparation

651.4.1.2.1 Fabrication

- 1 Fabricate sign blanks from a single piece of sheet aluminum without joints and without supporting frames unless otherwise specified. Cut metal to the proper size and provide bolt holes before surface preparation. Ensure that all edges including holes are true and smooth.
- 2 When the dimensions of the sign exceed what is normally available, signs may be horizontally spliced as specified in **Subsection 652.4.1.3**.

651.4.1.2.2 Degreasing

- 1 Degrease sheeting blanks using the sheeting manufacturer's current processes and specifications or one of the following methods:
 - A. Immerse blanks in a saturated vapor of trichloroethylene or perchloroethylene.
 - B. Immerse blanks in a tank containing an alkaline solution, controlled and titrated to the solution manufacturer's specification for a sufficient length of time to remove soil, and then, rinsed thoroughly with running water.

651.4.1.2.3 Etching

- 1 Use one of the following methods to etch the blanks after degreasing:
 - A. Etch in a 6% to 8% phosphoric acid solution or proprietary acid etching solution and rinse thoroughly with running cold water followed by a hot water rinse.
 - B. Etch in an alkaline etching solution that is controlled by titration using the temperature and concentration recommended by the solution manufacturer. Rinse thoroughly and remove smut with an acidic chromium compound solution as specified. Rinse thoroughly again.

651.4.1.2.4 Coating

- 1 After etching is complete, ensure that panels are free of any powdery residue. Treat the panels with a light, tightly adherent chromate conversion coating, ranging in color from a silvery iridescent to a pale yellow, conforming to ASTM B 449, Class 2, 10 to 33 mg/ft² with a median of 25 mg/ft²

651.4.2 Handling

- 1 From the beginning of the cleaning process until the application of the reflective sheeting, handle the metal with a device or clean canvas gloves. Do not expose the metal to grease, oil, or other contaminants after cleaning and etching and prior to the application of the final finish coat.

651.4.3 Application of Reflective Sheeting

- 1 Process the sign panels receiving reflective sheeting as specified by the manufacturer for the specific type of material used and for the specific method of adhesion (i.e. pressure sensitive, heat activated, etc.).
- 2 Splice the sheeting in accordance with the manufacturer's recommendation for the type of material used with the following additions or exceptions:
 - A. Do not splice flat sheet signs except where the narrowest dimension of the panel is in excess of the sheeting width.
 - B. Do not combine remnant pieces on any sign.
 - C. Do not use "Clear" paint or coatings.

651.4.4 Sign Patching Limits

- 1 Patch the reflective sheeting to repair incidental damage to the sheeting that occurs during manufacture, in transit, or after installation. Use patches of the same material from the same manufacturer as the material being patched and do not exceed the limits given in the following table.

Sign Area (ft ²)	Max. No. of Patches per Sign	Max. Patch Size per Patch (in ²)
0 - 15	0	0
15.1 – 50.0	1	1
50.1 and Over	2	2

651.4.5 Silk Screening

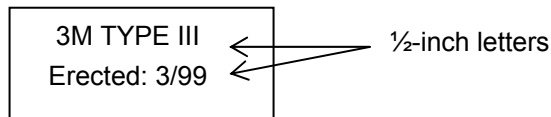
- 1 Apply legends and borders on flat sheeting with silk screening or reverse silk screening before or after the sheeting has been attached to the panels. Perform all screening accurately and as recommended by the reflective sheeting manufacturer.
- 2 Provide all legends, borders, and backgrounds in the colors and in the locations shown on the Plans or as specified in the *MUTCD*.
- 3 Use the proper size screen mesh in screening to ascertain that the finished colors match the prescribed standard colors from the *MUTCD*. Any noticeable deviation from the shades is cause for rejection of the screening paste.
- 4 After silk screening or reverse silk screening, dry the sign in accordance with instructions from the manufacturer of the screening ink.

651.4.6 Application of Direct Applied Legends

- 1 Apply messages and borders directly to clean, dust-free panels after background materials have been placed as specified and in a manner specified by the sheeting manufacturer.
- 2 Cut message and/or borders neatly at intersecting panel edges, finish with materials specified, and apply in accordance with the sheeting manufacturer.

651.4.7 Identification

- 1 Attach a permanent decal, produced by the sign fabricator, that indicates the brand of reflective sheeting first, followed by the type of reflective sheeting, and then, the month and year of erection to the side or under the brand and type as shown in the example below. Use ½-inch high letters.

**651.4.8 Packaging**

- 1 Protectively package all signs for shipment and storage. Use packing that adequately prevents touching of sign faces and damage to any part of the sign including legends or borders. Ensure that all signs are free of moisture and all paints are thoroughly dry before packaging. Keep packaged signs dry and store in an enclosed location after delivery. Follow sheeting manufacturer's special recommendations.

651.4.9 Location**651.4.9.1 General**

- 1 Erect signs in approximately the location indicated on the Plans. The exact location of each sign is determined by the Contractor and the RCE; however, make certain any major changes in location are approved by the Director of Traffic Engineering before erection.
- 2 Mount flat sheet signs on the flange side of U-section posts. If designated on the Plans, some flat sheet signs may be mounted on square tube or I-beam breakaway posts or on barricades.

651.4.9.2 Offset

- 1 Provide the horizontal clearance or the Pavement Edge Clearance (PEC) for flat sheet signs on the mainline, ramps, crossing routes, and frontage roads specified on the Plans or the *SCDOT Standard Drawings*.

651.4.9.3 Height

- 1 Measure the sign mounting height from the pavement edge level (reference grade) to the bottom of the sign assembly. Reference grade is defined as the elevation at the center of the pavement edge line. Mount the signs at the height specified on the Plans or the *SCDOT Standard Drawings* unless otherwise indicated.

651.4.10 Erection**651.4.10.1 General**

- 1 Erect and support all signs, bridge-end markers, and mileposts as specified on the Plans and the *SCDOT Standard Drawings*. Ensure that the horizontal edges of signs are level and the faces of ground signs are vertical.

- 2 Do not weld, cut, or fabricate signs or markers in any manner in the field.

651.4.10.2 Flat Sheet Signs Mounted on U-Section or Square Tube Posts and Barricades

- 1 After supports have been erected, attach flat sheet signs to U-section or square tube posts or barricades with $\frac{5}{16}$ -inch bolts with a nylon washer between the sign face and bolt head and a lock washer between the post and nut and flat washer. Use galvanized or stainless steel bolts, nuts, and flat and lock washers.

651.4.10.3 Flat Sheet Signs Mounted on Other Supports

- 1 After supports have been erected, attach flat sheet signs to I-beams or circular posts with $\frac{5}{16}$ -inch bolts using a nylon washer between the sign face and bolt head. Use a lock washer between I-beam posts and nuts. Use galvanized or stainless steel bolts, nuts, and lock washers. In lieu of field drilling the posts to attach the signs, extruded aluminum channel framing of the type manufactured by SIGNFix® may be used. The number, size, and spacing of the channels are determined by the manufacturer. Have the channels attached by the sign fabricator before delivery with VHB (Very High Bond), double-sided foam tape as specified by the manufacturer of the channels. Attach the signs to the posts with stainless steel post clips of the type recommended or provided by the channel manufacturer. No additional payment is made for the aluminum channels. Include the cost of the channels in the price bid for the signs. Before fabrication, obtain approval from the Director of Traffic Engineering of the brackets used to attach signs to circular posts.

651.4.10.4 Bracing

- 1 Brace all "D" type flat sheet signs that are 6 feet wide and wider with U-section posts of the size and length indicated in the *SCDOT Standard Drawings*. Secure the braces tightly to the vertical supports with $\frac{5}{16}$ -inch bolts and a lock washer and flat washer between posts and nuts. Attach the signs to the braces as indicated in **Subsection 651.4.10.1** through **Subsection 651.4.10.3**. Use galvanized or stainless steel bolts, nuts, and washers. Do not use the same bolts to attach the sign and brace to the vertical support.

651.4.10.5 Signs Removed or Relocated

- 1 Remove all conflicting or temporary signs erected by the Department as directed by the RCE. Remove existing signs at the same time the new replacement signs are erected. Dispose of the removed signs and supports. Do not stockpile any removed material on Department right-of-way.

651.5 Measurement

- 1 The quantity for the pay item Flat Sheet Sign (of the type required) is the area of the sign face installed and is determined to the nearest 1/100 square foot (SF) using the dimensions shown on the Plans or in the Special Provisions, complete and accepted.

651.6 Payment

- 1 Payment for the accepted quantity for Flat Sheet Sign (of the type required), determined in accordance with **Subsection 651.5**, is determined using the contract unit bid price for the applicable item. Payment is full compensation for fabricating and erecting the sign as specified or directed and includes providing mounting hardware; removing and disposing of existing signs, mounting hardware, and supports removed or replaced; lowering and relocating signs as indicated on the Plans or directed by the RCE; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 No separate payment is made for optional aluminum mounting channels. The cost for the channels are included in the contract unit bid price for the flat sheet sign to which the channel is attached.
- 3 No separate payment is made for mounting a flat sheet sign beneath a multiple panel sign. The cost of mounting the sign and the supports required is included in the contract unit bid price for the flat sheet sign.
- 4 No separate payment is made for the removal and disposal of existing signs and supports, or for repositioning or relocating signs in order to provide proper distance between sign installations. The cost related to this work is included in the contract unit bid price of the various items work for signs.
- 5 Payment for each item includes all direct and indirect costs and expenses necessary to fulfill the requirements of the pay item in an acceptable manner.
- 6 Pay items under this section include the following:

Item No.	Pay Item	Unit
6510105	Flat Sheet, Type III, Fixed Size & Message Sign	SF
6510106	Flat Sheet, Type III, Size Determined by Message	SF
6510108	Flat Sheet, Type VIII or IX, Size Determined by Message - Overhead	SF

SECTION 652

MULTIPLE PANEL SIGNS

652.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the fabrication and installation of multiple panel signs with message and design in conformity with the Plans and the Specifications.
- 2 When installing multiple panel signs, use the type support indicated on the Plans. Unless otherwise indicated, use ground-mounted supports for I-beam breakaway or overhead supports.

652.2 Materials

652.2.1 Sign Panels

- 1 Provide signs made from extruded aluminum panels or flat sheet aluminum panels with attached aluminum extrusions. Use aluminum alloy meeting the requirements of ASTM B 221, 6063-T6. Configure the signs as shown on the Plans and the *SCDOT Standard Drawings*.
- 2 When extruded panels receive a non-micro-prismatic reflective sheeting background, fabricate the panels with rounded corners at a radius of 0.031 inch and chamfer on the edge to facilitate wrapping the reflective sheeting around the edge and fitting the panels together.
- 3 When extruded panels receive a micro-prismatic reflective sheeting background, fabricate the panels with square corners. Apply the reflective sheeting to the face and cut flush with the edge of the extrusion.
- 4 Furnish extruded panels in widths of 6 inches and 12 inches. Use panels that are flat and straight within commercial tolerances set by the aluminum industry.
- 5 Provide flat sheet multiple panel signs consisting of 0.125-inch thick flat sheet aluminum meeting the requirements of ASTM B 209, Alloys 6061-T6, 5052-H38, or 5154-H38 with attached aluminum extruded stiffeners and splicers such as SIGNFix[®] extrusions or equal. Attach the extruded shapes to the flat sheet panels with Very High Bond (VHB) foam tape and/or rivets. Have the sign fabricator install the extrusions before delivery. If flat sheet multiple panel signs are mounted overhead, use a riveted connection at the end of each extruded shape to attach it to the flat sheet panel. Use a horizontal splice if the signs are constructed from more than one flat sheet panel. Do not use vertical splices.
- 6 Obtain approval for the number, length, and placement of the extruded shapes from the Director of Traffic Engineering before fabrication.

652.2.2 Mounting Hardware

- 1 Use post clips to fasten extruded multiple panels to supports. Use stainless steel or cast aluminum post clips conforming to ASTM B 26, Alloy SG70A-76 or ASTM B 108, Alloy 356-T6. Install post clips as indicated on the Plans and *SCDOT Standard Drawings*. Use aluminum or stainless steel mounting bolts, nuts, and washers as indicated.
- 2 Use stainless steel post clips for flat sheet multiple panel signs manufactured according to the extrusion manufacturer's specifications. Provide the information relative to the design, manufacture, and material to the Director of Traffic Engineering for review and acceptance before fabrication.

652.2.3 Reflective Materials

- 1 Provide the color and type of reflective material used for sign backgrounds, letters, digits, symbols, and borders meeting the requirements of the Plans, the *MUTCD*, and **Subsection 651.2.3**.

652.2.4 Inks

- 1 Use inks that are produced or approved by the sheeting manufacturer. Use inks that are compatible with the reflective sheeting.

652.2.5 Legends and Borders

- 1 Ensure that legends, borders, corner radii, arrows, shields, etc., are direct applied reflective sheeting as specified on the Plans. Shields and arrows may be direct applied or constructed of 0.80-inch flat sheet aluminum with direct applied copy riveted to the background panel.

652.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

652.4 Construction

652.4.1 Fabrication

652.4.1.1 General

- 1 Fabricate all signs in a uniform, professional manner and with dimensions specified in the *MUTCD* and on the Plans, *SCDOT Special Highway Sign Drawings*, and *FHWA Standard Highway Signs*. Fabricate route markers and shields used on guide signs with copy sizes and details shown on the drawing entitled *Detail of Route Markers and Arrows for Use on Large Guide Signs* included in the *SCDOT Standard Drawings*.
- 2 Fabricate all signs in a plant owned and operated by a fabricator experienced in manufacturing quality signs meeting these specifications. Inform the Director of Traffic Engineering of the name of the fabricator before proceeding

with fabrication of the signs. If requested, furnish the fabricator's qualifications and experience to the Director of Traffic Engineering for approval.

- 3 Ensure that the finished colors, including sign backgrounds and direct applied or demountable copy, match the prescribed standard colors in the *MUTCD*. Signs with noticeable deviations will be rejected.

652.4.1.2 Extruded Panel Signs

- 1 Mount all extruded sections horizontally with not more than one 6-inch wide panel per sign. When a 6-inch width is required, place it at the top of the sign. Do not use vertical joints. Use the approved assembly details shown in the *SCDOT Standard Drawings*.
- 2 Assemble extruded panel signs in the shop and firmly bolt to form a sign of the required length and width. Ensure that the webs of the panels are in the same plane before bolting to form a smooth and uniform surface. Adjust the ends carefully for correct line and position so that the edges are free of projections.

652.4.1.3 Flat Sheet Multiple Panel Signs

- 1 Assemble flat sheet multiple panel signs before application of reflective sheeting to ensure that the finished sign face is flat and edges are flush. Use only horizontal splices. When joining panels, use a splice plate made of the same thickness and alloy as the sign face and attach with rivets on 1-inch centers across the sign, or use splices as recommended by the extruded channel manufacturer.

652.4.1.4 Preparation of Sign Surfaces

- 1 Complete all fabrication including cutting, welding, riveting, and punching of holes except for mounting holes for demountable letters, numerals, symbols, and borders before surface preparation.

652.4.1.4.1 Degreasing

- 1 Degrease the sheeting blanks using the manufacturer's current processes and specifications or by one of the following methods:
 - A. Immerse in a saturated vapor of trichloroethylene or perchloroethylene.
 - B. Immerse in a tank containing an alkaline solution, controlled, and titrated to the solution manufacturer's specification for a sufficient length of time to remove soil and then rinsed thoroughly with running water.

652.4.1.4.2 Etching

- 1 Use one of the following methods to etch the panels after degreasing is completed:
 - A. Etch in a 6% to 8% phosphoric acid solution or proprietary acid etching solution. Rinse thoroughly with running cold water followed by a hot water rinse.

- B. Etch in an alkaline etching solution that is controlled by titration using the temperature and concentration recommended by the solution manufacturer. Rinse thoroughly, remove smut with an acidic chromium compound type solution recommended by the manufacturer, and rinse thoroughly again

652.4.1.4.3 Coating

- 1 Once etching is completed, ensure that panels are free of any powdery residue and treat the panels with a light, tightly adherent, chromate conversion coating, ranging in color from a silvery iridescent to a pale yellow, conforming to ASTM B 449, Class 2, 10 to 33 mg/ft², with a median of 25 mg/ft².

652.4.2 Handling

- 1 From the beginning of the cleaning process until the application of the reflective sheeting, handle the metal by using a clean device or clean canvas gloves. Ensure that the metal is not exposed to grease, oil, or other contaminants after cleaning and etching and before the application of the final finish coat.

652.4.3 Application of Reflective Sheeting

- 1 Apply Class 1 pressure sensitive adhesive with a squeeze roller applicator.
- 2 Match the panels of reflective sheeting carefully for color at the time of sign fabrication to provide uniform appearance and reflectivity in both daytime and nighttime conditions.
- 3 Ensure that alternate successive width sections of either sheeting or panels are reversed and consecutive so that corresponding edges of reflective sheeting lie adjacent to the finished sign.
- 4 If micro-prismatic reflective sheeting is used, align orientation marks in the same direction on the background of the sign and with all letters within a line copy on the legend. Failure to do so may result in variation in color and/or reflectivity at night, which is not acceptable.
- 5 Apply non-micro-prismatic reflective sheeting to extruded panels so that the horizontal edges of the sheeting overlap the edge. Wrap the overlapping sheeting around the edge and press with a squeeze roller. Heat to facilitate wrapping the sheeting around the corners and firmly apply to the extruded panels to prevent bubbles or puckers at the panel edges. If loose sheeting affects the appearance of the sign, it will be rejected.
- 6 Cut sheeting applied to flat sheet multiple panel signs smooth with the individual panel edges. Cut the sheeting copy, shields, and arrows where they cross seams between panels to allow for normal expansion.
- 7 Cover exposed rivet or screw head from splicing panels with the same type of sheeting installed on the face.

- 8 Splice the sheeting as follows:
 - A. Use either vertical splices overlapping not less than $\frac{3}{16}$ inch or butt splices.
 - B. Use splices made during fabrication only as necessary to join rolls of sheeting material as provided by the manufacturer.
 - C. Do not use any combination of remnant pieces on any sign.
 - D. Extend sheeting applied to extruded sections over the top edge and down side legs a minimum of $\frac{1}{16}$ inch.
 - E. Do not exceed a maximum of 4 splices in any 50-yard length of material.
 - F. Seal Class 1 adhesive coated reflective sheeting backgrounds in accordance with the recommendations of the sheeting manufacturer at all splices and sign edges with materials supplied and in a manner specified by the sheeting manufacturer.
 - G. Do not use clear paint to coat the remainder of the sign.
 - H. Ensure that after aging 48 hours at 75°F, adhesion of reflective sheeting to sign surface is strong enough to resist stripping from the panel when tested with a stiff putty knife.

652.4.4 Sign Patching Limits

- 1 Patch to repair incidental damage to the reflective sheeting that occurs during manufacture, in transit, or after installation using patches of the same material and manufacturer as the material being patched. Do not exceed the limits of patching given in the following table.

2

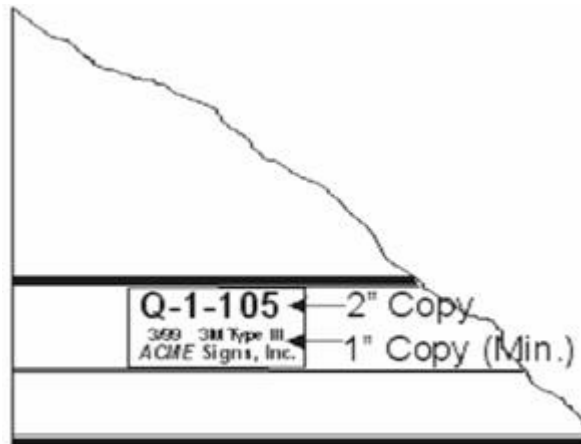
Sign Area (sq. ft.)	Max. No. of Patches per Sign	Max. Patch Size per Patch (sq. in.)
0 - 15	0	0
15.1 – 50.0	1	1
50.1 - 80.0	2	2
80.1 and Over	3	3

652.4.5 Legends, Borders and Accessories

- 1 Directly apply legends and borders to extruded panel signs unless otherwise noted. Apply reflective sheeting of the type indicated on the Plans directly to the background sheeting of the sign according to the manufacturer's recommendations and as shown in the sign face layout. Cut sheeting copy, border, shields, and arrows where they cross seams between extruded panels to allow for normal expansion.
- 2 Route markers and arrows used on guide signs may be fabricated as a separate flat sheet sign and attached to the larger sign with aluminum rivets as stated in **Subsection 652.2.5**.

652.4.6 Identification

- 1 Attach a permanent decal, produced by the sign fabricator, showing identification numbers in 2-inch high copy on the back of all multiple panel signs. Ensure that the numbers correspond with the sign numbers on the Plans (i.e. Q-1-105). Include in the decal in 1-inch (minimum) copy, the date the sign was manufactured (month and year), manufacturer of the reflective sheeting, sheeting type, and an imprint to identify the manufacturer of the sign. Use a decal similar to the example below.



- 2 Place the decal approximately 10 inches from the bottom of the sign and approximately 1 foot from the roadway side of ground-mounted signs or the left-hand side as viewed from the rear of overhead signs.

652.4.7 Packaging

- 1 Protect all signs by packaging during shipment and storage. Use packing that prevents damage to any part of the sign including any legends or borders and ensures that sign faces do not touch. Ensure that signs are free of moisture and paint is thoroughly dry before packaging. Keep packaged signs entirely dry and store in an enclosed location after delivery. Multiple Panel signs may be stored outside as noted in **Subsection 650.2.6**. Follow the sheeting manufacturer's special recommendations.

652.4.8 Location

652.4.8.1 General

- 1 Locate signs approximately as indicated on the Plans. Exact location for each sign is determined by the Contractor and the RCE; however, make certain major changes in sign location are approval from the Director of Traffic Engineering before erection.

652.4.8.2 Sign Positions

- 1 Mount signs at the proper elevation, offset, level, and orientation shown on the Plans and *SCDOT Standard Drawings*. Coordinate this work with the RCE.

652.4.8.3 Orientation of Signs

652.4.8.3.1 Ground Signs

- 1 Position signs as indicated on the Plans or on the drawing entitled *Orientation of Signs* included in the *SCDOT Standard Drawings*.
- 2 Erect ground sign faces truly vertical and turned away from the oncoming traffic. On straight roads and outside of curves (on the right side of curves to the left or on the left side of curves to the right), the angle of turn-out should be 3 degrees measured from the normal to the roadway. On the inside of curves, the turn-out should be 93 degrees measured from a line extending between the vertical centerline of the sign and an observation point on the center of the lane or lanes which the sign serves. Locate this observation point at a distance in advance of the sign approximately equal to 60 feet per inch of height of the lower case letters on the sign or per inch of height of capital letters in the major line of copy if no lower case is used.
- 3 Use the Pavement Edge Clearance (PEC) designated on the Plans to locate multiple panel ground signs from the edge of pavement.
- 4 Unless otherwise specified on the Plans, erect all multiple panel ground mounted signs at a height of 7 feet measured from the edge of pavement to the bottom of the sign.

652.4.8.3.2 Overhead Signs

- 1 Position signs as indicated on drawing entitled *Orientation of Signs* included in the *SCDOT Standard Drawings*.
- 2 Erect overhead signs with the face of the sign 3 degrees from vertical. The front top edge being forward of the front bottom edge and at 90 degrees to oncoming traffic. On horizontal curves, and just beyond curves, this 90-degree angle is measured from a line extending between the vertical centerline of the sign, or a group of signs, and an observation point on the center of the lane or lanes, which the sign serves. The observation point is determined as specified for ground signs in **Subsection 652.4.8.3.1**.

652.4.9 Erection

652.4.9.1 General

- 1 Support and erect all signs as previously specified herein and as shown on the Plans and approved Shop Plans. Ensure that horizontal edges of signs are level and faces for ground signs are vertical.
- 2 Do not weld, cut, or fabricate in any way in the field, except for attaching demountable legends and borders, which were removed in the shop to facilitate shipping.

652.4.9.2 Multiple Panel Signs

- 1 Mount multiple panel signs to firmly set supports as shown on the Plans. Ensure that all panels are horizontal and flush within commercial tolerances and that the face of the sign is flat. The entire sign will be rejected if any ap-

preciable buckling or warping of the sign face is evident. Install post clips along the back of extruded panels to attach signs to supports as detailed on the drawing entitled *Extruded Multiple Panel Signs* included in the *SCDOT Standard Drawings*.

652.4.9.3 Overhead Signs

- 1 Bolt all signs on overhead structures directly to the sign hanger members at the four corners of each sign on the structure. Use post clips at all other mounting points.

652.4.9.4 Exit Panels

- 1 Attach exit panels indicating the exit number to the top of the sign on the right-hand side for right-hand exits and on the left side for left-hand exits. Insert panels from the edge of the sign at a distance equal to the corner radius of the large sign. Attach the exit panel using two 3-pound U-section posts, 6-foot long, clipped to the back of the sign. Bolt the U-section support directly to the exit panel at the top and bottom of the panel or top and bottom of the support behind the main sign on overhead signs. Mount the bottom of the exit panel directly against the top of the larger sign with no space between and ensure that the face of the exit panel is flush with the face of the larger sign.

652.4.9.5 Supplemental Panels

- 1 If shown on the Plans, mount supplemental panels underneath guide signs. Attach the panels to the larger sign using two 3-pound U-section posts, 8-foot long, clipped to the back of the sign. Mount the top of the supplemental panel directly against the bottom of the larger sign and ensure that the face of the panel is flush with the face of the larger sign. Do not attach the panel to the breakaway supports of the larger sign by bolting or with post clips.

652.4.9.6 Glare Screens

- 1 On overhead sign structures having maintenance walkways, provide a glare screen between the bottom of each sign and the top of the walkway unless otherwise specified. Provide the screen between signs, from the top of the walkway equal to the bottom of the shortest sign on the structure. Use a non-reflective glare screen the same color as the signs, fabricated from extruded aluminum panels or 0.10-inch flat sheet aluminum with aluminum extrusions. Attach glare screens with direct bolted connections at the four corners and with post clips elsewhere.
- 2 Glare screens are not required for overhead sign structures attached to bridge overpasses, structures without maintenance walkways, or where so indicated on the Plans. Include the cost of the glare screens in the unit price bid for the sign structure to which they are attached.

652.4.10 Signs Removed or Replaced

- 1 Remove all temporary and other SCDOT signs as directed by the RCE. On the same day as the erection of the new signs, remove existing signs with

synonymous messages that are being replaced. If so directed on the Plans or in the Special Provisions, deliver the signs and supports removed or replaced to the RME at the maintenance shop for the county in which the signs were located, otherwise they become the property of the Contractor.

652.5 Measurement

- 1 The quantity for the pay item Extruded Panel Signs – Ground Mounted or Extruded Panel Signs – Mounted Overhead is the surface area of the multiple panel sign installed and is determined to the nearest 1/100 square foot (SF) of the sign face using dimensions shown on the Plans, complete and accepted.
- 2 No measurement is made for the installation of exit panels or supplemental panels including supports either on top or beneath multiple panel signs. The work for these sign is considered incidental to the multiple panel sign item.
- 3 No measurement is made for glare screens attached to overhead sign structures. The cost of glass screens is considered incidental work for the overhead sign structure to which they are attached.

652.6 Payment

- 1 Payment for the accepted quantity Extruded Panel Signs – Ground Mounted or Extruded Panel Signs - Mounted Overhead, determined in accordance with **Subsection 652.5**, is determined using the contract unit bid price for the applicable item. Payment is full compensation for fabricating and erecting the multiple panel sign as specified or directed and includes providing and installing extruded panels, flat sheet panels with bonded extrusions, mounting hardware, and attachment supports; removing and disposing of existing signs, mounting hardware, and supports being removed or replaced; lowering and relocating signs indicated on the Plans or as directed by the RCE; and for all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Installation of exit panels or supplemental panels including supports, either on top or beneath multiple panel signs, is included payment for the multiple panel sign to which they are attached.
- 3 Glare screens attached to overhead sign structures are included in the payment of the overhead sign structure to which they are attached.
- 4 No separate payment is made for the removal, transportation, or disposal of existing signs. The cost of this work is included in the payment for the various sign pay items.

652.6

652.6

5 Pay items under this section include the following:

Item No.	Pay Item	Unit
6520200	Extruded Panel Signs – Ground Mounted	SF
6520250	Extruded Panel Signs – Mounted Overhead	SF

SECTION 653

U-SECTION POSTS

653.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for U-section posts supporting ground mounted flat sheet signs, bridge end markers, milepost signs, and delineators in conformity with the Plans, the Specifications, the *SCDOT Standard Drawings*, or as directed by the RCE.

653.2 Materials

- 1 Use the specified number of steel U-section posts weighing either 2 pounds per foot (2P) or 3 pounds per foot (3P) of the specified length in feet to support flat sheet signs and delineators or to brace certain flat sheet signs indicated on the Plans (ex. 2-3P-12'). The sizes indicate the weight of the posts per linear foot (tolerance of $\pm 5\%$) before galvanizing.
- 2 Mounting of signs may be by some other means, such as square tube or I-beam breakaway posts with approval of the Director of Traffic Engineering.
- 3 Use posts that are made of either re-rolled rail steel or billeted steel conforming to the mechanical and implied chemical requirements of ASTM A 499, Grade 60, and FHWA *Technical Advisory T5040.22: Steel Flanged Channel Posts for Small Highway Sign Supports*.
- 4 Use 2P U-section posts, 10 feet long, for bridge end markers and 2P U-section posts, 7.5 feet long, for delineators. For all other posts, use the weight and length indicated on the Plans and the *SCDOT Standard Drawings*.

653.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

653.4 Construction

653.4.1 Fabrication

- 1 Ensure that U-section posts have a minimum of fifty-eight $\frac{3}{8}$ -inch diameter holes punched on 1-inch centers beginning 1 inch from the top of the post. If additional holes are necessary, conform to the standard punching procedures, but do not locate holes less than 1 inch on centers.
- 2 After fabrication, hot-dip galvanize the full length and total area of each post in accordance with ASTM A 123.

653.4.2 Erection

- 1 Unless otherwise directed by the RCE, drive the U-section posts firmly into ground at the required line and grade. Protect the posts while driving with a special driving cap. Install post in a true vertical position.
- 2 Align signs, delineators, and bridge end markers accurately. Mount signs and delineators on the flange side of the U-section posts, except where the Plans show signs mounted on both sides.
- 3 Drive posts at proper locations to provide the required pavement edge clearance for the sign and delineator.
- 4 Locate and orient the posts so that the mounted sign assembly or delineator approximates the location and orientation shown on the Plans. Use the Plans as a guide for placement of the signs. Some variations may be necessary to erect the sign in the best location.
- 5 Ensure that the top of the post is level with the top of the sign being supported. Cut off any excess post above the top of the sign. Treat the cut area by the field galvanizing method. Dispose of the cut off portion of the post.
- 6 If the RCE determines that the post cannot be driven, set the post in an augered hole and backfill to stabilize. When set in an augered hole, hold U-section posts in the proper position and backfill and thoroughly tamp the fill in 6-inch layers of backfill material.
- 7 Use material removed from the hole for backfilling, except in sandy soil backfill with a sand-clay mixture, crushed stone, or crushed stone mixed with cement with a 4:1 ratio as approved by the RCE.
- 8 Remove any rock or boulder that is encountered during augering or excavation to a depth that, in the opinion of the RCE, is sufficient to obtain the stability necessary to support the sign(s). Excavate holes to a minimum depth of 18 inches. Backfill holes less than 24 inches in depth with concrete or a 3:1 mix of soil and cement.
- 9 Remove all excavated material not needed to backfill and level the disturbed area.
- 10 Ensure that the posts are plumb above the ground level.
- 11 Remove and replace any post that is bent or otherwise damaged with no adjustment in compensation.

653.4.3 Braces on U-section Posts

- 1 Attach horizontal braces for D-type signs to vertical sign supports according to the Plans after placing the U-section posts. Tightly secure the brace to the U-section post with $\frac{5}{16}$ -inch bolts using a flat washer and a lock washer between the post and the nut. Do not use the same bolt to attach the sign and brace to a U-section post. Attach the signs to the braces with a separate bolt with a nylon washer under the head and a lock washer and nut. Use galva-

nized or stainless steel bolts, nuts, and washers.

653.4.4 Removing Existing U-section Posts

- 1 Remove the entire post and footing or cut off post at least 1 foot below ground level. Dispose of the post, which becomes the property of the Contractor, away from the construction site.
- 2 Backfill holes and depressions to the level of the surrounding soil.
- 3 Backfill and compact holes deeper than 1 foot with earth material approved by the RCE. Use topsoil in the top 1-foot of the backfill.
- 4 Seed the area in accordance with the requirements of **Section 810**.

653.5 Measurement

- 1 The quantity for the pay item U-Section Post for Sign Support – (2 or 3)P or U-Section Post for Sign Bracing –2P is the length of U-section post used for sign support or bracing and is measured to the nearest 1/100 of a linear foot (LF) of the required post, complete and accepted.

653.6 Payment

- 1 Payment for the accepted quantity for U-Section Post for Sign Support – (2 or 3)P or U-Section Post for Sign Bracing –2P, measured in accordance with **Subsection 653.5**, is determined using the contract unit bid price for the applicable pay item, and the payment includes all direct and indirect cost and expenses necessary to complete the work.
- 2 Payment is full compensation for fabricating and erecting U-section posts or braces as specified or directed and includes providing mounting hardware; removing and disposing of existing signs supports, braces, and mounting hardware removed or replaced; replacing or relocating supports or braces shown on the Plans or directed by the RCE; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
6531205	U-Section Post for Sign Supports – 2P	LF
6531210	U-Section Post for Sign Supports – 3P	LF
6531215	U-Section Post for Sign Bracing – 2P	LF

SECTION 654

BREAKAWAY SIGN SUPPORTS

654.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the fabrication and installation of steel I-beam breakaway supports for new signs and temporary wooden breakaway supports for existing signs in conformity with the Plans, the Specifications, *SCDOT Standard Drawings*, or as directed by the RCE.
- 2 This section also includes specifications for removing existing I-beam breakaway supports and refurbishing existing I-beam breakaway supports.

654.2 Materials

654.2.1 General

- 1 When "I-beam" is used in these specifications and the Plans in connection with breakaway sign supports, it denotes a "W" or "S" section beam as defined in the *American Institute of Steel Construction (AISC) Handbook*. Use materials and practices in fabrication in accordance with the requirements in **Section 709**. Comply with the requirements for the fabrication and use of the I-beam breakaway post found in the *SCDOT Standard Drawings*.

654.2.2 Structural Design

- 1 Other than those with sizes detailed on the Plans, design sign posts required by the Plans in conformance with the requirements of *AASHTO Standard Specifications for the Structural Supports for Highway Signs, Luminaires and Traffic Signals*. Use a wind speed of 90 miles per hour for design unless otherwise noted on the Plans or in the Specifications.

654.2.3 Perforated Fuse Plates

- 1 At locations where supports are vulnerable to being struck from either the front or back or at locations noted on the Plans, use perforated fuse plates of the type shown on the Plans and *SCDOT Standard Drawings* in lieu of the standard fuse and hinge plates.

654.2.4 Required Drawings

- 1 Before fabrication of the I-beam breakaway posts, verify all field dimensions and sign locations with the RCE. Submit six copies of Shop/Working Drawings to the RCE for review. Indicate the following information on the drawings: the I-beam sizes, lengths, weld sizes, bolt sizes, details for hinge and fuse plates and slip bases, and a procedure for erecting the supports.
- 2 The Director of Traffic Engineering will review the drawings as rapidly as possible and either approve them for fabrication or return them for corrections as noted. If corrections are required, provide a corrected copy to the Director of Traffic Engineering for the file.

654.2.5 Steel

- 1 For I-beam posts and components, use steel conforming to the requirements of ASTM A 709, Grade 36 as specified in **Section 709**.
- 2 Use high strength bolts, nuts, and washers conforming to the requirements of ASTM A 325 and **Section 709**. Comply with sizes and dimensions of the bolts shown on the Plans and the *SCDOT Standard Drawings*.
- 3 Use galvanized malleable iron for beveled washers on S3 x 5.7 or S4 x 7.7 beams.

654.2.6 Concrete

- 1 Use Class 3000 concrete for I-beam breakaway support footings and foundation pads in conformance with the applicable requirements of **Section 701**.

654.2.7 Temporary Wooden Breakaway Supports

- 1 Use pressure treated 4-inch x 4-inch or 4-inch x 6-inch Southern Yellow Pine as indicated on the Plans and the *SCDOT Standard Drawings* and in conformance with the requirements of **Sections 706** and **707**.
- 2 Attach signs to wood supports as detailed on the Plans and the *SCDOT Standard Drawings* using either aluminum angles or U-section posts. Use aluminum angles conforming to the requirements of ASTM B 221, Alloy 6061-T6. Use 3P U-section posts as specified in **Section 653**. Mechanically galvanize lag bolts, bolts, nuts, and washers as specified in **Section 709**.

654.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

654.4 Construction**654.4.1 General**

- 1 Fabricate I-beam breakaway posts in accordance with the Plans, the *SCDOT Standard Drawings*, and the approved Shop Plans. Fabricate in a uniform, workmanlike manner.
- 2 Fabricate I-beam breakaway posts in a plant owned and operated by a fabricator experienced in manufacturing quality supports conforming to these specifications. Inform the Director of Traffic Engineering of the name of the fabricator of the supports before fabrication begins, and if requested, furnish information as to the fabricator's qualifications and experience.

654.4.2 Fabrication**654.4.2.1 General**

- 1 Verify that the locations for installation and the post lengths on the Plans

are correct by taking field measurements with the RCE before fabrication of breakaway posts begins.

- 2 Replace posts and/or overhead structures that are fabricated incorrectly and do not fit the intended location at no additional cost to the Department. Do not make alterations after the posts and/or structures are fabricated that involve cutting, welding, or any procedure that damages the factory-applied protective finish of the posts and/or structure.
- 3 Create the fuse-hinge joint by blade cutting the post completely through before galvanizing.
- 4 Drill the holes in the I-beam flanges for the friction fuse plate and hinge fuse plate as well as the holes in the fuse plates. Ensure that the diameter for such holes conform to the requirements in the *SCDOT Standard Drawings*. For I-beams supporting flat sheet signs, such as freeway sized speed limit signs, drill holes for sign mounting. For attachment of hinge and fuse plates or for the support of signs, refer to **Section 709** for requirements for the installation of holes in I-beam flanges.
- 5 Conform welding required on I-beam breakaway posts to the requirements of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.

654.4.2.2 Galvanizing

654.4.2.2.1 Steel I-beams, Hinge and Fuse Plates

- 1 Clean and galvanize steel I-beam breakaway posts, hinge plates, and fuse plates by the hot-dip process in conformance with the requirements of ASTM A 123. Use this galvanized treatment on interior and exterior surfaces of hollow sections. Perform galvanizing after fabrication including hole punching, welding, or drilling.

654.4.2.2.2 Nuts, Bolts, and Washers

- 1 Galvanize bolts, nuts, and washers in conformance with the requirements of ASTM A 695, Class 50 as detailed in **Section 709**. Ensure that bolts, nuts, and washers are free of slag or other obstructions in the thread area and are pre-lubricated.

654.4.3 Erection

654.4.3.1 Temporary Wooden Breakaway Supports

- 1 At locations noted on the Plans or as directed by the RCE, erect existing signs on temporary wooden breakaway supports. Use post sizes indicated on the Plans and the *SCDOT Standard Drawings*.
- 2 Embed posts directly into soil a depth as shown on the Plans and the *SCDOT Standard Drawings*. Backfill and tamp in 6 inch lifts until reaching ground level. In areas with weak or sandy soils and as directed by the RCE, set wood posts in concrete foundations for additional stability. Auger the 18 inches diameter footing to a depth not less than 30 inches and backfill with Class 3000 concrete.

- 3 Where specified on the Plans, remove wood posts completely including concrete footings. Backfill and compact resulting holes with earth backfill material approved by the RCE. Use topsoil in the top 1-foot of the backfill. Seed the area in accordance with **Section 810**. Remove and dispose of the excavated footing material not used for backfill.

654.4.3.2 Excavation

- 1 Excavate for post installation to the levels and dimensions shown on the approved Shop Plans, the *SCDOT Standard Drawings*, the Plans, or as directed by the RCE. Excavate either manually or mechanically.
- 2 Remove any rock or boulder encountered during excavation to a depth that is sufficient, in the opinion of the RCE, to obtain the stability necessary to support the sign or signs under the design loads.
- 3 Remove all excavated material not needed for backfill from the job site and level the disturbed area.

654.4.3.3 Placing Concrete

- 1 Provide all I-beam post installations with concrete foundations. Use Class 3000 concrete and foundation dimensions shown on the Plans, and the *SCDOT Standard Drawings*.
- 2 As an integral part of the foundation, construct a vegetation control pad to the dimensions shown on the Plans. Use the same class of concrete for the pad that is used in the beam encasement and apply a broom finish. Excavate and form the pad so that the finish grade matches the surrounding soil elevation. Use 6-inch x 6-inch W2 Welded Wire Fabric as reinforcement, which conforms to the requirements of **Section 703**. Do not pour the concrete pad without forms nor separately from the beam encasement. At locations where the existing I-beam breakaway support is re-used, installation of a foundation pad is not required, unless otherwise noted on the Plans.
- 3 Ensure that the excavation for signposts is made as nearly to neat line as possible and all parts of the signpost footing or encasement are poured against the soil or rock face. If pouring in sandy soils, form the encasement below ground level or as directed by the RCE.
- 4 Ensure that posts set in concrete are securely held in proper position during encasing and backfilling operations. Erect a complete unit with stub attached.
- 5 Backfill and level foundation area as necessary. If not otherwise included in the Contract, seed the area of disturbed soil in accordance with **Section 810**. Remove and dispose of the excavated footing material not used for backfill.

654.4.3.4 Setting Posts

- 1 Set all posts firmly in the ground to the required line and grade. Ensure that the posts are truly vertical and are aligned accurately when signs are attached. Use of more than the specified number of shims or washers is not

acceptable to plumb posts improperly set. Ensure that the top of posts are level with the top of the supported sign.

- 2 Install the stub posts at the proper stub projection from the top of the footing in accordance with the *SCDOT Standard Drawings*. Unless otherwise specified, install the stub projection at 3 inches above the surrounding ground elevation. Remove and re-set or replace any stub that is installed too high or too low with no adjustment in compensation.
- 3 Set posts at the proper location as shown on the Plans to provide specified sign clearances.

654.4.3.5 Tightening Bolted Connections

- 1 After the sign has been erected on the posts, loosen and re-tighten the fuse plate bolts to the prescribed torques or tension indicated in the following table. Clean and lubricate the threads and nuts on the fuse plate bolts before tightening.

Fuse Plate Bolt Torque and Tension Values

Bolt Diameter	Applied Torque	Applied Minimum Residual Tension
1/2"	90 ft-lbs	12,000 lbs
5/8"	180 ft-lbs.	19,000 lbs
3/4"	320 ft-lbs	28,000 lbs

- 2 Loosen and re-tighten slip plate bolts to the prescribed torque or tension as shown in the following table. Clean and lubricate before tightening. After tightening, burr the bolt thread using a cold chisel or center punch to prevent loosening of the nut.

Base Plate Bolt Torque and Tension Values

Bolt Diameter	Clamping Force	Slip Base Torque
1/2"	920 - 1380 Lbs.	95 - 142 In-Lbs.
5/8"	1740 - 2660 Lbs.	226 - 345 In-Lbs.
3/4"	2400 - 3600 Lbs.	369 - 554 In-Lbs.

654.4.4 Removing Existing I-Beams Breakaway Supports

- 1 Remove existing I-beam breakaway supports indicated on the Plans or when directed by the RCE.
- 2 Erect new supports before the existing signs and supports are removed, except where a new sign is erected in the same position as an old sign. Where new supports replace existing supports, erect the new supports at least 10 feet from the existing installation. Avoid erecting a new support in front of an existing sign unless conditions make this absolutely necessary. Remove the existing support and sign the same day as the new sign is erected so that signs with like or synonymous messages are not at the same

location. Remove the entire footings, pad, and posts that are no longer needed or remove the posts and footings to a depth not less than 1 foot below the ground line.

- 3 Backfill the resulting hole using earth material and compact as directed by the RCE. Fill the top 1-foot of hole with topsoil and level area as necessary. Remove and dispose of any excavated material not used for backfill. If not otherwise included in the Contract, seed the of disturbed area in accordance with **Section 810**.

654.4.5 Refurbishing Existing I-Beam Breakaway Supports

- 1 Retain and refurbish existing I-beam supports at locations shown on the Plans. Clean rusted areas of the posts and repair the areas with zinc-rich paint. Replace hinge and fuse plate bolts, nuts, and washers and base plate bolts, nuts, and washers and retighten in accordance with the requirement for new installations. Replace damaged fuse or hinge plates. Determine the size of plates, bolts, nuts, and washers for replacement of damaged or missing items.

654.5 Measurement

- 1 The quantity for the pay item Breakaway Sign Supports is the weight of the breakaway sign support installed and is measured to the nearest 1/100 of a pound (LB) of steel in the installed sign support, complete and accepted. The weight is calculated using nominal weights of the W-section or S-section as given in the manufacturer's handbook multiplied by the length of beam in the fabricated supports and stubs with no allowance for hinges and fuse plates, attachments, hardware, welding, galvanizing, or holes. No measurement is made for furnishing, installing, and backfilling, foundations or for leveling or seeding the area disturbed by the installation of the foundation. The work for the foundation is considered incidental work for the sign support and the cost of such work is included in the contract unit price bid for the breakaway sign support item.
- 2 The quantity for the pay item Refurbish Breakaway Sign Supports is measured by each (EA) I-beam sign support refurbished, complete and accepted. There is no other measurement for material or work involved in this item.
- 3 The quantity 4"X 4" Treated Wood Post or 4"X 6" Treated Wood Post is the length of treated wood post for temporary support of existing signs and is measured by the linear foot (LF) of wood post erected, complete and accepted. No measurement is made for furnishing, installing, and backfilling, foundations, for leveling or seeding the area disturbed by the installation of the foundation, or for attaching the existing sign to the temporary wood posts. The work for the foundation and attaching the existing sign is considered incidental work for the temporary sign support and the cost of such work is included in the contract unit bid price for the treated wood post item post.
- 4 The quantity for the pay item Removal of I-Beam Post or Removal of Wood Post is measured by each (EA) post removed and disposed of to the satisfaction of the RCE, complete and accepted. There is no measurement made for

backfilling and leveling or seeding disturbed area or for the removal of existing sign. The backfilling, seeding, and removal of existing sign is consider incidental work for the post removal and is included in the contract unit bid price for the post removal item.

654.6 Payment

- 1 Unless otherwise noted, payment for the accepted quantities, measured in accordance with **Subsection 654.5**, is determined using the contract unit bid price for the applicable item, and the payment includes all direct and indirect costs and expenses necessary to fulfill the requirements of the pay item in an acceptable manner.
- 2 Payment for Breakaway Sign Supports is full compensation for furnishing and installing breakaway sign supports as specified or directed and includes fabricating and galvanizing I-beam posts, framing, hinges and fuse plates, stubs, and hardware as detailed on the Plans, Shop Plans and Working Drawings; erecting sign supports; providing concrete foundation and foundation pad; excavating and backfilling (when required); affixing the sign(s) to the support; leveling and seeding disturbed areas; and all other materials, labor, equipment, tools, supplies, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for Refurbish Breakaway Sign Supports is full compensation for refurbishing existing breakaway sign supports as specified or directed and includes inspecting existing sign supports; determining the materials required to replace damaged and missing parts; removing, disposing, and replacing damaged hinge and fuse plates; re-tightening bolts; removing rust; painting with zinc rich paint; and all other materials, labor, equipment, tools, supplies, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Payment for 4"X 4" Treated Wood Post or 4"X 6" Treated Wood Post is full compensation for installing treated wood post as specified or directed and includes furnishing and fabricating treat wood posts as detailed on the Plans and Working Drawings; providing necessary hardware; erecting the post; providing concrete foundations; excavating and backfilling (where required); relocating existing sign(s) (where necessary); affixing sign(s) to the posts; and all other materials, labor, equipment, tools, supplies, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 5 Payment for Removal of I-beam Post or Removal of Wood Post is full compensation for removing and disposing of I-beam or wood posts as specified or directed and includes removing and disposing of the footing; backfilling and leveling as necessary; seeding the area disturbed; removing the existing sign whether multiple panels or flat sheet (i.e. Interstate speed limit sign); and all other materials, labor, equipment, tools, supplies, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the

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Specifications, and other terms of the Contract.

⁶ Pay items under this section include the following:

Item No.	Pay Item	Unit
6541005	Breakaway Sign Supports	LB
6541007	Refurbish Breakaway Sign Supports	EA
6541305	4" x 4" Treated Wood Post	LF
6541310	4" x 6" Treated Wood Post	LF
6541405	Removal of I-Beam Post	EA
6541415	Removal of Wood Post	EA

SECTION 655

BREAKAWAY SQUARE TUBING POSTS

655.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the fabrication and installation of breakaway square tubing post assemblies in conformity with the Plans, the Specifications, *SCDOT Standard Drawings*, or as directed by the RCE.

655.2 Materials

- 1 Fabricate posts from cold-rolled steel strip with commercial quality zinc coating and conforming to the requirements of ASTM A 653, G90 or G140. Ensure that the posts are galvanized for their full length and total area. Ensure that the cross-section of the post is a square tube formed of 14-gauge (0.083 inches) or 12-gauge (0.105) steel, carefully rolled to the dimension specified herein or shown on the Plans, and welded directly in a corner. Use a $\frac{3}{8}$ -inch galvanized bolt, lock washer, and nut to connect the assembly as indicated in the drawing entitled *Flat Sheet Sign mounting Details* in the *SCDOT Standard Drawings*.
- 2 Provide the Mill Test Reports and a Materials Certification for each shipment of square tubing to the RCE. Make certain that the Mill Test Report identifies the various lots of tubing. Ensure that the chemical and physical properties conform to the requirements of the specified alloy. Ensure that the production lots are identifiable upon receipt at the site. Failure to provide Mill Test Reports and Materials Certifications may result in the rejection of all materials and require replacement at the Contractor's expense.

655.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

655.4 Construction

655.4.1 Fabrication

Fabricate the three-part, breakaway post assembly consisting of an 8-foot post, 3-foot anchor, and an 18-inch sleeve to the dimensions shown in the following table.

Type 1 Post Assembly	Type 2 Post Assembly
1¾" x 1¾" x 8' Post	1½" x 1 ½" x 6' Post
2" x 2" x 3' Anchor	1¾" x 1¾" x 3" Anchor
2¼" x 2¼" x 18" Sleeve	2" x 2" x 18" Sleeve

- 1 Ensure that the post is straight with a smooth finish to allow smaller tube to fit freely into the larger tube with minimum play. Punch standard clean-punched open holes $\frac{7}{16}$ inch ($+\frac{1}{64}$ inch) in diameter holes on 1-inch centers on all four sides beginning 1 inch from the top in each section with the hole spacing being accurate to $\frac{1}{8}$ inch in 20 feet of tube length. Ensure that holes are free from plugs and burrs. Holes do not require zinc treatment after fabrication.

655.4.2 Erection

- 1 Align and locate signs, delineators, and bridge marker posts accurately. Ensure that posts are located properly to provide the sign or delineator with the required pavement edge clearance.
- 2 Locate and orient the posts so that the mounted sign or delineator approximates the location and orientation shown on the Plans. Use the Plans as a guide for placement of the signs. Some variations may be necessary to erect the sign in the best location.
- 3 Unless otherwise directed by the RCE, drive the post anchor firmly into ground on the required line with the top approximately 3 inches above grade. Protect the post anchor with a driving cap while driving. Remove and replace post anchors bent or otherwise damaged with no adjustment in compensation. Ensure that the post anchor is installed in a true vertical position.
- 4 If the RCE determines that the post anchor cannot be driven, set the post anchor in an augured or excavated hole and backfill to stabilize. When set in a augered or excavated hole, hold the post anchor in the proper position and backfill and thoroughly tamping the fill in 6-inch layers. Use material removed from the hole for backfilling, except in sandy soil backfill with a sand-clay mixture, crushed stone, or crushed stone mixed with cement with a 4:1 ratio as approved by the RCE.
- 5 Remove any rock or boulder that is encountered during augering or excavation to a depth that, in the opinion of the RCE, is sufficient to obtain the stability necessary to support the sign(s) under the design loads specified. Ensure that the depth of the holes is a minimum of 18 inches. Backfill holes less than 24 inches in depth with concrete or a mix of 3:1 soil and cement.
- 6 Remove all excavated material not needed for backfill and level the disturbed area.
- 7 Place the sleeve over the anchor with the top of the sleeve flush with the top of the anchor. Place the post a minimum of 3 feet into the anchor section. Align the hole at the top sleeve with the hole in the anchor and post. Place a

$\frac{3}{8}$ -inch bolt, washer, and nut through the hole and tighten. Make certain that the post is plumb.

- 8 Ensure that the top of the post is level with the top of the sign being supported. Cut off any excess post above the top of the sign. Ensure that the cut off ends are free from burrs. Treat the cut area by the field galvanizing method. Dispose of the cut off portion of the post.
- 9 Use 12-gauge square tubing or post assemblies on concrete islands or as specified on the Plans where the posts are susceptible to being struck by vehicles.

655.5 Measurement

- 1 The quantity for the pay item Square Tube Post for Sign Supports (for each gauge, size, length of post) is the length of the square tube post assembly installed and is measured to the nearest 1/100 of a linear foot (LF) of post sect of the assembly, complete and accepted. The anchor post and the anchor sleeve are not included in the measurement, but are included in the contract unit bid price for the post assembly.

655.6 Payment

- 1 Payment for the accepted quantity for Square Tube Post for Sign Supports (of the gauge, size, and length of post), measured in accordance with **Subsection 655.5**, is full compensation for furnishing and installing the square tube post assembly as specified or directed and includes furnishing the post section, anchor post, anchor sleeves, and driving caps; driving and setting the post; cutting off and disposing of the excess length of post; field galvanizing, augering or excavating the assembly foundation; backfilling and disposing of the excess foundation material; affixing the new or existing signs to the post; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 The payment for this pay item also includes the removal and disposal of the existing sign supports and mounting hardware removed and replaced or relocated as shown on the Plans to the satisfaction of the RCE.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
6551105	Square Tube Post for Sign Supports 12 Gauge 1½" x 1½" X 6'	LF
6551110	Square Tube Post for Sign Supports 12 Gauge 1¾" x 1¾" X 8'	LF
6551115	Square Tube Post for Sign Supports 12 Gauge 2" x 2" X 8'	LF

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Item No.	Pay Item	Unit
6551120	Square Tube Post for Sign Supports 12 Gauge 2 $\frac{1}{4}$ " x 2 $\frac{1}{4}$ " X 8'	LF
6551125	Square Tube Post for Sign Supports 12 Gauge 2 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ " X 8'	LF
6551130	Square Tube Post for Sign Supports 14 Gauge 1 $\frac{3}{4}$ " x 1 $\frac{3}{4}$ " X 8'	LF
6551135	Square Tube Post for Sign Supports 14 Gauge 2" x 2" X 8'	LF
6551140	Square Tube Post for Sign Supports 14 Gauge 2 $\frac{1}{4}$ " x 2 $\frac{1}{4}$ " X 8'	LF

SECTION 656

DELINEATORS

656.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the installation of shoulder mounted, bridge mounted, median mounted, and barrier mounted delineators of various design in conformity with the Plans, the Specifications, *SCDOT Standard Drawings*, or as directed by the RCE.

656.2 Materials

656.2.1 General

- 1 Use one of the following types of delineators as shown on the Plans and *SCDOT Standard Drawings*:
 - Post-mounted plastic reflectors,
 - Flexible posts with reflective sheeting,
 - Post-mounted flat sheet aluminum with reflective sheeting,
 - Flexible bridge mounted, barrier mounted, or parapet mounted units with reflective sheeting, or
 - Prismatic plastic reflectors with aluminum angle bridge or median barrier mounts.

656.2.2 Prismatic Plastic Delineators

- 1 Provide center mounting prismatic-plastic delineators consisting of a hermetically sealed, acrylic plastic, reflex reflector in an embossed aluminum housing with a single grommet mounting hole.
- 2 Use 0.020-inch 5052-0 aluminum or other alloy approved by the Director of Traffic Engineering for housing formed to approximately a 3.25-inch diameter and to a depth that retains the acrylic reflector.
- 3 Expand a $\frac{3}{16}$ -inch inside diameter aluminum grommet in the reflector mounting hole.
- 4 Provide an acrylic plastic reflector consisting of a transparent plastic face with 7 square inches of reflective area referred to as the lens, a heat sealable plastic coated metallic foil back fused to the lens under heat and pressure around the entire perimeter of the lens, and a central mounting hole to form a unit permanently sealed against dust, water, and water vapor. Provide reflectors that are white, yellow, or red as required.
- 5 Ensure that the lens consists of a smooth front surface free from projection or indentations other than the central mounting hole and identification and with a rear surface bearing a prismatic configuration that effects total internal reflection of light. Identify the reflector unit by the manufacturer's trademark.

656.2.3 Flat Sheet Aluminum Delineators

- 1 Use 0.100-inch flat sheet aluminum measuring 3½ inches x 3½ inches with white or yellow Type IX reflective sheeting to construct flat sheet aluminum delineators with a ⁵/₁₆ inch attachment hole in the center of the aluminum.

656.2.4 Flexible Post Delineators

656.2.4.1 Prequalification and Certification

- 1 Provide flexible post delineators that have been tested and approved by the National Transportation Product Evaluation Program (NTPEP). Use post delineators made by manufacturers listed on the current edition of *SCDOT Qualified Product List 50*.
- 2 Provide the RCE with a certification from an officer of the manufacturing company that certifies that each shipment of the delineator posts meets the requirements of these specifications.

656.2.4.2 Materials

- 1 Provide a post made of durable material that is resistant to impact, ultraviolet light, ozone, common hydrocarbon solvents, motor fuels and lubricants, and herbicide formulations. Provide posts that are self-erecting after a vehicle impact. Ensure that posts are free of surface porosity and other defects that could affect appearance and serviceability. Cap the top of tubular posts to prevent the inclusion of water.
- 2 Provide posts in white, yellow, orange, or other special color as required. Ensure the post is wide enough to accommodate a minimum of 3-inch wide reflective sheeting on one or both sides without overhanging the edges. Use Type IX reflective sheeting in either yellow or white.
- 3 Provide posts lengths as shown on the Plans and *SCDOT Standard Drawings*.

656.2.4.3 Post Types

- 1 Provide either a surface mounted type or a driven or embedded type flexible delineator post as specified.
- 2 For surface mounted type post, use a two-piece system where the post fits into a surface mounted anchor with a locking mechanism. Secure the anchor with a bituminous or epoxy adhesive recommended by the manufacturer.
- 3 Use one of the following types of driven or embedded posts:
 - Chisel-pointed, drivable, reusable metal anchor into which the post is inserted and held in place by a locking mechanism.
 - Metal anchor designed for embedment in either Portland cement or asphalt concrete. Secure the anchor in the concrete with asphalt or epoxy adhesive recommended by the post manufacturer. Fit the post into the anchor and secure by a locking mechanism.

656.2.4.3

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- U-section steel post to which the post is securely attached and driven by mechanical means.
 - Direct driven post without a separate anchor.
- 4 Fabricate all metal anchors from galvanized steel, providing suitable corrosion resistance and a stable anchor that cannot be dislodged when the post is subjected to multiple vehicular impacts.

656.2.5 Flexible Barrier or Parapet Mounted Delineators

- 1 Provide delineators consisting of a T-shaped body that is co-extruded and fuses two materials, one for support and the other for flexibility. Ensure that the retroreflective surface is 4 inches x 4 inches and constructed of Type IX retroreflective sheeting. Bond the delineator to the barrier with an adhesive 3 inches from the top at 200-foot spacing. Provide a Dura-Flex Model Flex 2020 or equal delineator.

656.2.6 Reflective Materials

- 1 Provide white or yellow Type IX reflective sheeting material to reflectorize the delineators that conforms to the requirements of **Subsection 651.2.3**.

656.2.7 Certification

656.2.7.1 General

- 1 Ensure the manufacturer of prismatic plastic delineators conducts quality control tests that meet the requirements of these specifications.
- 2 Provide the OMR with 4 copies of a notarized certified report from the manufacturer showing the results of their quality control tests and a certification stating that the delineators furnished meet all the requirements of the Department's specifications for signing.

656.2.7.2 Optical Requirements

- 1 Use the following definitions in testing optical performance:
- Entrance (Incidence) Angle – The angle between the incident beam and a line perpendicular to the face of the reflective material.
 - Observation (Divergence) Angle – The angle between the observer's line of sight and the incident beam.
 - Specific Intensity – The candlepower returned at the chosen observation angle by a reflector for each foot-candle of illumination at the reflector.

656.2.7.3 Specific Intensity

- 1 Ensure that the specific intensity of sample reflex reflectors from each lot of reflectors used in delineators or markers meets or exceeds the minimum values in the following table.

Entrance (Incidence) Angle (Degrees)	Observation (Divergence) Angle (Degrees)	Specific Intensity (Candlepower / Ft-Candle/Reflector)		
0	1/10	Crystal 119	Yellow 71	Red 29
20	1/10	Crystal 47	Yellow 28	Red 11

- 2 Failure to meet the specific intensity minimum constitutes failure of the reflector being tested. Failure of more than 2 reflectors out of 50 subjected to test constitutes failure of the lot.

656.2.7.4 Optical Testing Procedure

- 1 Test the reflex reflector by locating it a distance of 100 feet from a single effective 2-inch diameter light source operated at approximately normal efficiency. Measure the return light from the reflector by means of a photoelectric photometer having a minimum sensitivity of 1×10^7 foot-candles per mm scale division. Use a photometer with a receiver aperture of 0.5-inch diameter shielded to eliminate stray light. Ensure the distance from the light source center to aperture center is 2.1 inches for 0.1-degree observance angle. Spin the reflectors during testing to average the orientation effect.
- 2 If a test distance other than 100 feet is used, modify the source and aperture dimensions and the distance between the source and aperture in the same proportion as the test distance.

656.2.7.5 Durability Testing

656.2.7.5.1 Seal Test

- 1 Submerge 50 samples in water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches gauge for 5 minutes. Restore atmospheric pressure and leave samples submerged for 5 minutes, then examine the samples for water intake. Reject the lot if more than 3 of the 50 tested fail.

656.2.7.5.2 Heat Resistance Test

- 1 Tests 3 reflectors for 4 hours in a circulating air oven at 175°F ($\pm 5^\circ\text{F}$). Place specimens in a horizontal position on a grid or perforated shelf permitting free air circulation. Remove from the oven and permit to cool in air to room temperature. The samples exposed to the heat should show no significant change in shape and general appearance when compared with unexposed control standards. If any test samples show significant change, then the lot is rejected.

656.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as

to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

656.4 Construction

656.4.1 Mounting Hardware

- 1 Attach delineators to U-section posts using $\frac{3}{16}$ -inch x 3-inch commercial lock bolt fastener and flanged (vandal proof) collar ($\frac{3}{16}$ -inch I.D. x $\frac{3}{4}$ -inch O.D.) as shown on the drawing entitled: *Installation Guide (3)* of the *SCDOT Standard Drawings* or other vandal-proof hardware approved by the RCE. Use aluminum alloy 6061 (artificially aged) for pin and collar. A $\frac{3}{16}$ -inch x 3-inch stainless steel pan head machine screw may be used in lieu of the flanged lock fastener.

656.4.2 Location

656.4.2.1 General

- 1 Locate delineators approximately as shown on the Plans and the drawing entitled *Installation Guide (3)* of the *SCDOT Standard Drawings* and as specified in the *MUTCD*.

656.4.2.2 Delineator Positions

- 1 Locate delineator positions in a temporary manner until approved by the RCE.

656.4.2.3 Orientation of Delineators

- 1 Position the reflector units of the delineators so that they are clearly visible at night under normal weather and atmospheric conditions when illuminated by the upper beam of standard automobile headlights when the vehicle is located in the right-hand traffic lane approaching the delineator. Erect the delineators vertically with the face at 90 degrees to oncoming traffic.

656.4.2.4 Clearances

- 1 Locate delineators in a manner so that the top reflective unit is approximately 4 feet above the grade of the pavement edge and 2 feet back of the shoulder edge or the face of an un-mountable curb along curbed sections or just behind the railing of guardrail, unless otherwise shown on the Plans. Use spacing along the roadway as shown on the Plans and the drawing entitled *Installation Guide (3)* of the *SCDOT Standard Drawings*.

656.4.3 Erection

656.4.3.1 General

- 1 Support and erect all delineators as specified on the Plans and the drawing entitled *Installation Guide (3)* of the *SCDOT Standard Drawings*.

656.4.3.2 Attaching Delineators

- 1 Mount delineators securely after driving the U-section posts. Mount each mono-directional delineator on the flange side of the posts. For bi-directional installations, add another delineator on the opposite side of the post.
- 2 Use the manufacturers recommended tool to crimp the flanged collar to the lock bolt fastener. Swage the collar uniformly into the locking grooves of the pin without deforming the delineator. After installation, cut the pin flush with the collar. If stainless steel screws are used in lieu of grooved pins with flanged collars, cut the ends of the screws as near the nut as possible and burr the threads to prevent loosening of the nut.
- 3 At special locations, mount delineators on bridges or concrete barriers. Bond the delineator to the barrier with an adhesive approved by the manufacturer at 3 inches from the top with a 200-foot spacing. Use the details shown on the *SCDOT Standard Drawings* for the methods of attachment for bridge mounted delineators. Mount all other delineators on driven 2P U-section posts.

656.5 Measurement

- 1 The quantity for the pay item Delineator (of the type required) is measured by each (EA) type of delineator installed, complete and accepted.

656.6 Payment

- 1 Payment for the accepted quantity for Delineator (of the type required), measured in accordance with **Subsection 656.5**, is determined using the contract unit bid price for the applicable item. Payment for Delineator (of the type required) is considered full compensation for providing and installing the required delineators as specified or as directed and includes providing delineator with the specified reflector, housing, and hardware; providing and installing posts and mounting supports; mounting delineators; and all other materials, labor, equipment, tools, supplies, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Pay for items under this section include the following:

Item No.	Pay Item	Unit
6562105	Delineator, Single, Mono-Directional, Including Supports	EA
6562107	Flexible Delineator 4"x12" Type 4 Sheeting Reflector	EA
6562110	Delineator, Double, Mono-Directional, Including Supports	EA

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Item No.	Pay Item	Unit
6562115	Delineator, Single, Bi-Directional, Including Support	EA
6562205	Delineator, Single, Mono-Directional, Bridge, Wall, or Barrier Mounted	EA
6562210	Delineator, Double, Mono-Directional, Bridge, Wall, or Barrier Mounted	EA
6562215	Delineator, Single, Bi-Directional, Bridge, Wall, or Barrier Mounted	EA
6562220	Delineator, Flexible, 4"x4" Bridge, Wall, or Barrier Mounted	EA

SECTION 657

OVERHEAD SIGN STRUCTURES

657.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the design, fabrication, and installation of overhead sign structures in conformity with the Plans, the Specifications, or as directed by the RCE.

657.1.1 Types of Overhead Sign Structures

- 1 This section contains characteristics for the following types of overhead sign structures:

- Cantilever Structure – One vertical support with an arm extending over the roadway. The cantilever arm is limited to 45 feet in length.
- Sign Bridge – Spans the entire roadway or a roadway in a single direction and has supports at either end. The vertical supports on either end may have an integral foundation built in to a bridge parapet, median barrier, or retaining wall.
- Butterfly – Single vertical support, usually installed on integral footings in median barriers along urban freeways or highways having six or more traffic lanes. Signs can be mounted on both sides (back to back) of the structure.
- Bridge Mounted – Structure attached to a bridge overpass over the highway. Structures are normally erected perpendicular to the traffic lanes if the roadway bridge is skewed, but may be slightly skewed to the traffic lanes in cases where the bridge skew is great. A single sign assembly can be made up of two or more individual structures mounted together in cases of extreme skew or length.
- Spanwire Structure – Two concrete or steel stain poles with a cable across the roadway. Signs are mounted on the cable using clamps, and tether cables are included to keep the signs stable in high winds.

- 2 The structure type, illustration of sign panel dimensions, span lengths, vertical and horizontal clearances, subsurface data when possible, and design wind loads are shown on the Plans. Unless otherwise noted, mount all signs with their horizontal centerlines on the same level with the horizontal centerline of the structure.

657.1.2 Structural Designs

- 1 Design the overhead sign structure and provide Shop/Working Drawings in conformity with these specifications, the Special Provisions, AASHTO *Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, and the AASHTO *Standard Specifications for Highway Bridges*.

- 2 Unless otherwise noted, include maintenance walkways on overhead sign supports with a walkway safety railing. When the railing is in an opened position, use two concentrated design live loads of 200 pounds; one applied vertically downward and one applied horizontally at a right angle to the walkway side of the railing. Apply each load separately and located to produce maximum stress in the safety railing.
- 3 For the design of cantilever sign assemblies, ensure that the design conforms to the design criteria in the AASHTO *Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, as well as the following requirements:
- Do not allow the vertical dead load deflection at end of the cantilever structure arm to exceed $L/150$ due to distortions in arm and vertical supports, where L is the length of arm from center of vertical support to the outer edge of sign.
 - Do not allow the horizontal deflection at end of arm to exceed $L/40$ due to distortions in arm and vertical supports because of design wind load.
 - Equip all structures with approved damping or energy absorbing devices to prevent significant aeolian vibration, unless the dead load deflection as defined above is equal to, or less than $d^2/400$ feet, where d is the sign depth in feet.
 - When required, provide camber to offset deflection in the structure caused by loads on the horizontal section of the structure. Shop Plans should indicate the amount of camber provided, and the method employed in the fabrication of the assembly to obtain the camber.
 - Install stiffener plates between the structure base plate and upright between the anchor bolts. Provide least six anchor bolts in cantilever structures.
 - Do not allow the cantilever arm to exceed a length of 45 feet.

657.1.3 Footings

657.1.3.1 General

- 1 Design the footings for overhead sign structures in conformity with the Plans, the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and the AASHTO *Standard Specifications for Highway Bridges*. Footing type may be shallow spread type foundations, deep cylindrical type foundations, or pile foundations depending on the soil conditions and structure type.

657.1.3.2 Subsurface Data for Design of Footings

- 1 Subsurface data will usually be included on the Plans. In some cases, when the information is not provided, obtaining subsurface data for design of footings is the responsibility of the Contractor. Include the cost for acquisition

of subsurface data in the price bid for the particular structure.

- 2 Construct all foundations in accordance with these specifications, the Special Provisions, and the applicable Supplemental Specifications.

657.1.4 Required Drawings

- 1 Before fabrication of an overhead sign structure, submit six copies of the Shop/Working Drawings for the overhead sign structure and details of the structure footing for review by the Director of Traffic Engineering along with two copies of the supporting design calculations. Ensure that the submittals are complete and indexed to include all structure and footing drawings and calculations. Partial or incomplete submittals will not be accepted and will be returned marked "Not Approved".
- 2 Complete drawings submittals will be reviewed as rapidly as practical and will either be accepted or returned for correction. After corrections are made, submit a corrected copy to the Director of Traffic Engineering. The review is general and does not include verification of calculations or procedures. Therefore, review and acceptance of the drawings and calculations does not relieve the Contractor of the responsibility for ensuring the adequacy of the structures.
- 3 Submit Shop/Working Drawings with fabrication details of overhead structures complete with illustrations of any electrical fittings, such as luminaires, pipe outlets, etc., in accordance with **Section 725**. Drawings are not considered complete without the electrical accommodations shown if required.
- 4 Before preparing required drawings, verify the position, dimension, size, condition, and any other information pertaining to design of an overhead sign structure. Check existing roadway bridges on which overhead signs will be mounted and determine the necessary dimensions, elevations, or other data needed to prepare the drawings for the overhead sign structures. Include the cost of this investigation in the unit price bid of the overhead sign structure.

657.1.5 Checking Structure Designs

- 1 Have an independent South Carolina registered Professional Engineer check the drawings and calculations for structural adequacy and compliance with Department specifications. The independent engineer cannot be an employee of the Contractor or the structure fabricator. Ensure that all designs and design calculations bear the seal of the South Carolina registered Professional Engineer responsible for the designs. Make certain that the drawings are accompanied by a letter from the South Carolina registered Professional Engineer checking the drawings and are stamped thereby certifying that the designs meet the requirements set forth herein and the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*. Furnish a stamped copy of the drawings, design calculations, and letter to the Director of Traffic Engineering.

657.2 Materials

657.2.1 Supports for Overhead Signs

- 1 Fabricate all overhead sign supports of steel as specified in **Subsection 657.2.2**. Design sign supports using only one type of structural component (i.e. pipe, steel angle, etc.) throughout the project to provide structures of similar appearance. Unless otherwise specified, provide overhead sign supports with maintenance walkways, wiring outlets, and other necessary provisions for sign illumination specified on the Plans and in the Special Provisions.
- 2 When specified, provide the overhead sign supports with provisions for lighting systems to be installed later. Plug all wiring outlets not used. Maintenance walkways may not be required on some structures, and this will be indicated on the Plans. Wire outlets and hand holes may be omitted from structures as well.

657.2.2 Steel Overhead Structures

- 1 Provide structural steel meeting the requirements of AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and the AASHTO *Standard Specifications for Highway Bridges* and the following:
 - Steel Pipe for overhead sign structures meeting the requirements of ASTM A 500, Grade B (modified to 52 ksi yield) or API-5L-x-52 (52 ksi yield).
 - Steel for flanges and plates meeting the requirements of ASTM A 572, Grade 50.
 - Steel angles meeting the requirements of ASTM A 36.
 - Nuts, bolts, washers, and direct tension indicators meeting the requirements of **Section 709**. Use ASTM A 325 bolts for structural steel fasteners. Galvanize all hardware.
 - Hardware, other than ASTM A 325 bolts, meeting the requirements of ASTM A 307.
 - Welds meeting the requirements of ANSI/AASHTO/AWS D1.1, *Structural Welding Code – Steel*.
- 2 Before leaving the shop, clean and galvanize all components, except stainless steel, by the hot-dip process meeting the requirements of ASTM A 123, including clamps and brackets for mounting the signs. Galvanize all interior and exterior surfaces of hollow sections. Galvanize after fabrication whenever possible. Galvanizing component parts during fabrication is permitted if the weld and cut areas are shop-treated by an approved field galvanizing process.

657.2.3 Base Plate or Sole Plate

- 1 To ensure full bearing on footings, seat bottoms of columns for overhead structures on a solid base plate or have separate sole plates of the same

material used in the structure. Do not use grout pads between the top of the footing and bottom of the base plate. Mount the base plate so that it rests on the leveling nuts. Do not allow the distance from the top of the footing to the bottom of the base plate to exceed two times the diameter of the anchor bolts.

657.2.4 Anchor Bolts

- 1 Use anchor bolts meeting AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and ASTM F 1554. Provide the anchor bolts with seismic hooks or a seismic plate. Do not use lock washers.
- 2 Galvanize anchor bolts, nuts, and washers in accordance with the requirements of ASTM A 153. Galvanize anchor bolts the entire length of the bolt.

657.2.5 Concrete Foundations

- 1 Use Class 3000 concrete for foundations and foundation pads conforming to the requirements of **Section 701**.

657.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

657.4 Construction

657.4.1 Fabrication

657.4.1.1 Overhead Sign Supports

- 1 Overhead sign structures may be welded, bolted, riveted, or fastened by other means provided the other means of fastening ensures adequate strength and does not detract from the aesthetics of the structure. If welding is used, consider the reduction of yield strength of the material due to welding in the design.
- 2 Ensure that fabricators of overhead sign structures are approved by the OMR before the start of fabrication. Make certain all shops fabricating structures are also AISC-certified for fabrication of simple and complex steel bridges. Make certain that the fabrication of overhead sign structures is inspected by an accredited and approved independent inspector or the OMR inspector during fabrication and both before and after galvanizing. Failure to have in-plant inspections before galvanizing will result in non-acceptance of the structures for erection. Coordinate in-plant inspections with the OMR before beginning fabrication so that an inspector can schedule a visit.
- 3 Ensure that all welding is done in the shop by qualified welders. Fabricate components in a jig or fixture constructed to prevent distortion during and after welding and to ensure exact alignment at the time of erection. Check the shop welding by carefully by visual inspection of all welds, proof testing of

welds, destructive testing of weld samples fabricated during the production welding, or other methods approved by the approved in-plant inspector. Use sufficient destructive testing of weld samples to verify the reliability of the production welding. Reject poor welding workmanship as noted by visual inspection.

- 4 Utilize Direct Tension Indicators conforming to **Section 709** for all bolted connections of chord and structure members. Conduct inspections of tightening of the bolts by the approved in-plant inspector or the SCDOT project inspector at the time of erection.
- 5 Install electrical outlets on the structure upright for connection of wiring from the upright to the lower chord member and at the bottom for mounting of an electrical control box. Install electrical outlets on the lower front chord member to provide connections to luminaires and to the vertical supports. Install outlets for the control box on the side of the upright farthest from the travel-way at a height of 5 feet to the lower outlet with the second outlet mounted 6¾ inches on center above it, measuring from the top of the base plate.
- 6 Provide adjustable brackets for mounting signs to the structures. Hinge the brackets at the top to permit mounting the sign faces at any angle between a truly vertical position and 3 degrees from vertical. Obtain the 3-degree angle by rotating the front lower edge of the sign behind the top edge. Use brackets lengths equal to the heights of the signs being supported. Provide two ¹³/₃₂-inch x 2-inch slotted holes, centered 1¹/₁₆ inches from the top and bottom of each hanger, for two direct connections using ³/₈-inch bolts between the hanger and the top and bottom bolt tracks on the sign panels so that the four corners of the sign are directly bolted to the sign hangers.

657.4.1.2 Maintenance Walkways

- 1 Provide maintenance walkways on all overhead structures unless specifically stated otherwise on the Plans or in the Specifications. Ensure that the walkways have a safety railing along the front side that can be folded to an unnoticeable position when not in use. To accommodate lighting fixtures, extend supports for the walkway in front of the walkway and railing.
- 2 Connect the walkway sections rigidly where sections join to avoid an uneven walking surface. Provide a 2½-foot wide walkway that extends across the entire width of the signs. On cantilever and sign bridge structures, extend the walkway over the shoulder of the roadway in conformance with the Plans and support it adequately at the end.
- 3 Construct the walkway to provide 1-foot vertical clearance between the walkway brackets and the bottom of the lowest sign served. Provide the following distances from the sign face to the walkway elements:
 - Safety Angle..... 6 inches.
 - Walkway, near edge..... 10 inches.
 - Walkway, far edge..... 3 feet 4 inches.
 - Safety Railing, raised..... 4 feet.

- Center of Luminaire..... 4 feet 9 inches.
- 4 Due to the variance in distances and location of the luminaire, use the recommendations of the luminaire manufacturer. Ensure that any deviations from these distances are approved by the Director of Traffic Engineering.
 - 5 Install a safety railing made of two steel angles at the back of and parallel to the walkway. Extend the railing the entire length of the walkway and design it to withstand a loading specified in **Subsection 657.1.2**.
 - 6 Fabricate the safety railing in 10-foot lengths and locate the two parallel rails at 1 foot 6 inches and 3 feet above the walkway grating. Join the railing post to each walkway support through a hinge assembly of appropriate design that rotates freely. Use a hinge assembly having a locking or latching device that can hold the railing in a steady manner, free of wobble, while in a raised position. Ensure that the maximum allowable displacement from vertical at the top of the railing is 1 inch.
 - 7 Ensure that the open ends of the walkway have a $\frac{3}{16}$ -inch galvanized steel coil safety chain of approximately 12 links per foot attached with $\frac{1}{4}$ -inch eyebolts on one end near the top of the safety rail and to the walkway support or other fixed member of the structure on the other end. Ensure that the chain does not hang below the walkway support when the railing is folded.

657.4.2 Location

657.4.2.1 General

- 1 Locate and erect overhead sign supports in conformance with the Plans. Obtain approval of the Director of Traffic Engineering for any major change in location before erection.

657.4.2.2 Orientation

- 1 Orient the face of overhead signs 3 degrees from vertical, the front bottom edge being forward of the front top edge, and at 90 degrees to oncoming traffic. On horizontal curves and just beyond curves, ensure that this 90-degree angle is measured from a line extending between the vertical centerline of the sign, or group of signs in the installation and an observation point on the center of the lane or lanes that the signs serve. Determine the observation point as specified for ground signs.

657.4.2.3 Vertical Clearances

- 1 Provide a clearance for the overhead signs of not less than 17.5 feet to the highest point of the roadway, over the entire width of the pavement and shoulders.

657.4.3 Erection

657.4.3.1 Placing Concrete

- 1 Use concrete foundations for all overhead sign supports, with the exception of structures attached to bridge overpasses or as noted on the Plans. Place, form, and finish concrete in accordance with **Sections 701 and 702**. Ensure

that foundations conform to the approved Shop Plans and are located as shown on the Plans.

- 2 Excavate foundations as nearly as possible to neat line. Form all sides of the footing or pour against firm soil or rock face. Always use forms in sandy soil or as directed by the RCE. Use forming for all concrete work above ground level and the top 4 inches of all concrete work. Provide necessary braces to keep anchor bolts and encased posts in the proper position and alignment, and in conformance to approved design for such foundations. Ensure that excavation work conforms to the requirements of **Section 204**.
- 3 Pour concrete flush with the ground surface. In case of sloping surface, level the top of the footing with the high side of the slope.
- 4 When forms are used, ensure that they conform to appropriate portions of the Specifications and that chamfer strips are used in all corners. Backfill around the foundations in 6-inch layers and thoroughly tamp each layer.
- 5 Finish the tops of all footings and pedestals for overhead sign supports smooth and truly horizontal with a steel trowel. Ensure that the formed sides of pedestals are truly vertical. Finish exposed concrete in conformance with **Section 702**.
- 6 If piles or cofferdams are required for construction of the footings, ensure that all work conforms to **Section 204**, the Plans, and/or the Special Provisions.
- 7 Install electric conduit in the footing of the structure on the side that is closest to the point where electric service is obtained unless otherwise noted in the Design Plans or Shop Plans. Use 2-inch galvanized steel conduit stubbed up 6 inches above the top of the footing pedestal. Ensure that the conduit enters the footing at a point 2 feet below ground level and is stubbed out 2 feet from the edge of the footing and capped off if unused.

657.4.3.2 Erecting Supports for Overhead Signs

- 1 Erect the supports for overhead signs as shown on the approved Shop Plans and as specified by the RCE. Erect cantilever structures by setting the upright without the cantilever arm attached. Rake the upright using the leveling nuts to allow for camber as detailed on the Shop Plans and tensioned before attachment of the arm. Either use a hydraulic wrench or the 1/3 turn-of-the-nut method to tension the anchor bolts as specified in **Section 709**. Have tightening of all anchor bolts verified by the SCDOT inspector.

657.4.3.3 Span-wire Sign Structures

- 1 Ensure that the span-wire sign structures are erected in conformity with the Plans and the Specifications. Provide structures consisting of two concrete or steel strain poles, strain cable, tether wire, and sign hangers. Ensure that the strain poles, cable, tether wire, and sign hangers conform to the Supplemental Specifications entitled:

- *Furnish and Install Steel Strain Pole,*
- *Furnish and Install Concrete Strain Pole, and*
- *Furnish and Install Steel Cable.*

Copies of the aforementioned Supplemental Specifications are available from the Director of Traffic Engineering.

- 2 Use sign hangers and tether clamps manufactured by Traffic Enterprises, Inc., Towson, Maryland, or an approved equal. Contact information for the aforementioned manufacturer is available from the Director of Traffic Engineering.
- 3 Provide footings for strain poles of either pre-cast or poured concrete of the pole manufacturer's design. Before erection of overhead span-wire structures, submit calculations and Shop Plans of the poles and foundations for review by the Director of Traffic Engineering.
- 4 Design span wire structures to have no more than 3% sag throughout the length of the span after loading.

657.4.4 Refurbishing Existing Overhead Sign Structures

- 1 At locations designated on the Plans, refurbish overhead sign structures, which requires the following:
 - Clean all damaged or rusty areas on the structures with a wire brush and repair the area with zinc-rich paint.
 - Inspect and replace damaged rusty or loose bolts on chord connections.
 - Replace damaged or rusty pipe outlet plugs.
 - Remove lock washers on anchor bolts and provide flat washers, if required.
 - Check torque on anchor bolts and tighten as required by the methods specified in **Section 709**.
 - Remove existing grout pads under the structure base plates.

Perform the aforementioned items as a minimum and additional items, if required, on the Plans or in the Special Provisions.

657.4.5 Modification of Existing Overhead Sign Structures

- 1 Modify existing overhead sign structures as detailed on the Plans and specified in the Special Provisions. Verify all dimensions and quantities before beginning work at locations on the Plans where existing overhead structures are modified. If available, existing structure Shop Plans and calculations will be provided with the Plans for reference. Prepare required structural modification design and drawings in accordance with the requirements for new overhead sign structure. Submit structural modification design and drawings for review and acceptance by the Director of Traffic Engineering before beginning work.

657.4.6 Removal of Existing Overhead Sign Structures

- 1 Where existing overhead sign structures are designated on the Plans for removal, either remove the entire footing or remove the pedestal to a depth of 2 feet below the ground line. The removed structure becomes the property of the Contractor. Remove it and any debris from the removal operation from the site.

657.4.7 Sign Lighting Systems

- 1 Install sign lighting systems on existing or new overhead sign structures as indicated on the Plans and specified in the Special Provisions. Perform the work in conformance with the Supplemental Specification entitled *Sign Lighting Systems*. Submit six copies of catalog cuts, photometric layouts, and schematic for the system to the Director of Traffic Engineering for review and approval before beginning work.

657.5 Measurement

- 1 The quantity for the pay item Overhead Sign Structure No. (XX) is measured by each (EA) new overhead sign structure erected, complete and accepted. If required, cofferdams and piles are measured in accordance with **Subsections 204.5 and 711.5**, respectively.
- 2 The quantity for the pay item Refurbish Overhead Sign Structure No. (XX) is measured by each (EA) existing overhead sign structure refurbished, complete and accepted.
- 3 The quantity for pay item Modification of Overhead Sign Structure No. (XX) is measured by each (EA) existing overhead structure modified, complete and accepted.
- 4 The quantity for the pay item Removal of Overhead Sign Structure No. (XX) is measured by each (EA) existing overhead sign structure removed, complete, and accepted. The removal of the foundation(s) and the existing sign panel(s) (whether multiple panel or flat sheet) are not measured separately, but are considered to be included the contract unit bid price for the removal of each overhead sign structure.
- 5 The quantity for the pay item Sign Lighting System No. (XX) is measured by each (EA) sign lighting system installed, complete and accepted.
- 6 Span-wire sign structures are measured as specified in the Supplemental Specifications in **Subsection 657.4.3.3**.

657.6 Payment

- 1 Payment for the accept quantity of each pay item, measured in accordance with **Subsection 657.5**, is determined using the contract unit bid price for the applicable item and includes all direct and indirect costs and expenses necessary to fulfill the requirements of the pay item in an acceptable manner.
- 2 Payment for Overhead Sign Structure No. (XX) is full compensation for the construction of the overhead sign structure as specified or directed and in-

cludes preparing the structural and electrical designs; providing design checks and certification; preparing Shop Plans and Working Drawings; obtaining subsurface data where required; excavating and backfilling foundations; constructing foundations, columns, supporting member for the signs, appurtenances, walkways, safety railings, and lighting fixture supports; providing wiring outlets, sign brackets, braces, and hardware; reshaping and seeding of disturbed area as necessary; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

- 3 If required, the cofferdams and piles are paid for in accordance with **Subsections 204.6** and **711.6** respectively.
- 4 Payment for Refurbish Overhead Sign Structure No. (XX) is full compensation for refurbishing the overhead sign support as specified or directed to the satisfaction of the RCE and includes inspecting the existing sign structure to determine extent of repair required; repairing or replacing damaged parts, removing and disposing of replaced parts; removing of grout pads; tightening anchor bolts; removing rust and repainting as necessary; and all other materials, labor, tools, equipment, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 5 Payment for Modification of Overhead Sign Structure No. (XX) is full compensation for modifying the overhead sign structure as specified or directed to the satisfaction of the RCE and includes preparing the structural and electrical designs; providing design checks and certification; preparing Shop Plans and Working Drawings; providing new or additional hardware, members, or parts; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 6 Payment for Removal of Overhead Sign Structure No. (XX) is full compensation for removing the overhead sign structure as specified or directed and includes removing and disposing of the existing foundation(s), overhead structure, and existing sign(s) (whether multiple panel or flat sheet) as directed, excavating and backfilling as required; reshaping and seeding of disturbed area as necessary; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 7 Payment for Sign Lighting System No. (XX) is full compensation for providing and installing the sign lighting system as specified or directed and includes preparing Shop Plans and Working Drawings; providing material submittals, luminaires, conduits, wiring, electrical cabinets and enclosures; trenching for conduits; providing power poles; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifica-

tions, and other terms of the Contract.

8 Span-wire sign structures are paid for as specified in the Supplemental Specifications in **Subsection 657.4.3.3**.

9 Pay items under this section includes the following:

Item No.	Pay Item	Unit
6573100	Overhead Sign Structure No. (XX)	EA
6573105	Modification of Overhead Sign Structure No. (XX)	EA
6573106	Refurbish Overhead Sign Structure No. (XX)	EA
6573115	Removal of Overhead Sign Structure No. (XX)	EA
6573200	Sign Lighting System No. (XX)	EA

SECTION 658 THROUGH SECTION 669

SECTIONS NOT USED

SECTION 670

PERMANENT TERMINAL IMPACT ATTENUATOR

670.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for furnishing, assembling, and installing permanent terminal impact attenuators on or adjacent to the roadways to protect the ends of concrete barrier walls and other hazards.
- 2 The function of the impact attenuator is to control the deceleration of an impacting vehicle and dissipate the vehicle's kinetic energy. When struck from the front, the unit must bring the errant vehicle to a safe and controlled stop. When impacted from the side, the unit must redirect the errant vehicle. Ensure that each impact attenuator functions within the requirements detailed by these specifications and the manufacturer's specifications.

670.2 Materials

670.2.1 General

- 1 Provide permanent impact attenuators meeting the requirements of this specification and approved in writing by the Director of Traffic Engineering
- 2 Provide impact attenuators that are 24, 30, 36, 69, or 90 inches wide and contain the number of bays specified in the Plans and/or the Special Provisions.
- 3 Prepare Shop Plans and furnish detailed specifications from the manufacturer to RCE and the Director of Traffic Engineering for approval before installation of the attenuator. Ensure that the Shop Plans and specifications include installation drawings, and instructions that completely describe the attenuator system. Make certain Shop Plan submittals conform to the requirements of **Subsection 725.1.2**.

670.2.2 Types of Impact Attenuators

670.2.2.1 Cartridge Type

- 1 The major performance components of this type of attenuator are the expendable individual cartridge units. Provide new cartridge units. Do not use cartridges exhibiting improper openings, gaps, or wrinkles in the plastic container package, creases in the plastic, or exposed internal material. Do not attempt to repair the defective cartridges with rivets, screws, etc. Do not allow such defective cartridges on the project site. Replace all defective cartridges before installation of the unit.

670.2.2.2 Mechanical Type

- 1 The major performance components of this type of attenuator are the mechanical parts, pieces, and systems working together to absorb and dissipate the energy. Provide new energy-absorbing units. Replace all defective parts

before installation of the unit.

670.2.3 Nose Assemblies

- 1 Provide yellow nose assemblies. Supplement the nose assembly of each attenuator with road signs, OM-3.8C-24, OM-3.8R-24, or OM-3.8L-24 for delineation of the approach end of the unit. Ensure that the signs conform to the requirements in the *SCDOT Standard Drawings*.

670.2.4 Performance Requirements

- 1 Ensure that the impact attenuator meets the test requirements for the *NCHRP Report 350* for re-directive, non-gating terminals and crash cushions as specified by the FHWA. Make certain that the impact attenuator has FHWA approval for use.
- 2 Ensure that the design, selection, and placement of the permanent impact attenuator is in conformance with the requirements in the following publications:
 - *AASHTO Roadside Design Guide*, and
 - *FHWA Report N5040.16, Crash Cushions, Selection Criteria, and Design*.
- 3 Require that the attenuator has the capability to decelerate and stop vehicles weighing 1800 to 4400 pounds during head-on impacts. Ensure that the attenuator meets the occupant risk and vehicle trajectory criteria as required by the *NCHRP Report 350*, Tests 30, 31, 32, and 33. Require the attenuator pass Test 31 to evaluate the capacity of the unit to absorb the energy of the 4400-pound standard $\frac{3}{4}$ -ton pickup truck.
- 4 Ensure that the attenuator has the capability to redirect vehicles weighing 1800 to 4400 pounds that impact the unit along the side at angles of 20 degrees or less for both right-way and wrong-way impacts. Measure all angles from the longitudinal centerline of the unit for impact angle determination. Ensure that the attenuator meets the requirements of the *NCHRP Report 350*, Tests 36, 37, 38, and 39. Use these tests to evaluate the occupant risk and vehicle trajectory criteria, re-directional capability, the structural adequacy of the attenuator, the potential for snagging, and performance during a reverse hit.
- 5 Make certain that all test result data for 4400-pound vehicles includes the standard $\frac{3}{4}$ -ton pickup truck.
- 6 Ensure that the attenuator retains the debris from an impact within design parameters to prevent posing a potential hazard to the vehicle occupants, other traffic, pedestrians, or workers present in the immediate area.
- 7 Ensure that the attenuator prevents penetration of the last 4 feet of the attenuator in front of the hazard, referred to as the "coffin corner," in all impacts from 0 miles per hour up to the maximum design speeds of the unit for vehicles in the weight range of 1800 to 4400 pounds. Ensure that the attenuator prevents lateral penetration with a subsequent impact against the sta-

tionary hazard at or near the "coffin corner."

670.2.5 Anchor System

- 1 Provide an anchor system conforming to the requirements of these specifications and the manufacturer's specifications.
- 2 Use a grout for the impact attenuator anchor systems that is a two-part polyester epoxy either recommended or manufactured by the supplier.

670.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

670.4 Construction

670.4.1 Site Preparation

- 1 Clear all obstructions from the immediate site location. Ensure that the immediate surrounding area and the approach area for 50 feet in advance of the system is free of curbs, islands, elevated objects, and depressions. Dress and clear the area where possible. Ensure that approach areas in advance of the site location are reasonably smooth and flat for not less than 100 feet. Grade unpaved approach areas where necessary to provide smooth and flat surfaces.
- 2 Each site location may require preparations such as grading, slope flattening, and excavation and construction of a concrete pad. Ensure that the immediate site location of the permanent impact attenuator is at the same grade elevation, including adjustments necessary for superelevation, as the adjacent travel lane or paved shoulder. Any location that exceeds a cross slope of 8% or has a variance in excess of 2% will require one or more of the abovementioned site preparations.

670.4.2 Assembly and Installation

- 1 Assemble and install the impact attenuator in conformance with these specifications, the manufacturer's specifications, the Special Provisions, the Plans, and as directed by the RCE.
- 2 The RCE will inspect each impact attenuator, including all parts and materials, before and immediately after installation to ensure conformance with the Department specifications and the manufacturer's specifications.
- 3 A site location within a two-way traffic situation will require utilization of an approved transition panel. Place the impact attenuator on the site location to minimize exposure of the rear of the unit to opposing traffic and the possibility of a vehicle snagging the rear of the unit. Drill each transition panel to permit attachment to the hazard or existing guardrail and to the attenuator. Attach the panel to the unit beneath the adjacent fender panel to permit the adjacent

forward set of fender panels to move over the transition panel during an impact from the front. Install the panel flat and securely against the side of the hazard to prevent snagging by vehicles as required by these specifications and as directed by the manufacturer's specifications.

670.4.3 Anchor System

- 1 Anchor the impact attenuator onto a concrete foundation constructed in accordance with the manufacturer's specifications. Ensure that the top of each foundation is at the same grade elevation as the adjacent travel lane and/or paved shoulder. Construct the foundation to be compatible with the anchor system.
- 2 Install the anchor system in conformance with the requirements of these specifications and the manufacturer's specifications

670.5 Measurement

- 1 The quantity for the pay item Permanent Terminal Impact Attenuator is measured by each (EA) permanent terminal impact attenuator furnished, assembled, and installed, complete and accepted.

670.6 Payment

- 1 Payment for the accepted quantity for Permanent Terminal Impact Attenuator, measured in accordance with **Subsection 670.5**, is determined using the contract unit bid price for the item. Payment is full compensation for furnishing, assembling, and installing the attenuator as specified or directed and includes preparing the site location; grading and flattening slopes if required; excavating for and constructing a concrete pad for the attenuator; providing and installing anchoring system; grouting anchors if required; connecting the attenuator to guardrail or concrete barrier where required; furnishing and installing transition panel if necessary; and all structural backing systems; and all other materials, labor, equipment, tools, supplies, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for this item includes all direct and indirect costs and expenses required to complete the work.
- 3 Pay items under this section includes the following:

Item No.	Pay Item	Unit
6700000	Permanent Terminal Impact Attenuator	EA

DIVISION 700

STRUCTURES

SECTION 701

PORTLAND CEMENT AND PORTLAND CEMENT CONCRETE

701.1 Description

- 1 This section contains specifications for the materials, construction, measurement, and payment for furnishing, storing, and handling of the materials; and the proportioning, mixing, and delivery of Portland cement concrete for structures.

701.1.1 Classes of Concrete

- 1 Classes of concrete typically used by the Department are listed in the Structural Concrete Table in **Subsection 701.2.12.2**. The numerical portion of the Class is the minimum 28-day mix design strength based on ASTM C 39.

701.2 Materials

701.2.1 Portland Cement

701.2.1.1 General

- 1 Use Portland cement conforming to the requirements of the following specifications for the type required or permitted and obtained from a source listed on the most recent edition of *SCDOT Qualified Product List 6* with the additional requirements stated hereafter.
- 2 Use Portland cement concrete for structures composed of Portland cement, fine aggregate, coarse aggregate, water, air-entraining admixture, and other permitted or required admixtures. Fly ash, water granulated blast-furnace slag, and silica fume may be added or used as a replacement for a portion of the Portland cement and is considered as cement in the water-cementitious material ratio unless otherwise designated. Ensure that the materials conform to the requirements hereinafter specified. Prepare and deliver the mixture in accordance with these specifications.
- 3 Comply with compressive strength requirements and meet the requirements for low-alkali cement (0.6 maximum).
- 4 Except for cement in RC pipe and prestressed or precast products, use cement complying with the maximum limits of fineness of grind in AASHTO M 85 controlled as follows:
 - A. Ensure that the cement in the mill test reports furnished by the manufacturer complies with the maximum fineness (air permeability test) values stated in AASHTO M 85.

B. Take job control samples at random at the project site and submit them to the OMR for testing. Make certain that the maximum fineness limit (air permeability test) is in conformance with the requirements of AASHTO M 85 with allowance for variations in sampling, presence of moisture in the sample, age of the cement production, and multi-laboratory coefficient of variation.

5 Type I (SM) slag-modified Portland cement may be used instead of Type I and Type II cement. If used, furnish Type I (SM) cement conforming to the requirements of AASHTO M 240 and obtain from the sources listed on the most recent edition of *SCDOT Qualified Product List 18*. Provide an intimate and uniform blend of Portland cement and granulated blast-furnace slag. In any case, make certain that the slag constituent is less than 25% of the total weight of the slag-modified Portland cement.

6 Furnish certified mill test reports to the RCE as outlined in the most recent edition of *SCDOT Qualified Product Policy 6*.

7 Do not store incompatible brands of cement or different types of cement in the same cement storage bin or silo and do not use them together in any continuous pour.

8 Have the weighing and handling procedures of bulk cement approved by the OMR before its use. Protect cement shipments at all times. Inspect, sample, and test questionable cement before its use. Do not use cement that is lumpy, caked, or from open or otherwise damaged bags.

9 Measure cement by weight or by the bag as packed by the manufacturer. Unless another weight is indicated on the bag, use 94 pounds as the weight of one bag of cement.

10 Whenever it is determined by subsequent laboratory testing of mill or job control samples that a cement shipment does not comply with these specifications, discontinue use of the cement from that cement mill until testing reveals that the problem has been corrected. The Contractor is responsible for replacing or otherwise making satisfactory the concrete in which any defective cement is used.

701.2.2 Fly Ash

1 Use fly ash (Type C or Type F) conforming to the requirements of AASHTO M 295, except for the supplementary optional physical requirements. Use fly ash from sources listed on the most recent edition of *SCDOT Qualified Product List 3*.

701.2.3 Water Granulated Blast-Furnace Slag

1 If slag is used, use water granulated blast-furnace slag Class 100 or higher conforming to the requirements of ASTM C 989.

701.2.4 Silica Fume

- 1 Use silica fume meeting the general requirements of ASTM C 1240. Make certain that the raw silica fume meets the chemical requirements of Table 1 and Table 2 and the physical requirements of Table 3 in ASTM C 1240. Furnish the manufacturer's certification stating the results of tests made on samples of silica fume during production and that the applicable requirements of ASTM C 1240 have been met. Provide certification for each lot of each shipment to the RCE and to the OMR.
- 2 Silica fume may be added to the mix in either a dry (densified) form or a wet (slurry) form. The dry form is usually supplied in 50-pound bags. When a dry form is used, adjust the mix design to use whole bags of silica fume, i.e. do not use partial bag(s). Whole bags of silica fume in excess of the normal 50-pound bag and whole bags as small as 40 pounds are permitted only if approved by the RCE. Make certain that the guidelines of OSHA regulations for worker protection are followed.
- 3 When a wet (slurry) form is used, compute the water contained in the slurry and count it as part of the total water in the mix. Ensure that this data is in accordance with the manufacturer's certified quality test report for the lots of silica fume being used in the mix.

701.2.5 Air Entrained Concrete

- 1 Unless otherwise specified, use a design mix for air-entrained concrete based on 4.5% ($\pm 1.5\%$) entrained air, except for prestressed concrete. If the concrete is pumped, then the entrained air will be acceptable at 5.5% ($\pm 1.5\%$) measured at the truck.
- 2 Do not use air entrainment exceeding the maximum limits specified in the paragraph above. Air entrainment for Class 10000 concrete is left to the judgment of the Contractor and approval of the OMR.
- 3 Use air entrained concrete in all bridge columns, bent or pier caps, decks, sidewalks, parapets, barrier walls, and other structural elements on the bridge deck regardless of the class of concrete used.
- 4 When air-entrainment is used, vary the proportions of water, fine aggregate, and coarse aggregate from those specified herein to maintain the specified strength of the concrete. Use approved admixture specified in **Subsection 701.2.5.1** to obtain the required air entrainment.

701.2.5.1 Air-Entraining Admixtures

- 1 When air entrainment is required, use air-entraining admixtures complying with AASHTO M 154. Submit an affidavit to the RCE and the OMR to show that the admixture conforms to the requirements of AASHTO M 154. Use admixtures from sources appearing on the most recent edition of *SCDOT Qualified Product List 5*.

701.2.6 Accelerating, Retarding, and Water-Reducing Admixtures

- 1 If the use of a chemical admixture to facilitate concrete placement in adverse conditions is desired, the use of an admixture complying with AASHTO M 194 must be approved by the RCE before its use. The RCE may direct the use of an admixture due to adverse placement conditions.
- 2 When a retarding admixture is desired and approved, use a Type G high range water reducing-retarding admixture or a Type D water reducer-retarder combined with a Type F high range water reducer as provided in **Subsections 701.4.7 and 701.4.8**. Do not use a Type B retarding admixture. Furnish the RCE with an affidavit showing that the admixtures conform to the requirements of AASHTO M 194. Use admixtures from sources appearing on the most recent edition of *SCDOT Qualified Product List 5*.

701.2.7 Corrosion Inhibitor

- 1 When a corrosion inhibitor is required in a concrete mix, add the corrosion inhibitor to the concrete while batching. Use the corrosion inhibitors that appear on the most recent edition of *SCDOT Qualified Product List 53*. Adhere to the manufacturer's written recommendations regarding the use of the admixture including storage, transportation, and method of mixing. Add the corrosion inhibitor to the mix by a dispenser meeting the requirements of **Subsection 701.4.3.4**.
- 2 Furnish the RCE a copy of the manufacturer's certified test report showing the composition of the corrosion inhibitor and the percent of solids.

701.2.8 Calcium Chloride

- 1 If calcium chloride is approved by the RCE for use in non-reinforced concrete during cold weather work, do not exceed a rate of 2% by weight of cementitious material. Use calcium chloride complying with the requirements of AASHTO M 144 for Type S or Type L. In any case, do not use calcium chloride in reinforced concrete structures.

701.2.9 Fine Aggregate for Portland Cement Concrete

701.2.9.1 General

- 1 Submit the fine aggregate in the concrete mix designs for approval by the OMR. Use natural sand, manufactured sand, or a combination of natural and manufactured sand meeting the requirements of **Subsections 701.2.9.2 through 701.2.9.8** below. Do not use marine limestone aggregate in reinforced concrete.

701.2.9.2 Natural Sand

- 1 Use natural sand, FA-10, composed of clean, hard, durable, and uncoated grains that is free of lumps or flaky particles, organic matter, loam, or other deleterious substances.

701.2.9.3 Manufactured Sand

- 1 Use manufactured sand, FA-10M, made from stone meeting all the quality requirements for coarse aggregates.

701.2.9.4 Mixtures of Sand

- 1 When a blend of sands is approved, store and batch the two materials separately unless otherwise approved in writing by the OMR.

701.2.9.5 Organic Impurities

- 1 Make certain that fine aggregate is free of injurious amounts of organic impurities. Do not use fine aggregates, which when subjected to the colorimetric test, AASHTO T 21 for organic impurities, produces a color darker than 3, unless the following criteria is met:
 - Fine aggregate with the color darker than 3 may be used if the relative strength at 7 and 28 days is not less than 95% when tested in accordance with AASHTO T 71 as revised herein.
- 2 Comply with Section 4.2 of AASHTO T 71 revised as follows:
 - Mix one batch of mortar with the aggregate treated in sodium hydroxide and one batch with untreated aggregate on the same day. Mold six 2-inch cubes from each batch. Test three of the cubes from each batch at 7 days and 28 days.

701.2.9.6 Soundness

- 1 Use fine aggregate that has a weighted loss not exceeding 10% by weight when subjected to five alternations of the sodium sulfate soundness test conducted according to AASHTO T 104.

701.2.9.7 Approved Sources

- 1 Use sand from sources that appear on the most recent edition of *SCDOT Qualified Product List 1*.

701.2.9.8 Gradation of Fine Aggregate

- 1 Use fine aggregate for all classes of Portland cement concrete and concrete pavement conforming to the following gradations of FA-10 or FA-10M as indicated in Gradation of Fine Aggregate table in the Appendix of these specifications.

701.2.10 Coarse Aggregate**701.2.10.1 General**

- 1 Use coarse aggregate that is clean, tough, durable crushed gravel or crushed stone. Make certain that it is free from soft, thin, elongated, or laminated pieces and sufficiently washed during production to produce a clean aggregate free from lumps or coatings of clay, disintegrated particles, vegetation, or deleterious substances. Adherent coatings are considered injurious. Do not use coarse aggregate with a Los Angeles Abrasion Loss exceeding 60% as determined by AASHTO T 96. Use coarse aggregate that has a

weighted loss not exceeding 15% when subjected to five alternations of the sodium sulfate soundness test conducted according to AASHTO T 104. Use coarse aggregate for Portland cement concrete conforming to the requirements in **Subsections 701.2.10.2 through 701.2.10.4.**

- 2 Use aggregate from marine limestone quarries only in applications of non-reinforced concrete. Use marine limestone coarse aggregate that has a weighted loss not exceeding 25% when subjected to five alternations of the sodium sulfate soundness test conducted according to AASHTO T 104. When marine limestone aggregate is used, use a sprinkler system to produce a saturated aggregate during concrete batching.

701.2.10.2 Slag

- 1 Use crushed slag or other inert materials having similar characteristics and approved in writing by the OMR, consisting of clean, tough, durable pieces of approved slag or other inert materials, is reasonably uniform in density and quality, and is reasonably free of thin or elongated pieces. Ensure that the slag or other inert material is air-cooled and has a weight of not less than 75 pounds per cubic foot. Do not use crushed slag with a Los Angeles Abrasion Loss exceeding 40% as determined by AASHTO T 96. Do not use slag containing free lime in deleterious quantities as determined by laboratory tests and containing more than 15% by weight of glassy pieces.

701.2.10.3 Approved Sources

- 1 Use coarse aggregate from sources listed on the most recent edition of *SCDOT Qualified Product List 2* and approved for use with Portland cement concrete.

701.2.10.4 Gradation of Coarse Aggregate

- 1 Use Aggregate No. 56, No. 57, or No. 67 as coarse aggregate for Portland cement concrete. Aggregate No. 78 may be used in thin sections and prestressed panels when approved in writing by the OMR. Use only Aggregate No. 67 in prestressed concrete. Do not use blends of aggregate other than Aggregate No. 67, except when approved in writing by the OMR. Use gradation requirements for Aggregate No. 56, No. 57, No. 67, and No. 789 as indicated in the table entitled Gradation of Coarse Aggregates, in the Appendix of these specifications.

701.2.11 Water

701.2.11.1 General

- 1 Make certain that water used in mixing, fogging, or curing of Portland cement concrete is free of salt, oil, acid, alkali, organic matter, sewage, or other substances injurious to the finished product. The RCE in consultation with the SME will be the sole judge in determining whether the water used in mixing, fogging, or curing of Portland cement concrete is reasonably free of salt, oil, acid, alkali, organic matter, sewage, or other substances injurious to the finished product. If at any time, the water is found to be unacceptable by the RCE, discontinue its

use and provide approved water at no additional cost to the Department.

- 2 Conduct tests using the services of a laboratory that has an equipment calibration and verification system, technician training, and an evaluation process in conformance with AASHTO R 18 or, for Chemical Testing, has otherwise been approved by the SCDHEC for the tests being conducted. Supply AASHTO R 18 documentation to the SME for review and acceptance before using a non-SCDHEC approved laboratory. Keep all laboratory test results on file at the concrete plant, and ensure that all reports are readily available to the RCE and the SME. Conduct testing at no additional cost to the Department.

701.2.11.2 Water from a Public Water Supply

- 1 Water from a public water supply may be accepted and approved without being tested.

701.2.11.3 Water from Sources Other than a Public Water Supply

- 1 Do not use water from sources other than a public water supply until tested and approved by the RCE. Do not use wash water in structural concrete or other applications using reinforcing steel.
- 2 For water sources of questionable water quality, except for wash water recycling sources, make a comparison of the water with distilled or other satisfactory water by means of the standard cement test for soundness, time of setting, and 1:3 mortar strength with standard sand conforming to ASTM C 778 using the same cement with each water. Reject the water being tested if there is any indication of unsoundness, change in time of setting of ± 30 minutes, or a reduction of more than 10% in strength from 7 day test results obtained with mixtures containing satisfactory water.
- 3 When required by the SME, determine the acidity or alkalinity of the water in accordance with AASHTO T 26. In the event an approved water source reservoir is relatively shallow, enclose the intake pipe and elevate it to exclude silt, mud, grass, or other foreign matter.
- 4 Water from washout operations or is a blend of concrete wash water and other acceptable water sources is certified by the concrete producer as complying with the requirements of AASHTO M 157, Table 2 (Level 3 – conventionally reinforced concrete in a moist environment, but not exposed to chloride) and either AASHTO M 157, Table 1 (using mortar) or the table below entitled Acceptance Criteria for Questionable Water Supplies (Using Concrete), may be used as mix water. Wash water from mixer washout may be used only with RCE approval. When wash water is permitted, provide satisfactory proof or data that no detrimental effects if potentially reactive aggregates are used. Discontinue use of wash water if undesirable reaction with admixtures or aggregates occurs. Test the wash water or blended water weekly for 4 weeks for compliance with the chemical and physical requirements indicated above. Conduct subsequent tests on the water every month with records of test results provided upon request by the RCE or the OMR.

701.2.11.3

701.2.12.1

- 5 In addition, do not allow the specific gravity of the mixing water sampled from the discharge line to exceed 1.03 at any time concrete is being produced for the Department. Check the specific gravity by acceptable means and document the value before commencing the batching operation for use in work for the Department.
- 6 Use the following table to determine acceptance of water.

Acceptance Criteria for Questionable Water Supplies (Using Concrete)		
Criteria	Limits	Test Method ⁽¹⁾
Compressive Strength, min. percent Control at 7 days	90	AASHTO T 22 (ASTM C 39)
Time of Set, Deviation from Control	From 1:00 hr. earlier to 1:30 hr later	AASHTO T 197 (ASTM C 403)
⁽¹⁾ Base comparison on fixed proportions and the same volume of test water compared to control mix using public water or distilled water.		

701.2.12 Concrete Mix Design

701.2.12.1 General

- 1 Design the concrete mix and determine the proportions of cementitious material, fine aggregate, coarse aggregate, water, air-entraining admixture, and water-reducing or water-reducing set retarding admixture (when used) that produces a workable concrete mix. Meet the criteria for the typical classes of concrete shown in the Structural Concrete Table in **Subsection 701.2.12.2**. Consider the amount of air-entrainment that is incidentally afforded by the use of water-reducing or water-reducing/retarding admixtures. Determine the proportions of ingredients in accordance with requirements for the particular type of work and with consideration of the specific gravities of the materials to provide the desired workability and consistency.
- 2 At its own expense, the Contractor may retain an independent testing laboratory accredited by the AASHTO Accreditation Program to design the mix for the class of concrete specified, or use a mix design previously reviewed and used by the Department.
- 3 Submit all design mixes to the OMR for review using standard forms approved by the SME. After successful review by the OMR, provide a copy of all concrete designs to the RCE.
- 4 For the water-cementitious material ratio, use the ratio of water to cementitious materials by weight.
- 5 Design the concrete mix using Department approved ingredients intended for use in the project and make all trial batches using such materials. Test trial mixes for complete conformance with the Specifications by the approved laboratory engaged by the Contractor.

701.2.12.1

701.2.12.2

- 6 Base mix designs on the air entrainment specifications in **Subsection 701.2.5.**
- 7 Base the total water content of the mix on the weight of cement, fly ash, and silica fume multiplied by the water-cementitious ratio. Do not include the absorbed water in the aggregate as mix water.
- 8 Base mix designs on specific gravities and saturated surface dry moisture contents of aggregate obtained from a source on the most recent edition of *SCDOT Qualified Product List 2.*
- 9 Base the sand to stone ratio on volume. Vary the ratio to obtain good workability.
- 10 No separate payment is made for the cost of the laboratory engaged by the Contractor, the materials furnished and used for trial batches, the preparation and testing of trial batches either by the Contractor or its laboratory, or furnishing the OMR with the mix data, the results of the cylinder tests, and yield to be tested. These costs are considered incidental to the work of the applicable item. Include the cost in the unit prices for the applicable pay items in the Contract.
- 11 After successful review of a design mix by OMR, do not change the mix proportions for concrete of that class unless modifications are necessary and are approved in advance.

701.2.12.2 Structural Concrete Table

- 1 Unless otherwise noted or directed, make certain that the properties of the various classes of concrete incorporated into the work conform to the following Structural Concrete Table. Compressive strength is based on ASTM C 39.

Structural Concrete Table					
Aggregate Type	Minimum Cement Content (lbs./CY)	Other Cementitious Material (lbs./CY)	Min. 28 Day Mix Design (psi)	Percent Fine to Coarse Aggregate Ratio	Max. Water to Cementitious Material Ratio
Class 2500 (Non Structural)					
Crushed stone	494	--	2500	36:64	0.54
Gravel	494	--	2500	35:65	0.52
Marine Limestone	494	--	2500	40:60	0.56

(table continued on the next page)

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Structural Concrete Table					
Aggregate Type	Minimum Cement Content (lbs./CY)	Other Cementitious Material (lbs./CY)	Min. 28 Day Mix Design (psi)	Percent Fine to Coarse Aggregate Ratio	Max. Water to Cementitious Material Ratio
Class 3000					
Crushed stone	588	--	3000	35:65	0.46
Gravel	588	--	3000	34:66	0.44
Marine Limestone	588	--	3000	39:61	0.47
Class 4000					
Crushed stone	611	--	4000	35:65	0.40
Gravel	611	--	4000	34:66	0.40
Class 4000S					
Crushed stone	682	--	4000	38:62	0.45
Gravel	682	--	4000	38:62	0.45
Class 4000DS (See Notes 2 & 4)					
Crushed stone	625	--	4000	40:60	0.44
Gravel	625	--	4000	39:61	0.43
Class 4000P (See Note 5)					
Crushed stone	682	--	4000	34:66	0.43
Gravel	682	--	4000	33:67	0.38
Class 5000					
Crushed stone	705	--	5000	35:65	0.46
Gravel	705	--	5000	34:66	0.42

(table continued on the next page)

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Structural Concrete Table					
Aggregate Type	Minimum Cement Content (lbs./CY)	Other Cementitious Material (lbs./CY)	Min. 28 Day Mix Design (psi)	Percent Fine to Coarse Aggregate Ratio	Max. Water to Cementitious Material Ratio
Class 6000					
Crushed stone	750	--	6000	34:66	0.44
Gravel	750	--	6000	33:67	0.39
Class 6500 (See Notes 1 & 3)					
Crushed stone	500	CF35, FA140	4000	37:63	0.37
Gravel	500	CF35, FA140	4000	38.62	0.37
Class 7000					
Crushed stone	800	---	7000	35:65	0.37
Gravel	800	---	7000	34:66	0.37
Class 8000					
Crushed Stone	840	---	8000	34:66	0.30
Gravel	840	---	8000	34:66	0.30
Class 10000					
Crushed stone, or Gravel	800	Silica Fume: 74 & Fly Ash, Type F: 100	10000	34:66	0.25

701.2.12.3 Structural Concrete Table Notes**1 Note 1:**

Provide a mix design that yields a 56-day minimum laboratory strength of 6500 psi. Acceptance of in-place concrete is based on a minimum strength of 4000 psi compression strength at a maximum of 28 days or 6500 psi at 56 days.

2 **Note 2:**

Use Type G or Type D admixture.

3 **Note 3:**

Use the following proportions for Class 6500 concrete mix per cubic yard:

Cement (min.).....	500 lbs.
Fly Ash.....	140 lbs.
Silica Fume.....	35 lbs.
Corrosion Inhibitor.....	(see Subsection 701.2.7)
Entrained Air (Range).....	4.5 (± 1.5)%
Water-Cementitious Material Ratio (max.)...	0.37
High Range Water Reducer.....	Required
Aggregates.....	Variable

4 If a Type A or Type D admixture is used, demonstrate that the admixture is compatible, does not adversely extend normal setting time, and does not cause excessive bleeding.

5 The slump of the concrete at time of placement in the forms may be increased by the use of a High Range Water Reducer, either Type F or Type G in accordance with the requirements of **Subsection 701.2.6**.

6 If silica fume slurry is used, add it at a point that produces an acceptable mix.

7 Add a High Range Water Reducer at the job site. Limit additional mixing to the minimum specified in accordance with **Subsection 701.4.7**, but it may be increased in order to obtain the necessary air entrainment.

8 Concrete Temperature: Do not allow the temperature of Class 6500 concrete to exceed the maximum permitted in **Subsection 701.4.4.3**.

9 Mix Design Review: Submit to the OMR a proposed sequence of mixing and a proposed concrete mix design based on trial mixes by the concrete supplier. Perform the laboratory mix design with the observation and assistance from the OMR. There is no separate payment for this mix design.

10 Class 6500 Trial Mix: Before placing Class 6500 concrete in the deck, place one or more small batches of Class 6500 concrete in a part of the structure as directed by the RCE. Test air content, slump, unit weight, temperature, cylinder for 28-day compressive strength, and time of set. Repeat the trial batch procedure until all desired mix properties are achieved.

11 No payment is made for the trial batches. The Class 6500 concrete used in trial batches may be substituted for another class of concrete elsewhere in the project if it meets proper strength requirements, and in which case, it is paid for at the contract unit price of the concrete for which it is being substituted.

- 12 Mixing Sequence: Develop a proposed mixing sequence for review that ensures breakup and distribution of the dry densified silica fume. (Generally, the addition of part of the water, aggregates, and silica fume at mixing speed adequately disperses the silica fume. The remaining ingredients may then be added in a sequence to produce a desirable mix.)
- 13 Include both silica fume and fly ash as part of the cementitious material.
- 14 **Note 4:**
Use Class 4000DS concrete for drilled shaft construction.
- 15 Design the mix for drilled shaft concrete and determine the proportions of cement, fine aggregate, coarse aggregate, water, and water reducing/retarding admixture that produces a workable concrete mix meeting the following criteria:
- Minimum cement per cubic yard.....625 lbs.
 - Slump.....7-9 inches
 - Max. water/cementitious ratio.....(see Table)
 - 28-day minimum compressive strength.....4000 psi
 - Air entraining admixture.....not required
 - Nominal coarse aggregate size..... ¾ inch
 - No. 67 aggregate gradation.....as required
- 16 Design concrete mix using approved ingredients intended for use on the project. Test trial mix for complete conformance with the Specifications.
- 17 Submit the proposed mix with test results showing full compliance with the Specifications to the OMR for review.
- 18 A Type G High-Range Water Reducing/Retarding admixture or a Type D Water Reducer-Retarder combined with a Type F High-Range Water Reducer may be used.
- 19 **Note 5:**
Minimum Class 4000P concrete is preferred in non-prestressed precast items.

701.2.12.4 Non-conforming Concrete

701.2.12.4.1 Price Reduction

- 1 If the 28-day compressive strength or tensile strength of the concrete test cylinders falls below the expected design strengths, but is at least 90% of the design strength, a price reduction is applied on the quantity of concrete represented by the non-conforming cylinders determined from the following table. (This subsection does not apply to prestressed concrete, which due to complex design criteria is handled on a case-by-case basis.)

Cylinder Test Results:	Price Reduction per cubic yard (Percent) X (Contract Unit Price)	
Percentage of Minimum Strength	With Contract Unit Price	Without Contract Unit Price*
98.0 - 100.0	0%	0%
95.0 - 97.9	5%	25%
90.0 - 94.9	10%	50%
<p>* If there is no contract unit price for concrete, use (percent reduction) x (supplier's invoice unit cost).</p> <p>The BCE may approve use of concrete test method SC-T-49 to determine the accepted strength if the concrete test cylinders have been considered non-conforming.</p> <p>The total amount of the price reduction will not be less than \$500.00.</p>		

- 2 If any cylinder test result is below 90%, take cores in the presence of the BCE or RCE from the concrete in the structure that is represented by the non-conforming test cylinders in order to evaluate the strength of the concrete in place. Ensure that test cores are taken, conditioned, and tested in accordance with the requirements of **Subsection 701.2.12.4.2.2**.

701.2.12.4.2 Procedure for Testing Non-conforming Concrete

701.2.12.4.2.1 Limits of Questionable Concrete

- 1 The limit of questionable concrete is determined by using concrete test method **SC-T-49**. Acceptance is solely based on the compressive strength of the cores removed from the in-place concrete, unless authorized otherwise by the BCE.

701.2.12.4.2.2 Obtaining Cores

- 1 Have the OMR or an independent firm, accredited by AASHTO, remove the cores from the structure in the presence of representatives of all affected parties. The BCE will determine the location(s) of the test cores that best represent the concrete in question. Take three cores (3 to 4 inches in diameter), sized to match the testing equipment used, from each area of concrete that produced a test cylinder with test strength less than 90% of the required strength. Take care to avoid damaging reinforcing steel. Properly label cores before shipment. Obtain and test cores at no expense to the Department.

701.2.12.4.2.3 Conditioning and Testing Cores

- 1 Deliver cores to the OMR or an independent testing laboratory accredited by AASHTO.
- 2 Have cores tested in accordance with AASHTO T 24. Provide a written report on the laboratory test results to all affected parties.

701.2.12.4.2.4 Acceptance of Concrete

- 1 Acceptance of the concrete from which the cores are taken is based on the core test results. If access to the concrete is not practical for obtaining cores or the taking of cores would result in irreversible damage to the structure, the BCE may approve concrete test method **SC-T-49** to determine the strength of the concrete.
- 2 If the **SC-T-49** test results or the core test results are below 90%, but are equal to or greater than 85% of the design strength, obtain a design analysis based on the reduced strength from the Designer-of-Record. Based on the design analysis, the BCE will determine if the concrete can remain in place. If the concrete test results are less than 85% of the design strength, remove the concrete unless authorized otherwise in writing by the BCE.
- 3 If non-conforming concrete is allowed to remain in-place, a price reduction on the quantity of concrete in question is determined by the following table.

Price Reduction for Non-conforming Concrete Left In-Place		
Core Test Results: *	Price Reduction per cubic yard (Percent) X (Contract Unit Price)	
Percent of Minimum Strength	With Contract Unit Price	Without Contract Unit Price**
98.0 - 100.0	0%	0%
95.0 - 97.9	5%	25%
90.0 - 94.9	10%	50%
85.0 - 89.9	15%***	80%
<p>* Or SC-T-49 if approved by the BCE.</p> <p>** If there is no contract unit price for concrete, use (percentage) x (supplier's invoice unit cost).</p> <p>*** Use 15% of contract unit price or 80% of supplier's invoice unit cost, whichever is greater.</p> <p>The total amount of the Price Reduction will not be less than \$500.00.</p>		

701.2.12.5 Changes in Mix Design

- 1 When changes are made in the mix design, furnish the new proportioning values for batching purposes to the OMR for review.

701.3 Equipment

701.3.1 Equipment, Inspection, and Approval

- 1 Have all equipment specified herein inspected and approved before use. Schedule such inspections at least annually and at other times considered necessary by the RCE.

701.3.2 Weighing Equipment

- 1 At all batch plants, provide equipment with a positive means of weighing ingredients in each batch of concrete.
- 2 Weigh individual cementitious material to not less than 99% of the required weights.
- 3 Ensure that the weight of individual aggregates is within $\pm 2\%$ of the required weight and the total weight of aggregate is within $\pm 2\%$ of the total required weight. Use beam, springless-dial, or load cell scales for weighing aggregates and cement. Make certain that scales are accurate to within 0.5% when used for cement and to within 1.0% when used for aggregate under operating conditions throughout the range of use. When beam scales are used, provide a device such as a "tell-tale" dial for indicating when the load in the weighing hopper is approaching the required weight. Use poises designed to lock in any position to prevent accidental change of position.
- 4 Provide dust tight enclosure for dial scales. Ensure that the chart is made from a durable material and has good readability.
- 5 Periodically have scales used in batching Portland cement concrete checked for accuracy by the Division of Weights and Measures of the State Department of Agriculture or by other qualified scale service agents. Post on the scales or in the batching room a statement certifying as to their accuracy with the date of inspection. Do not allow the interval between inspections to exceed 12 months.
- 6 Ensure that the cement weighing hopper is properly sealed and vented to preclude dusting during weighing operations.

701.3.3 Central Mixing Plant

- 1 Thoroughly mix concrete in a batch mixer of an approved size and type that ensures a uniform distribution of the materials throughout the batch. Use plants that are listed on the most recent edition of *SCDOT Qualified Product List 28*.
- 2 Ensure that there is adequate water storage. Make certain that the mixer is equipped with a device to accurately weigh or measure and automatic control the quantity of water used in each batch. Ensure that the device used is accurate, and so calibrated that under all operating conditions, it is accurate to within 1% of the quantity of water required for the batch. Furnish the Department's inspector with facilities for checking the water measuring equipment whenever deemed necessary by the RCE. Clearly mark scales or other means used to measure water to accurately show the quantity of water used. Ensure that there is no loss of water from the time it is measured until it is deposited in the mixer drum. Make certain that the water supply is automatically shutoff while the water is being discharged into the mixer. Use a mixer with an acceptable timing device capable of being locked and that does not permit the batch to be discharged until the specified mixing time has elapsed.

701.3.3**701.3.4**

- 3 Maintain mixers in good working condition. Repair mixers when necessary to ensure that the concrete is of uniform quality. Examine mixers for change in condition due to accumulation of hard concrete or mortar and for wear of the blades. Replace the pick-up and throw-over blades when any part or section is worn 1 inch or more below the original height of the manufacturer's design. If requested by the OMR, provide a copy of the manufacturer's design, showing dimensions and arrangements of blades.
- 4 Use mixers equipped with a separate dispenser for each type of admixture. The dispensers may operate either automatically or manually, but regardless of which type is used, make certain that they are capable of measuring and placing exactly and consistently the desired amount of admixtures in each batch.

701.3.4 Truck Mixers

- 1 Make certain that all truck mixers are pre-approved by the SCDOT or NRMCA and display a valid approved inspection sticker.
- 2 Ensure that the manufacturer's rating plate is attached on all truck mixers and the mixing speed and agitating speed are clearly visible and legible on the plate. If the speeds are not legible or if truck mixer does not have a rating plate, provide the OMR a written document from the truck mixer manufacturer stating the mixing and agitating speeds.
- 3 Use truck mixers capable of combining the ingredients of the concrete within the specified number of mixing revolutions into a thoroughly mixed and uniform mass and discharging the concrete with a degree of uniformity satisfactory to the RCE.
- 4 Do not exceed the manufacturer's rating for the volume of mixed concrete permitted in the drum of truck mixer indicated on the capacity plate. Ensure that the National Ready Mixed Concrete Association (NRMCA) plate is accessible, clear, and legible at all times. Ensure agitators are capable of producing concrete with a degree of uniformity to the satisfaction of the RCE.
- 5 If the equipment does not have an attached rating plate with maximum capacities. The approved capacity as a mixer and as an agitator will be assumed from the following table.

Maximum Gross Volume of Drum (cubic feet)	Maximum Capacity (cubic yards)	
	As Mixer	As Agitator
261	6.0	7.75
306	7.0	9.25
329	7.5	9.75
352	8.0	10.50

(table continued on the next page)

(table continued from the previous page)

Maximum Gross Volume of Drum (cubic feet)	Maximum Capacity (cubic yards)	
	As Mixer	As Agitator
376	8.5	11.25
399	9.0	12.00
423	9.5	12.75
446	10.0	13.25
493	11.0	14.75
540	12.0	16.00
587	13.0	17.50
634	14.0	19.00
681	15.0	20.25

- 6 If the volumes are determined using the table above, provide with each truck the proper documentation to be used instead of the manufacturer's rating plate showing the maximum mixing and agitating capacity.
- 7 Use truck mixers equipped with a water system and measuring device. Make certain that the device permits ready access and can accurately determine the quantity of water used. Use a water-measuring device that can accurately measure water in the tank to within 1.0% when the truck mixer is stationary and essentially level.
- 8 Ensure that truck mixers and agitators of the revolving drum type are equipped with a hatch in the periphery of the drum shell that will permit access to the inside of the drum for inspection, cleaning, and repair of the drum and blades.
- 9 Use truck mixers that have an electrically or mechanically actuated revolution counter that can be reset to zero. Make certain that this counter is mounted in a position such that it can be read from the ground.
- 10 Maintain truck mixers in good working condition. Repair when necessary to ensure that the concrete is of uniform quality. Replace blades when any part or section is worn 1 inch or more below the original design. If requested by the OMR, provide a copy of the manufacturer's design, showing dimensions and arrangements of blades.

701.4 Construction

701.4.1 Care and Storage of Concrete Aggregates

- 1 Handle and store concrete aggregates in a manner that prevents intermixing, segregation, and contamination by foreign materials. Handle and stock-

pile each aggregate component from a different source or grading separately. Clear vegetation and other extraneous matter from stockpile sites, so that they have natural ground bottoms, and ensure that they are generally smooth, firm, and well drained. Do not use the bottom 1-foot of any stockpile with a natural ground bottom except under direct supervision of the RCE. If excessive segregation is likely because of the stockpiling of an aggregate, construct the stockpile in layers not to exceed 3 feet in depth.

701.4.2 Storage of Cement

- 1 Store bulk cement in weatherproof bins or silos that protect the cement from dampness and provide for the free flow of the cement. If the OMR authorizes the use of bagged cement, store it in weatherproof buildings or temporary store it in the open on a raised platform with ample waterproof flooring and covering.
- 2 At a batching plant with two or more silos in which different types of cement or cementitious materials are stored, place a sign at each fill inlet indicating the type of cement stored therein. Make the sign from a durable material with raised, indented, or cut letters a minimum of 2 inches high and ¼ inch thick or deep. Ensure that the sign clearly identifies the material that is in the silo.
- 3 If concrete is to be proportioned at the work site and is only for the Department's use, keep accurate records of the deliveries of cement and of its use in the work. Provide copies of these records to the RCE and OMR in such form as they may require.

701.4.3 Measuring Materials

701.4.3.1 Portland Cement

- 1 Measure Portland cement and other cementitious materials by weight unless otherwise specified. Weigh the cementitious materials on scales meeting the requirements of **Subsection 701.3.2** and are not used to weigh other materials. If bagged cement is authorized, measure it in bags packed by the manufacturer. From time to time, weigh full bags as a check on the net weight. Prepare batches that do not require fractional bags of cement unless all the cement for each batch is weighed.

701.4.3.2 Water

- 1 Measure water by volume or by weight through an approved measuring system. Use a measuring system with a metering or weighing device capable of incorporating into the batch the predetermined quantity of water with an accuracy of 1.0% of the quantity of water required for the batch. Assume water to weigh 8.33 pounds per gallon.

701.4.3.3 Fine and Coarse Aggregate

- 1 Measure fine and coarse aggregates separately by weight on scales meeting the requirements of **Subsection 701.3.2**. In measuring aggregates, make allowance for water in the aggregates. For determinations of the moisture content of aggregates, use automatic sensing devices if available; otherwise,

take representative samples and investigate individually or combined in a composite sample.

701.4.3.4 Admixtures

- 1 Dispense admixtures into the batch as a solution of uniform concentration and in the amounts recommended by the manufacturer. Use properly equipped sight-tube dispensers with a graduation strip or strips that are labeled in terms of ounces or ounces per hundred pounds of cement. Identify graduated strips as to the rate at which the admixture is being measured for the particular diameter of the tube being used.
- 2 Calibrate meter and timing dispensers by obtaining a metered sample and checking the accuracy of the system. Have the equipment checked and approved during the annual inspection and at other times when deemed necessary or as directed by the RCE.
- 3 Maintain the accuracy of all systems to within $\pm 3\%$. Discharge the admixture into the stream of water entering the mixer drum or into the pre-measured or pre-weighed water for each batch. Take precautions to prevent the dilution of the admixture in storage by rain and condensation. For actual control, measure the air content with air meters only. Add additional admixtures at any time to achieve the proper amount of entrained air.
- 4 When adding Types A, C, D, or E admixtures, ensure that the dispensing equipment and procedure adds the admixture after the dispensing of the air entraining agent is complete and some mixing of the concrete has occurred. When adding Types F or G admixture, do not add the admixture agent until after all of the materials are in the mixer and have been mixed for 1 minute if in a truck mixer, for 15 seconds if in a central-mix mixer, or at approximately the midpoint of the primary mixing portion of the auger mixing chamber on a mobile concrete mixer unit.

701.4.4 Concrete Batching and Mixing

701.4.4.1 General

- 1 When concrete is furnished by a transit or central-mix plant, use the batching equipment that is sufficient to weigh out a load of the required size in not more than 15 minutes.
- 2 Make certain that an SCDOT-certified concrete field technician is present at the plant when concrete is being produced for SCDOT work. The SCDOT-certified concrete field technician may be an employee of the Contractor, the concrete supplier, or an independent testing laboratory. While concrete is being produced for SCDOT work, ensure that the SCDOT-certified concrete field technician's sole, full-time responsibility is to maintain quality control records and conduct physical testing of concrete and its constituent materials. Have the SCDOT-certified concrete field technician complete and sign a SCDOT *Form 700.04*. Except for Class 2500 concrete and prestressed, precast concrete, the Department will not accept concrete unless a completed SCDOT *Form 700.04*, signed and certified by the SCDOT-certified field tech-

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nician, accompanies the delivery of the concrete.

- 3 Provide sufficient advance notification to the RCE as to the name of the plant supplying the concrete in order to permit time to make the necessary arrangements for inspection of equipment at the plant.

701.4.4.2 Batching and Mixing in Cold Weather

- 1 Before starting work on the project, submit a written *Cold Weather Batching and Mixing Plan* developed in conjunction with the concrete supplier and to be used when the atmospheric temperature is below 35°F (determined by the RCE).
- 2 At a minimum, include in the plan the methods and equipment employed to meet the following requirements and restrictions:
 - Do not batch concrete with aggregates that contain frozen particles.
 - Do not heat mixing water to a temperature exceeding 170°F at discharge into the mixer.
 - Heat aggregates by either steam or dry heat.
 - Use heating apparatus to heat the aggregates uniformly and avoid hot spots.
 - Make certain that the temperature of the batched concrete is at least 50°F when placed in the forms.

The RCE may add other requirements to the plan if deemed necessary.

- 3 Batch concrete only after the plan has been accepted, and the RCE has specifically authorized the batching.

701.4.4.3 Batching and Mixing in Hot Weather

- 1 Before starting work on the project, submit a written *Hot Weather Batching and Mixing Plan* developed in conjunction with the concrete supplier to prevent the concrete mix temperature from exceeding 90°F measured before placement in the forms, unless specified otherwise. For Class 2500 concrete, do not allow the temperature of the concrete to exceed 95°F. For mass concrete pours, do not allow the mix temperature to exceed 80°F as measured at discharge into the forms. This requirement does not apply to concrete used in precast/prestressed members.
- 2 The plan may include the following methods and equipment to meet the mix temperature requirements:
 - Use Type II cement.
 - Sprinkle coarse aggregate with water to cool by evaporation.
 - Use chilled mixing water or shaved ice to replace part of the mixing water.
- 3 Ensure that the plan conforms to the applicable requirements of ACI 305R, *Hot Weather Concreting*.

701.4.4.4 Central Plant Mixing

- 1 Thoroughly mix concrete in a central mixer of an approved plant. Ensure that the period of mixing after all materials including water are in the drum exceeds 1½ minutes. During the mixing period, operate the drum at speeds specified by the mixer manufacturer and shown on the nameplate on the machine.
- 2 Mix concrete only in quantities required for immediate use. Transport the mixed concrete to the work site in a truck mixer operating at agitating speed.

701.4.4.5 Truck Mixing

- 1 After all materials, including water, have been placed in a truck mixer, rotate drum for not less than 70 revolutions at the mixing speed designated by the truck mixer manufacturer and shown on the rating plate. Mix concrete at the batching plant or at the job site. After mixing or while in transit between the plant and the work site, rotate the drum at agitating speed of 2 to 6 rpm or at the speed designated for agitation by the manufacturer.

701.4.4.6 Wash Water Stabilizers

- 1 Ready mix concrete producers may use mixer drum wash water stabilizer agents in truck and central mix drums. Use products that appear on the most recent edition of *SCDOT Qualified Product List 32*. Make certain that the stabilizing agents are used in accordance with the most recent edition of *SCDOT Qualified Product Policy 32*.
- 2 The RCE or the OMR may disallow the use of mixer drum wash water stabilizers if the Department's policy is not strictly adhered to or technical problems are encountered because of using a stabilizer.

701.4.4.7 Mobile Concrete Mixing Plants

- 1 Use a truck mounted mobile Portland cement concrete plant designed for automatic volume proportioning of the concrete materials and for mixing the concrete for immediate use at the work site for incidental construction and only when authorized by the OMR. If authorized, ensure that the plant provides a satisfactory rate of production and is capable of combining the concrete ingredients into a thoroughly mixed and uniform mass and of discharging the concrete without segregation.

701.4.5 Consistency

- 1 Provide compatible pozzolans and/or admixtures as necessary to obtain the appropriate workability and consistency at no additional cost to the Department. Provide the RCE and the OMR with written documentation from the concrete supplier stating that all products in the concrete mix are compatible.

701.4.6 Slump

- 1 Except for Class 2500 concrete and unless otherwise specified, provide concrete that has a maximum slump of 4 inches when measured in accordance with ASTM C 143. In any case, do not exceed the water to cementi-

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tious material ratio for the appropriate class of concrete shown in the Structural Concrete Table in **Subsection 701.2.12.2**.

- 2 For pumped concrete, the slump is measured at the truck.
- 3 In the event additional water is required to obtain the specified slump at the work site, the RCE may approve adding water from an acceptable water supply at the rate of 1 gallon per cubic yard per inch of desired slump, but not to exceed the maximum water to cementitious material ratio shown in the table in **Subsection 701.2.12.2**. When additional water is added, make certain that the truck mixer drum turns a minimum of 25 revolutions at mixing speed before discharge of the concrete.
- 4 For Class 2500 concrete with an initial slump between 4 to 6 inches, additional cement may be added at the work site at the rate of 20 pounds of cement per cubic yard of concrete per inch of slump over 4 inches to attempt to bring the slump down to the maximum of 4 inches. Batches of Class 2500 concrete with slumps greater than 4 inches after the allowable addition of cement will not be accepted for Department use, unless otherwise permitted by these specifications or the Special Provisions.

701.4.7 Water Reducers

- 1 A water reducer may be used to increase the slump of concrete. A Mid-Range Water Reducer (MRWR) may be used to increase the slump to a maximum of 6 inches. A High-Range Water Reducer (HRWR) may be used to increase the slump to a maximum of 9 inches. In any case, do not allow the slump to exceed the maximum slump for the following items:
 - Maximum 6" slump for concrete in bridge decks.
 - Maximum 9" slump for seal concrete and in drilled shaft concrete.
 - Maximum 9" slump for prestressed concrete.
- 2 Use MRWR or HRWR admixtures listed on the most recent edition of *SCDOT Qualified Product List 5*. Provide to the RCE for prior approval the admixture manufacturer's product data sheet that clearly states the product is intended for use as a MRWR or a HRWR. Use MRWR and HRWR admixtures strictly in accordance with the manufacturer's recommendations and the limitations specified in this subsection.
- 3 Type F or Type G admixtures may be added to concrete to increase workability and/or to reduce the water to cementitious material ratio. Type F is a HRWR, and Type G is a High Range Water Reducer-Retarder. If these admixtures are used, add them at the work site just before discharge, and mix concrete for a minimum of 30 seconds per cubic yard of concrete in the mixer after each addition of an admixture. Measure the slump of the concrete before the addition of the high-range admixture, and make certain not to exceed the maximum slump limits indicated above. Discontinue or avoid the use of admixtures when there is any indication of excessive flow, bleeding, or segregation. The admixture may be added a second or third time to re-establish mixture flow if the maximum time for placing the concrete after the mix water

is added has not expired.

701.4.8 Water Reducer-Retarders

- 1 A water reducer-retarder admixture may be added to concrete mixes to reduce the water content and shrinkage in the concrete, improve its workability, retard the initial set of the concrete, and/or reduce the rate of internal heat development in concrete pours without sacrificing quality or strength.
- 2 Use a water reducer-retarder, Type D or Type G complying with **Subsection 701.2.6** in concrete deposited underwater, and also in concrete that is not likely to reach its final position in the forms before initial set takes place. Ensure that proportioning and dispensing of the admixture is in accordance with **Subsection 701.2.6**.

701.4.9 Fly Ash and Water-Granulated Blast-Furnace Slag

- 1 The addition of fly ash or water granulated blast-furnace slag is allowed in the concrete mix if the following requirements are met when using these materials:
 - A. Fly ash or water-granulated blast-furnace slag may replace allowable percentages of Type I, Type II, or Type III Portland cement. Do not use fly ash or slag replacement for mixes using Type I (SM) or any other blended cement.
 - B. Remove forms in accordance with **Subsection 702.4.5**.
 - C. When fly ash is used to replace the Portland cement, replace at a ratio of not less than 1.2:1 by weight, and do not replace more than 20% of the cement originally called for in the mixture.
 - D. When water-granulated blast-furnace slag is used to replace Portland cement, replace at a ratio of 1:1 by weight, and do not replace more than 50% of the cement originally called for in the mixture.
 - E. Submit a mix design to the OMR for review a minimum of 7 calendar days in advance of batching. Indicate in the submittal the amount of cement to be removed, the material that will replace it, and compressive strength results of the mix.
 - F. After batching begins and as concrete is delivered to the work site, make certain that the concrete contains the specified entrained air content at the time it is discharged from the transit mixer. Do not use concrete with non-conforming air content.
 - G. To ensure accurate batching, provide separate storage bins, conveying devices, weighing equipment, and weighing procedures for each material (fly ash or slag) used.
 - H. Provide fly ash from sources that appear on the most recent edition of *SCDOT Qualified Product List 3*. Furnish certified mill test reports and shipping tickets from the supplier for each shipment.
 - I. Provide slag from sources that appear on the most recent edition of *SCDOT Qualified Product List 6*.

701.5 Measurement

- 1 The quantity for the pay item Concrete for Structures - Class (as specified) is the volume of specified concrete within the neat lines of the structure as shown on the Plans or as revised by the RCE (excluding precast/prestressed members, bridge barrier parapet, bridge barrier parapet transitions, and drilled shaft concrete) and is measured by the cubic yard (CY) of concrete, complete, and accepted. Deductions are made for the volume of embedded items, except for reinforcing steel; however, no deduction is made for edge chamfers of $\frac{3}{4}$ inch or smaller.
- 2 Measurement for the quantity of concrete in bridge slabs is computed from the neat line dimensions shown on the Plans with no allowance for form deflection. No additional payment is made for extra concrete required by the use of permanent steel bridge deck forms or for the SIP forms themselves.
- 3 The costs for concrete used in precast/prestressed members, bridge barrier parapet, bridge barrier parapet transitions, and drilled shafts, including the cost of designing the mix, testing, engaging the testing laboratory, and furnishing materials for testing is included in the contract unit bid price for the applicable pay item.

701.6 Payment

- 1 Payment for the accepted quantity of Concrete for Structures - Class (as specified), measured in conformance with **Subsection 701.5**, is determined using the contract unit bid price for each pay item. Payment is full compensation for furnishing and placing the Class of concrete as specified or directed and includes costs of the mix design, sampling, and testing; furnishing, storing, batching, mixing, and transporting concrete materials; admixtures; falsework and forms (including SIP forms); surface finishing and curing; quality control personnel and equipment; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Concrete is paid for at 100% of the contract unit bid price upon completion of the Initial Surface Finish.
- 3 Unless otherwise specified, payment for concrete includes the cost of pipe drains, French drains, weep holes, expansion joints, expansion joint materials, flashing, pipes, conduits, anchors, and other similar material. Payment for concrete also includes the cost of removing and disposing of portions of existing structures designated on the Plans to be widened or reconstructed and the costs of drilling for dowels or expansion bolts.
- 4 Payment for the item Concrete for Structures includes all direct and indirect costs and expenses required to complete the work.

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5 Pay items under this section include the following:

Item No.	Pay Item	Unit
7011100	Concrete for Structures – Class 3000 (Roadway)	CY
7011105	Concrete for Structures – Class 3000 (Retaining Wall)	CY
7011200	Concrete for Structures – Class 3000 (Bridge)	CY
7011300	Concrete for Structures – Class 2500	CY
7011400	Concrete for Structures – Class 4000	CY
7011400	Concrete for Structures – Class 4000	CY
7011401	Concrete for Structures – Class 4000 (Retaining Wall)	CY
7011402	Concrete for Structures – Class 4000 (Culvert)	CY
7011403	Concrete for Structures – Class 4000 (Roadway)	CY
7011500	Concrete for Structures – Class 4000S	CY
7011501	Concrete for Structures – Class 4000P	CY
7011510	Concrete for Structures – Class 4000DS For Drilled Shafts	CY
7011600	Concrete for Structures – Class 5000	CY
7011630	Concrete for Structures – Class 6500	CY
7011640	Concrete for Structures – Class 7000	CY

SECTION 702

CONCRETE STRUCTURES

702.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for structures involving the use of structural concrete, except where the requirements are specifically waived or revised by another governing section of these specifications. Construct concrete structures in accordance with the design requirements and details shown on the Plans and in conformity with the requirements of this specification and any Special Provisions pertaining thereto.

702.2 Materials

702.2.1 Concrete

- 1 Provide concrete conforming to the requirements of **Section 701**. Provide the class of concrete for each type of structure, structural element, or concrete item as specified herein and on or in the Plans, *SCDOT Standard Drawings*, Supplemental Specifications, the Special Provisions, or as directed by the RCE.

702.2.2 Expansion Joint Material

702.2.2.1 Preformed Joint Filler

- 1 Use preformed material composed of cane or other fibers of a cellular nature, securely bound together, uniformly saturated with a suitable bituminous binder, and complying with the requirements of AASHTO M 213, or a preformed material composed of 100% scrap tire rubber that is shredded and fused into cohesion with a non-toxic, odorless, and tasteless formulated polyurethane binder. Make certain that the shreds are treated to resist most types of microbes, oils, fungi, and biological growth. Provide joint filler meeting the physical properties of ASTM D 6690, Type I.

702.2.2.2 Hot-Poured Elastic Filler

- 1 Provide hot applied elastic filler material meeting the requirements of ASTM D 6690, Type I.
- 2 Make certain that the filler material does not exceed the maximum of 20% recycled tire rubber by weight of bituminous components. When using material with scrap tire rubber, obtain a certified statement from the vendor with each shipment stating the number of pounds of reclaimed scrap tire rubber contained in the filler material. Provide the certificate to the RCE before using the filler material.

702.2.2.3 Elastomeric Compression Seals for Bridge Decks

- 1 Use elastomeric compression seals for bridge deck joints meeting the requirements of AASHTO M 297. Provide seals that conform to the dimensions shown on the Plans. Ensure that the lubricated adhesive used with the seals

meets the requirements of ASTM D 2835. Install the seals in accordance with the manufacturer's recommendations or as directed by the RCE. Do not splice or cut the seal unless indicated to do so on the Plans.

- 2 Obtain from the vendor and furnish to the RCE three copies of the manufacturer's certification of conformance along with test results verifying that the seals and adhesive furnished meet the applicable specifications.

702.2.2.4 Metal Expansion Plates

Provide stainless steel plates, Type 301 or Type 302, with a No. 1 Finish as specified in ASTM A 167. If copper alloy expansion plates are required, use copper alloy No. 510 as specified in ASTM B 100.

702.2.2.5 Roofing Felt

- 1 Use a standard self-adhesive roofing underlayment with at least a 60 mil. thickness.

702.2.2.6 Copper Flashing

- 1 Use flashing of the thickness or weight indicated for Copper No. 110 as specified in ASTM B 152.

702.2.2.7 Plastic Waterstops

- 1 Provide flexible polyvinyl chloride waterstops of the size and type specified on the Plans. Unless otherwise specified, use material conforming to the current AASHTO *LRFD Bridge Construction Specifications*, Section 8.9.2.6.2.

702.2.2.8 Pipes and Conduits

- 1 If polyvinyl chloride (PVC) pipe schedule 40, 80, or 120 is used for conduit, ensure that it meets the requirements of ASTM D 1785.

702.2.2.9 Cold Applied Elastic Filler

- 1 Provide polymeric elastomeric, two-component, cold-applied, bridge joint filler recommended by the manufacturer for use in bridge joints and meeting the requirements of ASTM C 920 for a multiple component self-leveling material.
- 2 When specified or as an alternate to the abovementioned filler, use a self-leveling, cold-applied, rapid cure, two-part, ultra low modulus, 100% silicone rubber sealant. Provide this material packaged such that no pre-mixing or measuring is required. Use sealant capable of accommodating movements up to $\pm \frac{1}{2}$ inch for bridge joints 1 to 3 inches wide. Check throat depth immediately before and during installation. Have a manufacturer's representative on site during the first installation.
- 3 Provide circular cross-section backer rod consisting of closed-cell, polyethylene foam that is $\frac{1}{8}$ inch greater in diameter than the maximum joint width.

- 4 Use material from sources appearing on the most recent edition of *SCDOT Qualified Product List 11*.

702.2.2.10 Bridge Deck Joint Strip Seals

- 1 Provide bridge deck joint strip seals complying with the requirements of **Section 723**.

702.2.2.11 Liquid Curing Compounds

- 1 Unless otherwise specified, use Type 2, white pigmented, liquid curing compounds conforming to AASHTO M 148 either Class A all resin or all wax based, or Class B all resin based. Ensure that all products are VOC compliant (water-based or solvent-emulsion). Do not use total solvent-based products.
- 2 When tested in accordance with AASHTO T 155 procedures, small oven variations will be allowed in temperature, relative humidity, and velocity of air current.
- 3 Use materials from sources appearing on the most recent edition of *SCDOT Qualified Product List 33*.
- 4 For each project, provide the RCE with the following documents:
- Certificate of analysis and performance test results for each lot/batch number furnished, verifying that it meets AASHTO M 148 for the type and class furnished.
 - Materials Safety Data Sheet.
 - Application instructions.

The following information only needs to be furnished to the RCE once provided there are no manufacturing changes to the material.

- 5 Ensure that the shipping containers are plainly marked with the manufacturer's name and trademark, batch number, type and class of cure, and date of manufacture. With each load of material shipped in bulk tankers, provide a label and place it on the project storage tank for identification purposes.
- 6 The RCE and OMR will accept the material based on a manufacturer's certificate of analysis and performance test results, the fact that it is on the most recent edition of *SCDOT Qualified Product List 33*, and is delivered in properly labeled containers.
- 7 The above acceptance procedures will be honored by the Department until the documentation of the curing compound is found to be incorrect. If this condition should occur, the OMR will attempt to establish correct documentation. Results of these negotiations and/or tests will be used to determine the future status of the manufacturer as an authorized source.

702.2.2.12 Falsework

- 1 Submit to the BCE detailed Working Drawings and design calculations for falsework in accordance with **Subsection 105.2** and **Section 725** for work

involving cofferdams; structures over navigable waterways, highways, or railroads; caps adjacent to railroads or highways; temporary shoring walls; cast-in-place flat slabs or girders/beams; and any other items designated on the Plans or in the Special Provisions as requiring falsework.

- 2 Ensure that the Working Drawings and design calculations submitted as described above are sealed by a South Carolina registered Professional Engineer and comply with the requirements of **Subsection 702.4.1**. Working Drawings and design calculations will not be reviewed in-depth by the Department, and review or acceptance of Working Drawings and design calculations does not relieve the Contractor of the responsibility for the adequacy of the falsework.
- 3 If a falsework system has been previously used successfully on an SCDOT project, Working Drawings for that system are not required to be re-submitted to the BCE, but instead submit to the RCE for verification purposes, two copies of the Working Drawings for the previously accepted falsework system that have been stamped by the BCE. No deviations will be allowed to this previously accepted system without the approval of the BCE. If there are changes to the system, submit to the BCE for review and acceptance, the details of the changes along with calculations sealed by a South Carolina registered Professional Engineer.

702.2.2.13 Forms

- 1 Submit detailed Working Drawings for forms involving items of work listed in **Subsection 702.2.2.12** in accordance with **Subsection 105.2** and **Section 725**. Make certain that the Working Drawings are sealed by a South Carolina registered Professional Engineer and comply with the requirements of **Subsection 702.4.1.3**. Working Drawings will not be reviewed in-depth by the Department, and review or acceptance of Working Drawings does not relieve the Contractor of the responsibility for the adequacy of the forms.
- 2 If a form system has been previously used successfully on an SCDOT project, Working Drawings for that system are not required to be re-submitted to the BCE. Submit to the RCE for verification purposes, two copies of the Working Drawings for the previously accepted form system that have been stamped by the BCE. No deviations will be allowed to this previously accepted system unless the changes, sealed by a South Carolina registered Professional Engineer, are resubmitted to the BCE for review and acceptance.
- 3 Use forms made of wood or metal that are mortar-tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations. Make certain that the interior dimensions of the forms conform to the shape and dimensions of the finished concrete as shown on the Plans. Construct and maintain forms to prevent warping and opening of joints due to expansion or shrinkage of the forms. Ensure that the forms are substantial and unyielding and the design includes the effect of vibration of concrete and the impact of concrete as it is placed.

- 4 Use dressed lumber or plywood in wood forms. Ensure that the dressed lumber is of good quality and free of imperfections that would affect the strength or impair the finished surface of the concrete. Repair all mismatched forms, holes, or undesirable indentions in the forms to the satisfaction of the RCE before placing concrete.

702.3 Equipment

702.3.1 Vibrators

- 1 Use vibrators that are in good operating condition and are acceptable to the RCE. Provide an adequate number of working backup vibrators for each pour and backup sources of power throughout the pour, such that backups are available in event of failure of any of the required vibrators. Do not begin a concrete pour if not in compliance with this requirement.
- 2 Use the minimum number of vibrators for a pour based on the size of the batches, the frequency of batches, the size of the sections, and the size of the vibrators subject to acceptance by the RCE.

702.3.2 Tremie

- 1 If a tremie is used in depositing concrete under water, use one that consists of a metal tube, other than aluminum, and has a diameter of not less than 10 inches. Use a tremie constructed in sections having flanged couplings fitted with watertight gaskets.

702.3.3 Kettles for Heating Hot-Poured Elastic Filler

- 1 In order to avoid damaging hot poured elastic filler material by excessive heating, melt the filler material in a double-walled, oil-bath kettle. Provide an accurate pyrometer to accurately measure the heat of the filler material in accordance with the manufacturer's instructions.

702.3.4 Curing Blankets

- 1 Use curing blankets of a natural or synthetic fiber-polyethylene mat or other material expressly manufactured for curing concrete. Make certain that the exposed side is a white opaque polyethylene.

702.4 Construction

702.4.1 Falsework/Forming Systems

702.4.1.1 General

- 1 Apply the requirements of this subsection to all falsework/forming systems, including systems for flat slabs, cast-in-place girders/beams, reinforced concrete decks, bent or pier caps, reinforced concrete columns, cofferdams, sheeting or shoring, temporary work bridges, and any other temporary systems to support the structure, soil in excavations, embankments, personnel, or equipment during the construction of the project. Refer to **Subsections 702.2.2.12** and **702.2.2.13** for special submittal requirements.

702.4.1.2 Design

- 1 Design falsework/form systems to handle all vertical and horizontal loading that may be placed upon it and with sufficient redundancy to prevent failure of the system because of the failure of any individual element. Include the sum of all anticipated vertical dead and live loads and real and assumed horizontal loads. Include the weight of the concrete, reinforcing steel and other encased items, equipment, personnel, forms, and falsework. For the weight of concrete, do not use less than 150 pounds per cubic foot for normal concrete and not less than 120 pounds per cubic foot for lightweight concrete.
- 2 For live loads, use the actual weight of any equipment and personnel to be supported by falsework applied as concentrated loads at the points of contact plus a uniform load of not less than 20 pounds per square foot applied over the area supported, plus 75 pounds per linear foot applied at the outside edge of deck overhangs.
- 3 For horizontal loads, use actual horizontal loads due to equipment and personnel, construction sequence, or other causes, plus an assumed horizontal wind load of not less than 50 pounds per square foot of horizontal surface area or 2% of the total dead and live load, whichever is greater.
- 4 Erect falsework with sufficient camber and/or adjustment to compensate for deflection and settlement under the weight of concrete so that the completed structure or part thereof has the alignment and curvature shown in the Plans. When footing type foundations are used for falsework support, determine the bearing value of the soil and show the values assumed in the design on the Working Drawings. Consider the effects of differential settlement. Limit settlement and support of falsework to 1 inch or less.
- 5 When falsework is to be placed adjacent to public roads, consider the effects of vibrations from passing vehicles and include provisions for protection of the falsework from errant vehicles.
- 6 If falsework from one bridge is to be used on another bridge, determine new loading conditions and verify the adequacy of the falsework system. Incorporate into the design any adjustments or changes necessary.

702.4.1.3 Working Drawing Submittal

- 1 Provide fully detailed Working Drawings showing the layout of falsework/form elements, sizes, material specifications, and any manufacturer's recommendations for installation. Show allowable stresses for design, working loads, the load capacity of all support elements, and the design specifications. Refer to **Subsections 702.2.2.12** and **702.2.2.13** for special submittal requirements.

702.4.1.4 Inspection**702.4.1.4.1 General**

- 1 Install falsework/form systems in accordance with the submitted, reviewed, and accepted Working Drawings. Do not deviate from these drawings. Prop-

erly install clean, lubricated bolts in all bolted connections. Have the installation of falsework/forms inspected as required by **Subsection 702.4.1.4.2** or **702.4.1.4.3**. Correct all deficiencies found during the inspection to the satisfaction of the Contractor's qualified inspector and the RCE before loading the falsework system.

702.4.1.4.2 Category I

- 1 Have a South Carolina registered Professional Engineer, employed or retained, inspect the initial assembly and installation of the falsework/form system required for structural items listed in **Subsections 702.2.2.12** and **702.2.2.13**, or as otherwise specified on the Plans or in the Special Provisions for compliance with the accepted and approved falsework/form system except for bridge deck overhangs and cofferdams or sheeting with a design height of 8 feet or less. Provide the RCE with a written certification of compliance from the Contractor's designated qualified inspector before loading the system.
- 2 Have additional installations of the identical falsework system on the project inspected by a South Carolina registered Professional Engineer or the Contractor's designated qualified inspector. Provide the RCE with a written certificate of compliance with the accepted Working Drawings before loading the system.

702.4.1.4.3 Category II

- 1 Have falsework/form systems for bridge deck overhangs and cofferdams or sheeting with a design height of 8 feet or less and all other systems not covered by Category I above inspected by the Contractor's designated qualified Inspector to ensure that the assembly and installation of the system is in accordance with the accepted falsework/form Working Drawings. If in the opinion of the RCE a system may not be assembled or installed in accordance with the accepted Working Drawings, provide an inspection and a written certificate of compliance by a South Carolina registered Professional Engineer for the system in question.

702.4.1.4.4 Designated Inspector Qualifications

- 1 Provide the RCE with the name and qualifications of the Contractor's designated qualified inspector. Make certain that the inspector has a minimum of 5 years of supervisory experience in bridge construction or an Engineering degree and 4 years experience in structural design or bridge construction.

702.4.1.4.5 Responsibility

- 1 The Contractor is not relieved of any liability or responsibility based on the Department's review of falsework/form system designs and drawings. The Contractor is solely responsible for the adequacy of the installation and performance of the falsework/form system. Any delays due to failure to comply with this specification or due to the inadequacy of the proposed falsework/form system are not grounds for an extension of contract time or additional compensation.

702.4.1.5 Wood Forms

- 1 Use machined surface chamfer strips to form fillets on concrete member of the size and at the locations shown on the Plans. Design and construct forms such that they may be removed without injuring the concrete.
- 2 Ensure that metal anchors, bolts, struts, reinforcement, ties, etc., encased in the concrete are placed such that no metal remains closer than 1 inch to the surface of the concrete. Wire form-ties of special design with a weakened section not less than $\frac{3}{4}$ inch back from the concrete face may be used at places of minor pressure, provided such ties have $\frac{3}{4}$ -inch deep wooden or plastic cone nuts to ensure the breaking of the tie at least $\frac{3}{4}$ inch inside the face of the concrete. Do not use wire ties in forms other than those described above. Other devices may be submitted for consideration, but do not use them without the written approval of the BCE.
- 3 Roughen cavities left by washers, cone nuts, or falsework/form support systems, and then completely plug, without any voids, with non-shrink structural grout approved by the RCE. If the grout plug shows a crack after setting, remove it and re-plug the cavity. Float the plugged surface flush with the adjacent surface. Ensure that the texture and color of the plugged surface is similar to the surrounding surface.
- 4 Other devices may be submitted for consideration, but do not use them without the written approval of the BCE.

702.4.1.6 Metal Forms

- 1 When using metal forms, comply with the specifications for wood forms regarding design, mortar-tightness, fillets and chamfers, bracing, alignment, removal, re-use, and oiling. Use metal in forms of such thickness that the forms will remain true to shape. Countersink all bolts and rivet heads on the formed surface. Design clamps, pins, or other connecting devices to hold the forms rigidly together and to allow removal without injury to the concrete. Do not use metal forms that do not present a smooth surface or do not line up properly. Exercise special care to keep metal forms free from rust, grease, or other foreign matter that may discolor the concrete. Provide metal forms with an adjustable metal section or occasional sections where wooden forms may be inserted to compensate for inaccuracies in measurements.

702.4.1.7 Stay-in-Place (SIP) Forms for Concrete Deck Slabs

- 1 If allowed in the Plans, permanent stay-in-place steel bridge deck forms for concrete deck slabs may be used at the Contractor's option. If used, make certain that the forms comply with the requirements for SIP forms contained herein.

702.4.1.7.1 Material for SIP Forms

- 1 Fabricate permanent steel bridge deck forms and supports from steel conforming to ASTM A 446/A 653, Grades 40 or 50, and having a coating class of G165 in accordance with ASTM A 525.

702.4.1.7.2 Design of SIP Forms**702.4.1.7.2.1 Loads for SIP Forms**

- 1 Base design of SIP steel forms on dead load of forms, reinforcement, and plastic concrete plus 50 pounds per square foot for construction loads. Limit allowable unit working stress in the steel sheet to not more than 72.5% of the specified minimum yield strength of the material furnished. In any case, do not exceed 36,000 psi.

702.4.1.7.2.2 Deflection of SIP Forms

- 1 Calculate deflections using the weight of the forms, the plastic concrete, and reinforcement. In any case, do not use a loading of less than 120 pounds per square foot total for deflection calculations. Consider vibration effects from adjacent traffic, construction activities, etc. in the deflection calculations. For form span lengths less than or equal to 10 feet, do not allow deflections to exceed 1/180 of the form span length or 1/2 inch, whichever is less. For form span lengths greater than 10 feet, do not allow deflections to exceed 1/240 of the form span length or 3/4 inch, whichever is less.
- 2 Base the permissible form camber on the actual dead load condition. Do not use camber to compensate for deflection in excess of the limits in paragraph 1 above.

702.4.1.7.2.3 Span Length of SIP Forms

- 1 Use the clear span distance of the form plus 2 inches measured parallel to form flutes as the design span length for forms.

702.4.1.7.2.4 Design Properties of SIP Forms

- 1 Compute the physical design properties in accordance with requirements of the current edition of the AISC specification *Design of Cold Formed Steel Structural Members*.

702.4.1.7.3 Reinforcing Steel in SIP Forms

- 1 Make certain that the bottom mat of reinforcing steel in SIP forms has minimum concrete cover of 1 inch. Maintain the plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck.

702.4.1.7.4 Lateral Bracing for SIP Forms

- 1 Do not consider permanent steel bridge deck forms as lateral bracing for compression flanges of supporting structural members.

702.4.1.7.5 Longitudinal Deck Joints for SIP Forms

- 1 Unless authorized in writing by the BCE, do not use permanent steel bridge deck forms in bays in which longitudinal deck construction joints are located.

702.4.1.7.6 Welding of SIP Forms

- 1 Do not weld SIP forms to beam or girder flanges or other structural steel bridge elements, unless specified and the approved on Shop Plans.

702.4.1.7.7 Shop Plans for SIP Forms

- 1 Submit Shop Plans in accordance with **Section 725**. On the Shop Plans, indicate the grade of steel, the physical and section properties for all permanent steel bridge deck form sheets and details of form support devices.

702.4.1.7.8 Construction with SIP Forms

- 1 Prepare *Fabrication and Erection Plans* for SIP forms and submit them in accordance with **Section 725**. Install all forms in accordance with accepted *Fabrication and Erection Plans*.
- 2 Do not rest forms directly on the top of the stringer or floor beam flanges. Securely fasten form-to-form supports and provide a minimum bearing length of 1 inch at each end. Place form supports in direct contact with the flange of stringer or floor beam. Attach the form to the support by permissible welds, bolts, clips, or other approved means. However, welding of form supports directly to flanges is not permitted.
- 3 Where the galvanized coating of permanently exposed form metal has been damaged, thoroughly wire brush and clean the damaged metal to the satisfaction of the RCE, then paint with two coats of zinc oxide and zinc dust primer in accordance with ASTM A 780 with no color added. Minor heat discoloration in areas of welds need not be touched up.
- 4 Locate transverse construction joints at the bottom of a form flute. Field drill ¼-inch weep holes at not less than 12 inches on-center along the line of the joint.

702.4.1.7.9 Placing Concrete in SIP Forms

- 1 Place concrete in accordance with the manufacturer's recommendations and the Special Provisions. Make certain that the proper vibration of the concrete is performed to avoid honeycombing and voids especially at construction joints, expansion joints, and valleys and ends of form sheets.

702.4.1.7.10 Inspection of SIP Forms

- 1 Provide such facilities as are reasonable for the RCE to a conduct safe and convenient inspection of the SIP forms.
- 2 The Contractor's method of construction will be carefully observed during all phases of the construction of the bridge deck slab. These phases include installation of the metal forms, location and fastening of the reinforcement, composition of concrete items, mixing procedures, concrete placement and vibration, and finishing of the bridge deck. Should the RCE determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, remove at least one section of the forms at a location and time selected by the RCE for each span. Perform this removal as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the placement procedures are obtaining the desired results. Remove additional sections if the RCE determines any change in the concrete mix or placement procedures warrant additional in-

spection.

- 3 After the deck concrete has been in place for a minimum of 2 days, test the concrete for soundness and bonding of the forms by sounding with a hammer as directed by the RCE or BCE. If areas of doubtful soundness are disclosed by this procedure, remove the forms from such areas for visual inspection after the concrete has attained adequate strength. Perform this removal of the permanent steel bridge deck forms at no cost to the Department.
- 4 Unless otherwise directed, do not replace the forms at locations where sections of the forms are removed, but repair the adjacent metal forms and supports to present a neat appearance and ensure their satisfactory retention.
- 5 As soon as the form is removed, examine the concrete surfaces for cavities, honeycombing, and other defects. If irregularities are found and it is determined by the RCE that these irregularities do not justify rejection of the work, repair the concrete as directed by the RCE and give an initial surface finish in accordance with these specifications. If the concrete where the form is removed is unsatisfactory, remove additional forms as directed by the RCE for inspection. Remove or repair all unsatisfactory concrete as directed by the BCE. Modify the method of construction to obtain satisfactory concrete in un-poured slabs.
- 6 If after a substantial amount of slab has been satisfactorily constructed and inspected and the results of the inspection as outlined above indicate that sound concrete is being obtained throughout the slabs, the RCE may moderate the amount of sounding and form removal.

702.4.1.8 Construction of Falsework/Form Systems

- 1 Set all wood and metal forms as outlined in **Subsections 702.4.1.5** and **702.4.1.6** and maintain forms true to the line and grade with no mismatched forms or holes/indentions in forms until the concrete has gained sufficient strength to permit their removal. Install permanent steel bridge deck forms for concrete deck slabs in accordance with **Subsection 702.4.1.7**. If before or during the placing of concrete, the forms appear to be unsatisfactory in any way, the RCE will stop all work on the project until the defects have been corrected.
- 2 Do not place forms in patchwork arrangement by using small pieces. Stagger joints in lumber other than plywood.
- 3 For narrow walls, columns, etc., where the bottom of the forms or construction joint is inaccessible, leave the lower form boards loose, so they can be removed for cleaning out extraneous material immediately before placing the concrete, or provide suitable openings and methods of closing for this purpose.
- 4 Except for permanent steel bridge deck forms, treat forms with oil or saturate with water immediately before placing the concrete. For rail members or other members with exposed faces, treat the forms with approved oil to prevent the adherence of concrete. Do not use any material that adheres to or

discolors the concrete.

- 5 Inspect forms before as well as during the placement of concrete. Check all dimensions carefully and make certain that any errors, bulges, warping, or other defects are remedied before concrete is placed.
- 6 Ensure that the back face of forms for cast-in-place box girders are free of screw heads, protruding nails, and any other objects that would hinder inspection of the inside of the box girder.

702.4.2 Handling and Placing Concrete

702.4.2.1 General

- 1 Place concrete only during daylight hours unless otherwise specified, allowed or required by the Contract or approved by the RCE. Do not start the placing of concrete unless the pour can be completed and the concrete finished during daylight, except when an adequate lighting system is provided and the pour is accepted by the RCE.
- 2 Do not place concrete until the following items have been inspected by the RCE:
 - Depth, character, and water conditions of foundations in water,
 - Adequacy of falsework and forms,
 - Absence of debris in the forms,
 - Alignment and grade of the forms,
 - Condition of the construction joints, and
 - Condition and spacing of the reinforcing steel.
- 3 Unless authorized in writing by the BCE, do not place concrete before the RCE receives notification from the OMR or an OMR authorized AASHTO accredited testing laboratory that all reinforcing steel in the affected pour meets the contract requirements.
- 4 Do not deposit concrete under water unless permitted by the Plans or the Special Provisions or is authorized in writing by the BCE.
- 5 Provide sufficient hauling equipment to permit continuous placing of concrete, to maintain required pour rates, and to prevent placing of concrete on or against previously placed concrete that has begun its initial set in any one pour.
- 6 Establish a concrete operation with job site placement of concrete at a minimum rate of 25 cubic yards per hour, unless specified otherwise on the Plans or in the Special Provisions. For bridge deck slabs, establish the concrete placement at a minimum rate of 45 cubic yards per hour with a maximum pour time of 5 hours unless otherwise authorized in writing by the BCE. Before the first concrete deck pour, hold a Pre-pour Conference with the concrete supplier and the RCE to establish a *Concrete Operation Plan*. Prepare and submit this written plan to and have it accepted by the RCE before pouring any deck concrete. The RCE is not required to review the plan in-depth,

and the Contractor assumes all responsibility for the adequacy of the plan. Hold additional conferences when necessary or if directed by RCE.

- 7 Regulate placing concrete so that the pressures caused by wet concrete do not cause distortion of the forms.
- 8 Conduct the operation of depositing and compacting the concrete to form an artificial stone of maximum density and impermeability and uniform texture with smooth surfaces when the forms are removed.
- 9 Deposit concrete so that the total deflection or settlement of supporting members and the final screeding of the surface has occurred before initial set of the concrete.
- 10 Place concrete while fresh and before initial set has occurred. Do not use or re-temper concrete in which initial set has begun. Do not, in any case, re-temper concrete. Do not use concrete containing lumps or crusts of hardened materials. If any concrete is found defective, remove or repair it as specified herein or as directed by the BCE without extra compensation.
- 11 Do not retain concrete that has not reached its final position in the forms within 75 minutes after water or cement is first added to the mix, except when an approved water reducing retarder is used. If a water reducing retarder is used, the maximum time may be extended to 2 hours.
- 12 Place concrete to avoid segregation of the materials and displacement of the reinforcement. Obtain written permission from the BCE to use chutes over 50 feet in length for conveying concrete from the mixer to the forms. If an inferior quality of concrete is produced by the use of chutes, employ an alternate method of placing concrete that is satisfactory to the BCE.
- 13 Use open metal troughs, pipes, and chutes or metal lined (other than aluminum) troughs, pipes, and chutes. Where steep slopes are necessary, equip the chutes with baffle boards or use short lengths of chutes that change the direction of movement.
- 14 Keep all chutes, troughs, and pipes clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Discharge the water used for flushing away from the concrete in place.
- 15 Except in the fabrication of prestressed concrete members, drilled piles, and drilled shafts, do not drop concrete more than 5 feet unless flexible metal or rubber-like pipes are used. Take special care to fill each part of the form by depositing the concrete as near to its final position as practicable. Work back the coarse aggregate from the face of the forms and force concrete around the reinforcement without displacing the bars. Do not jar the forms after the initial set of the concrete. Do not place any strain on the ends of lap reinforcement projecting from the forms.
- 16 Consolidate concrete by continuously working with a suitable tool or by the use of an internal vibrator in accordance with **Subsection 702.4.2.4**. If vibration cannot be done effectively because of obstruction by reinforcement or other causes, consolidate concrete by vibrating the form in a manner satisfac-

tory to the RCE.

- 17 Except in the fabrication of prestressed concrete members, place concrete in horizontal layers not more than 18 inches thick, unless hereinafter specified. When less than a complete layer of concrete is placed in one operation, terminate it in a vertical plane. To prevent injury to the green concrete and to avoid surfaces of separation between the batches, place and compact each batch in a layer before the preceding batch has taken initial set.
- 18 When the placing of concrete is temporarily discontinued, wait until concrete has become firm enough to retain its form, and then, clean the concrete of laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid as many visible joints as possible, smooth the surface of the concrete adjacent to the forms with a trowel.

702.4.2.2 Construction Joints

- 1 Do not provide construction joints except for those shown on the Plans or those approved by the BCE. Provide approved bulkheads and keys as specified below.
- 2 When joining fresh concrete to concrete that has already set, thoroughly clean the surface of the concrete in-place and adjacent forms and remove all chalky, loose, or foreign materials. Clean reinforcing steel so that it is free from loose or thick rust, dirt, scale, dust, paint, oil, concrete mortar, curing compound, or other foreign material. In inaccessible places, such as small columns and thin walls, clean the surface as stated above before setting the forms. Immediately before placing the new concrete, draw the forms tight against the concrete already in-place; thoroughly wet the old concrete surface and coat with a thin coating of mortar, neat cement, or other suitable bonding material.
- 3 When shown on the Plans, make the construction joint resistant to shear by placing raised or depressed keys on the surface of the concrete first poured. In general, make the width of the key about 1/3 of the total width of the section and make the key occupy about the middle third of the section. Make the height/depth of the key about 1/3 of its width. Steel dowels may be used instead of keys only upon the written approval of the BCE.

702.4.2.3 Pumping Concrete

- 1 Make certain that vibrations from pumping equipment do not damage freshly placed concrete. Provide a suitable type of pumping equipment with adequate capacity for the work. Ensure that the pump provides a continuous stream of concrete without air pockets.

702.4.2.4 Vibration of Concrete

- 1 When required, use vibrators in conformance with the requirements of **Subsection 702.3.1**.

- 2 Vibrate all classes of concrete except Class 4000DS and Class 4000S. Use vibrators during placement of non-prestressed concrete as specified in this subsection. For prestressed concrete, use vibrators as specified in **Subsection 704.4.4.1** in addition to the requirements of this subsection.
- 3 Apply vibration at the point of deposit and in the area of freshly deposited concrete. Slowly insert and withdraw the vibrators from the concrete. Ensure that the vibration is of sufficient duration and intensity to thoroughly compact the concrete, but do not continue to the point of causing segregation. Do not continue vibration at any one point to the extent that localized areas of grout are formed.
- 4 Apply vibrators at uniformly spaced points, but not farther apart than twice the radius that the vibrator is visibly effective.
- 5 Supplement vibration by spading as is necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.
- 6 Perform vibration in a manner that avoids contact with forms and ties as much as is practicable. Do not use vibrators to move the concrete.

702.4.2.5 Mass Concrete Placement

- 1 Use procedures for mass concrete placement for a pour that has dimensions of 5 feet or greater in 3 different directions. In the case of a circular cross-section, a mass concrete placement is defined as a pour that has a diameter of 6 feet or greater and a length of 5 feet or greater. Mass concrete requirements do not apply to Drilled Shafts (Class 4000DS) and Foundation Seals (Class 4000S).
- 2 For all mass concrete pours, do not allow the mix temperature to exceed 80°F measured at discharge into the forms. Maintain a temperature differential of 35°F or less between the interior and exterior of all mass pour elements during curing.
- 3 Before placing mass concrete, submit to the BCE for review and acceptance a *Mass Concrete Placement Plan* containing, but not limited to, the following:
 - Analysis of the anticipated thermal developments within mass pour placements using the proposed materials and casting methods,
 - *Temperature Control Plan* outlining specific measures to control the temperature differential within the limits noted above, and
 - Details of the proposed monitoring system.
- 4 Submit for review by the OMR all special concrete mix designs, which are part of the *Temperature Control Plan*.
- 5 Provide temperature monitoring devices to record temperature development between the interior and exterior of the element at points accepted by the BCE and closely monitor the mass pour temperature differential. Generally, use one monitoring point in the center of the largest mass of concrete

and a second point approximately 2 inches inside the face nearest to the first monitoring point. Continue monitoring temperature until the interior temperature is within 35°F of the lowest ambient temperature or a maximum of two weeks. Provide the RCE with a copy of each set of readings as they are taken and a temperature chart for each mass pour element showing temperature readings vs. time.

- 6 If the monitoring indicates that the proposed measures are not controlling the concrete temperature differential within the 35°F specified, make the necessary revisions to the *Temperature Control Plan* and submit the revised plan for review.
- 7 The Contractor assumes all risks connected with placing a mass pour of concrete. RCE review of the Contractor's *Mass Concrete Placement Plan* will in no way relieve the Contractor of the responsibility for obtaining satisfactory results. Should any mass concrete placed under this specification prove unsatisfactory, make the necessary repairs or remove and replace the material at no expense to the Department.
- 8 Provide the control of temperatures in mass concrete pours in addition to any other requirements found on the Plans and/or in the Special Provisions that apply to the work in question. Include all costs associated with temperature controls for mass concrete placement in the unit cost of the concrete.

702.4.2.6 Depositing Concrete Underwater

- 1 When concrete is permitted to be deposited in water by the Plans, the Special Provisions, or with the written approval of the BCE, ensure that the concrete and procedure conform to the following requirements:
 - A. Conform to the requirements of **Subsection 712.4.13** for depositing Class 4000DS concrete in water.
 - B. Make certain that Class 4000S concrete has a slump of approximately 8 inches.
 - C. When considered desirable, use a water-reducing retarder to delay the initial set of the concrete deposited under water in the proportion accepted by the OMR.
 - D. To prevent segregation, carefully place the concrete in a compact mass in its final position by means of a tremie, or other method accepted by the BCE, and do not disturb the concrete after being deposited.
 - E. Maintain still water at the point of deposit.
- 2 Unless otherwise permitted, place concrete seals continuously from start to finish and keep the surface of the concrete as nearly horizontal as is practicable at all times. Ensure thorough bonding by placing each succeeding layer of a seal before the preceding layer has taken its initial set. Remove all laitance and foreign matter from the top surfaces before any concrete is placed upon it in the dry.
- 3 If a tremie is used to place the concrete, support the tremie to permit free

movement of the discharge end over the entire top surface of the work and to allow rapid lowering when necessary to retard or stop the flow of concrete. At the start of work, close the discharge end with an approved plug or mechanical means to entirely seal the tremie tube and prevent the entry of water. Keep the tremie tube full to the bottom of the hopper. When a batch is dumped into the hopper, induce the flow of concrete by slightly raising the discharge end of the tremie while keeping it in the deposited concrete. Make certain that the flow is continuous until the work is complete. Two or more complete tremies including hoppers may be required by the BCE for large footings and other locations where the additional tremies are considered desirable.

702.4.2.7 Concrete Exposed to Tidal Water

- 1 Make certain that concrete structures exposed to tidal water are constructed with maximum resistance to the disintegrating action of the water. Where reinforced concrete is used in tidal water, accurately place the reinforcement and rigidly hold it in place. Make certain that the clear distance from the face of the concrete to the nearest face of any reinforcement bar is not less than the clearance shown on the Plans.
- 2 Except for the initial surface finish, do not disturb the original formed surfaces below the elevation of high tide. In order to secure a thick and dense surface film, heavily coat the form surface with shellac or acceptable form oil.
- 3 In tidal water, do not locate construction joints in concrete between the elevations of extreme low tide and extreme high tide as indicated on the Plans. Bring to the attention of the BCE field conditions that are not addressed in the Plans that may affect the construction joint location or cause deterioration of concrete, such as wave action or other conditions. The BCE will implement changes if warranted.
- 4 Deposit concrete in-the-dry in tidal water within the range of tidal water indicated in paragraph 3 above. Do not allow tidal water to come in direct contact with the concrete until the concrete has hardened for at least 3 days.

702.4.2.8 Temperature Control

702.4.2.8.1 Concreting in Cold Weather

- 1 Before starting work on the project, submit a written *Placing and Curing Plan* that includes measures and equipment to ensure that the air temperature surrounding the concrete is maintained at a temperature above 50°F as monitored by Hi-Lo thermometers placed on the concrete surface for a period of 3 days after the concrete is placed. If curing blankets are used, make certain that they conform to the requirements found in **Subsection 702.3.4**, and remain in place for a minimum of 4 days. Provide provisions in the plan for sudden temperature changes below those forecasted during the curing period. If dry heat is used, provide a means of maintaining moisture in order to maintain the concrete in a wet condition during the curing period.
- 2 Do not place concrete unless specifically authorized by the RCE, who may

only issue such authorization upon receipt and acceptance of a written *Cold Weather Batching and Mixing Plan* as specified in **Subsection 701.4.4.2**.

702.4.2.8.2 Concreting in Hot Weather

- 1 Before starting work on the project, submit a written *Placing and Curing Plan* that includes measures and equipment to maintain the temperature of concrete below 90°F, with the exceptions of Class 2500 concrete and mass concrete pours. Ensure that the plan conforms to the applicable requirements of ACI 305R, *Hot Weather Concreting*. The plan may incorporate one or more of the following provisions as necessary to control the concrete temperature:
 - A. Schedule work so that concrete can be placed with the least possible delay.
 - B. Sprinkle coarse aggregate with water to cool by evaporation.
 - C. Use chilled mixing water or shaved ice to replace part of the mixing water, and consider the use of Type II cement.
 - D. Reduce loss of water through absorption by pre-wetting the sub-grade or forms just before pouring so that they will not absorb water from mix.
 - E. Spray forms and reinforcing steel with cool fresh water just before placement of concrete.
 - F. Erect windbreakers to prevent wind from drying exposed concrete surfaces while they are being finished.
 - G. Screed and float concrete as it is placed, and start curing procedures immediately.
 - H. Use water-curing methods to provide evaporative cooling.
- 2 Do not allow the temperature for Class 2500 concrete to exceed 95°F. Do not allow mass concrete mix temperature measured at discharge into the forms to exceed 80°F.
- 3 Do not place concrete unless specifically authorized by the RCE, who may only issue such authorization upon receipt and acceptance of a written *Hot Weather Batching and Mixing Plan* as specified in **Subsection 701.4.4.2**.

702.4.2.8.3 Responsibility for Satisfactory Results of Temperature Control

- 1 The Contractor assumes all risks connected with the placing of concrete, and any permission given to place concrete under such conditions will in no way relieve the responsibility for satisfactory results. Remove, dispose of, and replace all unsatisfactory concrete at no expense to the Department.
- 2 Provide the control of temperatures in concrete placement in addition to any other requirements found on the Plans and/or in the Special Provisions that may apply to the concrete placement. Include all costs associated with temperature controls for concrete placement in the unit cost of the concrete.

702.4.3 Setting Finished Grade of Concrete Bridge Deck Slabs**702.4.3.1 Setting Finished Grade When Covered with a Wearing Surface**

- 1 After concrete is placed in deck slab forms, strike-off the top to the proper crown and longitudinal profile with an approved template. Do not deviate from the surface indicated on the Plans by more than $\frac{1}{2}$ inch.

702.4.3.2 Setting Finished Grade When Not Covered with a Wearing Surface

- 1 As soon as the concrete has been placed and vibrated in the deck slab forms in a section of sufficient width to permit working, strike-off the concrete with sufficient passes of the screed to obtain the required grade (usually 1 or 2 passes for the transverse screed and 2 or 3 passes for the longitudinal screed are sufficient).
- 2 Maintain a slight excess of mortar along the entire leading edge of the screed at all times to fill low spots. On the final pass of the screed, leave the surface true to grade and free from water, laitance, or other conditions leading to an undesirable surface. Take care to remove all such surplus material from the gutters where final hand finishing is permitted. Complete all screeding before the initial set of the concrete has taken place.
- 3 As screeding is completed at the beginning or end of a pour, especially where fresh concrete adjoins hardened concrete, carefully check the surface of the slab in the longitudinal direction with a 20-foot straightedge, or if approved by RCE, use a 10-foot straightedge due to the vertical curve ordinate. Correct all abrupt changes that would affect the surface smoothness while the concrete is still plastic. Closely following the final pass of the screed, texture the surface by using a drag composed of 2 layers of wet burlap on a transverse screed or an RCE approved broom on longitudinal screeds.
- 4 Finish the surface of the deck under sidewalks or barriers to the proper grades shown on the Plans and finish the surface to the same surface texture as the wearing surface. Along the edges of the slab where the screed cannot pass, make certain that concrete finishers use a straightedge, minimum 4 feet in length, and ensure that the proper slope of the deck is maintained.
- 5 In the case of concrete slab spans or concrete girder spans supported on falsework, finish the top surface of the slab with a camber sufficient to offset the dead load deflection of the slab and the long-term creep of the concrete while still maintaining the proper vertical curve ordinate. Unless otherwise directed by the BCE, use a camber of $\frac{1}{8}$ inch for spans 20 to 30 feet long. Place camber strips on the falsework support beams, bar joist, etc., which include the effect of dead load deflection and any applicable vertical curve ordinate to maintain the proper thickness of the deck.
- 6 For spans of 80 feet and under, the Contractor may use a longitudinal screed equal to the length of the span. For spans greater than 80 feet, but equal to or less than 100 feet, if possible, use a screed equal to the span length, but in any case, do not use a major longitudinal screed less than $\frac{1}{2}$ of

the span length.

- 7 Include all costs for labor, equipment, and other items necessary to provide the finished grade of concrete deck described above in the unit price of the concrete.
- 8 Have the slab checked by the RCE at representative locations using suitable means to determine deviations from the theoretical plan grade. Do not allow the maximum deviation from the theoretical plan grade to exceed 1/1200 of the bridge length or ½ inch, whichever is smaller. Do not allow the maximum deviation from the theoretical crown in a direction normal to the traffic direction to exceed ¼ inch. Remove excessive height of ridges formed by the finishing processes. If the Plans indicate that the future design traffic count is less than 1000 vehicles per day, with the RCE present, check the slab for smoothness by means of a rolling straightedge immediately after the curing operation is complete. Provide the rolling straightedge equipped with devices for marking irregularities in the slab surface of ⅛ inch or more in a length of 10 feet. For temporary detour bridges, ¼ inch or more in a length of 10 feet is acceptable. Details of an acceptable rolling straightedge are available from the BCE office and will be furnished on request.
- 9 In addition to the longitudinal rolling straightedge check, make certain that the deck surface meets a 0.20 inch in 10 feet straightedge check made transversely across the slab at a spacing determined by the RCE. Perform the longitudinal rolling straightedge tests first.
- 10 Remove or correct irregularities that exceed the maximum deviations stated in this subsection in a manner satisfactory to the RCE and/or BCE at no expense to the Department. Do not perform grooving before satisfying the requirements of this subsection.

702.4.4 Concrete Curing

702.4.4.1 Curing of Bridge Decks

- 1 Exercise caution to prevent plastic cracking from occurring in bridge decks. Follow the latest ACI 224R and ACI 305R guidelines on control of cracking and hot weather concreting.
- 2 Protect freshly placed structural concrete from rapid drying. Use high efficiency multiple-head water foggers with individual shut-off valves or an alternative acceptable to the BCE to increase the humidity directly above the fresh concrete until the curing mats are placed. Demonstrate the fogger system for the RCE and make certain that it is accepted before placing concrete. Do not allow the foggers to spray directly onto the concrete. However, condensation from the foggers that wet the concrete without causing surface damage is acceptable. Provide a minimum of two foggers with a third back-up fogger on hand in case of a breakdown. Provide additional foggers as required for wide and/or large deck pours. The use of a pressure washer with a fine mist nozzle on the wand in lieu of using foggers is acceptable provided there is a satisfactory performance in the field as determined by the RCE. Make certain that the system does not drip or pond water on the concrete. Ensure that the

system sprays over the concrete (a minimum of 4 feet) and not directly on the concrete and maintains the humidity over the entire surface of the concrete until the curing mats are installed. Be aware that these measures alone may not prevent plastic cracking of the deck. Provide other preventative measures as necessary including windbreaks, placement of approved curing compound, or if necessary, delaying the pour until more suitable conditions.

- 3 Wet-cure the top surface of the bridge decks for a minimum of 7 days.
- 4 Construction traffic may be placed over the slab if 90% of the 28-day compressive design strength has been reached even though curing blankets are still in place. Obtain approval from the RCE to place construction traffic on the slab in less than 7 days. Base strength on breaks of cylinders that have been cured similarly to the deck.
- 5 Provide and maintain a curing box at the testing site to cure cylinders for 28-day breaks. Make certain that the curing box is capable of holding cylinders at a temperature between 60°F and 80°F until cylinders are shipped to the OMR for storage in a curing room before conducting compression breaks. Provide a Hi-Lo thermometer to monitor the temperature range. Modify the curing box as necessary if the required temperature range is not being maintained.
- 6 Perform curing by use of curing blankets conforming to the requirements of **Subsection 702.3.4**. Place curing blankets as soon as practicable after placing the concrete. Overlap edges of blankets. Re-wetting of the curing blankets may not be required if the blankets remain wet and the edges remain sealed throughout the 7-day curing period.

702.4.4.2 Curing Structural Concrete Other than Bridge Decks

- 1 Wet-cure structural concrete other than bridge decks for a period of 4 days and cover with curing blankets described in **Subsection 702.4.4.1**. Re-wetting of the curing blankets and overlapping edges may not be required if the blankets remain wet and the edges remain sealed throughout the curing period. Cure precast and prestressed concrete members in accordance with the requirements of **Subsection 704.4.4.3**.
- 2 Polyethylene sheeting may be used for curing concrete columns. Take extreme care and make certain that the overlapping edges of the adjacent wraps and the extreme edges of the sheeting are sealed and a saturated condition is maintained at all times inside the enclosure.
- 3 If a final finish coating is specified by the manufacturer as being capable of acting as a curing membrane, apply the coating immediately on any portions of the structure that require a finish coating. Apply material at the rate as specified in **Subsection 702.4.11**.

- 4 A clear, non-wax, water-based, dissipating membrane-curing compound may be used as soon as practical instead of curing blankets. Ensure that it meets the requirements of **Subsection 702.2.2.11**.
- 5 Apply the curing compound as soon as the finishing of the concrete surface is complete. Apply the compound uniformly at a rate of at least 1 gallon per 150 square feet until the entire surface has a solid and vapor-tight coating of the curing compound. Apply the compound by means of a spray nozzle that is held 2 feet or less from the concrete surface. If necessary, protect the spray from the wind by suitable means. Keep the spray nozzle and other spraying equipment clean at all times.
- 6 If rain falls on the newly sprayed surface before the film has sufficiently dried, immediately as conditions permit, re-spray the surface to the specified thickness. Where the curing compound is inadvertently applied to surfaces against which new concrete is to be cast, including projecting reinforcing steel, completely remove the compound by the use of steel wire brushes or by other means accepted by the RCE.
- 7 Protect the sprayed surface film from abrasion or damage for at least 3 days. Do not allow the placing of forms, lumber, reinforcing steel, equipment, or unnecessary walking on the surface until the film is at least 3 days old.

702.4.5 Removal of Falsework and Forms

- 1 In order to obtain a satisfactory surface finish, remove the forms for ornamental work, railings, parapets, and other vertical surfaces that will be exposed in the finished work as soon as the concrete has hardened sufficiently to allow the removal of the forms without damaging the edges, corners, and faces of the concrete. Do not remove the forms in less than 5 hours, nor more than 48 hours, unless the concrete is poured on Friday, in which case the forms may be removed the following Monday. Column and pier forms may be removed after 24 hours.
- 2 Keep forms and falsework under slabs, beams, girders, caps, arches, and structures or parts of structures carrying static dead loads in place until the concrete compressive strength reaches at least 75% of the design strength. Make additional test cylinders and cure under similar conditions for use in form removal strength determinations.
- 3 Do not use methods of form and falsework removal that are likely to cause overstressing of the concrete. In general, remove the forms from the bottom upward. Do not remove forms without the consent of the RCE.
- 4 Strike falsework supporting concrete beams, slabs, and brackets that will support sidewalks, concrete railing, or other applicable items before the sidewalk, concrete railing, or the other items are cast.
- 5 Make additional strength control cylinders if early removal of falsework is desired. The falsework may be struck when these cylinders, cured under the same conditions as the concrete in the structure, have developed a unit strength of 75% of the required 28-day compressive design strength. How-

ever, do not subject such concrete to a superimposed load until the compressive strength develops 90% of the required compressive design strength. Assist in transporting the additional strength control cylinders to the OMR for testing.

- 6 Extra test cylinders for early form or falsework removal will be at no additional expense to the Department.

702.4.6 Protecting and Loading Recently Placed Concrete

- 1 Do not place beams, girders, or other precast elements on concrete substructures until the concrete in the substructure develops a minimum of 75% of the design compressive strength. Do not place deck concrete until the concrete in the substructure develops a minimum of 90% of the design compressive strength.
- 2 Do not place backfill or fill for retaining walls, abutments, piers, wingwalls, or other structures that will retain material to an elevation higher on one side than on the other until the concrete develops a minimum of 90% of the specified design strength.
- 3 Do not place backfill for arch culverts and box culverts to an elevation higher than 1 foot above the top of footing or bottom slab until the concrete develops a minimum of 90% of specified design strength.
- 4 Adhere to the following time and strength requirements when performing construction activities on or near recently placed concrete:
- Wait a minimum of 12 hours between placing footing or drilled pier concrete and erecting column forms.
 - Wait a minimum of 24 hours between placing footing and drilled pier concrete and placing column concrete.
 - Wait a minimum of 72 hours between placing column concrete and beginning erection of cap forms or until column concrete attains a minimum of 75% of the design compressive strength as verified by testing extra test cylinders.
 - Wait a minimum of 96 hours between placing column concrete and placing cap concrete or until column concrete attains a minimum of 75% of the design compressive strength as verified by testing extra test cylinders.
 - Wait a minimum of 12 hours after a drilled shaft or drilled pile concrete has achieved the initial set, determined by the RCE or BCE, before installing adjacent piling or drilling adjacent shaft/drilled pile within a 20-foot radius of the cast concrete item. Multiple shafts or piles may be drilled before placing concrete if the drilled holes remain in a stable condition. For non-cased drilled shafts or drilled piles, wait until the cast concrete attains a minimum of 75% of the design compressive strength, verified by testing test cylinders, before placement of a construction vehicles or equipment are allowed within the 20-foot radius of the cast concrete item.

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- 5 Do not blast within a 50-foot radius of any cast structural concrete item until the cast item attains 90% of the design compressive strength verified by testing concrete test cylinders.
- 6 The requirements of this subsection are minimum requirements. Additional restrictions or increased wait times may be required to protect the concrete if deemed necessary by the RCE or BCE. Suspend any activity determined by the RCE or BCE to be detrimental to the concrete item cast regardless of the distance from the cast concrete until such time as the RCE or BCE allows the activity to proceed or until the cast concrete attains a minimum of 90% of the design compressive strength verified by testing concrete test cylinders.
- 7 Do not place highway traffic, construction vehicles, and/or construction loads/equipment on a bridge deck or approach slab until the concrete develops a minimum of 90% of the specified design compressive strength verified by testing concrete test cylinders.
- 8 Do not abruptly start or stop construction vehicles, construction equipment, concrete trucks, etc. on bridge deck(s) and/or approach slabs. Do not mix concrete in a truck mixer while the truck is on the deck without permission from the RCE. To avoid excessive vibrations while placing concrete barrier rail or parapet, do not place any equipment on the deck except for one concrete truck mixer if required. Do not place other equipment or traffic on the deck until concrete barrier rails and parapet walls obtain a minimum of 75% of the compressive design strength verified by testing test cylinders.
- 9 Make test cylinders for early testing to determine the concrete compressive strength for all items of the structure that are required to meet 75% of the design compressive strength.
- 10 Make early break test cylinders to determine concrete strength if early live loading, including highway traffic and/or construction equipment loading is desired. Assist the RCE in the making and transporting of early break test cylinders to the OMR.
- 11 If loads or equipment exceeding 80,000 pounds gross weight are intended to be placed on the structure, submit 7 copies of the proposed plan with calculations for placing the load(s) on the structure for review, comments, and written acceptance by the BCE. Have the plan and design calculations prepared by a South Carolina registered Professional Engineer.

702.4.7 Initial Surface Finish

- 1 Thoroughly vibrate and work the concrete in all structures during the placement operation by means of suitable tools. Ensure that the vibrating and working forces the coarse aggregate from the surface and thoroughly works the mortar against the forms to produce a smooth finish free from water-pockets, air pockets, sand streaks, and honeycombing.
- 2 As soon as the concrete has met the strength requirements specified in **Subsection 702.4.5**, carefully remove the forms. Immediately following form removal, perform the initial surface finishing as described herein.

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- 3 Remove fins and ridges in the concrete surface resulting from misaligned forms by grinding or other methods accepted by the RCE.
- 4 Use sand and cement mortar to carefully point all depressions resulting from the removal of metal ties and other holes and rough places. Make sure pointed surfaces are flush with the surrounding structure surface by means of a wooden float (or equivalent) before setting of the sand and cement mortar mixture occurs.
- 5 The RCE may assess a 10% price reduction to the unit bid price of concrete that does not have the initial surface finish described above completed within 7 calendar days of form removal. Provide this initial surface finish to all surfaces to receive the final finish in accordance with **Subsection 702.4.11**.

702.4.8 Repair of Concrete Surface Defects

- 1 After initial finishing is complete, the RCE will inspect the concrete surfaces. Repair minor surface defects as specified herein. When it is necessary to add a thin layer of structural grout/concrete to old concrete, use a suitable type of epoxy bonding compound that produces an adequate bond between the two layers. Make certain that the grout/concrete is suitable for the type of concrete repair for which it will be used, and that the epoxy compound meets the requirements of ASTM C 881. Obtain acceptance by the OMR or BCE of grout/concrete and epoxy before its use.
- 2 Make certain that repair areas have near-vertical edges and do not result in feathered-edged patches.
- 3 The repair described above does not apply to the top surface of bridge decks. Repair defective areas of concrete on the top surface of bridge decks in accordance with the requirements of **Subsection 702.4.10**.

702.4.9 Repair of Cracks in Top Surface of Bridge Decks

- 1 Fill bridge deck cracks or portions of cracks, including construction joints, with widths of 0.007 inch or greater, which appear before the bridge is opened to the traveling public, at no expense to the Department. Fill the cracks using a gravity flow, low viscosity, crack healer/penetrating material capable of filling cracks down to 0.003 inch. Use crack sealing material meeting the requirements of ASTM C 881. Obtain acceptance of the crack sealing material from the RCE before its use. Maintain a small pond of epoxy over the crack long enough to allow the gravity flow to fill the crack. Once the flow has stopped, remove excess material from the deck surface before the epoxy hardens. If the cracks cannot be filled with the gravity flow material, use a pressure injectable product acceptable to the BCE. Fill cracks before any contamination of the cracks occurs. If the RCE suspects that cracks are not being adequately filled, take cores as directed by the BCE to verify the extent to which the cracks are being filled.

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- 2 Make repairs at no additional cost to the Department, and such repairs will not justify extension of the contract completion date.

702.4.10 Repair of Top Surface of Bridge Decks

702.4.10.1 Repair of Small Areas in Top Surface of Bridge Decks

- 1 Repair isolated small holes (approximately 1 inch or less in diameter) with near vertical sides with an epoxy patching material with sand added.
- 2 For small defective areas (equal or less than 4 square feet total) on the top surface of bridge decks, use the following repair procedure:
 1. Outline the defective areas and sawcut the outline to a minimum depth of 1½ inches.
 2. Remove all defective and/or delaminated concrete in the outlined areas by use of a concrete milling machine to a minimum patch depth of 1½ inches. A mechanical scarifier may be used on small areas. If jackhammers are used, limit the maximum size to 15 pounds. Do not damage the vertical sides of the sawcut during concrete removal.
 3. Remove all grease, dirt, oil, or foreign material from the patch areas by blast cleaning.
 4. Immediately before placing patching material, remove all dust, sand, and blasting debris with oil-free compressed air.
 5. Design a repair concrete mix with 35% Aggregate No. 89M stone by volume. Submit the proposed concrete mix design to the OMR for review and furnish a copy to the RCE. Do not use the mix until it has been accepted by the OMR.
 6. Immediately after cleaning, while the vertical edge surface is dry and the air temperature and concrete surface temperature are between 50°F and 80°F, apply an approved moisture resilient epoxy bonding compound meeting the requirements of ASTM C 881 in accordance with the manufacturer's recommendations to all vertical edges of the repair area.
 7. While the epoxy is tacky, pour in the accepted concrete repair mix.
 8. Finish off the top on the new patch to the proper grade and cure the patch in accordance with **Subsection 702.4.4.1**, unless otherwise directed by the BCE.
- 3 Complete repair work before grooving the bridge deck.
- 4 Make repairs at no additional cost to the Department. Repairs will not justify extension of the contract completion date.

702.4.10.2 Repair of Large Areas on the Top Surface of Bridge Decks

- 1 For large defective areas (greater than 4 and less than 500 square feet total) on the top surface of bridge decks, repair using the following procedure:
 1. Outline the defective areas and sawcut the outline to a minimum depth of 1½ inches.
 2. Remove all defective and/or delaminated concrete in the outlined areas by use of a concrete milling machine and/or jackhammers to a minimum depth of 1 inch below the top mat of reinforcing steel. A mechanical scarifier may be used on small areas. If jackhammers are used, limited the maximum size to 15 pounds. Do not damage the reinforcing steel or the vertical sawcut sides during concrete removal.
 3. Remove all grease, dirt, oil, or foreign material from the patch areas by blast cleaning.
 4. Immediately before placing patching material, remove all dust, sand, and blasting debris with oil-free compressed air.
 5. Design a repair concrete mix with 35% Aggregate No. 89M stone by volume. Submit the proposed concrete mix design to the OMR for review and furnish a copy to the RCE. Do not use the mix until it has been accepted by the OMR.
 6. Immediately after cleaning, while the vertical edge surface is dry, and the air temperature and concrete surface temperature are between 50°F and 80°F, apply an approved moisture resilient epoxy bonding compound meeting the requirements of ASTM C 881 or AASHTO M 235 in accordance with the manufacturer's recommendations to all vertical edges of the repair area.
 7. While the epoxy is tacky, pour in the accepted concrete repair mix.
 8. Finish off the top on the new concrete patch to the proper grade and cure the patch in accordance with **Subsection 702.4.4.1**, unless otherwise directed by the BCE.
- 2 Complete all repair work before grooving the bridge deck.
- 3 For the repair of extremely large defective areas on top surface of bridge decks (equal to or greater than 500 square feet total), place a low slump or latex overlay to restore the deck to an acceptable condition. Make certain the overlay conforms to the requirements of **Section 726**.
- 4 Make repairs at no additional cost to the Department. Repairs will not justify extension of the contract completion date.

702.4.11 Final Finish or Exposed Concrete Surfaces Other than Bridge Decks

702.4.11.1 General

- 1 Provide a final finish of exposed concrete surfaces of structures, except for bridge deck slabs, as specified in the Plans and in accordance with the following requirements for a sprayed or brushed finish. Unless otherwise specified, the finish used is at the option of the Contractor. However, use the same finish, either sprayed or the brushed, throughout the structure. Notify the RCE of the type surface finish intended for use before the start of the finishing work. Obtain verification from the finishing material manufacturer that the curing membrane material is compatible with the specified finishing material.
- 2 Use final finish coating material from sources appearing on the most recent edition of *SCDOT Qualified Product List 7*.
- 3 Furnish the following information with each shipment of finish coating material:
 - Material certification showing brand name,
 - Production batch or lot numbers,
 - Manufacturer's recommended rate of application,
 - Materials Safety Data Sheet,
 - Materials Data Sheet,
 - SC File No.,
 - Shipping date, and
 - To whom it is shipped.
- 4 Make certain that the certificate states that the material meets SCDOT specifications and is essentially the same as that appearing on the most recent edition of *SCDOT Qualified Product List 7*. Ensure that the shipped containers are plainly marked with the manufacturer's name and trademark, the production lot or batch number, a clear date indicating date of manufacture and/or shelf life expiration date, and application procedures. Submit for evaluation by the OMR all formulation changes after initial approval.
- 5 Apply finish coating material at the manufacturer's recommended rate of application.

702.4.11.2 Surface Preparation for Finish Coat

- 1 Remove all foreign matter such as dirt, dust, mildew, efflorescence, and curing compound on the surface by water blasting. Ensure that water used for cleaning is either a potable water or a clean supply approved by the RCE. Make certain that the water leaves no residue that would impair bonding. Provide water blasting equipment that has a minimum working pressure of 3000 psi with a 15-degree tip, an output of approximately 4.5 gallons per minute, a 10 HP or equivalent pump, and is equipped with a working pressure gauge near the nozzle to check the working pressure.

- 2 In the event the foreign matter is not removed by the water blast method, use an alternate cleaning method, such as sandblasting or high-pressure water blasting equipment, to clean the surface.
- 3 When a clear curing compound has been used, allow enough time (usually 20 to 45 days) for the membrane to dissipate, and then clean completely to remove any membrane that remains.

702.4.11.3 Application of Final Finish Coating

- 1 Allow the concrete to cure for 28 days before application of final finishing coat. A shorter cure time may be allowed by the RCE if it is recommended by the manufacturer of the material. After the surface is cleaned, apply the coating before contamination occurs. If adverse weather or other obstacles prevent a timely coating application, re-clean the surface as determined by the RCE. Make certain that the surface is clean and surface dry in accordance with the manufacturer's recommendations before application of the coating. If the coating is sprayed, use application equipment recommended by the manufacturer of the coating. Make certain the spray procedure is as approved by the coating manufacturer. Ensure that the coverage per gallon of the coating is in accordance with these specifications and does not exceed 60 square feet per gallon.

702.4.11.4 Sprayed Final Finish

- 1 Use a material for the high-build spray finish coat that is a factory mixed coating applied as a single spray coat at the rate of 55(± 5) square feet per gallon of coating. Ensure that the finish coat is uniform in color, coverage, and texture. The uniform coverage may vary in dry mil thickness depending on the properties of the product being used, but minimize variation by strict control of the application rate. Apply the spray coat uniformly to dry and clean surfaces that have received the initial surface finish. Allow the concrete to cure 28 days before application of the final finish coating. A shorter cure time may be allowed by the RCE if it is recommended by the manufacturer of the material. Apply the sprayed finish strictly in accordance with the written instruction of the product manufacturer. Ensure that the actual application of the material is done by an operator specially trained for this work and is skilled in the application of the sprayed finish.
- 2 Ensure that the spray material is for exterior coating. Use the color Near White (Federal Shade No. 37778) with smooth texture. The spray coating material may be solventborne or waterborne. Make certain that it meets the following requirements:
 - A. Durability by accelerated weathering testing is 5000 hours minimum in accordance with ASTM G 153.
 - B. Durability by freeze thaw testing is 50 cycles minimum without detrimental effect. Conduct the test procedure by means of a test chamber capable of maintaining a -15°F temperature for 1 hour and a +70°F temperature for 1 hour, which constitutes one freeze thaw cycle.

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- C. Durability by salt spray testing is 300 hours minimum in accordance with ASTM B 117 without loss of adhesion or deterioration of the coating.
 - D. Moisture vapor permeability is 0.4 metric perms minimum in accordance with ASTM E 96.
- 3 Make certain that the solventborne coating complies with the following requirements:
- A. The resin is a vinyl toluene acrylic copolymer resin having a sward hardness of 48 minimum when tested at 33.3% solids.
 - B. The solvent is mineral spirits (aliphatic).
 - C. The pigment is 55% minimum by weight.
 - D. The non-volatile vehicle (% by weight of vehicle) is 35% minimum.
 - E. VOC is 3.5 pounds/gallon maximum.
 - F. The coating total solids is a minimum 68% by weight.
- 4 Ensure that waterborne coating complies with the following requirements:
- A. The resin is 100% pure acrylic copolymer emulsion. Monomers are Butyl acrylate or methyl methacrylate. Vinyl acetates and styrene-modified copolymers are not allowed.
 - B. The solvent is water.
 - C. The pigment is 55% minimum by weight.
 - D. The non-volatile vehicle (% by weight of vehicle) is 20% minimum.
 - E. The coating total solids is a minimum 62% by weight.
 - F. The pH is 9.0 to 10.5.

702.4.11.5 Brushed Final Finish

- 1 At the Contractor's option, a brushed finish material may be applied to all exposed surfaces throughout the structure instead of a sprayed finish material. If selected, apply the brushed final finish material in 2 separate coats to provide a uniform finish of good texture on exposed surfaces that have received the initial surface finish. Mix the material and apply strictly in accordance with the written recommendations of the product manufacturer. Have the material applied by workers who have been instructed in the preparation and application of the material. Ensure that the final brushing of the material is generally done in one direction and results in a uniform and attractive appearance.
- 2 Use material recommended for brush application. Ensure that the material is specially manufactured for waterproofing exterior concrete surfaces and for enhancing the appearance of concrete surfaces. Make certain the final color of the finish is Near White (Federal Shade No. 37778) with a smooth texture.
- 3 Use material from a source appearing on the most recent edition of *SCDOT Qualified Product List 7*. Furnish the manufacturer's certification with each shipment stating that it meets the Department's specifications for a brushed-

on application.

702.4.12 Limits of Initial and Final Finishes

- 1 Apply initial surface finish to all concrete surfaces as soon as the formwork is removed.
- 2 On bridges, apply final finish to all exposed surfaces as noted on the Standard Note Sheet of the Plans or in the Special Provisions. Discontinue the final finish 6 inches below the final ground line or at the low-water line.
- 3 For culverts and minor structures, apply the final finish on all permanently exposed concrete surfaces and carry it 18 inches back from the edges of all surfaces to be covered with earth. Continue the final finish at least 24 inches inside the barrel of the culvert at each end.
- 4 No separate payment for the initial and final finishes for concrete structures is made. Include the costs of labor, materials, and equipment in the items of work that receive the finishes.

702.4.13 Treatment of Horizontal Surfaces Not Subject to Wear

- 1 For upper horizontal surfaces, such as the tops of handrails, curbs, caps, parapets, coping, and bridge seats, place an excess of concrete in the form and remove or strike-off excess with a wooden template after a suitable interval of time and force the coarse aggregate below the mortar surface. Do not use a mortar topping for these surfaces. Finish all bearing surfaces smooth and level, either with a suitable trowel or by means of a suitable dry rub with an abrasive after the concrete is at least 2 days old.

702.4.14 Bridge Deck Rideability

702.4.14.1 Rideability When Contractor Provides Stakes, Lines, and Grades

- 1 Provide stakes, lines, and grades in accordance with **Subsection 105.8.3**, and perform bridge deck smoothness tests using a longitudinal rolling 10-foot straightedge check and a 10-foot straightedge check transversely across the deck as specified in **Subsection 702.4.3.2**. When the Plans indicate that the design (future) traffic count is greater than 1000 vehicles per day, provide a surface smoothness in conformance with **SC-M-701**.
- 2 Payment for the above work is in accordance with **Subsection 105.8.3**

702.4.14.2 Rideability When the Department Provides Partial Lines and Grades

- 1 The Department will furnish the lines and grades for projects as specified in **Subsection 105.8.1**, except for all lines and grades affecting the bridge superstructure. This exception includes screed, overhang, beam, and header lines and grades, as well as parapet, rail, sidewalk, curb, or median lines and grades. Make certain of the proper computation and setting of the above-mentioned lines and grades. The RCE will make random checks of the lines and grades set by the Contractor to determine if the work is in substantial

conformance with the Plans. The bridge deck rideability requirements of **Subsection 702.4.14.1** apply to the bridge structure.

702.4.15 Grinding and Texturing Bridge Decks

- 1 After checking the bridge deck for maximum allowable deviations and rideability requirements, remove irregularities and excessive deviations by grinding and texturing the deck as necessary to meet the requirements specified.
- 2 Make certain that the equipment used for grinding and texturing does not cause damage to other bridge components and does not damage deck concrete that is to remain. Do not allow depth of grinding to exceed ½ inch nor encroach upon the required rebar cover by more than ½ inch.
- 3 Use machines with diamond blades to produce a uniform texture finish with a high skid number without an excessive noise level under traffic. Do not texture the deck surface within 12 inches of the gutter lines and within 2 inches of expansion or deflection joints. The Contractor may elect to produce a textured finish simultaneously with the grinding operation.
- 4 Remove debris and residue from the grinding and texturing operation by vacuum or other methods approved by the RCE. Make certain all residue is legally disposed of off the construction site or uniformly distributed in the roadway embankment as directed by the RCE. Ensure that the debris and residue does not remain on the bridge deck nor is washed into the bridge drainage system.

702.4.16 Grooved Surface Finish

- 1 Except for rehabilitated decks or decks with staged construction and after the concrete has been cured and all applicable rideability specifications have been satisfied, groove concrete deck slabs perpendicular to the centerline for non-skewed bridges or parallel to the expansion or contraction joint for skewed bridges. Cut the grooves into the hardened concrete using a mechanical sawing device that leaves grooves that are 0.125 inch wide and 0.125 inch deep. Provide grooves with a center-to-center spacing that vary randomly from 0.625 inch to 1.125 inches.
- 2 After the concrete has been cured and all applicable rideability specifications have been satisfied, groove rehabilitated decks or decks with staged construction longitudinally and parallel to the centerline.
- 3 Limit grooving on non-skewed bridge decks as follows:
 - A. Extend grooving to a point measured 12 inches perpendicular to the gutterline or 12 inches perpendicular to the edge of any raised median.
 - B. Extend grooving to a point measured 2 inches from and perpendicular to the edge of expansion or contraction joints.
 - C. Do not groove across expansion or contraction joints.

- 4 Limit grooving on skewed bridge decks grooved parallel to the expansion or contraction joint as follows:
 - A. Extend grooving to a point not further than 18 inches and not closer than 6 inches from and perpendicular to the gutterline or edge of raised median.
 - B. Extend grooving to a point not further than 8 inches and not closer than 2 inches from and perpendicular to the edge of expansion or contraction joints.
 - C. Do not groove across expansion or contraction joints.
- 5 Remove residue from the sawing operation from the deck by vacuum or other methods. Make certain all residue is legally disposed of off the construction site or uniformly distributed in the roadway embankment as directed by the RCE. Ensure that the residue does not remain on the deck nor is washed into the bridge drainage system.
- 6 Notify the RCE at least 3 calendar days before performing any deck grooving work. Provide a written groove pattern to the RCE for approval before the work begins. Do not perform grooving without the presence of the RCE or a Department representative on site to view the grooving operation.

702.4.17 Joints

702.4.17.1 General

- 1 Provide fixed and expansion joints in concrete structures only at the locations shown on the Plans or otherwise specified. Ensure that expansion joint material conforms to the requirements of **Subsection 702.2.2**. Set all steel armor plates, strip seal joint plates, steel finger joint plates, etc. at $\frac{1}{4}$ inch below the finish roadway elevation.

702.4.17.2 Open Joints

- 1 Construct open joints by the use of removable bulk-heading forms that are removable without injury to concrete.

702.4.17.3 Sliding Joints

702.4.17.3.1 Roofing Felt

- 1 When roofing felt is used, make certain that the supporting or first formed concrete surface is true, smooth, and parallel to the direction of movement. Take care in cutting, placing, and holding the roofing felt against this surface so that it is smooth, snug, and does not become displaced or damaged during concrete placement. Hold the roofing felt in place by the forms or by asphalt cement carried well beyond the area of contact, then cut back after the forms are stripped and all rubbing and finishing near the joint is completed. Ensure that the entire joint presents a neat, workmanlike appearance, with absolutely no contact between the concrete on each side of the joint, and the joint is free to move in the proper direction for the required distance.

702.4.17.3.2 Metal Plates

- 1 When metal plates are used as friction joints, anchor them in the correct position with full bearing, and all sliding surfaces are planed true and smooth. When placed in position, thoroughly coat all sliding surfaces with graphite or other RCE approved lubricant. Do not impede movement because of contact with surfaces other than bearing surface.

702.4.17.3.3 Mortised Joints

- 1 Construct mortised joints as shown on the Plans and generally consisting of a concrete or metal element sliding in a concrete or metal socket. Ensure that the construction permits freedom of movement in the two opposite directions and is watertight and rustproof to the greatest extent practicable.

702.4.17.4. Fixed Joints

- 1 Separate fixed joints between superstructure and substructure by a layer of ¼-inch thick elastomeric bearing pads, unless otherwise shown on the Plans. Unless otherwise specified, furnish elastomeric bearing pads in conformance with the requirements of **Section 724**, including measurement and payment.

702.4.17.5 Expansion Joints**702.4.17.5.1 General**

- 1 Ensure that expansion joint materials consist of pre-molded filler, elastomeric compression seals, or deck joint strip seals.

702.4.17.5.2 Compression Seal Joints

- 1 Fabricate filled compression joints from elastomeric compression seals or pre-molded filler, or both as indicated on the Plans or in the Special Provisions or as directed by the BCE, and conforming to the requirements of **Subsection 702.2.2**.
- 2 Cut the joint filler out of the least number of pieces practicable to completely fill the space shown on the Plans. Bond the various pieces in the joint together as recommended by the manufacturer and approved by the OMR. Do not permit loose fitting sections or gaps between sections of filler or between filler and concrete or steel headers. Hold the material in place by asphalt cement or adhesive recommended by the manufacturer or by other suitable and RCE approved means.

702.4.17.5.3 Hot Poured Elastic Filler Joints

- 1 Sawcut or form joints in concrete in accordance with **Subsection 501.4.13**. Fill formed joint with hot applied elastic filler material as specified in ASTM D 6690, Type III.
- 2 To avoid damaging hot poured elastic filler material by excessive heating, melt the filler material in a double-walled, oil-bath kettle. Cut the material into appropriate sized pieces with a hot spade and lower slowly into the kettle. Stir continuously to prevent local overheating. Keep the kettle filled to approximately half of its capacity at all times by adding new pieces as material is

withdrawn. Provide an accurate pyrometer and heat the material in accordance with the manufacturer's instructions. Take care not to overheat the material. Watch for and avoid excessive smoke, which is one indication of local overheating.

- 3 Fill joint to within $\frac{3}{8}$ inch of the top surface of the slab. After joints are filled, the left over material in the kettle may be re-cut into suitable size pieces and re-heated later.

702.4.17.5.4 Deck Joint Strip Seals

- 1 Furnish and install deck joint strip seals in conformance to the requirements of **Section 723**.

702.4.17.6 Special Expansion Joints

- 1 Special types of expansion joints may be used when specified on the Plans or in the Special Provisions.

702.4.18 Encased or Supported Pipes and Conduits

- 1 Furnish and place pipes and conduits encased in the concrete as shown on the Plans or as specified in the Special Provisions without compensation unless otherwise specified.
- 2 In cases where the Department has authorized the placement of public utilities on a structure, the necessary pipes or conduits and any devices for supporting such utilities will be furnished by the owners of the utilities involved. Place such supporting devices without extra compensation unless otherwise specified on the Plans and/or in the Special Provisions.

702.4.19 Weep Holes and Drains

702.4.19.1 General

- 1 Locate and construct weep holes and drains or grates as indicated on the Plans or as directed by the RCE. No additional compensation will be made for such work. No deduction in measurement of concrete is made for these openings.

702.4.19.2 Weep Holes and French Drains for Box Culverts

- 1 When called for on the Plans, construct weep holes and French drains as described herein in box culverts that have inside vertical dimensions of 6 feet or greater. Provide 3-inch diameter weep holes in the outside walls of culverts and wingwalls at intervals of about 8 feet at an elevation of about 12 inches above the estimated normal water elevation. Cover the inside face of the weep hole with a 12 inch x 12 inch square of fiberglass or plastic mesh or grid that allows water to pass freely, but prevents the loss of the aggregate. Connect the weep holes with 12-inch square French drains constructed with aggregate conforming to Aggregate No. 5 or 57.

702.4.19.3 Weep Holes and French Drains in Retaining Walls

- 1 Construct weep holes in retaining walls with a height of 6 feet or more above footing. Space the holes approximately 20 feet on centers, or as shown on the Plans, and locate at or slightly above finished ground line elevation on the exposed side of the wall. Provide 3-inch diameter weep holes unless otherwise specified. Cover the inside face of the weep hole with a 12 inch x 12 inch square of fiberglass or plastic mesh or grid that allows water to pass freely, but prevents the loss of the aggregate. Connect the weep holes with 12-inch square French drains. In addition, extend 12-inch square French drains vertically above each weep hole to within 2 feet of the top of the retaining wall. Construct the French drains with aggregate conforming to Aggregate No. 5 or 57.

702.4.20 Bridge Sidewalks and Curbs

- 1 Take utmost care in placing and finishing curbs and sidewalks. Ensure that they are placed true to line and grade and meet ADA requirements. Screed, float, and finish the surface in a manner satisfactory to the RCE.

702.4.21 Widening Existing Concrete Structures

- 1 Dimensions of new construction on a widening project are subject to existing conditions, therefore, field verify all dimensions before ordering beams and performing any work on existing bridges. Make at least three profile line surveys of the existing bridge decks at the locations determined by the RCE. Make the profile line surveys at 5-foot intervals and determine elevation to the nearest 0.002 of a foot. Use identical stations for all surveys in order to facilitate survey comparisons. Compare the cross slope, bridge grades, and stationing of the actual surveys with the widening Plans to aid in determining the amount of necessary adjustments needed to eliminate any conflicts and improve the alignment of the new structure with respect to the existing structure.
- 2 Anticipate having to perform grinding and texturing of the deck in order to meet the longitudinal rolling straightedge, rideability, and transverse straight-edge requirements as specified in **Subsection 702.4.14**. Check the depth of the concrete cover over the reinforcing steel and limit the proposed grinding and texturing accordingly. For each structure, submit to the RCE for review and acceptance the following:
 - All plotted survey profiles,
 - Proposed grinding and texturing procedures,
 - Proposed grinding depths,
 - Existing concrete cover information,
 - Proposed finished grades, and
 - Proposed substructure elevations and stationing.
- 3 Include all costs of the abovementioned work, except grinding and texturing, in the lump sum price bid for Construction Stakes, Lines, and Grades, which includes all materials, labor, equipment, tools, and traffic control.

- 4 When casting new concrete against existing concrete, clean the contact surface of the existing concrete of all loose concrete, dirt, oil, grease, and any other deleterious material to the satisfaction of the RCE. In addition, before placing the new deck slab concrete, sawcut the edge of the existing deck slab (1 inch minimum) to give a straight line to tie into. Thoroughly roughen to an amplitude of $\frac{1}{4}$ inch just before casting the new concrete. Also, just prior to casting the new deck concrete, coat the portion of the existing slab from the top surface down to the top layer of reinforcing steel with a bonding epoxy conforming to ASTM C 881, Type II. Apply bonding epoxy in accordance with the manufacturer's written recommendations.
- 5 If feasible, embed in the new concrete all reinforcing steel protruding beyond the existing concrete surface after removal of the designated portion of the existing concrete. Unless a concrete overlay is used, cut off reinforcing steel that cannot be embedded in the new concrete to 1 inch below the existing concrete surface and patch the resulting hole with an epoxy-sand grout accepted by the BCE. When an overlay is used, cut off the reinforcing steel that cannot be embedded flush with the surface of the concrete.
- 6 Include the entire cost of removal and disposal of designated portions of existing bridge, including all drilling and chipping necessary to construct the new structure in the lump sum price bid for Removal and Disposal of Designated Portions of Existing Bridges.
- 7 At no expense to the Department, repair or replace in a manner satisfactory to the BCE any portion of the existing structure damaged by the Contractor's operations. Any other necessary repairs to the existing structure that are not called for in the Plans, and in the opinion of the BCE are needed, are paid as extra work.

702.5 Measurement

- 1 Measurement for work for concrete items described in this section is not made under this section. Measurement is made in accordance with other sections of these specifications that govern the items of work included in the concrete structure. No separate measurement is made for stay-in-place (SIP) steel bridge deck forms. Include all the cost of materials, labor, equipment, tools, supplies, and incidentals necessary to furnish and install permanent steel bridge deck forms in the contract unit bid price for the concrete item.
- 2 Measurement for the quantity of concrete in the bridge slabs is computed from the neat line dimensions shown on the Plans with no allowance for form deflection. No additional payment is made for extra concrete required by the use of permanent steel bridge deck forms or for the SIP forms themselves.
- 3 Unless otherwise specified herein, on the Plans, or in the Special Provisions, joints are not measured for separate payment. Include all materials, labor, equipment, tools, supplies, and incidentals necessary to furnish and install expansion joints, except deck joint strip seals, in the contract unit bid price for deck slab concrete.

- 4 Deck joint strips seals are measured and paid for in accordance with **Subsections 723.5 and 723.6.**
- 5 The quantity for the pay item Grooved Surface Finish is the surface area of the bridge deck provided with the grooved finish and is measured by the square yard (SY), complete, and accepted. Deck area not grooved is not included in the measurement.
- 6 There is no measurement for payment for grinding and texturing of new bridge decks to correct irregularities and excess deviations that are the fault of the Contractor. The quantity for the pay item Grinding and Texturing Concrete Bridge Deck for the removal or correction of irregularities and excessive deviations at the junction of new and existing bridge deck slabs is measured by the square yard (SY) of deck area ground and textured, complete, and accepted.

702.6 Payment

- 1 No separate payment, except as noted below, is made for compliance with this section. Consider all costs of the work described in this section incidental to the project and included in other items of work.
- 2 If the RCE requires inspection and certification of any falsework system by a South Carolina registered Professional Engineer as described in **Subsection 702.4.1.4.3**, payment will be made by Change Order. However, if the inspection reveals that the falsework system does not comply with the Working Drawings, no payment is due.
- 3 Payment for the accepted quantity of Grooved Surface Finish, measured in accordance with **Subsection 702.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for providing a grooved surface finish as specified or directed and includes cutting grooves into the harden concrete deck; removing and disposing of the debris; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Payment for the accepted quantity for Grinding and Texturing Concrete Bridge Deck, measured in accordance with **Subsection 702.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for removing or correcting irregularities and excessive deviations at the junction of new and existing bridge deck slabs and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

702.6

702.6

5 Pay items under this section include the following:

Item No.	Pay Item	Unit
7023200	Grooved Surface Finish	SY
7028000	Grinding and Texturing of Concrete Bridge Deck	SY

SECTION 703

REINFORCING STEEL

703.1 Description

703.1.1 General

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for furnishing and placing reinforcing steel consisting of bars, wire, wire mesh, bar supports, and ties.

703.1.2 Production of Iron and Steel Products on Federal Aid Projects

- 1 On federal-aid projects, use only iron and steel products, including tie wire and supports for reinforcing steel and coatings, for which the manufacturing processes occurred in the United States in accordance with **Subsection 106.11**.

703.2 Materials

703.2.1 Reinforcing Bars

- 1 Provide reinforcing bars (rebar) and dowels that meet the requirements of ASTM A 706 with a minimum single yield strength level of 60,000 psi, designated as Grade 60 and are from a source listed on the most recent edition of *SCDOT Qualified Product List 60*. Acceptance or rejection of all reinforcing steel is based on 30-inch long samples taken in the field and tested by the OMR or an OMR authorized AASHTO accredited testing laboratory.

703.2.2 Wire and Wire Fabric

- 1 Provide wire for concrete reinforcement, either as such or in fabricated form, conforming to AASHTO M 32 or AASHTO M 225. Provide welded steel wire fabric for concrete reinforcement meeting the requirements of AASHTO M 55.

703.2.3 Galvanized Reinforcing Bars

703.2.3.1 Use and Production

- 1 Use zinc-coated galvanized deformed steel reinforcing bars in structural concrete where shown on the Plans and extend it to the limits shown. Provide zinc-coated reinforcing steel in structures that is hot-dip galvanized in accordance with ASTM A 767, Class II, 2 ounces per square foot with a minimum thickness of 3.5 mils. Galvanize the steel bars after fabrication.
- 2 Do not use reinforcing steel produced by water quenching method.

703.2.3.2 Repair of Galvanized Reinforcing Steel

703.2.3.2.1 Shop Repair

- 1 Reject zinc-coated reinforcing steel bars that do not meet the requirements above and do not repair such reinforcing steel bars.

703.2.3.2.2 Field Repair

- 1 Field repair damaged areas of the rebar coating and replace bars exhibiting severely damaged coatings. Make certain that the field repair material has a minimum of 65% zinc by weight. Provide a minimum repair coating thickness of 3.5 mils.
- 2 The RCE and/or BCE will be the sole judges of the severity of damaged areas for purposes of repair or replacement. Do not incorporate into the work any reinforcing bar having a coating determined by the RCE and/or BCE to be severely damaged. Remove such rebar from the work site. Replace the damaged rebar in kind at no additional cost to the Department.

703.2.3.3 Handling, Placing, and Fastening

- 1 Provide systems for handling galvanized coated bars that have padded contact areas for the bars, wherever possible. Pad all bundling bands and lift all bundles with multiple supports or a platform bridge to prevent bar to bar abrasion from sags in the bar bundle. Do not drop or drag the bars or bundles. Flame cutting of the ends of reinforcing steel is allowable if requested, and such request is reviewed and approved by the RCE. Grind/trim ends of flame cut bars to remove any burrs and/or sharp edges before field coating.
- 2 Provide galvanized tie wire in accordance with AASHTO M 232, Class D or stainless steel. Ensure that chairs and reinforcing steel supports are plastic in Zone A (as defined in **Subsection 703.2.6.1**) and plastic or galvanized in Zone B. Have the specific hardware intended for use approved by the BCE.

703.2.4 Mechanical Couplers for Reinforcing Steel**703.2.4.1 General**

- 1 Ensure that all mechanical coupler components are compatible with the reinforcing bars specified in this subsection and that all splices with the mechanical couplers are made as specified and detailed on the Plans. In selecting a coupler, consider the clearance requirements for correct installation and proper alignment of the reinforcing after installation.

703.2.4.2 Quality Control Manager

- 1 Designate in writing, to the RCE, a Quality Control Manager (QCM) for all mechanical couplers. The QCM is responsible for the quality of the mechanical coupler splicing, including the inspection of materials and workmanship and for submitting, receiving, and approving all correspondence, required submittals, and reports to and from the RCE. The QCM may be an employee of the Contractor.

703.2.4.3 Material Information and Certification

- 1 Provide from the coupler manufacturer a description of the device, including dimensions, designations, material specifications, and the method of packaging and identification. Ensure that the couplers develop at least 125% of the actual yield strength of the control bar under the static tension test. When Ultimate Couplers are required, ensure that mechanical couplers develop ul-

imate butt splice connection strength under the static tension test of 100% of the specified tensile strength of the bar. Additionally, supply to the RCE detailed installation instructions from the mechanical coupler manufacturer for each type of mechanical coupler being used. Obtain the information required above in a document from the manufacturer certifying that the product meets the applicable SCDOT specifications.

703.2.4.4 Manufacturer's Quality Control Testing Facility and Reports

703.2.4.4.1 General

- 1 Ensure that all manufacturer quality control testing is performed in a laboratory that has been reviewed and accepted by the SME representative or has been satisfactorily inspected by AASHTO Materials Reference Laboratory (AMRL) for all applicable tests. Ensure that the qualified laboratory used to perform the manufacturer's quality control testing of all splices and control bars meets and complies with the requirements of **Subsections 703.2.4.4.2 through 703.2.4.4.5**.

703.2.4.4.2 Facilities

- 1 Ensure that the qualified laboratory has a tensile testing machine capable of breaking the largest bar requiring testing.

703.2.4.4.3 Markings

- 1 Ensure that the reinforcing bars are marked in such a way to measure any slippage across the splice.

703.2.4.4.4 Operators

- 1 Ensure that the machine operators have received formal training and are certified to perform the testing in conformance with ASTM A 370.

703.2.4.4.5 Calibration

- 1 Ensure that the qualified laboratory has a record of annual calibration of testing equipment performed by an independent third party that has standards that are traceable to the National Institute of Standards and Technology (NIST) and has a formal reporting procedure, including published test forms.

703.2.4.4.6 Test Reports

- 1 Ensure that the qualified laboratory submits test reports that include the following:
 - Sampling procedures,
 - Test specimen preparation procedures,
 - Test procedures, and
 - Results of all tests performed.

703.2.4.5 Quality Control (QC) Test Requirements

- 1 A lot of mechanical couplers is defined as 150, or fraction thereof, of the same type of mechanical couplers used for each bar size and each bar deformation pattern that is used in the work. Test sample splices in conformance with these specifications and the requirements of ASTM A 370.
- 2 For all mechanical couplers testing performed, in accordance with the test criteria, test in tension an unspliced control reinforcing bar of each size used in order to establish the actual yield and ultimate stress values and strain in the bar at actual yield stress. Ensure that for any bar group, all bars used for testing are from the same heat number. After all of the splices in a lot have been completed, provide the RCE with written statement from the QCM stating that all couplers in this lot conform to the specifications.

703.2.4.6 Quality Assurance (QA) Test Requirements

- 1 For each lot of each splice size, two complete samples of couplers with reinforcing bars of the same heat numbers that are being used in the work and one control bar from that same heat will be randomly obtained at the project site by the SCDOT inspector and submitted to the OMR for testing. Ensure that complete reinforcing bars with coupler splice samples and control bar samples are a minimum length of 30 inches long and are accompanied by a Certified Mill Test Report for the control bar's heat number. In the event one sample fails, submit a check sample of two couplers for testing.

703.2.4.7 Handling and Storage

- 1 Protect exposed threaded bars on staged work by installing the threaded coupler on the in-place bar and capping the open end of the coupler. Immediately before installation, check the threads and ease of rotation of any threaded parts of couplers to detect contamination that could cause blinding. Regardless of the method of mechanical coupling used, prevent damage to or contamination of the reinforcing or coupling devices that will inhibit or negatively affect the certified behavior of the device. If in the opinion of the RCE, such damage or contamination exists, replace the reinforcing, couplers, or both, or remove the contamination to the satisfaction of the RCE at no additional time or cost to the Department. In the choice of couplers, consider the clearance requirements for correct installation and proper alignment of the reinforcing after installation.

703.2.5 Ultimate Butt-Welded Splices (UBWS)

703.2.5.1 Material

Use UBWS containing steel that conforms to the requirements of **Subsection 703.2.1** and is from a manufacturer (mill) listed on the most recent edition of *SCDOT Qualified Product List 60*.

703.2.5.2 Fabricator Pre-job Test Requirements

- 1 Before incorporation into the work, ensure that Ultimate Butt Welded Splices are fabricated in conformance with the following pre-job test requirements:
 - A. Notify the OMR at least 14 calendar days before beginning production for the project so that a source visit can be arranged. The OMR will make random visits to the fabricator during production.
 - B. Obtain 4 pre-job sample splices and 4 control bars (total of 8 bars for 1 set) for each bar size UBWS that will be used in the work.
 - C. Fabricate the sample splices using the same splice materials, position, operators, location, and equipment, and following the same procedures that will be used to make the splices in the work.
 - D. Perform all fabricator pre-job testing in a laboratory that has been reviewed and accepted by the OMR.
 - E. Make certain that all sets of UBWS from each pre-job test conform to the test criteria specified herein. For each set, obtain a pre-job test report prepared by the laboratory performing the tests. Have the official, who represents the laboratory and accepts the responsibility for the report's contents, sign the report. Ensure that the report contains, as a minimum, the following information for each set:
 - SCDOT Contract No.,
 - SC File No.,
 - Bar size,
 - Type of splice,
 - Physical condition of test sample splice and control bar,
 - Any notable defects,
 - Limits of heat affected zone,
 - Location of visible necking area,
 - Ultimate strength of each splice,
 - Ultimate strength and 95% of this ultimate strength for each control bar,
 - Actual yield strength of each control bar, and
 - Comparison between 95% of the ultimate strength of each control bar and the ultimate strength of its associated splice.
 - F. Submit the pre-job test report to the OMR and the RCE for review and acceptance.

703.2.5.3 Quality Assurance (QA) Test Requirements

703.2.5.3.1 General

- 1 A UBWS lot is defined as a shipment of the same type of UBWS used for each bar size and each heat number that is used in the work. Test samples in accordance with **Subsection 703.2.5.3.4**.

- 2 Perform QA tests for all UBWSs used in the work. A QA test is considered as a sample splice and corresponding control bar removed from each lot of completed splices at the project site. The RCE will randomly select the sample splices to be removed from the lot and the associated control bar. Remove the sample splice and obtain the control bar in the presence of the RCE. Obtain all samples requested by the RCE at no additional cost.

703.2.5.3.2 Test Sample Requirements

- 1 A test sample of UBWSs will be randomly selected at the project site for each size and shipment of material for the work. Make certain that each sample is
 - A minimum of 30 inches in length with the splice located at mid-point,
 - Accompanied by a Certified Mill Test Report for that bar's heat number, and
 - Suitably identified before shipment with weatherproof markings.

703.2.5.3.3 Control Sample Requirements

- 1 Provide one control bar from the same bar lot as the test sample splice. Make certain that the control bars are
 - A minimum of 30 inches in length, and
 - Suitably identified before shipment with weatherproof markings.
- 2 Identify and mark each sample splice and its associated control bar as a set. When a portion of any hoop reinforcing bar is removed from assembled cages or columns to obtain a sample splice and control bar, replace the removed portion using a pre-qualified Ultimate Mechanical Butt Splice, or replace the hoop in kind.
- 3 Securely bundle together the set from each QA test and identify the bundle with a completed sample identification card before shipment for testing. Bundles of samples not containing a complete set of one sample splice and one associated control bar will not be tested. Submit a copy of the manufacturer's Certified Mill Test Report with each sample set.
- 4 Ensure that all sample test results are satisfactory before encasing any splices in concrete. If any splices are encased before receiving notification from the RCE, it is expressly understood that any material not conforming to these specified requirements will be subject to rejection, and the replacement of removed material will be at the no expense to the Department.

703.2.5.3.4 Test Criteria

- 1 Test the tensile strength of sample splices in conformance with the requirements described in ASTM A 370. Make certain that sample splices rupture in the reinforcing bar either
 - Outside of the heat affected zone, or
 - Within the heat-affected zone, if the sample has achieved at least 95% of the ultimate tensile strength of the control bar associated with

the sample.

- 2 In addition, ensure that necking of the bar is visibly evident at rupture regardless of whether the bar breaks inside or outside the heat-affected zone. The heat-affected zone is the portion of the reinforcing bar where any properties of the bar, including the physical, metallurgical, or material characteristics, have been altered by fabrication or installation of the splice.
- 3 Determine the ultimate tensile strength of each control bar by tensile testing the bar to rupture. Test the ultimate tensile strength for all applicable control bars, regardless of where each sample splice ruptures. Test sample splices for ultimate strength and the corresponding control bars for yield and ultimate strength.
- 4 Any material not conforming to the requirements herein will be subject to rejection. If the sample splice or control bar fail to conform to these provisions, all splices in the lot represented by the QA tests will be rejected.
- 5 If the sample splice and control bar from a QA set passes, all splices in the lot will be considered acceptable.
- 6 Do not mix or combine the lots of UBWSs being tested before the successful completion of the QA tests.

703.2.5.4 Corrective Action

- 1 Whenever a lot of UBWSs is rejected, fulfill the following requirements before using additional UBWSs in the work:
 - A. Perform a complete review of the producer's quality control process for these splices.
 - B. Submit a written report to the OMR describing the cause of failure for the splices in this lot and provisions for correcting the failure in future lots.
 - C. Ensure that the OMR has provided the RCE notification that the report is acceptable. The OMR will have at least 10 calendar days to review the report and notify the RCE of the report's status. The RCE will have at least 5 calendar days after notification to determine the course of action for the project.
- 2 If a QA test for any lot fails, replace all reinforcing bars representing failing sample splices before the RCE selects additional splices from the replacement lot for further testing.
- 3 When sampled bars are repaired with a pre-qualified Ultimate Mechanical Butt Splice as described in **Subsection 703.2.5.3**, QA tests are not required on the repaired splices.

703.2.6 Bar Supports

703.2.6.1 General

- 1 Unless otherwise approved in writing by the BCE, utilize plastic bar supports in lieu of wire bar supports in Zone A, which consists of Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry, and Jasper Counties.
- 2 Wire bar supports or plastic bar supports may be utilized in Zone B, which consists of all counties not in Zone A.
- 3 Provide bar supports for galvanized rebar as specified in **Subsection 703.2.3.3**.

703.2.6.2 Wire Bar Supports

- 1 Ensure that the wire bar supports comply with standard type and classes of protection as specified in the CRSI *Manual of Standard Practice* unless noted otherwise in this subsection, on the Plans, or in the Special Provisions. Space wire supports to provide adequate support for slab reinforcing steel.
- 2 For flat slab spans, support the lower layer of slab steel with Beam Bolster (BB) bar supports. Place 1 row near each end of span with interior rows spaced approximately 24 inches on centers.
- 3 For beam spans, support the lower layer of slab steel with Beam Bolster (BB) bar supports spaced approximately 36 inches on centers with a minimum of three rows between longitudinal beams and one row on each overhang placed not more than 12 inches from edge of slab. Ensure that the BB bar supports have Class 1 maximum protection, unless shown otherwise in the Plans. Support top reinforcing bars by Continuous High Chairs Upper (CHCU) bar supports or Beam Bolster Upper (BBU) bar supports as shown on the Plans and spaced a maximum of 30 inches on centers.
- 4 Provide tie wire galvanized in accordance with AASHTO M 232, Class D or stainless steel, for use with galvanized bars. Use black tie wire for non-galvanized bars.

703.2.6.3 Plastic Bar Supports

- 1 Ensure that plastic bar supports meet the following requirements:
 - A. Chairs and bolsters are of adequate strength to resist a 300 pound concentrated load without permanent deformation or breakage.
 - B. The plastic bar support material is manufactured from either resin or first generation recycled thermoplastic resin, is colored white, gray, or black, and is chemically inert in concrete.
 - C. Plastic reinforcing bar supports are in a configuration that does not restrict concrete flow and consolidation around and under the reinforcing bar support.

703.2.6.4 Concrete Blocks

- 1 When concrete is to be placed directly on soil, concrete blocks may be used to support reinforcing bars. Cast the blocks holding the lower reinforcing bars in position from concrete of the same materials and proportions as that used in the structure, and ensure that the blocks are properly cured. Do not use blocks over 6 inches in length. Place blocks to permit their ends to be covered with concrete. Do not use pebbles, pieces of broken stone or brick, metal pipe, or wooden blocks to support reinforcing bars.

703.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

703.4 Construction

703.4.1 Protection of Materials

- 1 Store steel reinforcement on platforms, skids, or other supports raised above the ground a minimum of 6 inches and protect it as far as practicable from mechanical injury, surface deterioration, and mud splatter. Place polyethylene sheeting or other acceptable material on the ground under the reinforcing steel and ground supports to minimize the possibility of mud splatter contamination. When placed in the work, ensure that steel reinforcement is free from loose or thick rust, dirt, scale, dust, paint, oil, concrete mortar, curing compound, or other foreign material. Ensure that the surface condition of the reinforcement is acceptable to the RCE before using it in the work.

703.4.2 Bending

- 1 Bend the reinforcement accurately to the shapes shown on the Plans. Utilize competent personnel for cutting and bending and provide the proper equipment for such work. Ensure that bar bending is performed in accordance with recommendations in the *CRSI Manual of Standard Practice*, unless otherwise shown on the Plans.
- 2 All dimensions relative to clearances are from the edge of the reinforcing steel to the edge of the concrete. All dimensions relative to spacing of reinforcing steel are from center to center of the bars. The overall length of the bars shown in the steel tables is the overall length of the bars along their centerlines after bending.
- 3 Provide finished bars conforming to the shapes and dimensions called for on the Plans and in the Special Provisions. Make any allowances necessary to account for creep in the bars during bending to secure the shapes and dimensions called for on the Plans and in the Special Provisions.

703.4.3 Placing and Fastening

- 1 Accurately place reinforcement, and during the placing and consolidation of concrete, firmly hold in the positions shown on the Plans. Maintain distances from the forms and between layers by means of concrete blocks, hangers, bolsters, or other approved supports complying with requirements of **Subsection 703.2.6**.
- 2 Hold the reinforcement together by tie wire at all intersections except where the spacing is 12 inches or less in each direction, in which case tie alternate intersections. Hold bars projecting beyond a construction joint in place by templates during concreting to ensure proper position.
- 3 Before concrete is deposited in the forms, replace, adjust, or bend back any steel or wires that project nearer to the forms than specified by the Plans. Correct to the satisfaction of the RCE all reinforcement that is not in its proper position, properly wired, and clean as specified in **Subsection 703.4.1**. Do not deposit concrete until the RCE has inspected the condition of the reinforcing steel and given permission to place concrete. Unless otherwise provided or permitted by the BCE, do not place reinforcement into the concrete as the concrete is being placed.

703.4.4 Splicing of Bars

703.4.4.1 General

- 1 Furnish all reinforcement in the full lengths indicated on the Plans unless otherwise permitted. Except for splices called for on the Plans, do not splice bars without advance written approval from the BCE. Stagger approved splices when possible.

703.4.4.2 Lapped Splices

- 1 Provide lapped splices of the length shown on the Plans. If not shown on the Plans, provide the length of lapped splices in accordance with the *AASHTO LRFD Bridge Design Specifications* and approved by the BCE. In lapped splices, place and wire the bars to maintain the minimum distance to the surface of the concrete shown on the Plans.

703.4.4.3 Ultimate Welded Lap Splices

- 1 Use welded splices only if detailed on the Plans or with the written approval of the BCE. Make certain that the welds conform to the AWS D1.4, *Structural Welding Code - Reinforcing Steel*.
- 2 Make welded lap splices with low-hydrogen type electrodes. Before beginning the fabrication of the splices, submit for approval by the OMR the welding procedure and two test samples. Ensure that the Ultimate Welded Lap Splices under the static tension and compression test develop at least 100% of the specified ultimate tensile strength of the bar. Repair hot dipped galvanized welded bars by use of a zinc rich formulation subject to approval of the OMR.

703.4.4.4 Ultimate Welded Butt Splices

- 1 Use Ultimate Welded Butt Splices only if detailed on the Plans or with the written approval of the BCE. Make certain that Ultimate Welded Butt Splices meet the requirements of **Subsection 703.2.5**.

703.4.4.5 Mechanical Couplers

- 1 Use Mechanical Couplers only if detailed on the Plans or with written approval of the BCE. Make certain that Mechanical Couplers meet the requirements of **Subsection 703.2.4**. Do not install any couplers until the passing strength test reports for that lot have been provided to the RCE.

703.5 Measurement

- 1 The quantity for Reinforcing Steel for Structures is the weight of reinforcing steel placed in a structure in accordance with the reinforcing steel schedule shown in the Plans unless otherwise directed and is measured by the pound (LB), complete, and accepted.
- 2 The weight of the bar supports is not included in the reinforcing steel quantity. Bar supports are considered incidental to the reinforcing steel work and all cost of furnishing and placing bar supports is included in the contract unit bid price for Reinforcing Steel for Structures.
- 3 The diameter, area, and theoretical weight of reinforcing bars are computed using Table 1 in ASTM A 706.
- 4 The weight of reinforcing wire, welded wire fabric, and plain bar of sizes other than those listed in Table 1 of ASTM A 706, is computed from tables of weight published by CRSI or computed using the nominal dimensions and an assumed unit weight of 490 pounds per cubic foot. The cross-sectional area of wire in square inches is assumed equal to its MW- or MD-Size Number. If the weight per square unit of welded wire fabric is given on the Plans, that is the weight used in the quantity for payment.
- 5 The weight of steel reinforcement in precast members is not measured when the cost of the reinforcement is included in the contract unit bid price for the precast member. Threaded bars or dowels placed in the work and used to secure such members to cast-in-place concrete after the installation of precast members is measured in the quantity for Reinforcing Steel for Structures.
- 6 No allowance is made for clips, wire, separators, wire chairs, and other material used in supporting, spacing, and fastening the reinforcement in-place or for galvanizing such items. If rebars are substituted at the Contractor's request and results in more steel than shown in the Plans, only the amount shown in the Plans is included in the measurement.
- 7 The additional steel for splices that are not shown on the Plans even though they are authorized as provided herein, is not measured. Mechanical couplers are not measured and are considered incidental to reinforcing steel item.

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- 8 No allowance is made for the weight of galvanizing in computing the weight of reinforcing steel.

703.6 Payment

- 1 Payment for the accepted quantity of Reinforcing Steel for Structures, measured in accordance with **Subsection 703.5**, is determined using the contract unit bid price for the applicable item. Payment is full compensation for furnishing and placing reinforcing steel as specified or directed and includes fabricating, cutting, splicing, repairing or replacing, placing, and securing the reinforcing steel in structures and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
7031100	Reinforcing Steel for Structures (Roadway)	LB
7031105	Reinforcing Steel for Structures (Retaining Wall)	LB
7031200	Reinforcing Steel for Structures (Bridge)	LB
7031210	Spiral Reinforcing Steel for Structures (Bridge)	LB
7031220	Hoop Reinforcing Steel for Structures (Bridge)	LB
7031400	Galvanized Reinforcing Steel for Structures (Bridge)	LB

SECTION 704

PRESTRESSED CONCRETE

704.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for the manufacture, handling, and installation of precast, prestressed concrete beams, cored slabs, channels, and other prestressed concrete members in structures. Specifications for the precast prestressed concrete piles are also a part of this section. This work is performed in accordance with the Plans, **Sections 701, 702, 703, 709, 711**, and any other sections that are pertinent to such prestressed members, except that this section governs where at variance from the other section or sections. Prestressing by pretensioning or post-tensioning method, or a combination of 2 methods, is performed as required by the Plans, the Special Provisions, applicable Supplemental Specification, these specifications, and as directed by the RCE and the OMR.

704.2 Materials

704.2.1 Concrete

- 1 Provide concrete for prestressed members of the class specified on the Plans or in the Special Provisions. When no class is specified, use Class 5000 with a minimum 28-day cylinder compressive strength of 5000 psi. Ensure that concrete conforms to the provisions of **Section 701**, except for the following modifications:
 - A. Do not use marine limestone as a coarse or fine aggregate.
 - B. Do not use slag material as a coarse aggregate.
 - C. Type I, Type II, or Type III cement, an approved admixture to secure high early strength, an approved admixture to secure a retardation in the initial set of concrete, or an approved air-entraining admixture to secure more workability may be used at the Contractor's option.
 - D. Where an air-entraining admixture is used, adjust the proportions of ingredients to produce 27 cubic feet per cubic yard.

704.2.2 Prestressing Strands

- 1 Provide prestressing strands of either high-tensile-strength steel wire, high-tensile-strength seven-wire strand, or high tensile-strength alloy bars as called for on the Plans or in the Special Provisions. Assign a lot number to all wire, strand, or bars and tag for identification purposes before shipment. Similarly, identify all anchorage assemblies. Store prestressing tendon material off the ground and protect from the weather by means of a building or other accepted cover. Do not use any prestressing strands with loose scaling rust or pitting.

704.2.2.1 High-Tensile Strength Steel Wire

- 1 Ensure that high tensile-strength wire conforms to the requirements of AASHTO M 204.

704.2.2.2 High-Tensile Strength Seven-Wire Strand

- 1 Ensure high-tensile-strength seven-wire strand conforms to the requirements of AASHTO M 203.

704.2.2.3 High-Tensile Strength Alloy Bars

- 1 Ensure high-tensile-strength alloy bars conform to the requirements of AASHTO M 275.

704.2.3 Anchorage Devices

- 1 Provide a wedge-type end-fitting anchorage cone approved by the OMR for steel tendon anchorage. Ensure that the wedge-type anchorage cones for wire and strand are strong enough to develop at least 95% of the total specified ultimate strength of the tendon. Ensure that wedge-type anchorage device for alloy bar post-tensioning is of sufficient strength to develop the minimum ultimate stress specified for the nominal bar diameter. Ensure that the anchorage cones bear against embedded grids of reinforcing steel of approved type or anchorage plates of hot rolled steel having physical characteristics not less than that specified for AASHTO M 270, Grade 36.

704.2.4 Testing Prestressing Steel and Anchorages

- 1 Testing of prestressing steel will be arranged by the OMR without cost to the Contractor. Have the manufacturer supply the OMR with typical curves obtained from mill tests of the material furnished for use in checking stresses by means of observed elongation. In addition, have the manufacturer of the strand furnish affidavits certifying as to the required properties. Where the Department intends to require nondestructive testing of one or more parts of the structure, the Special Provisions will specify the required details of the work.
- 2 Furnish all of the materials specified for testing without cost to the Department and have them delivered in time for testing well in advance of the anticipated time of use. Ensure that all samples submitted are representative of the lot furnished and in the case of wire or strand, taken from the same master roll.

704.2.4.1 Samples of Pre-tensioning Strands for Testing

- 1 Furnish the following samples from each lot of material as selected by the Department's inspector:
 - Two pieces, one at least 40 inches long and one approximately 12 inches long, from each shipment of each strand size and each heat number, per every 5 reels or part thereof.

704.2.4.2 Samples of Post-Tensioning Strands for Testing

- 1 Furnish the following samples from each lot of material as selected by the Department's inspector:
 - A. For wires requiring heading: 5 feet,
 - B. For wires not requiring heading: sufficient length to make up one parallel-lay cable 5 feet long consisting of the same number of wires as the cable to be furnished,
 - C. For strand furnished with fittings: 5 feet between near ends of fittings, and
 - D. For bars furnished with wedge anchors: 5 feet between faces of anchor plates.

704.2.4.3 Testing of Anchorage Assemblies

- 1 Testing of Anchorage Assemblies is at the discretion of the Department.

704.2.5 Steel Reinforcement

- 1 Make certain that deformed steel reinforcement bars conform to the requirements of **Section 703**.

704.2.6 Post-Tensioning Grout

- 1 Use grout consisting of a commercial premixed grout approved by the OMR or a mixture of cement, water, and sand in the proportions of 1 bag of cement to 50 pounds of sand (all passing the No. 30 sieve) to about 5½ gallons of water. Use the amount of water to provide a grout of the consistency of thick paint. The sand may be omitted if desired, but take care to obtain the consistency stated above. Mix the grout in a mechanical mixer for at least 2 minutes and keep constantly agitated.

704.2.7 Grout for Prestressed Cored Slabs

- 1 Use a non-shrink, non-corrosive, and non-metallic grout approved by the OMR in the shear keys, dowel holes, and all recesses in the prestressed concrete of cored slabs that reaches a compressive strength of 5000 psi in 24 hours.

704.3 Equipment**704.3.1 Jacks**

- 1 Provide all equipment necessary for the construction and tensioning process. Calibrate gauges, jacks, and pumps as a system in the same manner in which they are used in the tensioning operations. Perform calibration and written documentation by an independent testing laboratory, calibration service, or under supervision of a South Carolina registered Professional Engineer. Provide this documentation to the OMR or SCDOT representative upon request. Perform calibrations at any time a tensioning system indicates erratic results, and in any case, at intervals not greater than 12 months.

704.4 Construction

704.4.1 General

- 1 Have all fabrication of prestressed concrete members in structures performed by a fabricator certified in accordance with the Prestressed Concrete Institute (PCI) Plant Certification Program for the category of work to be done. Have a PCI-certified technician at the plant supervise all work done on prestressed concrete members for SCDOT projects. Have this technician make certain that all prestressing operations are performed properly and assist the Department's representative in making tests and measurements that may be necessary. Have each precast/prestressed concrete fabricator submit to the OMR for review and acceptance a copy of the standard operating procedures (SOP) proposed for use at each permanent and/or temporary plant.
- 2 Place a permanent beam identification marking showing name or symbol of manufacturer, date cast, a number identifying the beam in the structure and SCDOT File No. in permanent paint on each beam at a location that is readily accessible and which will not be covered by diaphragms, etc. Where orientation of the direction of the beam in the span is critical, ensure that this information is painted clearly with appropriate arrows to show the proper erection of beam. Place the information, described above, on piles in an area that will not be covered by the cap.

704.4.2 Shop Plans and Working Drawings

- 1 Before commencing fabrication, submit for review and acceptance by the designer 7 sets of the complete Shop Plans that are signed and sealed by a South Carolina registered Professional Engineer certifying conformance with contract documents. Include details of the plant, forms, equipment, and method of fabrication, including pickup devices and tensioning and detensioning procedures in detail for manufacturing the precast prestressed concrete members. Also include strand elongation computations, procedure and sequence of jacking and release of the deflected strands, description of the holdup or holddown devices for the deflected strands, and other methods or procedures that may be desired by the Department in order to fully describe the fabrication of the prestressed members. Include complete information on post-tensioning and grouting details, procedures, and materials in the Working Drawings for post-tensioned construction.
- 2 Prepare and submit Shop Plans and Working Drawings in accordance with **Subsection 105.2** and **Section 725**.

704.4.3 Forms

- 1 Ensure all forms have smooth joints and produce surfaces of the concrete members free of fins. Use forms that are well braced to maintain true shape and dimension. If forms ties are used, use the snap-off or threaded type, so that no tie metal remains closer than $\frac{3}{4}$ inch from the surface of the concrete. Form the bottom corners of the beams with $\frac{3}{4}$ inch x $\frac{3}{4}$ inch (45-degree) chamfer whether or not shown on the Plans. Carefully and accurately locate holes, inserts and other items with tolerances appropriate for the function of

the item. Where voids are formed in a prestressed member, use a positive means to hold the voiding device accurately in position. Have all forms accepted by the OMR before casting any concrete. If at any time during the course of construction any form becomes damaged or deformed such that it will not produce members of the proper dimensions, repair or replace it. When forms are continually reused, use steel forms.

- 2 Recess holddown devices for deflected strands a distance of 1 inch or more from the exposed face of the concrete and fill the resulting holes with non-shrink grout. As an alternative, rest holddown device on the bottom form and allow the device to remain in place after concrete placement. Mechanically galvanize, in accordance with ASTM B 695, the portion of the device in contact with the form for a minimum distance of 1½ inches and fill any voids with non-shrink grout. Ensure that the non-shrink grout has the same compressive strength as the concrete in the beam and is suitable for use in overhead repairs.
- 3 Ensure that the finished prestressed beam or girder meets the tolerances shown on the *Standard Beam Details* sheet included in the Plans.

704.4.4 Concrete Work

704.4.4.1 Placing Concrete

- 1 Do not deposit concrete in the forms until the Department's representative has inspected the placement of the reinforcement, prestressing steel, post-tensioning ducts, anchorages and other items and has given approval thereof. Vibrate the concrete internally and/or externally as required for proper consolidation of concrete. Vibrate with care and in such a manner to avoid displacement of reinforcing steel, conduits, or strands.

704.4.4.2 Finishing Concrete

- 2 Do not correct irregularities in the surface of the beams or piles without the prior approval of the Department's representative. Excessive surface defects may be cause for rejection of a member. Fill all surface air and water holes greater than ¼ inch with mortar, and ensure that the surfaces are smooth and free from irregularities. Provide the outside faces of exterior beams the surface finish as set forth in **Section 702** on the surfaces of all beams, piles, and exterior sides of hollow core bridges.
- 3 Rough float the top surfaces of beams against which cast-in-place concrete will later be placed with a wooden float to bring grout to the surface and cover aggregate. Intentionally roughen the top surface to full amplitude of approximately ¼ inch.

704.4.4.3 Concrete Curing

- 1 Curing may be by the moist curing method or accelerated curing with low-pressure steam or radiant heat. Have all wet mats and covers accepted by the Department's inspector. Side forms may be removed when, in the opinion of the Department's inspector, the concrete has hardened sufficiently to permit such removal without damage to the concrete member. Additional curing

is not required after detensioning.

704.4.4.3.1 Moist Curing Method

- 1 Under normal curing temperatures, ensure that moist curing method conforms to the following requirements:
 - A. As soon as possible after the units have been cast, cover with mats and keep wet until the side forms are removed. After the side forms are removed, protect the units with wet mats and a vapor proof cover until the units have attained the strength requirements for detensioning.
 - B. If it is necessary to remove the protective covering to point up honeycomb areas or to give the units a surface finish, keep the surfaces of the units moist during the entire time that the units are uncovered. During the curing period, do not allow the concrete to be exposed to temperatures below freezing.

704.4.4.3.2 Accelerated Curing with Low Pressure Steam or Radiant Heat

- 1 Perform low pressure steam curing or radiant heat curing under a suitable enclosure to contain the live steam or the heat. Place the enclosure over the units as soon as possible after the concrete placement has been finished. Allow the concrete to attain its initial set before application of the steam or the heat. Apply steam or the heat no sooner than 2 hours (4 hours if retarders are used) after the final placement of concrete to allow the initial set of the concrete to take place. If the time of initial set is determined by AASHTO T 197, then the time limits described above may then be waived. During the waiting period in cold weather, maintain the temperature within the curing chamber between 50°F and 80°F with live steam or radiant heat.
- 2 To avoid localized high temperatures, do not direct the application of steam on the concrete forms.
- 3 Apply radiant heat by means of pipes circulating steam, hot oil, or hot water or by electric heating elements. Minimize moisture loss by covering all exposed concrete surfaces with wet mats.
- 4 During the application of live steam or radiant heat, increase the ambient temperature within the curing enclosure at a rate not exceeding 40°F per hour until the desired curing temperature is reached. Do not allow the average curing temperature within the enclosure to exceed 160°F. Do not allow the curing temperature at any single point to vary more than 10°F from the selected average curing temperature.
- 5 Provide recording thermometers at the one-third and two-thirds points of the bed to verify the curing temperature from the time of final placement of concrete to the time of cover removal. Remove the covers in a manner to avoid rapid temperature changes in the concrete.

704.4.4.4 Detensioning Prestressed Units

- 1 Units may be detensioned as soon as they have attained the required initial minimum compressive strength. If the units have been cured by accelerated curing methods, detension units as soon as possible after the required initial minimum compressive strength of the concrete has been reached and while the concrete is still warm. Cure test cylinders for determination of minimum compressive strength for detensioning with the girder or under matching conditions. Additional curing is not required after detensioning.

704.4.4.5 Inspection and Testing

- 1 Ensure that the Department's representative has free access to the fabrication plant at all times for the purpose of inspecting materials, plant facilities, and fabrication and curing procedures. Inform the Department's representative of planned concrete placement and curing schedule in advance of the start of any work to afford time for the testing of materials, the inspection of equipment, and review of procedures used in casting the units.

704.4.4.6 Cylinder Molds

- 1 Furnish an ample supply of cylinder molds for the casting of test cylinders. Have all molds approved by the OMR. A mold size of 4 inches x 8 inches is acceptable.

704.4.4.7 Compression Testing Machine

- 1 Furnish a machine capable of measuring the compressive strengths of concrete cylinders cast during the fabrication of the units. Calibrate annually all testing machines used to determine the stress release time for the units by an independent recognized calibration service. Have calibration reports available for review on request of the OMR.

704.4.5 Tensioning Procedure

704.4.5.1 General

- 1 During the course of construction, take special care to protect the prestressing wire, strand or bars from damage due to use of welding or cutting equipment. This provision, however, does not exclude the use of burning torches to cut the strand beyond the ends of the casting bed before stressing the strands nor to cut the strands or wires projecting from the ends of the members. Ensure that no lubricant, dirt, paint, or other bond-reducing material is deposited on the strands. If any such material is so deposited, clean the tendon to the satisfaction of the Department's representative.

704.4.5.2 Pretensioning

- 1 Show the number, size, and location of the strands required to induce the necessary prestress force on the Shop Plans. At the request of the Contractor, the BDE will give consideration to the use of other size strands or to the use of strands of higher ultimate unit stress, provided approximately the same concrete stress pattern and approximately the same beam camber is obtained in the substitute beam as would have been obtained in the original beam design. Obtain written permission from the BDE before any such changes are

made. Give each tendon of all sizes, an initial tension as shown on the approved Shop Plans. Measure this initial tension by some suitable means indicating the stress directly from the jacking gauge or a dynamometer and do not measure by elongation of the tendon. Apply the remaining prestressing force to the strands by means of hydraulic jacks equipped with gauges graduated to indicate the load applied to the strands within an accuracy of 2%. In general, monitor the application of the final force using the calibrated pressure gauge and verified by measured elongation of the strands. Report any discrepancy greater than 5% between the pressure gauge and the tendon elongation to the OMR and make corrections as directed.

- 2 Maintain the force applied as described above until the concrete is deposited and has reached the required initial minimum compressive strength, at which time the strands may be released to transfer the prestress to the concrete. Release the strands, so that there is not a sudden imposition of bond stress between the concrete and the strands. Release the strands symmetrically about the vertical axis of the concrete member.
- 3 Where deflected pretensioned strands are required, stress these strands first in a horizontal position by a partial force in the amount as shown on the approved Shop Plans. Obtain the final stress by deflecting the strands upward at points at or beyond the ends of the concrete beams, progressing from the center of the bed outward in both directions. The strands may be tensioned in their deflected position where suitable rollers are used and where it can be shown that the variation in tension throughout the length of the tendon will not exceed 2%. If only one beam is being prestressed and low friction rollers are used, then the tendon may be stressed in the deflected position.

704.4.5.3 Post-tensioning

- 1 Recalibrate jacks for post-tensioning before use if not calibrated within the past 6 months. Provide the calibration results of the jack and gauge certification to the OMR with a graph or table showing the calibration data. Have the calibration re-checked every 6 months or furnish a proving ring to check calibration of the jack.
- 2 Do not begin post-tensioning of beams until the concrete has reached the required initial minimum compressive strength. Stress all strand or wires in a tendon simultaneously. Stress strands not on the vertical axis of beam in such manner that the force during tensioning on one side of the vertical axis is not greater than that on the other side of the vertical axis to an extent to cause undesirable bending about such axis. Apply tension in each tendon in accordance with that specified on the Plans. Carry out jacking by means of hydraulic jacks equipped with pressure gauges. Ensure that the gauges read within 2% of the true jack force. Ensure that the elongation of strands is measured and the stresses checked in accordance with the requirements of Section 10 of the most current edition of the *AASHTO LRFD Bridge Construction Specifications*. Account for the observed slip occurring at the end anchorages in the elongation of the strands. After the post-tensioning force has been transferred to the concrete by means of the end anchorages, grout the

ducts containing the strands. Have the methods and materials for anchoring and grouting post-tensioning strands accepted by the Designer before use.

- 3 Force the grout into one end of the duct to be grouted until all entrapped air and water are forced out through the other end and/or through an orifice located at the high point of the duct, and a steady stream of grout is emitted. Close the outlet end and orifice while the grout is under pressure and the pressure increased to about 75 psi and held at this pressure for approximately 10 seconds. Plug the entrance end under this pressure. Beams may be lifted before grouting, but do not lift after grouting or apply any other loads until the grout has cured for at least 36 hours.
- 4 The Plans may show the post-tensioning tendon enclosed in steel ducts. The Contractor may form channels by means accepted by the Designer and pull the strands into these channels instead of using ducts. Do not use channels with an outside diameter that exceeds the outside diameter of the duct shown on the Plans. Place the ducts or channels accurately according to the profile shown on the approved Shop Plans. Secure ducts by wire or bar ties fastened to the vertical bars in the beams.

704.4.5.4 Combined Pretensioning and Post-Tensioning

- 1 When the Plans call for or allow a combination of pre-tensioning and post-tensioning, adhere to all of the requirements of both the pretensioning and post-tensioning.

704.4.5.5 Handling and Erection of Prestressed Members

- 1 Prestressed piles, beams, slabs, channels, and other components may be handled as necessary immediately after the pretensioned stress is released. Take care in handling, storing and transporting to prevent damage to the components by excessive vibration, impact, improper supports, or other faulty methods of handling, storing, and transporting. Lift beams by attachments located near the beam ends and store in an upright position by supporting as simple beams with the supports near the end bearing areas. Temporary lateral stiffening of beams may be necessary to avoid buckling tendencies due to loads/vibrations caused by wind or other external forces and construction practices. Prestressed members may be transported and erected or piles driven after 3 days of curing and attainment of the specified 28-day concrete compressive strength. Before starting erection work, submit to the BCE for acceptance an *Erection Plan* that fully details the method of erection and the amount and type of equipment to be used. Include in the *Erection Plan* any necessary temporary bracing to adequately prevent overturning of the member(s) until all permanent bracing is in place and secured. The acceptance by the Department does not relieve the Contractor of the responsibility for the safety of the proposed method or equipment, or from carrying out the work in full accordance with the Plans and the Contract specifications. Do not start work until such acceptance by the Department has been obtained. After erection and before placement of deck falsework, verify the camber in beams and report any discrepancies between the actual and plan camber to the RCE.

704.4.6 Prestressed Cored Slabs

704.4.6.1 General

- 1 Unless otherwise specified below, ensure that prestressed cored slabs conform to the requirements of this section.

704.4.6.2 Forms

- 1 Conform to requirements of **Subsection 704.4.3**. In addition, provide a $\frac{3}{4}$ -inch chamfer to bottom edges on ends and sides of all slab sections, top outside edges of exterior slab sections, and acute corners of slab sections. Round top edges on ends of all sections with a $\frac{1}{4}$ -inch finishing tool. Provide square corners on top edges on all slab sections along shear keys. Do not chamfer vertical edges at ends of slab sections.
- 2 Provide holes and recesses at locations indicated in the Shop Plans for insertion of a $\frac{1}{2}$ -inch transverse post-tensioning strand.

704.4.6.3 Finishing

- 1 Give a broom finish to the top surface of the cored slab sections. No surface finish is required for sides and bottom of the slab sections except the exposed side of the exterior slab sections. Fill all voids with grout on the exposed side of the exterior slab sections, making certain that the resulting surface finish is essentially the same color and surface finish as the surrounding concrete.

704.4.6.4 Shop Fitting

- 1 In order ensure a proper field fit, assemble the cored slab spans in the shop/yard and match mark the pieces. Make certain that the pieces fit together neatly and in a manner acceptable to the Department's inspector. Make certain of the correct alignment of the holes for the post-tensioning strand.

704.4.6.5 Transverse Post-tensioning

- 1 In each span, place a $\frac{1}{2}$ -inch diameter transverse post-tensioning strand(s) and tension to 30,000 pounds. Grease the transverse strand, and then place in a non-corrosive $\frac{1}{2}$ -inch diameter, $\frac{1}{16}$ -inch minimum wall thickness black polyethylene pipe meeting the requirements of ASTM D 2239. Do not apply the grease nor place the pipe in the areas of the recesses at the ends of the tensioning strands where grout is to be applied.
- 2 At the Contractor's option, and at no additional cost to the Department, a steel rod may be substituted for each $\frac{1}{2}$ -inch diameter transverse post-tensioning strand. Make certain that the tensioned rod provides a force equal to the force provided by the strand. Tension the rod using a calibrated wrench, or other means approved by the RCE to obtain the desired force in the rod. Galvanize the rod, nuts, and washers in accordance with ASTM A 153. If the steel rod is used, provide the size of hole and recesses in the cored slab units as required to accommodate the rod with adequate tolerance for erection. Submit a method for locking the nut in place after tensioning the

rod. Also, indicate on the Shop Plans all details associated with using the rod, such as hole size, location of voids, size of recess, etc.

- 3 After the ½-inch diameter transverse strand (or rod) has been tensioned in a span and before any equipment, material or barrier parapet is placed on the span, fill the shear keys and dowel holes with the non-shrink grout as indicated on the Plans and allow curing for a minimum of 3 days. Ensure that the grout reaches a compressive strength of 5000 psi in 24 hours. Properly remove any foreign substance/materials including grease from the exposed transverse strand or rod before grouting the recess.
- 4 With the approval of the RCE, material and equipment may be placed on the cored slab spans after the transverse strands have been tensioned to 30,000 lbs, the grout in shear keys has cured for 3 days minimum, and the grout has reached a compressive strength of 5000 psi.

704.4.6.6 Placement of Equipment Exceeding Legal Load Limits

- 1 Support cranes or other equipment exceeding the legal load limit on mats, but before cranes or other equipment exceeding the legal load limit are placed on the structure, submit design calculations to check the adequacy of the cored slabs and structure to support the equipment and mats without damage. Ensure that a Professional Engineer registered in South Carolina seals the detailed drawings and calculations. Submit the drawings and calculations at least 30 days before the placement of the equipment to allow time for the Department's review. Additionally, submit to the RCE for review detailed drawings of the mats intended to place on the cored slabs. Ensure that these drawings give a complete description and location of the equipment that is intended to be place on the mats. Adequately address any review comments to the satisfaction of the Department before placing equipment and mats on the structure. Regardless of the review and acceptance by the Department, the Contractor is solely responsible for all damage that occurs because of placing such equipment and mats on the structure.
- 2 No payment is made for any materials and work necessary including design drawings and calculations in the construction and loading of the mats.

704.5 Measurement

- 1 The quantity for the pay item Prestressed Concrete Beams (Type specified) or Cored Slab (of the size specified) is the length of the prestressed concrete beam or cored slab erected in accordance with the Plans and the Special Provisions and is measured by the linear foot (LF) of beam of the type and size specified, complete, and accepted.
- 2 Prestressed concrete piling is not measured for payment under this section of the specification, but is measured and paid for as specified in **Subsections 711.5 and 711.6**.
- 3 Other prestressed members are measured and paid for as specified on the Plans or in the Special Provisions.

704.6 Payment

- 1 Payment for the accepted quantity of Prestressed Concrete Beams (Type specified) or Cored Slab (of the size specified), measured in accordance with **Subsection 704.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for the fabricating and erecting prestressed concrete beams or cored slabs as specified or directed and includes the necessary design; furnishing and installing or placing strands, anchorages, bearing plate assemblies, sole plates, reinforcing steel, and concrete; tensioning and releasing strands; forms; finishing and curing concrete; testing; transportation and erection of beams (or girders); and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Partial payment for prestressed concrete beams may be made in accordance with **Subsections 109.7** and **109.8**.
- 3 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 4 Pay items under this section include the following:

Item No.	Pay Item	Unit
7041000	Prestressed Concrete Beam (Type I)	LF
7042000	Prestressed Concrete Beam (Type II)	LF
7043000	Prestressed Concrete Beam (Type III)	LF
7044000	Prestressed Concrete Beam (Type IV)	LF
7045000	Prestressed Concrete Beam (Type V)	LF
7045100	Prestressed Concrete Beam (Type V Modified)	LF
7046000	Prestressed Concrete Beam (Type VI)	LF
7045991	3'-0" x 1'-9" Cored Slab	LF
7045992	3'-0" x 2'-0" Cored Slab	LF

SECTION 705

BRIDGE RAILING

705.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for the furnishing and erection of bridge railing of cast-in-place concrete, precast concrete, aluminum, steel, or other specified materials, or a combination of these materials on bridges, walls, or incidental structures as shown on the Plans.
- 2 Unless otherwise stated, bridge railing includes that portion of the structure erected on and above the bridge deck, curb, or sidewalk, or above the top of retaining walls for the protection of traffic and pedestrians.
- 3 Construct bridge railing in accordance with the details shown on the Plans and include the necessary devices for anchoring or attaching the railing to the main structure.

705.2 Materials

705.2.1 Concrete Railing Wall and Barrier Parapet

- 1 Unless otherwise specified, use Class 4000 concrete or greater. Use concrete and procedures conforming to the requirements of **Sections 701 and 702**. Provide reinforcing steel conforming to the requirements of **Section 703**.
- 2 If lightweight concrete bridge barrier parapet is required, produce the concrete from lightweight coarse aggregate sources approved by the OMR. Ensure that the concrete obtains a 28-day design compressive strength equal to or greater than Class 4000 and weighs 3100 ± 50 pounds per cubic yard.

705.2.2 Precast Bridge Barrier Parapet

- 1 Use Class 5000 concrete, or greater, for precast bridge parapet. Use concrete and procedures conforming to the requirements of **Sections 701 and 702**. Provide reinforcing steel conforming to the requirements of **Section 703**. Cast sections to the dimensions shown on the Plans. Galvanize all installation hardware consisting of bolts, nuts, washers, inserts, and rods in accordance with ASTM A 123 or ASTM A 153 as applicable.

705.2.3 Galvanized Steel Railing and Steel Handrail

705.2.3.1 Post and Rail

- 1 Fabricate steel post assembly to the same general appearances as the railing shown in the Plans. Prepare and submit Shop Plans in accordance with the requirements of **Subsection 105.2** and show complete details of all parts of the post and rail. Unless otherwise shown on the Plans, ensure all steel rail and post components conform to the requirements of ASTM A 709, Grade 36. Ensure rail caps conform to the requirements of ASTM A 245, Grade C. Provide required hardware including bolts, nuts, screws, etc., con-

forming to the requirements of **Subsection 705.2.5.**

705.2.3.2 Galvanizing

- 1 Hot-dip galvanize steel posts and railing in accordance with the current ASTM A 123 or ASTM A 153 as applicable.

705.2.3.3 Cut Ends of Galvanized Steel Railing

- 1 After grinding smooth, give cut ends of galvanized steel railing two coats of a zinc rich paint meeting the requirements of Federal Specification TT-P-641 or an equal material approved by the OMR.

705.2.4 Aluminum Railing

705.2.4.1 Extruded Aluminum

- 1 Provide aluminum alloy extruded rails, posts, bases, expansion bars, etc. conforming to the requirements of ASTM B 221, Alloy 6061, Condition T6.

705.2.4.2 Cast Aluminum

- 1 Ensure cast aluminum railing post and other items for permanent mold castings conform to the requirements of ASTM B 108, Alloy G70B, Condition T61, except that the elongation in 2 inches is not less than 8%.

705.2.5 Stainless Steel Bolts, Nuts, Set Screws, and Washers

- 1 Fabricate and erect galvanized steel or aluminum rail with stainless steel bolts and set screws meeting the requirements of ASTM F 593, and stainless steel nuts meeting the requirements of ASTM F 594.

705.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

705.4 Construction

705.4.1 General

- 1 Provide the type railing specified and construct in accordance with the details shown on the Plans and in conformance with the requirements herein. Construct railing to the alignment, grade, and camber designated on the Plans. Ensure that shop fabricated railing is of such uniformity as to ensure good joints and continuous lines after erection on the structure. Any appreciable amount of cutting, bending, or adjusting required during erection to produce a reasonable fit is cause for rejection of the railing. Unless otherwise provided, do not place railing on a span until after the falsework for the span has been removed. During erection of the railing, ensure proper functioning of expansion joints.

- 2 Unless otherwise shown on the Plans or approved in writing by the BCE, erect railing posts vertically with tops of posts parallel to the roadway grade shown on the Plans.

705.4.2 Fabrication and Erection of Metal Railing

- 1 Ensure the fabrication and erection of steel railing is in conformance with the pertinent provisions of **Section 709**, and to the requirements of this specification. Fabricate aluminum railings in accordance with the current AASHTO *LRFD Bridge Design Specifications*. Splice rail members generally near railing posts and do so only as shown on the Plans. Prepare and submit Working Drawings for metal railing in accordance with **Subsection 105.2** and **Section 725** of these specifications.
- 2 Carefully handle and store all components of metal railing to avoid scratching, marring, denting, or otherwise damaging the railing. Separate aluminum members from concrete or steel by methods called for on the Plans; or if not shown on the Plans, provide the separation by means of a 1/16-inch thick elastomeric sheet, Durometer 60, that meets the requirements of AASHTO M 251.
- 3 Weld all steel railing in accordance with the requirements of the current ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*. Weld all aluminum railing in conformance to the requirements of Section 10 of the current AWS D1.2, *Structural Welding Code - Aluminum*.

705.4.3 Concrete Bridge Railing Wall and Barrier Parapet

- 1 Construct the concrete railing wall and barrier parapet in conformance to the requirements of **Section 702**. Exercise extreme care in the construction of railing forms to ensure that true grade and alignment of railing or barrier members is obtained. Do not place concrete in forms until the forms have been inspected by the RCE. Remove and replace any portion of the concrete railing wall or barrier parapet that is not constructed to true grade and alignment and cannot be satisfactorily corrected in the opinion of the RCE. Removal and replacement is at the Contractor's expense.
- 2 At the option of the Contractor, the concrete bridge rail, curb base, or barrier parapets may be slip formed. Submit the method of slip forming the concrete to the RCE for approval. A 1½-inch extension of the concrete slab is provided on the Plans to enable the Contractor to slip form the concrete bridge rail, curb base or barrier parapets. No additional reinforcing steel is required, and the payment for the concrete in the slab is for the quantity shown on the Plans.

705.4.3.1 Concrete Bridge Rail Surface Finish

- 1 Provide either a rubbed finish or a final surface finish as specified in **Subsection 702.4.11** and as indicated on the Plans and/or in Special Provisions.

705.5 Measurement

- 1 The quantity for the pay item Concrete Bridge Parapet or Concrete Bridge Railing is the length of cast-in-place bridge parapet or bridge railing above the top of the deck, curb, or sidewalk, excluding all reinforcing steel and is measured by the linear foot (LF) along the continuous parapet or railing in-place from end to end, complete, and accepted. The bridge railing items include all posts and spaces between posts. The reinforcing steel is measured for payment in accordance with **Subsection 703.5**.
- 2 The quantity for the pay item Precast Bridge Barrier Parapet is the length of precast bridge barrier parapet above the top of the deck, curb, or sidewalk, including the reinforcing steel and is measured by the linear foot (LF) in-place, complete, and accepted.
- 3 The quantity for the pay item Steel Bridge Railing, Steel Handrail, or Metal Bicycle Handrail is the length of metal handrail above the top of the deck, parapet wall, or sidewalk and is measured by the linear foot (LF) in-place, from end to end, complete, and accepted.

705.6 Payment

- 1 Payment for the accepted quantity of Concrete Bridge Parapet, Concrete Bridge Railing, or Precast Bridge Parapet, measured in accordance with **Subsection 705.5**, is determined using the contract unit bid price for the applicable item. Payment is full compensation for constructing bridge parapets or railings as specified or directed and includes preparing Shop Plans; forming and placing concrete; furnishing and installing expansion joint material, metal castings, pipe, hardware, anchor bolts, and reinforcing steel (except in cast-in-place concrete); and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Reinforcing steel in cast-in-place concrete parapets and railings is paid for under the provisions of **Subsection 703.6**.
- 3 Payment for the accepted quantity of Steel Bridge Railing, Steel Handrail, or Metal Bicycle Handrail, measured in accordance with **Subsection 705.5**, is determined using the contract unit bid price for the applicable item. Payment is full compensation for constructing metal railings or handrails as specified or directed and includes preparing Shop Plans; fabricating and installing railing supports, base pads, hardware, and anchor bolts; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.

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5 Pay items under this section include the following:

Item No.	Pay Item	Unit
7051000	Concrete Bridge Barrier Parapet	LF
7051005	Precast Concrete Barrier Parapet	LF
7051010	Concrete Bridge Barrier Parapet (Lightweight)	LF
7051100	Concrete Bridge Median Barrier	LF
7053000	Steel Bridge Railing	LF
7054000	Concrete Bridge Railing Wall (3'6" Height)	LF
7054001	Concrete Bridge Railing Wall with Indentations	LF
7054009	Concrete Bridge Railing Wall (2'10" Height)	LF
7054010	Concrete Bridge Railing Wall (2'6" Height)	LF
7054012	Concrete Bridge Railing Wall (2' Height)	LF
7054014	Concrete Bridge Railing Wall (1.5' Height)	LF
7054030	Concrete Bridge Railing Wall with Formliner Finish	LF
7055010	Steel Handrail	LF
7055100	Metal Bicycle Handrail	LF

SECTION 706

WOOD PRODUCTS FOR USE IN HIGHWAY CONSTRUCTION

706.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for treated and untreated wood products for use in highway construction and pertains only to such products that become part of the completed work. Wood products for erection purposes such as false-work, forms, bracing, sheeting, and miscellaneous wood products without specification are provided without direct compensation.

706.2 Materials

706.2.1 Structural Lumber

- 1 Use materials as described in the current *Southern Pine Inspection Bureau Special Products Rules* for structural lumber. Provide the size, grade, and length specified on the Plans. Where specified, treat structural lumber in accordance with **Section 707**.

706.2.2 Dimension Lumber

- 1 Use materials as described in Section 300 of the current *Southern Pine Inspection Bureau Grading Rules*. Provide the size, grade, and length specified on the Plans. For other miscellaneous uses of lumber, not specified on the Plans, use grades and sizes in accordance with the *Southern Pine Inspection Bureau Grading Rules* for the intended use. Where specified, treat lumber in accordance with **Section 707** of these specifications.

706.2.3 Timbers

- 1 Use materials as described in Section 400 of the current *Southern Pine Inspection Bureau Grading Rules*. Provide the size, grade, and length specified on the Plans. Where specified, ensure that treatment is in accordance with **Section 707** of these specifications.

706.2.4 Guardrail Posts

- 1 Furnish wood posts and offset blocks of Southern Yellow Pine conforming to the requirements for rough or dressed timbers as described in Section 400 of the current *Southern Pine Inspection Bureau Grading Rules*. Use grade No. 1 timbers for guardrail posts and offset blocks. Conform to the nominal dimensions shown on the Plans. Ensure that lengths are as shown on the Plans with a tolerance of plus 2 inches. Saw the ends of all posts square. Treat wood guardrail posts and blocks in accordance with **Section 707** of these specifications.

706.2.5 Wood Fence Posts and Braces

706.2.5.1 General

- 1 Furnish wooden fence posts and braces of Southern Yellow Pine. Use

round or sawn square posts as specified. For sawn posts and braces, use No. 2 grade for dimension lumber or timbers as applicable and as described in the current *Southern Pine Inspection Bureau Grading Rules*. Ensure that round posts and braces are sound, free from decay, excessive knots, clusters of knots, or splits that exceed $1\frac{1}{2}$ times the diameter of piece. Seasoning checks not affecting serviceability are permitted. Ensure that all posts and braces are reasonably straight.

- 2 Furnish posts in lengths that provide a uniform height of 5 inches above the top strand of wire and a minimum embedment in firm ground of $2\frac{1}{2}$ feet for line posts and 3 feet for other posts.
- 3 Unless otherwise specified, treat Southern Yellow Pine posts and braces accordance with **Section 707**.

706.2.5.2 Line Posts and Post Braces

- 1 Unless otherwise specified, use round posts having a nominal diameter of 4 inches with no diameter less than $3\frac{1}{2}$ inches at any point or square posts sawn nominal 4 inches X 4 inches with no dimension less than $3\frac{5}{8}$ inches rough or $3\frac{1}{2}$ inches dressed.

706.2.5.3 End, Corner, Gate, and Pull Posts

- 1 Use round posts having a nominal diameter of 6 inches with no diameter less than $5\frac{1}{2}$ inches at any point or square posts sawn nominal 6 inches X 6 inches with no dimension less than $5\frac{5}{8}$ inches rough or $5\frac{1}{2}$ inches dressed.

706.2.6 Timber Piles

706.2.6.1 General

- 1 Furnish timber piles meeting the general quality requirements and physical characteristics as herein specified. Where specified, treat timber piles in accordance with **Section 707**.

706.2.6.2 Source

- 1 Use piles cut from sound, live trees, except that fire killed, blight killed or wind felled timber may be used if not attacked by decay or insects. Ensure that trees for piles are cut above the ground swell and with sound tip and butt ends.

706.2.6.3 Knots

- 1 Sound knots no larger than $\frac{1}{6}$ the circumference of the pile where the knot occurs are allowed. Consider cluster knots as a single knot. Do not allow the entire cluster greater in size than permitted for a single knot. Do not allow the sum of knot diameters in any 1-foot length of pile to exceed $\frac{1}{3}$ of the circumference at the point where they occur. Determine the size of a knot by measuring its diameter at right angles to the length of the pile.
- 2 Unsound knots not exceeding half the permitted size of a sound knot are allowed if the unsoundness extends to not more than $1\frac{1}{2}$ inches in depth and the adjacent areas of the trunk are not affected.

706.2.6.4 Checks, Shakes, and Splits

- 1 A check is defined as a lengthwise separation of the wood across the rings of normal growth, extending from the surface toward the pith, but not extending through the piece. Do not use piles with checks that extend to the pith. Do not use piles with any 2 or more checks extending to the pith that become contiguous at the pith, except as modified under splits.
- 2 A shake is defined as a circumferential separation of the rings of normal growth. Ensure that the length of any shake or combination of shakes in the outer 1/2 of the radius of the butt of the pile, when measured along the curve of the annual ring, does not exceed 1/3 of the circumference of the butt of the pile.
- 3 A split is defined as a lengthwise separation of the wood across the rings of normal growth, extending from one surface through the piece to the opposite surface. Do not use piles with splits longer than the butt diameter.

706.2.6.5 Holes and Scars

- 1 Holes less than 1/2-inch average diameter are allowed, provided the sum of the average diameters of all holes in any 1 square foot of pile surface does not exceed 1 1/2 inches, and the depth of any hole does not extend to more than 1 1/2 inches.
- 2 Sound turpentine scars undamaged by insects are allowed.

706.2.6.6 Sapwood in Piles for Treatment

- 1 Ensure that piles for use with preservative treatment contain a minimum of 1 1/2 inches of sapwood.

706.2.6.7 Peeling

- 1 Ensure that piles designated for treatment are peeled of bark, including the inner skin, soon after cutting so that piles are smooth and clean. Take care to remove as little sapwood as possible while peeling the bark.
- 2 Do not injure the sapwood by unnecessary axe cuts. Ensure that piles are peeled until all of the rough bark and at least 80% of the inner bark along the pile length is removed. Ensure that no piece of inner bark that remains is over 1/2 inch in width or over 6 inches in length, and there is 6 inches of clean wood surface between any 2 strips of inner bark.

706.2.6.8 Taper and Surface Finish

- 1 Use piles that have a gradual taper from the point of butt measurement to the tip. Cut knots and limbs flush with the surface of the pile in a manner to prevent fiber breaks around the knot. Hand-trim knots flush with the surface of the swell surrounding the knot. Saw the butt and tip square with the axis of the pile to an accuracy of 1/10 inch per inch of diameter.

706.2.6.9 Twist of Grain

- 1 Ensure that spiral grain does not exceed 180 degrees of twist when measured over any 20-foot section of the pile.
- 2 Ensure that all piles are straight to the extent that a line drawn from the center of the butt end to the center of the tip end lies within the middle third of the body of the pile at all points. Ensure that piles are free from short crooks in which the surface deviation from straightness in any 5 feet of length exceeds 1½ inches at any location as determined by a straight edge.

706.2.6.10 Dimensions

- 1 Ensure that the diameters of piles measured under the bark conform to the requirements shown in the following table, subject to a permissible variation of minus ½ inch in any diameter and in not more than 20% of the piles of that diameter.

Diameter of Pile			
Length (feet)	Diameter at 3 Feet from Butt (inches)		Minimum Diameter of Tip (inches)
	Minimum	Maximum	
Under 25	11	20	8
25 to 40 inclusive	12	20	8
45 to 50 inclusive	12	20	7
55 to 70 inclusive	13	20	7
75 to 90 inclusive	13	20	6
Over 90	13	20	5

- 2 In cases where the tree is not exactly round, determine the diameter of a pile either by measuring the circumference and dividing the number of inches by 3.14 or by taking the average of the maximum and minimum diameters at the location specified.
- 3 The Department specifies timber piles in multiples of 5 feet. For piles 40 feet and shorter, the length may exceed the specified length by 1 foot. For piles 45 feet and longer, the length may exceed the specified length by 2 feet.

706.2.6.11 Storage of Materials

- 1 Ship and store treated and untreated wood products by acceptable commercial methods that prevent damage before use in the work.

706.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide

706.4**706.6**

sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

706.4 Construction**706.4.1 Workmanship**

- 1 Construction requirements are as set forth in other sections of these specifications that govern the items of work using the specified wood products.

706.5 Measurement

- 1 Measurement for wood products is made in accordance with other sections of these specifications that govern the items of work that incorporate the wood products specified herein.

706.6 Payment

- 1 Payment for wood products is made in accordance with other sections of these specifications that govern the items of work that include the wood products specified herein.

SECTION 707

PRESERVATIVE TREATMENT OF WOOD PRODUCTS

707.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for preservative treatment for timber and lumber for guardrail posts, fence posts, fenders, and dolphins and piling in accordance with the following specifications.

707.2 Materials

707.2.1 General

- 1 Ensure that the supplier of treated wood products has an independent treated wood inspection company, approved by the OMR, inspect and test the material in accordance with AWPA M2, Part A, at no cost to the Department. Ensure that a copy of the independent testing company's inspection report is provided to the RCE for each shipment. The RCE will visually inspect and approve all treated wood products before use on the project.
- 2 Ensure that the treatment plant maintains standard quality control procedures as described in AWPA M3, Part A.

707.2.2 Wood

- 1 Use wood products that conform to the requirements of **Section 706**.

707.2.3 Preservative

- 1 Use preservatives and treatment methods that conform to the following specifications:

Preservative or Treatment	Specification
Creosote for Land, Fresh, Water, and Marine	AWPA P1 / P13
Creosote-Coal Tar Solutions	AWPA P2
Creosote-Petroleum Solution	AWPA P3
Petroleum for Blending with Creosote	AWPA P4
Pentachlorophenol	AWPA P8
Solvents used in Pentachlorophenol Solutions	AWPA P9
Acid Copper Chromate	AWPA P5
Ammoniacal Copper Arsenate	AWPA P5
Ammoniacal Copper Zinc Arsenate	AWPA P5

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Preservative or Treatment	Specification
Chromated Copper Arsenate, Type A	AWPA P5
Chromated Copper Arsenate, Type B	AWPA P5
Chromated Copper Arsenate, Type C	AWPA P5
Ammoniacal Copper Quat, Type B	AWPA P5
Copper Naphthenate	AWPA P8
Alkali Copper Quat, Type C	AWPA P5

- 2 Test the preservative in accordance with the requirements of AASHTO M 133 for the particular preservative involved.

707.3 Equipment

- 1 None specified.

707.4 Construction

707.4.1 Treating Methods

- 1 Treat wood products in accordance with AWPA C14, or the following specifications, except that in the case of conflict, AWPA C14 governs:
- Use the general requirements for timber treatment as set forth in AWPA C1.
 - Treat lumber and sawed timber, including guardrail posts and blocks, as set forth in AWPA C2.
 - Treat round timber piling as set forth in AWPA C3.
 - Treat sawed fence posts as set forth in AWPA C2.
 - Treat round fence posts as set forth in AWPA C5.

707.4.2 Retention of Preservative

- 1 For wood products treated with creosote, creosote-coal tar solution, or pentachlorophenol solution, the net retention is expressed in pounds of preservative per cubic foot of wood. For material treated with water-borne salts preservatives, the net retention is expressed in pounds of dry preservative per cubic foot of wood. Use the type of preservative and the minimum net retention allowed as set forth in AWPA C14.
- 2 Determine net retention by the assay method in accordance with AWPA M2, Part A.

707.4.3 Penetration

- 1 Determine the penetration of the preservative for treated wood products as set forth in AWPA M2, Part A. Provide lumber, structural timber, sawn fence post, and guardrail posts, with a minimum penetration of the preservative of 2½ inches or 85% of the sapwood. Provide foundation piles or piles for land

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or fresh water with a minimum penetration of preservative of 3 inches or 90% of the sapwood. Provide piles for use in coastal water, treated with creosote or creosote-coal tar solution with a penetration of 4 inches or 90% of the sapwood. Provide piles for use in coastal water, treated with waterborne preservatives with a minimum penetration of 3½ inches or 90% of the sapwood.

- 2 Fill all holes made for determining the penetration of preservative with tight-fitting treated plugs.

707.4.4 Handling and Storage

- 1 Handle and store treated wood products in accordance with AWPA M4.

707.4.5 Fabrication

- 1 Where practical, perform all required fabrication prior to treatment. If fabrication is required after treatment, perform it in accordance with AWPA M4.

707.5 Measurement

- 1 No measurement is made for the preservative treatment of wood products under these specifications.

707.6 Payment

- 1 No direct payment is made for the preservative treatment of wood products under these specifications. The cost of the preservative treatment of wood products is included in the contract unit bid price for the treated wood products or the items that incorporate the treated wood products.

SECTION 708

TIMBER STRUCTURE HARDWARE

708.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for fastening hardware used in the construction of timber structures including all bolts, lag screws, nuts, nails, washers, rods, eye bars, turnbuckles, shapes, and plates.

708.2 Materials

708.2.1 General

- 1 Furnish fastening hardware conforming to the requirements of these specifications unless shown otherwise in the Plans or as directed by the BCE.
- 2 Furnish bolts, drift pins, dowels, lag screws, nails, and machine bolts of low carbon steel conforming to the requirements of **Subsection 709.2.5**. Provide hardware of standard quality and of the sizes and quantities specified.

708.2.2 Rolled Steel

- 1 Furnish rods, plates, shapes and eye bars of structural carbon steel or malleable iron as specified, conforming to the requirements of **Subsection 709.2.1**.

708.2.3 Castings

- 1 Provide castings of cast steel or gray-iron as specified, conforming to the requirements of **Subsection 709.2.6**.

708.2.4 Nuts and Bolts

- 1 Use the plan length of bolts given for estimating purposes only. Furnish bolts of the proper length for each connection. Furnish square or hexagonal bolt heads and nuts where the washers bear on wood and hexagonal bolt heads and nuts where the washers bear on metal.

708.2.5 Washers

- 1 Provide washers on each end of all bolts, except with high strength bolts where only one washer is required.
- 2 Provide standard cut washers for $\frac{1}{2}$ inch bolts or smaller that are bearing on wood or metal.
- 3 For bolts larger than $\frac{1}{2}$ -inch diameter, furnish cast ogee or approved malleable castings where washers bear on wood. Furnish cast ogee washers with a diameter of four times the bolt and a thickness at least equal to the diameter of the bolt. Furnish malleable washers with a diameter of four times the bolt and a thickness of at least half of the diameter of the bolt.

708.2.6 Nails and Spikes

- 1 Provide cut or round wire standard form nails. Furnish spikes that are cut wire or boat spikes as specified.

708.2.7 Galvanizing

- 1 Unless specified otherwise, furnish galvanized hardware. Galvanize hardware in accordance with the requirements of AASHTO M 111, AASHTO M 232, or AASHTO M 298 as applicable.
- 2 Items described in AASHTO M 232, Class C may be coated in accordance with AASHTO M 298, Class 50.
- 3 Items described in AASHTO M 232, Class D may be coated in accordance with AASHTO M 298, Class 40.

708.3 Equipment

None specified.

708.4 Construction

- 1 Do not use blocking between piles and sway braces unless specifically shown on the Plans. Any extra length of bolts or extra washers used will be at the Contractor's expense. The unit weight for galvanized hardware is assumed the same as non-galvanized hardware for purposes of payment.

708.5 Measurement

- 1 The quantity for Hardware is measured for payment either as a lump sum (LS) unit or as a per pound (LB) unit as indicated in the Contract.
- 2 If the pay item Hardware is paid for at a lump sum bid price, no measurement of individual pieces is necessary.
- 3 When the pay item Hardware is paid for at a contract unit bid price per pound, the quantity is measured by the weight of each piece of hardware called for on the Plans or authorized by the BCE that remains in the structure. No allowance is made for extra lengths or additional washers.

708.6 Payment

- 1 Payment for the accepted quantity for Hardware is determined using the contract unit bid price or contract lump sum bid price for the pay unit as specified by the Contract.
- 2 Payment is full compensation for furnishing and installing all hardware as specified or directed by the BCE and includes galvanizing, painting (if required), and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.

708.6

708.6

4 Pay items under this section include the following:

Item No.	Pay Item	Unit
7081000	Hardware	LS
7082000	Hardware	LB

SECTION 709

STRUCTURAL STEEL

709.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for furnishing, fabricating and erecting steel structures as required by the Plans and the Special Provisions, and performed in conformance with these specifications and in reasonably close conformity to the lines, grades and dimensions shown on the Plans or established by the Department. It also includes incidental metal work on other structures not otherwise provided for in these specifications.

709.1.1 Design and Details of Design

- 1 When performed by the Contractor, ensure that the design methods, calculations, details of the design of structural steel comply with the requirements of the current edition of the AASHTO *LRFD Bridge Design Specifications* and the requirements of these specifications. In case of conflict between these specifications and the referenced AASHTO specifications, the requirements of these specifications govern.

709.1.2 Plans (Design Drawings)

- 1 The Department will furnish Plans (Design Drawings) showing a complete design with sizes, sections, and the relative locations of the various members. Plans will indicate camber of structural members, tolerances, finishes, type of fasteners and other information as may be required for the proper preparation of Shop Plans and Working Drawings by the Contractor.

709.1.3 Shop Plans and Working Drawings

- 1 Upon acceptance and execution of the Contract, prepare and furnish Shop Plans showing complete details and sizes of component parts of the structure and details of all miscellaneous parts such as nuts, bolts, drains, etc. Prepare and submit additional stress sheets, Working Drawings, and *Erection Plans* required for erection purposes. Ensure that Shop Plan, Working Drawing, and *Erection Plan* submissions conform to the requirements of **Subsection 105.2** and **Section 725**.

709.1.4 Production of Iron and Steel Products on Federal Aid Projects

- 1 On all federal-aid projects, ensure that the manufacturing processes of all iron and steel products, including fasteners and coatings, occurs in the United States in accordance with **Subsection 106.11**.

709.2 Materials

709.2.1 Structural Steel

709.2.1.1 General

- 1 Unless otherwise shown on the Plans, make certain all structural steel con-

forms to the requirements in the following table.

Type of Steel	Grade per Specification	
	AASHTO M 270	ASTM A 709
Structural Steel	Grade 36	Grade 36
High-Strength Low Alloy Steel	Grade 50	Grade 50
High-Strength Low Alloy Steel	Grade 50W	Grade 50W
Quenched and Tempered Low Alloy Steel	Grade 70W	Grade 70W
High Yield Quenched and Tempered Alloy Steel	Grades 100/100W	Grades 100/100W
High Performance Steel Quenched and Tempered	Grade HPS 70W	Grade HPS 70W

Notes:

1. When these materials are specified on the Plans, ensure that the longitudinal Charpy V-Notch criteria comply with the requirements of AASHTO M 270, Zone 2.
 2. Sample in accordance with the H frequency in AASHTO T 243.
 3. Perform testing in accordance with AASHTO T 266.
 4. For High Performance Steel Quenched and Tempered, non-quenched and tempered thermo-mechanical controlled processed (TMCP) HPS 70W steel may be directly substituted for Q&T HPS 70W steel for plate thickness up to 2 inches.
- 2 Protect the stock steel to be used in the project such that all surfaces are free from heavy rust and rust pitted areas at the start of and during fabrication.

709.2.1.2 Notch Toughness of Weld Metal

- 1 Ensure that the Charpy V-Notch Toughness of weld metal complies with the requirements of the latest edition of ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*, Table 4.1, 4.2, or 4.3 as applicable.

709.2.1.3 Charpy V-Notch Testing

- 1 Perform Charpy V-Notch testing of the following structural steel members at the location indicated in **Subsections 709.2.1.3.1 through 709.2.1.3.5**.

709.2.1.3.1 Simple Span Rolled Beam

- 1 Perform Charpy V-Notch testing of the beam itself as well as bottom cover plate, if applicable.

709.2.1.3.2 Simple Span Plate Girder

- 1 Perform Charpy V-Notch testing of the web, bottom flange plate, and web splice plates, and bottom flange, excluding any filler plates.

709.2.1.3.3 Continuous Span Rolled Beam

- 1 Perform Charpy V-Notch testing of the beam itself as well as any top or bottom cover plate located in a tension region as indicated in the Plans. In addition, test all web splice plates and top and bottom flange splice plates, excluding any filler plates.

709.2.1.3.4 Continuous Span Plate Girder

- 1 Perform Charpy V-Notch testing of the all web plates, the top flange plates and the bottom flange plates located in a tension region as indicated in the Plans. Also, perform testing on all web splice plates and top and bottom flange splice plates, excluding any filler plates.

709.2.1.3.5 Curved Girder

- 1 In addition to Charpy V-Notch testing of web, flange, and splice plates as applicable and as specified in **Subsections 709.2.1.3.1 through 709.2.1.3.4**, perform Charpy V-Notch testing of all diaphragm members, connection plates, and gusset plates.

709.2.1.4 Copper Bearing Steel

- 1 When copper-bearing steel is specified, ensure that the steel contains not less than 0.20% copper.

709.2.1.5 Corrosion Resistant Steel (Weathering Steel)

- 1 Ensure that all welding produces weld metal with atmospheric corrosion resistance and coloring characteristics similar to that of the base metal are in accordance with Section 4.1.4 of the latest edition of ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.
- 2 Clean all structural steel to the requirements of Near White Blast Cleaning in accordance with the current edition of Steel Structures Painting Council Surface Preparation, SSPC SP-10, *Near White Blast Cleaning Method*. Remove all contamination of the structural steel resulting from erection or concrete placement. Clean the structural steel by an acceptable method approved by the BCE and restores the surface finish to the specified Near White Blast Clean condition.

Do not paint corrosion resistant steel unless specifically indicated on the Plans.

709.2.2 Shear Connector Studs

- 1 Provide shear connector studs conforming to the requirements of AASHTO M 169, (ASTM A 108), Cold-drawn Bar, Grades 1015, 1018, or 1020, either semi or fully-killed. If flux-retaining caps are used, ensure that the steel for the caps are a low carbon grade suitable for welding and comply with the requirements of ASTM A 109.
- 2 Provide shear connector studs suitable for welding to steel beams and girders with automatically timed stud-welding equipment.

709.2.2

- 3 Ensure that studs are of the type, size or diameter, and length as specified by the Plans or the Special Provisions and are listed on **the most recent edition of SCDOT Qualified Product List 25.**
- 4 Before placing orders for studs, submit to the OMR for approval the following information on the studs intended for use:
 - Name of the manufacturer,
 - Detailed description of the stud and arc shield to be furnished,
 - Certification from the manufacturer that the stud meets the Department's requirements, and
 - Copy of a qualification test report as certified by an OMR authorized testing laboratory.

709.2.3 Welding Electrodes

- 1 Ensure that the electrodes used in welding structural steel conform to the requirements in the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.

709.2.4 High Strength Structural Steel Fasteners

709.2.4.1 General

- 1 Furnish high strength bolts, nuts, washers, and direct tension indicators in accordance with the appropriate ASTM materials specification as amended and revised herein.
- 2 Ensure additional requirements for field or shop installation of ASTM A 325 high strength bolts included herein are met.
- 3 Ensure that all bolts, nuts, washers, and Direct Tension Indicators (DTI) are marked in accordance with the appropriate ASTM specification.

709.2.4.2 Bolts

- 1 Provide bolts meeting the requirements of ASTM A 325 and the revisions contained herein. Mechanically galvanize Type 1 bolts in accordance with ASTM B 695, Class 50. When atmospheric corrosion resistant Weathering steel, ASTM A 709, Grade 50W is required by the Plans, use non-galvanized Type 3 bolts.
- 2 Ensure that the hardness number for bolt diameters ½ inch to 1½ inch inclusive is as noted in the table below.

Hardness Number					
Bolt Size (Inches)	Bolt Length (Inches)	Brinell		Rockwell C	
		Min.	Max.	Min.	Max.
ASTM A 325 (½ to 1, incl.)	Length < 3 Dia.	253	319	25	33

(table continued on the next page)

(table continued from the previous page)

Hardness Number					
Bolt Size (Inches)	Bolt Length (Inches)	Brinell		Rockwell C	
		Min.	Max.	Min.	Max.
ASTM A 325 (½ to 1, incl.)	Length ≥ 3 Dia.	---	319	---	33
ASTM A 325 (1⅛ to 1½, incl.)	Length < 3 Dia.	223	286	19	30
ASTM A 325 (1⅛ to 1½, incl.)	Length ≥ 3 Dia.	---	286	---	30

709.2.4.3 Nuts

- 1 Furnish nuts meeting the requirements of ASTM A 563, Grade DH or DH3 as indicated. Ensure that nuts are mechanically galvanized in accordance with ASTM B 695, Class 50. Additionally, ensure that plain nuts for Type 3 bolts are Grade DH3 and are provided with an additional lubricant that is clean and dry to the touch.
- 2 Provide galvanized nuts that are tapped oversize the minimum amount required for proper assembly. Ensure that the amount of over-tap in the nut is such that the nut will assemble freely on the bolt in the coated condition and meets the mechanical requirements of ASTM A 563 and the Rotational-Capacity tests **SC-T-150** and **SC-T-151**.
- 3 Provide all nuts with an additional lubricant that is clean and dry to the touch. Ensure that the lubricant has a color that contrasts with the zinc coating of galvanized nuts.

709.2.4.4 Washers

- 1 Provide washers that meet the requirements of ASTM F 436 as revised by these specifications.
- 2 Mechanically galvanize washers for Type 1 bolts in accordance with ASTM B 695, Class 50. Use non-galvanized weathering steel washers for Type 3 bolts having equal or better corrosion resistance than the Type 3 bolts.

709.2.4.5 Direct Tension Indicators (DTI)

- 1 Furnish DTI complying with the requirements of ASTM F 959, and install in accordance with **Subsection 709.4.4.9.4**.
- 2 Mechanically galvanize the direct tension indicators for Type 1 bolts in accordance with ASTM B 695, Class 50. Use non-galvanized weathering steel DTI for Type 3 bolts having equal or better corrosion resistance than the Type 3 bolts.

709.2.4.6 Testing High Strength Bolt Assemblies**709.2.4.6.1 Bolts**

- 1 Perform proof load tests in accordance with ASTM F 606, Method 1.

709.2.4.6.1

709.2.4.6.5

- 2 Perform wedge tests in accordance with ASTM F 606 on full size bolts. Perform tests after galvanizing. Perform testing at the minimum frequency specified in ASTM A 325.
- 3 Measure the thickness of the zinc coating on the wrench flats or top of bolt head.

709.2.4.6.2 Nuts

- 1 Perform proof load tests in accordance with ASTM F 606. Perform testing at the minimum frequency specified in ASTM A 563. Perform tests after galvanizing and lubricating.
- 2 Measure the thickness of the zinc coating on the wrench flats of the nut.

709.2.4.6.3 Washers

- 1 Perform hardness testing after galvanizing. Remove coating before taking hardness measurements.
- 2 Measure the thickness of the zinc coating.

709.2.4.6.4 Direct Tension Indicators (DTI)

- 1 Test the DTI in accordance with **SC-T-152** and ensure that the results comply with the Department's specifications.

709.2.4.6.5 Assembly and Verification

- 1 Perform the Rotational-Capacity (R/C) test in accordance with the requirements contained in **Subsection 709.4.4.10** for long bolts and/or **Subsection 709.4.4.11** for bolts too short to be tested in a Tension Measuring Device (TMD). Perform Rotational-Capacity tests on all structural fastener assemblies prior to shipping by the manufacturer or distributor. Test galvanized assemblies after galvanizing.
- 2 Perform the Rotational-Capacity test on 2 assemblies of each possible combination bolt, nut, and washer production lot. Assign a Rotational-Capacity lot number to each combination of lots tested.
- 3 Ensure that the tension for the long bolts at the completion of the required rotation is equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn tests are shown in the following table.

Minimum Installation Tension and Turn Test Tension For ASTM A 325 Bolts									
Bolt Diameter (inches)	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
Min. Installation Tension*	12	19	28	39	51	56	71	85	103
Min. Turn Test Tension**	14	22	32	45	59	64	82	98	118
*Installation Tension equals 70% x Min. Tensile Strength in kips.									
**Turn Test Tension equals 1.15 x 70% x Min. Tensile Strength in kips.									

- 4 Ensure that the measured torque is as follows:

$$\text{Torque} \leq 0.25 \times P \times D$$

Where:

Torque = Measured torque (foot-pounds)

P = Turn test tension (pounds)

D = Bolt diameters (feet)

- 5 For test bolts that are too short for testing in a TDM, test in a steel joint. The tension requirement of paragraph 3 above need not apply.

- 6 Failure of any portion of the Rotational-Capacity (R/C) test for either of the two sample assemblies tested constitutes failure of the R/C lot.

709.2.4.6.6 Reporting

- 1 Ensure that the manufacturer or distributor provides a record of the results of all tests (including the zinc coating thickness) required herein and in the appropriate ASTM specification on the appropriate document.

- 2 Report the location where tests are performed and date of tests on the appropriate document.

709.2.4.6.7 Witnessing

- 1 The tests need not be witnessed by an inspection agency; however, have the manufacturer or distributor that performs the tests certify that the results reported are accurate.

709.2.4.6.8 Documentation

709.2.4.6.8.1 Mill Test Report (MTR)

- 1 Furnish MTR for all mill steel used in the manufacture of the bolts, nuts, and washers. Ensure that the MTR indicates the place where the material was melted and manufactured.

709.2.4.6.8.2 Manufacturer Certified Test Report (MCTR)

- 1 Have the manufacturer of the bolts, nuts, and washers furnish a MCTR for the items furnished. Ensure that the MCTR shows the relevant information required in accordance with **Subsection 709.2.4.6.6**.

- 2 Ensure that the manufacturer performing the Rotational-Capacity test includes the following information on the MCTR:
- Lot number of each of the items tested,
 - Rotational-Capacity lot number as required in paragraph 2 of **Subsection 709.2.4.6.5**,
 - Results of the test required in **Subsection 709.2.4.6.5**, if performed by the manufacturer,
 - Pertinent information required in **Subsection 709.2.4.6.6**,
 - Statement that MCTR for the items are in conformance to this specification and the appropriate ASTM specification, and
 - Location where the bolt assembly components were manufactured.
- 3 Provide a MCTR that certifies that the furnished DTI meet Department specifications.

709.2.4.6.8.3 Distributor Certified Test Report (DCTR)

- 1 Include the MCTR for the various bolt assembly components in the DCTR. Include in the DCTR, the Rotational-Capacity test results if performed by a distributor instead of a manufacturer. Ensure that the DCTR certifies that the MCTR are in conformance with this specification and the appropriate ASTM specification.

709.2.4.6.9 Shipping

709.2.4.6.9.1 Marking

- 1 Permanently mark on the side of the each container the Rotational-Capacity lot number such that identification is possible at any stage before installation.

709.2.4.6.9.2 Documentation

- 1 Supply the appropriate MTR, MCTR, or DCTR to the RCE or OMR.

709.2.5 Low Carbon Unfinished Turned and Ribbed Bolts

709.2.5.1 General

- 1 The requirements of this subsection do not pertain to high-strength bolts.
- 2 For other than high strength bolts, provide bolts, nuts, and washers meeting the requirements of ASTM A 307, Grade A. Provide bolts with single self-locking nuts or double nuts unless otherwise shown on the Plans or in the Special Provisions. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

709.2.5.2 Unfinished Bolts

- 1 Provide unfinished bolts unless other types are specified.

709.2.5.3 Turned Bolts

- 1 Ensure that the surface of the body of turned bolts meets the ANSI roughness rating value of 125. Furnish bolts with hexagonal heads and nuts with standard dimensions of the nominal size specified or the next larger nominal size. Ensure that the diameter of threads is equal to the body of the bolt or the nominal diameter of the bolt specified.

709.2.5.4 Ribbed Bolts

- 1 Provide ribbed bolts with a body of an approved form with continuous longitudinal ribs and with the diameter of the body measured on a circle through the points of the ribs that is 5/64 inch greater than the nominal diameter specified for the bolts.
- 2 Furnish ribbed bolts with round heads conforming to ANSI B 18.5 unless otherwise specified. Provide nuts that are hexagonal, either recessed or with a washer of suitable thickness. Ensure ribbed bolts make a driving fit with the holes. Ensure that the hardness of the ribs is such that the ribs do not deform to permit the bolts to turn in the holes during tightening.

709.2.6 Miscellaneous Metals

- 1 Provide steel forgings meeting the requirements of AASHTO M 102 (ASTM A 668), Class C, D, F, and G).
- 2 Furnish steel castings meeting the requirements of AASHTO M 103 (ASTM A 27) as designated on the Plans.
- 3 Provide iron castings meeting the requirements of AASHTO M 105, Class No. 30B. Ensure test bars are Type B and are made and tested in accordance with AASHTO M 105.
- 4 Furnish malleable castings meeting the requirements of ASTM A 668. Furnish Grade No. 35018 unless otherwise specified.
- 5 Provide bronze castings meeting the requirements of AASHTO M 107 (ASTM B 22), Alloy 913 or 911.
- 6 Unless otherwise specified, furnish other miscellaneous metals conforming to the requirements of the current edition of the *AASHTO LRFD Bridge Design Specifications*.
- 7 Furnish 5 copies of a certification for the above listed metals stating that they meet all SCDOT specifications. Ensure that the certification indicates the project SC File No. and the number of pieces being furnished.

709.2.7 Elastomeric Bearing Pads

- 1 Furnish elastomeric bearing pads meeting the requirements of **Section 724**, and of the size and thickness of elastomeric material and laminae indicated on the Plans.

709.2.8 Stainless Steel Bearings

- 1 Provide stainless steel bearing and expansion plates meeting the requirements of ASTM A 167 for Type 301 or Type 302, No. 1 Finish.

709.2.9 Paint

- 1 Unless otherwise specified, provide the paint and paint system specified on the Plans or in the Special Provisions and in conformance with requirements of **Section 710**.

709.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

709.4 Construction**709.4.1 Shop Fabrication****709.4.1.1 General**

- 1 Generally, shop weld structural members and field bolt structural members.
- 2 Provide the falsework and all tools, machinery, and appliances including drift pins and fitting-up bolts, necessary for the expeditious handling of the work.

709.4.1.2 Notice of Beginning of Work

- 1 Provide the OMR ample notice (14 calendar days minimum) before beginning of work at the fabrication shop and in the rolling mill or foundry when specified so that inspection may be provided. Do not perform any work before the OMR has been notified and inspection is provided.

709.4.1.3 Quality of Workmanship

- 1 Provide workmanship and finish equal to the best general practice in modern bridge shops. Neatly finish portions of the work exposed to view. Perform shearing, flame cutting, and chipping carefully and accurately.
- 2 Ensure that all structural steel fabrication is performed by a fabricator certified in accordance with the American Institute of Steel Construction (AISC) Quality Certification Program for the category of work required.

709.4.1.4 Storage of Materials

- 1 Store structural materials, both plain and fabricated, at the fabricating shop above the ground upon platforms, skids, or other supports. Keep materials free of dirt, grease, and other foreign matter and protect as far as practicable from corrosion.

709.4.1.5 Facilities for Inspection

- 1 Furnish facilities for the inspection of material and workmanship in the mill and shop and allow the Department's inspectors free access to all parts of the work.

709.4.1.6 Inspector's Authority

- 1 The Department's inspectors have the authority to reject any materials or work that does not meet the requirements of the Contract. In case of dispute, the Contractor may appeal to BCE. The acceptance of any material or finished members by the Department's representative does not preclude their subsequent rejection, if found defective. Materials and workmanship whether previously inspected or not, will be inspected after its delivery to the site of the work or after being erected in the structure. Promptly replace or make satisfactory rejected material or workmanship.

709.4.1.7 Mill Test Reports and Shipping Statements

- 1 Furnish the OMR with complete certified mill test reports showing chemical analysis and the physical tests for each heat of steel for all members. Also, furnish the OMR with 5 certified copies of mill test reports and 5 copies of shipping statements.

709.4.1.8 Identification of Steel During Fabrication

- 1 Properly identify each piece of steel to be fabricated to the Department's inspector. Before cutting pieces of steel into smaller pieces, legibly mark each smaller piece with the heat number and piece mark. Individually marked pieces of steel, which are used in furnished size, or are reduced from furnished size only by end or edge trim may be used without additional identification as long as the original heat number is legible.
- 2 The Contractor may furnish from stock, material that can be identified by heat number and mill test report. When separated from the full size piece furnished by the supplier, mark any excess materials placed in stock for later use with the project SCDOT File No., the MTR number, and the AASHTO/ASTM specification identification.

709.4.1.9 Straightening Material

- 1 Before being laid off or worked, straighten rolled material if necessary. If straightening is required, use Department approved methods that do not injure the metal. If heat is applied, do not allow the maximum temperature of the steel to exceed 1125°F. Sharp kinks and bends are cause for rejection of the material.

709.4.1.10 Flame Cutting

- 1 Ensure that flame cutting of structural steel conforms to the requirements of the current edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.

709.4.1.11 Edge Planing

- 1 Plane, mill, grind, or thermal cut to a depth of $\frac{1}{4}$ inch the sheared edges of plates more than $\frac{5}{8}$ inch in thickness and which carry calculated stress.

709.4.1.12 Fit of Stiffeners

- 1 Ensure that end stiffeners of girders and stiffeners intended as supports for concentrated loads have full bearing on the flanges to which they transmit load or from which they receive load. Obtain full bearing obtained by milling, grinding, or welding as shown on the Plans. Ensure that stiffeners not intended to transfer load, unless shown or specified otherwise, fit sufficiently tight to exclude water after being painted.

709.4.1.13 Flange Bearing Area

- 1 Ensure that flange surfaces bearing on sole plates conform to the tolerances specified in the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*. In addition, do not allow the remaining contact area between the flange and sole plate to deviate more than $\frac{1}{16}$ of an inch from a plane measured perpendicular to the web. Ensure that the field fit-up of the flange to the sole plate does not produce a gap exceeding $\frac{1}{8}$ inch. Correct gaps exceeding $\frac{1}{8}$ inch in fit-up by a method approved by the BCE before welding the flange to the sole plate.

709.4.1.14 Abutting Joints

- 1 Face and bring to even bearing abutting joints in compression members designed to transfer stress. Where joints are not required elsewhere to be faced or brought to even bearing, do not allow the opening to exceed $\frac{1}{4}$ inch.

709.4.1.15 End Connection Angles

- 1 Build floor beams, stringers and girders having end connection angles to exact length back to back of connection angles. If end connections are faced, do not allow the finished thickness of the angles to be less than that shown on the detail drawings.

709.4.1.16 Web Splices

- 1 At bolted web splices, cut the ends of the beams or girders and grind smooth. During shop assembly, do not allow the clearance between the ends of the members (web and flanges) to exceed $\frac{1}{4}$ inch.

709.4.1.17 Bent Plates

- 1 Obtain unwelded, cold-bent, load-carrying, rolled-steel plates from the stock plates such that the bend line is at right angles to the direction of rolling.
- 2 Use sufficient care that bending does not cause cracking of the plate. Do not use less than the minimum bend radii, measured to the concave face of the metal, given in the following table.

Minimum Bending Radius for All Grades Of Structural Steel					
Thickness of Plate	Up to ½	Over ½ to 1	Over 1 to 1½	Over 1½ to 2½	Over 2½ to 4
Minimum Bending Radius for Thickness, t, in Inches	2 t	2½ t	3 t	3½ t	4 t

- 3 For break press forming, ensure that the lower die span is at least 16 times the plate thickness. Multiple hits are advisable.
- 4 If a shorter radius is essential, hot bend the plates at a temperature not greater than 1125°F. Reject plates from all ASTM or AASHTO designations inadvertently heated above 1125°F or re-quench and re-temper the plates using correct ASTM procedures.
- 5 Before bending, round the corners of the plate to a radius of 1/16 inch throughout the portion of the plate at which the bending is to occur.

709.4.1.18 Camber

- 1 Furnish to the OMR a camber diagram prepared by the fabricator, showing the camber at each panel point in the cases of trusses or arch ribs, and at the location of field splices and fractions of span length (1/4 points minimum, 1/10 points maximum) in the cases of continuous beam and girders or rigid frames. When the shop assembly is Full Truss or Girder Assembly or Special Complete Structure Assembly, ensure that the camber diagram shows the camber measured in the assembly. When any of the other methods of shop assembly is used, have the camber diagram show calculated camber.
- 2 Camber girders before heat curving. Camber for rolled beams may be obtained by heat-cambering methods approved by the OMR. Camber girders and rolled beams in accordance with the camber diagram as shown in the Plans. Camber for rolled beams may be obtained by heat cambering methods or by cold bending with hydraulic rams. Moderate deviations from the specified camber may be corrected by a carefully supervised application of heat when approved by the OMR. Ensure that horizontal heat curving does not change vertical camber. This effect may be more pronounced when the top and bottom flanges are of unequal width on a given transverse cross-section.

709.4.1.19 Shop Assembly

709.4.1.19.1 General

- 1 Clean metal contact surfaces before assembling. Assemble the field connections of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames in the shop with milled ends of compression members in full bearing and have their sub-size holes reamed to specified size while the connections are assembled.
- 2 Check assemblies with N/C drilled or punched field connections and template drilled field connections of rolled beam stringers continuous over floor-

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beams or cross frames in accordance with **Subsection 709.4.1.19.7.**

- 3 Have each assembly, including camber, alignment, accuracy of holes, and fit of milled joints, approved by the Department's inspector before commencing reaming or before an N/C drilled check assembly is dismantled.

709.4.1.19.2 Full Truss or Girder Assembly

- 1 When Full Truss or Girder Assembly is required, assemble all members of each truss, arch rib, bent, tower face, continuous beam line, plate girder, or rigid frame at one time.

709.4.1.19.3 Progressive Truss or Girder Assembly

- 1 When Progressive Girder Assembly is required, initially assemble each arch rib, continuous beam line, or plate girder for at least three contiguous shop sections. When Progressive Truss Assembly is required for truss, bent, tower face, or rigid frame, initially assemble all members in at least three contiguous panels, but not less than the number of panels associated with three contiguous chord lengths. Have successive assemblies consist of not less than two sections or panels of the previous assembly (repositioned if necessary and adequately pinned to assure accurate alignment) plus one or more sections or panels added at the advancing end. In the case of structures longer than 150 feet, ensure that each assembly is not less than 150 feet long regardless of the length of individual continuous panels or sections. At the option of the fabricator, sequence of assembly may start from any location in the structure provided the preceding requirements are satisfied.
- 2 Have assemblies consisting of less than three shop sections or panels approved by the OMR.

709.4.1.19.4 Full Chord Assembly

- 1 When Full Chord Assembly is required, using geometric angles at the joints, assemble the truss the full length of each chord of each truss or open spandrel arch or each leg of each bent or tower. Ream their field connection holes while the members are assembled and ream the web member connections to steel templates set at geometric (not cambered) angular relation to the chord lines.
- 2 Ream field connection holes in web members using steel templates. Mill at least one end of each web member or scribe normal to the longitudinal axis of the member and accurately locate the templates at both ends of the member from one of the milled ends or scribed lines.

709.4.1.19.5 Progressive Chord Assembly

- 1 When Progressive Chord Assembly is required, assemble contiguous chord members in the manner specified for Full Chord Assembly and in the number and length specified for Progressive Truss or Girder Assembly.

709.4.1.19.6 Special Complete Structure Assembly

- 1 When Special Complete Structure Assembly is required, assemble the entire structure including the floor system. This procedure is ordinarily needed only for complicated structures such as those having curved girders or extreme skew in combination with severe grade or camber.

709.4.1.19.7 Check Assemblies with Numerically Controlled (N/C) Drilled Field Connections

- 1 Produce a check assembly for each major structural type of each project, unless otherwise designated on the Plans or in the Special Provisions. Have the check assembly consist of at least three contiguous shop sections or in a truss, all members in at least three contiguous panels, but not less than the number of panels associated with three contiguous chord lengths (i.e., length between field splices). Base check assemblies on the proposed order of erection, joints in bearings, special complex points, and similar considerations. Such special points could be the portals if skewed trusses, etc.
- 2 Use either geometric angles (giving theoretically zero secondary stresses under dead-load conditions after erection) or cambered angles (giving theoretically zero secondary stresses under no-load conditions) as designated on the Plans or in the Special Provisions.
- 3 For each major structural type, fabricate the check assemblies first.
- 4 No match-marking and no shop assemblies other than the check assemblies are required.
- 5 If the check assembly fails, in some specific manner, to demonstrate that the required accuracy is being obtained, further check assemblies may be required by the Department's shop inspector for which there is no additional compensation.

709.4.1.20 Match-Marking

- 1 Match-mark connecting parts assembled in the shop for reaming holes in field connections and furnish a diagram showing such marks to the Department's shop inspector.

709.4.1.21 Finished Members at Fabrication Shop

- 1 Ensure finished members are true to line, free from twists, bends, and open joints.

709.4.1.22 Weighing Members

- 1 When specified that any part of the material is paid for by actual weight, weigh finished work in the presence of the Department's inspector. In such case, supply satisfactory scales and perform all work involved in handling and weighing the various parts.

709.4.1.23 Marking and Shipping

- 1 Paint or mark each member with an erection mark for identification and furnish an erection diagram with erection marks shown thereon.
- 2 Furnish as many copies of material orders, shipping statements and erection diagrams as requested by the OMR. Show the weights of the individual members on the statements. Mark weight on members weighing more than 3 tons.
- 3 Load structural members on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged.
- 4 Pack bolts of one length and diameter and loose nuts or washers of each size separately. Ship pins, small parts and packages of bolts, washers and nuts in boxes, crates, kegs, or barrels, but do not allow the gross weight of any package to exceed 300 pounds. Post a plainly marked list and description of the contained material on the outside of each shipping container.

709.4.2 Painting**709.4.2.1 General**

- 1 Unless otherwise provided in the Contract, perform the following items of work when painting metal structures:
 - A. Proper preparation of the metal surfaces;
 - B. Application, protection and curing of the paint coatings;
 - C. Protection of pedestrians, vehicular or other traffic upon, near, or underneath the bridge structure;
 - D. Protection of all portions of the structure (superstructure and substructure) against disfigurement by spatter, splashes and smirches of paint or of paint material; and
 - E. Supplying of all tools, tackle, scaffolding, labor, workmanship, and materials necessary to complete the work.
- 2 Have available at each bridge the name, telephone number, and address of the person(s) responsible for processing all claims resulting from the painting work. Process claims in an expedient manner.

709.4.2.2 Painting of Welded, Bolted, Concrete Contact, and Inaccessible Surfaces

- 1 Paint surfaces to be bolted together in the shop or the field. Provide a prime coat of paint on surfaces to be in contact with concrete (exclusive of top surfaces of beam flanges where shear connectors are welded). Paint those surfaces before assembly or erection that will be inaccessible after assembly or erection. Do not paint surfaces to be welded together in the shop or the field. Do not paint surfaces on which welding is performed.

- 2 Where the application of inorganic zinc primer on new structural steel is specified, paint the entire surface area of the steel member after the specified cleaning.
- 3 During the painting of steel beams/girders, paint the top surface area of the top flange. However, a full 3.5 mils of paint thickness is not required on the top surface area where concrete will be placed. Provide a light spray to prevent any potential rust stains from running down the edges of the flange prior to concrete placement.

709.4.2.3 Slip Critical Surfaces

- 1 For friction type connections designated on the Plans as Class B Slip Critical, blast clean as defined in the *Steel Structures Painting Council System-SP-10* and coat the contact surfaces with an inorganic zinc-rich paint.

709.4.2.4 Painting of Corrosion Resistant (Weathering) Steel

709.4.2.4.1 Paint Zones

- 1 Paint all corrosion resistant steel in accordance with the requirements of Paint Zone A and B as defined as follows:
 - Paint Zone A: Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry, and Jasper Counties.
 - Paint Zone B: All counties not included Paint Zone A.

709.4.2.4.2 Painting Requirements for Paint Zone A

- 1 Paint weathering steel with the NS1 Paint System. Use galvanized ASTM A 325, Type 1 bolts, nuts, washers, and direct tension indicators.

709.4.2.4.3 Painting Requirements for Paint Zone B

- 1 Paint weathering steel with the NS2 Paint System unless noted otherwise in the Plans. Use galvanized ASTM A 325, Type 1 bolts, nuts, washers, and direct tension indicators when the Plans do not specify partial painting of the weathering steel. When the Plans specify partial painting of weathering steel, use non-galvanized ASTM A 325, Type 3 weathering bolts, nuts, washers, and direct tension indicators and do not field paint unless otherwise noted in the Plans. When the Plans specify field painting of non-galvanized ASTM A 325, Type 3 weathering bolts, nuts, washers, and direct tension indicators, coat the hardware with one primer coat (5 mils minimum dry film thickness) of Aluminum Epoxy Mastic Paint, one intermediate coat (5 mils minimum dry film thickness) of Aluminum Epoxy Mastic Paint and one finish coat (2 mils minimum dry film thickness) of water reducible 100% Acrylic Paint in accordance with **Section 710**.

709.4.3 Structural Welding

709.4.3.1 General

- 1 Ensure welding of steel structures and all subsequent references to welding conform to the latest edition of ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*, the Plans, and the Special Provisions. In addition, adhere to the provi-

sions of **Subsection 709.4.3.2** through **709.4.3.6**.

709.4.3.2 Preheat and Interpass Temperatures

- 1 Obtain the pre-heat and interpass temperatures required for welding structural steel as specified in the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.

709.4.3.3 Restricted Welded Processes

- 1 Do not use gas metal arc and flux cored arc welding without written approval of the OMR. If authorization is granted, perform the procedure and provide operator qualifications in accordance with the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*. In any case, do not use electro-slag and electro-gas.

709.4.3.4 Welding Shear Studs

- 1 Weld shear connector studs in conformance with the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.
- 2 Do not allow longitudinal and lateral spacing of studs with respect to each other and to edges of beam or girder flanges to vary by more than ½ inch from the dimensions shown on the Plans. Spacing may vary by up to 1 inch to avoid conflicts with other attachments on the flange or where a new stud is being welded to replace a defective one.
- 3 After welding, ensure that the studs are free from any defect or substance that may interfere with their function as shear connectors.

709.4.3.5 Field Welding

709.4.3.5.1 General

- 1 Consider all field welding as structural welding, except for welding of reinforced pile tips, temporary falsework (unless specified), SIP formwork, armor plate at bridge ends, and armor plate at expansion joints. Ensure that personnel performing structural welding of structural steel, steel reinforcement, steel pile splices, and other types of field structural welds are SCDOT-certified welders and are qualified to perform structural welding in accordance with the qualification procedure of the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code* modified as follows:
 - A. A welder or tacker (hereafter known as “welder”) may be qualified by preparing test specimens in the 2G position (horizontal groove) for limited thickness groove welding and in the 2F position (horizontal fillet) for fillet welding as a minimum.
 - B. The above testing is a minimum and will qualify the welder for field welding at the job site. The welder may choose to qualify for additional positions and unlimited metal thickness as part of the above testing. Specialized welding and welding positions at the job site may require additional welder qualification testing if required by the Department.

- C. Ensure that testing is administered by an independent laboratory listed on *SCDOT Qualified Product List 26*. Prepare the test specimens in the presence of and have tested and evaluated by an OMR authorized independent laboratory person qualified as a Welding Inspector. Perform radiographic, non-destructive testing by an ASNT Level II or III technician. Have the independent laboratory furnish a welder qualification test report on company letterhead stationery stating the type welding approved, name of the welder, the welder's social security number along with a statement that the welder is duly qualified as a field welder in accordance with the SCDOT requirements. Ensure that the report shows the name of the independent laboratory technician(s) making the evaluation and it is signed by the independent laboratory manager. Submit a copy of the report to the OMR.
- D. The welder will be given a SCDOT certification good for 2 years and renewable every 2 years provided the welder has been engaged in welding procedures during the preceding 2-year period.

709.4.3.5.2 Submittals and Notification

- 1 Notify the RCE and the SME at least 14 calendar days before performing any field welding including, but not limited to, the welding of reinforced pile tips, armor plates at bridge joints, temporary falsework, SIP forms, and any other items that are incorporated into the structure. Document this notification by completing the form entitled *SCDOT Welding Procedure Specification* (Form 700.16) and forwarding one copy each to the RCE and the SME. Submit this completed form a minimum of 10 days prior to performing any field welding. The Department will accept this form via e-mail and/or fax provided the original copy is sent by mail. The Department may or may not review and provide comments on the submittal. If the Department has not responded within the 10 days of the submittal date, the Contractor may proceed with the welding.
- 2 Submit for review and acceptance, a *Structural Field Welding Quality Control (QC) Plan* for all structural field welding to the RCE and OMR a minimum of 30 calendar days before performing any field welding. Ensure that the *Structural Field Welding QC Plan* conforms to the requirements set forth in the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*. Do not perform any structural field welding before the Department's review and acceptance of the *Structural Field Welding QC Plan*.
- 3 Within 14 calendar days after receipt of the plan, the Contractor will be notified of plan acceptance or any additional information required and/or changes that may be necessary to meet the requirements of the Plans and Specification. If any parts of the plan are unacceptable and rejected, resubmit changes for re-evaluation. The Contractor will be notified of their acceptance or rejection within 7 days after receipt of proposed changes.

- 4 Coordinate and schedule structural field welding with the Department's inspector or Department authorized inspection agency's inspector a minimum of 14 calendar days before welding. The inspector may be present any time the Contractor performs structural field welding. The inspector will perform the Department's Quality Assurance (QA) nondestructive testing.

709.4.3.6 Inspection of Welds

709.4.3.6.1 General

- 1 Ensure that the structural steel fabrication and construction assembly, including all shop and field welding, is performed in accordance with the latest edition of ANSI/AASHTO/AWS D1.5, *Bridge Welding Code* except as noted herein. Fabrication and welding quality assurance (QA) inspection in the fabricating shops will be done by the Department's representative, either an OMR inspector or an inspector from a commercial testing laboratory acting for the Department.

709.4.3.6.2 Nondestructive Testing of Welds and Metals

- 1 Perform radiographic, ultrasonic, magnetic particle, and dye penetrant testing of welds in conformance with the requirements of the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code* with the following exceptions:
- A. Test all girder flange butt welds radiographically, whether in tension or compression.
 - B. Interpret Quality Assurance (QA) and Quality Control (QC) nondestructive testing as referenced in AASHTO and AWS as follows:

Quality Assurance (QA) nondestructive testing required by the contract documents will be performed by the Department's inspector or authorized inspection agency's inspector acting for the Department. At the discretion of the Department's inspector or authorized representative, Quality Control (QC) nondestructive testing performed by the Contractor in the presence of the Department's inspector may be used to satisfy like nondestructive testing requirement(s) specified for QA. The observing inspector will maintain test result records of the work performed.
- 2 The cost of the QC nondestructive testing is borne by the Contractor regardless of the Department's acceptance for QA testing. The cost of Department performed QA testing will be borne by the Department.
- 3 The cost of re-testing repaired welds is borne by the Contractor.

709.4.3.6.3 Inspection of Welded Studs

- 1 After welding the first 2 studs on the flange and the material is allowed to cool, strike with a hammer and bend to 45 degrees off the vertical. If failure occurs in the weld of either stud, correct the welding procedure, then weld and successfully test 2 successive studs before any more studs are welded to

the beam or girder. Promptly inform the OMR of any changes in the welding procedure.

- 2 When the temperature of the base metal is below 32°F, test 1 stud in each 100 studs welded in addition to the first 2 specified above.
- 3 If visual inspection reveals a stud which does not show a full 360-degree weld, or has been repaired by welding, or has had a reduction in height (due to welding) less than normal, test the stud by striking with a hammer and bending 15 degrees off the vertical. For studs showing less than 360-degree weld, bend in the direction opposite to the lack of weld. Replace studs that crack in either the weld or the shank.
- 4 After welding, select 10 studs at random along each beam or girder or 10% of the studs along other structural members. Hammer these studs 30 degrees out of line. Ensure that none of these test studs shows any signs of failure.
- 5 If any of the studs fail, then hammer all studs on the member (but not necessarily bent the full 30 degrees) and replace all that fail. Before replacing the stud, grind the area free of any metal left from the old weld, or in the case of a pocket, fill with E-7018 weld metal, and grind flush.
- 6 In addition to the above test, if any of the studs in any group of studs checked show the need for additional all-around welding due to faulty operation of the welding gun, remove all the studs in the group as required in the paragraph above and replace.
- 7 The studs tested that show no sign of failure may be left in the bent position.
- 8 If during the progress of the work, inspection and testing indicates in the judgment of the Department's representative that the shear connections being obtained are not satisfactory, make required changes in welding procedure, welding equipment, and the type of shear connector as necessary to secure satisfactory results at no expense to the Department.

709.4.4 Bolted Connections

709.4.4.1 Bolt Holes

709.4.4.1.1 Bolt Holes for High-Strength Bolts

- 1 Unless otherwise specified, punch or drill holes for high strength bolts. Unless sub-punching and reaming are required under **Subsection 709.4.4.7**, material forming parts of a member composed of not more than five pieces of metal may be punched $\frac{1}{16}$ inch larger than the nominal diameter of the bolts whenever the thickness of any of the pieces is not greater than $\frac{3}{4}$ inch for structural steel, $\frac{5}{8}$ inch for high-strength steel or $\frac{1}{2}$ inch for quenched and tempered alloy steel.
- 2 When there are more than 5 pieces of metal or when any of the main material is thicker than $\frac{3}{4}$ inch for structural steel, $\frac{5}{8}$ inch for high-strength steel, or $\frac{1}{2}$ inch for quenched and tempered alloy steel, either sub-drill or drill full-size

holes.

- 3 When required under **Subsection 709.4.4.7**, sub-punch or sub-drill (sub-drilled if thickness limitation governs) all holes $\frac{3}{16}$ inch smaller and, after assembling, reamed $\frac{1}{16}$ inch larger or drilled full size to $\frac{1}{16}$ inch larger than the nominal diameter of the bolts.
- 4 When permitted by the BCE, enlarged or slotted holes are allowed with high-strength bolts.

709.4.4.1.2 Holes for Ribbed Bolts, Turned Bolts, or Other Approved Bearing Type Bolts

- 1 For holes for ribbed bolts, turned bolts, or other approved bearing-type bolts, sub-punch or sub-drill $\frac{3}{16}$ inch smaller than the nominal diameter of the bolt and ream. Assemble or drill with a steel template, or after assembling, drill from the solid at the option of the fabricator. In any case, provide a driving fit in the finished holes specified on the Plans or in the Special Provisions.

709.4.4.2 Punched Holes

- 1 Do not use a die with a diameter more than $\frac{1}{16}$ inch greater than the diameter of the punch. Ream any holes that must be enlarged to admit the bolts. Clean out holes and ensure that there are no torn or ragged edges. Poor matching of holes is cause for rejection.

709.4.4.3 Reamed or Drilled Holes

- 1 Ensure reamed or drilled holes are cylindrical, perpendicular to the member, and comply with the requirements of **Subsection 709.4.4.1** as to size. Where practicable, direct reamers by mechanical means. Poor matching of holes will be cause for rejection. Perform reaming and drilling with twist drills.
- 2 Assemble and securely hold connecting parts requiring reamed or drilled holes while being reamed or drilled and match-mark before disassembling.
- 3 Remove burrs on the outside surfaces. If required by the Department's shop inspector, take apart assembled parts for removal of burrs caused by drilling.

709.4.4.4 Accuracy of Punched, Sub-punched, or Sub-drilled Holes

- 1 Ensure that holes punched full-size, sub-punched, or sub-drilled are accurately punched, so that after assembling (before any reaming is done) a cylindrical pin, $\frac{1}{8}$ inch smaller in diameter than the nominal size of the punched hole, can be entered perpendicular to the face of the member, without drifting, in at least 75% of the contiguous holes in the same plane. If this requirement is not fulfilled, inaccurately punched pieces will be rejected. If any hole will not pass a pin, $\frac{3}{16}$ inch smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

709.4.4.5 Accuracy of Reamed and Drilled Holes

- 1 When holes are reamed or drilled, ensure that after reaming or drilling, 85% of the holes in any contiguous group show no offset greater than 1/32 inch between adjacent thicknesses of metal.
- 2 Ensure that steel templates have hardened steel bushings in holes accurately dimensioned from the centerlines of the connection as inscribed on the template. Use the centerlines to accurately locate the template from the milled or scribed ends of the members.

709.4.4.6 Preparation of Field Connections

- 1 Unless otherwise specified in the Special Provisions or on the Plans, sub-punch holes (or sub-drill if sub-drilling is required according to **Subsection 709.4.4.2**) in field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders and rigid frames, and subsequently ream while assembled onto a steel template, as required by **Subsection 709.4.1.19**. Holes for field splices of rolled beam stringers continuous over floor beams or cross frames may be drilled full size unassembled to a steel template. Sub-punch and ream holes for floor beams and stringer field end connections to a steel template or ream while assembled. Perform reaming or drilling full size field connection holes through a steel template after the template has been located with utmost care as to position and angle and firmly bolted in place. Ensure that templates used for reaming matching members, or the opposite faces of a single member, are exact duplicates. Ensure that templates used for connections on like parts or members are so accurately located that the parts or members are duplicates and require no match-marking.
- 2 Unless otherwise authorized by the Department's shop inspector, assemble the adjacent panels or sections of each individual truss, arch, continuous beam or girder in the shop before reaming or full drilling is commenced. Block up and set the parts that make up the joint to be reamed or drilled to the exact relative position and grade that such parts will later assume in the completed bridge; and fasten such parts securely in position before and during the reaming or drilling of the holes in the joint.
- 3 For any connection, instead of sub-punching and reaming or sub-drilling and reaming, the fabricator may drill holes full size with all thickness or material assembled in proper position.
- 4 Perform additional sub-punching and reaming specified in the Special Provisions or on the Plans.
- 5 For any connection or splice designated above, in lieu of sub-sized holes and reaming while assembled or drilling holes full-size while assembled, the fabricator may drill or punch holes full-size in unassembled pieces and/or connections including templates for use with matching sub-sized and reamed holes by means of suitable Numerically Controlled (N/C) drilling or punching equipment subject to the specific provisions contained in this section. Ensure

that full-size punched holes meet the requirements of **Subsection 709.4.4.1**.

- 6 Unless otherwise specified in the Special Provisions or on the Plans, when N/C drilling or punching equipment is used, the OMR may require the Contractor, by means of check assemblies, to demonstrate that this drilling or punching procedure consistently produces holes and connections meeting the requirements of **Subsections 709.4.4.5** and **709.4.1.19**.
- 7 Submit to the OMR for approval a detailed outline of the procedure to accomplish the work from initial drilling or punching through check assembly, if required. Include in the outline, the specific members of the structure that will be N/C drilled or punched, the sizes of the holes, the location of common index and other reference points, composition of check assemblies, and all other pertinent information.
- 8 Drill or punch holes with N/C equipment to appropriate size through individual pieces or through any combination of pieces held tightly together.

709.4.4.7 Fitting for Bolting

- 1 Clean contact surfaces of metal before assembling. Ensure that the parts of a member are assembled, well pinned, and firmly drawn together before drilling, reaming or bolting is commenced. Take apart assembled pieces, if necessary, for the removal of burrs and shavings produced by the operation. Ensure that the members are free from twists, bends, and other deformations.
- 2 Perform drifting during assembling only to bring the parts into position without causing holes to enlarge or metal to distort.

709.4.4.8 Installation of High Strength Bolts

- 1 The following requirements in this subsection apply to the installation of high strength bolts installed in the shop or field.
- 2 Install bolt, nut, and washer combinations from a lot represented by an accepted Rotational-Capacity test as certified by the manufacturer or distributor. Install structural bolts with a DTI on each assembly to verify proper tensioning.
- 3 Assemble fastener components of appropriately assigned Rotational-Capacity test lot numbers together. Store assembled fasteners in buildings or similar enclosures to protect them from dirt and moisture at the job site. Take only as many fasteners as are anticipated to be installed and tightened during a work shift from protected storage. Protect fasteners not used and return them to storage at the end of the shift. Do not remove lubricant from fasteners that is required to be present in as-delivered condition. Clean, re-lubricate and retest prior to installing fasteners for slip-critical connections that accumulate rust or dirt resulting from job site conditions.
- 4 Perform the Rotational-Capacity test as required in **Subsection 709.4.4.10** or **709.4.4.11** on each Rotational-Capacity lot before the start of bolt installation. Perform the Rotational-Capacity tests in the shop or field on the lots as shipped to the job site with certifications by the manufacturer or distributor.

Test 2 assemblies consisting of a nut, bolt, and washer from each lot. Provide hardened steel washers as part of the test. Reject fastener assemblies that fail any part of the Rotational-Capacity test.

- 5 Provide a Tension Measuring Device (TMD) and a dial type torque wrench of suitable range at each job site during erection of structural steel.
- 6 Conduct periodic re-testing as directed by the RCE to confirm that storage has not reduced the effectiveness of the lubricant on material.
- 7 Provide the galvanized nuts with a lubricant containing a visible dye. When the bolt head is the turned element in the assembly, apply a manufacturer recommended lubricant to the washer face of the bolt or to the washer. Use lubricant waxes such as bee's wax or stick waxes for use on metal. Water/wax emulsions for use on fasteners may also be used. Apply the waxes by dipping the nuts, or when necessary, the washers in the water/wax emulsion or warmed bee's wax or stick wax. Remove the nuts and washers from the wax, allow the excess wax to drain and cool as necessary and place them back in protected storage until they are needed for installation.
- 8 Perform Installation Verification tests for each possible Rotational-Capacity lot in combination with each lot of Direct Tension Indicators. Perform the Installation Verification test in accordance with the procedures in this subsection.
- 9 During installation, regardless of the tightening method used, exercise particular care so that the snug tight condition is achieved. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. Provide hardened washers under the turned element for all installation methods.
- 10 Conduct periodic re-testing as directed by the RCE to confirm that storage has not reduced the effectiveness of the lubricant. Have re-testing witnessed by the Department's representative. Reject any lot with failing assemblies.
- 11 Check galvanized nuts to verify that a visible lubricant is on the threads. When the bolt head is the turned element in assembly, add a lubricant approved by the Department to the washer face under the bolt head or to the washer.
- 12 Reject bolts or nuts not satisfying the requirements above and bolts, nuts or washers that are weathered, rusty, or dirty. Submit for approval a procedure for cleaning and re-lubricating rejected fastener lots. Retest re-cleaned or re-lubricated bolt, nut, and washer assemblies before installation.

709.4.4.9 Procedures for Verification and Installation of High Strength Bolt DTI

709.4.4.9.1 Verification of DTI Performance

- 1 Verify DTI performance in accordance with **SC-T-152** before installation of bolts in the work. In bridgework, the manufacturers typically specify smaller gaps in the space between the protrusions on the washer than is normally used in other construction or than is specified for testing in the product speci-

fication ASTM F 959. The basic principle used in this verification test is to make sure that there is a DTI gap when the test tension is 1.05 times greater than the job installation tension requirement. Test 3 bolts from each Rotational-Capacity lot and position of DTI.

709.4.4.9.2 Test Equipment

- 1 Use equipment for DTI verification and testing as outlined in **SC-T-152**.

709.4.4.9.3 Verification Test Procedure

- 1 Perform the DTI verification test procedure in accordance with **SC-T-152**.
- 2 The DTI fails the verification test if the 0.005-inch feeler gauge is refused in half or more of the gaps during the test procedure.
- 3 The DTI and assembly pass the test if the nut on the bolt assembly is unable to go the full length of the threads of the bolt at the completion of **SC-T-152**, and the load at the minimum DTI gap is less than 95% of the bolt tension recorded at the nut rotation required in **SC-T-150** for the Rotational-Capacity test. If the nut cannot be run the full thread length, but the load at the smallest gap condition is greater than the 95% of the bolt tension recorded at the nut rotation required for the Rotational-Capacity test, the load required for the smallest gap is too large. Reject the lot if this occurs.
- 4 Test bolts from Rotational-Capacity lots that are too short to fit in the tension measuring device in accordance with **SC-T-151** by tightening to the minimum DTI gap measured and checked in accordance with paragraph 3 above. Do not use the 95% alternative since short bolts are not tested in the tension-measuring device for Rotational Capacity. Check the DTI used with the short bolt in accordance with **SC-T-152** using a longer bolt in the tension measuring device.

709.4.4.9.4 Installation of DTI

- 1 The use of a DTI under the unturned bolt head requires that the element bearing against the DTI does not turn. Use two workers to install the DTI: one to operate the wrench and the other to prevent turning of the element with the DTI and monitor the gap. If the DTI is used under the turned element, provide an additional hardened washer between the turning element and the protrusion on the DTI.
- 2 Tighten the bolts systematically to the inspection gap. Ensure that the number of spaces in which the 0.005-inch thickness gauge is refused is equal to or greater than the number shown in the following table. Do not tighten beyond the smallest gap. Replace bolts that have a DTI with a smaller gap or no gap with a new DTI.

INSPECTION CRITERIA						
Number of spaces in washer	4	5	6	7	8	9
Min. spaces gauge is refused*	2	3	3	4	4	5
* Refuse the gauge in all spaces when a coated DTI is used under the turned element.						

709.4.4.10 Procedure for Performing Rotational-Capacity Test (Long Bolts In TMD)

- 1 Perform the Rotational-Capacity (R/C) test on the long bolts meeting ASTM A 325 in accordance with the testing procedure **SC-T-150**.
- 2 Ensure that the measured bolt tension is equal to or greater than the values shown in the following table. Assemblies that do not meet this tension fail the test (Value is 115% of Minimum Installation Tension).

Turn Test Bolt Tension									
Bolt Diameter (inches)	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
Tension (kips)	14	22	32	45	59	64	82	98	118

- 3 Assemblies that have evidence of stripping fail the test.
- 4 Ensure that the measured torque does not exceed 0.25 x tension in pounds x bolt diameter in feet. Assemblies with torque values exceeding this calculated value fail the test.

709.4.4.11 Procedure for Performing Rotational-Capacity Test on Bolts Too Short to Fit TMD

- 1 Perform the R/C test on bolts too short to fit a Tension Measuring Device (TMD) in accordance with the testing procedure **SC-T-151**.
- 2 Ensure that the measured torque does not exceed the values listed in the following table. Assemblies that exceed the listed torque fail the test.

*Torque									
Bolt diameter (inches)	1/2	5/8	3/4	7/8	1	1⅛	1¼	1⅜	1½
Torque (ft-lbs)	150	290	500	820	1230	1500	2140	2810	3690
*Torque ≤ 25% x P x D, where P is Turn Test, and D is bolt diameter.									

- 3 Assemblies that fail prior to required rotation either by stripping or by fracture, fail the test.

709.4.4.12 Installation of Turned and Ribbed Bolts**709.4.4.12.1 General**

- 1 This subsection does not pertain to the use of high-strength bolts.

709.4.4.12.2 Turned Bolts

- 1 Carefully ream holes for turned bolts to provide for a light driving fit. Ensure threads are entirely outside of the holes. Provide a washer under the nut.

709.4.4.12.3 Ribbed Bolts

- 1 Install ribbed bolts with a driving fit in the holes. Ensure that the ribs do not deform to permit the bolts to turn in the holes during tightening. If for any reason, the bolt twists before drawing tight, carefully ream the hole and replace with an oversized bolt.

709.4.5 Bridge Bearing Assemblies**709.4.5.1 General**

- 1 Unless otherwise specified, use rolled steel conforming to the requirements of AASHTO M 270 (ASTM A 709), Grade 36, for all steel bearing plates.

709.4.5.2 Facing of Bearing Surfaces

- 1 Ensure that the surface finish of bearing and base plates and other bearing surfaces that come in contact with each other or with concrete meets the ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness, and Lay, Part I indicated in the following table.

Surfaces in Contact	Roughness
Steel slabs	ANSI 2000
Heavy plates in contact in shoes to be welded	ANSI 1000
Milled ends of compression members, milled or ground ends of stiffeners and fillers	ANSI 500
Bridge rollers and rockers	ANSI 125
Pins and pin holes	ANSI 125
Sliding bearings	ANSI 125

709.4.5.3 Sole Plates Embedded Concrete Beams or Girders

- 1 Ensure that the exposed face of the sole plate embedded in the concrete is straight and truly perpendicular to the vertical axis of the concrete girder. Do not exceed a variation of more than 1/16 inch from a plane perpendicular to the vertical axis.

709.4.5.4 Rocker and Masonry Plates

- 1 Machine sliding surfaces of both the rocker and the plate flat to an ANSI 125 finish in direction of movement. If machined in a direction other than the

expansion, machine to a flat ANSI 63 finish. When the fabricator is ready for inspection, give sufficient notice to allow for inspection by the Department. Do not paint machined surfaces until after inspection. Plates may be cut to size by torch; and holes and slots may be cut by torch provided the ends of slots are drilled before cutting is done. Remove burrs from torch cuts. Machine bridge bearing components, including bridge rollers, rockers, and sliding bearings that are hot dipped galvanized, to a surface roughness requirement of ANSI 250 or better regardless of expansion direction.

709.4.5.5 Elastomeric Bearing Pads

- 1 Ensure that elastomeric bearing pads meet the requirements of **Section 724**. Provide elastomeric material and laminae to the size and thickness indicated on the Plans.

709.4.6 Field Erection

709.4.6.1 Delivery of Materials

- 1 If the Contract is for erection only, receive the materials entering into the finished structure free of charge at the place designated, loaded, or unloaded as specified. Upon delivery, promptly unload any material delivered to the site designated; otherwise, the Contractor is responsible for demurrage charges.

709.4.6.2 Handling and Storing Materials

- 1 Place material stored on skids above the ground. Keep area clean and properly drained. Place polyethylene or other acceptable material under the storage skids to minimize mud splatter damage. Place, support, and store girders and beams in an upright position. Support long members, such as columns and truss chords, on skids placed near enough together to prevent injury from deflection. If the Contract is for erection only, check the material being accepted against the shipping list and promptly report in writing any shortage or injury discovered. The Contractor is responsible for the loss of any accepted material or for any damage caused to it after being received.

709.4.6.3 Falsework

- 1 Ensure that the falsework is properly designed, substantially constructed, and properly maintained for the loads it is intended to support. If requested by the BCE, prepare and submit for review and acceptance, Working Drawings for falsework or for changes in an existing structure necessary for maintaining traffic. Review and acceptance of the Working Drawings will not relieve the Contractor of any responsibility. Submit Working Drawings for falsework as specified in **Section 725**.

709.4.6.4 Methods, Equipment, and Erection

- 1 Before starting erection work, submit to the BCE for acceptance an *Erection Plan* that fully details the method of erection proposed and the amount and type of equipment to be used. Include in the *Erection Plan* any necessary temporary bracing to adequately prevent overturning of the member(s)

until all permanent bracing is in place and secured. The acceptance by the Department does not relieve the Contractor of the responsibility for the safety of methods or equipment utilized or from carrying out the work in full accordance with the Plans and the Specifications. Do not start work until obtaining such acceptance from the Department.

709.4.6.5 Bearings and Anchorages

- 1 Finish masonry/concrete buildups level unless indicated otherwise in the Plans. Verify that all masonry/concrete buildups are level prior to placing any bridge bearings or elastomeric bearing pads and furnish the RCE written documentation of the verification. Set bridge bearings level, in exact position, and ensure that they have full and even bearing on the girder bottom and the masonry/concrete buildup.
- 2 Set elastomeric bearing pads, if used, directly on the concrete masonry.
- 3 Drill holes for anchor bolts and set them in Portland cement grout or preset them as shown on the Plans or as specified.
- 4 When setting the location of anchors, rockers, or rollers, take into account any variation from mean temperature at time of setting and anticipated lengthening of bottom chord or bottom flange due to dead load after setting. The intention being that at mean temperature and under dead load, the rockers and rollers are vertical and anchor bolts at expansion bearings are centered in their slots as near as practicable. Ensure that there is full and free movement of the superstructure at the movable bearings without being restricted by improper setting or adjustment of bearings or anchor bolt and nuts.
- 5 Do not place bridge bearings on masonry/concrete bearing areas that are irregular or improperly formed.

709.4.6.6 Erection of Structure

- 1 Erect the metal work, remove the temporary construction, and do all the work required to complete the bridge or bridges as covered by the Contract, including the removal of the old structure or structures, if stipulated, all in accordance with the Plans and contract specifications.

709.4.6.7 Assembling Steel

- 1 Accurately assemble the parts shown on the Plans and follow the fabricator's match-marks. Handle the material carefully and ensure that no parts are bent, broken, or otherwise damaged. Do not allow hammering that injures or distorts the members. Clean bearing surfaces and surfaces in permanent contact before the members are assembled.
- 2 Unless erected by the cantilever method, erect truss spans on blocking to give the trusses proper camber. Leave the blocking in place until the tension chord splices are fully bolted and all other truss connections are pinned and bolted. Do not tighten permanent bolts in splices of butt joints of compressing members or permanent bolts in railings until the span has been swung.

- 3 Fill half of the holes in splices and field connections with fitting bolts and cylindrical erection pins (half bolts and half pins) before bolting with high-strength bolts. In splices and connections carrying traffic during erection, fill three-quarters of the holes with fitting bolts and cylindrical erection pins (half bolts and half pins) before bolting with high-strength bolts. Ensure that fitting bolts are of the same nominal diameter as the high-strength bolts and cylindrical erection pins are $\frac{1}{32}$ inch larger.

709.4.6.8 Misfits

- 1 The correction of minor misfits involving harmless amounts of reaming, cutting and chipping are considered a legitimate part of the erection. However, immediately report any error in the shop fabrication or deformation resulting from handling and transportation that prevents the proper assembling and fitting up of parts by the moderate use of pins or by a moderate amount of reaming and slight chipping or cutting, to the RCE and along with a proposed method of correction. When approved, make the correction in the presence of the RCE.
- 2 If the Contract provides for complete fabrication and erection, the Contractor is responsible for all misfits, errors, and injuries. Make the necessary corrections and replacements. If the Contract is for erection only, the RCE with the cooperation of the Contractor will keep an accurate record of labor and materials used. Within 30 days, render an itemized bill for the approval of the BCE.

709.4.6.9 Straightening Bent Material

- 1 When permitted by the BCE, straighten plates, angles, other shapes, and built-up members, by methods that do not produce fracture or other injury. Straighten distorted members by mechanical means, or if approved by the BCE, by carefully planned procedures and supervised application of a limited amount of localized heat. Do not allow the maximum temperature of ASTM or AASHTO designated metals to exceed 1125°F and do not allow the temperature to exceed 950°F within 6 inches of weld metal. Do not apply heat directly on weld metal. Monitor the metal temperature by means of temperature indicating crayons, liquids, or bimetal thermometers. Reject all metal inadvertently heated above 1125°F or re-quench and re-temper the metal using correct ASTM procedures.
- 2 Ensure that parts to be heat straightened are substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat.
- 3 Following the straightening of a bend or buckle, carefully inspect the surface of the metal for evidence of fracture.

709.4.7 Removal of Existing Structure and Falsework

- 1 Remove existing structures in accordance with the requirements of **Section 202**. If the existing structure is designated to be removed and remain the property of the Department, carefully dismantle and store the material in the

immediate vicinity of the bridge site as directed by the RCE. If the existing structure is to be re-erected, dismantle without unnecessary damage, match-mark the parts, and carefully stockpile in an area determined by the RCE.

- 2 Upon completion of the erection and before final acceptance, remove falsework, excavated or useless materials, rubbish, and temporary buildings. Replace or renew any fences damaged and restore in an acceptable manner all property, both public and private, that may have been damaged during the prosecution of this work and leave the bridge site and adjacent highway in a neat and presentable condition as satisfactory to the RCE. Remove excavated material or falsework placed in the stream channel during construction before final acceptance.

709.5 Measurement

- 1 The quantity for the pay item Structural Steel is measured for payment by the pound (LB) or is paid on a lump sum (LS) basis, as specified in the Contract.
- 2 When the Contract specifies payment on a contract unit bid price per pound basis, the quantity is the weight in pounds of all structural steel actually erected and is a permanent part of the structure, completed and accepted by the RCE. The structural steel weight is the computed weight assuming the unit weight of steel is 490 pounds per cubic foot and the unit weight of cast iron at 450 pounds per cubic foot.
- 3 The weight of rolled shapes, bars, and plates is computed on the basis of the nominal weight as given in the manufacturers' handbooks, without plus tolerances for rolled plates, using the dimensions shown on the approved Shop Plans. Deduction is made for all copes, cuts, and open holes. No allowance is made for overrun in weight.
- 4 The weight of high-strength bolts, nuts, and washers is established by scale weight. No separate measurement or payment is made for ordinary fasteners since they are considered incidental to the contract price bid for Structural Steel.
- 5 The weight of castings is computed from the dimensions shown on the approved Shop Plans with an addition of 5% for fillets and overrun.
- 6 The right is expressly reserved to weigh a portion or all of the material used in the work, and if the weight of any member is more than 2% less than the computed weight, the member may be rejected. This applies to both the price per pound and lump sum basis.
- 7 If the Contract specifies payment on a contract lump sum bid price basis, no measurements are taken.

709.6 Payment**709.6.1 General**

- 1 Payment for the accepted quantity of Structural Steel is determined using either the contract unit bid price per pound or contract lump sum bid price as stated in the Contract. Partial payments are made as indicated in **Subsections 109.7 and 109.8**.
- 2 Payment for each item includes all direct and indirect costs and expenses required to complete the work.

709.6.2 Price Per Pound Basis

- 1 If a price per pound basis is stipulated in the Contract, payment for Structural Steel, measured in accordance with **Subsection 709.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for furnishing, fabricating, and installing structural steel as specified or directed by the BCE or RCE and includes preparation of Shop Plans, Working Drawing, and *Erection Plan*; providing, erecting, and removing falsework or temporary bracing (if necessary); testing, welding, bolting, shop assembly and disassembly, field erecting, surface finishing, and painting structural steel; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 The Department's computed weights are final unless such weights are found in error by more than 1½%.

709.6.3 Lump Sum Basis

- 1 If payment on a lump sum basis is stipulated in the Contract, payment for Structural Steel, measured in accordance with **Subsection 709.5**, is determined using the contract lump sum bid price for the pay item. Payment is full compensation for furnishing, fabricating, and installing structural steel as specified or directed by the BCE or RCE and includes preparation of Shop Plans, Working Drawing, and *Erection Plan*; providing, erecting, and removing falsework or temporary bracing (if necessary); testing, welding, bolting, shop assembly and disassembly, field erecting, surface finishing, and painting structural steel; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 The average price per pound obtained by dividing the lump sum price by the estimated weight of structural steel is used in adjusting changes in structural steel from that required by the original Contract.

709.6.4

709.6.4

709.6.4 Pay Items

1 Pay items under this section include the following:

Item No.	Pay Item	Unit
709110X	Structural Steel	LS
7091120	Structural Steel	LB
709120X	Structural Steel (Weathering Type)	LS

SECTION 710

PAINT FOR STRUCTURAL STEEL

710.1 Description

- 1 This section contains specifications for the materials, construction, measurement, and payment for furnishing paint and paint materials and applying these paints as indicated on the Plans and in accordance with the provisions and requirements of the Special Provisions, applicable Supplemental Specifications, these specifications, and as directed by the RCE.

710.2 Materials

710.2.1 General

- 1 Furnish paint that is thoroughly ground, and neither settles excessively, nor cakes in the container. Ensure that the paint mixes readily with a paddle to a smooth, uniform consistency. Small amounts of anti-skinning agents and anti-settling agents may be added during manufacture. If kept in storage, ensure that the paint retains the original paint characteristics for a period not less than the stated shelf life. Maintain containers of paint unopened until required for use. Use containers first that have been recently opened and premixed or blended together. Do not use paint that has livered, gelled, or otherwise deteriorated during storage or is beyond the stated shelf life. Ensure that wet paint is protected against damage from dust, sand, blast debris, or other detrimental foreign matter. Comply with the manufacturer's recommendations for health and safety (*Safety Data Sheets*) when handling, storing, and applying paint.
- 2 During the painting operation, use precautionary measures to protect any surfaces that are not to be painted or that have already been painted. Repair and spot-paint any areas of paint film damaged by the Contractor's operations at no additional cost to the Department. Remove to the satisfaction of the RCE all spillage, drippings, spattering, or inadvertent applications caused by the Contractor's operations.
- 3 Ensure that paint is applied by individuals with a minimum of 2 years of experience in the application of the paint system being applied. Use paint subcontractors that have a minimum of 2 years experience in the application of the specified paint system on structural steel bridges.

710.2.1.1 Inspection, Sampling, and Acceptance

- 1 The Department reserves the right to sample all ingredients at the point of origin and to sample finished paint either at the point of origin or at the destination and to withhold acceptance of the paint until analysis of such samples are made.
- 2 Inspection and/or sampling will be done at the point of manufacture whenever practicable. When inspection and/or sampling are performed at the point of manufacture, ensure that all necessary assistance is furnished by the

manufacturer so that the inspector can inspect and/or sample all the ingredients and the finished paint. Submit samples to the OMR for testing. The manufacturer may proceed with making the paint prior to receiving test results on the ingredient samples; however, should any of the ingredient materials fail to meet the specified test requirements, paint made with the failing material will be rejected. For finished paint that is sampled at the point of destination, furnish a manufacturer certification to the RCE and OMR that the ingredient materials meet all applicable SCDOT specifications.

- 3 Furnish paint in compliance with the current EPA, SCDHEC, and local City or County requirements for Volatile Organic Compounds (VOC). Use material from the Department's most recent edition of *SCDOT Qualified Product List 19*.

710.2.1.2 Packing and Marking

- 1 Ensure that each shipment of paint is accompanied by written certification from the manufacturer stating that the material furnished complies with the Department's paint specifications. Have paint shipped in new, strong containers that are properly sealed. Have each container plainly marked with the type and color of paint, number of gallons, lot or batch number, the date of manufacture, and the name and address of the manufacturer.

710.2.2 Inorganic Zinc Silicate Primer Paint

- 1 Provide an Inorganic Zinc Silicate primer paint that is a two-component, self-curing paint that cures without the use of a separate curing solution. Use the Inorganic Zinc Silicate paints appearing on the most recent edition of the *SCDOT Qualified Product List 19*. Ensure that the prime coat is produced by the same manufacturer as the intermediate and the finish coats.

710.2.3 Aluminum Epoxy Mastic Paint

- 1 Furnish Aluminum Epoxy Mastic paint that is a two-component, modified epoxy bitumen primer, intermediate coat, or finish coat paint. Provide leafed aluminum color. Use Aluminum Epoxy Mastic paints appearing on the most recent edition of the *SCDOT Qualified Product List 19*.

710.2.4 High Build Aliphatic Polyurethane Paint

- 1 Provide a High Build Aliphatic Polyurethane paint that is a two-component finish coat paint. Use High Build Aliphatic Polyurethane paints appearing on the most recent edition of the *SCDOT Qualified Product List 19*.

710.2.5 Acrylic Paint

- 1 Furnish Acrylic paint that is a single component, water reducible, and 100% acrylic intermediate or finish coat paint. Use the Acrylic paints appearing on the most recent edition of the *SCDOT Qualified Product List 19*.

710.2.6 Paint Zones

- 1 Paint Zone A consists of Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry, and Jasper Counties.

710.2.6

710.2.7.2

- 2 Paint Zone B consists of all counties not included Paint Zone A above.

710.2.7 Paint Systems

710.2.7.1 Paint System NS1

- 1 When Paint System NS1 is called for in Paint Zone A on new structural steel, including all grades of weathering steel, apply the following paints in accordance with these specifications, the Plans, and the Special Provisions:

- One primer coat of Inorganic Zinc Silicate paint (3.5 mils minimum dry film thickness),
- One intermediate coat of Aluminum Epoxy Mastic paint (5 mils minimum dry film thickness), and
- One finish coat of High Build Aliphatic Polyurethane paint (3.5 mils minimum dry film thickness).

Furnish a light gray color (Federal Shade No. 26622) finish coat unless specified otherwise in the Special Provisions or in writing by the BCE.

- 2 Ensure that the primer coat, the intermediate coat, and finish coat of paint are produced by the same manufacturer.

710.2.7.2 Paint System NS2

- 1 When Paint System NS2 is called for in Paint Zone B on new structural steel, including all grades of weathering steel, apply the following paints in accordance with these specifications, the Plans, and the Special Provisions:

- One primer coat of Inorganic Zinc Silicate paint (3.5 mils minimum dry film thickness),
- One intermediate coat of water reducible 100% Acrylic paint (2 mils minimum dry film thickness), and
- One finish coat of water reducible 100% Acrylic Paint (2 mils minimum dry film thickness).

Furnish a light gray color (Federal Shade No. 26622) finish coat unless specified otherwise in the Special Provisions or in writing by the BCE. Ensure that the intermediate coat of Acrylic paint is of a different color than the finish coat of Acrylic paint.

- 2 If the Plans do not specify only partial painting of any grade of weathering steel, field paint the galvanized bolts, nuts, washers, and DTIs with Paint System NS2 as specified above.

- 3 When the Plans specify partial painting of any grade of weathering structural steel, paint with paint system NS2 as specified above, except furnish the a brown color (Federal Shade No. 30045) finish coat to match the long-term color of the weathering steel, unless specified otherwise in the Special Provisions or in writing by the BCE.

- 4 When the Plans specify partial painting of weathering steel in Paint Zone B, and non-galvanized weathering steel bolts, nuts, washers, and DTIs are used,

710.2.7.2

710.2.7.4

do not field paint hardware unless noted otherwise in the Plans.

- 5 When the Plans specify field painting of non-galvanized weathering steel bolts, nuts, washers, and DTI's, coat hardware with the following paints in accordance with these specifications, the Plans, and the Special Provisions:
- One primer coat of Aluminum Epoxy Mastic paint (5 mils minimum dry film thickness),
 - One intermediate coat of Aluminum Epoxy Mastic paint (5 mils minimum dry film thickness), and
 - One finish coat of water reducible 100% Acrylic paint (2 mils minimum dry film thickness).

Furnish a brown color (Federal Shade No. 30045) finish coat to match the long-term color of the weathering steel.

- 6 Ensure that the primer coat, the intermediate coat, and finish coat of paint are produced by the same manufacturer.

710.2.7.3 Paint System NS3

- 1 When Paint System NS3 is called for on exposed new steel H-bearing piling, sway bracing, and casing left in place, apply the following paints in accordance with these specifications, the Plans, and the Special Provisions:
- One primer coat of Aluminum Epoxy Mastic primer (5 mils minimum dry film thickness) and
 - One finish coat of Aluminum Epoxy Mastic paint (5 mils minimum dry film thickness).

Ensure that the primer coat and finish coat of paint are produced by the same manufacturer.

710.2.7.4 Paint System ES1

- 1 When Paint System ES1 is called for on exposed areas of the existing structural steel, bearing assemblies (including exposed portions of anchor bolts), steel railing and any other previously painted steel surfaces of the existing structure, apply the following paints in accordance with these specifications, the Plans, or the Special Provisions:
- One primer coat of Aluminum Epoxy Mastic paint (5 mils minimum dry film thickness),
 - One intermediate coat of Aluminum Epoxy Mastic paint (5 mils minimum dry film thickness), and
 - One finish coat of High Build Aliphatic Polyurethane paint (3.5 mils minimum dry film thickness).

- 2 Furnish a light gray color (Federal Shade No. 26622) finish coat unless specified otherwise by the Department in the Special Provisions or in writing by the BCE. Tint the intermediate coat of Aluminum Epoxy Mastic paint to be clearly distinguishable from the primer coat of Aluminum Epoxy Mastic paint.

710.2.7.4

710.4.1.1.2

- 3 Ensure that the primer coat, the intermediate coat, and finish coat of paint are produced by the same manufacturer.

710.2.7.5 Determination of Paint System

- 1 Unless specified otherwise on the Plans or in the Special Provisions, use the table below to determine the Paint System for use on projects for the type of material located in the specified Paint Zones.

Material	Paint Zone	Paint System
New Structural Steel (For Any Grade of New Weathering Structural Steel, see Note 1 below)	A	NS1
	B	NS2
	A and B	NS1
Existing Structural Steel	A or B	ES1
Exposed Portions of New Steel H Bearing, Piling & Sway Braces, Casing left in place	A or B	NS3
Note 1: For NS2 paint system, painting is required for all grades of any weathering structural steel surfaces unless the Plans specify partial painting.		

710.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

710.4 Construction

710.4.1 Primer Application

710.4.1.1 Inorganic Zinc Silicate Primer

710.4.1.1.1 Surface Preparation

- 1 Clean structural steel (including all grades of weathering steel in Paint Zone A and in Paint Zone B unless noted otherwise in the Plans) to the requirements of SSPC SP-10, *Near White Blast Cleaning*. Ensure the quality of the blast cleaning is such that the prime coat of Inorganic Zinc Silicate paint specified adheres tightly to the steel in all cases. Ensure that the blast cleaning operation produces a surface (anchor) profile between 1.5 mils and 3 mils.
- 2 Clean surfaces to be in contact with concrete, areas adjacent to bolted connections and splices, including bolt holes, as stated above.

710.4.1.1.2 Application of Paint

- 1 Shop apply Inorganic Zinc Silicate primer unless otherwise specified on the Plans and/or in the Special Provisions. Mix inorganic zinc silicate primer and apply within 12 hours after cleaning and before rusting occurs. Apply paint in accordance with the manufacturer's written recommendations and by people

skilled in this type of work.

- 2 Apply the Inorganic Zinc Silicate primer only when the paint, the surrounding air, and the steel surface temperatures are above 25°F or the minimum temperature recommended by the paint manufacturer, whichever is higher. Do not apply paint on damp surfaces. Do not apply paint when in the opinion of the OMR representative conditions are otherwise unsatisfactory for the work. Do not apply paint when the steel surface temperature is less than 5°F above the dew point.

710.4.1.1.3 Thickness Requirements

- 1 Obtain a smooth uniform coating with a minimum dry film thickness of 3.5 mils without film cracking, sagging, or loss of adhesion.
- 2 Before the steel is moved out of the shop paint bay to shop storage, and within 6 hours of original painting, correct areas of each component found to have dry film thickness less than 3.5 mils. Correct by adding touch-up coats of the inorganic zinc primer, which has been thinned according to the manufacturer's recommendations for touch-up. Correct areas with flaws such as mud cracking or sags before moving steel to shop storage. Re-clean as described in **Subsection 710.4.1.1.1** and repaint components with severe deficiencies (i.e., areas with readings less than 2.5 mils dry film thickness, excessive mud-cracking or sagging) that in the opinion of the OMR representative cannot be easily corrected by the touch-up method.
- 3 Allow the Inorganic Zinc Silicate primer to cure a minimum of 60 calendar days (no maximum) before the aluminum epoxy mastic touch-up (see **Subsection 710.4.1.1.5**) or the intermediate coat (i.e. Aluminum Epoxy Mastic paint or Acrylic paint) or the finish coat is applied.

710.4.1.1.4 Method of Application

- 1 Apply the Inorganic Zinc Silicate primer by spray application. Ensure that the equipment used is suitable for the intended purpose. Control the painting by appropriate pressure regulators and gauges. Use air caps, nozzles, and needles recommended by the manufacturer of the paint being sprayed. Adjust the pressure on the paint in the pot and the air at the gun when necessary for changes in elevation of the gun above the pot.
- 2 Keep the equipment in satisfactory condition to permit proper application. Keep spray equipment sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film. Completely remove any solvents left in the equipment before applying paint to the steel surface being painted. Use solvents approved by the paint manufacturer.

710.4.1.1.5 Shop Applied Touch-up of Damaged or Deficient Areas

- 1 When the steel is removed from shop storage for shipment to the project, correct damaged surface areas and areas deficient in dry film thickness (less than 3.5 mils) by applying 1 coat (5 mils minimum dry film thickness) of an approved Aluminum Epoxy Mastic paint produced by the same manufacturer

as the Inorganic Zinc Silicate primer.

710.4.1.2 Aluminum Epoxy Mastic Primer

710.4.1.2.1 Surface Preparation

- 1 Clean new or existing structural steel to the requirements of SSPC SP-6, *Commercial Blast Cleaning* unless otherwise directed by the BCE or specified on the Plans or in the Special Provisions. Ensure that the quality of the blast cleaning is such that the prime coat of Aluminum Epoxy Mastic paint adheres tightly to the steel in all cases. Ensure that the surface (anchor) profile is in the range specified by the paint manufacturer of the Aluminum Epoxy Mastic paint.
- 2 Ensure that the steel surface meets the requirements of SSPC SP-6 just before the application of the Aluminum Epoxy Mastic primer coat and all steel surfaces are dust free. Apply the Aluminum Epoxy Mastic primer coat within 8 hours of blast cleaning, unless specified otherwise by the BCE.
- 3 When Aluminum Epoxy Mastic paint is specified for existing structural steel, clean surfaces to be in contact with new concrete and areas adjacent to bolted connections and splices, including bolt holes, as stated in paragraph 1 of this subsection. Furthermore, ensure that this blast cleaning operation removes all existing paint and any layered rust. Perform abrasive blasting with recyclable steel grit abrasive. Wire brush primed surfaces damaged by blasting. If visibly rusted, re-blast to cleaned condition specified.
- 4 Immediately prior to the application of any specified intermediate coat or finish coat of paint, clean steel surfaces of all contaminants present on the coated surface in accordance with the paint manufacturer's written instructions unless approved otherwise by the BCE.

710.4.1.2.2 Application of Paint

- 1 Apply Aluminum Epoxy Mastic primer within 8 hours after cleaning and before any rusting occurs. Mix paint and apply in accordance with the paint manufacturer's written recommendations using people skilled in this type of work.
- 2 Apply Aluminum Epoxy Mastic primer only when the paint, surrounding air, and steel surface temperatures are above 40°F. Do not apply paint on damp surfaces. Do not apply paint when, in the opinion of the OMR representative, conditions are otherwise unsatisfactory for the work. Do not apply paint when the surface temperature is less than 5°F above the dew point.
- 3 Make required touch-up of thin areas of the applied Aluminum Epoxy Mastic primer coat within 72 hours after application of paint. Allow cure time, as recommended by the manufacturer, between the application of the Aluminum Epoxy Mastic primer and any specified intermediate and/or finish coat.

710.4.1.2.3 Thickness Requirements

- 1 Mix the primer paint and apply according to the manufacturer's application instructions. Obtain a smooth uniform coating with a minimum dry film thickness of 5 mils without film cracking, sagging, or loss of adhesion.

710.4.1.2.4 Methods of Application**710.4.1.2.4.1 General**

- 1 Apply the Aluminum Epoxy Mastic paint by spray, brush, and /or roller application as specified herein. Do not apply the Aluminum Epoxy Mastic paint by spray if the structure is over existing traffic or in an urban area. Apply Aluminum Epoxy Mastic paint to structures over existing traffic or in urban areas by brushes and/or rollers unless an alternate method is approved by the BCE. However, spray application may be used any time the structure is within a closed containment system.

710.4.1.2.4.2 Brush and/or Roller Application

- 1 Apply a minimum of two coats, with each obtaining a required minimum dry film thickness of 5 mils, when utilizing brush and /or roller application. Use brushes and rollers of such quality that foreign materials are not deposited in the paint film. Only use solvents approved by the paint manufacturer.

710.4.1.2.4.3 Spray Application

- 1 Use spray equipment suitable for the intended purpose. Control painting by appropriate pressure regulators and gauges. Use air caps, nozzles, and needles recommended by the manufacturer of the paint being sprayed. Adjust the pressure on the paint in the pot and the air at the gun when necessary for changes in elevation of the gun above the pot.
- 2 Maintain the spray equipment in satisfactory condition to permit proper application. Keep the spray equipment sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film. Completely remove cleaning solvents left in the equipment before applying paint to the steel surface. Only use solvents approved by the paint manufacturer.

710.4.2 Field Painting**710.4.2.1 New Superstructure Steel****710.4.2.1.1 General**

- 1 Immediately prior to the application of any specified intermediate coat or finish coat of paint, clean steel surfaces of all rust, dirt, inorganic zinc primer dry spray, grout and/or concrete spillage, or any other contaminants present on the surface in accordance with the paint manufacturer's written instructions unless otherwise approved by the BCE. Do not allow that the maximum time between application of the intermediate coat of paint and the finish coat of paint to exceed 30 calendar days. Apply field coats of paint only when the surrounding air, the steel surface, and the paint temperatures are above 40°F. Do not apply paint on damp surfaces. Do not apply paint when the air is misty

710.4.2.1.2

710.4.2.1.4.3

or, in the opinion of the BCE, is otherwise unsatisfactory for work. Do not apply paint when the surface temperature is less than 5°F above the dew point.

710.4.2.1.2 Surface Preparation

- 1 Clean surface areas and all high strength bolts, washers, and nuts (except galvanized bolts, washers, and nuts) as described in **Subsection 710.4.2.1.1** using wire brushes or other suitable tools of all objectionable material as listed above to the satisfaction of the BCE. Clean galvanized bolts, washers, and nuts of all oil, lubricant, dirt, or objectionable material using a solvent that is recommended by the paint manufacturer and approved by the OMR. In addition to the specified cleaning and just prior to the application of the intermediate coat of paint, pressure wash (1500 psi minimum water pressure) all surface areas of the structural steel and all high strength bolts, washers, and nuts (plain or galvanized), and then, immediately blow dry with oil free and moisture free compressed air.

710.4.2.1.3 Field Touch-up Coat

- 1 Apply a field touch-up coat of paint to all surface areas of structural steel with damaged primer paint and/or deficient (thin dry film thickness) primer paint. Immediately after field cleaning as specified above and before any rusting occurs (within 8 hours), apply a touch-up coat (5 mils minimum dry film thickness) of approved Aluminum Epoxy Mastic paint produced by the same manufacturer as the Inorganic Zinc Silicate primer to the above noted steel surfaces.
- 2 Allow the Inorganic Zinc Silicate primer paint to cure a minimum of 60 calendar days (no maximum) before application of the touch-up coat of paint. Allow the touch-up coat of Aluminum Epoxy Mastic paint to cure as recommended by the paint manufacturer before application of the intermediate coat of paint.

710.4.2.1.4 Field Coats

710.4.2.1.4.1 Paint System NS1

- 1 Apply field coats of paint to all new structural steel including all grades of weathering steel in Paint Zone A as specified in **Subsection 710.2.7.1**.

710.4.2.1.4.2 Paint System NS2

- 1 Apply field coats of paint to all structural steel including all grades of weathering steel in Paint Zone B as specified in **Subsection 710.2.7.2** unless noted otherwise in the Plans.

710.4.2.1.4.3 Contractor Proposed Plan

- 1 The Contractor may elect to apply the specified field coats of paint before casting the concrete bridge deck provided the following conditions are satisfied:
 - A. The proposed plan (including site location and applicator) for applying the required field coats of paint is submitted to the BCE for review and approval a minimum of 30 calendar days prior to beginning

the painting work.

- B. The contact surfaces (including surfaces in contact with the nuts and bolt heads) of all bolted or welded steelwork is masked and does not receive the specified field coats of paint until after all steelwork is totally erected and all bolted or weld connections are complete.
- C. Any required cleaning and touch-up of the primer coat of paint is performed as noted in **Subsections 710.4.2.1.1** and **710.4.2.1.2** before applying any specified field coat of paint, and the Inorganic Zinc Silicate primer paint's cure time is a minimum of 60 calendar days before application of any specified field coat of paint.
- D. Any damage to the painted steelwork is corrected before the final inspection of the project.
- E. The painted steelwork is pressure washed (1200 psi maximum) within 6 hours after casting the deck to remove any drippings or runs of concrete from the painted steelwork. Any objectionable material on the steelwork not removed by pressure washing is removed to the satisfaction of the RCE by other suitable means recommended by the paint manufacturer.
- F. Special handling procedures are furnished for proposed handling, transporting, and placing the structural steel to minimize damage to the painted steelwork. The paint manufacturer's data is furnished with the minimum time before handling steelwork after paint has been applied on the steel surface.
- G. The specified finish coat of field paint cures a minimum of 2 weeks prior to casting the deck concrete.

710.4.2.1.5 Application of Paint

710.4.2.1.5.1 General

- ¹ Allow the Inorganic Zinc Silicate primer paint applied as specified in **Subsection 710.4.1** to cure a minimum of 60 calendar days (no maximum) before application of either intermediate coat of paint.

710.4.2.1.5.2 High Build Aliphatic Polyurethane Paint

- ¹ Apply a single finish coat of High Build Aliphatic Polyurethane paint on steelwork that has been coated with the intermediate coat of Aluminum Epoxy Mastic paint. Make required touch-up of thin areas of the applied coating within 48 hours after application of the paint. Allow a cure time as recommended by the paint manufacturer between the application of the Aluminum Epoxy Mastic paint and the finish coat of High Build Aliphatic Polyurethane paint.

710.4.2.1.5.3 Acrylic Paint

- ¹ Apply a single finish coat of the Acrylic paint to steelwork which has been coated with the intermediate coat of Acrylic paint as specified in **Subsection 710.2.7.2**. Allow a cure time between the intermediate coat and the finish coat of Acrylic paint as recommended by the paint manufacturer unless ap-

proved otherwise by the BCE.

710.4.2.1.6 Thickness Requirements

- 1 Apply paint coat with a minimum dry film thickness as specified in **Subsection 710.2.7.2**. Apply a smooth uniform coating without film cracking, sagging, or loss of adhesion.

710.4.2.1.7 Methods of Application

710.4.2.1.7.1 Brush and/or Roller Application

- 1 Use brushes and rollers that are of such quality that foreign materials are not deposited in the paint film. Apply a minimum of two coats of Aluminum Epoxy Mastic paint with each obtaining a required dry film thickness of 5 mils when utilizing the brush and/or roller method of application. For all other applied coatings, apply with brush and/or roller application as specified by the paint manufacturer.

710.4.2.1.7.2 Spray Application

- 1 Use equipment suitable for the intended purpose. Control painting by appropriate pressure regulators and gauges. Use air caps, nozzles, and needles recommended by the manufacturer of the paint being sprayed. Adjust the pressure on the paint in the pot and the air at the gun when necessary for changes in elevation of the gun above the pot.
- 2 Maintain the spray equipment in satisfactory condition to permit proper application. Keep the spray equipment sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film. Completely remove solvents left in the equipment before applying paint to the steel surface. Use only solvents approved by the manufacturer.

710.4.2.1.7.3 Aluminum Epoxy Mastic Paint

- 1 The Aluminum Epoxy Mastic paint may be applied by spray, brush and/or roller application, except if structure is over existing traffic or in an urban area, in which case, apply paint by brushes and/or rollers unless an alternate method is approved by the BCE. Spray application may be used any time the structure is within a closed containment system.

710.4.2.1.7.4 High Build Aliphatic Polyurethane Paint

- 1 Apply High Build Aliphatic Polyurethane paint by spray application unless approved otherwise by the BCE. If the structure is over existing traffic or in an urban area, use a closed containment system unless otherwise permitted by the BCE.

710.4.2.1.7.5 Acrylic Paint

- 1 Apply the intermediate coat of Acrylic paint by spray application. If the structure is over existing traffic or in an urban area, use a closed containment system unless otherwise permitted by the BCE.
- 2 Apply the finish coat of Acrylic paint by either spray, brush and/or roller ap-

plication, except if structure is over existing traffic or in an urban area, in which case, apply paint by brushes and/or rollers unless an alternate method is approved by the BCE. Spray application may be used any time the structure is within a closed containment system.

710.4.2.2 New Steel H-Bearing Piling and Sway Braces

710.4.2.2.1 General

- 1 Steel piling that is entirely below ground need not be painted. Paint exposed portions of steel piling from the bottom of bent cap down to an elevation 1 foot below the 100-year scour line as shown on the Plans. When the 100-year scour line is not shown on the Plans, paint the piling to a depth of 5 feet below the ground line or streambed elevation whichever depth is greater. Paint exposed steel angle sway bracing welded to steel piles. Paint piles driven through water either before driving or before the portion of the pile on which paint is required reaches the water level.

710.4.2.2.2 Surface Preparation

- 1 Clean the portions of the piles and sway braces that require paint with wire brushes or other suitable tools to remove all rust, dirt, oil, grease, concrete spillage, and other objectionable materials to the satisfaction of the RCE.

710.4.2.2.3 Field Coats

- 1 Paint the portions of the piles and sway braces that require paint in accordance with Paint System NS3 as specified in **Subsection 710.2.7.3**.

710.4.2.2.4 Application of Paint

- 1 Apply Aluminum Epoxy Mastic primer within 12 hours after cleaning and before any rusting occurs. Apply paint in accordance with the paint manufacturer's written recommendations using people skilled in this type of work.
- 2 Touch-up of thin areas of the applied Aluminum Epoxy Mastic primer coat within 72 hours after application of paint. Allow a cure time between the application of the Aluminum Epoxy Mastic primer and the Aluminum Epoxy Mastic finish as recommended by the paint manufacturer. Do not allow the maximum time between the application of the Aluminum Epoxy Mastic primer and the Aluminum Epoxy Mastic finish coat to exceed 30 calendar days.

710.4.2.2.5 Thickness Requirements

- 1 Mix and apply the intermediate coat and finish coat of paint according to the paint manufacturer's application instructions. Ensure that the applied coat obtains a minimum dry film thickness as specified in **Subsection 710.2.7.3**. Apply a smooth uniform coating without film cracking, sagging, or loss of adhesion.

710.4.2.2.6 Methods of Application

- 1 Apply the Aluminum Epoxy Mastic paint by either spray, brush and/or roller application in accordance with **Subsection 710.4.2.1.7.3**.

710.4.2.3 Existing Structural Steel**710.4.2.3.1 Surface Preparation**

- 1 Prior to the application of the intermediate coat and finish coat of paint, clean surface areas of dirt, oil, grease, rust, grout, concrete spillage, and other contaminants present on the coated surface in accordance with the paint manufacturer's written instructions unless approved otherwise by the BCE.

710.4.2.3.2 Field Touch-up Coat

- 1 Re-coat surface areas that have been damaged by the cleaning operation and surface areas deficient in primer dry film thickness in accordance with **Subsection 710.4.1.2.3**.

710.4.2.3.3 Field Coats

- 1 Paint all structural steel as specified in **Subsection 710.2.7**.

710.4.2.3.4 Application of Paint**710.4.2.3.4.1 Aluminum Epoxy Mastic Paint**

- 1 Cure Aluminum Epoxy Mastic primer paint as recommended by the paint manufacturer before the application of the intermediate coat of Aluminum Epoxy Mastic paint. Do not allow the maximum time between the application of the Aluminum Epoxy Mastic primer and the Aluminum Epoxy Mastic finish coat to exceed 30 calendar days.

710.4.2.3.4.2 High Build Aliphatic Polyurethane Paint

- 1 Touch-up thin areas of the applied coating within 48 hours after application of the paint. Ensure that the cure time between the application of the Aluminum Epoxy Mastic Paint and the finish coat of High Build Aliphatic Polyurethane is as recommended by the paint manufacturer. Do not allow the maximum time between the application of the Aluminum Epoxy Mastic Paint and the finish coat of High Build Aliphatic Polyurethane to exceed 30 calendar days.

710.4.2.3.5 Thickness Requirements

- 1 Mix and apply the intermediate coat and finish coat of paint according to the manufacturer's application instructions. Ensure that the applied coat has a minimum dry film thickness as specified in **Subsection 710.2.7**. Ensure that a smooth uniform coating is applied without any film cracking, sagging, or loss of adhesion.

710.4.2.3.6 Methods of Application**710.4.2.3.6.1 Aluminum Epoxy Mastic Paint**

- 1 Apply the Aluminum Epoxy Mastic paint either by spray, brush, and/or roller application as specified in **Subsection 710.4.2.1.7.3**.

710.4.2.3.6.2 High Build Aliphatic Polyurethane Paint

- 1 Apply the High Build Aliphatic Polyurethane Paint by spray application as specified in **Subsection 710.4.2.1.5.2**.

710.4.3 Measurement of Dry Film Paint Thickness

- 1 Perform measurement of dry film paint thickness in accordance with the SSPC PA-2, *Paint Application Specification No. 2* unless specified otherwise by the BCE.

710.5 Measurement

- 1 Painting of new structural steel is not measured for direct payment, and is considered included in the various items of construction on which paint is applied.
- 2 The quantity for the pay item Cleaning and Painting Existing Structural Steel is measured for payment as a lump sum (LS) unit; therefore, no specific measurement is made.

710.6 Payment

- 1 The work and materials required, described, and specified in the cleaning and painting of new structural steel in accordance with these specifications, the Plans, the Special Provisions, or as directed is not paid for directly, and is considered as part of the work pertaining to the various items of construction on which paint is applied, and the cost is included in the contract bid price for each such item.
- 2 Include all costs of materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to clean and paint the sway braces and steel piling in accordance with these specifications in the contract unit bid price for the item Steel H-Bearing Piling, as specified in **Subsection 711.6**.
- 3 Payment for Cleaning and Painting Existing Structural Steel is determined using the contract lump sum bid price for the pay item. Payment is full compensation for cleaning and painting existing structural steel in accordance with these specifications, the Plans and/or the Special Provisions or as directed and includes surface preparation; furnishing and applying paint systems of the color, type, and thickness specified; scaffolding, platforms, and falsework; brushes, rollers, sprayers, and other painting equipment; cleaning up and disposing of paint materials; protection of people and property; safety equipment; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Payment for each item includes all direct and indirect costs and expenses

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required to complete the work.

5 Pay items under this section include the following:

Item No.	Pay Item	Unit
7101000	Cleaning and Painting Existing Structural Steel	LS
710100X	Cleaning and Painting Existing Structural Steel - Bridge #X	LS

SECTION 711

DRIVEN PILE FOUNDATIONS

711.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for furnishing and installing prestressed concrete piling, steel H-piling, steel pipe piling, and treated timber piling of the kind, dimensions, at the locations, and to the bearing values, lines and elevations shown in the Plans or as directed by the BCE, RCE, or BDGE, and in conformance with the Plans and the Special Provisions.
- 2 This section supplements **Section 704** for the manufacture and handling of prestressed concrete piling. Prestressed pilings are those made using high ultimate strength reinforcement and are subjected to a prestressing force to place the concrete in compression.
- 3 Ensure that the steel pile points for prestressed concrete piling meet the requirements for steel piling, except for payment.

711.2 Materials

711.2.1 Prestressed Concrete Piling

711.2.1.1 Concrete

- 1 Unless otherwise specified, use Class 5000 concrete to produce prestressed concrete. Ensure that materials, equipment, construction methods, etc conform to the applicable requirements of **Sections 701, 702, 703, and 704** unless otherwise specified in this section.

711.2.1.2 Formwork

- 1 Ensure that forms for concrete piling conform to the general requirements for concrete formwork as provided in **Sections 702 and 704**.

711.2.1.3 Reinforcement

- 1 Unless otherwise shown on the Plans, provide steel reinforcement consisting of longitudinal bars or strands in combination with spiral reinforcement in the form. Use reinforcement meeting the requirements of **Section 703** or **Section 704**, whichever is applicable. Ensure that the reinforcing system is rigidly wired or fastened and held to true position in the forms by means of approved devices. Install splices in reinforcing steel as detailed on the Plans or approved in writing by the BCE.

711.2.1.4 Casting

- 1 Cast piling in a horizontal position. Vibrate and tamp the concrete around the reinforcement, especially at the pile head, and avoid the formation of stone pockets, honeycomb, or other such defects that may require rejection of the piling. During the placing of the concrete, the forms may be vibrated with a hammer or wooden maul. Place concrete continuously in each pile and

carefully spade, vibrate with an approved type of internal vibrator, and tamp. Avoid horizontal or diagonal cleavage planes. Properly embed the reinforcement in the concrete. Overfill the form, screed off the surplus concrete after a suitable period of time, and finish the top surface to a uniform, even texture similar to that produced by the forms.

711.2.1.5 Curing and Pointing

- 1 Cure prestressed concrete piling in accordance with the provisions of **Section 704**. When concrete has cured sufficiently, remove the side forms and carefully inspect the piling. Point cavities and irregularities with 1:2 mortar. After removing the side forms, the curing blankets may be turned back for a short time at the immediate location of pointing work. Conduct the work to keep this interference with the curing to a minimum. Prestressed piling may be transported and driven after the concrete is at least 3 days old and has attained the minimum design compressive strength.

711.2.1.6 Surface Finish

- 1 Provide a surface finish for prestressed piling in accordance with the provisions of **Section 702** that govern the surface finish of concrete.

711.2.1.7 Prestressed Concrete Piling in Tidal Water

- 1 Construct piling for use in tidal water as provided for in this specification, except as otherwise specified in **Subsection 702.4.2.7**.

711.2.2 Steel Piling

711.2.2.1 Structural Steel H-Piling and Steel Pipe Piling

- 1 Provide structural steel H-piling conforming to the requirements of AASHTO M 160 (ASTM A 6) and AASHTO M 270 (ASTM A 709), Grade 36 unless otherwise noted on the Plans. Provide steel pipe conforming to the requirements of ASTM A 252, Grade 2 either seamless or spiral welded. Ensure that chemical properties conform to the requirements of ASTM A 53, Grade B.

711.2.2.2 Concrete for Pipe Pile Anchors

- 1 Unless otherwise specified on the Plans or in the Special Provisions, use Class 5000 concrete for pile anchors for steel pipe piling.

711.2.2.3 Reinforcing Steel

- 1 Use reinforcing steel for pipe pile anchors conforming to the requirements of **Section 703**.

711.2.3 Timber Piling

711.2.3.1 General

- 1 Unless otherwise specified on the Plans or in the Special Provisions, use treated timber for timber piling.

711.2.3.2 Timber

- 1 Use treated Southern Yellow Pine conforming to the requirements of **Section 706**, unless otherwise specified.

711.2.3.3 Preservative Treatment

- 1 Treat timber piling for preservation in accordance with **Section 707**. Dual treatment of marine piling is not required unless specified on the Plans or in the Special Provisions.

711.2.4 Length of Piling**711.2.4.1 Length of Prestressed Concrete Piling**

- 1 Cast concrete piling to the length specified on the Plans or in the Special Provisions except in cases where index piling or load test piling is required. In such cases, the BCE will determine piling length after evaluating the data from the index piles and any required load tests. Any piling ordered before the piling length is determined by the BCE is the sole responsibility of the Contractor. For piling with pile points, ensure that the correct length of the concrete portion and steel portion of the piling is ordered. The BCE reserves the right to vary the casting length if, in the opinion of the BCE, the driving conditions warrant such change.

711.2.4.2 Length of Steel Piling

- 1 The lengths of steel piling shown on the Plans are approximate and are used solely for the comparison of bids.
- 2 When index piling is specified, the BCE will determine piling length after evaluating the data from the index piles and any required load tests. Any piling ordered before the piling length is determined by the BCE is the sole responsibility of the Contractor.
- 3 Provide length of steel piling utilized as prestressed pile points as shown on the Plans or as directed by the BCE.

711.2.4.3 Length of Timber Piling

- 1 The lengths of timber piling shown on the Plans are approximate and are used solely for comparison of bids. For treated piling, submit the length thus determined, together with any other data used in determining such length, to the BCE for review before such piling is ordered. Do not construe such review in any way as relief of the responsibility for obtaining piling of proper length.
- 2 Use full-length piling. Do not splice timber piling. Retain possession of pile cut-offs and dispose of cut-offs away from the site.

711.2.5 Transporting, Storage, and Handling of Piling**711.2.5.1 Concrete Piling**

- 1 Use only methods of transporting, storing, and handling concrete piling that eliminates the danger of cracking. Lift concrete piling by suitable devices at-

tached to the pile at sufficient points to prevent cracking. Avoid damage to the surface of the pile. Reject all piling that is cracked or broken unless a repair procedure is approved in writing by the BCE, and the procedure is completed to the satisfaction of the RCE.

711.2.5.2 Steel Piling

- 1 Ensure that the method of transporting, storage, and handling steel piling is such as to avoid injury to the piling. Store piling material on skids above the ground. Keep material clean and properly drained. Support long members on skids spaced near enough together to prevent injury from deflection.
- 2 For steel H-piling, one handling hole, 1½ inches in diameter, may be placed in the web of the pile at either or both ends. For steel pipe piling, two handling holes, 1½ inches in diameter, may be placed in the wall at one end.

711.2.5.3 Timber Piling

- 1 Ensure that the method of transporting, storage, and handling timber piling avoids injury to the piling. Avoid breaking the surface of treated piling. Do not use cant-dogs, hooks, or pike-poles for handling piling. Field treat unavoidable cuts or breaks made in the surface of treated piling in accordance with AWPA M4, which requires that the repair material be the same as the original treatment or may be copper naphthenate regardless of original treatment.
- 2 Store piling to be air-seasoned by segregating according to size and length, and each layer separated by 2-inch strips so that there is an air space of 2 inches or more underneath and between each layer. Reverse the ends of piling in alternate layers in order to keep the stack level. Leave alleys at least 3 feet wide between rows of stacks. Keep the space under and between the stacks free at all times of rotting wood, weeds, or rubbish. Ensure that the yard is drained so that no water will stand under the stacks or in their immediate vicinity.

711.3 Equipment

711.3.1 Pile Hammers for Prestressed Concrete and Steel Piling

- 1 Drive prestressed concrete and steel piling by means of a single acting air, steam or diesel hammer or double acting diesel hammer. Hydraulic hammers may be used if authorized in writing by the BCE. Maintain hammers in good operating condition and operate at the manufacturer's rated number of blows per minute when driving piling. Fit the hammer with an anvil base or bonnet that is built especially for holding the pile under the center of the hammer during the entire driving operation.

711.3.2 Pile Hammers for Timber Piling

- 1 Drive timber piling by means of a gravity, single-acting air, steam, diesel hammer or double-acting diesel hammer.

- 2 Use gravity hammers weighing neither less than 2000 pounds nor more than 2800 pounds. Regulate the fall of the hammer to avoid injury to the pile. Do not allow fall to exceed 14 feet for 2000-pound hammers or 10 feet for 2800-pound hammers. Proportionally adjust the maximum permissible fall for hammer weights between 2000 and 2800 pounds.
- 3 Use steam, air, or diesel hammers that develop an energy per blow at each full stroke of the piston of not less than 7200 foot-pounds nor more than 16,000 foot-pounds or sized as determined in **Subsection 711.4.2.3**. The BCE reserves the right to reduce the maximum size of hammer where hard material is encountered that will likely cause injury of the pile. Maintain hammers in good operating condition and operate at the manufacturer's rated number of blows per minute when driving piling. Fit the hammer with an anvil base or bonnet that is built especially for holding the pile under the center of the hammer during the entire driving operation.

711.3.3 Hammer Cushions

- 1 Use pile-driving equipment with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to ensure uniform driving behavior. Use hammer cushions made of durable manufactured materials, provided in accordance with the hammer manufacturer's guidelines. Do not use wood, wire rope, and asbestos hammer cushions. Place a striker plate as recommended by the hammer manufacturer on the hammer cushion to ensure uniform compression of the cushion material. Inspect the hammer cushion in the presence of the RCE when beginning pile driving and after each 100 hours of pile driving. When the reduction in thickness of hammer cushion exceeds 25% of the original thickness, replace the hammer cushion before driving is continued.

711.3.4 Pile Cushions for Prestressed Concrete Piling

- 1 Protect the head of concrete piling by a pile cushion made of plywood. Use a minimum plywood thickness placed on the pile heads prior to driving of not less than 4 inches. Provide a new pile cushion for each pile. Replace the pile cushion if during the driving of any pile the cushion either is compressed more than 1/2 of the original thickness or begins to burn. Ensure that the pile cushion dimensions match the cross-sectional area of the pile head.

711.3.5 Caps and Collars for Timber Piling

- 1 Drive timber piling with the aid of a metal casting that securely holds the pile in position during driving and distributes the load on the head of the pile to prevent splitting or brooming.
- 2 For treated timber piling, use a flexible and adjustable metal collar, accepted by the BCE, tightly strapped around the head of the pile below the cap casting to further prevent splitting of the pile during driving.

711.3.6 Leads

- 1 Use pile driver leads for driving piling that afford freedom of movement of the hammer. Support leads at sufficient points to maintain position and provides support of the pile during driving. Ensure that the vertical axis of the leads and hammer coincide with the vertical axis of the pile.
- 2 Except where piling is driven through water, use leads of sufficient length that make the use of a follower unnecessary.

711.3.7 Templates

- 1 Provide an adequately fixed template to maintain the pile in proper position and alignment during driving with swinging leads or with semi-fixed leads. Provide detailed drawings of templates for review and acceptance as part of the *Pile Installation Plan* in accordance with **Subsection 711.4.1**.
- 2 For piles on land, locate the template within 5 feet of cut-off or within 5 feet of ground line whichever is lower, except as otherwise indicated in this subsection or approved by the BCE. For piles in water, locate the template within 5 feet of cut-off or within 5 feet of the waterline whichever is lower. Do not use floating templates attached to a barge. Where practical, place the template so that the pile can be driven to cut-off elevation before the template is removed.
- 3 When driving piles in water with a follower using floating equipment, provide a double template, or other approved equipment to maintain alignment of the hammer, follower, and pile. Provide a double template consisting of a pile template within 5 feet of cut-off elevation and a second upper support above the water surface for the leads. Ensure that the individual pile positions of the second upper template are adjustable in size to serve as a guide for both the pile and follower. Where practical, place the template so that the pile can be driven to the cut-off elevation before the template is removed. Ensure that templates do not restrict the vertical movement of the pile.
- 4 For piling driven on land at interior bents, use a double template consisting of a lower template within 2 feet of the ground and an upper template a minimum of 8 feet above the lower template. For double templates on land, provide a minimum of 4 spuds, one on each of the 4 corners. Place additional spuds, if deemed necessary in the opinion of the RCE and/or BCE in order to keep the pile within the plan alignment tolerances.
- 5 If at any time during pile installation, the template does not maintain the pile alignment within the specified alignment tolerances, resubmit revised template details to the RCE and BCE for review and acceptance. Include in the revised template details such items as the change in the size, length, and number of spuds that help maintain the template in the desired location.

711.3.8 Followers

- 1 Unless specifically allowed on the Plans, in the Special Provisions, or approved in writing by the BCE, do not use followers in the driving of piling, ex-

cept when pile placement is required through water. Do not use followers during driving of index or test piling unless approved in writing by the BCE. If the use of a follower is desired, make the hammer selection with consideration that a follower can greatly reduce the energy transferred to the pile. Any hammer and follower combination must be capable of driving the piling to the required tip elevations and ultimate bearing values, without damaging the piles.

- 2 Include details of any proposed follower in the information provided to the Department so that the proposed follower can be modeled into the pile analysis.

711.3.9 Water Jets

- 1 Do not use water jets unless approved by the BCE or specified in the Special Provisions or on the Plans. If approved, ensure that the number of jets and the volume and pressure of water at the jet nozzles are sufficient to freely erode the material adjacent to the pile. Ensure that the pump has sufficient capacity to deliver at least 100psi pressure at 2 jet nozzles of $\frac{3}{4}$ -inch diameter at all times. Before the desired penetration is reached, withdraw the jets and drive the piling with a hammer to secure the final penetration and bearing.

711.4 Construction

711.4.1 Pile Installation Plan

- 1 Within 30 calendar days of award of Contract or no later than 30 days before driving the first pile, submit a *Pile Installation Plan* to the BDGE, with a copy to the BCE, and the RCE. Include in this plan the following detailed information:
 - List and size of proposed equipment including cranes, driving equipment, jetting equipment, compressors and predrilling equipment, including manufacturer's data sheets on hammers.
 - Pile and Driving Equipment Data form.
 - Methods to determine hammer energy or stroke in the field for determination of pile capacity. Include in the submittal, the necessary charts, and recent calibrations for any pressure measuring equipment, as well as the method for monitoring pile advancement.
 - Detailed drawings of any proposed followers.
 - Detailed drawings of templates. As a minimum include an elevation view and either a plan view or end view. Also, include the spud locations and the dimensions of the openings for the production piles.
 - Details of proposed load test equipment and procedures including recent calibrations of jacks and required load cells. See Pile Load Test specifications for additional requirements.
 - Sequence of driving footing piles for each different configuration of pile layout.
 - Proposed schedule for index pile program and production pile driv-

ing.

- Details of proposed items and procedures used to protect the integrity of existing structures.
- Required Shop Plans for piles, cofferdams, etc.
- Methods and equipment proposed to prevent displacement of piles during placement and compaction of fill, including MSE Wall backfill placement, within 15 feet of the piles. Include detailed procedures with sketches for maintaining the piling within the plan alignment.
- Other information required by the Plans or Special Provisions or otherwise requested by the Department.

- 2 The *Pile Installation Plan* will be evaluated for conformance with the Plans and the Special Provisions. Within 21 days after receipt of the plan, the Contractor will be notified of plan acceptance or any additional information required and/or changes that may be necessary to meet the Plans and specifications requirements. If any part of the plan is found to be unacceptable, agree upon changes and resubmit changes for re-evaluation. The Contractor will be notified within 7 days after receipt of proposed changes of their acceptance or rejection. All accepted plans are subject to trial and satisfactory performance in the field. Make any required changes that may result from unsatisfactory field performance. Do not make changes in the driving system after the final acceptance without the written consent of the BCE.
- 3 No extension of contract time will be granted for delays due to failure of the Contractor to observe these time requirements. Any claim by the Contractor for the delay based on the Department's failure to comply with the 21-day or 7-day requirements will be limited to an extension of contract time as the only possible compensation. The Department will evaluate only one pile driving system at a time for each pile type. It is strongly advised to submit only the pile driving system intended for use for each pile type. If more than one system is submitted per pile type, delays in acceptance of the plan should be expected and no additional compensation or extension of contract time will be given.
- 4 The criteria, which will be used to evaluate the driving equipment from the wave equation results, will consist of both the required number of blows per foot and the pile stresses throughout the entire driving process. The required number of hammer blows indicated by the wave equation or dynamic pile analyzer (PDA) at the ultimate pile resistance must be between 36 and 180 per foot for the driving equipment to be acceptable. In addition, for the driving equipment to be acceptable, the compressive stress in the pile due to driving as indicated by the wave equation or dynamic pile analyzer (PDA) must not exceed the allowable installation stresses as indicated in **Subsection 711.4.7**. When PDA testing is performed, perform the testing in accordance with ASTM D 4945.
- 5 Acceptance of the pile driving equipment does not relieve the Contractor of the responsibility to properly install the piling. The hammer acceptance and driving criteria will be based on commonly accepted hammer efficiencies,

component properties, and soil parameters. Local soil conditions and the actual driving system will affect the driving. If in the opinion of the BCE, the accepted driving system fails to perform satisfactorily during actual driving, the Department reserves the right to revise the driving criteria.

711.4.2 Allowable Installation Stresses in Piling

711.4.2.1 Prestressed Concrete Piling

- 1 Do not allow the tensile stresses in the concrete pile to exceed 3 multiplied by the square root of the concrete compressive strength (f'_c in psi) plus the effective prestress value shown as follows:

$$\text{Tensile Stresses} < 3 \times \text{SQRT}(f'_c) + \text{prestress}$$

- 2 Do not allow the compressive stress to exceed 85% of the compressive strength of the concrete minus the effective prestress shown as follows:

$$\text{Compressive Stress} < 0.85f'_c - \text{prestress}$$

- 3 Determine the stresses by Wave Equation Analysis or Dynamic Pile Analyzer (ASTM D 4945), whichever is appropriate.

711.4.2.2 Steel Piling

- 1 Do not allow the compressive stresses in the steel pile due to driving to exceed 90% of the yield stress. Determine stresses by Wave Equation Analysis or Dynamic Pile Analyzer (ASTM D 4945), whichever is appropriate.

711.4.2.3 Timber Piling

- 1 Do not allow the compressive stress in the timber pile due to driving as indicated by the Wave Equation Analysis or Dynamic Pile Analyzer (ASTM D 4945), to exceed three times the Allowable Unit Working Stress Compression Parallel to Grain for Normal Duration of Loading - σ_a . For Southern Pine, σ_a is 1200 psi, which then computes to a maximum driving stress of 3600 psi.

711.4.3 Index Piling

- 1 When index piling is required, drive index piling of the type specified and of the length stipulated at the location designated in the Plans, subject to the approval of the BCE. Drive index piling to practical refusal as defined in **Subsection 711.4.6**. Incorporate index piling into the final structure unless otherwise directed by the BCE. Unless otherwise approved in writing by the BCE, drive index piling with the same equipment used in driving the production piling. Provide driving data to the BDGE for determining the proper length of production piling. Do not use a follower for driving index piles unless approved in writing by the BCE. Drive index piling as soon as practical to minimize delay in determining length of production piling. The estimated production pile lengths shown on the Plans are for bid estimation purposes only. Unless approved in writing by the BCE, do not order production piling until all index piling have been driven, the data evaluated, and the piling length approved by the BCE. The Contractor will be notified by the BCE of the approved pile lengths within 7 working days after receipt of the Index Pile and/or Load Test data. Any claim by the Contractor for delay based on the Depart-

711.4.3

711.4.5.3

ment's failure to comply with the 7 working day requirement is limited to an extension of contract time as the only possible compensation.

- 2 The Department reserves the rights to add, delete, or shift index piling. Any additional index piling will be paid for at the unit price bid for the specified index piling. The Department also reserves the right to revise the length of any additional index piling after evaluating driving records from earlier index piling.

711.4.4 Pile Load Test

- 1 In special cases, it will be desirable to load test certain piling in order to determine the relationship between the driving resistance of the pile and the actual load bearing capacity of the driven pile as determined by actual test loading of the pile, taking into consideration the assumed safety factor of the pile. In this case, the Plans and the Special Provisions will outline the work to be done and the method of payment for the portion of work to be done.

711.4.5 Driving of Piling

711.4.5.1 Preparation for Driving

- 1 Do not drive piling until after the excavation is complete.

711.4.5.2 Methods of Driving

- 1 Drive piling in accordance with an accepted *Pile Installation Plan* as specified in **Subsection 711.4.1** and with equipment meeting the requirements of **Subsection 711.3**.
- 2 Do not pre-drill for piling, except where specifically noted in the Plans or approved in writing by the BCE. When pre-drilled holes are allowed, drive the piling by the hammer to its final position and to the required ultimate bearing. If pre-drilled holes are larger than the pile, backfill the space between the pile and the pre-drilled hole with sand, pea-gravel, or an approved material and tamp in an approved manner.
- 3 Do not use spudding to facilitate pile installation unless specifically approved in writing by the BCE.
- 4 Build-up prestressed concrete piling driven below grade where necessary as shown in the Plans or directed by the RCE and/or BCE and in accordance with **Subsection 711.4.9**.
- 5 Splice steel piling driven below grade in accordance with **Subsection 711.4.10**.
- 6 Remove any material forced up between the piling to the correct elevation before concrete for the foundation is placed.

711.4.5.3 Allowable Variation in Driving

- 1 Drive piling with a variation of not more than ¼ inch per foot from the vertical or from the batter indicated and a maximum pile head variation of not more than 3 inches from the position shown on the Plans. Drive piling with the head in the proper location without inducing excessive stresses in the pil-

ing.

- 2 When approved by the BCE, withdraw piling not within the maximum tolerances stated above, and re-drive within such tolerances, or replace by an additional pile without compensation. If impracticable to replace, piling not within the above tolerances will be subject to an appropriate reduction in payment for unsatisfactory workmanship.
- 3 Drive piling such that the cap may be placed in its proper location without inducing objectionable stresses in the piling in the opinion of the RCE. Do not apply lateral pressure to any pile during installation or to the pile after installation.

711.4.6 Minimum Penetration

- 1 Drive piling to a minimum penetration equal to 10 feet excluding any prestressed pile point, the minimum tip elevation shown in the Plans, or the depth at which the required ultimate bearing has been achieved, whichever is greater unless directed otherwise by the BCE. Do not consider penetration through fill material as acceptable penetration.
- 2 If the required ultimate bearing value, the minimum tip elevation, and the minimum penetration are obtained before the top of pile is to grade, continue driving prestressed concrete piles and steel piles for 2 feet or until the pile reaches grade, whichever is less.
- 3 To avoid cutting off a prestressed pile, the Contractor may elect, at his/her risk, to continue driving the pile until it reaches the required elevation.
- 4 After the minimum penetration and minimum bearing value requirements have been obtained and if the RCE so directs and the length of pile in the leads will permit, continue driving timber piling to 125% of the minimum bearing specified where a gravity hammer is used and to 150% where a mechanical hammer is used.
- 5 Immediately stop any extended driving beyond the required ultimate bearing value and minimum penetration as specified above if damage to the pile occurs or if the RCE determines that further driving would damage the pile. Also, stop such extended driving if the recommendations on the driving criteria are exceeded or if the pile reaches practical refusal. Practical refusal is defined as 5 blows in $\frac{1}{4}$ inch at full stroke or equivalent multiples thereof.
- 6 If practical refusal or pile damage is encountered before reaching the minimum penetration or the minimum tip elevation, stop pile driving and notify the BCE.

711.4.7 Determination of Bearing Values

- 1 Pile bearing will be determined by the BDGE and/or BCE based on the wave equation analysis or Dynamic Pile Analyzer Test (ASTM D 4945). If a pay item for Dynamic Pile Analyzer Test Set-up is provided, then use the Dynamic Pile Analyzer. If conditions warrant, the Department reserves the right to require Dynamic Pile Analyzer Tests even if not provided for in the Plans.

Unless otherwise specified on the Plans or in the Special Provisions, determine the allowable pile bearing for timber piles by the Dynamic Formula in **Subsection 711.4.7.3**.

711.4.7.1 Wave Equation Analysis

- 1 Drive piling to the required ultimate bearing shown in the Plans. The actual ultimate pile bearing obtained during driving will be determined by the Department based on a Wave Equation Analysis.

711.4.7.2 Dynamic Pile Analyzer

- 1 Drive piling to the required ultimate bearing shown in the Plans as determined by the Department using the Dynamic Pile Analyzer in accordance with ASTM D 4945.
- 2 The Department will utilize a Dynamic Pile Analyzer to monitor the driving of the index piling and a selected number of production piling, to be determined by the Department, for determining actual ultimate bearing. Before placement in the leads, make each designated pile available for wave speed measurements and for pre-drilling the required instrument attachment holes. The Department will furnish the equipment, materials, and labor necessary for the attachment of the instruments. Provide a responsible person to attach the instruments to the pile after the pile is in the leads. Provide a minimum 4 feet x 4 feet platform to be raised to the top of the pile while the pile is located in the leads. Anticipate short delays to allow for the attachment of the dynamic test instruments. Furnish electrical power for the dynamic test equipment. Ensure that the power supply at the outlet is 10 amp, 115 volt, 55-60 cycle, AC only. Equip field generators used as a power source with functioning meters for monitoring voltage and frequency levels.

711.4.7.3 Dynamic Formula

- 1 Ensure that timber piling has the minimum bearing value required by the Plans or in the Special Provisions. In the absence of requirements on the Plans or in the Special Provisions, use a minimum bearing value of 35 tons. Determine the bearing value by the following formulas based on English units of measure:

For gravity hammers,

$$P = \frac{2 WH}{S + 1.0}$$

For single acting steam, air, diesel hammers,

$$P = \frac{2 WH}{S + 0.1}$$

For double acting steam hammers,

$$P = \frac{2 H(W + A \times p)}{S + 0.1}$$

Where

- P = Bearing value in pounds.
 S = The average penetration in inches per blow for the last 3 to 10 blows for gravity hammers, and the last 10 or more blows for steam, air or diesel hammers.
 W = Weight, in pounds, of falling parts of hammer.
 H = Height of fall in feet. Use a fall of 14 feet in testing the capacity of pile using a gravity hammer
 A = Area of piston in square inches.
 p = Mean effective steam pressure in pounds per square inch at the hammer.

- 2 The above formulas are applicable only when
 - Hammer has a free fall,
 - Head of the pile is free from broomed or crushed wood fiber,
 - Penetration is at a reasonably quick and uniform rate, and
 - There is no sensible bounce after the blow.
- 3 In case water jets are used in connection with the driving, determine the bearing value by the above formulae from the results after driving the pile without the aid of jets.
- 4 Do not use water jets, predrilling, etc. to obtain penetration if considered unnecessary by the BCE.
- 5 Replace piling that does not meet all of the requirements of these specifications with piling that complies with the requirements of these specifications at no additional compensation.

711.4.8 Restriking Piling

- 1 The Contractor may be required to restrike a number of index piling or selected production piling after initial driving. If a Dynamic Pile Analyzer is being utilized, a restrike may be required after the dynamic test instruments are attached. The length of time required between initial driving and restriking will be determined by the BDGE and/or BCE. The time limit for a requested restrike will not be greater than 14 days, unless specified otherwise on the Plans or in the Special Provisions. Warm-up the hammer before re-driving begins by applying at least 20 blows to another pile. Ensure that the maximum distance of re-driving required to determine bearing is 6 inches or a maximum of 50 blows, whichever occurs first. If the pile has not reached the required ultimate bearing, continue driving until the required ultimate bearing is obtained.
- 2 Measurement and payment for restriking of piling is as specified in **Subsections 711.5** and **711.6**, respectively.

711.4.9 Build-Ups for Prestressed Concrete Piling

- 1 When build-ups are necessary, provide concrete in build-ups of the same quality and strength as required in the original pile. Just before placing the concrete, coat the pile tops with a moisture insensitive bonding epoxy acceptable to the RCE. Leave forms in place for at least 6 days. This period may be reduced to 3 days if high-early-strength cement is used or if an approved admixture is used to obtain high-early strength. No payment is made for build-ups where made necessary by damage to the pile during driving. Where build-ups are necessary, provide the reinforcement as shown on the Plans.

711.4.10 Splices for Steel Piling

711.4.10.1 Steel H-Piling

- 1 If splices are necessary for steel H-piling, make splices as follows:
 1. If bent during the driving process, straighten the top portion of the lower pile or, if it cannot be satisfactorily straightened, cut off below the bent portion.
 2. Bevel the bottom surface of the upper pile on the outside edge of the flanges and along one edge of the web. Make the bevel at an angle of approximately 45 degrees with the horizontal. A surface of $\frac{1}{8}$ inch may be left un-beveled. Guide plates may be temporarily attached to the web or flanges to properly align the pile sections before welding.
 3. Set the upper pile on the lower pile and temporarily clamp thereto. Separate the beveled edges of the upper pile about $\frac{1}{8}$ inch from the un-beveled edges of the lower pile. Make the axes of the two piling coincide by adjusting the clamps.
 4. Butt weld the entire periphery of the pile joint with a shielded metal arc low hydrogen electrode of proper size and with sufficient generating amperage to fuse the root of the weld. Make the weld with sufficient passes to completely fill the joint, removing the slag of each pass before beginning the next pass. Make the butt weld designated as B-U4b as specified in the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.
- 2 Pre-fabricated splicers may be used with the written approval of the BCE and at no additional cost to the Department. Install in accordance with the manufacturer's installation recommendations. Ensure that each splice has the moment, shear, and axial capacity of the pile. Ensure that as a minimum, each flange has full penetration butt welds, and the total amount of weld provided on the web is at least equal to the length of weld if a splicer was not utilized. Use pre-fabricated splicers with equal strength and thickness as the web.
- 3 Remove all paint and/or coating from the metal at the welds before welding begins. After all welding is completed, remove the slag and paint the welds as prescribed in **Subsection 711.4.15**.

711.4.10.2 Steel Pipe Piling

- 1 If splices are necessary for steel pipe piling, make them as follows:
 1. Bevel the surface of one of the piling on the outside edge of the wall at an angle of approximately 45 degrees with the horizontal. A surface of $\frac{1}{8}$ inch may be left un-beveled. Guide bars may be temporarily attached to the pipe wall to properly align the pile sections before welding.
 2. Butt the beveled pile to other pile and temporarily clamp thereto. Separate the beveled edge of the pile about $\frac{1}{8}$ inch from the squared edge of the other pile. Make the axes of the two piling coincide by adjusting the clamps.
 3. Butt weld the entire periphery of the pile joint with a shielded metal arc low hydrogen electrode of proper size and with sufficient generating amperage to fuse the root of the weld. Make the weld with sufficient passes to fill the joint completely, removing the slag of each pass before beginning the next pass. Make the butt-weld designated as B-U4b as specified in the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.
- 2 Remove all paint and/or coating from the metal at the welds before welding begins. After all welding is completed, remove the slag, and paint the welds as prescribed in **Subsection 711.4.15**.

711.4.11 Splices and Cut-offs at Cap for Steel Piling

- 1 Position the tops of steel piling to the elevation indicated on the Plans or in the Special Provisions or as approved by the BCE. Splices at concrete caps will not be required if the head of the pile, after removing pile material deformed during driving, is less than 6 inches below its plan position and extends not less than 12 inches, or the required minimum shown on the Plans, into the concrete cap. Make cut-offs at right angles to the axis of the pile.

711.4.12 Elevation of Cut-Off for Timber Piling

- 1 Saw-off the tops of all timber piling to a true plane at the elevation indicated on the Plans or as approved by the RCE. Saw piling that support timber caps to the exact plane of the superimposed structure and fit it exactly. Before the roofing pitch and galvanized metal or aluminum sheet are applied on such pile heads, temporarily set the timber cap and correct all misfits in an approved manner. Withdraw broken, split, or misplaced piling and properly replace. Withdraw piling driven below the cut-off grade and replace with new, and if necessary, longer piling at no additional expense to the Department. Drive down piling raised by heaving during the process of driving adjacent piling unless this requirement is waived in writing by the BCE.

711.4.13 Treatment of Timber Piling Heads

- 1 After a timber piling head has been cut-off, field treat the sawn surface by heavy applications of preservative treatment as recommended by the latest edition of AWPA M4. Apply the preservative until there is visible evidence

that penetration has ceased. Cover the pile head with a heavy application of coal-tar roofing cement meeting ASTM D 4022 specifications. Next, place a covering of 20-gauge galvanized metal or aluminum sheet. Bend the metal or sheet down neatly over the sides of the pile and firmly secure thereto with large-headed galvanized nails or a galvanized wire band. Pile heads that are to be encased in concrete do not require the galvanized metal or aluminum cap.

711.4.14 Welding of Steel Piling

- 1 Weld steel piling, including bracing, caps, splices, etc., in accordance with the requirements of **Section 709** of these specifications unless otherwise indicated on the Plans and in the Special Provisions or directed by the BCE or RCE.

711.4.15 Painting of Steel Piling

- 1 Paint steel piling in accordance with the requirements of **Subsection 710.4.2.2** unless otherwise indicated on the Plans and in the Special Provisions or directed by the BCE or RCE.

711.4.16 Encasement of Steel Piling

- 1 Where steel piling is to be encased in concrete, provide the encasement in accordance with the Plans or the Special Provisions.

711.4.17 Prestressed Pile Points and Reinforced Pile Tips

711.4.17.1 Prestressed Pile Points

- 1 When indicated on the Plans, provide the prestressed concrete piling with pile points of the size and shape as required. Ensure that pile points conform to the requirements for steel piling as required in this section of the specifications, and as amended by the Special Provisions. The Department reserves the right to require the extension of pile points by field welding an additional length of pile point, or the shortening of the pile point by cutting off a portion of the pile point. If reinforced pile tips are required, do not weld any reinforced pile tips onto the pile point until directed by the RCE, which normally occurs just prior to driving. If in the opinion of the RCE and/or BCE splices are necessary, provide slices as indicated in **Subsection 711.4.10**.

711.4.17.2 Reinforced Pile Tips

- 1 When specified in the Contract, provide reinforced steel piling with manufactured cast steel pile tips conforming to the requirements of AASHTO M 103 (ASTM A 27). Install the steel pile tips in accordance with the manufacturer's recommendations, except that as a minimum, extend the welds across the full width of each flange or the full circumference of steel pipe piles. Ensure that the steel pile tips are approved by the RCE before installation and the welds are visually inspected by the RCE in the field.

711.5 Measurement

711.5.1 Dynamic Pile Analyzer Test Set-Up and Restrikes

- 1 The quantity of Dynamic Pile Analyzer Test Set-Ups shown in the Plans is estimated and for bid purposes only. The quantity for the pay item Dynamic Pile Analyzer Test Set-Ups is measured for payment by each (EA) of index or production pilings to which Dynamic Pile Analyzer test equipment is attached for testing, complete, and accepted.
- 2 Dynamic Pile Analyzer Test Set-Ups required due to Contractor errors or inadequate pile driving procedures or equipment are not measured for payment.
- 3 A restrike of piling is not directly measured for payment. If a Dynamic Pile Analyzer Test is performed on the pile, any restrike is considered part of the Dynamic Pile Analyzer Test Set-Up item.
- 4 If a pay item for Dynamic Pile Analyzer Test Set-Up is not included in the Contract or test equipment is not attached to the pile, an allowance of 3 linear feet is added to the piling measurement of each piling on which a restrike is ordered by the BCE.

711.5.2 Prestressed Concrete Piling

- 1 The quantity for the pay item Prestressed Concrete Piling (of each size and shape) is the length of prestressed concrete piling, approved by the BCE, cast and driven regardless of cut-off plus the length of build-up and is measured by the linear foot (LF), complete, and accepted. The length of build-up is the length above the original pile head in addition to the length chipped back on the original pile for proper installation of the build-up. Measurement does not include length of piling cut-off due to damage during driving or due to the unnecessary driving past the designated top of pile elevation.

711.5.3 Pile Build-Up Preparation

- 1 The quantity of Pile Build-Up Preparations included in the Plans is estimated for bid purposes only. The quantity for the pay item Pile Build-Up Preparation (of each size and shape) is measured by each (EA) of prestressed concrete piles receiving a reinforced concrete build-up. Measurement does not include build-ups required because of driving damage or due to unnecessarily driving past the designated top of pile elevation.

711.5.4 Prestressed Pile Points

- 1 The quantity for the pay item Prestressed Pile Points (of each type) is of steel pile point cast into the concrete piling plus any length spliced on at the direction of the BCE measured by the linear foot (LF), complete, and accepted. A splice to extend the pile point is eligible for payment only when directed by the BCE. An allowance of 4 feet of pile point is made for each steel H-pile splice eligible for payment and installed as per **Subsection 711.4.10.1**. An allowance of 6 feet of pile point is made for each pipe pile splice eligible for payment and installed as per **Subsection 711.4.10.2**. Pile points not in

conformance with these specifications or not accepted by the RCE and/or BCE are not included in this measurement.

711.5.5 Reinforced Pile Tips

- 1 The quantity for the pay item Reinforced Pile Tips (of each type) is measured for payment by each (EA) reinforced pile tip installed in the finished structure, complete, and accepted.

711.5.6 Pile Load Tests

- 1 The quantity for pay item Pile Load Test (of each type) is measured by each (EA) Pile Load Test performed, complete, and accepted.

711.5.7 Index Piling

- 1 The quantity for the pay item Index Piling (of each type) is the length of piling, including allowance for splices, driven and removed if specified and is measured for payment by the linear foot (LF), complete, and accepted.

711.5.8 Steel Piling

- 1 The quantity for the pay item Steel Piling (of each type) is the length of steel H-pile of pipe furnished and driven with allowances for splices and is measured for payment by the linear foot (LF), complete and accepted: A splice is eligible for payment only when it is directed by the BCE, and it extends the pile beyond plan length or the length initially established by the BCE. An allowance of 4 feet of steel H-pile is added for each steel H-pile splice eligible for payment and installed as per **Subsection 711.4.10.1**. An allowance of 6 feet of steel pipe pile is added for each pipe pile splice eligible for payment and installed as per **Subsection 711.4.10.2**. These measurements do not include piling that is not in conformance with these specifications or not accepted by the RCE and/or BCE.

711.5.9 Reinforced Concrete Encasement

- 1 Reinforced concrete encasement in the finished structure, placed in accordance with the Plans and the Special Provisions, is measured for payment by the cubic yard (CY) of concrete and pound (LB) of steel reinforcement measure in **Sections 701** and **703**, respectively.

711.5.10 Treated Timber Piling

- 1 The quantity for the pay item Treated Timber Piling is the length of piling furnished and driven in the finished structure and is measured by the linear foot (LF), complete, and accepted. A cut-off of less than 3 feet is not included in the measurement. An allowance of 0.4 linear foot per linear foot of cut-off in excess of 3 feet is included in the measurement. These measurements do not include piling that is not installed in accordance with the Plans and specifications, piling driven for falsework, or piling used in bracing.

711.5.11 Pile Driving Set-Up

- 1 The quantity for the pay item Pile Driving Set-Up is measured for payment by each (EA) pile to be driven as shown in the Plans.

711.6 Payment

711.6.1 Dynamic Pile Analyzer Test Set-Up and Restrikes

- 1 Payment for the accepted quantity of Dynamic Pile Analyzer Test Set-Ups, measured in accordance with **Subsection 711.5.1**, is determined using the contract unit bid price for the pay item. Payment is full compensation for preparing and assisting in Dynamic Pile Analyzer tests as specified or directed and includes mobilization and attaching testing equipment to the pile; work platform; supplying AC power; piling restrikes; monitoring and assisting the Department in interpreting test results; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 1 If the item for Dynamic Pile Analyzer Test Set-Up is not included in the Contract or test equipment is not attached to the pile, restrikes ordered by the BCE are included as a 3 linear foot allowance in the appropriate piling quantity and paid for as of piling.

711.6.2 Prestressed Concrete Piling

- 1 Payment for the accepted quantity of Prestressed Concrete Piling (of each type), measured in accordance with **Subsection 711.5.2**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for furnishing and installing prestressed concrete piling as specified or directed and includes prestressing, casting, curing, protecting, transporting, driving, and cutting off piling, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. The fixed pile driving costs are included in the pay item Pile Driving Set-Up.

711.6.3 Pile Build-Up Preparation

- 1 Payment for the accepted quantity of Pile Build-Up Preparation (of each type), measured in accordance with **Subsection 711.5.3**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for preparing the pile head to receive the build-up as specified or directed and includes the necessary drilling, chipping, welding, and grouting, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

711.6.4 Prestressed Pile Points

- 1 Payment for the accepted quantity of Prestressed Pile Points (of each type), measured in accordance with **Subsection 711.5.4**, is determined using

the contract unit bid price for the applicable pay item. Payment is full compensation for furnishing and installing prestressed pile points as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

711.6.5 Reinforced Pile Tips

- 1 Payment for the accepted quantity of Reinforced Pile Tips (of each type), measured in accordance with **Subsection 711.5.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for furnishing and installing reinforced pile tips as specified or directed and includes welding tip to the piling and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

711.6.6 Pile Load Tests

- 1 Payment for the accepted quantity of Pile Load Test (of the applicable pile), measured in accordance with **Subsection 711.5.6**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for setting-up and conducting a pile load tests as specified or directed and includes all materials, labor, and equipment to perform the required test monitoring; assisting the Department in interpreting test results; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. In the absence of a pay item for Pile Load Test, perform the work under the direction of the BCE with payment by a Change Order.

711.6.7 Index Piling

- 1 Payment for the accepted quantity of Index Piling (of each type), measured in accordance with **Subsection 711.5.7**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for furnishing and installing index piling as specified or directed and includes providing, driving, splicing, welding, cutting off, painting (if specified or directed), and removing piling (if specified), and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. The payment also includes the furnishing and placing of any temporary bracing necessary to hold the piling in alignment and the removal of any obstructions in order to complete the work as required.
- 2 Any length of concrete pile build-ups and number of pile build-up preparations necessary in conjunction with index piling are paid for at the contract unit price for Prestressed Index Piling and Pile Build-Up Preparation respectively.

711.6.8 Steel Piling

- 1 Payment for the accepted quantity of Steel H-Bearing Piling or Steel Pipe Piling (of each type), measured in accordance with **Subsection 711.5.8**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for furnishing and installing the steel piling as specified or directed and includes providing, driving, cutting off, splicing, welding, and painting (if specified) of piling exclusive of encasement, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. The fixed pile driving costs are included in the pay item Pile Driving Set-Up.

711.6.9 Reinforced Concrete Encasement

- 1 Payment for concrete and reinforcing steel used in pile encasement is paid as prescribed in **Sections 701** and **703**.

711.6.10 Treated Timber Piling

- 1 Payment for the accepted quantity of Timber Piling, measured in accordance with **Subsection 711.5.10**, is determined using the contract unit bid price for the pay item. Payment is full compensation for furnishing and installing treated timber piling as specified or directed and includes providing the necessary length, driving, and cutting-off treated timber piling (exclusive of hardware), and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. The fixed pile driving costs are included in the pay item Pile Driving Set-Up.
- 2 The payment for the necessary hardware is in accordance with the requirements in **Section 708**.
- 3 The cost of furnishing metal shoes for timber piling when directed by the BCE is paid for in a Change Order, but the placing thereof is included in the contract price for Treated Timber Piling.

711.6.11 Pile Driving Set-Up

- 1 Payment for the accepted quantity of Pile Driving Set-Up, measured in accordance with **Subsection 711.5.11**, is determined using the contract unit bid price for the pay item. Payment is full compensation for the fixed costs of the preparation for pile driving including site preparation; removing obstructions relating to the set-up for pile driving; furnishing mats, barges, templates, pile driving heads, hammer cushions, leads, and followers; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. The payment also includes the furnishing and placing of any temporary bracing necessary to hold the piling within plan alignment during all adjacent construction operations that affect the pile alignment such as placement of MSE Wall fills and approach

embankment.

711.6.12 Pay Items

- 1 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Pay items under this section include the following:

Item No.	Pay Item	Unit
7110001	Dynamic Pile Analyzer Test Set-Up	EA
7110010	Pile Driving Set-Up	EA
7110XX0	Prestressed Concrete Piling - (<i>(size)</i> " Sq.)	LF
7110XX1	Pile Build-Up Preparation (<i>(size)</i> " Sq.)	EA
7110XX2	Pile Load Test - Prestressed Concrete Piling (<i>(size)</i> " Sq.)	EA
7110XX5	Prestressed Index Piling (<i>(size)</i> " <i>(shape)</i>)	LF
71104X0	Prestressed Concrete Octagonal Piling - (<i>(size)</i> "	LF
71104X1	Prestressed Concrete Octagonal Pile Build-Up Preparation - (<i>(size)</i> "	EA
71104X2	Pile Load Test - Prestressed Concrete Octagonal Pile - (<i>(size)</i> "	EA
71111XX	Prestressed Pile Point - (<i>(HP size)</i>)	LF
71113XX	Prestressed Pile Point - (<i>(pipe diameter)</i> " <i>(Extra Strong or Double Extra Strong pipe)</i>)	LF
71115XX	Reinforced Pile Tips - (<i>(size)</i>)	EA
71117XX	Reinforced Pile Tips - (<i>(pipe diameter)</i> " <i>(Extra Strong or Double Extra Strong)</i>)	EA
7112XXX	Steel H-Bearing Piling - (HP <i>(size)</i> X <i>(weight)</i>)	LF
7112XX1	Pile Load Test - Steel H-Piling (HP <i>(size)</i> X <i>(weight)</i>)	EA
7112XX2	Steel H-Bearing Index Piling - (HP <i>(size)</i> X <i>(weight)</i>)	LF
7113XX0	Steel Pipe Piling (<i>(diameter)</i> " Diameter)	LF
7113XX1	Pile Load Test - Steel Pipe Piling (<i>(dia.)</i> " Diameter)	EA
7113XX2	Steel Pipe Index Piling - (<i>(dia.)</i> " Diameter)	LF
7119100	Treated Timber Piling	LF
7119101	Pile Load Test - Treated Timber Piling	EA

SECTION 712

DRILLED SHAFTS AND DRILLED PILE FOUNDATIONS

712.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for the construction of Portland cement concrete foundations consisting of fully cast-in-place shaft foundations and pile foundations within drilled excavations of the size and locations as shown on the Plans and performed in strict accordance with this section, the Plans, and the Special Provisions, and complying with the applicable requirements of **Sections 701, 702, 703, and 711** of these specifications.
- 2 For the purposes of this specification:
 - Drilled Foundations refers to both Drilled Shafts and Drilled Pile Foundations.
 - Drilled Shafts are cast-in-place shafts with reinforcing steel.
 - Drilled Pile Foundations consist of a drilled excavation of the proper size, with a pile section concreted or grouted in place. Reinforcing steel may or may not be required in a Drilled Pile Foundation.
 - Construction casing refers to casing that remains in-place. Temporary casings are removed during the concreting process.

712.1.1 Site Information

- 1 Data on subsurface conditions are not intended as representations or warranties of continuity of such conditions. It is expressly understood that the Department will not be responsible for interpretations or conclusions drawn by the Contractor. Data is made available for convenience of the Contractor and is not guaranteed to represent conditions that may be encountered.
- 2 Available soil borings are plotted on the Plans, and a copy of the boring logs is included in the proposal for the project.
- 3 Additional test borings and other exploratory operations may be made at the Contractor's option at no additional cost to the Department.

712.2 Materials

- 1 When cast-in-place concrete is required, provide Class 4000DS as specified in **Section 701**. Adjustments to the mix design may be requested, when characteristics of materials, job condition, weather, test results, or other circumstances warrant. All adjustments are subject to acceptance by the OMR. Make accepted adjustments at no additional cost to the Department.
- 2 Furnish reinforcing steel conforming to the requirements of ASTM A 706, Grade 60.
- 3 Ensure that piling used in a Drilled Pile Foundation conforms to the applicable requirements of **Section 711**.

712.3 Equipment

- 1 Use excavation and drilling equipment with adequate capacity including power, torque, and down thrust to excavate a hole of both the maximum diameter and to a depth 10 feet beyond the depth shown on the Plans.
- 2 Ensure that the excavation and over-reaming tools are of adequate design, size, and strength to perform the work shown in the Plans or described herein. Keep equipment well maintained and in good working condition. The BCE will be the sole judge of whether the drilling equipment is appropriate and in good working condition. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.
- 3 When the material encountered cannot be drilled using conventional earth augers with soil or rock teeth, drill buckets, and/or under-reaming tools, provide special drilling equipment including, but not limited to, rock core barrels, rock tools, air tools, blasting materials, and other equipment as necessary to construct the excavation to the size and depth required. Obtain written concurrence of the RCE and BCE before performing excavation by blasting. Due to variations in rock strength, provide equipment capable of drilling rock up to 25% stronger than maximum rock shear strength shown on the Plans or in the Special Provisions at no additional time or cost to the Department. If rock core specimens are required, use NQ or NX coring equipment unless otherwise approved by the BDGE.

712.4 Construction

712.4.1 Qualifications of the Contractor

- 1 Ensure that the installation of drilled foundations is performed by personnel who specialize in drilled foundation construction. Ensure that the supervisory personnel in charge of daily operations or the subcontractor's personnel in charge of daily operations have a minimum of 3 years of work experience in the installation of drilled foundations. Provide a drilled shaft supervisor with at least this minimum experience on site during the entire construction process of all drilled foundations (i.e. drilling, coring, placing of reinforcement, concreting, etc.) to troubleshoot any problems that may arise during the construction process. Complete and sign the drilled shaft documentation as specified in **Subsection 712.4.2**.
- 2 After award of the Contract, but before the start of drilled foundation construction, or along with the *Drilled Foundation Installation Plan* submittal, submit for BCE review and approval, the work experience records of the personnel, or those of the subcontractor, proposed for use to install drilled foundations. The BCE will be the sole judge of the Contractor's and/or the subcontractor's qualifications and experience to perform the drilled foundation work.
- 3 Failure to comply with the above requirements will result in the suspension of all work related to the drilled foundations. Do not begin work on the drilled

foundations until the required personnel qualifications and experience is provided. The Department is not be liable for any damages or costs of any type related in any way to the suspension of this work, nor will the project completion date be postponed for delays in furnishing the qualifications.

- 4 The BCE may waive the minimum experience requirements for drilled pile foundations if the Contractor or subcontractor installing the drilled pile foundations is knowledgeable in this type of construction.

712.4.2 Drilled Foundation Installation Plan

- 1 Submit a *Drilled Foundation Installation Plan* and transmittal letter to the BDGE for review and acceptance. Also, submit a copy of the submittal to the RCE and BCE. Submit the *Drilled Foundation Installation Plan* a minimum of 30 days before the proposed date to begin drilled shaft or drilled pile work.
- 2 Ensure that the plan addresses and includes, but is not limited to, the following information:
 - List and size of proposed equipment to be used on the project such as cranes, drills, augers, bailing buckets, final cleaning equipment, de-sanding equipment, tremies, concrete pumps, casings, templates, etc.
 - Details of sequence of construction operations and sequence of shaft or pile construction in bents or in shaft or pile groups. Anytime the Contractor anticipates and submits the dry method of construction, also submit the wet method of construction to minimize construction delay in the event the wet method of construction criteria occurs.
 - Details of the method of determining the elevation of the top and bottom of any construction casing.
 - Details of excavation methods.
 - Details of proposed methods to clean the excavation after initial drilling.
 - When slurry is required, details of methods to mix, circulate, de-sand, and dispose of slurry.
 - Details of the steel reinforcing cage, such as method of placement, spacers, concrete feet, supports, method of centering the cage in the shaft or pile, handling, lateral stability, prevention of buckling, etc.
 - Details of concrete placement, such as proposed procedures for concrete tremie or pumping, initial placement, lifts during placement, and overfilling of the concrete. Indicate the intervals (minimum of 1 after each truckload) at which the top of concrete will be measured for plotting the Theoretical vs. Actual Concrete Volume graph (Drilled Shafts only). Indicate the total length of time (time from when first load of concrete is batched until all concrete is in the drilled shaft) necessary to pour the shaft based on availability of materials, equipment, and construction techniques being utilized, concrete trucks available, haul distance, etc. If a wet excavation is required,

equip the tremie or pump line with a flat metal plate or a foam plug of sufficient size to ensure separation between the water in the tremie or pump line and the concrete being placed. Basketballs, trash bags filled with hay or other materials are not acceptable for use. Either remove the device from the excavation, or ensure that it is of a material accepted by the BCE that will not cause a defect in the shaft if not removed.

- Required submittals such as shop drawings and concrete design mixes with slump loss tests (if concrete batching, mixing and placement exceed 2 hours).
 - Means of disposing of excavated materials.
 - The type and frequency of tests performed, including but not limited to chemical and specific gravity tests for slurry. Also, supply the name(s) of personnel who are qualified to perform these tests.
 - The proposed method to check the dimensions, depth of the shaft or pile. Indicate the method for determining horizontal and vertical alignment, vertical position of the top of shaft or pile and potential movement of the reinforcing cage.
 - Construction and/or temporary casing details with sketch and dimensions, elevations, including splice details, painting, and/or casing removal details if applicable.
 - Details of fixed template, adequate to maintain shaft position and alignment during all excavation and concreting operations, when drilling from a barge. Do not use floating templates (attached to a barge).
 - Details of the proposed method of protecting the integrity of adjacent structure(s) during installation of the shafts or piles.
 - Other information required by the Plans or requested by the Department.
- 3 The BDGE and BCE will evaluate the *Drilled Foundation Installation Plan* for conformance to requirements of these specifications, the Plans, and the Special Provisions. The BCE will notify the Contractor within 21 days of receipt of the plan of any additional information required and/or if changes are necessary for acceptance of the plan. If any part of the plan is unacceptable, the entire plan will be rejected. If that is the case, submit a revised *Drilled Foundation Installation Plan* for re-evaluation. The BCE will notify the Contractor within 7 days after receipt of the revised plan of its acceptance or rejection. Acceptance given by the BCE is subject to satisfactory performance in the field. Any claim for delay based on the Department's failure to comply with the above notification time provisions will be limited to an extension of contract time as the only possible compensation.
- 4 Do not commence installation of drilled shafts or drilled pile foundations until the *Drilled Foundation Installation Plan* is accepted by the BCE.
- 5 Acceptance of the *Drilled Foundation Installation Plan* does not relieve the

Contractor of the responsibility to provide sound and adequate foundations that conform to these specifications, the Plans, and the Special Provisions. Do not make changes in methods or equipment after acceptance of the *Drilled Foundation Installation Plan* without the written consent of the BCE.

- 6 With the assistance of the inspector, provide the RCE with the following documentation, as appropriate, complete and signed, for each drilled shaft or drilled pile foundation before excavation is initiated on subsequent drilled shafts or drilled piles:
 - *Drilled Shaft Log,*
 - *Drilled Shaft Excavation Log,*
 - *Slurry Inspection Log,*
 - *Drilled Shaft Inspection Log,*
 - *Drilled Shaft Concrete Placement Log,* and
 - *Drilled Shaft Concrete Volumes Log (waived for drilled piles).*
- 7 Ensure that the documentation indicates the theoretical versus actual concrete volume (drilled shafts only). Provide the elevation of the top of concrete after placement of each truckload of concrete or at intervals as specified by the RCE. Provide a qualified and competent person to make the necessary measurements.
- 8 Submit the documentation for one shaft or pile before the beginning of construction on other shafts or piles. This sequence requirement may be waived if more than one shaft or pile is completed in 1 day. In that case, submit completed and signed documentation by the drilled shaft/drilled pile supervisor prior to beginning construction the next working day. Provide the RCE with the above documentation for each drilled shaft or drilled pile foundation no later than 72 hours after the completion of each drilled shaft or drilled pile foundation. Submit only those forms applicable to a specific shaft or drilled pile (i.e. Slurry Inspection Logs will not be required for shafts utilizing dry concrete placement methods).
- 9 If soil conditions warrant, the BDGE and/or BCE may direct that the shafts or piles to be extended below the estimated bottom elevations shown on the Plans. Any additional compensation will be at the contract unit price for respective items as described in **Subsection 712.6.**

712.4.3 General Methods and Equipment

- 1 Perform the excavations required for the drilled shaft and drilled pile foundations through whatever materials encountered, to the dimensions and elevations shown on the Plans or otherwise required by the Special Provisions. Use methods and equipment for the intended purpose and the materials encountered.

712.4.4 Dry Construction Method

- 1 Use the dry construction method only when approved by the RCE at sites where the groundwater level and soil conditions are suitable to permit construction of the drilled shaft or drilled pile foundation in a relatively dry excavation, and where the sides and bottom of the excavation may be visually inspected by the RCE before placing the concrete.
- 2 The dry construction method will be allowed by the RCE only when the excavation demonstrates the following:
 - A. Less than 6 inches of water accumulates in the bottom of the excavation over a one-hour period with no pumping permitted. For dry excavations, do not allow the depth of water to exceed 3 inches immediately before concrete placement in the excavated hole. Record in the *Drilled Shaft Report* the actual depth of water in the excavated hole just prior to concrete placement.
 - B. The sides and bottom of the excavation remain stable without detrimental caving, sloughing, or swelling. If immediately following the completion of the excavation, the stability of the hole is questionable, the RCE may order up to a 4-hour observation period prior to setting rebar cage and placing concrete.
 - C. Loose material and water can be satisfactorily removed before inspection and before concrete placement.
- 3 If the RCE and/or BCE deems that the excavation meets all the criteria for the dry construction method, drill the excavation by removing accumulated water and loose material from the excavation, set the reinforcing cage, and concrete the shaft or pile in a relatively dry excavation. Casing may be used to facilitate dry construction if shown on the Plans or authorized in writing by the BCE.
- 4 Begin the setting of the rebar cage and concreting immediately after completion of the excavation, cleaning, inspection, and acceptance of the hole.
- 5 Use the wet construction method for excavations that do not meet the above requirements for the dry construction method.

712.4.5 Wet Construction Method

- 1 Use the wet construction method at sites where a dry excavation cannot be maintained for placement of the drilled shaft or drilled pile foundation concrete. Use water, mineral slurry, or a casing to maintain stability of the excavation perimeter while advancing the excavation to its final depth, placing the reinforcing cage, and concreting the shaft or pile foundation. Conform to the requirements in **Subsection 712.4.9**.

712.4.6 Casing Method of Construction

- 1 Casing may be used to stabilize the excavation with either wet construction methods or dry construction methods when shown on the Plans or authorized in writing by the BCE. Where drilled shafts or drilled pile foundations are lo-

cated in detrimental wet subsurface conditions as determined by the RCE or in open water areas, extend construction casings down from above the water elevation to protect the shaft or drilled pile concrete from water action during placement and curing of the concrete. Install the construction casing in a manner that produces an effective seal at the bottom of the casing. Ensure that casings left in place conform to the requirements for construction casing in **Subsection 712.4.8.3**.

712.4.7 Excavation

712.4.7.1 General

- 1 Unless otherwise specified or accepted by the BDGE and/or BCE, install casing before beginning excavation. The Plans will indicate the expected length of shaft or drilled pile, the elevation of the top of the shaft or drilled pile foundation, and the estimated elevation of the bottom of drilled shaft or drilled pile foundation. The BCE reserves the right to alter the elevations of the drilled shaft or drilled pile foundations based on the top of rock and/or the results of a Load Test, if performed. Where drilled shaft or drilled pile foundation lengths are altered, adjustment in price will be made by applying original contract unit prices to the change in quantity with no additional expense per unit.
- 2 Perform the drilling process for each individual excavation as a continuous operation. With written acceptance by the BCE, the drilling for an individual excavation may be discontinued if the walls can remain stable until drilling is resumed within 12 hours. See **Subsection 712.4.13** for additional requirements.
- 3 Haul off waste material removed from excavations, concrete spillage, and other debris and dispose of offsite at location(s) provided and obtained by the Contractor. Assume responsibility for all fees or permits required for disposal of waste material. Submit copies of all agreements and/or licenses for the disposal site(s) to the RCE. Ensure that the disposal is in strict accordance with local, state and federal environmental pollution laws and ordinances.
- 4 The Contractor may be allowed to dispose of the waste material on the project site if the RCE and/or DCE determine that the waste material can be incorporated into the project.
- 5 Do not permit workers to enter the excavation for any reason unless both a suitable casing has been installed and the water level has been lowered and stabilized below the level to be occupied. Ensure that the proper OSHA safety equipment and procedures are used by the workers entering the confined space excavation.

712.4.7.2 Obstructions

- 1 Remove surface and subsurface obstructions located no more than 10 feet below the elevation of the original ground at drilled shaft or drilled pile foundation locations at no cost to the Department. Notify the RCE of any unforeseen obstruction deeper than 10 feet below the elevation of the original ground.

Such obstructions may include man-made materials such as old concrete and timber foundations. Use special procedures and/or tools if excavation cannot be advanced using conventional augers fitted with soil or rock teeth, drilling buckets, and/or under-reaming tools. Such special procedures/tools may include, but not be limited to, chisels, boulder breakers, core barrels, air tools, hand excavation, temporary casing, and increasing the excavation diameter. Do not perform blasting unless specifically accepted in writing by the RCE and BCE. All reasonable costs for removing unforeseen obstructions are paid by the Department as extra work.

- 2 Drilling tools that are lost in the excavation are not considered obstructions. Promptly remove them without compensation. Assume all costs due to lost tool removal including, but not limited to, costs associated with excavation degradation due to removal operations for the time the excavation remains open.

712.4.7.3 Drilled Shafts with Wet and Dry Excavation

- 1 All excavation for drilled shafts is considered Wet and Dry Excavation unless a pay item is included for Rock Excavation. If rock is encountered, and there is a Rock Excavation pay item, Wet and Dry Excavation is measured from the top of shaft to the top of rock elevation in each individual shaft. Top of rock elevation is determined as indicated in **Subsection 712.4.7.5**.
- 2 Do not use salt water and/or tidal water in the drilled shaft excavation or drilled shaft construction. Do not use salt water and/or tidal water to hydrate mineral slurry.

712.4.7.4 Soil Excavation for Drilled Pile Foundations

- 1 Consider all excavation for drilled pile foundations as Soil Excavation unless a pay item is included for Rock Excavation. If rock is encountered, and there is a Rock Excavation pay item, Soil Excavation is measured from the actual top of ground to the top of rock elevation for each individual pile. Top of rock elevation is determined as indicated in **Subsection 712.4.7.5**.

712.4.7.5 Elevation of Rock

- 1 If rock is encountered more than 2 feet higher or lower than the elevation shown on the Plans, immediately notify the RCE. The RCE will then immediately notify the BDGE and/or BCE for further instructions.
- 2 Rock is defined as any material that cannot be drilled with rock augers and under-reaming tools and requires the use of core barrels, rotary percussion drills, and/or blasting. Notify the RCE when rock is encountered during drilling for verification of the rock elevation. Provide the RCE with samples of the excavated material to verify that rock has been encountered. For pay purposes, all earth seams, rock fragments, and voids included in the rock excavation area are considered rock for the full volume of the excavation from the initial contact with rock.
- 3 Use drilling equipment appropriate for the purpose and depths to determine the top of rock. Due to variations in rock strength, drill rock up to 25%

stronger than the maximum rock shear strength shown on the Plans or noted in the Special Provisions at no additional time or cost to the Department. If additional cost is requested due to rock strengths exceeding 125% of the maximum strengths provided by the Department, provide rock strength testing performed by an OMR approved AASHTO accredited testing firm. Obtain rock core specimens using NQ or NX coring equipment unless otherwise approved by the BDGE. Determine rock shear strengths using **SC-T-39**.

712.4.8 Steel Casings

712.4.8.1 General

- 1 Use steel casings that are smooth, clean, watertight, and have ample strength to withstand both handling and driving stresses and the pressure of both concrete and the surrounding earth materials. Ensure that the outside diameter of casing is not less than the specified size of shaft or pile foundation. Unless otherwise authorized in writing by the BCE, insert casings near existing foundations or structures to the full required depth prior to any drilling.
- 2 Pre-drilling with slurry and/or over-reaming to beyond the outside of the casing may require installation of casing, but do not utilize unless accepted in writing by the BDGE and/or BCE. Even when the use of an oversized casing or excavation is allowed, it will be at no extra cost and the extra concrete used to fill the oversized casing or excavation will not be considered for payment. When removing a casing to substitute a longer or larger diameter casing through caving soils, stabilize the excavation with slurry or backfill before removing the old casing. Other methods may be used to control the stability of the excavation and protect the integrity of the foundation soils. All methods must be accepted by the BDGE and/or BCE prior to use. Such removal and stabilization operations are at the Contractor's expense.

712.4.8.2 Temporary Casing

- 1 Unless a pay item for Construction Casing is included in the pay quantities, all subsurface casing are considered Temporary Casing. Withdraw casings from excavations before the completion of the concrete placement.
- 2 Use temporary casing consisting of spiral welded steel pipe or straight seam welded steel pipe. Do not use "Zipper Cans" as temporary casing.
- 3 If the Contractor intends to use telescoping casing, it must be requested in the *Drilled Foundation Installation Plan*. Provide details indicating adequate support for the reinforcing cage. The use of telescoping casing will be at the discretion of the BDGE and/or BCE. If allowed, use telescoping casing with spacers of adequate dimension arranged within the required intervals or stiffen the reinforcing cage with additional steel to eliminate the potential of buckling. Space the reinforcing cage concentrically inside the excavation with adequate support.
- 4 Do not extend oversized casings larger than the specified construction casing below the scour elevation. Where potential scour is not specified, do not extend oversized casings larger than the specified construction casing lower

than 10 feet below the top of ground elevation.

- 5 Do not use temporary casing where the design calls for a smaller diameter reinforcement cage for the column to be inserted into a larger diameter drilled shaft reinforcement cage. Use only construction casing for this type of detail.
- 6 Do not withdraw the casing until the level of fresh concrete in the casing is a minimum of 5 feet above the hydrostatic water level. As the casing is withdrawn, exercise care to maintain an adequate level of concrete within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the concrete.
- 7 Temporary casing that becomes bound or fouled during concreting and cannot be practically removed constitutes a defect in the foundation. Improve the defective work to the satisfaction of the BCE. Such improvement may consist of, but is not limited to, removing the concrete and extending the shaft or pile deeper to compensate for loss of frictional capacity in the cased zone, providing straddle shafts or piles to compensate for capacity loss, or providing a replacement shaft or pile. Complete all corrective measures including removal or re-design of structural members to the satisfaction of the BCE without compensation or extension of contract time. In addition, no compensation will be paid for any abandoned casing remaining in place.

712.4.8.3 Construction Casing

- 1 Use construction casing that is specified in the Plans to facilitate construction through water or other material that is not normally conducive to the use of temporary casing. Do not use construction casing unless it is specified in the Plans, or approved in writing by the BCE.
- 2 Use construction casing of the size specified in the Plans or by the BDGE and/or BCE. Assume responsibility for determining the wall thickness of the casing. Unless otherwise directed by the BDGE and/or BCE, use new steel casing conforming to AASHTO M 183, (ASTM A 36 or ASTM A 252, Grade 2) spiral welded steel pipe, or straight seam welded steel pipe. Do not use "Zipper Cans" as construction casing. Additional stiffening may be required to withstand handling and driving stresses and the pressure of concrete and of the surrounding earth and/or fluid pressures. Increase the casing wall thickness as necessary to allow for installation within the subsurface conditions anticipated on the project. Ensure that the casing is smooth and watertight.
- 3 When construction casing is installed to the top of rock elevation, establish an effective seal before excavating to prevent overburden material from caving into the proposed excavation. Unless a seal into rock is required, do not extend the bottom of the construction casing below the elevation shown on the Plans without approval of the BDGE and/or BCE. Review the water elevations indicated on the Plans and determine the appropriate top of casing elevations based on this information and the field conditions encountered at the time of construction. Support the top of the casing to maintain construction tolerances and stability during construction. Determine the elevation of

the top and bottom of the construction casing in accordance with the method accepted in the *Drilled Foundation Installation Plan*.

- 4 If the Contractor intends to use telescoping casing, it must be requested in the *Drilled Foundation Installation Plan*. Provide details indicating adequate support for the reinforcing cage. The use of telescoping casing will be allowed at the discretion of the BDGE and/or BCE. If allowed, use telescoping casing with spacers, of adequate dimension, arranged within the required intervals or stiffen the reinforcing cage with additional steel to eliminate the potential of buckling. Space the reinforcing cage concentrically inside the excavation with adequate support.
- 5 Paint construction casing before installation to an elevation 5 feet below the mean low water elevation in lakes and tidal environments or 5 feet below the mud line/ground elevation. Paint the casing in conformance with the requirements of **Subsection 710.2.7.3**. Install casing in a continuous unit. Each unit may be fabricated from 1 or more sections. Use section as long as feasible and spliced as described below. Grind exposed edges of construction casing smooth, remove attached steel, and apply touch-up painting.
- 6 Thoroughly clean wall surfaces of construction casings of any organics and other materials detrimental to soundness of the shaft or drilled pile concrete and reinforcing steel.

712.4.8.4 Welded Splices

- 1 Do not use splices in construction casing unless authorized in writing by the BDGE and/or BCE. If splices in casings are necessary and are authorized, make welds as follows:
 1. Bevel the surface of only one section of casing on the outside edge of the wall at an angle of approximately 45 degrees with the horizontal. A surface of $\frac{1}{8}$ inch may be left unbeveled. Guide bars may be temporarily attached to the casing wall in order to align the sections before welding.
 2. Butt the beveled section to the unbeveled section and temporarily clamp thereto. Separate the beveled edge about $\frac{1}{8}$ inch from the edge of the other section and make the axes of the two sections coincide by adjusting the clamps.
 3. Butt weld the entire periphery of the joint with a shielded metal arc low hydrogen electrode of proper size and with sufficient generating amperage to fuse the root of the weld. Make the weld with sufficient passes to completely fill the joint, removing the slag of each pass before beginning the next pass. The weld specified here is the butt weld designated as B-U4b in the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.
- 2 Remove all coatings from the metal at the welds before welding is begun and remove the slag after all welding is complete.

- 3 Splices in temporary casing are considered incidental work and no additional compensation is allowed for this work.
- 4 Ensure that the welding of steel casing, including bracing, caps, splices, etc, conforms to the requirements of the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.

712.4.9 Slurry

- 1 If the wet construction method is utilized, use mineral slurry as a drilling fluid. Test mineral slurries at the time intervals and maintain within the tolerances indicated in this subsection. Do not use salt water, high yield mineral slurry, and/or polymers. Use water as the drilling fluid only when specified on the Plans or in the Special Provisions. Use only potable when water is allowed to be used as the drilling fluid, install temporary casing or construction casing to the estimated tip elevation shown on the Plans or as otherwise specified by the BDGE prior to any drilled shaft excavation.
- 2 Use mineral slurries with a mineral grain size that will remain in suspension and possess sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Ensure that the percentage and specific gravity of the material used to make the suspension is sufficient to maintain the stability of the excavation and allows proper concrete placement. During construction, maintain the level of the slurry at a height sufficient to prevent caving of the excavation. In case of a sudden significant loss of slurry to the excavation, stop the construction of the foundation until a method to stop the slurry loss or an alternate construction procedure is accepted by the BDGE and/or BCE.
- 3 Thoroughly premix the mineral slurry with potable water. The RCE and/or BDGE may allow the use of on site/off site fresh water from a creek, river or lake provided the water is not muddy, dingy, and is free from oil, acid, alkali, organic matter, sewage or other substances injurious to the hydrated slurry mix or slurry (water only). Place the water into a holding tank for a minimum of 24 hours prior to mixing with the mineral slurry or use in the shaft unless otherwise directed by the BDGE. Ensure that the pH value of the water meets the values shown in this subsection. All costs for testing of the water quality are borne by the Contractor. The BDGE is the sole judge of whether water is acceptable for hydrating the mineral slurry.
- 4 Allow an adequate time (as prescribed by the mineral manufacturer) for hydration of the slurry in the storage tank before introduction into the shaft excavation. Provide slurry tanks of adequate capacity for slurry circulation, storage, and treatment. Do not use excavated slurry pits without the written permission of the BCE. Provide desanding equipment as necessary to control slurry sand content to less than 4% by volume at any point in the excavation. Desanding is not required for setting casing, signpost, lighting mast foundations, or during the actual drilling operation in the drilled shaft and drilled pile construction unless specified on the Plans or in the Special Provisions. Sand content requirements of the slurry remain in effect before and

after the drilling process for shafts and drilled piles. Take all steps necessary to prevent the slurry from "setting up" in the shaft. Such methods may include, but are not limited to, agitation, circulation, and/or adjusting the properties of the slurry. Dispose of all slurry offsite in suitable areas.

- 5 Carry out control tests on the mineral slurry using suitable apparatus to determine density, viscosity, and pH. Adhere to the acceptable range of values for those physical properties shown in the following table.

MINERAL SLURRY (Sodium Bentonite)			
Acceptable Range of Values			
Property (Units)	Range of Values At Time of Slurry Introduction	Range of Values In Excavation at Time of Concreting	Test Method
Density (pcf)	64.3 - 69.1	64.3 - 75.0	Density Balance API 13B-1, Section 1
Viscosity (seconds/quart)	28 – 45	28 – 45	Marsh Cone API 13B-1, Section 2.2
pH	8 – 11	8 – 11	pH paper, pH meter

Notes:

1. Perform tests when the slurry temperature is above 40°F.
 2. If desanding is required, do not allow sand content to exceed 4% (by volume) at any point in the borehole as determined by the American Petroleum Institute Sand Content Test (API 13B-1, Section 5).
- 6 Obtain a test sample of the slurry from the storage tank, and ensure that it meets the requirements shown in above table for density, viscosity, pH value, and sand content before introduction into the shaft and during shaft construction to establish and maintain a consistent working pattern. Make a minimum of 4 sets of tests during the first 8 hours of slurry use. Slurry sampling and testing will be observed by the RCE. When the results show consistent behavior, the testing frequency may be decreased to one set every 4 hours of slurry use.
- 7 Ensure that heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft. Before placing concrete in any shaft excavation, take slurry samples using a slurry-sampling tool. Extract slurry samples from the base of the shaft at intervals not exceeding 10 feet up the shaft, until two consecutive samples produce acceptable values for density, viscosity, pH, and sand content. Do not cast any concrete before the RCE accepts the slurry.

- 8 When any slurry samples are unacceptable, take whatever action is necessary to bring the mineral slurry within specification requirements. Do not pour concrete until re-sampling and testing yield acceptable values.
- 9 Have reports of all the tests required above completed and signed by the Drilled Shaft Supervisor and furnished to the RCE on completion of each drilled shaft.
- 10 During construction, maintain the level of mineral slurry in the shaft excavation at a level not less than 4 feet above the highest expected piezometric pressure head along the depth of the shaft. If at any time, in the opinion of the RCE, the slurry construction method fails to produce the desired results, discontinue this method and propose an alternate method for acceptance by the BDGE and/or BCE.

712.4.10 Inspection of Excavations

712.4.10.1 Dimensions and Alignment

- 1 Provide equipment for checking the dimensions and alignment of each excavation. Determine the dimensions and alignment of the drilled shaft or drilled pile foundation excavation under the observation and direction of the RCE. Check the alignment and dimensions during and after excavation by the following methods as necessary:
- A. Insertion into the shaft excavation of a rigid rod or pipe assembly with several 90-degree offsets equal to the shaft diameter for alignment and dimension checks.
 - B. Other proposed methods provided to and accepted by the BDGE and/or BCE.
- 2 Ensure that any rod or pipe assembly, or other device used to check dimensions and alignment can be inserted into the excavation to the full-depth of the foundation.

712.4.10.2 Depth

- 1 Reference the depth of the excavation during drilling to appropriate marks on the Kelly bar or other suitable methods. Measure final excavation depths after final cleaning with a suitable weighted tape or other accepted methods.

712.4.10.3 Excavation Inspection

- 1 The RCE will verify each excavation for acceptance before placement of the reinforcing cage and concrete. Provide necessary equipment and qualified personnel for inspecting the excavation. Ensure that the inspection equipment is compatible with the construction methods. The Contractor is responsible for providing all necessary safety precautions, equipment, and procedures required for confined space entry and fall protection by current OSHA standards for these inspections. Perform any corrective work found necessary because of the inspections. Allow the necessary time for performance of these inspections.

712.4.10.4 Excavation Cleanliness

- 1 Provide a cleaning operation so that a minimum of 50% of the base of each excavation has less than ½ inch of sediment at the time of placement of the concrete. Ensure that the maximum depth of sedimentary deposits or any other debris any place on the base of the excavation does not exceed 1½ inches. Inspect the excavation for cleanliness. Cleanliness will be verified by the RCE. In addition, for dry excavations, ensure that the maximum depth of water does not exceed 3 inches immediately before concrete placement. Have the Drilled Shaft Foreman record in the *Drilled Shaft Report* the actual depth (in inches) of water present in the shaft at start of concreting.
- 2 Check the bottom of the excavation before setting the reinforcement cage and immediately before concreting the excavation. If the cleanliness of the excavation does not meet the requirements indicated above before concreting, remove the reinforcement cage and clean the excavation until the requirements are satisfied.

712.4.10.5 Construction Tolerances**712.4.10.5.1 Drilled Shafts**

- 1 Ensure that the following construction tolerances for drilled shafts are met unless otherwise stated on the Plans or in the Special Provisions:
 - A. The drilled shaft is within 3 inches of plan position in the horizontal plane at the plan elevation for the top of the shaft.
 - B. The top elevation of the shaft has a tolerance of plus 1 inch to minus 3 inches from the plan elevation.
 - C. The vertical alignment of a vertical shaft excavation does not vary from the plan alignment by more than ¼ inch per foot of depth. The alignment of a battered shaft excavation does not vary by more than ½ inch per foot of depth from the prescribed batter.
 - D. After all the concrete has been placed, the top of the reinforcing cage is no more than 6 inches above and no more than 3 inches below the plan position.
 - E. All casing diameters shown on the Plans refer to OD (outside diameter) dimensions. The dimensions of casings are subject to American Pipe Institute tolerances applicable to regular steel pipe. When allowed by the BCE, a casing larger in diameter than shown on the Plans may be used. However, take steps to ensure that the reinforcing cage does not move when temporary casing is extracted. It may be necessary to increase the size of the spacers.
 - F. Excavation equipment and methods are designed so that the completed shaft excavation has a planar bottom. Ensure that the cutting edges of excavation equipment are normal to the vertical axis of the equipment within a tolerance of $\pm \frac{3}{8}$ inch per foot of diameter.

- 2 Drilled shaft/drilled pile excavations and completed shafts/drilled piles not constructed within the required tolerances are unacceptable. The Contractor is responsible for correcting all unacceptable shaft/drilled pile excavations and completed shafts/drilled piles to the satisfaction of the BCE. Ensure that the materials and work necessary, including engineering analysis and re-design to complete corrections for out of tolerance drilled shaft/drilled pile excavations are furnished without cost to the Department or an extension of contract time. On shafts that are within all tolerances, but are slightly off plan location, construct columns plumb and concentric around the rebar cage extending out of the drilled shaft.

712.4.10.5.2 Drilled Pile Foundations

- 1 Construction tolerances are the same as tolerances mandated for the applicable piling as shown in **Section 711** of these specifications.

712.4.10.6 Shaft Load Test

- 2 Material, equipment, and procedures for a Shaft Load Test are specified in the Special Provisions for the project. Measurement and payment are also included in the Special Provisions.

712.4.11 Construction of Drilled Foundations Using Cofferdams

- 1 Cofferdams for the construction of drilled foundations in open water or other areas may be used where such a method of construction is advantageous. The Contractor is responsible for obtaining of any required permits.
- 2 If cofferdams are used, comply with the requirements of **Subsections 204.4.3** and **702.4.1** for design, installation, and inspection of cofferdams.

712.4.12 Reinforcing Cage

712.4.12.1 Fabrication and Placement

- 1 Do not begin any drilling before the cage of reinforcing steel, consisting of longitudinal bars, ties, spirals, any necessary cage stiffener bars, and spacers is completely assembled and ready to be placed in the excavation. Place the reinforcing cage immediately after the excavation is inspected and accepted. Do not allow the maximum time between completion of excavation and concrete placement to exceed 12 hours unless otherwise approved in writing by the BCE.
- 2 Provide the necessary temporary or permanent stiffening against distortion during assembly, lifting, and placement of reinforcing cage. Ensure that stiffening of the cage is sufficient to prevent rupturing or buckling of Crosshole Sonic Logging (CSL) tubes. Place the CSL tubes halfway between the longitudinal bars. For more information about CSL tubes, see **Section 727**.

712.4.12.2 Splicing of the Reinforcing Cage

- 1 If the bottom of the constructed shaft or pile elevation is lower than the bottom of shaft or pile elevation shown on the Plans, extend all longitudinal bars the additional length. Continue hoops for the extra depth and extend the stiff-

ener bars to the final depth. Splice these bars by mechanical couplers, or use unspliced bars of the proper length. Splice cage due to additional depth of excavation at the bottom of cage unless otherwise shown on the Plans or approved in writing by the BCE. Do not weld reinforcing steel unless called for on the Plans or in the Special Provisions.

712.4.12.3 Support, Alignment, and Tolerance

- 1 Tie and support the reinforcing steel in the shaft so that the location of the reinforcing steel remains within allowable tolerances. Use concrete spacers or other approved non-corrosive spacing devices at sufficient intervals (near the bottom, the top, and at intervals not exceeding 10 feet vertically) to ensure concentric spacing for the entire cage length. Provide 1 spacer for each foot of excavation diameter, with a minimum of 4 spacers at each level.
- 2 Construct spacers of approved material equal in quality and durability to the concrete specified for the shaft. Ensure that the spacers are of adequate dimension to provide an annular space between the outside of the reinforcing cage and the side of the excavation along the entire length of the shaft as shown in the Plans. Contact between the concrete spacer and the wall of the excavation is required to assure the cage is concentrically supported along the entire length of the excavation. Provide acceptable concrete feet (bottom supports) to ensure that the bottom of the cage is maintained the proper distance above the base of the excavation. If an oversize casing or excavation is used, adjust spacer sizes to ensure concentric spacing.
- 3 Check the elevation of the top of the reinforcing cage before and after the concrete is placed. If the rebar cage is not maintained within the specified tolerances, make corrections to the satisfaction of the BCE. Do not construct additional shafts until the reinforcing cage support is modified in a manner satisfactory to the BCE.

712.4.13 Concrete Placement

712.4.13.1 Drilled Shafts

- 1 Place concrete as soon as possible after placing the reinforcing steel cage. Place concrete continuously from the bottom to the top elevation of the shaft. Continue concrete placement until good quality concrete is evident at the top of shaft. Place concrete by either a tremie or concrete pump. Free fall placement of concrete from the end of the tremie or pump line is not permitted. Free fall from the top may be allowed in a dry hole with conditions outlined in **Subsection 712.4.13.5**.
- 2 Do not allow the elapsed time from the beginning of concrete placement (time first concrete is batched) to the completion of the placement (time all concrete is placed in the shaft) to exceed 2 hours. Adjust admixtures, if accepted for use, for the conditions encountered on the job such that the concrete remains in a workable plastic state throughout the 2-hour limit. Before concrete placement, provide test results of both a trial mix and a slump loss test conducted by an approved testing laboratory using approved methods to demonstrate that the concrete meets the 2-hour workable plastic state re-

quirement.

- 3 A longer placement time may be requested provided the concrete mix supplied maintains a slump of 4 inches or greater over the longer placement time as demonstrated by trial mix and slump loss tests. Conduct the trial mix and slump loss tests using concrete and ambient temperatures appropriate for site conditions. Provide the slump loss test data in a form acceptable to the RCE. The Department may conduct random slump loss tests on production shafts.
- 4 Once concrete starts to set, wait a minimum of 12 hours as determined by the RCE or BCE before drilling adjacent shafts within a 20-foot radius of the cast concrete. Multiple shafts may be drilled prior to placing concrete if the drilled holes remain in a stable condition. For non-cased drilled shafts, wait until the cast concrete attains a minimum of 75% of the design compressive strength, as verified by testing test cylinders, before placement of a construction vehicles or equipment are allowed within the 20-foot radius of the concrete item cast.

712.4.13.2 Drilled Pile Foundation

- 1 Place the piles in the excavation and, if shown on the plans, drive to the required ultimate bearing at the design tip elevation. Practical refusal of the pile is defined as 5 blows per 0.25 inch. Pile driving bearing criteria will be waived if the bottom of the hole is sound rock as determined by the RCE.
- 2 Place concrete as soon as possible after placing the steel H-pile. The concrete may be placed before placement of steel H-pile provided that a suitable set retarding agent is used to ensure the ability to place steel H-pile to the specified tip elevation and verify bearing, if required, before hardening of the concrete.
- 3 Maintain continuous concrete placement from the specified tip elevation of the excavation to the final elevation specified on the Plans. Place concrete by either a tremie or concrete pump. Free fall from the top may be allowed in a dry construction excavation with conditions outlined in **Subsection 712.4.13.5**.
- 4 Multiple drilled piles may be drilled prior to placing concrete if the drilled holes remain in a stable condition. Multiple drilled piles may be concreted and driven provided the concrete remains in a workable plastic state throughout. A longer concrete placement time than the specified 2 hour limit may be requested provided the concrete mix supplied maintains a slump of 4 inches or greater over the longer placement time as demonstrated by trial mix and slump loss tests. Provide the slump loss test data in a form acceptable to the RCE. Conduct the trial mix and slump loss tests using concrete and ambient temperatures appropriate for site conditions.
- 5 Once concrete starts to set, wait a minimum of 12 hours as determined by the RCE or BCE before installing adjacent piling or drilling adjacent shaft/drilled pile within a 20-foot radius of the concrete item cast.
- 6 After installation of the pile and concreting is complete, backfill the space

between the pile and the excavation with clean sand and tamp in an approved manner. Do not backfill above the top of concrete until at least 24 hours after concrete placement. Remove any accumulation of water from the excavation by pumping before concreting and backfilling. If water cannot be removed, concreting using the wet construction method may be required.

712.4.13.3 Tremies

- 1 Tremies may be used for concrete placement in either wet or dry construction excavations. Use tremies to place concrete that consist of a rigid pipe or tube of sufficient length, weight, and diameter to discharge concrete at the bottom of the excavation. Ensure that the tremie does not contain aluminum parts that have contact with the concrete. Make certain that the inside diameter of the tremie is at least 6 times the maximum size of aggregate used in the concrete mix, but not less than 10 inches. Ensure that the inside and outside surfaces of the tremie are clean and smooth to permit both flow of concrete and allow unimpeded withdrawal during concreting. Make sure the wall thickness of the tremie is adequate to prevent crimping or sharp bends that may restrict concrete placement.
- 2 Ensure that the tremie used for wet excavation concrete placement is watertight. Do not begin underwater placement until the tremie reaches the bottom of the excavation. Discharge of concrete may begin at one tremie diameter above the bottom of the excavation. If a wet excavation is required, make sure the tremie is equipped with a flat metal plate or a foam plug of sufficient size to ensure separation between the water in the tremie and the concrete being placed. Remove the device from the excavation, or ensure that it is of a material accepted by the BCE and will not cause a defect in the shaft if not removed. Construct the discharge end of the tremie to permit the free radial flow of concrete during placement operations.
- 3 Immerse the tremie discharge end at least 10 feet in concrete at all times after starting the flow of concrete. Maintain a continuous flow of the concrete. Ensure that the concrete in the tremie maintains a positive pressure differential at all times to prevent water or slurry intrusion into the concrete column.
- 4 If at any time during the concrete placement, the tremie line orifice is positioned above the concrete-slurry interface, the shaft is considered defective. In such a case, remove the reinforcing cage and concrete, complete any necessary sidewall repairs directed by the BCE, and re-pour the shaft. The Contractor is responsible for all costs of the replacement of defective shafts.
- 5 If at any time during the concrete placement the tremie line orifice is less than 10 feet below the concrete slurry interface, the BCE has the right to order a CSL test of the shaft to determine if the shaft concrete has been contaminated because of this occurrence.
- 6 If a CSL test indicates an anomaly is present within a shaft and concrete coring or other testing methods confirm the presence of the anomaly, the Contractor bears the cost of all testing and remedial measures required to satisfy the BCE of the integrity of the shaft. If the testing cannot confirm the

presence of the anomaly and the shaft is found to be acceptable, the reasonable cost for all testing will be paid for by the Department.

712.4.13.4 Pumping Concrete

- 1 Concrete pumps and lines may be used for concrete placement in either wet or dry excavations. Ensure that pump lines are a minimum of 5 inches in diameter and are constructed with watertight joints. Do not begin concrete placement until the pump line discharge orifice is at the bottom of the excavation.
- 2 If a wet excavation is required, equip the pump line with a flat metal plate or a foam plug of sufficient size to ensure separation between the fluid in the pump line and the concrete being placed. Remove the device from the excavation, or ensure that the device is of a material accepted by the BCE and will not cause a defect in the shaft if not removed.
- 3 Ensure that the discharge orifice remains at least 10 feet below the surface of the fluid concrete for wet excavation concrete placement. When lifting the pump line during concreting, temporarily reduce the line pressure until the orifice has been repositioned at a higher level in the excavation. If at any time during the concrete placement, the pump line orifice is removed from the fluid concrete and discharges concrete above the rising concrete level, the shaft is considered defective. In such case, remove the reinforcing cage and concrete, complete any necessary sidewall repairs directed by the BCE, and repour the shaft. The Contractor is responsible for all costs of replacement of defective shafts.

712.4.13.5 Free-Fall of Concrete

- 1 With the written acceptance of the BCE, the free-fall of concrete may be allowed under the following conditions:
 - A. The excavation is a dry construction method excavation as defined under **Subsection 712.4.4**.
 - B. The inspector can see the top of the rising concrete during the pour and can determine if the concrete is striking the reinforcing cage.
 - C. The concrete is placed in a chute with a rigid pipe to direct the concrete straight down.
 - D. The concrete fall is less than 75 feet.
 - E. The maximum size of aggregate is $\frac{3}{4}$ inch; the slump is in the 7 inch to 9-inch range; and there are no strength problems.
 - F. A tremie or pump is on site and is prepared for use if it becomes necessary.
 - G. It is expressly understood that permission to use the free-fall method is conditional and the Department reserves the right to require a tremie or pump on any shaft if, for any reason, the RCE, BDGE and/or BCE determines that the free-fall method is not producing satisfactory results.

712.4.13.6 Forms

- 1 When the top of shaft or pile elevation is above ground and not formed by construction casing, form the portion of the structure above ground to the dimensions shown on the Plans with removable forms or another accepted method.
- 2 When required, remove casing used as form in a manner that will not damage the underlying concrete. Remove the casing in accordance with the following requirements:
 - A. The concrete has attained a compressive strength of 3000 psi as determined from test cylinder breaks.
 - B. After removal of the casing, continue curing the concrete for the full curing period in accordance with **Subsection 702.4.4.2**.
 - C. The concrete is not exposed to moving water or tidal water for at least 7 days after removal of the casing.

712.5 Measurement**712.5.1 Drilled Shafts with Wet and Dry Excavation**

- 1 The quantity for the pay item Drilled Shafts with Wet and Dry Excavation (of the specified diameter) is length of the reinforced concrete drilled shaft determined below and is measured by the linear foot (LF), complete, and accepted.
- 2 If a pay item for Drilled Shaft with Rock Excavation is not included in the Contract, then the length for Drilled Shafts with Wet and Dry Excavation is the difference between the top of shaft elevation shown on the Plans and the final bottom of shaft elevation authorized by the RCE, BDGE, and/or BCE or the actual bottom of shaft elevation, whichever produces the lesser length. No measurement is made for overdrilling beyond the elevation authorized by the RCE, BDGE, and/or BCE.
- 3 If a pay item for Drilled Shaft with Rock Excavation is included in the Contract, the length for Drilled Shafts with Wet and Dry Excavation is the difference between the top of shaft elevation shown in the Plans and the top of rock elevation determined in accordance with **Subsection 712.4.7.5**.

712.5.2 Drilled Shafts with Rock Excavation

- 1 The quantity for the pay item Drilled Shaft with Rock Excavation is the length of the reinforced concrete drilled shaft determined below and is measured by the linear foot (LF), complete, and accepted.
- 2 The length of Drilled Shaft with Rock Excavation is the difference between the elevation of the top of rock determined in accordance with **Subsection 712.4.7.5** and the elevation of the final bottom of shaft authorized by the RCE, BDGE, and/or BCE or the actual bottom of shaft elevation, whichever produces the lesser length. No measurement is made for overdrilling beyond the elevation authorized by the RCE, BDGE, and/or BCE.

- 3 If a pay item for Drilled Shaft with Rock Excavation is not included in the Contract, then all excavation for the drilled shaft is included in the item Drilled Shafts with Wet and Dry Excavation.

712.5.3 Soil Excavation for Drilled Pile Foundation

- 1 The quantity for the pay item Soil Excavation for Drilled Pile Foundations is the length of the soil excavation required to place the reinforced or non-reinforced concrete portion of the drilled pile foundation determined below and is measured by the linear foot (LF), complete, and accepted.
- 2 If a pay item for Rock Excavation for Drilled Pile Foundation is not included in the Contract, the length for Soil Excavation for Drilled Pile Foundations is the difference between the elevation of the top of ground determined by field measurement and the elevation of the final bottom of the drilled pile foundation authorized by the RCE, BDGE, and/or BCE or the actual elevation of the bottom of the concrete pile, whichever produces the lesser length. No measurement is made for overdrilling beyond the elevation authorized by the RCE, BDGE, and/or BCE.
- 3 If a pay item for Rock Excavation for Drilled Pile Foundation is included in the Contract, the length for Soil Excavation for Drilled Pile Foundation is the difference between the elevation of the top ground determined by field measurement and the authorized elevation of the top of rock determined in accordance with **Subsection 712.4.7.5**.

712.5.4 Rock Excavation for Drilled Pile Foundation

- 1 The quantity for the pay item Rock Excavation Drilled Pile Foundation is the length of the rock excavation required to place the reinforced or non-reinforced concrete portion of the drilled pile foundation and is measured by the linear foot (LF), complete, and accepted.
- 2 The length of the rock excavation is the difference between the top of rock excavation determined in accordance with **Subsection 712.4.7.5** and the final bottom of the concrete pile elevation authorized by the RCE, BDGE, and/or BCE or the actual bottom of drilled pile elevation, whichever produces the lesser length. No measurement is made for overdrilling beyond the elevation authorized by the RCE, BDGE, and/or BCE.
- 3 If a pay item for Rock Excavation for Drilled Pile Foundation is not included in the Contract, then all excavation for the drilled pile foundation is included in the price bid for Soil Excavation for Drilled Pile Foundation.

712.5.5 Reinforcing Steel

- 1 The quantity for the reinforcing steel in drilled shafts and drilled pile foundations is the theoretical number of pounds (LBS) of reinforcing steel required to construct the drilled shafts or drilled pile foundations to the dimensions and elevations shown on the Plans unless revised by the authority of the BCE and is measured in accordance with **Subsection 703.5**.

712.5.6 Concrete for Drilled Shafts

712.5.6

712.5.11

- 1 Concrete in drilled shafts is not measured for separate payment. All work for concrete in drilled shafts is included in the contract unit bid price for Drilled Shafts.

712.5.7 Drilled Pile Foundation Concrete

- 1 The quantity for the pay item Drilled Pile Foundation Concrete (Class 4000DS) is the volume of Class 4000DS concrete in the drilled pile foundations calculated using the dimensions and elevations shown on the Plans unless revised by the BCE and the unit of payment is cubic yard (CY) of concrete, complete, and accepted.

712.5.8 Construction Casing

- 1 The quantity for the pay item Construction Casing is the length of the construction casing determined below and is measured by the linear foot (LF), complete, and accepted.
- 2 Unless otherwise directed by the BCE, the length construction casing is the difference between authorized top of casing elevation and the final authorized bottom of casing elevation. Portions of the unpaid length of construction casing removed become the property of the Contractor for disposal away from the site.
- 3 An allowance of 5 feet of construction casing is added to the total measurement for cost of the work to provide an approved splice eligible for payment. There is not an allowance for any splice made for the convenience of the Contractor.
- 4 Measurements do not include casing that is not provided or installed in accordance with these specifications or directed and accepted by the BCE.
- 5 Installation and removal of temporary casing is not measured for payment, and is included in the cost of the drilled shaft or drilled pile foundation item.

712.5.9 Steel H-Piling

- 1 Steel H-piling for drilled pile foundations is measured in accordance with **Subsection 711.5**.

712.5.10 Drilled Pile Set-up

- 1 The quantity for the pay item Drilled Pile Set-Up is measured for payment by each (EA) drilled pile set-up, complete, and accepted.

712.5.11 Drilled Shaft Set-up

- 1 The quantity for the pay item Drilled Shaft Set-Up is measured for payment by each (EA) drilled shaft set-up, complete, and accepted.

712.6 Payment**712.6.1 Drilled Shafts with Wet and Dry Excavation**

- 1 Payment for the accepted quantity of Drilled Shafts with Wet and Dry Excavation, measured in accordance with **Subsection 712.5.1**, is determined using the contract unit bid price for the applicable pay item. Pay is full compensation for constructing drilled shafts as specified or directed and includes disposal of excavated materials; installing and removing temporary casings; slurry; removing of unforeseen obstructions; de-watering and cleaning excavation; furnishing and placing concrete; painting casings left in place; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. Fixed drilled shaft costs are included in the pay item Drilled Shaft Set-Up as specified in **Subsection 712.6.11**.

712.6.2 Drilled Shafts with Rock Excavation

- 1 Payment for the accepted quantity of Drilled Shafts with Rock Excavation, measured in accordance with **Subsection 712.5.2**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for constructing drilled shafts as specified or directed and includes disposal of excavated materials; installing and removing of temporary casings; removing of unforeseen obstructions; de-watering and cleaning excavation; furnishing and placing concrete; painting casings left in place; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. Fixed drilled shaft costs are included in the item Drilled Shaft Set-Up as specified in **Subsection 712.6.11**.

712.6.3 Soil Excavation for Drilled Pile Foundation

- 1 Payment for the accepted quantity of Soil Excavation for Drilled Pile Foundations, measured in accordance with **Subsection 712.5.3**, is paid for at the contract unit bid price for the pay item. Payment is full compensation for excavating soil for placement of drilled pile foundations as specified or directed and includes disposing of excavated materials; installing and removing of temporary casings; removing unforeseen obstructions; de-watering and cleaning excavation; painting casings left in place; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

712.6.4 Rock Excavation for Drilled Pile Foundation

- 1 Payment for the accepted quantity of Rock Excavation for Drilled Pile Foundations, measured in accordance with **Subsection 712.5.4**, is determined using the contract unit bid price for the pay item. Payment is full compensation for excavating rock for placement of drilled pile foundations as

specified or directed and includes disposing of excavated materials; installing and removing temporary casings; removing of unforeseen obstructions; dewatering and cleaning excavation; painting casings left in place; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

712.6.5 Reinforcing Steel

- 1 The quantity of reinforcing steel measured as specified in **Subsections 712.5.5** and **703.5** is paid for as Reinforcing Steel for Structures (Bridge) in accordance with **Subsection 703.6**, and payment is full compensation for furnishing rebar, tying, assembling, stiffening, and placing reinforcing steel cages. It also includes furnishing and attaching spacers on cages, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

712.6.6 Concrete for Drilled Shafts

- 1 Concrete for drilled shaft foundations including mix designs, trial batches, testing, concrete, forms, placing, and curing concrete is not paid for directly and is included in the contract unit bid price for Drill Shaft items.

712.6.7 Drilled Pile Foundation Concrete

- 1 Payment for the accepted quantity of Drilled Foundation Concrete (Class 4000DS), measured in accordance with **Subsection 712.5.7** is determined using the contract unit bid price for the pay item. Payment is full compensation for furnishing and placing concrete as specified or directed and includes all costs of mix designs; trial batches; testing; backfilling foundations; forms; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

712.6.8 Construction Casing

- 1 Payment of the accepted quantity of Construction Casing, measured in accordance with **Subsection 712.5.8**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for furnishing and installing the construction casing as specified or directed and includes removing casing (when specified or directed); cleaning and painting casing left in-place (if necessary); disposing of removed portions of casing; splicing and welding as required; casing stiffening materials; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. It also includes any temporary bracing necessary to hold the casing in alignment and the removal of any obstructions to satisfactorily complete the work as specified.

712.6.9 Steel H-Piling

- 1 Steel H-piling for drilled pile foundations is paid for in accordance with **Subsection 711.6**.

712.6.10 Drilled Pile Set-Up

Payment for the accepted quantity of Drilled Pile Set-Up, measured in accordance with **Subsection 712.5.10**, is determined using the contract unit bid price for the pay item. Payment is full compensation for the fixed costs in the preparation for installation of drilled piles as specified or directed and includes mobilization of drilling equipment; site preparation; removing foreseeable obstructions; templates; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

712.6.11 Drilled Shaft Set-Up

- 1 Payment for the accepted quantity of Drilled Shaft Set-Up, measured in accordance with **Subsection 712.5.11**, is determined using the contract unit bid price for the pay item. Payment is full compensation for the fixed costs in the preparation for installation of drilled shafts as specified or directed and includes mobilization of drilling equipment; site preparation; removing foreseeable obstructions; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

712.6.12 Pay Items

- 1 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Pay items under this section include the following:

Item No.	Pay Item	Unit
7120006	Drilled Shaft Set-Up	EA
7120008	Drilled Pile Set-Up	EA
712002X	Soil Excavation for Drilled Pile Foundations - (<i>diameter</i>)" Diameter	LF
712006X	Rock Excavation for Drilled Pile Foundations - (<i>diameter</i>)" Diameter	LF
7120XX1	Drilled Shafts with Wet & Dry Excavation - (<i>diameter</i>)" Diameter	LF

(table continued on the next page)

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(table continued from the previous page)

Item No.	Pay Item	Unit
7120XX2	Drilled Shafts with Rock Excavation - (<i>diameter</i>)" Diameter	LF
7120XX5	Construction Casing - (<i>diameter</i>)" Diameter	LF
7120500	Drilled Pile Foundation Concrete (Class 4000DS)	CY

SECTION 713

MECHANICALLY STABILIZED EARTH (MSE) WALLS

713.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for designing, furnishing materials, and constructing temporary or permanent Mechanically Stabilized Earth (MSE) walls in accordance with these specifications and the MSE wall system supplier's recommendations, and in conformance with the lines, grades, designs, and dimensions shown on the Plans or established by the RCE.
- 2 MSE wall exposed facings are precast concrete panels, modular concrete blocks, or other facings specified in the Plans. Design details for MSE wall structures such as type of wall facing (i.e. precast concrete panel, modular concrete block facing, etc.); loading conditions; leveling pad requirements; temporary surcharge retaining walls; and details for appurtenances are shown on the Plans or specified herein. MSE wall design includes supplying engineering calculations and drawings (Shop Plans/Working Drawings). Furnishing materials includes all MSE wall components such as facing elements, leveling pad, soil reinforcement and attachment devices, MSE wall backfill, wall coping, and any other project specific requirements such as structural frames or other methods to design around obstructions in walls, drainage features, etc. MSE wall construction includes structural excavation for the MSE wall, constructing the concrete leveling pad, erecting the wall facing, placing and compacting reinforced backfill, installing soil reinforcements, installing a drainage system, installing coping, and installing other project specific items required in the Plans or as directed by the BDGE or RCE.
- 3 Use those MSE wall systems that are listed in the Plans and listed on the most recent edition of *SCDOT Qualified Product List 64*.

713.1.1 MSE Wall Submittals, Review, and Acceptance

- 1 Submit 4 sets of design calculations and 8 sets of Shop Plans/Working Drawings to the BDGE for review in accordance with the requirements provided herein. Allow 30 calendar days from the day the submittals are received by the BDGE for review and acceptance.
- 2 Acceptance of the MSE wall design will be based on a review of the design calculations and the Shop Plans/Working Drawings for conformance with the Plans, specifications, and SCDOT standard design practices. Ensure that all calculations and Shop Plans/Working Drawings bear the legible seal, date, and signature of the responsible civil engineer registered as a Professional Engineer in the State of South Carolina. The Contractor's Designer is solely responsible for the accuracy, completeness, and constructability of the submitted design before and after review. Do not begin fabrication of the MSE wall components until written acceptance of the design and Shop Plans/Working Drawings is provided. The BDGE will notify the Contractor in

writing when the review process is complete and will transmit the reviewed and accepted Shop Plans/Working Drawings.

- 3 If the Contractor or the wall supplier is required to supplement or revise the design submittal in order to obtain acceptance of the MSE wall design, the time allowances for acceptance may increase. No additional contract time will be given for any subsequent loss of construction time due to time delays caused by revisions, modifications, clarifications, or re-submittal of calculations or Shop Plans/Working Drawings that is not in conformance with the Plans and specifications.
- 4 Payment for MSE wall construction will not begin until the MSE wall material certifications and MSE wall reinforced backfill material tests have been reviewed and accepted by the OMR.

713.1.2 MSE Wall Design

713.1.2.1 Scope of Design

- 1 Consider MSE wall structures as gravity walls. Design for external and internal stability of the reinforced soil mass. The Department will be responsible for the external stability of temporary and permanent MSE wall structures, which consists of checking the global stability for deep-seated failures, sliding stability, overturning, settlement analysis, and bearing capacity. The external stability of the MSE wall structure, with appropriate safety factors, is satisfied with the minimum base width required, B_{Req} , that is specified in the Plans.
- 2 The Contractor and the MSE wall system supplier are responsible for the internal stability design of temporary and permanent MSE wall structures. Determine the required soil reinforcement length and strength, facing/soil reinforcement connection strength, and facing stability in accordance with the Plans and this specification. The Contractor and the MSE wall system supplier are responsible for the design of any temporary MSE wall facings required during staging, or other project specific requirements (such as wall drainage systems, designs that allow obstructions within the reinforced soil mass, etc.) that are required to build the MSE wall structure. Ensure that the project specific design criteria provided in the Plans are used in developing the MSE wall design. If design criteria are not shown in the Plans, use the minimum design criteria listed in the SCDOT retaining wall design guidelines. Do not allow the MSE wall bearing pressures to exceed the allowable bearing pressures provided in the Plans. Prepare the Shop Plans/Working Drawings using the MSE wall details provided in the Plans and the SCDOT standard design practice as a guide for the design. Ensure that the design specifies the minimum required wall face batter to limit the amount of horizontal movements resulting from the outward rotation of the wall as a result of the development of internal equilibrium between the loads applied to the wall and the internal structure of the wall.

713.1.2.2 Design Methodology

- 1 Design temporary and permanent MSE walls and miscellaneous structures or systems associated with the MSE walls (i.e. structural frames for obstructions, wall drainage, joints, etc.) in accordance with the SCDOT retaining wall design guidelines, the current edition of the AASHTO *LRFD Bridge Design Specifications* (including interims), these specifications, the *Supplemental Specifications*, the Special Provisions, and SCDOT standard practices. In instances of conflict between specifications, the design requirements in the SCDOT retaining wall design guidelines and the SCDOT specifications supersede the AASHTO design specifications. The Department will not accept designs based on methodology other than required by this specification. Use the MSE wall design criteria shown in the Plans. If the design criteria in the Plans are incomplete, use the design criteria shown in the SCDOT retaining wall design guidelines.

713.1.2.3 Design Calculations

- 1 Submit to the RCE four complete sets of the MSE wall system supplier's design calculations in accordance with this specification. Fully document the determination of all loading conditions and assumptions. Include in the calculations (including computer runs) load cases that exist during construction and at the end of construction for surcharges, hydraulic conditions, live loads, combinations, and obstructions within the reinforced backfill.
- 2 If computer generated designs are used, furnish verification that the computer program's design methodology meets the requirements specified herein. This can be accomplished by providing either of the following:
 - Complete, legible, calculations that show the design procedure step-by-step for the most critical geometry and loading condition that will govern each design section of the MSE wall structure. Calculations may be computer generated provided that all input, equations, and assumptions used are clearly shown, or
 - A diskette with the input files and the full computer output of the FHWA's MSEW computer program (latest version) for the governing loading condition for each design section of the MSE wall structure. This software may be obtained at:

ADAMA Engineering, Inc.
33 The Horseshoe, Covered Bridge Farms
Newark, Delaware 19711, USA
Tel. (302) 368-3197, Fax (302) 731-1001
- 3 Special designs where computer runs do not adequately model the structure will require hand calculations. Provide a summary of the design computations that include design section identification, location, wall geometry (height, backslope, etc.), loadings (traffic loading, hydrostatic, seismic, traffic barrier, etc), governing design safety factors and level where they occur, and any other pertinent information in the design calculations.

713.1.2.4 Shop Plans/Working Drawings

¹ Include on the Shop Plans/Working Drawings, the horizontal and vertical alignment of the walls as well as the existing and proposed ground lines shown in the contract Plans. Clearly show the vertical bearing pressure exerted by the MSE wall structure relative to changes in wall height and soil reinforcement length. Furnish the Shop Plans/Working Drawings on size A plan sheets in accordance with **Subsection 725.1.1**. Include the following information needed to fabricate and erect the walls on the Shop Plans/Working Drawings:

- Elevation sheet or sheets for each wall;
- Existing ground elevations that have been verified by the Contractor for each location;
- MSE wall profile elevation showing top of the leveling pad elevations, maximum bearing loads, top of wall elevation at a minimum interval of 50 feet, etc.;
- Typical cross-section or cross-sections showing the elevation relationship between ground conditions and proposed grades;
- General notes pertaining to design criteria and wall construction;
- Details of slip joints if required to prevent stresses due to anticipated settlement shown on the Plans or at interfaces with other walls;
- Details of all joints indicating type, size, and manufacturer;
- Details of wall batter;
- Shape, dimensions, and any structural design details of the MSE wall facings;
- Details of the architectural or finish treatment supplied;
- Details of facing/reinforcement connections;
- The number, size, type, length, and details of the soil reinforcing elements in each design section;
- Details showing location and installation of geotextile fabric;
- Details of the leveling pad showing dimensions;
- Finishing details at the top of wall (i.e. cap block, panel coping, barrier, pavements);
- Details at miscellaneous obstructions (i.e. drainage structures, utility conduits, pipes) located within the reinforced backfill;
- Details at bridge foundation obstructions (including foundations to be installed with the current project);
- Dimensions of reinforced backfill required; and
- Any additional details pertaining to coping, railing, temporary facing, and internal drainage, as required by the Plans.

713.1.2.4.1 Shop Plans/Working Drawing Notes

- 1 Ensure that notes shown in the Shop Plans/Working Drawings do not conflict with SCDOT specifications and standard practice unless the notes are more stringent.

713.1.2.4.2 Top of Wall Elevation

- 1 Obtain written approval by the BDGE to lower the top of wall elevation from that shown on the Plans. When the top of the MSE wall with modular concrete block facing is stepped and covered with cap blocks, the top of wall elevation may be adjusted by increasing the top of the wall by a maximum of 8 inches. Make these adjustments in wall heights at stepped locations of MSE wall with modular concrete block facing without increases in wall quantity or additional compensation. Ensure that the top of the wall elevations allow for proper interfacing with barriers, copings, surface ditches, bridge abutments, etc. as shown in the Plans.

713.1.2.4.3 Leveling Pad

- 1 Written approval by the BDGE must be obtained to raise the leveling pad elevation from that shown on the Plans. However, leveling pad embedment dimensions shown in the Plans may be increased a maximum of 20 inches of embedment without written approval if no obstructions are encountered. Ensure that the leveling pad elevations allow for the transverse and longitudinal drainage structures shown on the Plans. Unless otherwise indicated on the Plans, embed all MSE walls a minimum of 2 feet below the finished grade at the wall face, or 2 feet below the design scour elevation for streams adjacent to the wall face, or 2 feet below the bottom of any drainage features adjacent to the wall face. If scour potential is mitigated, place the leveling pad a minimum of 2 feet below the finished grade at the wall face. If utilities, ditches, or other structures are located adjacent to the wall, embed the leveling pad a minimum of 1 foot below the bottom of these structures.

713.1.2.4.4 Wall Interface and Vertical Joint Details

- 1 Should conditions arise within the project where an MSE wall interfaces with another wall (e.g. MSE wall, concrete barrier wall, wing wall, etc.), ensure that the Shop Plans/Working Drawings contain slip joints details, special facing element details; and details on how to end this wall or walls; and how to compact the embankment at these locations. Do not place the wall ends over foundations. Consider all vertical joint lines to be slip joints and detail them so that the vertical joint is not wider than 1 inch and the vertical joint remains covered for the life of the structure to ensure that the reinforced backfill does not migrate outside of the MSE wall system. At locations where an MSE wall makes a 90-degree turn, use corner panels or corner blocks to make the turns and cover the vertical joints at these locations. Show a detailed soil reinforcement layout where walls intersect (i.e. permanent MSE wall intersects a temporary MSE wall at 90 degrees or less).

713.1.2.4.5 Earth Surcharges

- 1 If the Plans indicate an earth surcharge is to be placed over the reinforced zone, the surcharge may be retained by using a temporary MSE wall structure.

713.1.2.4.6 Precast Concrete Panel Facing Layout

- 1 For MSE walls with precast concrete panel facing, provide a numbered panel layout drawing for fabrication and erection purposes.

713.2 Materials

713.2.1 MSE Wall Facings

- 1 Purchase or manufacture all applicable materials such as facing panel, facing block, connectors, facing aggregate, block fill, wire baskets, and all other necessary components. Obtain written approval from the Director of Construction (DOC) to use materials or sources of materials not conforming to the specifications or not listed in the contract documents.

713.2.2 MSE Wall With Precast Concrete Panel Facings

713.2.2.1 Precast Concrete Panel Facing

- 1 Fabricate the precast concrete panels in accordance with requirements of the current edition of the AASHTO *LRFD Bridge Design Specifications* with the following exceptions and additions in the following **Subsections 713.2.2.1.1** through **713.2.2.1.10**.

713.2.2.1.1 Size

- 1 Provide precast concrete panels a maximum width (w) to height (h) ratio, $(w/h) \leq 1.20$ and a maximum height (h) to width (w) ratio, $(h/w) \leq 1.20$. Ensure that the panels have a maximum surface area of 30 square feet.

713.2.2.1.2 Reinforcing Steel

- 1 Unless otherwise noted in the Plans, provide reinforcing steel meeting the applicable requirements of ASTM A 706, Grade 60, and **Section 703**. Ensure that fabrication and placement of reinforcing steel conforms to the applicable requirements of **Section 703**.

713.2.2.1.3 Concrete

- 1 Make certain concrete and admixtures meet the requirements of applicable subsections of **Section 701**, except that a certified plant is not required. Provide concrete conforming to the requirements of Class 4000P with a minimum 28-day compressive strength of 4000 psi.

713.2.2.1.4 Casting

- 1 Notify the SME at least 14 days before the production of precast concrete panels. Cast the panels on a flat surface, with the front face of the panel facing downward and the back face of the panel facing upward. Do not allow the tie strip guide or other galvanized devices to be in contact with or attached to

the face panel reinforcement steel.

- 2 Place the concrete in each panel without interruption and consolidate by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the form. Fully support the units until the concrete reaches a minimum compressive strength of 1000 psi. Cure the panels with burlap blankets for 36 hours or steam cure. Keep forms in place until they can be removed without damage to the panel. The panels may be shipped 3 days after casting and attainment of the required concrete strength of 4,000 psi.

713.2.2.1.5 Compressive Strength

- 1 Acceptance of the precast concrete panels with respect to compressive strength will be determined on a lot basis. A lot is defined as either 40 panels or a single day's production, whichever is less. The lot will be randomly sampled for compressive strength testing in accordance with ASTM C 172 and tested in accordance with ASTM C 39. Strength testing and acceptance will be in accordance with applicable subsections of **Section 701**. Panels represented by test cylinders that do not reach the above requirements will be rejected.

713.2.2.1.6 Markings

- 1 Clearly scribe the date of manufacture, the production lot number, and the panel identification number on the rear face of each panel.

713.2.2.1.7 Finish

- 1 Unless otherwise indicated on the Plans or directed by the RCE, ensure that the concrete surfacing for the front face has a natural gray stone block (Ashlar) wall finish. Make certain all concrete finishes conform to the requirements of applicable subsections of **Section 702**. Provide the rear face with a uniform surface finish. Ensure that the rear face of the panel is roughly screeded to eliminate open pockets of aggregate and surface distortions in excess of $\frac{1}{4}$ inch.

713.2.2.1.8 Tolerances

- 1 Manufacture precast concrete panels within the following tolerances:
 - Panel Dimensions: position panel connection devices to within 1 inch of the specified dimension; all other dimensions to within $\frac{3}{16}$ inch of the specified dimension.
 - Panel Squareness: as determined by the difference between the two diagonals not to exceed $\frac{1}{2}$ inch.
 - Panel Surface Finish: surface defects on smooth formed surfaces measured over a length of 5 feet not to exceed $\frac{1}{8}$ inch. Surface defects on the textured-finish surfaces measured over a length of 5 feet not to exceed $\frac{5}{16}$ inch.

713.2.2.1.9 Rejection

- 1 Panels will be rejected because of failure to meet any of the requirements specified above. Any or all of the following defects are sufficient cause for rejection:
- Defects that indicate imperfect molding.
 - Defects indicating honeycomb or open texture concrete.
 - Cracked or severely chipped panels.
 - Color variation on front face of panel due to excess form oil or other reasons.
 - Defective or damaged reinforcement connection devices.

713.2.2.1.10 Handling, Storage and Shipping

- 1 Handle, store, and ship panels in such a manner as to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Support panels in storage on firm blocking located immediately adjacent to tie strips to avoid bending the tie strips.

713.2.3 MSE Wall With Modular Concrete Block Facings**713.2.3.1 Modular Concrete Block Facing**

- 1 Submit a manufacturer's certification to the RCE that the modular concrete blocks for each lot shipped are in conformance with the following specifications. Ensure that the certification for each shipment lists for each particular lot shipped, the date manufactured, type of block, the average compressive strength, and the water absorption.

713.2.3.1.1 Concrete

- 1 Use Portland cement concrete with a minimum 28-day compressive strength of 4000 psi. Maximum water absorption limit shall be 6% in accordance with ASTM C 140. Ensure that admixtures conform to the requirements in applicable subsections of **Section 701**.

713.2.3.1.2 Casting

- 1 Cast the modular concrete blocks in steel molds and in a manner that will ensure the production of uniform modular concrete blocks. Place the concrete in each block without interruption and consolidate. Steam cure the blocks for a minimum of 24 hours. Make certain the blocks reach a minimum compressive strength of 4,000 psi before being shipped.

713.2.3.1.3 Compressive Strength

- 1 Acceptance of the modular concrete blocks with respect to compressive strength is determined on a per lot basis. The maximum number of blocks in each lot is 10,000. Clearly mark the lots until acceptance of testing results. Randomly sample the lot in accordance with ASTM C 140. Have the manufacturer perform compressive strength tests on test specimens prepared by the manufacturer. Ensure that the compressive strength test specimens con-

713.2.3.1.4

713.2.3.2

form to the saw-cut coupon provisions of Section 5.2.4 of ASTM C 140. Approve block lots when the average compressive strength is 4000 psi of 3 test coupons and with no individual test having a compressive strength less than 3500 psi. Reject block lots not meeting these requirements.

713.2.3.1.4 Markings

- 1 Clearly mark the date of manufacture, lot number, and type of block in accordance with the approved MSE wall design drawings on each lot.

713.2.3.1.5 Finish

- 1 Unless otherwise indicated on the Plans, provide a natural gray with tri-planar fractured rock face finish on the front face of the block.

713.2.3.1.6 Tolerances

- 1 Provide modular concrete blocks manufactured within the following tolerances:
 - Length and width of each individual block is within $\frac{1}{8}$ inch of the specified dimension. Hollow units have a minimum wall thickness of $1\frac{1}{4}$ inch.
 - Height of each individual block is within $\frac{1}{16}$ inch of the specified dimension.
 - When a broken or fractured face is required, the dimension of the front face is within 1 inch of the theoretical dimension shown on the Plans.

713.2.3.1.7 Rejection

- 1 Reject modular concrete blocks because of failure to meet any of the requirements specified in **Subsection 713.2.2.1.6**. In addition, any or all of the following defects is sufficient cause for rejection:
 - Defects that indicate imperfect molding.
 - Defects indicating honeycomb or open texture concrete.
 - Cracks greater than 0.02 inches in width and longer than 25% of the height of the block.
 - Severely chipped or broken blocks.
 - Color variation on front face of block due to excess form oil or other reasons.
 - Defective or damaged reinforcement connection devices built into the modular concrete block.

713.2.3.1.8 Handling, Storage and Shipping

- 1 Handle, store, and ship modular concrete blocks in such a manner as to eliminate the dangers of chipping, discoloration, cracks, or fractures.

713.2.3.2 Block Fill

- 1 Furnish block fill when modular concrete blocks require a block fill for connection strength or when vertical void spaces exist within the modular con-

crete block.

713.2.3.3 Free Draining Aggregate

- 1 Provide a 12-inch thick free draining aggregate layer with a geotextile fabric when a granular backfill is used with modular concrete block facings. In addition to the 12-inch aggregate layer, fill any void spaces along the backside of the modular concrete blocks with the aggregate.

713.2.3.4 Cap Blocks

- 1 Provide cap blocks unless otherwise shown in the Plans. Place precast concrete cap block over the uppermost level of blocks. Secure the cap blocks with mortar that meets the requirements of **Subsections 718.2.5** and **718.4.1**.

713.2.3.5 Cast-In-Place Concrete Coping

- 1 If required in the Plans, place a cast-in-place concrete coping over the uppermost level of modular concrete blocks as indicated in the Plans or as shown on the accepted Shop Plans/Working Drawings. Use Class 4000 concrete conforming to applicable subsections of **Section 701** for the cast-in-place concrete coping. If precast concrete coping is used, use Class 4000P concrete conforming to applicable subsections of **Section 701**. Unless noted otherwise in the Plans, use ASTM A 706, Grade 60 reinforcing steel meeting the requirements of **Section 703**. Ensure that fabrication and placement of reinforcing steel conforms to the requirements of applicable subsections of **Section 703**.

713.2.4 Temporary MSE Wall Facing

713.2.4.1 Welded Wire Mesh Facing

- 1 Furnish reinforcing mesh that is shop-fabricated of cold drawn steel wire. Supply a manufacturer's certification that the material conforms to the minimum requirements of AASHTO M 55 and galvanization (when required) conforms to the minimum requirements of AASHTO M 111. Apply galvanization after the mesh is fabricated.

713.2.4.2 Temporary Facing Aggregate

- 1 Provide the temporary facing aggregate of crushed stone or crushed gravel with the same gradation as the stone backfill referenced in **Subsection 713.2.7**.

713.2.5 Vertical and Horizontal Joint Materials

- 1 Provide the type and grade of bearing pads approved by the MSE wall supplier.
- 2 Provide a polyester filter fabric cover, as shown on the Plans and approved by the supplier, for horizontal and vertical joints between panels. Use an adhesive approved by the manufacturer to attach the fabric material to the back of the facing panels.

713.2.6 Panel Coping

- 1 Provide panel coping unless otherwise shown on the Plans. Place the panel cast-in-place concrete coping over the upper most level of the precast concrete panels as detailed on the Plans. Use Class 4000 concrete conforming to the requirements of **Section 701**. If necessary, place concrete to level up the top row of MSE wall precast concrete panel facings prior to placing panel coping. Ensure that the stepped joint line between the leveling concrete and the top row of blocks is not exposed. Construct a lip to produce a joint line parallel to the finished grade. Unless otherwise noted on the Plans, use ASTM A 706, Grade 60 reinforcing steel meeting the requirements of applicable subsections of **Section 703**. Ensure that the fabrication and placement of reinforcing steel conforms to applicable subsections of **Section 703**.

713.2.7 Reinforced Backfill Material

713.2.7.1 General

- 1 Unless otherwise indicated on the Plans or in the specifications provide either granular or stone backfill for the reinforced backfill material for permanent MSE walls. Ensure that the granular and stone backfills conform to applicable subsections of **Section 205** with the engineering properties and material requirements in **Subsections 713.2.7.2** through **713.2.7.8**.

713.2.7.2 Granular Backfill

- 1 Ensure that the internal friction angle (ϕ) for the reinforced granular backfill is not less than 32 degrees. Use a total unit weight of 120 pcf and a friction angle of 32 degrees for design purposes, unless otherwise indicated in the MSE wall design criteria shown on the Plans. Use a maximum of 34 degrees for internal friction angle for design of the MSE wall regardless of project specific testing. Use a granular backfill material with a gradation in accordance with the following table.

Reinforced Granular Backfill Gradation	
Sieve Size (AASHTO T 27)	Percent Passing
Extensible Reinforcement (geosynthetic) = $\frac{3}{4}$ " Inextensible Reinforcement (steel) = $1\frac{1}{2}$ "	100
No. 40	0 – 60
No. 100	0 – 30
No. 200	0 – 15

713.2.7.3 Stone Backfill

- 1 Ensure that the internal friction angle (ϕ) for the reinforced stone backfill is not less than 36 degrees. Use a total unit weight of 110 pcf and a friction angle of 36 degrees for design purposes, unless otherwise indicated in the MSE wall design criteria shown on the Plans. Use a maximum of 38 degrees for the internal friction angle for design of the MSE wall regardless of project spe-

cific testing. Use stone backfill material with a coarse aggregate in accordance with the following table and obtained from a source listed on *SCDOT Qualified Product List 2*.

Reinforced Stone Backfill	
Soil Reinforcement Type	Coarse Aggregate No.
Extensible Reinforcement (geosynthetic)	67, 6M
Inextensible Reinforcement (steel)	5, 57, 67, 6M

713.2.7.4 Block Fill

- 1 Use Coarse Aggregate No. 67 or No. 6M obtained from a source listed on *SCDOT Qualified Product List 2*.

713.2.7.5 Free Draining Aggregate

- 1 Use Coarse Aggregate No. 67 or No. 6M obtained from a source listed on *SCDOT Qualified Product List 2*.

713.2.7.6 Soil Property Requirements For Backfill

- 1 Ensure that all reinforced backfill, block fill, and free draining aggregate have the following soil properties:

- pH value between 3.5 and 9.0 (granular) (AASHTO T 289) and between 4.5 and 10.0 (stone) (**SC-T-143**).
- Organic content not to exceed 1.0 percent (weight of organic material to weight of total sample) as determined by AASHTO T 267 for material finer than the No. 10 sieve.
- Internal friction angle not less than the values specified in **Subsections 713.2.7.2 and 713.2.7.3** as determined by the standard direct shear test (AASHTO T 236) or the triaxial test (AASHTO T 234) on the portion passing the No. 10 sieve. Compact material test samples to 95% (AASHTO T 99, Method C or D) of maximum density at optimum moisture content. Internal frictional angle testing of backfills is not required where 80% or more of the particles sizes are $\frac{3}{4}$ inch or larger.
- Coefficient of uniformity, C_u , of 4 or greater (granular only). Compute the coefficient of uniformity, C_u , as follows:

$$C_u = \frac{D_{60}}{D_{10}}$$

Where D_{60} is the particle diameter at 60% passing and D_{10} is the particle diameter at 10% passing.

Obtain written approval from the DOC to use soils with a coefficient of uniformity less than 4.

- Plasticity Index (PI) less than or equal to 6 and the Liquid Limit (LL)

less than or equal to 30 as determined by AASHTO T 90.

- 2 Make certain the reinforced backfill and modular concrete block fill have the following electrochemical properties if steel soil reinforcements are used:
 - The resistivity is greater than 3000 ohm-cm (AASHTO T 288).
 - The chloride content is less than 100 ppm (AASHTO T 291).
 - The sulfate content is less than 200 ppm (AASHTO T 290).
- 3 Use SC T-143 for testing stone resistivity.
- 4 The chloride and sulfate testing is waived if the resistivity is greater than or equal to 5000 ohm-cm.

713.2.7.7 Temporary MSE Wall Reinforced Backfill

- 1 Borrow materials or on-site soils may be used if the plasticity index, PI, is less than or equal to 15 (AASHTO T 90) and the liquid limit, LL, is less than or equal to 30 (AASHTO T 90).
- 2 Typically, these soils are classified as A-1-a, A-1-b, A-3, or A-2-4. Ensure that the internal friction angle (ϕ) for these soils is not less than 28 degrees.
- 3 Use a total unit weight of 115 pcf and a friction angle of 28 degrees for design purposes, unless otherwise indicated on the Plans. Use a maximum of 30 degrees for the internal friction angle for the design of the MSE wall regardless of project specific testing.
- 4 For a temporary MSE wall that interfaces with the reinforced backfill of a permanent MSE wall, use the same type of reinforced backfill that is used in the permanent MSE wall.

713.2.7.8 Testing Frequency

- 1 Test soil property during initial source evaluation or if a change in source is requested. Sample reinforced backfill material once for every 15,000 cubic yards and test for gradation, PI, and pH. Sample reinforced backfill material once every for 15,000 cubic yards and test for internal friction angle, C_u , organic content, resistivity, chloride content, and sulfate content. If the coefficient of uniformity, C_u , of the reinforced backfill for permanent MSE walls is less than 4, then test the internal friction angle for every 5,000 cubic yards. A variation in testing frequency may be required if a variation in material gradation or composition is observed.

713.2.8 Soil Reinforcements and Attachment Devices

713.2.8.1 General

- 1 Make arrangements to purchase or manufacture all applicable materials such as soil reinforcements, attachment devices, and all other necessary components. Obtain written approval from the DOC to use materials or sources of materials not conforming to the specifications or not listed in the contract documents.

713.2.8.2 Inextensible Soil Reinforcement**713.2.8.2.1 General**

- 1 Make certain inextensible soil reinforcement conforms to the required shape and dimensions and is free of defects that may impair its strength and durability. Provide a mill test report to the RCE with each shipment. Sample and test reinforcement from each heat number.

713.2.8.2.2 Reinforcing Steel Strips

- 1 Provide galvanized reinforcing strips that are hot rolled from bars to the required shape and dimensions. Ensure that their physical and mechanical properties conform to ASTM A 572, Grade 65 or equal. Make certain galvanization conforms to the minimum requirements of AASHTO M 111.

713.2.8.2.3 Reinforcing Mesh

- 1 Ensure that galvanized reinforcing mesh is shop-fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M 55. Apply galvanization after the mesh is fabricated, and ensure that it conforms to the minimum requirements of AASHTO M 111.

713.2.8.2.4 Bar Mats

- 1 Fabricate bar mats from ASTM A 709, Grade 36 reinforcing steel as shown on the Plans. Ensure that galvanization conforms to AASHTO M 111. Apply galvanization after the bar mats and connector pins have been welded as shown on the Plans. Ensure that galvanization conforms to the minimum requirements of AASHTO M 111.

713.2.8.2.5 Galvanization Damage

- 1 Repair damage done to the galvanization prior to the installation of soil reinforcement with a cold galvanizing repair compound to provide a galvanized coating comparable to that provided by AASHTO M 111.

713.2.8.3 Extensible Soil Reinforcement**713.2.8.3.1 General**

- 1 Ensure that reinforcing conforms to the required shape and dimensions and is free of defects that may impair its strength and durability.

713.2.8.3.2 Geosynthetic Soil Reinforcement

- 1 Make certain that geosynthetic soil reinforcement used in MSE walls is listed on the most recent edition of *SCDOT Qualified Product List 63*. Use geosynthetic soil reinforcement design requirements shown on the Plans and specified in the Shop Plans/Working Drawings.

713.2.8.3.3 Delivery, Storage, and Handling of Geosynthetic Materials

- 1 Check the geosynthetic soil reinforcement upon delivery to ensure that the proper material has been received. Make certain geosynthetic rolls are labeled per ASTM D 4873. During all periods of shipment and storage, protect

713.2.8.3.3

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the geosynthetic materials from temperatures greater than 140°F, mud, dirt, dust, and debris. Follow the manufacturer's recommendations regarding protection from direct sunlight.

- 2 At the time of installation, reject the geosynthetic materials if it has defects, tears, punctures, flaws, deterioration, or damage that incurred during manufacture, transportation, or storage. At no additional cost to the Department, replace any geotextile fabric or geosynthetic reinforcement damaged during storage or installation.

713.2.8.3.4 Manufacturing Quality Control

- 1 Provide to the RCE a manufacturing quality control certificate and conformance testing results for all geosynthetic soil reinforcement delivered to the site. Perform sampling and conformance testing in accordance with ASTM D 4354. Base geosynthetic product acceptance on conformance with the requirements of ASTM D 4759. Ensure that the quality control certificate includes roll numbers and identification, sampling procedures, and results of the conformance testing with a description of test methods used.

713.2.8.4 Reinforcement Attachment Devices

713.2.8.4.1 General

- 1 Make certain all reinforcing and attachment devices conform to the required shape and dimensions and are free of defects that may impair their strength, durability, functionality, and design. Supply a manufacturer's certification to the RCE that the materials are in conformance with this specification.

713.2.8.4.2 Tie Strips

- 1 Have the tie strips shop-fabricated of a hot rolled steel conforming to the minimum requirements of ASTM A 1011, Grade 50, or equal. Ensure that galvanization conforms to the minimum requirements of AASHTO M 111.

713.2.8.4.3 Fasteners

- 1 Provide fasteners consisting of galvanized hexagonal cap screw bolts and nuts conforming to the requirements of ASTM A 325 or equal. Galvanize in accordance with AASHTO M 232.

713.2.8.4.4 Connector Pins

- 1 Fabricate connector pins from AASHTO M 270, Grade 36, steel and weld to the soil reinforcement mats as shown on the Plans. Galvanize in accordance with AASHTO M 111. Fabricate connector bars from cold drawn steel wire conforming to the requirements of ASTM A 82 (AASHTO M 32) and galvanize in accordance with ASTM A 123 (AASHTO M 111).

713.2.8.4.5 Clevis Connector

- 1 Fabricate clevis connector bar from cold drawn steel wire conforming to the requirements of AASHTO M 32 and weld in accordance with AASHTO M 55. Galvanize loops in accordance with AASHTO M 111.

713.2.9 Miscellaneous Construction Materials

713.2.9.1 Leveling Pad

- 1 Construct an unreinforced concrete leveling pad as shown in the design drawings using Class 3000 concrete conforming to the requirements of applicable subsections of **Section 701**.

713.2.9.2 Geotextile

- 1 Provide a fabric that is resistant to chemical, biological, and insect attack. Make certain the geotextile meets the requirements shown in the following table. Supply to the RCE a manufacturer's certification that the materials are in conformance with the following table.

Geotextile Properties		
Property	Test Method	Minimum Average Roll Value (MARV), except for AOS for which it is the average maximum roll value
AOS (Sieve Opening, mm)	ASTM D 4751	0.300 maximum opening average roll value
Permittivity sec ⁻¹	ASTM D 4991	1.0
Grab Tensile Strength, lbs.	ASTM D 4632	80
Grab Tensile Elongation (%)	ASTM D 4632	50
Trapezoidal Tear Strength, lbs.	ASTM D 4533	40
Puncture Strength, lbs.	ASTM D 4833	50
Burst Strength, psi	ASTM D 3786	150
Ultraviolet Stability (%) (Retained strength after 500 hours of exposure)	ASTM D 4355	70

713.2.9.3 Geomembrane

- 1 If indicated on the Plans, place a single-layer continuous polymeric sheet as specified on the Plans. Use a geomembrane manufactured from a virgin polymeric resin. Make certain that the geomembrane conforms to the requirements shown in the table below. Supply to the RCE a manufacturer's certification that the materials are in conformance with the following table.

Geomembrane Properties		
Property	Test Method	Minimum Average Roll Value (MARV)
Thickness, mills	ASTM D 5199	40
Tensile, lb/in.	ASTM D 882, 1 inch strip	70
Tear, lb.	ASTM D 1004, Die C	20
Puncture, lb.	ASTM D 4833	40
Impact, ft.-lbs.	ASTM D 1424	25

713.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

713.4 Construction

713.4.1 Wall Excavation and Foundation Preparation

- 1 Prepare wall excavation and foundation in accordance with **Section 204**. In addition to the requirements of **Section 204**, proof roll the area where the MSE wall is constructed with a minimum of 5 passes by pneumatic tire equipment weighing a minimum of 8 tons.

713.4.2 Leveling Pad Construction

- 1 At each MSE wall foundation level, provide a precast reinforced or cast-in-place unreinforced concrete leveling pad of the type shown on the Plans. Cure the leveling pad a minimum of 12 hours before placement of wall blocks. If the permanent MSE wall facing is to be installed in front of a temporary MSE wall facing, install the leveling pad just prior to construction of the permanent MSE wall facing.

713.4.3 MSE Wall System Supplier's Assistance and Samples

- 1 Have the MSE wall system supplier/designer provide qualified and experienced advisory personnel at the start of the wall construction and until such time that the RCE feels the SCDOT inspectors and the Contractor's personnel are adequately acquainted with the MSE wall construction procedures and no longer require technical assistance. Ensure that the representative is also available on an as needed basis, as requested by the RCE, during construction of the MSE wall structures.
- 2 Provide the RCE with three MSE wall field installation manuals, specific to the MSE wall type being constructed. If the MSE wall is reinforced with geosynthetics, provide the RCE with two sets of samples (approx. 1 square foot each) of each geosynthetic soil reinforcements that will be used. Ensure that

each sample has a durable tag attached to it, stating the geosynthetic manufacturer and type/model.

713.4.4 Internal Drainage System

- 1 If indicated on the Plans, install an internal drainage system behind the wall as specified on the Plans or as shown on the approved Shop Plans/Working Drawings. Place outlet pipes at sags in the flow line, at the low end of the collector pipe, and at other locations as shown or specified. Determine the location and elevation of the internal drainage system and submit it to the RCE for review.

713.4.5 Location of Geotextile Fabric

- 1 For MSE wall with precast concrete panel facings, provide a geotextile fabric covering all joints between panels on the backside of the wall. Make certain the geotextile fabric has a minimum width of 12 inches and overlaps adjacent geotextile fabrics a minimum of 4 inches. Adhere the geotextile fabric to panels by applying adhesive to the back of the panel on each side of the joint. Do not apply adhesive directly on the geotextile fabric or within 2 inches of the panel joint edge.
- 2 For MSE walls with modular concrete block facings and granular reinforced backfill, place a geotextile between the free draining aggregate and the reinforced backfill. If a stone-reinforced backfill is used, place the geotextile between the reinforced backfill and the retained backfill as shown in the Plans.
- 3 If required on the Plans, place geotextile fabric between the natural ground and the reinforced backfill. Ensure that the subgrade to receive the geotextile fabric is free of loose or extraneous material and sharp objects that may damage the geotextile fabric during installation. Stretch, align, and place the geotextile fabric in a wrinkle-free manner and ensure that it has intimate contact with the soil. Overlap adjacent geotextile fabric edges a minimum of 1.5 feet.
- 4 At the direction of the RCE, repair or replace torn or punctured sections of the geotextile fabric. Cut out geotextile fabric damaged during installation by tearing or puncturing and completely replace or repair by placing a piece of fabric that is large enough to cover the damaged area. Provide a sufficient overlap, 1.5 feet minimum, on all sides to secure the damaged geotextile fabric area.

713.4.6 Wall Erection

- 1 Place precast concrete panels and modular concrete block facings so that their final position is vertical or battered as shown on the Plans. Place precast concrete panels and modular concrete block facings in successive horizontal lifts. Construct the MSE wall structure using a pre-determined backward batter corresponding to the anticipated outward wall deflection due to the active soil pressures. Have MSE wall system supplier determine the backward batter and adjust batter during construction as needed to build the wall to the required construction tolerances.
- 2 Handle MSE wall precast concrete panels by a lifting device set into the

upper edge of the panels or as indicated in the Shop Plans/Working Drawings. Place the first level of precast concrete panels directly on the concrete leveling pad. Do not use horizontal joint material or wooden shims between the first course of panels and the leveling pad. As backfill material is placed behind a panel, maintain the panel in position by means of temporary wooden wedges or bracing in accordance with the MSE wall system supplier's recommendations. Remove the wooden wedges as soon as the panel above the wedged panel is completely erected and backfilled. Provide external bracing for the first lift of precast concrete panels.

713.4.7 Joint Material

- 1 Install joint material to the dimensions and thickness shown on the Plans, or the approved Shop Plans/Working Drawings.

713.4.8 Reinforced Backfill Placement

- 1 Closely follow the erection of each lift of facing elements with the backfill placement. At each level of soil reinforcement, roughly level the backfill material to an elevation approximately 1 inch above the level of the connection at the facing before placing the soil reinforcement. Place backfill in such a manner as to avoid any damage or disturbance of the wall materials. Remove and replace, at the Contractor's expense, all wall materials that become damaged during backfill placement. Make certain that backfill placement methods near the facing do not create voids directly beneath the reinforcing elements.
- 2 Construct the reinforced embankment in accordance with applicable subsections of **Section 205**. Compact reinforced backfill to not less than 95.0% of the maximum dry density in accordance with AASHTO T 99. Perform compaction control testing of the reinforced backfill with a minimum frequency of 1 density test per every 2 lifts for every 25 feet of wall at bridge abutments (including the first 100 feet of wall parallel to the roadway) and every 100 feet of wall along roadways (more than 100 feet away from bridge abutments).
- 3 Compact stone backfill material with a minimum of 4 passes with a smooth heavy roller (approximately 6 to 8 tons). Compaction testing will not be required for stone backfill material. Do not use sheepsfoot or grid-type rollers for compacting backfill within the reinforced backfill.
- 4 Achieve compaction within 3 feet of the back face of the wall by at least 3 passes of a lightweight walk-behind vibratory plate or roller. In order to determine the number of passes needed to compact the area within 3 feet of the back face of the wall to 95% of the maximum dry density, establish a test strip area measuring a minimum of 3 feet by 5 feet within the reinforced backfill and compact it with a lightweight walk behind vibratory plate or roller. Ensure that the moisture content of the backfill material prior to and during compaction is uniformly distributed throughout each layer. Place stone backfill in 6 inch lifts within 3 feet of the back face of the wall and compact by at least 4 passes of a lightweight walk behind vibratory plate or roller.
- 5 Ensure that the backfill materials have a placement moisture content not more than 2 percentage points below the optimum moisture content and not

more than the optimum moisture content. Remove and rework backfill material with placement moisture content in excess of the optimum moisture content until the moisture content is uniformly acceptable throughout the entire lift.

- 6 Make certain the maximum soil lift thickness (loose) is 8 inches and closely follows the MSE wall facing erection. Place stone backfill in 6 inch to 12 inch lift thickness (loose). Decrease this lift thickness if necessary to obtain the density. Accomplish backfill compaction without disturbance or distortion of the reinforcement. Maintain a minimum of 6 inches of backfill material at all times between the compaction equipment and the soil reinforcement.
- 7 At the end of each day's operations, shape the last level of backfill to permit runoff of rainwater away from the wall face. In addition, do not allow surface runoff from adjacent areas to enter the wall reinforcement zone until this zone is protected from infiltration. Repair any damage or movement caused by erosion, sloughing, or saturation of the reinforced backfill or retained backfill at no expense to the Department.

713.4.9 Placement of Soil Reinforcement

713.4.9.1 General

- 1 Install the soil reinforcement in accordance with the manufacturer's recommendations and these specifications. Place the soil reinforcement within the layers of the compacted backfill material at the locations shown on the Plans. Only place that amount of soil reinforcement required for immediately impending work to prevent undue damage. Place soil reinforcement with the strongest direction of soil reinforcement perpendicular to the wall face, unless otherwise shown on the Plans. Connect the soil reinforcement to the MSE wall facing in accordance with the MSE wall system supplier's recommendations. Next, lay the soil reinforcement flat and uniformly tension it to remove any slack in the connection or soil reinforcement material.

713.4.9.2 Construction Tolerances

- 1 Make certain the vertical alignment construction tolerance for temporary and permanent MSE walls does not exceed $\frac{3}{4}$ inch when measured along a 10 feet straight edge.
- 2 Do not allow the horizontal alignment construction tolerance for temporary and permanent MSE walls to exceed $\frac{3}{4}$ inch when measured along a 10 foot straight edge for straight wall sections and along a 3 foot straight edge for curved wall sections.
- 3 Ensure that the wall tolerance for plumbness from top to bottom for temporary and permanent MSE walls does not exceed $\frac{1}{2}$ inch per 10 feet of wall height. Determine the wall tolerance from the net measurements after allowance is given for the offset batter of the MSE wall facing. A negative slope or batter (sloping outward from the face) is not acceptable regardless of the wall tolerance achieved.
- 4 Make certain the maximum offset between panels at the joint does not ex-

ceed $\frac{3}{4}$ inches. Ensure that the horizontal and vertical joints widths between panels are within $\frac{1}{2}$ inch of the joint width specified in the Shop Plans/Working Drawings.

- 5 Ensure that temporary MSE wall facing constructed with welded wire form and geosynthetic wrap or other approved temporary facing method do not bulge in excess of 2 inches when backfill behind the facing elements is compressed due to compaction stresses or weight of the backfill. Measure bulging as the maximum displacement from the theoretical vertical or sloped face of the temporary MSE wall that extends over a section of 1 foot or more along the theoretical wall face.

713.4.10 Surcharge

- 1 Should the Contract indicate an earth surcharge to be placed over the reinforced zone, retain the surcharge using a temporary wall. The temporary wall may be built with a temporary MSE wall or other approved method. Place the face of the temporary surcharge wall approximately 1 foot from the permanent wall face. Ensure that the top surface of the surcharge allows the surface water to drain away from the wall. Place a plastic membrane over the reinforced zone prior to placing the surcharge material. Include the materials and the placement and removal of the temporary wall in the cost of the temporary MSE wall unless otherwise indicated on the Plans.

713.4.11 Abutment Piling

- 1 If abutments piles are placed within the reinforced zone, and the Plans or Contractor's *Pile Installation Plan* indicate piles are cased through the reinforced backfill, adhere to the following requirements and sequence unless otherwise indicated on the Plans.
 1. Drive all piles within the reinforced zone prior to installation.
 2. Encase each pile in a Smooth Wall or Corrugated Galvanized Steel (SWCGS) pipe of sufficient thickness to prevent buckling or distortion during placement and compaction of wall backfill. Include cost of encasement in the cost of the MSE wall.
 3. Stabilize the SWCGS pipe to prevent the pipe from coming in contact with the pile during backfilling of the wall.
 4. Extend the SWCGS pipe from the bottom of the backfill to the bottom of the bridge abutment cap.
 5. After positioning, seal the top of the SWCGS pipe to prevent debris accumulation during placement of wall backfill, and keep the pipe sealed until filled with granular material.
 6. Fill the SWCGS pipe loosely with granular material after completion of wall construction to the satisfaction of the RCE.

713.5 Measurement

713.5.1 MSE Wall

- 1 The quantity for the pay item MSE Retaining Wall (of the type specified) is area of the face of MSE wall constructed and is measured by the square foot (SF) and is measured vertically from the top of the leveling pad (or bottom of temporary MSE wall) to the top of the wall as shown on Plans for the MSE wall profile, complete, and accepted. There will be no separate measurements for precast concrete panels or modular concrete blocks, galvanized steel reinforcing and tie strips or galvanized steel mesh and mesh connectors or geosynthetic reinforcement, geotextile fabric, leveling pad, perforated pipe, drain pipe, or other incidental items required for construction of the MSE wall. If no field revisions are made to the length and/or height of the MSE wall from the specified dimensions on the Plans, field measurement is not required and the quantity is the Plan quantity.

713.5.2 MSE Wall Backfill

- 1 The quantity for the pay item MSE Retaining Wall Backfill (of the specified material) is the volume of the material specified for temporary or permanent MSE walls and is measured by the cubic yard (CY) in-place, complete, and accepted. The volume is measured as follows:

The depth is measured between the finished grade and the elevation of the top of the leveling pad. The width is measured between the vertical planes located along the back of the MSE wall facing and 1 foot outside and parallel to the back end of the soil reinforcement as shown on the accepted Shop Plans/Working Drawings. The length is measured from beginning to end of wall along the MSE wall stationing.

713.5.3 Coping

- 1 The quantity for the item Coping for MSE Retaining Wall (*Roadway or Bridge*) is the length of the cast-in-place coping and is measured by the linear foot (LF) along the length of the top of the wall in-place, complete, and accepted. There is no separate measurement for leveling concrete, dowels, grout, concrete, steel reinforcement, or other incidental items required for construction of the coping. If no revisions are made to the length of the MSE wall from the specified dimensions on the Plans, field measurement of the coping is not required and the quantity is the Plan quantity.

713.6 Payment

713.6.1 MSE Wall

- 1 Payment for the accepted quantity of MSE Retaining Wall (of the type specified), measured in accordance with **Subsection 713.5.1**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for constructing MSE retaining walls as specified or directed and includes, but is not limited to, furnishing and installing precast concrete panels or modular concrete blocks, galvanized steel reinforcing and tie strips or galvanized steel mesh and mesh connectors or geosynthetic reinforce-

ment, geotextile fabric, leveling pad, and drainage systems (even when not shown on the Plans); material testing; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. When changes in the work are ordered by the RCE, which vary the square foot MSA retaining wall quantity shown on the Plans, is adjusted to reflect the field changes.

713.6.2 Backfill Material

- 1 Payment for the accepted quantity of MSE Retaining Wall Backfill (of the specified material), measured in accordance with **Subsection 713.5.2**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for furnishing, placing, and compacting the specified backfill material as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

713.6.3 Coping

- 1 Payment for the accepted quantity of Coping for MSE Retaining Wall (*Roadway or Bridge*), measured in accordance with **Subsection 713.5.3**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for constructing cast-in-place coping on top of the MSE retaining wall as specified or directed and includes furnishing and installing leveling concrete, dowels, grout, concrete, and steel reinforcement, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

713.6.4 Pay Items

- 1 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Pay items under this section include the following:

Item No.	Pay Item	Pay
7137005	MSE Retaining Wall Backfill	CY
7137006	MSE Retaining Wall Backfill (Granular)	CY
7137007	MSE Retaining Wall Backfill (Stone)	CY
7137008	MSE Retaining Wall Backfill (Temporary)	CY
7137010	MSE Retaining Wall (Roadway)	SF
7137050	MSE Retaining Wall (Bridge)	SF

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Item No.	Pay Item	Pay
7137105	MSE Retaining Wall (Temporary) Roadway	SF
7137120	MSE Retaining Wall (Block Facing) Roadway	SF
7137130	MSE Retaining Wall (Panel Facing) Roadway	SF
7137190	Coping for MSE Retaining Wall (Roadway)	LF
7137205	MSE Retaining Wall (Temporary) Bridge	SF
7137220	MSE Retaining Wall (Block Facing) Bridge	SF
7137230	MSE Retaining Wall (Panel Facing) Bridge	SF
7137290	Coping for MSE Retaining Wall (Bridge)	LF

SECTION 714**PERMANENT PIPE CULVERTS****714.1 General**

- 1 Ensure that all types and sizes of permanent and temporary pipe culverts to conform to the requirements of the Special Provisions and the latest edition of applicable SCDOT Supplemental Specifications, OMR Standard Method of Tests, and the Supplemental Technical Specification **SC-M-714** in effect at the time the bid proposal for the project was advertised.

SECTION 715

TEMPORARY PIPE AND PIPE ARCH

715.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for temporary pipe or pipe arches installed only during the construction work for a project.

715.2 Materials

715.2.1 General

- 1 Use materials specified for permanent installations in **SC-M-714** or the items listed herein for temporary pipe installations unless specified in the Plans or by the RCE. For materials and installation methods not detailed or described in **SC-M-714** or *SCDOT Standard Drawings*, provide a copy of pipe manufacturer's fill height tables, and installation specification to the RCE before installing temporary pipe. Note that fill height tables shown on *SCDOT Standard Drawings* are only appropriate for installation procedures described in **SC-M-714**. For pipe that will not be structurally loaded, fill height table and installation specifications are not required.

715.2.2 Permanent Pipe used as Temporary Pipe

- 1 Pipe meeting the requirements of **SC-M-714** may be installed for temporary use. Once the pipe has been use in a temporary application, the pipe may not be used in a subsequent permanent installation.

715.2.3 Galvanized Corrugated Steel Pipe & Pipe Arch (CSP)

- 1 Provide corrugated steel pipe (CSP) meeting the requirements of AASHTO M 36 and corrugated steel pipe arch (CSPA) meeting the requirements of AASHTO M 36, Type II. Where elliptical pipe is called for on the Plans or in the Special Provisions, furnish pipe that is distorted from a true circle to provide an increase in the vertical diameter of approximately 5%. Perform distortion at the fabricating shop. Make certain that the thickness of the pipe is in accordance with the Plans.
- 2 Ensure that the dimensions of the pipe arch are in accordance with Table 4 of AASHTO M 36, Type II as measured from the inside crest of the corrugations. Make certain metal thickness of the pipe arch is in accordance with the Plans.
- 3 Fabricate end sections from materials conforming to the applicable requirements of AASHTO M 218. Make certain metal thickness of the end section is in accordance with the Plans.

715.2.4 Corrugated High Density Polyethylene Pipe (HDPE) Type C

- 1 Provide corrugated high density polyethylene pipe conforming to the requirements of AASHTO M 294 Type C or Type S.

- 2 For Type C pipe, provide pipe with corrugated high density surface both inside and outside.

715.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

715.4 Construction

715.4.1 Installation of Temporary Pipes and Pipe Arches

- 1 Install temporary pipe or pipe arch in accordance with submitted manufacturer's recommendations for loading conditions and installation procedures for the temporary pipe or pipe arch.

715.4.2 Abandoning Pipe

- 1 At locations on the Plans where drainage pipe is to be abandoned, plug the existing pipe using brick and mortar or use the Taylor Made Plastics, Inc. "Pipe Plug" or equal. No additional payment will be made for this work regardless of the method chosen. Fill the entire abandoned pipe with CLSM that meets the minimum strength requirements of the embankment and can be excavated. Measurement and payment for CLSM in abandoned pipe will be in accordance with **Section 210**.

715.4.3 Removal of Temporary Pipes and Pipe Arches

- 1 Remove temporary pipe or pipe arch installations if required by the RCE or as an alternate to abandoning pipe or pipe arch. Remove temporary pipe or pipe arch without damaging or disturbing permanent structures, environmentally sensitive items, embankments, utilities, or other items noted on the Plans or discovered during construction.
- 2 Salvaged temporary pipe or pipe arch may be used for temporary installation only. No additional payment will be made for handling, transportation, and storage of salvaged pipe or pipe arch.

715.5 Measurement

- 1 Measurement will be made only for temporary pipe or pipe arch that is shown on the Plans.
- 2 The quantity for the pay item Corrugated High Density Polyethylene (HDPE) Pipe Type (C or S) - Temporary, Corrugated Steel Pipe (CSP) – Temporary, or Corrugated Steel Pipe Arch - Temporary (of the size specified) is the length of temporary pipe or pipe arch shown on the Plans and is measured by the linear foot (LF) of the net length of temporary pipe or pipe arch, complete-in place, and accepted.

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- 3 The net length of temporary pipe or pipe arch is obtained by adding the centerline length of each run of temporary pipe.
- 4 When used in conjunction with temporary pipe or pipe arch shown on the Plans, beveled or flared ends, pipe end structures, wingwall/apron system, tees, wyes, elbows, bends, reducers, and increasers are not measured and are consider incidental materials for the temporary pipe or pipe arch item.
- 5 Excavation of unyielding, unstable, or otherwise unsuitable material necessary to obtain a satisfactory foundation in accordance with manufacturer’s installation requirements for temporary pipe or pipe arch is not measured and is consider incidental materials for the temporary pipe or pipe arch item. Dispose of the unstable material in the manner outlined in **Subsection 203.2.1.5**.

715.6 Payment

- 1 Payment will be made only for temporary pipe or pipe arch that is shown in the Plans.
- 2 Payment for the accepted quantity of Corrugated High Density Polyethylene (HDPE) Pipe Type (C or S) - Temporary, Corrugated Steel Pipe (CSP) – Temporary, or Corrugated Steel Pipe Arch - Temporary (of the size specified), measured in accordance with **Subsection 715.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for installing temporary pipe or pipe arches as specified or directed and includes furnishing, hauling, and laying temporary pipe or pipe arch sections, beveled or flared ends, pipe end structures, wingwall/apron system, tees, wyes, elbows, bends, reducers, and increasers; excavating, bedding, and backfilling the new or existing trench; constructing pipe or pipe arch joints; removing or abandoning temporary pipe or pipe arches; disposing of surplus materials; and all other materials, labor, equipment , tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 4 Pay items under this section include the following:

Item No.	Pay Item	Unit
71580XX	<u>XX</u> " Corrugated Steel Pipe (CSP) - Temporary	LF
7158005	Corrugated Steel Pipe Arch - Temporary	LF
71590XX	<u>XX</u> " Corrugated High Density Polyethylene (HDPE) Pipe Type (<u>C or S</u>) - Temporary	LF

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SECTION 716

THIS SECTION NOT USED

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SECTION 717

THIS SECTION NOT USED

SECTION 718

BRICK, RUBBLE, AND CONCRETE BLOCK MASONRY

718.1 Description

- 1 This section contains specifications for the materials, construction, measurement, and payment for the construction of brick, rubble, or concrete block masonry laid in full beds of mortar in accordance with these specifications and conforming to the Plans and the shapes, lines and grades shown on the Plans or set by the RCE. This work includes the placing of reinforcing steel when shown on the Plans or specified in the Special Provisions.

718.2 Materials

718.2.1 Clay or Shale Brick

- 1 Provide clay or shale brick used in the construction of manholes, catch basins, and other drainage related structures conforming to the requirements of AASHTO M 91, Grade MM. Ensure that clay or shale brick used in the construction of buildings, retaining walls, steps, and other above the ground structures conforms to the requirements of AASHTO M 114, Grade SW. Back-up brick for buildings above ground may be Grade MW.

718.2.2 Concrete Brick

- 1 Furnish concrete brick and similar solid units conforming to the requirements of ASTM C 55, Grade S.

718.2.3 Stone Rubble

- 1 Provide stone for rubble masonry of an approved quality, sound, durable, and free from seams, cracks, and other structural defects or imperfections tending to reduce its resistance to weathering. Make certain it is free from rounded, worn, or weathered surfaces.
- 2 In general, provide stones with thickness of not less than 6 inches, a width of not less than 1½ times their thickness, and a length of not less than 1½ times their width.
- 3 In walls 18 inches or less thick, provide stone for headers of sufficient length to extend entirely through the wall.

718.2.4 Concrete Block

- 1 Unless otherwise indicated on the Plans or in the Special Provisions, furnish concrete block that are hollow or solid load-bearing concrete masonry units made from Portland cement and suitable aggregates such as sand, gravel, crushed stone, bituminous or anthracite cinders, or blast-furnace slag and conforms to the requirements of ASTM C 90.

718.2.5 Mortar**718.2.5.1 Portland Cement**

- 1 Provide Portland cement that complies with the provisions set forth in **Subsection 701.2.1**.

718.2.5.2 Masonry Cement

- 1 Provide masonry cement conforming to the requirements of ASTM C 91 for the type necessary to make the type of mortar specified in ASTM C 270.

718.2.5.3 Hydrated Lime

- 1 Furnish hydrated lime conforming to the requirements of ASTM C 207, Type S.

718.2.5.4 Aggregate

- 1 Ensure that aggregate is fine aggregate conforming to the requirements in **Subsection 701.2.9**.

718.2.5.5 Reinforcing Steel

- 1 Provide reinforcing Steel conforming to the requirements of ASTM A 706, Grade 60, and meeting the requirements of applicable subsections of **Section 703**.

718.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

718.4 Construction**718.4.1 Proportioning and Mixing Mortar**

- 1 Prepare mortar in accordance with the required proportioning specified in ASTM C 270 by blending the required materials to produce Type M, Type S, or Type N mortar. Use proportioning shown in the table on the following page.

Proportions By Volume (Cementitious Materials)					
Mortar	Type	Portland Cement Or Blended Cement	Masonry Cement	Hydrated Lime or Lime Putty	Aggregate Ratio (Measured in Damp Loose Conditions)
Cement- Lime	M	1	---	1/4	Not less than 2 1/4 and not more than 3 times the sum of the separate volumes of cementitious materials
	S	1	---	1/4 to 1/2	
	N	1	---	1/4 to 1 1/4	
Masonry Cement	M	1	1	---	
	S	1/2	1	---	
	N	---	1	---	

- 2 Ensure that the minimum 28-day strength of the mortar types are as follows:

Type M: 2500 psi

Type S: 1800 psi

Type N: 750 psi

- 3 For general construction, use Type N mortar or better. Use Type S or Type M mortar in constructing masonry retaining walls. Use Type S or Type M mortar in constructing masonry in contact with water.
- 4 Dry mix the material in a mixer or in a clean tight box until a uniform mixture is produced. Add the appropriate amount of clean water and mix continuously until the desired consistency is obtained. Discard mortar that is not used within 60 minutes after water is added. Do not re-temper mortar.

718.4.2 Brickwork

- 1 Lay brick to line in courses of full and close joints of mortar that are not less than 1/4 inch nor more than 1/2 inch thick. Ensure that the thickness of the mortar joint is uniform throughout. Pre-wet brick and ensure that brick is moist when being laid. Break joints in adjoining courses at half a brick as nearly as practicable. Make courses level except where otherwise necessary. Make at least one course in seven composed entirely of headers. Finish joints properly as the work progresses and neatly struck on exposed faces. Broken or chipped brick is not allowed in the face of the structure. In making closures, do not use pieces of brick less than the width of a whole brick. Lay whole brick with the long side at right angles to the face of the structure wherever practicable in making such closures. Thoroughly clean the exposed surface of the masonry structure of mortar stains and point satisfactorily.
- 2 When Brick Masonry (Reinforced) is specified, place the reinforcing steel

as specified on the Plans.

718.4.3 Shaping Stone

- 1 Shape and dress stone before the stone is laid. When laying stone, do not dress or hammer stone that could loosen the stone already set.

718.4.4 Stonework

718.4.4.1 General

- 1 Lay stones in full mortar beds and bond firmly in all directions. Lay stratified stone on their natural beds and not on their edges. Lay stones to form substantial masonry of neat and finished appearance on the face. Make the spaces between the stones flush with mortar and pack with spalls. Do not place spalls in the mortar bed. Rake the joints on exposed faces clear of loose mortar and point neatly with the mortar specified. Keep the masonry wet while pointing and protect the pointed masonry from the sun. Keep masonry wet for a period of 3 days after completion in hot or dry weather. Do not point masonry in freezing weather. Remove and replace work that is damaged by frost.

718.4.4.2 Stonework for Walls

- 1 Compose the wall foundations and bottom courses of larger stones. Use stones of decreasing thickness from the bottom to the top of wall. Ensure that at least a quarter of the stone area of the face of the wall is composed of headers, which extend for a distance of twice their thickness into the backing. For walls up to 18 inches thick, ensure that the headers extend through the wall. Make certain that the cross-section area of the header in the heart of the wall is approximately the same area as visible in the face of the wall. Use selected stones roughly squared and pitched to line at all angles and ends of walls. Break joints at least 4 inches on the face of the wall and have no joints in the face more than 2 inches thick.
- 2 Use large well shaped stones for backing and lay to break joints. Do not allow voids in any part of the wall. Ensure that the rear face of wall is an approximately plane surface. Provide walls with weep holes where called for on the Plans or directed by the RCE.

718.4.5 Blockwork

- 1 Adhere to the provisions of **Subsection 718.4.2**, when laying concrete block.

718.4.6 Backfilling

- 1 Backfill the excavated areas that are not occupied by masonry to the required elevation with suitable material and tamp in layers of not more than 8 inches of loose material until firm and solid.

718.5 Measurement

- 1 The quantity for the pay item Brick Masonry, Brick Masonry (Reinforced), Rubble Masonry, Rubble Masonry Tree-Well, or Concrete Block Masonry is the volume of brick, rubble, or concrete block masonry constructed as specified and is measured by the cubic yard (CY), complete, and accepted.
- 2 Brick masonry used in manholes, catch basins, drop inlets, and similar items is not measured for payment. Masonry in those drainage structures is not measure for pay and is included in the contract unit bid price of each drainage item.
- 3 Excavation for masonry, except for catch basins, manholes, drop inlets and similar items, is measured as prescribed in **Subsection 204.5**.
- 4 Reinforcing steel is not measured for direct payment. The cost of the reinforcing steel is included in the unit price of Brick Masonry (Reinforced).

718.6 Payment

- 1 Payment for the accepted quantity of Brick Masonry, Brick Masonry (Reinforced), Rubble Masonry, Rubble Masonry Tree-Well, or Concrete Block Masonry, measured as specified in **Subsection 718.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for constructing brick, block, or rubble masonry as specified or directed and includes mixing, placing, and pointing mortar; shaping stones; drainage openings; backfilling; and disposing of surplus materials; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Excavation, measured as provided in **Subsection 718.5**, is paid for as Unclassified Excavation as prescribed in **Subsection 204.6**.
- 3 Masonry used in constructing catch basins, drop inlets, manholes, spring boxes, junction boxes, and similar items is paid for in accordance with the provisions of **Section 719**.
- 4 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 5 Pay items under this section include the following:

Item No.	Pay Item	Unit
7181000	Brick Masonry	CY
7182000	Brick Masonry (Reinforced)	CY
7183000	Rubble Masonry	CY
7184000	Concrete Block Masonry	CY
7185000	Rubble Masonry Tree-Well	CY

SECTION 719

CATCH BASINS, DROP INLETS, MANHOLES, JUNCTION BOXES, AND SPRING BOXES

719.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the construction or adjustment to grade of catch basins, drop inlets, manholes, junction boxes, and spring boxes at the location shown on the Plans or as directed by the RCE, in accordance with these specifications, and in conformity with the lines and grades shown on the Plans or established by the RCE.

719.2 Materials

719.2.1 Cast-In-Place Concrete

- 1 Unless otherwise specified on the Plans or in the Special Provisions, provide Class 4000 for cast-in-place concrete conforming to the requirements of applicable subsections of **Section 701**

719.2.2 Clay or Shale Brick

- 1 Provide clay or shale brick conforming to the requirements of **Subsection 718.2.1**.

719.2.3 Concrete Brick

- 1 Provide concrete brick and similar solid units conforming to the requirements of **Subsection 718.2.2**.

719.2.4 Mortar Materials

- 1 Provide mortar materials conforming to the requirements of **Subsection 718.2.5**.

719.2.5 Castings

- 1 Provide iron castings for frames, grates, covers, etc., conforming to the requirements of AASHTO M 105, Class 35B, and the alternate load test conforming to the requirements of AASHTO M 306.
- 2 Produce castings in closed molds and boldly filleted at angles. Ensure that the arises are sharp and perfect and make certain that they are true to pattern in form and dimensions, free from pouring defects, sponginess, cracks, blow holes, and other defects affecting their strength and value for the service intended. Ensure that the castings are clean and neatly finished. Make certain gratings and covers fit firmly into their respective frames.
- 3 Steel grates and frame may be used instead of cast iron as long as the loading and hydraulic requirements are met and they conform to the following:
- A. Hot dip zinc coat steel grates and frame in accordance with AASHTO M 111.

- B. Dimension steel grates and frame to be interchangeable with each piece of the cast iron grate and frame shown on the Plans.
 - C. Provide steel grates and frames of sufficient strength to meet or exceed the loading requirements of *Federal Specification RR-F-621* (latest edition).
- 4 Ensure that the manufacturer has a testing program to verify that the castings comply with the strength requirements of AASHTO M 105. Make certain test bars are Type B and are made and tested in accordance with the requirements of AASHTO M 105.

719.2.6 Reinforcing Steel

- 1 Furnish reinforcing steel conforming to the requirements of ASTM A 706, Grade 60, and meeting the applicable requirements of **Section 703**.

719.2.7 Structural Steel

- 1 Provide structural steel conforming to the requirements of AASHTO M 270, Grade 36.

719.2.8 Steel Tubular Sections

- 1 Provide steel tubular sections conforming to the requirements of ASTM A 53, Schedule 80.

719.2.9 Precast Reinforced Concrete Drainage Structures

719.2.9.1 General

- 1 Subject to the approval of the RCE, precast reinforced concrete drainage structures may be substituted for constructed-in-place structures shown on the Plans. If precast structures are specified on the project, or if permission is given to substitute precast alternates, ensure that they conform to the details shown on the Plans and the applicable provisions of this specification. Design precast concrete drainage structures for HS-25 loading. Use Class 4000P Portland cement concrete conforming to the applicable requirements of **Section 701**. Use reinforcing steel that conforms to ASTM A 706, Grade 60, and is from a source listed on the most recent edition of *SCDOT Qualified Product List 60*. Use wire mesh that conforms to the requirements of AASHTO M 55 and AASHTO M 221.
- 2 Supply components of precast concrete drainage structures from a single source precast manufacturer. Have the manufacturer inform the OMR of the planned concrete placement and curing schedule in advance of the start of any fabrication work to afford time for the testing of materials, the inspection of equipment, and the review of the procedures for casting the units. Allow the OMR inspector free access to the fabrication plant at all times for the purpose of inspecting materials, plant facilities, and fabrication and curing procedures.

719.2.9.2 Precast Drainage Base

- 1 Have drainage bases manufactured to the sizes shown on the Plans and in accordance with the applicable requirements of AASHTO M 199. Ensure that drainage bases are manufactured with all required openings to accept all prescribed inlet and outlet pipes.

719.2.9.3 Precast Concrete Transition Section

- 1 A precast concrete transition section may be used to transition from a larger diameter riser to a smaller diameter riser. Use transition sections that are either a cone shape or a flat slab as specified on the Plans. Ensure that they are manufactured in accordance with the requirements of AASHTO M 199.

719.2.9.4 Precast Concrete Risers

- 1 Have risers manufactured to the diameters and lengths shown on the Plans and in accordance with the requirements of AASHTO M 199. Place risers plum and backfill in a manner that preserves their alignment.

719.2.9.5 Flat Slab Adapter

- 1 Use flat slab adapters to change round precast concrete risers to rectangular openings to facilitate construction of the prescribed catch basins or drop inlets to grade. Use the flat slab adapters as foundations for the necessary courses of brick. Flat slab adapters are not required for manholes. Use a flat slab top with an eccentric 24-inch diameter hole on top of the manhole riser when the casting is placed directly thereon, and as shown on the Plans. Do not allow the distance from the top of the adapter to the top of the cover or casting to be more than 6 feet.

719.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

719.4 Construction**719.4.1 Excavation**

- 1 Excavate to the required depth and compact the material on which the masonry is constructed to a firm even surface.

719.4.2 Brick Masonry

- 1 Construct brick masonry in accordance with the applicable requirements of **Section 718**.

719.4.3 Reinforced Concrete

- 1 Construct reinforced concrete in accordance with applicable requirements of **Sections 701, 702, and 703**. Provide and place reinforcing steel, if re-

quired, in position as shown on the Plans and hold securely in place.

719.4.4 Placing Pipe

- 1 Incorporate inlet and outlet pipes into the structure at the elevation, direction, and grade required. Neatly and substantially hold these pipe connections in the masonry. Place the ends of the pipe flush with the inner faces of the walls unless the RCE directs otherwise. Place grout up to the lowest flow elevation in the structure to maintain continuous flow. For grout, use Type M mortar material in accordance with applicable requirements of **Section 718**.

719.4.5 Placing Castings

- 1 Set the castings in a full mortar bed composed of 1 part Portland cement to 2 parts of fine aggregate, meeting the requirements of **Subsection 718.2.5** and **718.4.1**.

719.4.6 Precast Concrete Drainage Structures

- 1 Fabricate and install precast concrete drainage structures in accordance with these specifications and applicable AASHTO specifications. Have the manufacturer of precast components provide recommendations for all field connections of precast sections and piping.
- 2 Provide the proper bedding for precast concrete drainage structures to ensure proper installation and elimination of point bearing. Provide bedding of sand, gravel, or crushed stone. Include cost of bedding in the cost of the respective drainage items.
- 3 Seal joints with a butyl rubber joint sealant meeting the requirements of **Section 714** and AASHTO M 198, Type B. Apply the sealant in accordance with the manufacturer's recommendations. Supply a copy of the recommendations to the RCE.

719.4.7 Grade Adjustment of Existing Structure

- 1 When grade adjustment of existing structure is required, remove the frames, covers, and gratings and reconstruct the walls as required. Perform the work using salvaged materials when practicable. Furnish new materials as necessary to complete the adjustment.
- 2 Adjust the existing structures to the required grade and elevation by carefully removing the grating, removing or adding masonry below or above the existing masonry, and replacing the casting on a full mortar bed to the new elevation.
- 3 Where the pavement consists of an asphaltic mix or mixes and unless otherwise permitted or directed, adjust the casting to grade after the last base or binder course has been laid and before placing the surface course. Where the pavement, base, or subgrade is removed from around the structure to make the adjustment, fill the area with concrete before placing the surface course.

719.4.8 Backfilling

- 1 Backfill the excavated areas not occupied by the structure with suitable material placed and thoroughly compacted in layers not more than 8 inches.

719.5 Measurement

- 1 The quantity for new or adjusted cast-in-place, brick, or block masonry drainage structure is measured by each (EA) unit complete in place and accepted, and includes all frames, covers, gratings, and fittings necessary to complete the unit.
- 2 When the depth of a catch basin, drop inlet, manhole, junction box, or spring box is greater than 6 feet, the quantity for the pay item Extra Depth of Box is the depth of excavation for the drainage structure in excess of 6 feet and is measured by the linear foot (LF), complete, and accepted. The depth of the drainage structure is measured from the top of manhole cover, concrete masonry, hood, or grate and, in the case of drop inlets, from the top of the bottom slab.
- 3 The quantity for precast drainage structure components is measured by the linear foot (LF) or each (EA) unit in place, complete and accepted and includes all frames, covers, gratings, and fittings necessary to complete the unit. Extra Depth of Box is not measured for precast drainage structures. The lay length of a precast transition section is not included in the measurement for the precast concrete drainage structure to which it is connected.
- 4 The excavation required for the installation of drainage structures includes the removal of all obstructions and the removal and replacement of unstable materials as necessary for a proper foundation, but such excavation is not measured nor paid for as a separate item. The cost of excavation is included in the contract unit bid price for the associated drainage structure.

719.6 Payment

- 1 Payment for the accepted quantity for a new or adjusted drainage structures, measured in accordance with **Subsection 719.5**, is determined using the contract unit bid price for such items as Catch Basin, Drop Inlet, Manhole, Junction Box, Spring Box, or Adjust Catch Basin, Drop Inlet, Manhole, Junction Box, Utility Box of the size and type specified, or the respective precast concrete drainage structures, Precast Concrete Riser, PC Drainage Base, PC Transition Section (Flat Slab) PC Transition Section (Cone) of the size specified. Payment is full compensation for constructing drainage structures as specified or directed and includes furnishing and placing precast and cast-in-place drainage structure; furnishing and placing reinforcing steel, bricks, blocks, and mortar for masonry structures; providing inlet and outlet openings and joint sealant; excavating (6 foot maximum depth); providing and placing bedding material and backfilling; disposing of surplus material; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract

- 2 Payment for drainage structures is made in accordance with the following schedule:

Drainage Structure Pay Schedule			
Structure	Brickwork Complete	Throat/Pad Complete	Lid/Grate Complete
Type 1	90%	---	10%
Type 9	90%	---	10%
Type 9 Manhole	90%	---	10%
Type 12	80%	10%	10%
Manhole	90%	---	10%
Type 14 and 14 MG	80%	10%	10%
Type 15	90%	---	10%
Drop Inlet	90%	---	10%
Spring Box	90%	---	10%
Type 16	70%	10%	20%
Type 17	70%	10%	20%
Type 18	70%	10%	20%

- 3 Payment for the accepted quantity of Extra Depth of Box, measured in accordance with **Subsection 719.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for excavating for drainage structures beyond the 6 feet included in the structure pay item as specified or directed and includes backfilling and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. Extra Depth of Box is not applicable to pre-cast drainage structures.
- 4 Making connection with an existing culvert or drain including joint sealant, drainage openings, excavation, bedding material, backfilling, disposal of surplus material, replacing pavement, reinforcing steel, bricks, mortar and other miscellaneous items needed to complete the work is not paid for separately, and the cost thereof is included in the contract unit bid price for the pay item that requires the work.
- 5 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.

719.6

719.6

6 Pay items under this section include the following:

Item No.	Pay Item	Unit
7191XXX	Catch Basin (type)	EA
71920XX	Drop Inlet (<i>size</i>)	EA
7192105	Manhole	EA
71922XX	(<i>size</i>) Junction Box	EA
7192300	Spring Box	EA
71930XX	Precast Concrete Riser - (<i>size</i>)" Diameter	LF
71931XX	PC Drainage Base - (<i>size</i>)" Diameter	EA
71931XX	PC Transition Section (Flat Slab) - (<i>size</i>)" to (<i>size</i>)"	EA
719317X	PC Transition Section (Cone) - (<i>size</i>)" to (<i>size</i>)"	EA
7196000	Extra Depth of Box	LF
7197110	Adjust Catch Basin	EA
7197120	Adjust Manhole	EA
7197130	Adjust Drop Inlet	EA
7197140	Adjust Utility Box	EA
7197150	Adjust Junction Box	EA

SECTION 720

CONCRETE CURB, GUTTER, CURB AND GUTTER, SIDEWALK, DRIVEWAY, AND MEDIAN

720.1 Description

- 1 This section contains specifications for the materials, construction, equipment, measurement, and payment for the construction of Portland cement concrete curb, Portland cement concrete gutter, Portland cement concrete curb and gutter, Portland cement concrete sidewalk, Portland cement concrete driveway, and Portland cement concrete median in one course on a prepared subgrade in accordance with these specifications, conforming to the dimensions, typical cross-section, and notes shown on the Plans, and to the lines and grades shown on the Plans or established by the RCE.
- 2 This work includes the placing of reinforcing steel in the concrete when indicated on the Plans.

720.2 Materials

720.2.1 Portland Cement Concrete

- 1 Provide Class 2500 Portland cement concrete conforming to the applicable requirements of **Section 701**.

720.2.2 Expansion Joint Material

- 1 Provide expansion joint materials meeting the requirements of **Subsection 702.2.2.1**.

720.2.3 Reinforcing Steel

- 1 Provide reinforcing steel conforming to the requirements of ASTM A 706, Grade 60, and meeting the applicable requirements of **Section 703**.

720.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

720.4 Construction

720.4.1 Subgrade

- 1 Thoroughly compact the subgrade and finish to a smooth, firmly compacted surface, which is moist at the time the concrete is placed. In areas where it is impractical to use standard type rollers, accomplish compaction by vibratory hand compactors. Remove and replace concrete that settles and/or cracks after placement as directed by the RCE without additional compensation.

720.4.2 Forms

- 1 Use wood or metal forms of a depth equal to the thickness of the concrete course. Make certain they are free from warp and are of sufficient strength when staked, to hold the alignment during the concrete placing and finishing operations. Before concrete is placed against them, clean and oil the forms. Use flexible or curved forms on curves as necessary in order to prevent a chord effect in the alignment of the finished work.

720.4.3 Existing Sidewalks and Driveways

- 1 Where a portion of an existing sidewalk or driveway is reconstructed, cut the existing section to a minimum depth of 2 inches with a suitable saw at the location designated by the RCE and remove the entire section to be reconstructed. Join the new sidewalk or driveway with the old work at this line.

720.4.4 Mixing and Placing Concrete

- 1 Batch and mix the concrete in accordance with the applicable requirements of **Section 701**.
- 2 Unless otherwise indicated on the Plans, construct concrete curbs, concrete gutters, and concrete curb and gutters in uniform 10-foot sections, except where shorter sections are necessary for closures; but ensure that no section is less than 4 feet in length. Separate the sections by sheet steel templates or dividing plates set normal to the face and top of the curb. Carefully set the plates during the placing of the concrete and keep in place until the concrete has set sufficiently to hold its shape. Remove the plates while the forms are still in place.
- 3 Deposit concrete in the forms so that the forms do not displace out of grade or alignment. During the placing operations, spade or vibrate the concrete throughout the entire mass and especially against the forms and joints. Tamp, float, trowel, broom, edge, and finish the surface of the concrete to the typical section, lines, and grades as soon as practicable after the placing of the concrete. Leave the forms in place until the concrete has set sufficiently and their removal does not injure the concrete.

720.4.5 Extruded or Slip-Formed Curb or Curb and Gutter Construction

- 1 Unless otherwise specified and except on structures, concrete curb may be placed by an extrusion machine acceptable to the RCE. An accepted slip-form machine may be used to construct concrete curb or curb and gutter if satisfactory results are obtained. When, in the opinion of the RCE, satisfactory results are not being obtained, discontinue the extrusion or slip-form work and use the stationary form type of construction with no adjustment in compensation. Remove and replace unsatisfactory work without any additional compensation.
- 2 Construct expansion and weakened joints at the same locations as required when form construction is being used. Make weakened joints, spaced at 10 foot intervals, by cutting the plastic concrete with a trowel or by other

acceptable methods. Ensure that the manner of construction of joints meets the approval of the RCE and has a workmanlike finish after edging.

720.4.6 Joints

720.4.6.1 Expansion Joints

- 1 Ensure that preformed expansion joints are $\frac{3}{4}$ inch thick and extend the full-depth of the concrete. Construct joints at the locations indicated on the Plans and at the following locations:
 - Wherever a sidewalk is constructed between an adjoining substantial structure on one side and curbing on the other side, form an expansion joint adjacent to the curbing.
 - Place an expansion joint between the sidewalk and the radius curbing at street intersections.
 - Where concrete sidewalks or medians are constructed adjacent to existing or new concrete pavement or structures, place a transverse expansion joints in the sidewalk or median opposite such joints in the concrete pavement or structure.
 - Where existing structures such as light standards, poles, fire hydrants, etc., are within the limits of the sidewalk or median area, surround them with an expansion joint.
 - Place transverse expansion joints at intervals of not more than 100 feet in all concrete shapes.

720.4.6.2 Contraction Joints

- 1 Divide the concrete slabs in sidewalks between expansion joints into blocks 10 feet in length, by scoring transversely after floating operations are completed. Where the sidewalk slabs are more than 10 feet in width, score them longitudinally in the center. Extend transverse and longitudinal scoring for a depth of 1 inch and not less than $\frac{1}{4}$ inch or more than $\frac{1}{2}$ inch in width. Edge and finish joints smooth and true to line.
- 2 In concrete medians, locate transverse contraction joints, formed as described above, at intervals of not more than 25 feet and extend not less than a quarter of the median depth.

720.4.7 Final Finish

720.4.7.1 Curbs and Curb and Gutters

- 1 As soon as the concrete has set sufficiently, remove the forms from the exposed surfaces. Float and trowel the concrete on the curb face and top as necessary to provide a smooth uniform finish. Leave joint templates in place a minimal length of time to prevent bonding or distortion at the joint.
- 2 After the surface of the gutter has been properly shaped and prepared and the water sheen has disappeared, produce the final finish by brooming. Apply brooming transverse to the line of traffic. Ensure that joints are in a vertical plane perpendicular to the curb face. Make certain that joints are clean and

corners well rounded. Edge corners and conform to the typical cross-section. Eliminate all tool marks in final finish.

720.4.7.2 Sidewalks, Gutters, Medians, and Driveways

- 1 Apply the final finish for sidewalks, gutters, medians, and driveways by brooming as specified in **Subsection 720.4.7.1**, unless otherwise directed. As soon as the forms are removed from concrete median, rub down the sides to a smooth and uniform finish. Remove mortar or aggregate particles that spill onto the pavement.

720.4.7.3 Repair of Defects

- 1 As soon as the forms are removed from all concrete shapes, fill honey-combed places and other minor defects with a mortar composed of one part Portland cement and two parts sand. Plastering is not allowed. Replace sections with visible cracks at no expense to the Department.

720.4.8 Protection and Curing

- 1 Protect the concrete as specified in **Subsection 702.4.6** and cure with liquid membrane-forming compounds meeting the requirements of **Subsection 702.2.2.11**. Ensure that methods and rates of application of curing compounds are in accordance with **Subsection 702.4.4.2**.

720.4.9 Backfilling

- 1 After the concrete has set sufficiently and the forms have been removed, backfill the spaces on both sides to the required elevation with suitable material that is firmly compacted and neatly graded. Backfill concrete gutter so that the earth materials are a minimum of 1 inch above the concrete. Maintain an earth roll on each side as necessary to prevent undermining of curb and gutter.

720.5 Measurement

- 1 The quantity for the pay item Concrete Curb, Concrete Gutter, or Concrete Curb and Gutter (of the type and size specified) is the length of the cast-in-place curb and/or gutter and is measured by the linear foot (LF), complete, and accepted. Concrete Curb and Gutter is measured along the roadway face of the curb at the gutter line. Concrete Curb and Concrete Gutter are both measured along the roadway at the finished grade elevation.
- 2 The quantity for the pay items Concrete Sidewalk, Concrete Driveway, and Concrete Median is the finished surface area of the top of the cast-in-place sidewalk, driveway, or median and is measured by the square yard (SY), complete, and accepted. Deductions for drainage structures such as catch basins, drop inlets, etc., are in accordance with the Plans, the Specifications, and *SCDOT Standard Drawings*.
- 3 Excavation, when applicable and approved, is measured for in accordance with **Subsection 203.5**

720.6 Payment

- 1 Payment for the accepted quantity, measured in accordance with **Subsection 720.5**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for constructing curb and/or gutter as specified or directed and includes fine grading; compacting the subgrade; formwork; concrete, reinforcing steel; joint templates; joint materials; curing concrete; backfilling; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Excavation, when applicable and approved, is paid for in accordance with **Subsection 203.6**.
- 3 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 4 Pay items under this section include the following:

Item No.	Pay Item	Unit
7201000	Concrete Curb (9" X 15")	LF
7201010	Concrete Bridge Curb (6")	LF
7201100	Concrete Transition Curb	LF
72020X0	Concrete Gutter Type (X)	LF
7203110	Concrete Curb and Gutter (1'-6")	LF
7203210	Concrete Curb and Gutter (2'-0")	LF
7203240	Concrete Curb and Gutter (2'-6")	LF
7203310	Concrete Curb and Gutter (3'-0")	LF
7204100	Concrete Sidewalk (4" Uniform)	SY
7205000	Concrete Driveway (6" Uniform)	SY
7205100	Concrete Driveway (8" Uniform)	SY
7206000	Concrete Median	SY

SECTION 721

ASPHALT CURB

721.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for construction of an asphalt curb on a prepared subgrade or other surface conforming to the configuration shown on the Plans, in accordance with these specifications, and to the lines and grades furnished by the RCE.

721.2 Materials

- 1 Provide the materials conforming to the requirements in **Section 403**. Conform to the requirements pertaining to the manufacture and hauling of the asphalt mixture specified in **Sections 401** and **403**.

721.3 Equipment

- 1 Construct asphalt curb by use of a self-propelled automatic curb machine or a paver with curbing attachments.
- 2 Ensure that the automatic curb machine meets the following requirements and is accepted by the RCE prior to use:
 - A. The automatic curb machine is constructed and is operated to consolidate the mixture to produce a dense mass free of voids.
 - B. The machine forms the curb true to line and grade and to a uniform shape and texture.
- 3 The RCE may permit the construction of curb by means other than the automatic curb machine when short sections or sections with short radii are required or for other reasons deemed warranted by the RCE. Ensure that the resulting curb conforms in all respects to the required curb.
- 4 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

721.4 Construction

721.4.1 Weather and Surface Temperature Restrictions

- 1 Do not construct asphalt curb when the pavement or base is wet or frozen.

721.4.2 Preparation of Bed

721.4.2.1 Subgrade

- 1 When the curb is to be placed directly on the subgrade, prepare the subgrade in accordance with the requirements set forth in **Section 208**.

721.4.2.2 Existing Pavement or Base

- 1 When curb is to be placed on a Portland cement concrete base, asphalt pavement, or other base, thoroughly sweep and clean using compressed air and/or other cleaning methods as necessary to provide a clean surface. Make certain the surface is thoroughly dry and when directed by the RCE, apply a tack coat of asphalt material as specified in **Subsection 401.4.18**. During application, prevent the spread of the tack coat to areas outside of the area occupied by the curb.

721.4.3 Backfilling

- 1 When required, backfill after the curb has reached ambient temperature and do so promptly to afford support and protection. Accomplish backfilling using such methods, equipment, and compaction to prevent damage to the curb and to obtain satisfactory results.

721.4.4 Painting and Sealing

- 1 When sealing or painting is required, perform on a curb that is clean and dry and that has reached the ambient temperature.

721.5 Measurement

- 1 The quantity for the pay item Asphalt Curb is the length of asphalt curb in-place and is measured by the linear foot (LF) along the front face of the section at the finished grade elevation, complete, and accepted. No deduction in length is made for drainage structures installed in the curb such as intake spillway assemblies, catch basins, etc., unless otherwise noted on the Plans or the Specifications.
- 2 Excavation, when applicable and approved, is measured for in accordance with **Subsection 203.5**.

721.6 Payment

- 1 Payment for the accepted quantity of Asphalt Curb, measured in accordance with **Subsection 721.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for constructing asphalt curb as specified or directed and includes furnishing, mixing, hauling and placing materials, including the asphalt binder in the mix; fine grading; compacting the subgrade; tack coat; backfilling; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract, except for excavation.
- 2 Excavation, when applicable and approved, is paid for in accordance with **Subsection 203.6**.
- 3 Payment includes all direct and indirect costs and expenses necessary to complete the work.

721.6

721.4

4 Pay items under this section include the following:

Item No.	Pay Item	Unit
7212000	Asphalt Curb	LF

SECTION 722

PRECAST CONCRETE BOX CULVERTS

722.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for production, transportation, and storage of precast concrete box culverts of the size and dimensions indicated on the Plans, installed in conformity with the Plans, the *SCDOT Standard Drawings*, the Special Provisions, and these specifications, and true to the line and grades established by the RCE. This section includes specifications for the proper fabrication at the precast plant, finishing, marking, joining, and other incidental items of work. See *SCDOT Standard Drawing 722-1* for details and additional installation requirements.

722.2 Materials

722.2.1 Precast Concrete Sections

- 1 Ensure that precast concrete box culvert sections conform to the requirements of either AASHTO M 259 for depths of cover 2 feet and greater or AASHTO M 273 for depths of cover less than 2 feet with the exception of modifications as stated herein. Conform precast concrete box culverts to the requirements of ASTM C 1433 or ASTM C 1577 for manufacturing procedures, tolerance, and designs meeting or exceeding ASTM C 1433, Table 2 or ASTM C 1577, Table 1.
- 2 Manufacture the sections in accordance with the appropriate AASHTO or ASTM designation based on the size (span (W) and rise (H) dimensions), loading (minimum earth dead load and Interstate Live Load to be used in all applications unless otherwise indicated), and earth cover as specified on the Plans and in the Special Provisions. Box sections that exceed the minimum specified requirements may be substituted for the Plan designated box sections at no extra cost to the Department and with prior written approval of the OMR. Ensure that box culvert is obtained from a source listed on the most recent edition of *SCDOT Qualified Product List 14*.

722.2.2 Site Cast Concrete

- 1 Except for the aggregate gradation, provide concrete for the precast sections meeting the applicable requirements of **Sections 701** and **714**. Ensure that concrete for components cast at the site (wingwalls, headwalls, aprons, cut-off walls, etc.) meet the applicable requirements of **Section 701** for Class 4000P concrete (minimum).

722.2.3 Reinforcing Steel

- 1 Provide reinforcing steel conforming to the requirements of ASTM A 706, Grade 60, AASHTO M 259, AASHTO M 32, AASHTO M 55, AASHTO M 221, or AASHTO M 225 as applicable. Ensure that ASTM A 706 steel is obtained from a source listed on the most recent edition of *SCDOT Qualified Product*

List 60.

722.2.4 Joint Material

- 1 Use a joint seal material that is a preformed flexible joint sealant conforming to the requirements of AASHTO M 198 and is manufactured by a supplier listed on the most recent edition of *SCDOT Qualified Product List 13*.

722.2.5 Liquid Membrane-Forming Compounds

- 1 Use liquid curing compounds conforming to the requirements of **Subsection 702.2.2.11**.

722.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

722.4 Construction

722.4.1 Fabrication

722.4.1.1 General

- 1 The precast concrete box sections may be precast by either the dry cast (machine) or wet cast method. Use steel forms for both, and ensure that forms are mortar-tight and of sufficient strength to prevent bulging and the misalignment of adjacent boxes when placed in the field. Ensure that the forms permit removal without damage to the concrete.
- 2 Do not allow offsets at form joints to exceed $\frac{1}{8}$ inch. Make certain forms are clean and have a light coating of a bond-breaking material applied before concrete placement.
- 3 Provide a maximum of four lifting holes, 2 inches in diameter or 2 inches square or lifting lugs, as required, in each section to properly complete fabrication and installation. Form the holes in-place, cut them into the fresh concrete, or core them into the hardened concrete.
- 4 Provide precast sections with a minimum length of 4 feet. Use positive methods acceptable to the OMR to support reinforcing steel and prevent displacement during the casting operation. Weld reinforcing steel only as shown on the Plans.
- 5 Cast precast boxes by a process that provides for uniform placement of the concrete in the forms and compaction by mechanical devices that ensures dense, well-compacted concrete. Mix concrete in a central batch plant or other approved batching facilities.
- 6 Construct all formed openings between the precast sections and adjacent structures (including pipes, inlet structures, manholes, connecting culverts, etc.) to accommodate a soil tight seal. Provide additional reinforcement

around all formed openings as shown in the *SCDOT Standard Drawings* for culvert openings or as directed by the RCE.

- 7 Install 3-inch diameter weep holes at intervals of approximately 8.0 feet at an elevation of about 1.0 foot above the normal water surface in accordance with **Subsection 702.4.19.2**.

722.4.1.2 Finishing and Marking

- 1 Finish and mark precast sections in accordance with the applicable requirements of AASHTO M 259, AASHTO M 273, ASTM C 1433, or ASTM C 1577 with the addition of the SCDOT project number.

722.4.1.3 Fabrication Tolerances

- 1 Make certain that the precast sections do not exceed the geometric tolerances allowed in the applicable sections of AASHTO M 259, AASHTO M 273, ASTM C 1433, or ASTM C 1577.
- 2 Cast the slab thickness and the tongue and groove joint configuration to provide a continuous line of box sections with interior offsets at the joints less than 1% of the dimensions of the rise and span. Fabricate end sections with exposed end flat in lieu of tongue or groove joint. Fabricate end sections with holes for resin anchors or inserts for mechanical anchors to connect headwall, wingwalls, and apron unless these connections are specifically omitted by directions in the Plans.
- 3 To ensure the proper fit of contiguous sections, check the squareness tolerance of the boxes by measuring the distance between opposite interior corners at the ends of the sections. Make certain the diagonal measurements do not vary by more than ½ inch.
- 4 Deviations from the above tolerance are acceptable if the sections can be fitted at the plant and it is determined that an acceptable joint can be made. A joint is considered acceptable if the sections can be fitted together on a flat surface in the position in which they will be installed and the joint opening at any point does not exceed ¾ inch.
- 5 Match-mark sections pre-fitted at the precast plant.
- 6 Repair small damaged or honeycombed areas that are purely cosmetic. Excessive damage, honeycomb, or cracking is subject to structural review. Make repairs to the satisfaction of the OMR. Ensure that such repairs are sound, properly finished, and cured in accordance with **Subsection 722.4.1.5**. When fine cracks or hair-checks on the surface indicate poor curing practices, discontinue further production of precast boxes until corrections are made and proper curing is provided.
- 7 Store precast boxes on level blocking in a manner acceptable to the OMR. Do not place load upon sections until design strength is reached and curing completed. Ship boxes when the design strength has been met and the boxes have been inspected and stamped by the Department's inspector.

722.4.1.4 Samples and Tests

- 1 Provide concrete compressive strength test cylinders in accordance with the requirements of AASHTO M 259, AASHTO M 273, ASTM C 1433, or ASTM C 1577, except that when a wet cast method is used, provide a minimum of 4 test cylinders for each day's production of each size and design of box. Strength tests for each production lot are based on the average strength of 2 cylinders that are tested any time after the curing period. When design strength is attained on the initial test, further tests on that lot are not required.
- 2 Should the initial test fail to meet the design strength, perform a subsequent test at 28 days unless additional cylinders were made for intermediate breaks. Check low cylinder strengths by compression strength of cores. Obtain cores for testing and repair the core holes at no cost to the Department.

722.4.1.5 Curing

- 1 Cure precast concrete box culverts made in a precast plant in accordance with the requirements of AASHTO M 259, AASHTO M 273, ASTM C 1433, or ASTM C 1577.
- 2 Protect the boxes from freezing during the curing period.
- 3 Cure test cylinders at the same time and in the same manner as the boxes.
- 4 Cure concrete placed at the job site during construction in accordance with **Subsection 702.4.4.2.**

722.4.2 Bedding

- 1 Ensure that excavation for foundations of precast concrete box culverts conform to the requirements of **Section 204** and the details shown on the Plans. Exercise special care in leveling the foundation area to ensure uniform support throughout the entire width and length of the structure. Make certain bedding material is minimum fine aggregate, and no larger than coarse aggregate (No. 57 stone) in conformance with the requirements in **Section 701**. Erect shoring, bracing, or other devices necessary to achieve safe working conditions without additional compensation. Ensure that culvert bedding is protected from scour during the installation of culvert sections.
- 2 When a firm foundation is not encountered at the required grade, remove all such unstable material and backfill the resulting excavation with suitable material (no larger than Aggregate No. 57) in accordance with **Section 203**, the Plans, or the contract documents. For culverts on shallow rock, cast-in-place construction is recommended. If placing precast culvert sections on rock is required, provide a minimum of 3 inches of bedding material between the rock surface and the bottom of the bottom slab.

722.4.3 Laying Sections

- 1 Place sections beginning at the outlet end of the conduit with the groove end being laid up grade (and the flat end toward the outlet) unless otherwise approved by the RCE. Install successive tongue ends into each adjoining

groove. Provide positive means to pull or push each section firmly into the previously placed section so that the joints are tightly meshed. Install final section with flat end toward inlet. Repair and fill lift holes with mortar or concrete and cure as directed after the sections have been installed. Install French Drain in accordance with the requirements of **Subsection 702.4.19.2**. Completely wrap French drain with geotextile for drainage filtration to prevent migration of site soils into aggregate.

722.4.4 Joints

- 1 Make joints between the precast box sections using preformed flexible joint sealant in accordance with AASHTO M 198. Do not use mortar. Install joint sealant in conformance with the details on *SCDOT Standard Drawing 722-1*, and in accordance with the manufacturer's recommendation and as specified herein.
- 2 Clean and dry all surfaces of the joint to remove all debris and contaminants. Lubricate joint surfaces with a lubricant that does not cause damage to or deteriorate joint sealant material. Use continuous sealant of the minimum size to produce a soil-tight joint in the annular space of the joint. The joint sealant size may be varied by the RCE to provide enough sealant material to properly fill the annular space or to prevent waste of the sealant material. When the culvert is in place, ensure that the joint sealant is visible on the inside or the outside of the joint. Give special attention placing the joint sealant on the tongue to prevent excess seal from squeezing out of the culvert joints. If excess seal is observed squeezing out on the inside and outside, check the placement of the joint sealant or reduce the joint sealant size if required to prevent waste of seal material.
- 3 Ensure that the culvert trench is free of standing water and mud when a section is placed. Press culvert sections together to form a durable soil tight and structurally sound joint. Install the joint sealant material without stretching it.

722.4.5 Backfilling

- 1 Conform backfilling materials and construction methods to the requirements on the Plans and **Subsection 205.4.2**.
- 2 When multiple barrel structures are specified, place the barrels a minimum of 3.5 inches apart. Place the material between culvert barrels in accordance with the Plans and the *SCDOT Standard Drawings*. When not specified in the Plans, use flowable fill or continuous concrete for gap material. Provide a minimum 6-inch cast-in-place concrete plug along the length of the barrels at the exposed ends of the barrel to prevent erosion of the gap material.

722.4.6 Connections

- 1 Make connections with other structures including headwalls, wingwalls, aprons, inlets, structures, or manholes in accordance with the Plans.

- 2 Construct wingwalls, cut-off walls, headwalls, parapet walls, and aprons using cast-in-place reinforced concrete consisting of Class 4000 (minimum) Portland cement concrete conforming to the applicable requirements of **Sections 701** and **702** unless directed by the RCE. Use reinforcing steel conforming to the requirements of ASTM A 706, Grade 60 and applicable requirements of **Section 703**.
- 3 Place a minimum of ½ inch grout layer between culvert top slab and bottom of drainage structure. Do not install risers directly on top slab of culvert unless directed by the RCE.
- 4 Ensure that all inlet structures and pipe openings are soil tight. Consult the Design Engineer and the box culvert manufacturer before field cutting any opening in the culvert.
- 5 Install resin anchors in accordance with the Plans and *SCDOT Standard Drawings for Road Construction*.

722.5 Measurement

- 1 The quantity of the precast concrete box culvert is the length of the box culvert and is measured by the linear foot (LF) in-place, complete, and accepted. The length is obtained by measuring the centerline length of each barrel between the end treatments.
- 2 Structure excavation is measured in accordance with **Subsection 204.5** and includes unstable material removed as specified in **Subsection 203.4**.
- 3 The quantity of cast-in-place Class 4000 concrete used in wingwalls, cut-off walls, parapet walls, and aprons is measured for payment by the cubic yard (CY) of Concrete for Structure Class 4000 (Culvert) in accordance with **Subsection 701.5**.
- 4 Reinforcing steel used in the cast-in-place portion of the culvert is measured for payment by the pound (LB) of Reinforcing Steel for Structures (Roadway) in accordance with **Subsection 703.5**. Reinforcing steel in the precast portion of the culvert, including resin anchors, is not measured for payment, but is included in the contract unit bid price of the precast culvert.

722.6 Payment

- 1 Payment for the accepted quantities of PC Box Culverts (of the size, type, and fill height specified), measured in accordance with **Subsection 722.5**, is determined using the contract unit price for the applicable pay item. Payment is full compensation for constructing precast concrete box culverts as specified or directed and includes bedding; fabricating, transporting, and laying culvert sections; furnishing and installing joint material; connections to headwalls and other drainage structures; French drains and weepholes; backfilling; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

722.6

722.6

- 2 Structure excavation is paid for as Structure Excavation for Culverts in accordance with **Subsection 204.6**.
- 3 The quantity of cast-in-place Class 4000 concrete is paid for in accordance with **Subsection 701.6**.
- 4 The quantity of reinforcing steel other than that in precast box sections is paid for as Reinforcing Steel for Structures in accordance with **Subsection 703.6**.
- 5 Payment includes all direct and indirect costs and expenses necessary to complete the work.
- 6 Pay items under this section include the following:

Item No.	Pay Item	Unit
722XXXX	<i>(size)</i> P C Box Culvert <i>(type)</i> Fill Height \leq <i>(fill height)*</i>	LF

SECTION 723

DECK JOINT STRIP SEAL

723.1 Description

- 1 This section contains specifications for the materials, construction, measurement, and payment for furnishing and installing expansion joints consisting of elastomeric strip seal gland with extruded steel anchoring elements on concrete bridge decks in accordance with these specifications and as shown on the Plans.
- 2 Install the complete expansion joint including steel extrusions and strip seal gland.
 Ensure that the joint manufacturer has a history of successful product manufacture and has AISC shop certification specific to the type work being performed.
- 4 Make certain that the deck joints are of sufficient strength to support, in all positions, a HS-25 highway truck loading and impact as defined in the current edition of the AASHTO *LRFD Bridge Design Specifications* or alternate military loading of 2 axles 4 feet apart with each axle weighing 24,000 pounds, whichever produces greater stress, and can accommodate the movements shown on the Plans.
- 5 Before fabricating any joints, submit Shop Plans to the bridge designer for review. Make certain that the Shop Plans meet the requirements of **Section 725** and include, but not limited to, the items listed in **Subsection 723.4.1**.
- 6 Prior to final acceptance of an expansion joint, submit manufacturer certifications attesting that the materials and fabrication of the entire expansion joint assembly including all accessories meeting the requirements of the Plans, specifications, and the reviewed Shop Plans.

723.2 Materials

- 1 Provide the joint material consisting of a continuous elastomeric strip seal gland with extruded steel anchoring elements.
- 2 Ensure that the seal gland material for bridge deck joint is a vulcanized elastomeric compound using polymerized chloroprene as the basic elastomer. Install the seal gland in 1 continuous strip. Field splicing of the gland material is not permitted.
- 3 Make certain that the physical properties of the strip seal gland are in accordance with the following table and have the manufacturer provide certified test results to the OMR.

Physical Property	Requirements	Test Method
Tensile strength, min., psi	2000	ASTM D 412
Elongation @ break, min., %	250	ASTM D 412
Hardness, Type A durometer, points	55 ± 5	ASTM D 2240
Oven aging, 70h @ 212°F Tensile strength, max. % Loss Elongation, max. % Loss Hardness, Type A durometer, points change	20 20 0 to +10	ASTM D 573
Oil Swell, ASTM Oil No. 3, 70h @ 212°F, Weight change, max., %	45	ASTM D 471
Ozone resistance, 20% strain, 300 pphm in air 70h @ 104°F	no cracks	ASTM D 1149
Low temperature stiffening, 7 days @ 14°F. Hardness, Type A durometer, points change	0 to +15	ASTM D 2240
Compression Set, 70h @ 212°F. max., %	40	ASTM D 395, Method B

- 4 Provide one-piece extruded steel anchoring elements from AASHTO M 270, Grade 50W Steel. The use of exposed aluminum is not allowed. Welding pieces together in any manner to gain the final shape of the steel anchoring elements is not allowed. Ensure that the configuration has a minimum backwall thickness of ½ inch.
- 5 Provide a lubricant/adhesive for bonding the seal to the steel elements. Use a lubricant/adhesive that is a 1-part moisture curing polyurethane and hydrocarbon solvent mixture meeting the requirements of ASTM D 4070.
- 6 Ensure that studs utilized in anchorage system meet the requirements of **Subsection 709.2.2**. Use straps for erection purposes conforming to the requirements of AASHTO M 270, Grade 36.

723.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

723.4 Construction

723.4.1 Shop Plans

- 1 Provide Shop Plans for review and approval of the joint proposed for use. Ensure that the Shop Plans submittals are in accordance with **Section 725** and include the following items:
 - Manufacturer's brochures concerning the joint proposed which should include all physical dimensions of components, installation procedures, material certifications, and a table of variable temperatures and dimensions.
 - Plans detailing the installation of the joint indicating length of component members, treatment of any directional changes, field splicing of steel anchoring elements (the gland component is not field spliced), fabrication of metal components at barriers, curbs and parapets.
- 2 The Department assumes no responsibility for the accuracy of the Shop Plans. The Contractor is responsible for conformity with the Special Provisions and the Plans.

723.4.2 Installation

- 1 Recess the joint $\frac{1}{4}$ inch below the finished grade of the bridge deck when installed.
- 2 Mechanically lock the gland component into place. Make certain the joint is installed such that it is watertight.
- 3 Do not start installing the joint seal on the project until a trained factory representative is on the job site to provide direction and assistance throughout the installation work. Notify the joint manufacturer of the scheduled installation a minimum of 2 weeks in advance. The factory representative must be present for the installation of the first joint seal and succeeding joint seals until the Contractor becomes proficient in the work.
- 4 Clean the surfaces of joint cover plates and the exposed surfaces of the steel extrusions in accordance with the requirements of SSPC SP-10 as specified in **Subsection 710.4.1.1.1**. Paint all surfaces of any joint cover plates and the exposed surfaces of the steel extrusions, except for the areas that are in contact with the seal gland, with an inorganic zinc primer in accordance with **Subsection 710.4.1**. Anchor studs or straps need not be painted.

723.5 Measurement

- 1 The quantity for the pay item Deck Joint Strip Seal is the length of the strip seal expansion joint in-place and is measured by the linear foot (LF), complete, and accepted. The length of expansion joint length is measured from gutterline to gutterline along the centerline of joint.

723.6 Payment

- 1 Payment for the accepted quantity of Deck Joint Strip Seal, measured in accordance with **Subsection 723.5**, is determined using the contract unit bid

price for the item pay item. Payment is full compensation for furnishing and installing strip seals as specified or directed and includes preparing Shop Plans; providing and installing elastomeric sealing gland and steel components including welded studs and straps, extruded steel anchoring elements, and additional extruded anchor extension required to terminate the joint at the face of parapet, curb, or sidewalk parapet; cleaning and painting of steel components; having manufacturer's technical representative on-site; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

2 Payment includes all direct and indirect costs and expenses necessary to complete the work.

3 Pay items under this section include the following:

Item No.	Pay Item	Unit
7232310	Deck Joint Strip Seal	LF

SECTION 724

ELASTOMERIC BEARINGS

724.1 Description

- 1 This section contains specifications for materials, equipment, construction, measurement, and payment for furnishing and installing elastomeric bearings, either “plain” (consisting of elastomer only) or “laminated” (consisting of alternating individual layers of elastomer and internal steel laminates) as shown on Plans.

724.2 Materials

- 1 Provide elastomer materials consisting of Polychloroprene (Neoprene) Grade 2 elastomer as shown in AASHTO *LRFD Bridge Design Specifications*, Table 14.7.5.2-1, Temperature Zone B and for Low Temperature Brittleness. In accordance with the AASHTO *LRFD Bridge Design Specifications*, Section 18, Grade 2 material does not require a brittleness test. Make certain that the physical properties of the cured elastomer comply with the requirements shown in Table I of AASHTO M 251. Provide reinforced pads with 50 or 60 Durometer Hardness as specifically designated on the Plans.
- 2 Obtain elastomeric bearings that are fabricated by a manufacturer listed on the most recent edition of *SCDOT Qualified Product List 24*. Submit pre-qualification test samples, certifications, and elastomer formulation to the OMR for approval prior to its first use on Department projects. Submit the materials well in advance of anticipated use and ensure that the submission contains certified test results showing the actual test values obtained when the physical properties of the elastomer to be furnished were tested for compliance with the pertinent specification requirement. Pre-qualification test samples consist of at least two bearings typical of the formulations and workmanship intended for use on Department projects. Provide sample size no larger than 11 inches x 17 inches.

724.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

724.4 Construction

724.4.1 Fabrication

- 1 Fabricate the bearing pad in conformance with the AASHTO M 251 and in conformance with details shown in the Plans, or the requirements of the current edition of the AASHTO *LRFD Bridge Design Specifications* where referenced.
- 2 Fill pin grooves in laminated bearings with a vulcanized neoprene or a sili-

cone material capable of bonding and maintaining integrity with the pad.

- 3 Adhere to tolerance in dimensions of completed pads as listed in Table 2 of AASHTO M 251 unless other tolerances are shown on the design drawings.

724.4.2 Acceptance Testing

724.4.2.1 General

- 1 Acceptance is based on either Level I or Level II testing. Level I testing is applied to all bearings and Level II is, at the discretion of the OMR, applied to the more critical or unusual bearings. It is also used to resolve differences over acceptance of bearings under Level I. Have the fabricator notify the OMR a minimum of 14 calendar days prior to the start of fabrication so that the OMR inspector can be present during fabrication and testing.

724.4.2.2 Level I Testing

- 1 Perform Level I testing as stated in Section 8 of AASHTO M 251 except that only 10% of the bearings are required to undergo the compressive test. Submit the results of the compressive stress-strain curve to the RCE.

724.4.2.3 Level II Testing

- 1 Perform Level II testing as specified in Section 8 of AASHTO M 251. Level II certification requires that all Level I conditions are satisfied except that individual conditions are waived by the OMR if Level II certification is used as an arbitration of disputes.

724.4.3 Certifications

- 1 Have the bearing manufacturer certify that all of the pre-qualification samples submitted are of the same elastomer formulation and of equivalent cure to that used in the finished products to be furnished on Department projects.
- 2 Require the manufacturer to perform the complete pre-qualification testing procedure again during later production should the OMR feel such action appropriate based on performance of the pad in service.
- 3 After pre-qualification approval, have the manufacturer perform inspection, sampling, and testing of actual bearing production with certified laboratory test results of the following:
 - Elastomer properties on each batch or lot of elastomer used in the manufacture of the bearings, as contained in Table 1 of AASHTO M 251.
 - One Bond Strength test per lot of reinforced bearings.
 - Compressive load results required by Level I testing which requires each bearing to be load tested at 150% of maximum design load.

724.4.4 Installation

- 1 Plane bearing surfaces under the elastomer to within 0.062 inch and horizontal to within 0.01 radians in accordance with Plans and the Special Provisions. Ensure that the elastomeric bearings bear directly on the concrete sur-

face.

- 2 Tighten nuts for anchor bolts finger tight then back off $\frac{1}{16}$ inch, then peen the threads or burr with a sharp pointed tool.
- 3 When the sole plates are attached to the beam flange, place the plates to be aligned with the anchor bolts after the dead load deflection has occurred if the dead load deflection and slope produce a change in length of more than $\frac{1}{4}$ inch.
- 4 Exercise caution where field weld or shop weld is made while elastomeric bearing pad is in contact with the metal. Do not expose the elastomer or elastomer bond to instantaneous temperatures greater than 400°F. Any damage to elastomeric bearing due to welding is cause for rejection. Monitor temperature by use of heat crayons.

724.5 Measurement

- 1 The quantity for the pay item Elastomeric Bearing is measured by each (EA) elastomeric bearing pad conforming to the size and dimensions specified on the Plans installed, complete, and accepted.
- 2 The steel sole plate welded to the bottom flange of the beam or girder is not measured for payment under the Elastomeric Bearing item, but is included in the item for structural steel or prestressed concrete beams depending on the type of beam to which it is welded.

724.6 Payment

- 1 Payment for accepted quantity of Elastomeric Bearing, measured in accordance with **Subsection 724.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for furnishing and installing elastomeric bearing pads as specified or directed and includes sampling, testing, and certification of bearing pads; welding sole plates; burring or peening anchor bolt threads; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for the steel sole plate is included in the contract unit bid price for structural steel or prestressed concrete beams as applicable.
- 3 Anchor bolts, washers, and nuts are not included in this item, but are paid for under the appropriate substructure item.
- 4 Payment includes all direct and indirect costs and expenses necessary to complete the work.
- 5 Pay items under this section include the following:

Item No.	Pay Item	Unit
7243100	Elastomeric Bearing	EA

SECTION 725

SHOP PLANS AND WORKING DRAWINGS FOR STRUCTURES

725.1 Description

- 1 This section contains specifications for submitting Shop Plans and Working Drawings for structures. Failure to follow the procedures herein may cause delay in processing of submittals. Any subsequent loss of construction time due to failure to follow these procedures will not be accepted by the Department as a valid reason to change the project's completion date.

725.1.1 Shop Plans

- 1 Provide Shop Plans for fabricated items that will remain a permanent part of structures. No later than 30 days before fabrication, submit 7 sets of Shop Plans to the bridge designer or as otherwise specified. No extension of contract time is granted for delays due to failure to observe this time requirements. Have the fabricator of the material component of the structure notify the OMR a minimum of 14 calendar days prior to the start of fabrication.
- 2 Send Shop Plans for projects designed in-house to the BDE.
- 3 Send Shop Plans for projects designed for the Department by a design consultant directly to the consultant. Obtain the necessary mailing information at the Preconstruction Conference.
- 4 For Shop Plans sent to the BDE, send a copy of the transmittal letter to the BCE, the OMR, and the RCE. For Shop Plans sent directly to a design consultant, send a copy of the transmittal letter to the BDE, the BCE, the OMR, and the RCE.
- 5 Clearly mark Shop Plans submission as containing "SHOP PLANS."
- 6 Ensure that Shop Plans contain 7 white print sets of drawings of one of the following plan sizes:
 Size A 22 inches x 36 inches (ISO A1 metric size 841.0 mm x 594.0 mm) is acceptable, or
 Size B 11 inches x 17 inches (ISO A3 metric size 420.0 mm x 297.0 mm) is acceptable.
- 7 Submit Shop Plans for the items in the following table on plan size A or B as indicated:

Items Requiring Submittal	Plan Size
Structural Steel Members	A
Structural Steel Parts of Expansion Joint	A
Structural Steel Parts of Bearings	A

(table continued on the next page)

(table continued from the previous page)

Items Requiring Submittal	Plan Size
Miscellaneous Steel Members except Piling and Sway Bracing	A
SIP Bridge Deck Forms	A
Prestressed Concrete Beam or Girder	A or B
Post-tensioned Concrete Beam or Girder	A
Prestressed Concrete Piling	B
Miscellaneous Prestressed and Post-tensioned Concrete Members	A or B
Other items as may be required as specified in the Plans or in the Special Provisions	A or B

- 8 Ensure that Shop Plans bear the seal and signature of a South Carolina registered Professional Engineer with the exception of the following items fabricated in accordance with details shown in Plans:
- Armor plates,
 - Prestressed concrete piling,
 - Bearing or sole plates, shims, and booster plates, and
 - Anchor bolt assemblies and tie rod assemblies.
- 9 Temporary FAX submittals are only accepted when approved in advance by the Designer of Record and are followed by submittal of the proper number and size of Shop Plans.
- 10 Have the fabricator electronically submit "As-Fabricated" drawings to the BDE for the Department's project records. Submit the "As-Fabricated" drawings for all items requiring Shop Plans required items, except for SIP Bridge Deck Forms.

725.1.2 Working Drawings and Design Calculations

- 1 Ensure that the Working Drawings (or Design Drawings for Contractor designed items such as MSE Walls) are fully detailed, showing layout of elements, sizes, material specifications, and manufacturer's recommendations for installation. State the allowable stresses used for design, working loads, the load capacity of all support elements and the design specifications on the drawings.
- 2 Submit 7 sets of the required Working Drawings and design calculations for construction falsework/form systems and temporary structures to the BCE for review a minimum of 21 calendar days before erection or installation. Send a copy of the transmittal letter to the RCE.
- 3 For falsework/form systems over or adjacent to railroad tracks, submit all Working Drawings and design calculations required by the Railroad to the designated railroad representative for acceptance a minimum of 30 calendar

725.1.2**725.6**

days before erection or installation. Furnish 3 sets of the railroad accepted falsework/form system to the BCE for final review and acceptance a minimum of 7 calendar days before erection or installation with copy to the RCE.

- 4 No extension of contract time is granted for delays due to failure to observe these time requirements.

725.2 Materials

- 1 None specified.

725.3 Equipment

- 1 None specified.

725.4 Construction

- 1 Do not begin fabrication of items that require Shop Plan until the reviewed Shop Plans have been stamped and distributed by the Department. When Working Drawings are required, do not begin installation of such items until the accepted drawings have been received from the Department or from the Designer of Record on Value Engineering and Design-Build projects.

725.5 Measurement

- 1 This work is not measured for payment.

725.6 Payment

- 1 No separate payment is made for compliance with this specification. All costs of the above work are considered incidental to the project and included in other items of work.

SECTION 726

BRIDGE DECK REHABILITATION

726.1 Description

- 1 This section contains specifications for installing a low slump or latex modified Portland cement concrete overlay over an existing Portland cement concrete bridge deck. The work includes removing deteriorated concrete for the full or partial depth of the deck, preparing the area for the new concrete, placing, curing, and finishing the overlay area.

726.2 Materials

726.2.1 General

- 1 Obtain BCE approval for overlay materials prior to use. Control the moisture contents of the overlay aggregates, especially the fine aggregate, so that at the time of mixing, the moisture content of each aggregate is relatively uniform. Feed the material uniformly when continuous type mixers are used; and the moisture content of the aggregate is not so great that the water-cement ratio or slump requirement for the concrete mixture is violated. Replace concrete, which is not properly proportioned or is not in conformity with the specified slump and/or water-cement ratio and is rejected by the RCE, with concrete meeting the requirements at no cost to the Department. When the water-cement ratio or slump requirements are violated, correct this condition at no additional expense to the Department before mixing operations are continued. Stockpile the aggregates a minimum of 48 hours prior to placement of the overlay. Cover the stockpiles with white burlene or equivalent to assist in maintaining uniformity of temperature and moisture content.

726.2.2 Cement

- 1 Provide Portland cement conforming to the requirements of **Subsection 701.2.1**. Store the cement in a manner to prevent excessive temperature build-up that is detrimental to the concrete mix.

726.2.3 Water

- 1 Provide water conforming to the requirements of **Subsection 701.2.11**.

726.2.4 Fine Aggregates

- 1 Provide fine aggregate for the concrete mixture that is natural sand conforming to the requirements of **Subsection 701.2.9.2**. Determine the moisture content of the sand in order to calculate its free water content and the resulting water-cement ratio of the concrete mixture.

726.2.5 Coarse Aggregate

- 1 Provide Coarse Aggregate No. 8M or No. 789 conforming to the requirements of **Subsection 701.2.10.4**. Determine the moisture content of the coarse aggregate in order to calculate its free water content and the resulting

water-cement ratio of the concrete mixture.

726.2.6 Air-Entraining Admixture

- 1 Use air-entraining admixture conforming to the requirements of **Subsection 701.2.5.1**.

726.2.7 Water-Reducing Admixture

- 1 Use water-reducing admixture conforming to the requirements of **Subsection 701.2.6**. Furnish the OMR a copy of the manufacturer's recommendations for use.

726.2.8 Epoxy Cement

726.2.8.1 General

- 1 Use epoxy cement that is a moisture insensitive, two-component system meeting the requirements of ASTM C 881, Type III. Supply the two components in separate containers that are non-reactive with the materials contained therein. Identify the containers as "Component A - Contains Epoxy Resin" and "Component B - Contains Hardener" and show the type, mixing directions and usable temperature range. Clearly mark each container with the name of the manufacturer, the lot or batch number, the date of packaging, the type of pigmentation, and the quantity contained therein in pounds and gallons. Mix and apply the epoxy in accordance with the manufacturer's recommendations. State the potential hazards on the package in accordance with the Federal Hazardous Products Labeling Act.

726.2.8.2 Basis for Acceptance

- 1 Present to the OMR a letter of certification from the manufacturer indicating that the epoxy cement complies with the product specifications.

726.2.8.3 Sampling and Testing

- 1 Provide to the RCE separate unopened, 1-quart samples of each component from each lot or shipment and have them forwarded along with the certification to the OMR. Failure of samples to conform to the applicable specification requirements is cause for the epoxy cement to be rejected and removed from the job site.

726.2.9 Sand for Epoxy-Sand Slurry Mixture

- 1 Provide the fine aggregate for slurry mixtures that is white silica sand containing no less than 90% insolubles and is rounded to subangular in shape, clean, dry, and non-friable. Test the fine aggregate in accordance with AASHTO T 21. Ensure that the gradation is as shown in the table below.

Sieve	Percent Passing
No. 8	100
No. 50	0-40
No. 100	0-5

- 2 Material not meeting this gradation is allowed, provided it produces a workable mixture and an acceptable slurry seal as approved by the RCE.

726.2.10 Sand for Grout-Bond Coat

- 1 Use sand in the grout-bond coat that is mortar sand conforming to the requirements of **Subsection 701.2.9** with the exception that the gradation requirements do not apply.

726.2.11 Latex

- 1 Select the latex admixture from the list of acceptable products on the most recent edition of *SCDOT Qualified Product List 12*. Ensure that the latex admixture is a material that is produced in the United States.
- 2 Submit a certified test report from the independent laboratory, a 1-gallon sample of the latex admixture, and a material safety data sheet to the OMR prior to beginning work. Approval of the latex admixture is based upon the submitted information.
- 3 Ensure that the latex admixture does not contain any chlorides. Furnish with each shipment a report of tests performed in accordance with the certification program contained in *Report No. FHWA-RD-78-35*. In addition to actual test results, ensure that the report includes the date of manufacture, batch or lot number(s), quantity represented, manufacturer's name, place of manufacture, a statement that all test results are satisfactory, and the date on which the 1-year certification period expires.
- 4 Package and store the latex admixture in containers and storage facilities that protects the material from freezing and from temperatures above 85°F. Additionally, do not store the material in direct sunlight, and shade when stored outside of building during moderate temperatures. Do not use latex admixture that has been exposed to freezing or elevated temperatures (i.e. above 85°F) to be used without approval from the OMR.
- 5 When latex is used, have the manufacturer of the latex material furnish a representative who is available for technical assistance as needed during the placement of the latex overlay.

726.2.12 Grout-Bond Coat for Portland Cement Overlay

- 1 Use a grout-bond coat consisting of a one-to-one (1:1) mixture by weight of Type I Portland cement and mortar sand plus sufficient water to produce slurry of uniform spreading consistency.

726.2.13 Concrete for Full-Depth Patching

- 1 Ensure that concrete for full-depth patching is Class 4000 concrete conforming to the requirements of applicable subsections of **Section 701**.

726.2.14 Epoxy-Sand Slurry

- 1 Provide an epoxy-sand slurry mixture composed as follows:
 - 1 gallon of Component A
 - 1 gallon of Component B
 - 2 gallons of dry, white, silica sand
- 2 The above quantities are considered as one standard batch for the purpose of measurement and payment. If approved in writing by the OMR, minor adjustments may be made in the quantity of sand in order to produce a more workable mixture.

726.3 Equipment**726.3.1 Existing Deck Preparation Equipment**

- 1 Use mechanical scarifiers or grinders designed specifically for scarifying bridge decks subject to approval of the RCE. Hydro-demolition equipment instead of mechanical scarifiers and/or hammers is allowed, subject to the approval of the RCE, and compliance with all South Carolina and Federal Laws pertaining to air, water pollution, safety, and health regulations.
- 2 When cleaning the entire machine-prepared area with compressed air supplied by an air compressor having suitable separators and traps, ensure that the compressed air is free of detrimental quantities of water, oil, grease, or any other injurious substances. Do not allow leakage of oil, grease, gasoline, or other substances from the compressor(s) or other equipment on to the deck. Place protective sheeting (plastic, tarpaulins, etc.) under any equipment that leaks.
- 3 Blast clean the machine-prepared area with equipment using wet sandblasting, high pressure water blasting, blasting grits, shrouded dry sandblasting, dry sandblasting with dust collectors, or other methods approved by the RCE.

726.3.2 Concrete Mixing Equipment**726.3.2.1 General**

- 1 Mix concrete for concrete overlays at the work site by two batch or two continuous mixers approved by the OMR. Do not use drum-type transit truck mixers or rotating drum batch-type mixers for Portland cement concrete overlays. Ensure that batch mixers are equipped with rotating blades or paddles.
- 2 Ensure that the latex admixture supply lines and the water supply line are separate lines and are connected immediately before discharge into the hopper. Do not use connected latex admixture and water lines discharging through a single valve even if check valves are incorporated in the supply

lines.

- 3 Maintain calibration valves as manufactured. Ensure that gauges and dials are accessible, clear, and legible. Make certain the mixer consistently produces a uniform, thoroughly blended mixture within the specified air content and slump limits. Repair malfunctioning mixers immediately or replace with acceptable units.

726.3.2.2 Batch Mixers

- 1 Ensure that batch-type mixers are equipped with or accompanied by suitable devices for accurately measuring the weight of the cement, fine aggregate, and coarse aggregate for each batch. Make certain they are also able to accurately determine the volume or the weight of the water, the water reducing and air entraining admixtures, and latex admixture, as applicable, for each batch. Provide approved methods for adding the air-entraining admixture and the water reducing admixture. Keep the admixtures separated, and add them separately to the mixture. Do not use batch-type mixers that entrap unacceptable volumes of air in the mixture.

726.3.2.3 Continuous Type Mixers

- 1 Use continuous type mixers so equipped such that the proportions of the latex admixture (when required), cement, fine aggregate, and coarse aggregate can be fixed by calibration of the mixer; and thereafter, do not change proportions without approval by the OMR. Equip the latex admixture supply part and the water supply part of the mixer with a flow meter or other suitable device for calibrating the water supply, and a cumulative type water meter that can be read to the nearest 0.1 gallon or 1 pound. Ensure that the latex and water meters are readily accessible, accurate to within $\pm 1\%$, and easy to read. Provide approved methods for adding the air-entraining admixture and the water-reducing admixture. Add the admixtures separately as far as practicable. Calibrate the continuous type mixer in accordance with Department procedures before starting the work. Re-calibrate it thereafter at least once during each 50 cubic yards production if yield checks indicate re-calibration is necessary, and at any other time the RCE deems necessary to ensure proper proportioning of the ingredients. Do not use continuous type mixers that entrap unacceptable volumes of air in the mixture.

726.3.3 Finishing Machine for Portland Cement Concrete Overlay

- 1 Use a finishing machine capable of forward and reverse motion under positive control. Ensure that the finishing machine is equipped with a strike off to provide a uniform thickness of concrete in front of the screeds and with 2 oscillating screeds set accurately to the crown specified. Make certain the screeds of the finishing machine are metal. Ensure that the front oscillating screed is designed to thoroughly consolidate the concrete by vibration to the specified density for Portland cement concrete. Be sure a sufficient number of identical vibrators are effectively installed on the screed so that at least 1 vibrator is provided for each 5 feet of screed length. Ensure that the bottom face of this screed is at least 5 inches wide with a turned up or rounded lead-

ing edge to minimize tearing of the surface of the plastic concrete. Make certain each screed has an effective weight of at least 75 pounds for each square yard of bottom face area. Provide each screed with positive control of the vertical position, the angle of tilt and the slope of the crown. Ensure that the final screed oscillates and finishes without vibration. Be sure the design of the finishing machine together with appurtenant equipment is such that positive machine screeding of the plastic concrete is obtained within 1 inch of the face of the curbs or construction joint. Ensure that the vibrating screed is of sufficient length to extend at least 6 inches beyond an intended longitudinal joint, and to extend at least 6 inches beyond the longitudinal edge of a previously placed section of overlay.

726.3.4 Finishing Machine for Latex Concrete Overlay

- 1 Use a finishing machine capable of forward and reverse motion under positive control. Ensure that the finishing machine is equipped with a strike off to provide a uniform thickness of concrete in front of the screeds and with 2 oscillating rollers set accurately to the crown specified. Make certain that the screeds of the finishing machine are metal. Make certain that the design of the finishing machine together with appurtenant equipment is such that positive machine screeding of the plastic concrete is obtained. Be sure that the vibrating screed is of sufficient length to extend at least 6 inches beyond an intended longitudinal joint, and to extend at least 6 inches beyond the longitudinal edge of a previously placed section of overlay.

726.3.5 Equipment On Site

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

726.4 Construction

726.4.1 General

Adhere to the following sequence of operations when patching existing concrete decks:

1. Machine prepare existing deck and remove unsound concrete, and restore reinforcement.
2. Rehabilitate joints.
3. Blast clean the machine prepared deck.
4. Apply a grout-bond coat.
5. Mix, place, and consolidate the concrete overlay mixture.
6. Finish, texture, and cure overlay.
7. Seal joints and cracks.
8. Apply the epoxy-sand slurry.
9. Saw textured grooves if specified.

- 2 When longitudinal construction joints are necessary, cure each section of overlay in accordance with the requirements of **Subsections 726.4.17.5** and **726.4.18.6** before the adjacent overlay is placed.

726.4.2 Scheduling

- 1 Perform the work on placing the concrete overlay between the hours of 7:00 P.M. and 9:30 A.M. Notify the RCE at least 12 hours in advance of the date and time intended to begin placing concrete overlay. When placing of concrete is not started within 2 hours after the scheduled time, then all engineering costs from the scheduled time until the time placing actually begins or is canceled are deducted from monies due or become due to the Contractor. No engineering costs are deducted when placing is delayed for reasons beyond the control of the Contractor, such as inclement weather or equipment failure after placing begins. No time extensions are granted for delay in placing concrete resulting from the RCE receiving less than 12 hours notice specified above.

726.4.3 Weather Limitations

- 1 Perform placement of overlay when the deck and weather conditions are such that the rate of evaporation does not exceed 0.2 pounds per square foot per hour for Portland cement concrete overlay or 0.15 pounds per square foot per hour for latex concrete overlay. Use the Nomograph For Determining Rate Of Evaporation located in the Appendix of these specifications in determining the rate of evaporation. Do not place the concrete overlay when the air temperature is above 85°F or the air temperature away from artificial heat is less than 45°F. In all instances, place and keep the concrete at a temperature above 50°F for at least 96 hours. This requires approved housing and heating or insulation methods during cold weather. Do not place the concrete when raining or drizzling. If during the process of placing concrete, it begins to rain or drizzle, stop the placement and protect and finish the concrete already in place.

726.4.4 Machine Preparation of Existing Deck, Removal of Concrete, and Restoration of Reinforcement

- 1 Perform machine preparation of the entire area of the deck between the parapets and the ends of the structure (i.e. 100% of the deck area) consisting of removal of the concrete to a depth of at least ¼ inch below the existing concrete surface. The RCE may require removal of concrete to depths greater than ¼ inch for designated portions of the deck in order to provide a uniform surface profile upon which to place the overlay. Unless authorized otherwise by the RCE, accomplish the machine preparation of the deck by alternate passes of the mechanical scarifiers. Ensure that the scarifier or grinder produces a surface matching the existing slab cross-section and each pass of the machine matches the adjacent edge of the previous pass. If satisfactory results are not achieved, the RCE may direct that the work be performed with other equipment.
- 2 End walls do not require the machine preparation unless otherwise noted.

Remove epoxy, asphalt, foreign surfaces, and patches in a manner acceptable to the RCE. Do not use hammers exceeding 40 pounds in weight or any other equipment that may cause damage to the underlying concrete.

- 3 Remove all other concrete deemed unsound by the RCE. Perform removal of concrete within areas where the depth of removal exceeds $\frac{1}{4}$ inch by use of hammers not exceeding 40 pounds in weight or other such small equipment approved by the RCE. Ensure that the periphery of routed areas is as nearly vertical as possible. Should removal of unsound concrete extend through $\frac{1}{2}$ of the depth of the concrete slab or more, remove the remaining sound concrete and replace as outlined herein for full-depth patching.
- 4 Avoid damage to any existing deck steel reinforcement. Remove concrete to a depth of $\frac{3}{4}$ inch below any reinforcement bar that is more than $\frac{1}{2}$ exposed or any others that appear not to be bonded to the existing concrete. Exercise caution to protect any underlying sound concrete and steel reinforcement. Tie exposed steel reinforcement that is not tied. Replace rebar damaged by the concrete removal operations at no expense to the Department.
- 5 Remove unsound concrete in the deteriorated or spalled areas near the joints, and remove the joint filler material. Reform the joints to exact width specified and true alignment by the installation of a template made of styrofoam, or timber covered with polyethylene sheeting, or of other suitable material or as otherwise specified in the Plans. Remove concrete within the area of the joint rehabilitation by use of jackhammers not exceeding 60 pounds in weight or other such small equipment down to the mid-depth of the deck.
- 6 Blast clean exposed steel reinforcement and structural steel to remove scale, rust, grease, oil, etc. Before placing concrete, replace deteriorated or damaged reinforcement or supplement as directed by the RCE. Dispose of dust, chips of asphalt materials, concrete, or other debris in a manner approved by the RCE. Clean the entire machine prepared area with compressed air supplied by an air compressor that meets the requirements of **Subsection 726.3.1**.

726.4.5 Blast Cleaning

- 1 Blast clean the entire area of the deck surface to a clean appearance that is free from curing compound, laitance, dust, dirt, oil, grease, asphalt material, paint, and foreign matter. Perform the blast cleaning of an area of the deck within the 24-hour period preceding placement of the overlay on the area. However, if any portion of the bridge is open to traffic, blast clean the area to be overlaid within 12 hours before placing the overlay.
- 2 Blast clean the prepared area by methods and equipment designated in **Subsection 726.3.1**. Perform the method used in conformance to air and water pollution regulations applicable to the county or city where the work site is located and to any state (SCDHEC) and federal (EPA) regulations. Ensure that the blast cleaning conforms to applicable safety and health regulations (OSHA). Immediately discontinue using a method that does not consistently

provide satisfactory results and does not conform to the above requirements and replace by an acceptable method. Reasonably confine debris, including dirty water, resulting from the blast cleaning operation during the performance of the blast cleaning work and immediately and thoroughly remove from the blast cleaned surfaces and other area where escaped debris may have accumulated.

- 3 Apply water or other approved materials to effectively prevent dust from becoming an air pollutant, safety hazard, or other type of nuisance during the blast cleaning operation. Failure to perform this item of work satisfactorily is cause for deferring the processing of pay estimates due the Contractor for the project.
- 4 When water or other material is used to control dust, no separate payment is made as all costs for furnishing and applying the materials are considered incidental to the pay items in the Contract.
- 5 Protect the blast-cleaned areas against contamination before placement of the overlay. Blast clean contaminated areas and areas exposed more than 24 hours (12 hours when under traffic) again as directed by the RCE at no additional expense.

723.4.6 Full-Depth Patching

- 1 The area of removal of the concrete to full-depth is from center of girder to center of girder. In the event that the full-depth holes are small (less than 6 square feet), the RCE will consult with a representative of the BCE for the method in which the areas are to be repaired. Otherwise, fill full-depth holes with Class 4000 concrete.
- 2 Immediately before placement of concrete, dampen the contact surface and allow to dry. Then apply a grout-bond coat by vigorously scrubbing or brushing it into the contact surfaces of full-depth patch areas.
- 3 Carefully place the Class 4000 Concrete and tamp or vibrate into place. Rough finish full-depth patched areas to an elevation corresponding to the top of the scarified deck and wet cure for a period of not less than 7 calendar days, or until the overlay is placed, by means of a double layer of wetted bur-lap or similar material. If the concrete surrounding a full-depth concrete patch requires partial depth removal, then finish the full-depth concrete patch to an elevation corresponding to the bottom of the partial depth patch areas instead of the elevation of the original deck.
- 4 After the concrete has hardened sufficiently to maintain the proper shape, remove joint templates in a manner to avoid chipping or breaking down the edges of the repaired joint. Remove forming material prior to the completion of the project unless otherwise specified.
- 5 Blast clean the surfaces of patched areas to remove all laitance and all sand before the overlay is placed. Complete all full-depth patching in each lane before beginning operations on another lane, unless otherwise permitted or directed.

- 6 Do not place the concrete overlay or any equipment on the full-depth patches until the patches are at least 7 days old, or have developed a compressive strength of 3600 psi.

726.4.7 Partial Depth Patching

- 1 When a Portland cement concrete is used for the overlay, fill areas of partial depth patches with overlay material to the level of the existing deck. Cure these areas until the overlay is placed over the patch or the cure time expires. When latex concrete is used for the overlay, place partial depth patches monolithically with the overlay.

726.4.8 Prohibited Field Welding

- 1 Except as approved on the Plans, do not allow welding of any nature without the written consent of the BCE, and then only in the manner and at the locations designated.

726.4.9 Mixing and Placing Concrete Overlay

- 1 Use either batch or continuous mixers in accordance with the requirements of **Subsection 726.3.2**. Keep the mixer, whether batch or continuous type clean and free of partially dried or hardened materials at all times. Do not allow the maximum time between completion of mixing and placement to exceed 20 minutes.
- 2 Hold the formation of longitudinal joints and transverse construction joints to the minimum number necessary. Blast clean both types of joints thoroughly and coat with grout-bond coat material before fresh concrete is placed against the hardened sides of the joints. When longitudinal joints are necessary, form them by use of a longitudinal header secured to the deck. Ensure that the longitudinal header thickness is $\frac{1}{4}$ inch less than the overlay. Locate longitudinal joints along lane lines unless otherwise permitted. After removal of the header, saw the overlay longitudinally 3 inches or more inside the formed edge and then remove the overlay outside the sawcut. The volume of the overlay removed is deducted from the volume measured for payment. Alternate methods of constructing longitudinal joints may be used on latex concrete overlays if approved by the RCE.

726.4.10 Placing and Finishing

- 1 Use sufficient hand tools for placement of stiff, plastic Portland cement concrete or latex concrete and for working it down to approximately the correct elevation for striking off with a screed.
- 2 Place supporting rails upon which the finishing machine travels outside the area to be surfaced, and extend beyond each end of the deck a sufficient distance to accommodate the finishing machine. Ensure that the anchorage for the supporting rails is substantial enough to provide for rigid horizontal and vertical stability of the rails. Submit the method proposed for anchoring the supporting rails to the deck to the BCE for approval before beginning the work.

- 3 Make provision for raising the screeds to clear the screeded surface for traveling in reverse.
- 4 Ensure that the top surface of the overlay is uniform, smooth, and even textured after finishing by an approved finishing machine. Ensure that the latex concrete is thoroughly consolidated by vibration during the finishing operations.
- 5 Closely following the final pass of the screed, texture the surface by use of a drag composed of 2 layers of wet burlap on a transverse screed.

726.4.11 Epoxy-Sand Slurry

- 1 After the overlay has been completed and cured, apply a thin coat (approximately $\frac{1}{16}$ inch) of epoxy-sand slurry to the 12 inches of the overlay adjacent to the curbs, concrete barrier walls, or other vertical walls. Unless otherwise indicated on the Plans, extend the epoxy-sand slurry mixture up the faces of the curbs and walls for 3 inches above the overlay. Thoroughly blast clean the areas to a clean, bright appearance before the slurry is applied. Ensure that the deck is dry when the epoxy-sand slurry is started, and the deck has not been subjected to rain within 12 hours preceding the application of the slurry. Before applying the slurry, protect joints in the area receiving the application by placing strips of masking along the joints in a manner to exclude the slurry from the joints. Place masking on the deck to ensure a straight line for applying the epoxy-sand slurry.
- 2 Thoroughly mix the ingredient materials as indicated in **Subsection 726.2.14** in 3 to 5 minutes. Spread the slurry as smoothly and uniformly as possible to completely fill the blast cleaned pitted areas, cracks, and rough surfaces. Ensure that the finished thickness of slurry is no more than $\frac{1}{16}$ inch. Sprinkle silica sand very lightly over the slurry to prevent a slippery condition.

726.4.12 Cleaning and Sealing Joints

- 1 Rework joints as shown on the Plans and specified in the Special Provisions.

726.4.13 Approach Roadway Sections

- 1 When the rigid type (concrete) approach roadway sections at the bridge ends are indicated on the Plans to receive an overlay, place a latex or Portland cement concrete overlay as indicated on the Plans. Remove the existing concrete approach roadway as necessary to maintain the minimum specification thickness of the overlay.

726.4.14 Material Hauling

- 1 Do not allow trucks with continuous mixers hauling materials for latex concrete or Portland cement concrete overlays or any other type of vehicles to exceed the regulation for either the legal axle weights or axle spacing contained in the appropriate sections of the most current publication of the *South Carolina Laws Covering Size, Weight, Load, and Truck Operations*. Before

doing any overlay work on a structure, furnish to the BCE a certified statement listing the empty weight of each hauling vehicle, the axle weights when empty, axle weights when fully loaded, the gross weight of each vehicle when loaded with a specified number of cubic yards, and the spacing of the axles. This information is used by the Department for limiting the quantity of materials the Contractor is permitted to haul. This limitation is based on the capacity and condition of the bridge after unsound concrete has been removed and prior to placement of the overlay. Under no circumstances are loads that exceed legal gross or axle gross or axle load limits permitted.

726.4.15 Damage to Structures

- 1 The Contractor is responsible for all damage to the structure during construction until the work is complete, even to the replacement of entire spans at no additional expense, should they fail because of the construction operations.

726.4.16 Unacceptable Work

- 1 The Department determines the overlay thickness with coring done in accordance with Department procedures. Fill any core holes in the overlay using concrete overlay materials, at no additional cost to the Department. Areas found to be deficient in thickness not more than ½ inch are paid for as specified in **Subsection 726.6.8**. Remove and replace areas found deficient by more than ½ inch with concrete overlay of the specified thickness at no cost to the Department.
- 2 Remove and replace any areas of the overlay displaying a significant number of cracks, or are not intimately bonded to the underlying deck, with acceptable concrete at no additional expense. Thoroughly seal small cracks that exist, but are not significant enough to require removal of the overlay, using a low viscosity polymer sealant approved by the RCE.

726.4.17 Special Requirements for Latex Concrete Overlays

726.4.17.1 General

- 1 In addition to the requirements in **Subsections 726.4.1** through **726.4.16**, ensure that the latex concrete overlay conforms to the requirements of **Subsections 726.4.17.2** through **726.4.17.5**.

726.4.17.2 Pre-wetting and Grout-Bond Coat

- 1 Thoroughly and continuously wet with water the blast cleaned areas to receive the overlay at least 1 hour before placement of the overlay is to start. Keep the areas wet and cooled with the water until the overlay is placed. Disperse and/or remove accumulations of water before applying the grout-bond coat. Immediately before placing the overlay mixture, thoroughly brush and scrub onto the wet surface a thin coating of the latex concrete mixture to be used for the overlay as a grout-bond coat. Remove accumulations of coarser particles of the mixture that cannot be scrubbed into intimate contact with the surface.

- 2 Apply the grout-bond coat only for a short distance in advance of the placement of the overlay and do not allow it to show any signs of drying before being covered with the overlay.

726.4.17.3 Proportioning

- 1 Ensure that an OMR representative is present during the mixing of the latex concrete overlay to verify the properties and proportioning of the mix.
- 2 Make certain the latex concrete overlay contains not less than 7 bags of cement and not less than 24.5 gallons of latex admixture per cubic yard. Accurately proportion the latex concrete as shown in the following table:

Mix Proportions for Latex Concrete Overlay	
Type I Portland Cement	94 pounds
Latex Admixture	3.5 gallons
Fine Aggregate	210 to 250 pounds*
Coarse Aggregate	140 to 180 pounds*
Water (including free moisture on the fine and coarse aggregates)	22 pounds max.**
Notes: *The OMR will design the mixture, and will determine the actual quantity of this ingredient used. **The actual quantity of water to be used within this limit is determined by the Contractor and is subject to the approval of the OMR.	

- 3 Have a certified ACI Concrete Field Testing Technician test the properties of the mix and have the OMR on site verify the testing and results.
- 4 Provide latex concrete with the properties in the following table.

Property	Value
Slump (Measured 4 to 5 minutes after discharged from the mixer) ASTM C 143	4 to 6 inches
Air Content ASTM C 231	3 to 6½%
Water-Cementitious Ratio (Considering all the non-solids in the Latex Admixture as part of the total water)	No more than 0.40
Minimum Compressive strength at 28 calendar days ASTM C 39	4000 psi
Maximum Mix Temperature ASTM C 1064	85°F

- 1 Ensure that the technician verifying the properties of the mix is a certified ACI Concrete Field Testing Technician.

726.4.17.4 Placing, Consolidating, and Finishing Overlays

- 1 Pass the finishing machine over the existing deck before placing the overlay and take measurements to ensure that the proper cross slope and thickness are achieved. Place the latex concrete overlay on the blast cleaned and pre-wetted deck immediately after the grout-bond coat is applied.

726.4.17.5 Curing

- 1 Immediately following the finishing operation and as soon as the overlay cannot be deformed by the added weight, cover the overlay with a curing blanket and leave in place for at least 24 hours. Re-wet if any signs of drying appear.
- 2 After the 24-hour period has ended, remove the curing blankets, and allow the overlay to air cure for at least 72 hours.
- 3 After curing of the overlay is complete, give the tops of all longitudinal and transverse construction joints a thorough coating of an RCE approved low viscosity polymer sealant. Ensure that the coating is at least 2 inches wide and is neatly and uniformly applied. This coating is intended to seal any minute cracks that have developed at these locations. Do not use epoxy-sand slurry instead of the RCE approved low viscosity polymer sealant. The overlay may be opened to traffic as soon as all curing is completed and a compressive strength of 3000 psi is obtained, all joints and cracks are sealed as specified above, and the bridge deck is grooved in accordance with these specifications.

726.4.18 Special Requirements for Portland Cement Concrete Overlays

726.4.18.1 General

- 1 In addition to the requirements in **Subsections 726.4.1** through **726.4.16**, ensure that the Portland cement concrete overlay conforms to the requirements of **Subsections 726.4.18.2** through **726.4.18.6**.

726.4.18.2 Grout-Bond Coat

- 1 After the concrete surface is blast cleaned and accepted, and immediately before placing the concrete overlay mixture on the deck, vigorously scrub a thin coating of bonding grout into the dry, clean surface areas. Do not wet the surface areas before applying the grout. When the bridge deck is exposed to rain before application of the grout, delay the application until the bridge deck has dried sufficiently to proceed. The length of the delay will be determined by the RCE, but a minimum drying time of 4 hours is required. Make certain the grout consists of equal parts, by weight, of Portland cement and mortar sand, mixed with sufficient water to form wet slurry. Ensure that the consistency of the grout is such that it can be applied with a stiff brush or broom in a thin, even coating that does not run or puddle in low spots. Ensure that all areas of the blast-cleaned deck receive a thorough even coating of the grout

and that no excess grout is permitted to collect in any areas. Apply the grout only for a short distance in advance of the placement of the overlay and ensure that it does not show any signs of drying prior to being covered with the overlay. Thoroughly re-coat with fresh grout any areas that show any signs of drying.

726.4.18.3 Proportioning the Overlay Mix

- 1 Ensure that an OMR representative is present during the mixing of the Portland cement concrete overlay to verify the properties and proportioning of the mix.
- 2 Accurately proportion the concrete for the overlay to contain 8.75 bags of cement per cubic yard and no more than 35 gallons of water per cubic yard, including free moisture on the aggregates. Determine the amount of water to be added to the mixture to maintain the proper slump, but do not exceed the limit of 35 gallons per cubic yard.
- 3 Determine the amount of fine aggregate and coarse aggregate for the concrete subject to the review of the OMR on an approximately 1:1 proportion by volume and incorporate into the concrete mixture.
- 4 Add the water-reducing admixture to the concrete in accordance with the manufacturer's recommendations.
- 5 Provide concrete overlay with the properties in the following table.

Property	Value
Slump (Measured 4 to 5 minutes after discharged from the mixer), (ASTM C 143)	½ to 1 inch
Air Content, (ASTM C 231)	3 to 6%
Minimum Compressive strength at 28 calendar days, (ASTM C 39)	4000 psi

- 6 Ensure that the technician verifying the properties of the mix is a certified ACI Concrete Field Testing Technician.

726.4.18.4 Placing, Consolidating and Finishing the Overlay

- 1 Pass the finishing machine over the existing deck before placing the concrete overlay in order to make measurements to ensure that proper cross slope and thickness is achieved. After the grout-bond coat has been applied, promptly deposit the concrete on the deck, strike-off, and consolidate with the finishing machine.
- 2 Consolidation using hand-held vibrators is required when placing the mixture around steel reinforcement or structural steel members.
- 3 First strike off the concrete at ¼ inch or more above the specified final thickness, and then consolidate by vigorous mechanical vibration. Determine

the in-place density of the consolidated mixture by use of a nuclear gauge immediately following the screeding operation.

- 4 Immediately correct areas of concrete with deficient density by additional passes of the finishing machine. When any concrete cannot be consolidated to the specified density, remove and replace it with acceptable concrete at no additional expense. Hand finishing of the consolidated concrete with a float may be required in order to produce a tight uniform surface.
- 5 Ensure that the top surface of the consolidated and finished concrete overlay is smooth, uniform, and tight. Provide a surface smoothness and rideability in conformance with **SC-M-702** and **Subsection 702.4.14**.

726.4.18.5 Use of Nuclear Gauge In Determining Overlay Density

- 1 Determine the in-place density of the consolidated Portland cement concrete overlay mixture by use of a nuclear gauge immediately following the screeding operation.
- 2 Ensure that operations of the nuclear gauge are carried out by personnel certified in the use of a nuclear gauge.
- 3 Make certain that the procedure that is provided in the instrument's instruction manual for determining the density of an overlay is followed along with appropriate nomographs or formulas for the nuclear gauges used by the Department. Take readings of the existing concrete and the overlay, and then calculate the density of the overlay based on a nomograph or appropriate formula.
- 4 Prepare sections of the existing deck for density measurements. Preparations include cutting and removing steel reinforcing bars in the vicinity of the density determination area. Preparations may also include adequate leveling of rough areas after the milling operation to allow density determinations to be carried out.
- 5 Adjust the density of the overlay as determined by use of the nuclear gauge according to the hardened concrete density by use of a nomograph or appropriate formula as supplied by nuclear gauge manufacture/supplier.
- 6 Ensure that this adjusted density equals or exceeds the target density, where the target density is 100% of the maximum theoretical density calculated assuming an entrained air content of 4.5%. Immediately correct areas of deficient density by additional passes of the finishing machine. When any concrete cannot be consolidated to the specified density, remove and replace it with acceptable overlay material at no additional expense. Hand finishing of the consolidated concrete with a float may be required to produce a tight uniform surface.

726.4.18.6 Curing

- 1 Initiate curing of the overlay immediately after texturing. Cure by use of a curing blanket that is continuously and thoroughly wetted by automatic fogging or sprinkling equipment for at least 96 hours after the curing is started.

Improper curing is a basis for rejection of the concrete and non-payment for the total cost of the rejected concrete. A curing compound is not permitted on the overlay. After the curing of the overlay is completed, give the tops of all longitudinal and transverse construction joints a thorough coating of a low viscosity polymer sealant approved by the RCE. Apply the coating neatly and uniformly. This coating is intended to seal any minute cracks that developed at these locations. Do not use epoxy-sand slurry instead of an approved low viscosity polymer sealant. The overlay may be opened to traffic as soon as all curing is completed, a compressive strength of 3000 psi is obtained, all cracks and joints are sealed with a low viscosity polymer sealant, and the specified surface texture treatment is applied.

726.5 Measurement

726.5.1 General

- 1 The quantities for payment are measured in units for complete in-place and accepted work as hereinafter specified. In computing quantities, all dimensions used are measured by the RCE.

726.5.2 Removal and Disposal of Existing Overlays

- 1 The quantity for the pay item Removal of Epoxy, Asphalt, and Foreign Overlay is the horizontal surface area of foreign overlay removed as specified and is measured by the square yard (SY), complete, and accepted. When this item is not included in the Contract, no measurement is made and the cost of this work is considered incidental to the installation of the new overlay.

726.5.3 Machine Preparation of Existing Surface

- 1 The quantity for the pay item Machine Preparation of Existing Surface is the horizontal surface area of the deck prepared as specified and is measured by the square yard (SY), complete, and accepted. No deductions in area is made for existing deck drains, castings, expansion dams, patches of foreign material, etc.

726.5.4 Partial-Depth Removal of Unsound Concrete

- 1 The quantity for the pay item Partial-Depth Removal of Unsound Concrete is horizontal surface area of the deck under which the partial depth of concrete is removed as specified and is measured by the square yard (SY), complete, and accepted. The limit of the range of the depth of removal is to the mid-depth of the slab. This item includes the removal of sound concrete below the mid-point of rebar in order to provide adequate concrete coverage around the reinforcing steel exposed below the mid-point.

726.5.5 Concrete Class 4000 for Full-depth Patching

- 1 The quantity for the pay item Concrete Class 4000 for Full-Depth Deck Patching is volume of concrete removed to make the patch and is measured by the cubic yard (CY) calculated from the dimensions of the areas patched as measured by the RCE. This item also includes the removal of concrete in the patched areas.

726.5.6 Reinforcing Steel

- 1 The quantity of reinforcing steel required to replace existing deteriorated reinforcing steel is measured in accordance with **Subsection 703.5**.

726.5.7 Blast Cleaning

- 1 The quantity for the pay item Blast Cleaning is the horizontal surface area of deck blast-cleaned including the 12 inches adjacent to the curb and the 3 inches of the vertical face of the curb to receive the epoxy-sand slurry and is measured by the square yard (SY), complete and accepted,. The blast cleaning of any longitudinal and transverse construction joints is not measured for payment.

726.5.8 Concrete Overlay (Latex or Portland Cement)

- 1 The quantity the pay item Concrete Overlay (Latex) or Concrete Overlay (Portland Cement) is the computed volume of concrete overlay and is measured by the cubic yard (CY), complete in-place, and accepted. In computing the volume, the dimensions used are those shown on the Plans or as ordered by the RCE. The volume of patches cast monolithically with the overlay is included in this quantity and is based on measurements of the patched area taken by the RCE. The volume of material wasted or not incorporated in the finished work is not included in the measured quantity. Grout used for the bond coat and crack sealing is considered incidental to the latex concrete overlay, and it is not measured for separate payment.

726.5.9 Epoxy-Sand Slurry

- 1 The quantity for the pay item Epoxy-Sand Slurry is the horizontal surface area covered by a $\frac{1}{16}$ -inch coating of the epoxy-sand slurry and is measured by the square foot (SF), complete in-place, and accepted.

726.5.10 Repair or Rehabilitation of Expansion Joints and Bridge Ends

- 1 Unless otherwise stated, the rehabilitation or repair of expansion joints and bridge ends is considered incidental to the work of providing the overlay, and it is not measured for payment.

726.5.11 Dust Control

- 1 All drilling, grinding, and sawing of rock, shale, concrete, and other similar dust-producing materials performed by equipment provided with water sprays, fabric filtered collection systems, or other suitable devices to prevent excessive dust from becoming airborne is not measured for separate payment. Dust control is considered incidental to the other items of work.

726.6 Payment**726.6.1 Compensation for Excess Underrun and Overrun of Overlay Quantity**

- 1 As provided in **Subsections 104.2** and **109.4**, the following formulas in paragraph 3 of this subsection are used for determining adjusted unit prices for concrete overlay when either an underrun of more than 25%, or an over-

run of more than 25%, occurs in the quantity of this item. Underruns and overruns exceeding these percentages are deemed to be excessive and are defined as follows:

- An Excessive Underrun (EU) of overlay is 75% of the original contract quantity minus the final quantity
- An Excessive Overrun (EO) of overlay is the final quantity minus 125% of the original contract quantity.

2 When there is more than one bridge in the Contract, the compensation for excessive quantity is determined based on the total contract quantity.

3 After the RCE has determined that either an actual excessive underrun or excessive overrun has occurred in the overlay quantity, the unit price for all the placed and accepted quantity is adjusted in all subsequent pay estimates in accordance with the appropriate following formula:

$$\text{Excessive Underrun Formula: } NP = OP + \frac{(EU)(0.25)(OP)}{FQ}$$

$$\text{Excessive Overrun Formula: } NP = OP - \frac{(EO)(0.25)(OP)}{FQ}$$

Where:

NP = New Unit Price

OP = Original Unit Price by Contractor

EU = Excessive Underrun Quantity

EO = Excessive Overrun Quantity

FQ = Final Quantity of Contract Item

4 By the act of submitting a completed bid proposal for Contract which contains this provision of "Compensation for Excess Underrun or Overrun of Overlay Quantity," the Contractor agrees to accept payment for this pay item involving either excessive underrun or excessive overrun of the overlay quantity in accordance with the appropriate formula. The Contractor further agrees that no claim will be submitted, nor will any allowance be made for any increased expenses, any loss of expected reimbursement, or the loss of anticipated profits which may occur as the results of the excessive underrun and excessive overrun.

5 However, when the final quantity of the item is less than 20% of the original Contract quantity of the item, the Excessive Underrun Formula is not applied, but instead a Change Order with a mutually accepted unit price is prepared as provided in **Subsections 104.2, 109.4, and 109.5.**

726.6.2 Removal and Disposal of Existing Overlays

1 Payment for the accepted quantity for Removal of Epoxy, Asphalt, and Foreign Overlay, measured in accordance with **Subsection 726.5.2**, is determined using the contract unit bid price for the pay item. Payment is full compensation for the complete removal and disposal of the overlay as specified or directed and includes all other materials, labor, equipment, tools, supplies,

transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

- 2 When a pay item for this work is not included in the Contract, the satisfactory removal and disposal of existing overlay is considered incidental to the overlay item.

726.6.3 Machine Preparation of Existing Surface

- 1 Payment for the accepted quantity for Machine Preparation of Existing Deck, measured in accordance with **Subsection 726.5.3**, is determined using the contract unit bid price for the pay item. Payment is full compensation for the machine preparation operation as specified or directed and includes removal and disposal of debris; dust control; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

726.6.4 Partial-Depth Removal of Unsound Concrete

- 1 Payment for the accepted quantity for Partial-Depth Removal of Unsound Concrete, measured in accordance with **Subsection 726.5.4**, is determined using the contract unit bid price for the pay item. Payment is full compensation for removing unsound concrete for the partial depth of the deck slab as specified or directed and includes removing sound concrete below a rebar exposed below its mid-point due to the removal of unsound concrete; removing and disposing of debris; dust control; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 The estimated quantities shown in the proposal for Partial-Depth Removal of Unsound Concrete is for bid purposes only. The actual amount of quantities is determined in the field by the RCE after completing the removal of concrete.

726.6.5 Concrete Class 4000 for Full-Depth Patching

- 1 Payment for the accepted quantity for Concrete Class 4000 for Full-Depth Patching, measured in accordance with **Subsection 726.5.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for furnishing and placing concrete for full depth patching of the deck as specified or directed and includes forming; providing and placing the specified concrete mix; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

726.6.6 Reinforcing Steel

- 1 Payment for providing and placing reinforcing steel in patched areas is in accordance with **Subsection 703.6**.

726.6.7 Blast Cleaning

- 1 Payment for the accepted quantity for Blast Cleaning, measured in accordance with **Subsection 726.5.7**, is determined using the contract unit bid price for the pay item. Payment is full compensation for the blast cleaning operation as specified or directed and includes removing and disposing of debris; dust control; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

726.6.8 Concrete Overlay (Latex) or (Portland Cement)

- 1 Payment for the accepted quantity for Concrete Overlay (Latex) or Concrete Overlay (Portland Cement), measured in accordance **Subsection 726.5.8**, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for installing the overlay as specified or directed and includes cleaning the deck surface; providing overlay materials; proportioning, mixing, placing, testing, curing, and texturing of the overlay; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Areas of concrete overlay found to be deficient in the attaining the minimum required compressive strength (4000 psi) by not more than 1000 psi are paid at an adjusted unit price determined as follows:

$$AP = CP \times (ACS / RCS)^2$$

Where

AP = Adjusted Unit Price

CP = Contract Unit Price

ACS = Actual Compressive Strength

RCS = Required Compressive Strength

- 3 The adjusted unit price as determined above is used as the contract unit price for further price adjustments due to deficiencies.
- 4 Areas of concrete overlay found to be deficient in attaining the minimum required compressive strength by more than 1000 psi are not eligible for payment and are removed at the Contractor's expense.
- 5 If the average thickness of the concrete overlay is deficient in the required thickness by not more than ½ inch, the overlay is paid for at an adjusted unit price determined by the following table:

Average Deficiency In Thickness (inches)	Adjusted Unit Price: Percent of Contract Unit Price
0	100.0
1/16	95.0
1/8	90.0
3/16	80.0
1/4	70.0
5/16	57.5
3/8	45.0
7/16	25.0
1/2	0.0

- 6 The adjusted unit price as determined above will be used as the contract unit price for further price adjustments due to deficiencies.
- 7 In determining the average thickness, thicknesses greater than the required thickness are entered as the required thickness, and thicknesses $\frac{1}{2}$ inch less than the required thickness are not used, because those areas are removed by the Contractor at no additional expense. Areas of overlay that are monolithic with partial depth patches are used in calculation of the average thickness.
- 8 At the Contractor's option, areas with a deficient compressive strength of less than 1000 psi or in average thickness of not more than $\frac{1}{2}$ inch may be removed and replaced with concrete overlay conforming to the specifications at no cost to the Department. Payment at the contract unit bid price is made for areas where the deficient overlay is removed and replaced with overlay meeting all requirements specified herein.
- 9 No additional payment is made for concrete overlay in excess of the specified thickness except as required to fill areas where partial depth removal of unsound concrete has been performed.
- 10 When it is determined by analysis that the proportion of latex in the overlay mix when discharged from the mixer is less than the specified amount, payment for the batch is made at an adjusted unit price determined by the following formula:

$$AP = CP \times (100 - 2 \times LD) / 100$$

Where

AP = Final Adjusted Price

CP = Contract Unit Price

LD = Latex Deficiency (percentage)

726.6.8**726.6.10**

- 11 If the proportion of latex in the overlay mix when discharged from the mixer is less than the specified amount by more than 20%, the batch is rejected for use. These provisions for a reduction in the unit price apply regardless of the readings of gauges or monitoring devices on the supply lines. No adjustment in the unit price is made for latex in excess of the minimum specified.
- 12 Payment for the accepted quantity at the contract unit price, adjusted as required, is full compensation for all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

726.6.9 Epoxy-Sand Slurry

- 1 Payment for the accepted quantity of Epoxy-Sand Slurry, measured in accordance with **Subsection 726.5.9**, is determined using the contract unit bid price for pay item. Payment is full compensation for providing placing epoxy-sand slurry as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

726.6.10 Pay Items

- 1 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Pay items under this section include the following:

Item No.	Pay Item	Unit
7260100	Removal of Epoxy, Asphalt, and Foreign Overlay	SY
7260200	Machine Preparation of Existing Surface	SY
7260300	Blast Cleaning	SY
7260400	Partial-Depth Removal of Unsound Concrete	SY
7260500	Concrete Overlay (Latex)	CY
7260600	Concrete Overlay (Portland Cement)	CY
7260700	Epoxy-Sand Slurry	SF
7260800	Concrete Class 4000 for Full-Depth Deck Patching	CY

SECTION 727

CROSSHOLE SONIC LOGGING OF DRILLED SHAFT FOUNDATIONS

727.1 Description

- 1 This section contains specifications for Crosshole Sonic Logging (CSL), which entails sending ultrasonic waves through a concrete drilled shaft foundation to inspect concrete quality. Department personnel or a Department designated representative will perform the CSL accordance with ASTM D 6760.

727.2 Materials

- 1 Provide Schedule 40 steel pipe for CSL testing access tubes.

727.3 Equipment

- 1 Use equipment furnished by the Department or a Department designated firm for CSL preparation and testing as outlined in ASTM D 6760.
- 2 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

727.4 Construction

727.4.1 Preparation

- 1 Perform CSL preparation in accordance with ASTM D 6760.
- 2 If the drilled shafts are constructed without access tubes or if the tubes are rendered unserviceable during shaft construction, core additional hole(s) at no additional expense to the Department.
- 3 The number of tubes to be installed depends on the shaft diameter. Generally, the distance between adjacent tubes is less than 30 inches. A minimum of 4 access tubes per shaft is required. Use the following table to determine the number of tubes:

Shaft Diameter	Number of Tubes Required	Configuration around the inside of a Circular Reinforcement Cage
36 to 48 inches	4	90 degrees apart
Greater than 48 inches	1 tube per 12 inches of shaft OD	(360 degrees / No. of tubes)

- 4 Inspect the access tubes prior to concreting to verify that water is not leaking from the joints or the bottom cap. If the access tubes are leaking, repair the leaking area prior to concreting and inform the RCE in writing of the loca-

tion of the problem area.

- 5 Provide an access platform for the Department's personnel to safely and adequately perform the CSL Testing.

727.4.2 Test Procedure

- 1 Department personnel will perform the CSL logging in accordance with ASTM D 6760 between 72 hours and 15 calendar days after shaft concrete placement contingent on the concrete having obtained a compressive strength of at least 3000 psi before any CSL logging is performed. Furnish information regarding the shaft, tube lengths and depths, construction dates, and other pertinent shaft installation observations or details to the RCE or the Department's designated testing representative at the time of testing. Prior to any scheduling of CSL tests, verify access tube lengths and their condition in the presence of the Department's personnel. If the access tubes do not provide access over the full length of the shaft, the Contractor may be required to repair the existing tube(s) or core additional hole(s) at no additional cost to the Department. The RCE will schedule the CSL test based on the timeframe in which the shaft meets the prerequisite requirements and the Contractor's schedule.
- 2 When shafts contain 4 tubes, the Department will test every possible tube combination. For shafts with 5 or more tubes, the Department will test all pairs of adjacent tubes around the perimeter and a limited number of tube pairs involving tubes that are not immediately adjacent to each other. During CSL testing, the RCE or the Department's designated testing representative will observe the results to obtain a preliminary evaluation of the shaft and to verify proper equipment function.

727.4.3 Evaluation of CSL Test Results

- 1 The BCE will evaluate the CSL test results, drilled shaft reports, and other field records to determine whether the drilled shaft construction is acceptable.
- 2 If the BCE determines that the drilled shaft is unacceptable based on the CSL tests, drilled shaft reports and other field records, core the shaft in accordance with **Subsection 727.4.4** to allow further evaluation of the shaft. Perform strength testing by an OMR approved AASHTO accredited laboratory on portions of the cores that exhibit questionable concrete or that were obtained from a questionable area of the shaft as determined by the BCE. The Contractor may request that additional CSL tests be performed or other testing methods used in place of or prior to coring subject to the written acceptance of the BCE. If the drilled shaft is proven defective, coring, strength testing, additional CSL testing, and/or other testing at the direction of the BCE is at no additional cost to the Department and no additional contract time is allowed. If no defect is found, the BCE will consider all reasonable costs for core drilling and testing, and an extension of contract time is considered if this work is proven critical to the work schedule.

727.4.4 Core Drilling of Drilled Shaft Concrete

- 1 At the direction of the BCE, take one or more cores from each unacceptable shaft for the full-depth of the shaft or to the depth directed by the BCE. The number and location of the cores will be determined by the BCE. Determine the diameter of the cores based on the core strength testing equipment of the lab used, but in no case allow the cores to exceed 4 inches.
- 2 The RCE will observe the coring operation and note all areas of questionable concrete in the extracted core. Keep an accurate log of cores and place the cores in a crate. Properly mark the shaft depth at each interval of core recovery. The RCE in consultation with the BCE will determine if the shaft is unacceptable based on the observations of the extracted core. If no significant visual defects are observed, sawcut strength test cores from the main core for testing. Cut the strength test cores at the locations directed by the RCE and transport the test cores to the independent lab for testing. Deliver the main cores in the crate, along with 5 copies of the coring log to the RCE.
- 3 If the drilled shaft CSL tests and corings indicate that the shaft is defective, the Contractor is responsible to improve such defective shafts to the satisfaction of the BCE. Such improvement may consist of, but is not limited to correcting defective portions of the shaft, providing straddle shafts to compensate for capacity loss or providing a replacement shaft.
- 4 Perform all corrective measures including re-design of bent caps caused by defective shafts to the satisfaction of the BCE with no additional time or cost to the Department.
- 5 After acceptance of production shafts by the BCE, remove all water from the test pipes or core holes and fill the pipes or core holes with a structural non-shrink grout approved by the BCE.

727.5 Measurement

- 1 There is no separate measurement for providing and installing CSL pipes, filling and removing the potable water from the CSL pipes, and grouting the CSL pipes for each drilled shaft and taking cores as directed by the RCE or BCE. The cost of this work is included in the contract unit bid price for the drilled shaft in which it they are placed.
- 2 The quantity for the item Crosshole Sonic Logging Set-Up is measured by each (EA) platform set-up, complete, and accepted.

726.6 Payment

- 1 Payment for the accepted quantity for Crosshole Sonic Logging Set-Up, measured in accordance with **Subsection 727.5**, is determined using the contract unit bid price for the pay item. Payment is full compensation for providing an access platform for the Department personnel to safely and adequately perform the CSL testing and preparation of the CSL conduits required to conduct the testing on a drilled shaft as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and inci-

727.6

727.6

dentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

2 Payment includes all direct and indirect costs and expenses necessary to complete the work.

3 Pay items under this section include the following:

Item No.	Pay Item	Unit
7270010	Crosshole Sonic Logging Set-Up	EA

SECTION 728

TEMPORARY DETOUR BRIDGES

728.1 Description

- 1 This section contains specifications for construction of temporary detour bridges, which includes providing design calculations and Working Drawings and furnishing all necessary members and materials required to construct, maintain, and remove them. Approaches to temporary detour bridge(s) are not a part of this work.

728.1.1 Design Requirements

- 1 Design the temporary detour bridge(s) for live load in accordance with the requirements of the AASHTO *LRFD Bridge Design Specifications*. Unless others required by the Plans or the Special provisions, a detailed seismic analysis is not required. Ensure that all design calculations and drawings are signed and sealed by a South Carolina registered Professional Engineer.
- 2 The use of timber floors or timber mat floors for final riding surface is not permitted.
- 3 Do not reuse high strength bolts, nuts, and washers that have been previously used and removed.
- 4 Design the bridge rails in accordance with the requirements of the current edition of the AASHTO *LRFD Bridge Design Specifications* and construct the Thrie beam bridge connectors so that they can be bolted to the ends of the bridge rails.
- 5 Make certain the foundation design includes, but is not limited to: pile bearing calculations, stress analysis of the pile as a structural member, dynamic pile driving analysis (GRL WEAP© output, etc.), and axial and lateral stability analysis of the pile bents. Also, utilize the existing soil borings for the new bridge(s) in the foundation design of the temporary detour bridge(s) if applicable.
- 6 Develop and provide to the BDGE pile driving criteria that as a minimum, includes an ultimate bearing graph. It is the Designer's responsibility to approve the pile driving system and pile lengths for the detour bridge(s) and to provide the BDGE with documentation of the approval.
- 7 For stream crossings, determine the pile stability assuming a scour depth equal to 250% of the pile diameter or width below the existing bed elevation. Furnish a more detailed analysis of scour depth to the BDGE for pile bents containing more than a single row of piles. Design piles assuming a minimum geotechnical factor of safety equal to 2.0.
- 8 Design and install the span over the mainstream channel to match at least the span length of the existing bridge. Design and install a bridge with a length at least equal to the existing bridge length unless otherwise specified

on the bridge Plans.

- 9 Ensure that the detailed Working Drawings of the structure include material specifications for all new and used materials. In addition make certain the drawings show the location and a detailed sketch of the used materials indicating condition of the material, the location and geometry of existing but unused holes, attachments left over from previous use and any other irregularities in the material.
- 10 Ensure that the design calculations reflect the condition of any used materials. Prior to assembly, provide access to used materials for inspection by the RCE.
- 11 Submit 3 sets of design calculations and 7 sets of Working Drawings to the BDE or Design Consultant as appropriate, and as a minimum, include stress calculations for the following structural components: railings, rail post, rail post connections, deck or flooring, main girders or floor beam system, bent cap, and foundation design as defined above. Ensure that design calculations and Working Drawings comply with **Subsection 725.1.2**.
- 12 Consider additional impact loads on the end of the bridge due to potential settlement of the approaches.

728.2 Materials

728.2.1 Piling

728.2.1.1 General

- 1 The Contractor may elect to use timber piling, prestressed concrete piling, steel H-piling, or steel pipe piling in conformance with these specifications.

728.2.1.2 Timber Piling

- 1 Ensure that timber piling is new and conforms to the requirements of ASTM D 25 and **Sections 706** and **707** of these specifications except as hereinafter specified. When timber piling are utilized, use treated timber piling in Zone A. Treated or untreated timber piling may be utilized in Zone B. Zone A consists of Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry, and Jasper Counties. Zone B consists of all counties not included in Zone A.
- 2 Use timber piling with an average rate of growth measured in the outer 50% of the radius at the pile tip of not less than 6 rings per inch and have an average summerwood content of not less than 33.3% in the outer 50% of the tip radius. Exception: piles with less than 6 rings per inch are acceptable if the average is 50% or more summerwood present in the outer 50% of the tip radius. Ensure that timber piling complies with the design requirements of **Subsection 728.1.1**.

728.2.1.3 Prestressed Concrete Piling

- 1 Prestressed concrete piling may be new or used piling. Ensure that new prestressed concrete piling complies with **Section 704**. Make certain previously used prestressed concrete piling is in good condition, structurally sound

and suitable for the intended use. Ensure that the prestressed concrete piling complies with the design requirements of **Subsection 728.1.1**.

728.2.1.4 Steel Piling

- 1 Steel H piling and steel pipe piling may be new or used piling. Ensure that new steel piling complies with **Subsection 711.2**. Make certain previously used steel piling is in good condition, structurally sound and suitable for the intended use. Ensure that the steel piling complies with the design requirements of **Subsection 728.1.1**.

728.2.2 Other Construction Materials

- 1 Ensure that all other new materials used in the construction of the temporary detour bridge(s) comply with the applicable sections of these specifications. Make certain all other previously used materials are in good condition, structurally sound and suitable for the intended use. Ensure that the materials comply with the design requirements of **Subsection 728.1.1**.

728.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

728.4 Construction

728.4.1 General

- 1 Construct temporary detour bridge(s) according to the width, length, and at the location shown on the Plans. The bridge width is the clear distance between curbs. Determine and provide the additional width necessary to construct barrier rails, sidewalk, or other items shown on the Plans or required by specifications. Construct the bridge to the alignment and grade indicated on the Roadway Plans. Do not allow the low chord elevation of the detour bridge(s) to encroach below the low chord elevation of the corresponding existing bridge(s) or as shown in the Plans or as approved by the BCE.

728.4.2 Bridge Deck Finishing and Rideability

- 1 Ensure that bridge deck finishing and rideability comply with the requirements of **Subsections 702.4.12** and **702.4.14**.

728.4.3 Bridge Removal

- 1 Remove the temporary detour bridge(s) in accordance with **Subsection 202.4.2** as applicable. After removal, the temporary detour bridge(s) become the property of the Contractor.

728.5 Measurement

- 1 The work for Temporary Detour Bridge is paid on a lump sum (LS) basis; and therefore, there is not a specific measurement of quantities.

728.5

728.6

- 2 The approach fills are not a part of work under this section and are measured and paid for in other items of work.

728.6 Payment

- 1 Payment for Temporary Detour Bridge is determined using the contract lump sum bid price for the pay item. Payment is full compensation for constructing temporary detour bridges as specified or directed and includes all costs for design, drawings, submittals, construction, maintenance, and complete removal and disposal of the detour bridge, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 2 Payment for this item includes all direct and indirect costs and expenses necessary to complete the work.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
7280010	Temporary Detour Bridge No. <u>(XX)</u>	LS

DIVISION 800
INCIDENTAL CONSTRUCTION
SECTION 801
AGGREGATE UNDERDRAINS

801.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the construction of aggregate underdrains using granular filter materials in conformity with the Plans and the Specifications or as directed by the RCE.

801.2 Materials

801.2.1 Coarse Aggregate

- 1 Use crushed stone, gravel, slag, recycled glass aggregate, or tire chips that meet the gradation requirements of Coarse Aggregate No. 57 as provided in the Appendix. Do not use slag and recycled glass with more than 60% abrasion loss when tested according to AASHTO T 96. Testing for abrasion loss is not required for tire chips. Use aggregate obtained from sources listed on the most recent edition of *SCDOT Qualified Product List 2*.
- 2 Use recycled glass aggregate that is free of organic and toxic materials, hypodermic needles, and other hazardous materials. Make certain that it meets SCDHEC regulations as a non-hazardous material. Do not use recycled glass aggregate with more than 1% impurities (non-glassy materials) by dry weight of the glass aggregate. Do not use glass aggregate with lead or silver content exceeding 5 ppm. Make certain that the aggregate meets the limits established by the EPA for primary and secondary drinking water standards. Before placing any glass on projects, furnish the RCE certified test results from the glass supplier showing that the glass meets the requirements of this specification. Ensure that the tests were completed less than one year before placement of the aggregate.
- 3 Use tire chips that are dry, clean, and free of grease, oil, and any other contaminant that could leach into groundwater or aid in starting a fire. Use tire chips that are free of wood fragments, wood chips, fibrous organic matter, and residue of burned tires. Use tire chips that have at least one sidewall detached and that are generated from whole tires shredded with shear-shredding equipment. The Hammermill process is not acceptable. Use tire as subgrade material with not more than 1%, by weight, of free steel (metal fragments not attached to rubber) in its composition. Do not use tire chips in which more than 75% of the pieces have metal partially embedded in the tire rubber and extending more than 1 inch from the cut edge of a chip. Do not use any chips that have metal partially embedded in the tire rubber and extending more than 2 inches from the cut edge of a chip.

801.2.2 Fine Aggregate

- 1 When used as fine aggregate underdrain material, use fine aggregate that is porous and free of clay lumps, humus, and other objectionable material and meets the gradation requirements for FA-12 or FA-13 provided in the Appendix.
- 2 If recycled glass aggregate or tire chips are used for fine aggregate underdrain material, ensure that they meet the quality requirements in **Subsection 801.2.1** and the gradation requirements for Aggregate No. FA-12 or FA-13 provided in the Appendix. Except for glass or tire chips, use aggregate obtained from sources listed on the most recent edition of *SCDOT Qualified Product List 1*.

801.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

801.4 Construction**801.4.1 General**

- 1 Excavate a 12-inch wide trench to the required depth. Finish the bottom of the trench to the grade directed by the RCE and with a gradient of at least $\frac{1}{2}$ inch in 10 feet. If necessary, tamp to ensure that it is smooth and firm.

801.4.2 Transverse Drains

- 1 When aggregate underdrains are constructed as a transverse drain for removing water from porous foundation courses, extend the aggregate to the bottom of the porous foundation material. Place and compact the aggregate backfill to a depth of 6 inches unless directed otherwise by the RCE.

801.4.3 Longitudinal Drains

- 1 When aggregate underdrains are used as longitudinal drains or at other locations determined necessary by the RCE, excavate a 12-inch wide trench to a depth directed by the RCE.

801.4.4 Backfill

- 1 Fill the remainder of trenches not filled with aggregate with suitable earth material and thoroughly compact in 4-inch layers. Provide suitable outlets and protect with small dry stone box openings. Maintain the outlets such that they function properly at all times.
- 2 When recycled glass or tire chips are used as the underdrain aggregate, cover with a minimum of 6 inches of mineral aggregate or suitable earth material and thoroughly compact to ensure that glass or tire chips are not exposed.

801.4.5 Aggregate Underdrain above Pipe Underdrain

- 1 When an aggregate underdrain is constructed above a pipe underdrain in accordance with **Section 802**, make the width of the aggregate underdrain the same width as the pipe underdrain.

801.5 Measurement

- 1 The quantity for the pay item Aggregate Underdrain is the quantity of aggregate underdrain, measured as specified in the Contract by either the linear foot (LF) along the top centerline of the underdrain or the cubic yard (CY) of aggregate in the drain, complete, and accepted. When an aggregate underdrain is authorized for placement in excess of a 6-inch depth, it is measured by the linear foot (LF) and directly proportioned to a 6-inch deep underdrain.
- 2 If it is necessary to place the bottom of the aggregate underdrain either more than 24 inches below the subgrade or below the cross-section lines to which the roadway is graded or more than 24 inches below the ground surface when the drain is constructed outside of the roadway lines, the excavation in excess of 24 inches is measured as Unclassified Excavation in accordance with the provisions of **Subsection 203.5**.

- 3 The stone box outlets are included in the measurement of the quantity for Aggregate Underdrain.

801.6 Payment

- 1 Payment for the accepted quantity for Aggregate Underdrain (Aggregate No. XXX), measured in accordance with **Subsection 801.5**, is determined using the contract unit bid price for the applicable pay item, and the payment includes all direct and indirect costs and expenses required to complete the work.
- 2 Payment for Aggregate Underdrain (Aggregate No. XXX) is full compensation for constructing aggregate underdrains as specified or directed and includes excavating the trench (except that specified beyond 24 inches); hauling and placing aggregate; backfilling or disposing of excavated materials; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 The additional excavation for underdrains beyond 24 inches is paid for as Unclassified Excavation in accordance with **Subsection 203.6**. If Unclassified Excavation is not included in the Contract, the excavation is considered incidental work for the aggregate underdrain and is not paid for separately.

- 4 Pay items under this section include the following:

Item No.	Pay Item	Unit
8011100	Aggregate Underdrain (Aggregate No. 789)	LF

(table continued on the next page)

(table continued from previous page)

Item No.	Pay Item	Unit
8011200	Aggregate Underdrain (Aggregate No. 789)	CY
8011300	Aggregate Underdrain (Aggregate No. 57)	LF
8011400	Aggregate Underdrain (Aggregate No. 57)	CY
8011650	Aggregate Underdrain (Aggregate No. FA-12)	LF
8011655	Aggregate Underdrain (Aggregate No. FA-12)	CY
8011750	Aggregate Underdrain (Aggregate No. FA-13)	LF
8011755	Aggregate Underdrain (Aggregate No. FA-13)	CY

SECTION 802

PIPE UNDERDRAINS

802.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the construction of underdrains using pipe and granular filter material and the construction of underdrain pipe outlets in conformity with the Plans and the Specifications or as directed by the RCE.

802.2 Materials

802.2.1 Pipe Underdrain

802.2.1.1 Corrugated Polyethylene Pipe Underdrain

- 1 Provide pipe meeting the requirements of AASHTO M 252 for corrugated polyethylene pipe.

802.2.1.2 Perforated Corrugated Aluminum Alloy Pipe Underdrain

- 1 Provide pipe meeting the requirements of AASHTO M 196 for Type III corrugated aluminum alloy underdrains.

802.2.1.3 Polyvinyl Chloride (PVC) Pipe Underdrain

- 1 Provide PVC pipe meeting the requirements of AASHTO M 278, Class PS 46, cell classification 12454-B as defined in ASTM D 1734, **or** pipe meeting the requirements of ASTM D 3034, SR 35.

802.2.1.4 Polyethylene (PE) Pipe Underdrain

- 1 In all underdrain applications under **Section 802**, polyethylene pipe may be substituted where PVC PS 46 pipe is specified. Ensure that the polyethylene pipe meets AASHTO M 252 with the following exceptions:
- A. Corrugated polyethylene pipe underdrain, in nominal sizes of 4 inches through 10 inches, having a full circular cross-section with an outer corrugated pipe wall and smooth inner liner as specified in AASHTO M 294, Section 4.1.2 – Type S for non-perforated or Section 4.1.4 – Type SP for perforated pipe as specified in the Plans.
 - B. Polyethylene pipe underdrain meeting the minimum pipe stiffness (PS) of AASHTO M 278 at 5% deflection when tested in accordance with ASTM D 2412.
 - C. Acceptance of polyethylene pipe underdrain is based on conformance with the above specifications. Sampling of the pipe is in accordance with the *SCDOT Construction Manual*.

802.2.2 Aggregate Fill

- 1 Use coarse aggregate No. 57 consisting of crushed stone, crushed slag, or gravel conforming to the requirements of **Subsection 801.2.1**.

802.2.3 Material for Endwalls

- 1 Use Class 2500 or Class 3000 concrete conforming to the requirements of the applicable subsections of **Section 701** and reinforcing steel conforming to the requirements of the applicable subsections of **Section 703**.

802.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

802.4 Construction**802.4.1 General**

- 1 Excavate trenches for pipe underdrains to a width equal to the outside diameter of the pipe plus 8 inches and to a depth required to permit the pipe to be laid to the desired grade. Where the underdrains are placed in cut sections, place the bottom of the trench at a sufficient depth below the side ditch or median ditch to adequately intercept the water.
- 2 Place and tamp a layer of coarse aggregate No. 57 in the bottom of the trench to a depth of 4 inches. Place the pipe in the center of the trench and bed it firmly on the course of aggregate. If bell and spigot type pipe is used, lay the bell end upgrade. Lay perforated pipe with the perforations on the underside of the pipe, except when the pipe is being used strictly for outlet purposes in which case, lay the pipe with the perforations on the upper side of the pipe. Cover the joints of butt-end drain tile with burlap, roofing paper, or other approved material that is not less than 6 inches in width, is of sufficient length to wrap the entire joint, covers at least 3 inches on each section of pipe turns outward, and lays flat on the bedding course of stone. Lay bell and spigot or tongue and groove pipe without mortar in joints and press the lengths firmly together to prevent infiltration of the aggregate. Join lengths of perforated metal pipe, aluminum alloy pipe, or bituminous-fiber pipe with couplers. Make connections with suitable tee, wye, bend, reducer, or increaser specials as required. Cap or plug the upgrade end in a satisfactory manner if not terminating in a structure.
- 3 After the pipe has been laid, inspected, and approved, place coarse aggregate No. 57 around the pipe. Place the aggregate to provide a minimum cover of 4 inches above the top of the pipe, but not less than a minimum depth of 20 inches above the bottom of the pipe. Do not disturb the pipe when placing the aggregate. Fill the remainder of the trench with suitable earth or when directed by the RCE, use aggregate instead of earth backfill. Compact the backfill material in 4-inch layers. Construct in accordance with **Subsection 801.4**.

802.4.2 Pipe Outlets

- 1 Construct pipe outlets and protect with endwalls as directed by the RCE. Use the same type outlet pipe as in the underdrain or, if indicated, use a bell and spigot pipe meeting the requirements specified herein. In all cases, connect the outlet pipe joints and seal in accordance with applicable subsections of **Section 714** or connect and seal with materials recommended by the pipe manufacturer.
- 2 Instead of aggregate, fill the trench for pipe outlets with suitable earth material approved by the RCE. Place and compact the earth material in 4-inch layers. Construct endwalls for pipe outlets of Class 2500 or Class 3000 concrete and reinforcing, as specified or directed by the RCE, in accordance with applicable subsections of **Sections 701, 702, and 703**.

802.5 Measurement

- 1 The quantity for the pay item Pipe Underdrain (of the type and size required) is the length of pipe underdrain constructed as specified in-place and is measured by the linear foot (LF) along the centerline of pipe underdrain, complete, and accepted.
- 2 When construction of an endwall is required, the quantity of concrete is measured in accordance with **Subsection 701.5**. If required and unless otherwise specified, the quantity of reinforcing steel is measured in accordance with **Subsection 703.5**. If these items are not included in the Contract, the concrete and reinforcing steel are considered as incidental work for the pipe underdrain and are not measured separately.
- 3 If it is necessary to place the bottom of the pipe underdrain more than 36 inches below the subgrade or below the cross-section lines to which the roadway is graded or more than 36 inches below the ground surface when the drain is constructed outside the roadway lines, the quantity of the excavation in excess of 36 inches is measured as Unclassified Excavation in accordance with the provisions of **Subsection 203.5**.

802.6 Payment

- 1 Payment for the accepted quantity for Pipe Underdrain (of the type and size required), measured in accordance with **Subsection 802.5**, is determined using the contract unit bid price for the applicable pay item, and the payment includes all direct and indirect costs and expenses required to complete the work.
- 2 Payment for Pipe Underdrain (of the type and size required) is full compensation for constructing pipe underdrains as specified or directed and includes excavating the trench (except that specified beyond 36 inches); furnishing, hauling, and placing the pipe, aggregate, incidental concrete, wyes, tees, bends, joints, bands and coupling, outlets, and other connections; backfilling and tamping; disposing of surplus materials; and all other materials labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifica-

tions, and other terms of the Contract.

- 3 Unless otherwise indicated, the concrete for construction of endwalls is paid as Concrete Class 2500 or Concrete Class 3000 in accordance with **Subsection 701.6**. If the concrete pay item is not included in the Contract, the concrete is considered incidental work for the pipe underdrain, and no separate payment is made for such work.
- 4 Unless otherwise indicated, reinforcing steel incorporated in endwalls is paid for using the contract unit bid price for Reinforcing Steel for Structures (Roadway) as specified in **Subsection 703.6**. If this item is not included in the Contract, the reinforcing steel is considered incidental work for the pipe underdrain, and no separate payment is made for such work.
- 5 Pay items under this section include the following:

Item No.	Pay Item	Unit
8021104	4" Pipe Underdrain	LF
8021106	6" Pipe Underdrain	LF
8021108	8" Pipe Underdrain	LF
8021110	10" Pipe Underdrain	LF
8021112	12" Pipe Underdrain	LF
8021204	4" Perforated Pipe Underdrain	LF
8021206	6" Perforated Pipe Underdrain	LF
8021208	8" Perforated Pipe Underdrain	LF
8021210	10" Perforated Pipe Underdrain	LF
8021212	12" Perforated Pipe Underdrain	LF
8021804	4" Perforated Corrugated Aluminum Alloy Pipe Underdrain	LF
8021806	6" Perforated Corrugated Aluminum Alloy Pipe Underdrain	LF
8021808	8" Perforated Corrugated Aluminum Alloy Pipe Underdrain	LF
8021904	4" Polyvinyl Chloride (PVC) Pipe Underdrain	LF
8021906	6" Polyvinyl Chloride (PVC) Pipe Underdrain	LF
8021908	8" Polyvinyl Chloride (PVC) Pipe Underdrain	LF
8021910	10" Polyvinyl Chloride (PVC) Pipe Underdrain	LF

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802.6

802.6

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Item No.	Pay Item	Unit
8022040	4" Corrugated Polyethylene Underdrain	LF
8022060	6" Corrugated Polyethylene Underdrain	LF
8022080	8" Corrugated Polyethylene Underdrain	LF

SECTION 803

PIPE SLOPE DRAINS

803.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the construction of temporary or permanent intake spillway assemblies and pipe slope drains constructed on the shoulders, slopes, and at other designated locations in conformity with the Plans and the Specifications or as directed by the RCE.

803.2 Materials

803.2.1 Permanent Installations

803.2.1.1 Corrugated Aluminum Alloy Pipe (CAAP)

- 1 Provide corrugated aluminum alloy pipe (CAAP) conforming to the requirements of AASHTO M 196 for Type I culvert pipe.

803.2.1.2 Class PS 46 Polyvinyl Chloride (PVC) Pipe

- 1 Provide polyvinyl chloride (PVC) pipe conforming to the requirements of AASHTO M 278, Class PS 46, cell classification 12454-B as defined in ASTM D 1784, or pipe conforming to the requirements of ASTM D 3034, SR 35.

803.2.1.3 Metal Intake Spillway Assembly

- 1 Fabricate metal intake spillway assembly from aluminum conforming to the requirements of AASHTO M 196.

803.2.1.4 Corrugated High Density Polyethylene (HDPE) Pipe

- 1 For up to 10-inch diameter pipe slope drains only, use corrugated high density polyethylene (HDPE) pipe conforming to the requirements of AASHTO M 252. Larger sizes of HDPE pipe are not recommended for permanent slope drain. Furnish certification from the manufacturer with each shipment stating that the pipe meets the required specifications.

803.2.2 Temporary Installations

803.2.2.1 General

- 1 All materials acceptable for use in permanent installations are permitted for temporary installations in addition to the following:

803.2.2.2 Corrugated Steel Pipe (CSP)

- 1 Use corrugated steel pipe (CSP) meeting the requirements of AASHTO M 36.

803.2.2.3 Corrugated High Density Polyethylene (HDPE) Pipe

- 1 Use corrugated high density polyethylene (HDPE) pipe conforming to the requirements of AASHTO M 294 Type C or Type S.

803.2.2.4 Metal Intake Spillway Assembly

- 1 Fabricate metal intake spillway assembly from steel conforming to the requirements of AASHTO M 218.

803.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

803.4 Construction

- 1 Construct pipe slope drains and intake assemblies in conformance with details on the Plans and at locations designated by the RCE. Lay the pipe and perform all construction in accordance with all applicable provisions and requirements stipulated in the applicable subsections of **Section 714**. Clamp the pipe joints together with bands or couplings with gaskets so that separation is prevented and the connections are watertight for all permanent and temporary pipe slope drains.
- 2 Install intake assemblies that function properly and efficiently. Prevent water from percolating under or around them.
- 3 When an intake assembly is not used in conjunction with the installation of a pipe slope drain, pave the area around and in front of the inlet with approved asphalt surfacing to prevent erosion and undermining of the entrance pipe. The pipe forming the entrance may be field cut when necessary to provide a satisfactory entrance.

803.5 Measurement**803.5.1 Permanent Installations**

- 1 The quantity for the pay item Pipe Slope Drain (of the diameter specified) is the length of the pipe slope drain constructed as specified and is measured by the linear foot (LF) along the centerline of the pipe slope drain in-place, complete, and accepted.
- 2 The quantity for Intake Spillway Assembly is measured by each (EA) assembly in-place, complete, and accepted.
- 3 No measurement is made for excavation and backfilling necessary for the construction and installation of the above items. This work is considered incidental to the pipe slope drain work, and no separate measurement is made.

803.5.2 Temporary Installations

- 1 Measurement for temporary installations that are shown on the plans is the same as for permanent installations. No measurement is made for temporary installations that are not shown on the plans.

803.6 Payment**803.6 Permanent Installations**

- 1 Payment for the accepted quantity for Pipe Slope Drain (of the diameter specified) or Metal Intake Spillway Assembly, measured in accordance with **Subsection 803.5**, is determined using the contract unit bid price for the applicable pay item, and the payment includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Payment for Pipe Slope Drain (of the diameter specified) is full compensation for constructing pipe slope drains as specified or directed and includes furnishing, hauling, and placing the pipe, bends, elbows, bands couplings etc.; excavating and backfilling; making connections; disposing of surplus materials; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for Metal Intake Spillway Assembly is full compensation for furnishing and installing the metal intake spill way assembly as specified of directed and includes excavating and backfilling; making connections; disposing of surplus materials; and all other materials, labor, equipment, tools, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

803.6.2 Temporary Installations

- 1 Payment for temporary installations that are shown on the plans is the same as for permanent installations with the exception that payment for temporary installations includes payment for removal of the installation and restoration of the area involved, as necessary. No payment is made for temporary installations that are not shown on the plans.
- 2 Pay items under this section include the following:

Item No.	Pay Item	Unit
8034060	6" Pipe Slope Drain	LF
8034060	8" Pipe Slope Drain	LF
8034100	10" Pipe Slope Drain	LF
8034120	12" Pipe Slope Drain	LF
8034150	15" Pipe Slope Drain	LF
8034180	18" Pipe Slope Drain	LF
8035000	Metal Intake Spillway Assembly	EA

SECTION 804

RIPRAP AND SLOPE PROTECTION

804.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the construction of the protective layer of broken stone or concrete (grouted or ungrouted), bagged sand and cement, polyvinyl chloride (PVC) coated wire enclosed rock gabions, precast concrete units, or concrete slope protection in conformity with the Plans and the Specifications or as directed by the RCE.

804.2 Materials

804.2.1 Stone for Riprap

- 1 Provide hard quarry stone or fieldstone that does not disintegrate on exposure to water or weathering. Ensure that stone has a sodium sulfate content less than or equal to 15% as tested in accordance with AASHTO T 104. Use stone that is suitable in all respects for the purpose intended and obtained from a source listed on the most recent edition of *SCDOT Qualified Product List 2*.
- 2 Provide well graded stone with test samples falling between the gradation limits for riprap shown in the following table.

Stone Size Range (feet)	Stone Weight Range (pounds)	Percent Smaller Than
1.4 D ₅₀ to 1.6 D ₅₀	3.0 W ₅₀ to 5.0 W ₅₀	100
1.14 D ₅₀ to 1.33 D ₅₀	2.0 W ₅₀ to 2.75 W ₅₀	85
0.95 D ₅₀ to 1.09 D ₅₀	1.0 W ₅₀ to 1.5 W ₅₀	50
0.38 D ₅₀ to 0.57 D ₅₀	0.1 W ₅₀ to 0.2 W ₅₀	15

- 3 Provide riprap conforming to the gradation classes in the following table.

Riprap Class	Rock Size (Feet)	Rock Size ⁽²⁾ (Lbs.)	Percent of Riprap Smaller Than
A	0.75	37	100
	0.50	11	50
	0.20	0.7	15

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Riprap Class	Rock Size (Feet)	Rock Size(2) (Lbs.)	Percent of Riprap Smaller Than
B(1)	1.33	200	100
	1.0	75	85
	0.75	37	50
	0.42	5	10
C(1)	1.80	500	100
	1.30	200	50
	0.40	5	10
D(1)	2.25	1000	100
	1.80	500	50
	0.95	75	10
E(1)	2.85	2000	100
	2.25	1000	50
	1.80	500	5
F(1)	3.60	4000	100
	2.85	2000	50
	2.25	1000	5
(1) Based on AASHTO Gradations			
(2) Specific Gravity > 2.6			

804.2.2 Stone for Foundation Riprap

- 1 Provide stone pieces for the protection of foundations, piers, abutments, and walls ranging in weight from a minimum of 25 pounds to a maximum of 250 pounds. Ensure that at least 60% of the stone pieces weigh more than 150 pounds.

804.2.3 Concrete for Riprap

- 1 With written approval from the RCE, broken concrete may be used in lieu of stone for hand placed riprap. If approved, use acceptable concrete broken into proper size pieces, having no exposed reinforcing steel, and meeting the requirements as specified in these specifications.

804.2.4 Bagged Sand-Cement Riprap**804.2.4.1 Bags**

804.2.4.1

804.2.7.2

- 1 Provide bags with a capacity of 1 to 2 cubic feet and made of burlap or other approved material. The RCE will approve bag sizes before use.

804.2.4.2 Sand

- 1 Provide sand conforming to the requirements of **Subsection 701.2.9**.

804.2.4.3 Portland Cement

- 1 Provide Portland cement conforming to the requirements set forth in **Subsection 701.2.1**.

804.2.5 Grouted Riprap

- 1 Provide riprap conforming to the requirements of Class B Riprap specified in **Subsection 804.2.1**.
- 2 Use grout consisting of one part Portland cement conforming to the requirements of **Subsection 804.2.4.3** and three parts sand conforming to the requirements set forth in **Subsection 804.2**. Adjust water content of the grout to permit gravity flow into the voids with limited spading and brooming.

804.2.6 Precast Concrete Riprap

- 1 Provide precast concrete riprap consisting of unreinforced Portland cement concrete units of the thickness specified and conforming to the details shown on the Plans. Use concrete for precast riprap that conforms to the requirement for Class 2500 concrete specified in **Section 701**.

804.2.7 Polyvinyl Chloride (PVC) Coated Wire-Enclosed Gabions

804.2.7.1 General

- 1 Provide gabions consisting of baskets fabricated from PVC coated galvanized wire mesh, filled with stone, connected together, and anchored to the slope or channel bottom. Ensure that the materials in the finished gabion meet the requirements of **Subsections 804.2.7.2 through 804.2.7.5**.

804.2.7.2 Polyvinyl Chloride (PVC) Coated Wire

- 1 Ensure that the wire mesh in the gabions has the physical properties shown in the following table.

Physical Property	Gabion Wire
Wire Diameter (gauge)	12 gauge (0.105 inch)
Tensile Strength of Wire	60,000 psi
Mesh openings	3 inches X 3 inches
Galvanizing	In accordance with ASTM A 641, Class 3
PVC Coating	gray color, 0.015 inch thick min.
Lacing Wire diameter (gauge)	13.5 gauge (0.087 inch)

Spiral Binder diameter (gauge)	12 gauge (0.105 inch)
--------------------------------	-----------------------

- 2 Ensure that the longitudinal and transverse members of the wire mesh are securely connected at each intersection and substantially form square or rectangular openings. Ensure that the PVC coating of the wire mesh is accomplished after fabrication of the mesh.
- 3 Ensure that the PVC coating is resistant to the destructive effects of immersion in acidic, salt, or polluted water, exposure to ultraviolet light, and abrasion and retain these resistant characteristics after a period of not less than 3000 hours under tests in accordance with ASTM G 23.

804.2.7.3 Rock

- 1 Provide rock, to fill the PVC coated wire units, that meets the requirements of **Subsection 804.2.1**. Ensure that the rock is well graded and that the smallest dimension of 70% of rock, by weight, exceeds the wire mesh openings. Ensure that the maximum rock size, measured normal to the slope, does not exceed the thickness of the gabion.

804.2.7.4 Lacing Wire, Spiral Binder Wire, and Stiffeners

- 1 Provide lacing wire and spiral binder wire, which are used to assemble, interconnect, and close the gabion units, have the same PVC coating as the wire mesh. Provide stiffeners for support by providing diagonal braces having the same PVC coating as on the wire mesh.

804.2.7.5 Geotextile Fabric

- 1 Provide geotextile fabric in conformance with **Subsection 804.2.11**.

804.2.8 Polyvinyl Chloride Coated Wire-Enclosed Rock Mattresses

- 1 Provide PVC coated wire-enclosed rock mattresses conforming to the requirements of **Subsection 804.2.7**.

804.2.9 Cast-in-Place Concrete Slope Protection

- 1 Provide cast-in-place concrete for slope protection conforming to the requirements for Class 2500 concrete specified in the applicable subsections of **Section 701**.

804.2.10 Fiber Reinforced Concrete Slope Protection

- 1 Provide fiber reinforced concrete for slope protection conforming to the requirements of ASTM C 94, ASTM C 1116, ASTM C 1018, and ASTM E 119 and having the following characteristics:
- Chemical. Use fiber reinforcement that is virgin polypropylene and is inert to alkali and chemical attack. Do not use fiberglass or polyester-based fibers.
 - Physical. Use the fibrillated twisted-bundle form for reinforcement. Do not use monofilament or untwisted fibers.
 - Length. Base the minimum fibrous length on the top-size coarse ag-

gregate – Multi-Design Gradation.

804.2.11 Geotextile Fabric for Erosion Control Under Riprap

- 1 Provide an engineered fabric capable of reducing soil erosion. Use fabrics appearing on the most recent edition of *SCDOT Qualified Product List 44*. Submit the manufacturer’s literature concerning the proposed product and proof of satisfactory performance to the RCE before use.
- 2 Provide geotextiles for erosion control under riprap applications that conform to the physical requirements in the following tables.

Strength Property Requirements (All Fabrics)		
Property	Class 1 Fabric Protected*	Class 2 Fabric Unprotected
Grab Strength ASTM D 4632	90 lbs.	200 lbs.
Seam Strength** ASTM D 4632	80 lbs.	180 lbs.
Puncture Strength ASTM D 4833	40 lbs.	80 lbs.
Burst Strength ASTM D 3786	140 psi	250 psi
Trapezoid Tear Strength ASTM D 4533	40 lbs.	80 lbs.
Elongation at Failure ASTM D 4632	15% minimum	15% minimum
Ultraviolet Degrada- tion at 500 Hours ASTM D 4355	50% Strength Retained	50% Strength Retained
<p>* Fabric is protected when cushioned from rock placement by a sufficient layer of sand or gravel at least 6 inches thick or by zero height of placement. All other conditions are unprotected.</p> <p>** Values apply to both field and manufactured seams. Sew seams upwards for inspection.</p>		

Piping Resistance (Soil Retention) & Permittivity Requirements		
Type	AOS (ASTM D 4751)	Permittivity (ASTM D 4491)
Type A	≥ No. 30 Std Sieve	≥ 0.7 per sec
Type B	≥ No. 40 Std Sieve	≥ 0.2 per sec

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Piping Resistance (Soil Retention) & Permittivity Requirements		
Type	AOS (ASTM D 4751)	Permittivity (ASTM D 4491)
Type C	≥ No. 60 Std Sieve	≥ 0.1 per sec
Type D	AOS and fabric permittivity requirements are based on site specific design and are indicated in the Special Provisions.	

- 3 Unless otherwise specified, use Type A fabric for soils with less than 15% particles, by weight, passing the No. 200 sieve.
- 4 Unless otherwise specified, use Type B fabric for soils with 15% to 50% particles, by weight, passing the No. 200 sieve.
- 5 Unless otherwise specified, use Type C fabric for soils with more than 50% particles, by weight, passing the No. 200 sieve.
- 6 Unless otherwise specified, use Type D fabric for Critical/Severe Applications.

804.2.12 Granular Filter

- 1 When specified on the Plans, provide granular filter instead of geotextile filter fabric under riprap. Place a layer or layers of well-graded crushed stone or gravel meeting the gradations specified on the Plans. Ensure that the gradation of each layer is in the following relationship with the gradation of the underlying material, either soil or filter material:

$$\frac{D_{15} \text{ (coarser layer)}}{D_{85} \text{ (finer layer)}} \leq 5 \leq \frac{D_{15} \text{ (coarser layer)}}{D_{15} \text{ (finer layer)}} \leq 40$$

Where:

- D₁₅ is the diameter of the particle size that 15% of the material is smaller than.
- D₈₅ is the diameter of the particle size that 85% of the material is smaller than.
- No more than 5% of the filter material should pass the No. 200 sieve.

804.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

804.4 Construction

804.4.1 General

- 1 Shape and grade the slope or area on which riprap is placed to the lines, grades, thickness, or typical sections shown on the Plans or as directed by the RCE. Install either a fabric or a granular filter as specified on the Plans. If indicated by the Plans or directed by the RCE, place a layer of sand over the fabric to prevent puncture by large size riprap.
- 2 Place riprap to the thickness equal to the maximum stone diameter or the thickness specified in the Plans, whichever is greater. Place riprap either mechanically or by hand in a manner such that the larger stones are well distributed, and the entire mass of stone conforms to the specified gradation. Place riprap with the percentage of voids is as small as practical. Place riprap to its full thickness in one operation and in a manner that avoids displacing the underlying material. Hand place or re-arrange individual stones by mechanical equipment to the extent necessary to secure the results specified.
- 3 Unless the Plans specify a different toe treatment, dig a 2-foot deep trench along the toe of the fill at the bridge end fills and place the riprap from the bottom of the trench to the specified height shown on the Plans.

804.4.2 Riprap (Stone)

- 1 Place the stone by dumping such that the smaller stone is uniformly distributed throughout the mass. Place stone to the required thickness on approved slopes at locations designated on the Plans or at other locations designated by the RCE.

804.4.3 Sand-Cement Riprap

- 1 Prepare the slope as specified in **Subsection 804.4.1**. Fill the bags with sand and cement with sufficient water to moisten the mix in the ratio of 5 parts sand to 1 part cement. After filling, securely tie the bags closed. Start placing bags at the bottom and progress upward with the tied ends of the bags turned inward. Offset the joint between bags in successive rows and manipulate the bags until their surfaces are in full contact to the extent feasible.
- 2 Place terminal cutoff walls at each end of the bagged sand-cement riprap treatment. Place cutoff walls, 3 feet wide by 3 feet deep, approximately every 30 feet along the length of the treatment or as directed by the RCE.
- 3 Whenever placement of sand-cement bags is delayed sufficiently to affect the bond between succeeding courses, excavate a small trench, one-half a sack in depth, after the last row in place and fill the trench with concrete before laying the next layer. At the start of each day's work or when a delay of over 2 hours occurs during the placing of successive layers of sacks, moisten and dust the previously placed sacks with cement to develop a bond.

804.4.4 Grouted Riprap

- 1 Prepare the slope and place the riprap as specified in **Subsection 804.4.1**. After the riprap has been placed and approved, fill all voids between the stones with mortar to a depth of not less than 4 inches below the surface of the stone. Leave the face or surface of the stones reasonably free of grout. Do not plaster the riprap. Ensure that the spaces between the stones are reasonably free of sand or other material and wet during the placing of the grout.
- 2 Ensure that the edges on the ends of the grouted riprap intersect solid rock, formed into smooth transitions, or trenched well back into the bank to prevent undermining. Ensure that the bottom of the grouted riprap is founded on solid rock or extended below the depth of possible scour. Provide weep holes through the grout blanket to relieve any hydrostatic pressure behind the blanket.

804.4.5 Precast Concrete Riprap

- 1 Prepare the slope as specified in **Subsection 804.4.1**. Begin placing precast concrete pieces in a 2-foot deep trench below the toe of the slope and progress upward. Place each piece by hand perpendicular to and firmly embedded against the slope, and ensure that the vertical and horizontal joint between individual pieces does not exceed $\frac{3}{8}$ inch unless otherwise permitted. Use half pieces, odd shaped pieces, or Class 2500 concrete to fill the voids at the end of the sections placed or in curved shaped sections.
- 2 Conform the top course as nearly as practicable to the prescribed berm or shoulder elevation. Obtain any adjustment necessary to achieve this elevation by constructing a wedge course, when required, that consists of Class 2500 concrete. Use toe walls, when required, that consist of Class 2500 concrete. Joint and texture concrete as directed to blend with the precast blocks.

804.4.6 Geotextile Fabric for Slope Protection

- 1 Place geotextile fabric for slope protection in accordance with the Plans or the *SCDOT Standard Drawings* or as directed by the RCE. Place the fabric on a slope that conforms to the Plans and in a relatively smooth condition free from obstructions, debris, or sharp objects that could puncture the fabric. Do not operate construction equipment directly on the fabric.
- 2 Place fabric with the long dimension parallel to the toe of the slope and lay smooth and free of tension, stress, folds, wrinkles, or creases. If more than one strip is necessary, overlap the strips a minimum of 18 inches. Place transverse laps with the upstream strip overlapping the downstream strip. Place horizontal laps with the lower strip overlapping the upper strip. Laps may be eliminated if the joint is sewn using an approved method.
- 3 Install approved fastener pins through both strips of overlapped fabric at no less than 5-foot intervals along a line through the midpoint of the overlap and at any other locations as necessary to prevent any slippage of the fabric.

- 4 When placing material on the fabric, limit the height of the drop in order to prevent damage to the fabric. Demonstrate to the satisfaction of the RCE that the placement technique prevents damage to the fabric. Begin placement of the material at the toe of the slope and proceed upward.
- 5 Repair or replace any fabric damaged during installation or during placement of filter materials, slope protection, or other materials. Remove and replace extensively damaged fabric as directed by the RCE. Repair individual isolated cuts, tears, or punctures by placing a patch of geotextile fabric over the damaged areas. Extend patch at least 18 inches beyond the damage in all directions or fasten the entire perimeter of the patch by a sewing method approved by the RCE.
- 6 Cover the fabric with the specified material before damage or deterioration from ultraviolet light occurs. Remove and replace fabric not covered within 30 calendar days after placement. If damage or deterioration is evident before 30 days after placement, as determined by the RCE, remove and replace the fabric.

804.4.7 PVC Coated Wire-Enclosed Gabions

- 1 Excavate the channel before the installation of gabions as shown in the Plans or as directed by the RCE. Ensure that the resulting subgrade is smooth, firm, and free from protruding objects or voids that would affect the proper placement of the PVC coated wire mesh units or damage the geotextile fabric.
- 2 Use geotextile fabric meeting the requirements of **Subsection 804.2.11** (Class 2) for all gabions. Place on a prepared subgrade and overlap adjacent strips a minimum of 2 feet. Exercise care in placing and anchoring the empty PVC coated wire mesh units to ensure proper alignment and avoid damage to the geotextile fabric. If the geotextile is damaged, replace or repair it as directed by the RCE.
- 3 Begin placing the units at the vertical abutment wall and proceed upstream or downstream. Place the empty units on the geotextile fabric. Bind the vertical ends together with lacing or spiral binder wires sufficiently to allow stretching of the units to remove any kinks. Use any stretching methods that do not damage the fabric or the units. Use stakes, pins, or other approved methods to secure the units once they are placed in proper alignment. Interconnect adjacent units at intervals not to exceed 6 inches with lacing or spiral binder wire.
- 4 Fill the empty units carefully with rock placed by hand or machine to maintain alignment of the units. Place the rock uniformly in the units with a minimum of voids between the rocks. Avoid bulging of the side or top mesh. Limit the dropping of the rock to a height that avoids damage to the PVC coating or a maximum of 36 inches, whichever is less. Once filled, close the lid of the units and secure with lacing or spiral binder wire. When space limitations along the channel bottom or slope prevents the use of a complete unit, cut the unit to fit as approved by the RCE.

- 5 Backfill any excavation voids existing along the edges of the completed gabions in a manner acceptable to the RCE.

804.4.8 PVC Coated Wire-Enclosed Rock Mattresses

- 1 Use construction methods specified for gabions in **Subsection 804.4.7**.

804.4.9 Concrete Slope Protection

- 1 Provide cast-in-place concrete slope protection consisting of Class 2500 concrete meeting the requirements of **Subsection 804.2.9**, or fiber-reinforced Class 2500 concrete meeting the requirements of **Subsection 804.2.10** as indicated in the contract documents. Construct in accordance with the Plans at the locations indicated or where directed by the RCE. Ensure that the slope on which slope protection is placed conforms to requirements shown on the Plans unless otherwise directed by the RCE.
- 2 When specified, provide reinforcement meeting the requirements of **Section 703**, and place in accordance with the Plans and the *SCDOT Standard Drawings*. Finish surface of the slope uniformly with floats and textured by dragging with wet burlap. After finishing, cure the slope protection in accordance with the requirements of **Subsection 501.4.11**.

804.5 Measurement

- 1 The quantity for the pay item Riprap (of the type specified) is indicated in the Contract as either the weight of riprap placed, measured by the ton (TON), or the volume of riprap in-place, measured by cubic yard (CY) as applicable, complete, and accepted.
- 2 The quantity for the pay item Sand-Cement Riprap is the volume of riprap in-place and is measured by the cubic yard (CY), complete, and accepted.
- 3 The quantity for the pay item Grouted Riprap or Precast Concrete Riprap (including the area occupied by the wedge course) is surface area the riprap in-place and is measured by the square yard (SY) parallel to the slope, complete, and accepted.
- 4 The quantity of PVC Coated Wire-Enclosed Rock Gabion or PVC Coated Wire-Enclosed Rock Mattress is the volume of gabions or rock mattresses in-place and is measured by the cubic yard (CY), complete, and accepted.
- 5 The quantity of Slope Protection 4" Concrete or Geotextile Fabric for Slope Protection is the surface area covered by the slope protection materials or slope protection in-place, measured by the square yard (SY) parallel to the slope, complete, and accepted.

804.6 Payment

- 1 Payment for the accepted quantity for each pay item, measured in accordance with **Subsection 804.5**, is determined using the contract unit bid price for the applicable pay item, and the payment include all direct and indirect costs and expenses necessary to complete the work.

- 2 Payment for Riprap (of the class required), Sand-Cement Riprap, or Precast Concrete Riprap is full compensation for furnish and placing riprap protection as specified or directed and includes preparing slopes, excavating the footing trench; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract, except for the geotextile fabric under the riprap, which is paid for as a separate item.
- 3 Payment for Grouted Riprap is full compensation for furnishing, mixing, and placing the grout only as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. The establishment of the riprap itself is paid as separate items.
- 4 Payment for Slope Protection - 4" Concrete is full compensation for constructing concrete slope protection as specified or directed and includes preparing of slopes; furnishing and placing the concrete; and all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. .
- 5 When fiber reinforcement is required in the concrete slope protection, payment of Slope Protection 4" Concrete (Fiber Reinforced) is full compensation for constructing the fiber reinforced concrete slope protection as specified or directed and includes preparing slopes; furnishing and placing concrete; providing and mixing fiber reinforcement; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract
- 6 Payment for Geotextile for Erosion Control Under Riprap (of the type and class required) is full compensation for furnishing and placing geotextile under riprap as specified or directed and includes providing sand or granular filter layer and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 7 Payment for PVC Coated Wire-Enclosed Rock (Gabion) or PVC Coated Wire-Enclosed Rock (Mattress) is full compensation for constructing rock gabions or mattresses as specified or directed and includes excavating; furnishing and placing geotextile fabric, PVC coated baskets, and rock; tying baskets together; anchoring, staking, fastening, and bracing the baskets; backfilling or disposing of excess material; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

8 Pay items under this section include the following:

Item No.	Pay Item	Unit
8041010	Riprap (Class A)	TON
8041015	Riprap (Class A)	CY
8041020	Riprap (Class B)	TON
8041025	Riprap (Class B)	CY
8041030	Riprap (Class C)	TON
8041035	Riprap (Class C)	CY
8041040	Riprap (Class D)	TON
8041045	Riprap (Class D)	CY
8041050	Riprap (Class E)	TON
8041055	Riprap (Class E)	CY
8041060	Riprap (Class F)	TON
8041065	Riprap (Class F)	CY
8041100	Hand Placed Riprap	TON
8041200	Hand Placed Riprap	CY
8042100	Foundation Riprap	TON
8042200	Foundation Riprap	CY
8043100	Dumped Riprap	TON
8043200	Dumped Riprap	CY
8043350	Sand Cement Riprap	CY
8043370	Grouted Riprap	SY
8043390	Precast Concrete Riprap	SY
8044050	PVC Coated-Wire Enclosed Rock (Mattress)	CY
8044100	PVC Coated-Wire Enclosed Rock (Gabion)	CY
8047040	Slope Protection - 4" Concrete	SY
8047041	Slope Protection 4" Concrete (Fiber Reinforced)	SY
80481XX	Geotextile for Erosion Control Under Riprap (Class 1) Type (A, B, C, or D)	SY
80482XX	Geotextile for Erosion Control Under Riprap (Class 2) Type (A, B, C, or D)	SY

SECTION 805

GUARDRAIL

805.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the installation of guardrail in conformity with the Plans and the Specifications or as directed by the RCE.

805.1.1 Guardrail Types

- 1 Guardrail types in this section include the following:
- Steel Beam Guardrail (W-Beam),
 - Adjustable Guardrail,
 - Steel Beam Guardrail (Double Layer),
 - Steel Beam Guardrail (Thrie),
 - Steel Beam Guardrail (Thrie-Double Layer),
 - Box Beam Median Barrier,
 - Tubular Beam Guardrail (Bridge Railing),
 - Temporary Guardrail,
 - Concrete Median Barrier, and
 - Median Cable Barrier.

805.1.2 Scope of Work

- 1 Installation of guardrail includes the construction of anchor blocks and anchorage of the specified kind and dimensions at the approach and off ends of bridges, terminal and end anchor sections and blockouts; and includes the assembly and erection of all component parts and materials at the locations shown on the Plans and in the Specifications or as directed by the RCE.

805.2 Materials

805.2.1 Steel Beam Rail Elements

- 1 Provide W-beam or Thrie beam rail elements, as specified, fabricated from sheet steel conforming to the requirements of AASHTO M 180 for Class A, Type 2.
- 2 If guardrail is erected on radii of 150 feet or less, make field measurements before fabrication to determine the proper curvature of the rail elements. Shop fabricate the rail elements to conform to the curvature of the radii. Whenever field fabrication that is approved by the RCE requires cutting or drilling, coat the cut or drilled members by applying two coats of 90% minimum zinc-rich cold galvanizing compound.

805.2.2 Adjustable Guardrail Rail Elements

- 1 Use materials conforming to the material requirements indicated on the Plans and in the Specifications.
- 2 The Department may allow the substitution of composite or plastic blockouts for treated wood blockouts for use with adjustable guardrail if they meet the requirements shown on the Plans and as stated in **Subsection 805.2.4.2**. The substitution is subject to approval by the RCE.

805.2.3 Posts

805.2.3.1 General

- 1 Use wood or steel posts with W-beam guardrail elements. Do not use wood posts with Thrie beam guardrail elements. For adjustable W-beam guardrail, use wooden or steel posts manufactured with the appropriate holes for blockout attachment. Field drill or punch additional holes if necessary. Ensure that steel posts, blocks, and base plates for median cable barriers conform to the requirements of **Subsection 805.2.9.2**.

805.2.3.2 Steel Posts

- 1 Use steel posts conforming to the requirements of AASHTO M 270, Grade 36 steel. Ensure that the dimensions and weight of the posts are as shown on the Plans. Fabricate the posts from structural steel conforming to the requirements of **Section 709**. Galvanize the posts in accordance with ASTM A 123 after fabrication.
- 2 Whenever field fabrication that is approved by the RCE requires cutting or drilling, protect the cut or drilled metal by applying two coats of 90% minimum zinc-rich cold-galvanizing compound.

805.2.3.3 Wood Posts

- 1 Use Southern Yellow Pine conforming to the requirements for guardrail posts specified in **Section 706** unless otherwise indicated on the Plans or in the Specifications.

805.2.3.4 Extra Length Posts

- 1 Ensure that extra length of post material meets the requirements of **Subsection 805.2.3.2** or **805.2.3.3** as applicable.

805.2.4 Blockouts

805.2.4.1 Wood Blockouts

- 1 Use Southern Yellow Pine conforming to the requirements for guardrail posts as set forth in **Section 706** unless specified otherwise on the Plans or in the Specifications. Ensure that the dimensions of the blockout are as described herein or as shown on the Plans.

805.2.4.2 Composite or Plastic Blockouts

- 1 Use composite or plastic blockouts appearing on the most recent edition of *SCDOT Qualified Product List 49*.

805.2.4.3 Steel Blockouts

- 1 Use steel blockouts that conform to the requirements **Subsection 805.2.3.2**. Do not use steel blockouts on steel posts on a W-beam guardrail system.

805.2.5 Box Beam Median Barrier

- 1 Use hollow structural tubing rail elements conforming to the requirements of ASTM A 500, Grade B or ASTM A 501 and conforming in all respects to the details and dimensions shown on the Plans. Ensure that the beams are hot-dipped zinc-coated in accordance with AASHTO M 111.
- 2 Use hot-dipped zinc-coated steel posts of the section and length shown on the Plans and conform to the requirements of **Subsection 805.2.3.2**.
- 3 Use splice bolts, anchor bolts, and nuts that conform to the requirements of ASTM A 307 and are galvanized in accordance with **Subsection 708.2.7**.
- 4 Provide the rail hardware that includes end caps, bolts, nuts, splice joints, anchor assemblies, and all other items to complete the railing. Except for bolts and nuts, provide rail hardware that meets the requirements of AASHTO M 270 and is galvanized in accordance with AASHTO M 111.
- 5 Ensure that all fabrications are complete and ready for assembly before hot-dipped zinc coating. No punching, drilling, cutting, or welding is permitted after hot-dipped zinc coating. Furnish each rail length with splice joint at one end as required. Use welding conforming to the current edition of AWS specifications.

805.2.6 Temporary Guardrail

- 1 Due to the staging of projects at locations shown on the Plans, guardrail may be required on a temporary basis. Use guardrail that meets all requirements indicated on the Plans and as specified herein.
- 2 Place temporary guardrail at the locations shown in the Plans. Remove temporary guardrail as dictated by the staging requirements.
- 3 Used guardrail materials may be installed in permanent locations with approval of the RCE, provided they are undamaged and have been properly stored and maintained after their removal in accordance with **Subsection 202.4.4**.
- 4 Thoroughly clean reused guardrail elements and apply two coats of 90% minimum zinc-rich cold galvanizing to all steel parts that are not galvanized. Obtain approval of reused material from the RCE before permanent installation.

805.2.7 Guardrail Hardware and Accessories for Steel Beam Guardrail

- 1 Use blockouts and brackets of the type shown on the Plans and meeting the same requirements as the posts.
- 2 Use bolts of the sizes specified on the Plans and that conform to ASTM A 307. Use nuts conforming to the requirements of ASTM A 563. Use washers that conform to the requirements of AASHTO M 180. Coat the bolts, nuts, and washers after fabrication in accordance with AASHTO M 232 as tested by **SC-T-137**. Use post bolts at least long enough to extend through posts, blockouts, one washer, and the nut plus an extension of one bolt diameter beyond the nut. Do not allow the extension to be longer than 2 inches after an additional washer is placed under the nut.
- 3 Use end anchor sections and other guardrail appurtenances conforming to the requirements shown on the Plans.

805.2.8 Concrete and Reinforcing Steel

- 1 When required, use Class 2500 concrete for filling around posts. Use Class 3000 concrete for Concrete Median Barrier and Median Cable Barrier. Ensure that concrete conforms to the requirements of applicable subsections of **Section 701**. Use reinforcing steel conforming to the requirements of applicable subsections of **Section 703**.

805.2.9 Median Cable Barrier

805.2.9.1 Cable

- 1 Use cable consisting of $\frac{3}{4}$ -inch wire rope manufactured in accordance with AASHTO M 30, Type I, Class A coating.

805.2.9.2 Steel Posts, Blocks, and Base Plates

- 1 Where required, use steel posts, blocks, and base plates that conform to AASHTO M 270, Grade 36 and galvanize in accordance with AASHTO M 111. Weld and repair welds, when necessary, for steel fabrication in conformance with the latest edition of the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*. Complete fabrication before galvanizing.

805.2.9.3 Compensating Devices

- 1 Use compensating devices that have a spring rate of 450 lbs. (\pm 50 lbs.) per inch and a total available throw of 6 inches. Ensure that the spring develops a minimum compressed strength of 27,000 lbs., and is made from $\frac{9}{16}$ -inch steel wire with a minimum breaking strength of 25,000 lbs.

805.2.9.4 Hardware

- 1 Design all fittings to develop a minimum tensile strength of 25,000 lbs. Use open-end wedge type cable socket fittings that permit visual inspection of the cable end and wedge after installation. Ensure that hook bolts develop an ultimate pull open strength of 500 lbs. to 1000 lbs. applied in the direction normal to the longitudinal axis of the post.

805.2.9.4

805.2.9.7

- 2 Ensure that malleable iron fittings conform to the requirements of ASTM A 47. Use cast steel fittings conforming to the requirements of AASHTO M 103, Grade 70-36 unless otherwise designated on the Plans or in the Specifications.
- 3 Galvanize bolts, nuts, washers, plates, rods, and other hardware in accordance with AASHTO M 232.

805.2.9.5 Concrete for Median Cable Barrier

- 1 Use Class 3000 concrete conforming to the applicable requirements of **Section 701**.

805.2.9.6 Certification, Sampling, and Testing Requirements

- 1 Before inclusion in the work, provide the certifications listed below to the RCE. Ensure all certifications are original signed copies. If requested, the RCE will make a file copy of the original and return the original to the Contractor. Certifications include the following:
 - Cable Rope - manufacturer's certification of test data per 2000 feet or spool,
 - Hook Bolts - manufacturer's certification of compliance per lot or heat,
 - Posts – manufacturer's certification of compliance per lot or heat,
 - Delineators - certification per lot indicating brand and grade of reflective sheeting, and
 - Concrete Blocks for End Anchors - certification per end anchor indicating supplier, date of pour, and results of concrete compressive strength testing.
- 2 Bolts, nuts, compensating devices, turnbuckle assemblies, and splices will be sampled by the RCE. In addition, the RCE may, at its sole discretion, sample any materials used in the work at any time ranging from the point of manufacture to the construction site for whatever testing or inspection the RCE deems necessary.

805.2.9.7 Cable Barrier Delineator

- 1 Furnish non-metallic, flexible delineators made of recycled plastics meeting the requirements of ASTM D 5033, Section 3.1.7 and 3.1.18. Ensure that the materials are flexible polymers and elastomers, which are resistant to impact, ultraviolet light, ozone, and hydrocarbons. Provide delineators of good workmanship and free of burrs, discoloration, contamination, and other objectionable marks or defects that affect their appearance or serviceability.
- 2 Furnish the delineators in the standard color of white and yellow unless otherwise specified by the Department. Ensure that the dimensions of the delineator conform to the details and dimensions shown on the *SCDOT Standard Drawings* for Cable Barrier Delineators.

- 3 Ensure that the sheeting is Type IV and conforms to the requirements specified in the latest edition of the *SCDOT Qualified Product List 20*.
- 4 Attach delineators on cable barrier posts with either VHB 4941 or VHB 4943 double-coated acrylic foam tape manufactured by 3M or ¼-inch galvanized or stainless steel bolts, one inch in length with nuts, and fender washers.

805.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

805.4 Construction

805.4.1 Installation of Posts

805.4.1.1 General

- 1 Set post plumb either driven in-place or set in a hand or mechanically dug hole backfilled as specified herein. Separate contact surfaces with an approved protective coating for dissimilar metal-to-metal post and rail installations. When posts are placed within paved areas, restore any pavement disrupted to a depth of 4 inches in like kind.

805.4.1.2 Installation of Wood Posts

- 1 Drive wood posts or set in excavated holes. If post is driven, drive with approved methods and equipment that leaves the post in its final position free from any distortion, battering, burring, or any other damage. If post is set in excavated holes, ensure that the postholes have a firm bottom. Backfill with suitable material and thoroughly compact. Do not set in concrete. Install top of treated posts to final elevation. Do not saw treated posts.

805.4.1.3 Installation of Steel Post

- 1 Ensure that the installation of steel posts is in conformance with the details shown on the Plans. Drive steel posts or set in dug holes. Conform to installation requirements in **Subsection 805.4.1.2**.

805.4.2 Erection of Rail Element

- 1 Erect rail elements at the proper height in a manner resulting in a smooth, continuous installation. Tighten all bolts, except those required at expansion joints. While still allowing rail elements to slide past one another longitudinally, tighten bolts through expansion joints as much as practicable.
- 2 Use lengths of rail elements so that splices occur at posts. Lap splices in the direction of adjacent traffic.
- 3 Where hot-dipped zinc-coated surfaces are abraded, the base metal is exposed, and bolts have field cut ends, apply two coats of 90% minimum

zinc-rich cold-galvanizing compound.

- 4 When new guardrail is being erected on a project that is open to traffic, proceed with work in the direction of traffic flow, so the end of the installed sections does not face oncoming traffic. Do not begin work on any section of guardrail until preparations are made to complete the installation of the section, including posts, rail, anchors, and hardware in a continuous operation. Once the work is initiated on a section, continue the work to its completion unless inclement weather or other conditions beyond the Contractor's control interfere with the work. If interrupted sections are allowed by the Plans or the RCE, place the proper traffic control devices to protect the traveling public.

805.4.3 Resetting Guardrail

- 1 Carefully remove existing guardrail. When necessary, store it in a careful manner and erect it where shown on the Plans or as directed by the RCE.
- 2 If not galvanized, thoroughly clean all steel parts and apply two coats of 90% minimum zinc-rich cold-galvanizing compound.
- 3 When resetting or replacing existing guardrail, remove only the length of guardrail that can be replaced or reset in the same day. Do not reuse any existing posts or blocks. If a portion of existing guardrail is reset, use the same type of materials used in the existing guardrail. Reset guardrail to new guardrail standards with any additional materials necessary for this work.

805.4.4 Adjusting Guardrail Blockouts and Post

- 1 Carefully remove the existing rail element, adjust the blockout assembly to raise the height of the guardrail as shown on the Plans, and reinstall the rail where shown on the Plans or as directed by the RCE. Thrie beam guardrail is not adjustable. Steel blockouts are not allowed with adjustable W-beam guardrail. In order to provide the required ground elevation under the guardrail when the guardrail is raised, fill the area under and adjacent to the guardrail by adding material specified as Unclassified Excavation, Borrow, or HMA Under Guardrail. Place earthwork in accordance with **Section 203**. If replacement of guardrail elements is required, use elements that conform to the applicable requirements of this subsection.
- 2 If wood guardrail posts are required, use blockouts with the nominal dimensions of 6 inches x 8 inches x 14 inches. Mount the blockout to the wood post by means of a $\frac{5}{8}$ -inch bolt, of the necessary length, placed through a $\frac{3}{4}$ -inch diameter hole located 7 inches from the top and 3 inches from either side. Place an additional $\frac{3}{4}$ -inch hole 11 inches from the top of the blockout and 3 inches from either side, which is used on the final adjustment and an additional bolt is required at that time. For initial installation and the first 2-inch adjustment, drive two 16d hot-dipped zinc-coated nails or corrugated fasteners ($\frac{5}{8}$ inch x $1\frac{1}{8}$ inches minimum) through the blockout and into the post after the post bolt is installed to prevent the block from rotating.
- 3 If steel guardrail posts are used, use guardrail blockouts with the nominal dimensions of 6 inches x 8 inches x 14 inches. Create a slot measuring $4\frac{1}{2}$

inches (maximum width) x 14 inches (nominal height) x ¼ inch (minimum depth), centered along the back of the blockout, to facilitate mounting to the steel guardrail post and to prevent rotation. Create the slot to allow a 7½-inch minimum offset from the post. Mount the blockout to the steel guardrail post by means of a ⅝-inch bolt, of the necessary length, placed through a ¾-inch diameter hole in the blockout located 7 inches from the top of the blockout and 1⅝ inches from the side. Place an additional ¾-inch hole 11 inches from the top of the blockout and 1⅝ inches from the same side as shown in the Plans. Use both holes on the final adjustment and supply an additional bolt at that time.

805.4.5 Construction of Permanent Concrete Median Barrier

- 1 Construct permanent concrete median barrier in accordance with the details shown on the Plans and the applicable requirements of **Section 702**. Place concrete median barrier on pavement or directly on an earth or another foundation. Drilled holes may be required in the existing concrete pavement to accommodate dowel bars. Grout dowel bars as shown on the Plans with approved grout.
- 2 When a trench is required, excavate the trench for the base of the barrier to the lines and grades shown on the Plans or established by the RCE. Properly compact the bottom of the trench and have it approved by the RCE before placing concrete.
- 3 An approved slip-form machine may be used to construct concrete median barrier provided satisfactory results are obtained. When in the opinion of the RCE satisfactory results are not being obtained, discontinue the work and use form type construction with no adjustment in compensation. Remove unsatisfactory work and replace it without additional compensation.
- 4 Where median paving is removed or damaged in placing the barrier, furnish an approved pavement mix and repair the pavement without additional compensation.

805.4.6 Installation of Temporary Concrete Barrier

- 1 Install temporary concrete barrier in conformance with applicable requirements of **Section 605**.

805.4.7 Installation of Median Cable Barrier

805.4.7.1 Anchor Placement

- 1 Set the concrete end anchors into an excavation as detailed on the *SCDOT Standard Drawings*. The end anchor may be precast or cast-in-place concrete. Ensure that the bottom of the anchor has a full and even bearing on the surface under it. After the concrete end anchor is in place, backfill the excavation in accordance with **Subsection 205.4.2**. When the anchor is set into a slope, construct the top of the anchor so that a 6:1 slope is created from side to side, and the anchor resembles the natural slope of the ground. Prior to pre-casting the anchors, provide the total of left-sloping or right-sloping

anchors as determined by the RCE.

805.4.7.2 Cable Connections

- 1 Ensure that cables are continuous between the spring cable assemblies or spring cable assemblies and turnbuckles. At all locations where the cable is connected to a cable socket with a wedge type connection, crimp one wire of the wire rope over the base of the wedge to hold it firmly in place.

805.4.7.3 Cable Barrier Tensioning

- 1 Install and tension the cable barrier as follows:
 1. Properly seat the spring compensation device and then permanently mark the unloaded position.
 2. Complete assembly of the cable barrier and set the compensating devices to a spring compression of 3.5 inches.
 3. Leave the springs at this setting for at least 2 weeks, then set them to the proper setting according to chart for the ambient temperature in the following table.

Temperature (°F)	Spring Compression (inches)
110 - 120	1
100 - 109	1.25
90 - 99	1.5
80 - 89	1.75
70 - 79	2
60 - 69	2.25
50 - 59	2.5
40 - 49	2.75
30 - 39	3
20 - 29	3.25
10 - 19	3.5
0 - 9	3.75
-10 - -1	4
-20 - -11	4.25

805.4.7.4 Cable Splices

- 1 Allow only one splice per cable between end anchor assemblies. Stagger cable splices a minimum of 20 feet from splices on adjacent cables. Carefully assemble cable splices in accordance with the details shown in the Plans.

805.4.7.5 Mounting Cable Barrier Delineators

- 1 If tape is used to mount the delineators to the steel posts, use the following procedure:
 1. Use a minimum of 5 square inches of tape to mount each delineator.
 2. Use VHB 4941 or VHB 4943 tape to apply delineators when the temperature at installation is 60°F or above. If the temperature is between 32°F and 60°F, use VHB 4943 tape. Do not install the guardrail delineators with tape when the temperature is less than 32°F.
 3. Before applying the tape, clean the surface of the delineator and the post with a solvent that is a 50:50 mixture of isopropyl alcohol and water. Wipe the surfaces with a clean dry cloth to remove any solvent.
 4. After cleaning, prime the surface of the post with 3M primer 94 or 3M Aerosol Spray 80.
 5. The tape may be applied first to either the post or the delineator. Ensure that the tape is applied only to dry surfaces. Apply firm pressure when locating the delineator on the post. Ensure that both surfaces are fully in contact with the tape.
 6. Follow additional installation recommendations by the tape manufacturer.
- 2 If bolts are used to mount the delineators, provide two 0.31-inch diameter holes in the delineator and steel post. Use two ¼-inch, galvanized or stainless steel, bolts with nut and fender washer. Place fender washer under the nut on the outside of the delineator. Tighten bolts snugly.

805.4.7.6 Site Clean-Up

- 1 Remove all construction debris from the site at the end of each day.

805.4.7.7 Maintenance During Construction Phase

- 1 Maintain the erected median cable barrier until it is accepted. No additional measurement or payment is made for this work.
- 2 Begin repairs within 48 hours of receiving notification from the Department of the damage to the median cable barrier. Perform all repairs necessary to bring the damaged section back to full service within 96 hours of receiving notification of damage.

805.5 Measurement

- 1 The quantity for the pay item Guardrail, Box Beam Median Barrier or Concrete Median Barrier (of the type specified) is the length of guardrail or barrier constructed as specified in-place, measured by the linear foot (LF) along the centerline of the guardrail or barrier from end to end, complete, and accepted, excluding end anchorages and bridge end connections.
- 2 The quantity for the pay item End Anchor or Guardrail Bridge Connection is measured by each (EA) unit constructed as specified in-place, complete, and

accepted.

- 3 The quantity for the pay item Temporary Guardrail is the length of temporary guardrail installed as specified in-place and is measured by the linear foot (LF) in the same manor as permanent guardrail, complete, and accepted.
- 4 The quantity for the pay item Additional Length of Guardrail Posts is the length of required post installed in excess of the standard 6-foot post, measured by the linear foot (LF), complete, and accepted.
- 5 The quantity for the pay item Adjustable Guardrail is the length of guardrail for each stage of adjustment as specified, measured by the linear foot (LF) along the line of adjusted guardrail, complete, and accepted. Additional materials required to make adjustments are considered incidental items and are not measured separately.
- 6 The quantity for the pay item Median Cable Barrier is the length of median cable barrier constructed as specified and is measured by the linear foot (LF) along the line of median cable barrier between barrier end anchors, complete, and accepted.
- 7 The quantity for the pay item the Cable Barrier End Anchor is measured by each (EA) end anchor constructed as specified, complete, and accepted.
- 8 No separate measurement or payment is made for the median cable barrier delineators. Furnishing and installing the delineators are considered incidental to median cable barrier work and are not measured separately.
- 9 Minor excavation, disposal of surplus materials, painting, and making necessary repairs to pavement are considered incidental items necessary to complete the work as specified and included in the unit price of guardrail, median barrier or related guardrail item; and therefore, this work is not measured separately.

805.6 Payment

- 1 Payment for the accepted quantity for each pay item, measured in accordance with **Subsection 805.5**, is determined using the contract unit bid price for the applicable pay item, and the payment includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Payment for Guardrail, Box Beam Median Barrier, or Concrete Median Barrier (of the type or class required), is full compensation for constructing guardrail or barrier as specified or directed and includes furnishing and installing the required guardrail or barrier, anchorages to bridge ends when a bridge end connector is not installed, hardware, posts, and blockouts and all other materials, equipment, labor, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for the accepted quantity for Reset Guardrail is full compensation for resetting guardrail as specified or directed and includes removing guardrail; storing and resetting undamaged guardrail; replacing damaged guardrail

or missing parts; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

- 4 Payment for the accepted quantity for Temporary Guardrail (of the type required) is full compensation for constructing the temporary guardrail as specified or directed and includes placing and removing temporary guardrail; anchoring to structures; disposing of guardrail or barrier materials that cannot be reused on the project; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 5 Payment for the accepted quantity for End Anchor is full compensation for constructing end anchors as specified or directed and includes providing and installing concrete, reinforcing steel, structural steel, rail segments, cable, rods, turn buckles, anchor bolts, backing rail, soil tubes, plates, nuts, bolts, washers, attachments, and transition sections and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 6 Payment for the accepted quantity for Adjustable Guardrail (for each stage of adjustment) is full compensation for constructing adjustable guardrail as specified or directed and includes the initial installation or incremental adjustments specified or indicated on the Plans and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 7 Payment for the accepted quantity for Median Cable Barrier is full compensation for constructing median cable barrier as specified or directed and includes furnishing, installing, splicing, and tensioning the cable median barrier; supplying and installing delineators; maintaining and repairing cable barrier during construction; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract, except for the end anchors, which are paid for separately.
- 8 Payment for the accepted quantity for Cable Barrier End Anchor is full compensation the constructing median cable barrier end anchors as specified or directed and includes furnishing and installing the median cable barrier end anchors, concrete foundation, compensating devices, and hardware and all other materials, labor, equipment, tools, supplies transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

9 Pay items under this section include the following:

Item No.	Pay Item	Unit
8051100	Steel Beam Guardrail	LF
8051101	Adjustable Height Steel Beam Guardrail (Initial Installation)	LF
8051102	Adjustable Height Steel Beam Guardrail (2 Inch Adjustment)	LF
8051103	Adjustable Height Steel Beam Guardrail (Final Adjustment)	LF
8051200	Steel Beam Guardrail (Double Layered)	LF
8051300	Steel Beam Guardrail (Thrie)	LF
8051400	Steel Beam Guardrail (Thrie - Double Layered)	LF
8051600	Box Beam Median Barrier	LF
8051655	Median Cable Barrier	LF
8051656	Reset Median Cable Barrier	LF
8051800	Temporary Guardrail	LF
8051900	Reset Guardrail	LF
8052210	End Anchor - Type B	EA
8052220	End Anchor - Type B (Thrie Beam)	EA
8052300	End Terminal - Type T	EA
8052500	Cable Barrier End Anchor	EA
8052600	Thrie Beam Guardrail Bridge Connection	EA
8053000	Additional Length Guardrail Post	LF
8058100	Concrete Median Barrier (Type-1)	LF
8058105	Concrete Median Barrier (Type-2)	LF
8058110	Concrete Median Barrier (Type-3)	LF
8058115	Concrete Median Barrier (Type-4)	LF
8058120	Concrete Median Barrier (Type-5)	LF
8058125	Concrete Median Barrier (Type-6)	LF

SECTION 806

FENCES

806.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the construction of fences and gates in conformity with the Plans and the Specifications or as directed by the RCE.

806.1.1 Fence Types

- 1 The fence types in this section include the following:
 - Woven Wire,
 - Barbed Wire,
 - Chain-Link, and
 - Ornamental Steel Picket.

806.2 Materials

806.2.1 Wood and Braces

- 1 Use wood posts and braces that meet the requirements of **Subsection 706.2.5**.
- 2 If approved by the RCE, use galvanized studded T-posts instead of wood posts for Woven Wire Fence. Use the T-posts for line installation only, but do not use as corner or pull posts. Provide T-posts meeting the requirements of ASTM A 702, and galvanizing conforming to the requirements of AASHTO M 111.

806.2.2 Steel Fence Posts

- 1 Provide steel posts that conform to the size, shape, and dimensions shown on the Plans and to the requirements of ASTM A 120 for tubular steel fence posts, AASHTO M 111 for all other posts, and ASTM A 153 for all anchor plates attached to posts. Protect cut ends that are not placed underground by applying two coats of a 90% minimum zinc-rich, cold-galvanizing compound. Provide posts and anchor plates for line posts of good commercial quality steel and of the shapes, weights, and dimensions shown on the Plans. Provide tubular section posts with heavy malleable iron caps made to provide a drive-fit over the outside of the section to exclude moisture. Ensure the weight per linear foot for tubular posts and braces is not less than 95% of the weight specified. Furnish all end, pull, and brace posts for farm-field type fence with braces, fittings and details required to make a complete installation as shown on the Plans. Furnish all line posts for farm-field fence with anchor plates.
- 2 If fastenings are necessary for attaching farm-field fence to the posts, use either 9-gauge galvanized wire or galvanized clamps of the manufacturer's standard design. Furnish a sufficient quantity of individual tie-wires or clamps to provide for 5 attachments of the fencing to each line post and one tie-wire

for each strand of barbed wire.

- 3 Furnish line posts for chain-link type fence with the necessary tie-wires or fabric bands for fastening the fabric to the posts. Use fastenings of either aluminum strip or wire of approved gauge and design or galvanized steel wire and in accordance with the manufacturer's standard design. If galvanized steel wire ties are furnished, use wire no smaller than 9-gauge. Furnish a sufficient quantity of individual ties or bands to provide for attaching the fabric to each line post every 12 inches or as called for on the Plans.

806.2.3 Zinc-Coated Steel Woven Wire Fabric

- 1 Use zinc-coated steel woven wire fabric conforming to the requirements of AASHTO M 279, Grade 60, Coating Type Z, and Coating Class 1.

806.2.4 Barbed Wire

- 1 Furnish barbed wire with two 12½-gauge (or heavier) steel wires or two 15½-gauge high tensile strength steel wires with 14-gauge (or heavier) 4-point round barbs placed not more than 5 inches apart in conformance with AASHTO M 280, Coating Type Z, Class 1 (or better), for zinc-coated (galvanized) steel barbed wire or ASTM A 121, Coating Type A, for aluminum-coated steel barbed wire.

806.2.5 Chain-Link Fence Fabric

- 1 Use chain-link fence fabric conforming to the requirements of AASHTO M 181, except perform tensile strength testing in accordance with AASHTO T 244 for the kind of metal, coating, size of wire, and mesh specified on the Plans or *SCDOT Standard Drawings*.

806.2.6 Ornamental Steel Picket Fencing

806.2.6.1 Tubing

- 1 Use cold roll steel sheet meeting the requirements of ASTM A 924 for fence elements. Ensure that cold roll sheet metal conforms to requirements of ASTM A 787, Type 2 AWG, light oil 1008/1010. Coat fence elements in accordance with the requirements of ASTM A 653, LFQ RS Coating G90 C10088/C1010, Grade C.

806.2.6.2 Welds

- 1 Weld elements with ⅛-inch fillet butt weld on two sides with 50,000 psi tensile strength.

806.2.6.3 Pickets

- 1 Use 1-inch x 1-inch x 16-gauge galvanized cold roll steel for pickets.

806.2.6.4 Rails

- 1 Use 1-inch x 2-inch x 14-gauge galvanized cold roll steel for rails.

806.2.6.5 Posts

- 1 Use 2½-inch x 2½-inch x 14-gauge galvanized cold roll steel for posts.

806.2.6.6 Post caps

- 1 Provide pressed steel caps to fit over the posts.

806.2.6.7 Concrete and Reinforcement (if required)

- 1 Unless otherwise specified, use Class 2500 concrete for embedment of steel posts. Ensure that concrete conforms to the applicable requirements in **Section 701**. If reinforcing steel is required, use reinforcing steel conforming to the applicable requirements in **Section 703**.

806.2.6.8 Finish Color

- 1 Furnish fence elements with a black finish unless otherwise specified.

806.2.7 Gates**806.2.7.1 Chain-Link Fence Gates**

- 1 Ensure that chain-link fence gate material conforms to the requirements of AASHTO M 181 for the kind of metal, coating, sizes of wire, and mesh specified.

806.2.7.2 Farm-Fence Gates

- 1 Furnish materials and fabricate farm-fence gates in accordance with the Plans or *SCDOT Standard Drawings*, or in the absence of Plan details, as directed by the RCE and in keeping with the type fence being erected and the purpose it serves.

806.2.8 Staples

- 1 To attach woven wire and barbed wire to wooden fence posts, use staples made of galvanized steel wire of not less than 9-gauge and not less than 1½ inches in length or 16-gauge stainless steel pneumatically driven staples, made from 304 stainless steel, coated with adhesive, and not less than 2 inches in length.

806.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

806.4 Construction**806.4.1 General**

- 1 Perform clearing and grubbing as necessary to construct the fence to the required grade and alignment. Remove and dispose of existing fences, trees,

brush, stumps, logs, weeds, or other debris that interfere with the construction of the fence.

- 2 Grade the surface of the ground beneath the fence to a reasonable contour to prevent the bottom strand from coming in contact with the ground. Provide spaces between the various types of wire, namely barbed wire and fabric as shown on the Plans and prevent excessive openings between the ground and the bottom of the fence before erecting the fabric. Where it is not practicable for the fencing to closely follow the contour of the ground, close the openings under fences caused by crossing ditches or small ground depressions sufficiently to retain livestock or serve the purpose intended.
- 3 Where new fences are constructed to replace existing fences, erect the new fence before removing the existing fence. The Contractor is responsible for all crop or property damage caused by livestock escaping or entering through gaps left in fences during erection.
- 4 At locations where breaks in a run of fencing are required or at intersections with existing fences, make appropriate adjustment in post-spacing to conform to the requirements for the types of closure indicated.
- 5 Unless otherwise permitted, do not install fence elements on posts, strain guys, or bracing set in concrete until 4 days after the placement of the concrete.
- 6 Set the tops of posts to the required grade and alignment. Do not cut the tops of treated wooden posts or metal posts unless approved by the RCE under specified conditions.
- 7 Firmly attach the required wire or fencing to the posts and braces as indicated on the Plans or the Specifications. Stretch all wire taut at the required elevations.
- 8 At each location where an electric transmission, distribution, or secondary line crosses any of the fence types covered by these specifications, furnish and install a ground conforming to the requirements of Section 9 of the *National Electric Safety Code*.
- 9 Whenever farm type fence is erected for farm purposes, construct access gates at locations of existing access points or at other locations when, in the opinion of the RCE, such access is essential to the farming or other land use operations.

806.4.2 Setting Posts

- 1 Unless otherwise directed, set posts (including the concrete base for posts of fences erected for control of access purposes) so that the entire fence is inside the right-of-way with the fence placed on the side of the post facing the mainline pavement. For fences erected for land use purposes, set posts and related items outside of the right-of-way with the fence placed on the side of the post as determined by the property owner.

- 2 Unless otherwise indicated on the Plans, use the same posts spacing as the fence being replaced, but with a maximum distance of 12 feet on centers for woven wire and barbed wire fences and a maximum of 10 feet for chain-link fence.
- 3 Set posts accurately spaced, lined, plumb, and to a uniform height before the fabric is attached. Set end, corner, gate, and pull posts to a minimum depth of 3 feet. Set line posts to a minimum depth of 2½ feet. Posts may be driven into place provided the method of driving does not damage the post. Treated posts that are driven may have the small end machine-pointed at the plant before being treated. When the posts are hand set, backfill and thoroughly compact the holes in layers not exceeding 6 inches in depth and such that the post is securely held.
- 4 Securely brace the corner, end, gate, and pull posts at intervals of not more than 500 feet as indicated on the Plans or as directed by the RCE. When changes in the fence line result in an angle of deflection of 30 degrees or more, install corner posts at point of change. Brace all corner and pull posts in two directions. Brace end and gate posts in one direction. Ensure the posts at intersecting fences are properly braced to withstand the pull of the intersecting fence.
- 5 At stream crossings and other locations where it is not practicable for the fencing to follow the contour of the ground closely, furnish extra-length posts without additional compensation.
- 6 Install posts of additional lengths when erecting sections of fence in low, swampy areas where the nature of the soil and water conditions prevents the posts from being held firmly in place at the usual required depths (2½ feet for line posts and 3 feet for pull and corner posts) and when additional lengths are included in the proposal. The RCE will determine the lengths of posts required.
- 7 When post is set in concrete, use Class 2500 concrete crowned at the top to shed water.

806.4.3 Installing Woven Wire

- 1 Stretch the wire fabric taut and securely attach to each wood post with a galvanized staple in each horizontal wire and as many additional staples as required to secure the fabric in a workmanlike installation. Stretch with an approved stretcher that produces equal tension in each line of wire. At each end, corner, or gatepost wrap each strand of wire around the post and securely fasten by winding the end around the beginning of the loop close to the post. Do not splice fence between posts unless splicing devices recommended by the fence manufacturer are used and are approved by the RCE.

806.4.4 Installing Chain-Link Fabric

- 1 Stretch and securely attach the fabric to the end, corner, gate, and pull posts with stretcher bars and stretcher bands as indicated on the Plans. Fasten the fabric to line posts, top rail, and tension wires with the wires or bands

specified and spaced as indicated on the Plans.

806.4.5 Installing Barbed Wire

- 1 Whether used in conjunction with chain-link fabric, woven wire fabric, or as a separate fence, stretch and fasten to each wood post by means of galvanized staples or to metal posts by means of suitable fasteners. Wrap the ends of wire around wood posts and securely fasten by winding the end around the wire close to the post. Do not splice fence between posts.

806.4.6 Installing Ornamental Steel Picket Fencing

- 1 Set all posts plumb in 9-inch diameter x 36-inch deep holes in Mechanically Stabilized Earth walls and in 4-inch x 9-inch x 12-inch deep holes in brick walls.
- 2 Construct fence in accordance with details shown on the Plans.
- 3 Apply black finish as follows:
 1. Clean, degrease, and prime welded panels and posts.
 2. Powder coat primed panel, post, and cap with one coat.
 3. Touch up field welds with cold galvanized primer and enamel spray paint.

806.4.7 Installing Gates

- 1 Install gates in accordance with the Plans, *SCDOT Standard Drawings*, or as otherwise specified. Ensure that gates are square, plumb, and swing freely through their entire range of required movement.

806.5 Measurement

- 1 The quantity for the pay item Fence (of the size or type required) is the length of fence in-place and is measured by the linear foot (LF) along the top of fence from outside to outside of end posts for each continuous run of fence including gates, unless gates are in the proposal as a separate pay item, complete, and accepted.
- 2 When included as a pay item, the quantity for Gate (of the size or type required) is measured by each (EA) gate installed, complete, and accepted. When not included in the Contract as a pay item, the gate is measured as fence.
- 3 When included as a pay item, the quantity for Additional Length of Post is the length of post installed in excess of the normal post length specified and is measured by the linear foot (LF) of post, complete, and accepted.

806.6 Payment

- 1 Payment for the accepted quantity for each pay item, measured in accordance with **Subsection 806.5**, is paid at the contract unit bid price for the applicable pay item, and the payment includes all direct and indirect costs and expenses necessary to complete the work.

- 2 Payment for Woven Wire Fence, Barbed Wire Fence, or Chain-link Fence (of the type and size required) is full compensation for constructing fence as specified or directed and includes furnishing and installing fence including posts, rails, post caps, and braces; clearing and grubbing; grading, excavating, backfilling, and disposing of surplus materials; providing and installing gates unless otherwise specified; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for Ornamental Steel Picket Fence (of the height required) is full compensation for constructing ornamental steel picket fence as specified or directed and includes furnishing and installing the fence including pickets, rails, posts, post caps, concrete, primer, paint, powder coat, and welds and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Payment for Gate (of the type and size required) is full compensation for fabricating and installing gates as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 5 Payment for Additional Length of Post is full compensation for furnishing and installing the additional length of post beyond the standard post length as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 6 Pay items under this section include the following:

Item No.	Pay Item	Unit
8061XX0	Woven Wire Fence <i>(type)</i>	LF
8062X00	Barbed Wire Fence – <i>(1, 2, 3, 4, 5, or 6)</i> Strands	LF
8063100	48" - Chain-link Fence	LF
8063200	60" - Chain-link Fence	LF
8063300	72" - Chain-link Fence	LF
8063600	96" - Chain-link Fence	LF
8063800	120" - Chain-link Fence	LF
806XXXX	<i>(width)'</i> <i>(type)</i> Gate <i>(height)"</i> Height	EA

(table continued on the next page)

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(table continued from the previous page)

Item No.	Pay Item	Unit
8066000	Additional Length of Post	LF
8068142	Ornamental Steel Picket Fence – 42"	LF
8068148	Ornamental Steel Picket Fence – 48"	LF
8068154	Ornamental Steel Picket Fence – 54"	LF

SECTION 807

RESET FENCE

807.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for removing existing fence within the limits of the improvement and, if necessary, storing it in a careful manner and resetting or rebuilding it in conformity with the Plans and the Specifications or as directed by the RCE.

807.1.1 Classification of Work

807.1.1.1 Reset Chain-Link Fence

- 1 The work for the item Reset Chain-link Fence consists of resetting of chain-link fabric mounted on metal or concrete posts irrespective of the height of the fabric. Chain-link fabric attached to wooden posts is not considered nor classified as Reset Chain-Link Fence.

807.1.1.2 Reset Fence

- 1 The work for the item Reset Fence consists of all types of fences necessary to be reset, except for the work classified as Reset Chain-Link Fence as described above. Reset fence includes board or timber fences unless otherwise provided.

807.2 Materials

- 1 Unless otherwise specified or directed by the RCE, use materials from the original fence and, when necessary, furnish new posts, braces, wire, or other materials required to complete the fence. Provide materials that are of the same character, size, and type as in the original fence. If new wood posts are required in the reconstruction, but posts of the same type used in the original fence are not available, use equivalent posts meeting the requirements of **Subsection 706.2.5**. Do not use posts of different types in the same fence

807.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

807.4 Construction

- 1 Remove and rebuild the fences at the location designated on the Plans or by the RCE. Ensure that the fence is left in the same or better condition than it was before removal. Rebuild the fence using the same type of construction used in the original fence. Space posts at the same distance as in the original fence with a maximum distance of 16 feet on center, except for chain-link fence where the maximum distance is 12 feet on center. Remove and dis-

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pose of all trees, brush, stumps, logs, or other debris that interfere with the resetting of the fence.

- 2 Rebuild fences true to line and set vertical. Ensure that all wires are taut. Staple barbed wire and fabric wire to each post and attach chain-link fabric to each post in accordance with applicable requirements of **Subsection 806.4**. When resetting is finished, ensure that the fence has an acceptable appearance.
- 3 Remove all gates and restore for service at the new location. Repair all damage to fence and gates caused by the removal and rebuilding process.
- 4 The Contractor is responsible for all crop or property damage caused by livestock or other animals escaping or entering through gaps left in fences during the resetting work. When the reset fence crosses ditches or low areas, fence or otherwise close the openings under the fence to retain livestock.

807.5 Measurement

- 1 The quantity for the pay item Reset Fence or Reset Chain-link Fence is the length of fence reset, in-place and is measured by the linear foot (LF) along the top of the rebuilt fence from outside to outside of end posts for each continuous run of fence including gates, complete, and accepted.

807.6 Payment

- 1 Payment of the accepted quantity for Reset Fence or Reset Chain-Link Fence, measured in accordance with **Subsection 807.5**, is determined using the contract unit bid price for the appropriate pay item, and the payment includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Payment for Reset Fence or Reset Chain-Link Fence is full compensation for resetting the fence as specified or directed and includes removing the existing fence; storing portions of existing fence; rebuilding and/or relocating fence; restoring gates to service; clearing and grubbing; grading, excavating, and backfilling; furnishing replacement materials; disposing of surplus materials; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Pay items under this section include the following:

Item No.	Pay Item	Unit
8071000	Reset Fence	LF
8072000	Reset Chain-Link Fence	LF

SECTION 808

RELOCATION OF STRUCTURES AND OTHER ITEMS (MOVING ITEMS)

808.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the removal and relocation of structures, buildings, and other scheduled moving items in conformity with the Plans and the Specifications or as directed by the RCE.
- 2 Scheduled moving items include relocating buildings or structures with incidental improvements or appurtenances, such as walkways, driveways, animal enclosures, fences, steps, pipe lines, septic tanks, pumps, grease pits or lifts, signs, plants, shrubs, etc. that are not an integral part of the relocated item, and may not necessarily be shown on the Plans, but the moving of which is necessary because of the relocation of a building or structure. Each moving item is identified by a unique schedule number.
- 3 It is the Contractor's responsibility to investigate each moving item and determine the actual work involved in the moving and relocation of each item before bidding. The size and description of buildings or structures, distance to be moved, and placement elevation shown on the Plans are only approximate. The RCE may require the Contractor to move any building or structure an additional distance of 50 feet; raise or lower from the final elevation shown on the Plans a distance of 18 inches; or turn a building or structure through an angle of 15 degrees more or less than called for on the Plans without additional compensation.
- 4 Moving items shown on the Plans as parts of power transmission or other public utility lines are approximate as to distance to be moved, materials to be furnished, and appurtenances. Perform this work in accordance with the owner's standard practice and to its satisfaction. It is the Contractor's responsibility to contact the owner of such moving items and determine the amount of work required before bidding.
- 5 The relocation of a building or structure, any part of which is used as a service station, includes the removal, relocation, and installation of all pumps, tanks, pipes, signs, grease pits or lifts, and other accessories appurtenant to the service station in accordance with SCDHEC regulations.

808.2 Materials

- 1 The RCE will determine the suitability of materials salvaged from the existing structure for use in the relocated structure.
- 2 Use new material for brick or concrete block to reconstruct exterior walls, pillars, and chimneys that are unable to be moved with the structure. Use masonry mortar that meets the requirements specified in **Subsection 718.2.5**.

- 3 Construct concrete driveways and walkways to replace existing drives and walks in accordance with the applicable requirements of **Section 720**. Construct driveways at a uniform thickness of 6 inches and walkways or sidewalks at a uniform thickness of 4 inches.
- 4 Use new materials for all well casings, water pipes, and steps unless the material salvaged from the old structure is acceptable to the owner and RCE.
- 5 Use new material for septic tanks and sewer pipes.
- 6 Ensure that new materials conform to the applicable contract specifications.

808.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

808.4 Construction

- 1 Prepare structures for removal and then move and place them in their new locations as shown on the Plans or as designated by the RCE. Set structures plumb and level. Leave the entire structure including appurtenances in the same or better condition in all respects than it was before moving.
- 2 Do not make any change or alteration in the work specified unless approved in advance by the RCE.
- 3 Do not place the bottom of the wooden sill of a structure less than 12 inches above ground.
- 4 Because steps, outside stairways, porches, sheds, and other appurtenances forming an integral part of the building are considered as part of the building, move and relocate them accordingly. Disconnect and remove cellars, cellar steps, drains, walls, concrete or masonry porches and floors, concrete, brick, and masonry foundations and supports, septic tanks, fireplaces, chimneys, and other appurtenances attached or connected to the building but are not movable as an integral part of the building. Unless otherwise specified, construct such new appurtenances of the same size, type, and character as existed before the building was moved. Replace all driveways and walkways to conform to the new location of the building. Relocate all shrubbery and miscellaneous items appertaining to the structure to maintain the same symmetry existing before relocation unless otherwise specified.
- 5 Where work involves new materials or the reuse of salvaged materials in the relocation and reconstruction of buildings or structures or in the construction of new buildings or structures, paint all such work to the satisfaction of the RCE.
- 6 Whenever sanitary sewers, water, gas, electric, or telephone service lines are connected to the building being relocated, move and reconnect such ser-

vice lines without unnecessary inconvenience to the occupants of the building. Plug or otherwise satisfactorily disconnect utilities not reconnected in a manner preventing infiltration of foreign matter. The Contractor is responsible for arranging for the removal of all utility connections where the connections interfere with the construction of the road. Include all work and costs incidental to removing and relocating these utilities in the contract unit or lump sum price for moving the building to which they are attached. Ensure that all connections and installations are in accordance with all codes, ordinances, or regulations governing such work. The Contractor is responsible for notices to public utility companies and fees charged by the utilities concerning the moving operation.

- 7 Conduct moving operation to allow businesses to render service to their customers without undue interruption. After work is started on any building, maintain a sufficient force to ensure satisfactory progress. Weather permitting; do not discontinue work on any building without consent of the RCE.
- 8 Remove and dispose of materials in existing foundations, drives, walks, concrete or masonry floors, chimneys, etc. not used in the reconstruction of appurtenances to structures being moved as directed by the RCE.
- 9 Relocate the content of structures along with the structure to its new site. In the event that it is not practicable to move the structure with the contents therein, remove, protect, and replace the contents. Take the necessary precautions to prevent damage to or loss of the contents.
- 10 Carry all foundations for pillars, underpinning, or chimneys a minimum of 12 inches below ground and/or to a solid bearing. Construct footings 6 inches wider than pillars or underpinnings and 12 inches wider than chimneys proper.
- 11 Install septic tanks, tile drainage fields, and privy meeting the requirements of SCDHEC.
- 12 Ensure that new wells and pumps furnish an adequate supply of potable water and, in all cases, ensure that they furnish at least the amount of water as the pump or well being replaced. Ensure that new pumps and wells are in service before the old units are made ineffective.
- 13 Whenever the Plans specify buildings, structures, etc. to be dismantled or salvaged, dismantle them with sufficient care to preserve the salvage value of the materials therein. Store all salvage materials at locations shown on the Plans or designated by the RCE. Dispose of all discarded material, rubbish, or debris as directed by the RCE.
- 14 Perform all transplanting work required in the removal and relocation of buildings and structures indicated on the Plans in accordance with the requirements of **Section 811**.

808.5 Measurement

- 1 Unless otherwise specified, moving items are paid on a lump sum (LS) basis; and therefore, there is no specific measurement of quantities for these

items. For acceptance for payment, the completed moving item must be accepted by the property owner and the RCE.

808.6 Payment

- 1 Payment for a moving item accepted in accordance with **Subsection 808.5** is determined using the contract lump sum bid price for the applicable scheduled moving item, and the payment includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Payment for Moving Item No. (*schedule number*) is full compensation for moving the specified item as specified or directed and includes the necessary clearing, grubbing, and grading of the relocation site, except as otherwise provided for on the Plans and all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for a moving item involving transplanting of trees, shrubbery, etc. is full compensation for excavating and preparing planting pits; moving, setting, and watering the transplanted items; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to satisfactorily complete the work.
- 4 No payment is made for a moving item until the Contractor secures a statement from the property owner or owners certifying that the work has been performed to the property owner's satisfaction and that the Department and Contractor are released from all responsibility and liability in connection with the work. In extreme cases when, in the opinion of the RCE, this requirement is being abused by the property owner the Department, at its option, may waive the procurement of the owner's release.
- 5 Pay item under this section include the following:

Item No.	Pay Item	Unit
8081000	Moving Item No. (<i>Schedule No.</i>)	LS

SECTION 809

RIGHT-OF-WAY MARKERS

809.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the furnishing and installation of Portland cement concrete markers or rebar caps as right-of-way markers in conformity with the Plans and specifications or as directed by the RCE.

809.2 Materials

809.2.1 Portland Cement Concrete

- 1 Use Portland cement concrete conforming to the applicable requirements for Class 3000 or better as specified in **Section 701**.

809.2.2 Reinforcing Steel

- 1 For reinforcing steel, use one No. 6 deformed steel reinforcing bar that meets the applicable requirements of **Section 703** and ASTM A 706, Grade 60 and is from a source listed on the most recent edition of *SCDOT Qualified Product List 60*.

809.2.3 Marker Caps

- 1 Ensure that the rebar caps used as right-of-way markers are Berntsen International, Inc. RBX6325, 3¼-inch, 6000 series, orbital forged aluminum, domed cap, or an approved equal, and meet the Department's specifications. Obtain right-of-way markers from sources listed on the most recent edition of *SCDOT Qualified Product List 16*.

809.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

809.4 Construction

809.4.1 Reinforced Concrete Markers

- 1 Provide and install reinforced concrete right-of-way markers in accordance with *Drawing No. 809-1* of the *SCDOT Standard Drawings*. Precast the right-of-way markers to the dimensions specified in *Drawing No. 809-1*. Rigidly attach the letters "R/W" to the forms to create the lettering as shown on the *Drawing No. 809-1*. When the concrete has set the required time, remove the forms in a manner that is not damaging to the marker lettering. Finish all surfaces to a smooth workmanlike finish by removing the fins and form marks with a carborundum rubbing stone and point all holes with mortar so that the surface of all pointed areas is flush with the adjacent surfaces. No further

finishing is required unless necessary to create an acceptable workman-like finish. Cure the marker as specified in the applicable subsections of **Section 702**.

- 2 Place right-of-way markers plumb and accurately at the location specified. Backfill with suitable material in layers not exceeding 6 inches (loose measurement) and thoroughly compact each layer.

809.4.2 Rebar and Cap Markers

- 1 Provide and install rebar and cap right-of-way markers in accordance with *Drawing No. 809-2* of the *SCDOT Standard Drawings* following the manufacturer's installation instructions and as directed by the RCE. Set the markers on $\frac{3}{4}$ -inch (No. 6) reinforcing steel a minimum of 2 feet in length. Set the top of the marker slightly below the ground surface to eliminate conflict with mowing and other maintenance operations.

809.4.3 Reset Right-of-Way Markers

- 1 When the proposal provides for existing right-of-way markers to be reset, remove the existing markers and, if necessary, store, protect and reset them at designated locations as set forth in **Subsection 809.4.1** or **809.4.2** as applicable.

809.4.4 Right-of-Way Survey and Report

- 1 Make certain that Right-of-Way Survey and Right-of-Way Report conform to the requirements specified on *SCDOT Standard Drawings 809-1* and *809-2*.

809.5 Measurement

- 1 The quantity for the pay item Right-of-Way Marker (Reinforced Concrete), Right-of-Way Marker (Rebar & Cap), or Reset Right-of-Way Marker is measured by each (EA) marker installed or reset, complete, and accepted.
- 2 There is no specific measurement for Right-of-Way Survey and Right-of-Way Report as these items of work are lump sum (LS) pay items.

809.6 Payment

- 1 Payment for accepted quantity for each pay item, measured in accordance with **Subsection 809.5**, is determined using the contract unit bid price for the applicable pay item, and the payment includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Payment for Right-of-Way Marker (Reinforced Concrete), Right-of-Way Marker (Rebar & Cap), or Reset Right-of-Way Marker is full compensation for supplying and installing the right-of-way markers as specified or directed and includes excavating and backfilling; providing and installing right-of-way marker caps, concrete, and rebar; and all other materials, labor, equipment, tools, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

- 3 Payment for Right-of-Way Survey or Right-of-Way Report is full compensation for performing the survey or preparing the report as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Pay items under this section include the following:

Item No.	Pay Item	Unit
8090001	Right-of-Way Survey	LS
8090050	Right-of-Way Report	LS
8091000	Right-of-Way Marker (Reinforced Concrete)	EA
8091010	Right-of-Way Marker (Rebar & Cap)	EA
8092000	Reset Right-of-Way Marker	EA

SECTION 810

SEEDING

810.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the seeding, interseeding, fertilizing, applying nitrogen and lime when specified, and mulching in conformity with the Plans and the Specifications or as directed by the RCE.
- 2 Interseeding consists of the planting of centipede grass seed within the existing turf.

810.2 Materials

810.2.1 General

- 1 At the time of delivery, furnish invoices for materials received in order to determine the application rate of materials.

810.2.2 Seed

- 1 Ensure that seed conforms to state laws and the requirements and regulations of the South Carolina Department of Agriculture (SCDA).
- 2 Provide individually packaged or bagged and tagged varieties of seed that show the name of seed, net weight, origin, percentages of germination and purity, lot number, and other information required by the SCDA.
- 3 The Department reserves the right to test and reject or approve any or all seed before application of the seed.
- 4 For mixtures of different types of seed called for in the seeding schedule, weigh and mix in the proper proportions at the site of the work in the presence of the RCE.

810.2.3 Seeding Schedules

- 1 Unless otherwise provided, select the type of seeding from the tables shown below for the upper state and the lower state regions as applicable to the project.
- 2 The total seed rate in pounds per acre is the sum total shown for all the varieties of seed opposite the schedule number in the seeding schedules included herein.

810.2.3.1 Permanent Vegetation Seeding Schedules

- 1 The upper state region consists of all counties west of the counties of Aiken, Lexington, Richland, Kershaw, and Chesterfield. The lower state region consists of the above-cited counties and all counties east.

2 Adhere to the following two seeding schedules.

Seeding Schedule for Permanent Vegetation Upper State				
Schedule No.	Common Name of Seed	Pounds/acre		Planting Dates
		Rural	Urban ¹	
1	Common Bermuda (hulled) ³	23	23	March 15 to August 14
	Sericea Lespedeza (scarified) ²	50	50	
	Kentucky 31 Fescue	50	60	
	Weeping Lovegrass ²	10	10	
2	Kentucky 31 Fescue	50	80	August 15 to March 14
	Sericea Lespedeza (unhulled, unscarified) ²	80	80	
	Common Bermuda (unhulled) ³	30	30	
	Weeping Lovegrass ²	10	10	
	Reseeding Crimson Clover ⁴	20	0	
	Annual Rye Grass ⁵	5	15	
	Rye Grain	20	0	
<p>Notes:</p> <p>¹ Includes rural areas adjacent to well-developed lawns.</p> <p>² Not required on shoulders, medians, etc. and on slopes under 5 feet in height.</p> <p>³ Do not use Giant Bermuda seed including NK-37.</p> <p>⁴ Inoculate Reseeding Crimson Clover in accordance with Subsection 810.2.4. Do not plant clover in medians or in rural areas adjacent to well-developed lawns.</p> <p>⁵ The use of Italian Rye Grass is prohibited on all projects.</p>				

Seeding Schedule for Permanent Vegetation Lower State				
Schedule No.	Common Name of Seed	Pounds/acre ¹		Planting Dates
		Rural	Urban	
3 ⁵	Common Bermuda (hulled) ³	30	30	March 1 to August 14
	Weeping Lovegrass ²	10	10	
	Sericea Lespedeza (scarified) ²	50	50	
4 ⁵	Common Bermuda (unhulled) ³	40	40	August 15 to February 28
	Weeping Lovegrass ²	10	10	
	Sericea Lespedeza (unhulled, unscarified) ²	80	80	
	Reseeding Crimson Clover ⁴	20	0	
	Annual Rye Grass ⁷	5	15	
	Rye Grain	20	0	
5 ⁶	Centipede	10	10	March 1 to April 15
<p>Notes:</p> <p>¹ Includes rural areas adjacent to well-developed lawns.</p> <p>² Not required on shoulders, medians, etc. and on slopes under 5 feet in height.</p> <p>³ Do not use Giant Bermuda seed including NK-37.</p> <p>⁴ Inoculate Reseeding Crimson Clover in accordance with Subsection 810.2.4. Do not plant clover in medians or in rural areas adjacent to well-developed lawns.</p> <p>⁵ Pensacola Bahia is allowed only as shown in Seeding Schedules 3 and 4 at the rate of 50 pounds per acre only when seeding pit areas that are governed by the South Carolina Mining Act. Otherwise, do not include Bahia seed in the mix.</p> <p>⁶ Apply one-half of lime rates and one-half of maintenance fertilizer rates. Fertilize centipede at the application rate of 20 pounds per acre of 16-4-8 or 15-0-15 fertilizers in May and repeat in August.</p> <p>⁷ The use of Italian Rye Grass is prohibited on all projects.</p>				

- ³ The Contractor may include quantities of rye grain and millet in Schedule Nos. 1 and 3 to establish quick ground cover for erosion control purposes.

810.2.3.2 Interseeding Schedule

- 1 Adhere to the following schedule for interseeding.

Interseeding Schedule			
Schedule No.	Common Name of Seed	Pounds per acre	Planting Dates
1	Centipede	10	October 15 to July 15

810.2.3.3 Temporary Vegetation Seeding Schedule

- 1 Adhere to the following seeding schedules for temporary vegetation.

Seeding Schedules For Temporary Vegetation Upper and Lower State			
Schedule No.	Common Name of Seed	Pounds per acre	Planting Dates
1	Brown Top Millet	50	April 1 to August 15
2	Rye Grain	55	August 16 to March 31
	Annual Ryegrass ¹	15	
¹ The use of Italian Rye Grass is prohibited on all projects.			

- 2 Add oat grain at the rate of 10 pounds per acre to schedules if the seeding date is between March 1 and April 16.

810.2.4 Inoculants

- 1 Provide an inoculant for treating reseeding crimson clover seed of a pure culture of nitrogen-fixing bacteria selected for a maximum vitality and ability to transform nitrogen from the air into soluble nitrates and deposit them into the soil. Ensure that inoculants consist of purebred cultures and are not more than one year old. All cultures are subject to the approval of the RCE.

810.2.5 Commercial Fertilizer

- 1 Provide commercial fertilizers that comply with state fertilizer laws.
- 2 When a fertilizer is required for any grass, use a mixed fertilizer with a designation such as 10-10-10, where the first number represents the minimum percent of nitrogen required, the second number represents the minimum percent of available phosphoric acid required, and the third number represents the minimum percent of water soluble potash required in the fertilizer.
- 3 For centipede grass, use only 15-0-15 or 16-4-8 fertilizer.

810.2.6 Lime

- 1 Ensure that lime is agricultural grade, standard ground limestone conforming to the current *Rules, Regulations, and Standards of the Fertilizer Board of Control*. These rules, regulations, and standards are promulgated and issued by the Fertilizer Board of Control at Clemson University in accordance with Section 16 of the South Carolina Liming Materials Act. Ensure that each bag has affixed in a conspicuous manner a tag or label, or in the case of bulk sales, a delivery slip showing the brand or trade name, calcium carbonate equivalent, percent by weight passing prescribed U.S. Standard sieves, and other pertinent information to identify lime as agricultural grade, standard ground limestone.
- 2 The Contractor may substitute liquid lime for ground lime if it meets all requirements for agricultural grade lime specified herein, except percent by weight passing U.S. Standard Sieves, which is waived for liquid lime.

810.2.7 Tackifiers as Mulch Binders**810.2.7.1 Emulsified Asphalt**

- 1 If emulsified asphalt is used as a tackifier, ensure that it meets the requirements of **Subsection 407.2.4**. Ensure that emulsified asphalt is diluted at the manufacturing plant with water, if necessary, to provide a homogenous and satisfactory material for spraying.

810.2.7.2 Chemical Tacking Agents

- 1 If a chemical tacking agent is used, ensure that it consists of a polymer synthetic resin, polypectate, liquid latex, or other material that gives similar adhesive properties as asphalt emulsion when sprayed on straw and cellulose fiber mulches. Chemical tacking agents require approval by the RCE.

810.2.8 Straw Mulch

- 1 Use straw mulch material consisting of straw or hay. Use straw that consists of stalks of wheat, rye, barley, oats, or other approved straw. Use hay that consists of Timothy, Peavine, Alfalfa, Coastal Bermuda, or other grasses from sources approved by the RCE. Ensure that these materials are reasonably dry and reasonably free from mature seed-bearing stalks, roots, or bulblets of Johnson Grass, Nutgrass, Sandburg, Wild Garlic, Wild Onion, Wild Mustard, Crotonaria, Pigweed, Witchweed, and Cocklebur. Comply with all state and federal domestic plant quarantine regulations.

810.2.9 Wood Fiber Hydroseeding Mulch

- 1 Use wood fiber hydroseeding mulch made from wood chip particles manufactured particularly for discharging uniformly on the ground surface when dispersed by a hydraulic water sprayer. Ensure that it remains in uniform suspension in water under agitation and blends with grass seed and fertilizer to form homogeneous slurry. Make certain that the fibers intertwine physically to form a strong moisture-holding mat on the ground surface and allow rainfall to percolate the underlying soil. Use a fiber material that is heat processed

and contains no germination or growth-inhibiting factors. Use a fiber material dyed (non-toxic) an appropriate color to facilitate the uniform application of material.

- 2 Use suppliers that certify that their product has been laboratory and field tested and meets all of the foregoing requirements based upon such testing.
- 3 Ensure that the weight specifications from suppliers and for all applications of this material refer only to the absolute air-dry weight of the fiber material. Absolute air-dry weight is based on the normal weight standard of the Technical Association of the Pulp and Paper Industry for wood fiber hydroseeding mulch and is considered equivalent to 10% moisture. Ensure that the manufacturer marks each package of the wood fiber hydroseeding mulch to show the air-dry weight content.

810.2.10 Cellulose Fiber Hydroseeding Mulch

- 1 Use cellulose fiber hydroseeding mulch consisting of recycled magazine stock products shredded into small pieces for application by hydraulic seeding equipment. Ensure that it mixes readily and uniformly under agitation with water and blends with grass seed and fertilizer to form homogeneous slurry. When applied to the ground surface, ensure that the material forms a strong moisture-holding mat, allows rainfall to percolate to the underlying soil, and remains in place until the grass root system is established. Ensure that the material contains no growth inhibiting characteristic or organisms. Obtain mulch from suppliers that certify that their product meets these requirements.

810.2.11 Wood/Cellulose Fiber Mix Hydroseeding Mulch

- 1 If approved by the RCE, use wood/cellulose fiber mix hydroseeding mulch that consists of a combination of **Subsections 810.2.9** and **810.2.10** at a ratio recommended by the manufacturer.

810.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

810.4 Construction

810.4.1 Partial and Temporary Seeding

- 1 Coordinate seeding with the construction of cut and fill slopes. Limit the area of erodible material by bringing partially completed slopes to the required slope and perform seeding operations at that time as directed by the RCE. Temporarily seed slopes to coincide with the embankment work.

810.4.2 Erosion Control Measures

- 1 In addition to the erosion control measures specified herein and in the Plans and the Special Provisions, the Contractor is advised that all land dis-

turbing activities (clearing and grubbing, excavation, borrow and fill) are subject to the requirements set forth in the following permits and regulations:

- South Carolina Code of Regulations 63-380, Standard Plan for Erosion, Sediment, and Stormwater Runoff Control. The regulation may be viewed at the following Internet web address:

<http://www.scstatehouse.net/coderegs/c063.htm>

- Erosion and Sediment Reduction Act of 1983 (Title 48, Chapter 18 of the South Carolina Code of Laws of 1983, as amended). Section 70 of this code authorized the South Carolina Department of Health and Environmental Control (SCDHEC) to administer this regulation with respect to lands under the jurisdiction of the South Carolina Department of Transportation. The code may be viewed at the following Internet web address:

<http://www.scstatehouse.net/code/t48c018.htm>

- National Pollutant Discharge Elimination System (NPDES) General Permit Number SCR100000, effective September 1, 2006: The Environmental Protection Agency, in accordance with the Federal Clean Water Act, has granted to the South Carolina Department of Health and Environmental Control (SCDHEC) the authority to administer the Federal NPDES permit program in the State of South Carolina. The permit may be viewed at the following Internet web address:

<http://www.scdhec.net/environment/water/docs/finalcgp.pdf>

- 2 In accordance with the NPDES General Permit, sign a Co-Permittee Agreement and Contractor Certification statement (shown in Part 3.2D of the General Permit) and require all subcontractors performing land-disturbing activities to sign a Co-Permittee Agreement and Contractor Certification statement as part of their subcontract. These certifications are incorporated into the proposal form for the Contract. By signing either form, the Contractor acknowledges that upon award and execution of the Contract, he/she accepts/understands the terms and conditions of the *Storm Water Pollution Prevention Plan (SWPPP)* as required by the NPDES General Permit and may be legally accountable to SCDHEC for compliance with the terms and conditions of the *SWPPP*. In addition, the Contractor certifies that the NPDES certification statement and/or co-permittee status is made part of all its subcontracts.
- 3 Prepare and submit a *Contractor's Erosion Control Plan (CECP)* to the RCE before the pre-construction conference. Ensure that the plan meets the requirements of the NPDES General Permit. The plan will be reviewed and approved by the Department before commencing any land disturbing activities. Upon approval of the *CECP*, the RCE will complete and forward a *Notice of Intent (NOI)* to SCDHEC. If SCDHEC does not send a letter within 10 business days of receipt of the *NOI*, authorizing coverage, denying coverage, or advising that a review of the *CECP* will take place, coverage will be auto-

matically granted.

- 4 At the pre-construction conference, with all contactors and subcontractors performing land-disturbing activities present, the CECP will be explained and discussed so that each contractor and subcontractor is made aware of their responsibilities in the *CECP*.
- 5 Once approved, fully implement the *CECP*. Coordinate the prompt installation of erosion control devices with construction activities to maintain compliance with the above regulations and NPDES General Permit.
- 6 Conduct an Erosion and Sediment Control Inspection by an appointed Certified Erosion Prevention and Sediment Control Inspector (CEPSCI) from the Contractor and the Department at least every 7-calendar days. Both parties will acknowledge participation in the inspection by signing the inspection report and include their inspector's CEPSCI number on the report. Correct deficiencies noted during these inspections within the assigned priority period. If deficiencies are not corrected within this timeframe, the RCE will stop all work (except erosion and sediment control measures) until the deficiencies are corrected.
- 7 Give special attention to critical areas within the project limits (i.e., running streams, water bodies, wetlands, etc.). In these areas, the RCE may direct the Contractor to undertake immediate corrective action, but in no case allow these deficiencies to remain unresolved more than 7 days or 48 hours in accordance with their assigned priority after being identified during the Erosion and Sediment Control Inspection.
- 8 Closely follow the grading operations with the seeding operations. Shape and prepare the slopes for seeding as the grading progresses. Unless the RCE grants prior written approval, limit the amount of surface area exposed by land disturbing activities to 750,000 square feet. Commence seeding operations within 7 days following completion of construction activities within an area.
- 9 Initiate stabilization measures within 7 days for an area where construction activities will be temporarily or permanently ceased for 21 days or longer.
- 10 Coordinate the installation of all other permanent erosion control items with the grading and seeding operations. These items include, but are not limited to, asphalt gutter and riprap. Construct gutter work before or promptly after the seeding is performed. Place riprap at the ends of pipe immediately after the pipe is laid and promptly install riprap ditch checks after ditch work has been performed.
- 11 Failure to adequately comply with the provisions as detailed above or any other required erosion control measures will result in stoppage of all contract operations (except erosion and sediment control measures) until corrective action has been taken. Additional sanctions may be invoked by the SCDHEC in accordance with their authority.

- 12 Keep the following documents at the RCE's office from the start of construction until the site is finally stabilized:
- Copy of the *CECP*,
 - Copies of all the co-permittee agreements and Contractor certification statements,
 - Copy of the permit,
 - Letter from DHEC authorizing permit coverage, and
 - A marked-up set of site plans.
- 13 When uniform perennial vegetation achieves a cover density of 70%, submit a *Notice of Termination (NOT)* to SCDHEC to terminate coverage. Include a signed statement with the *NOT* certifying that all work on the site has been completed in accordance with the *SWPPP* and the NPDES General Permit for all sites one acre or greater.
- 14 Fines assessed on the Department by SCDHEC as the result of the Contractor's non-compliance or violation of said permit provisions will be paid by the Department and will subsequently be deducted from any monies due or that may become due to the Contractor. In case no monies are due or available, the fines incurred will be charged against the Contractor's Surety.

810.4.3 Stand of Grass

- 1 Before acceptance of the seeding performed for the establishment of permanent vegetation, produce a uniform perennial vegetative cover with a density of 70% of the seeded area. Ensure that the root system is developed sufficiently to survive dry periods and winter weather and is capable of re-establishment in the spring.
- 2 Before acceptance of the seeding performed for the establishment of temporary vegetation, produce a stand of grass sufficient to control erosion for a given area and length of time before the next phase of construction or the establishment of permanent vegetation commences.

810.4.4 Seeding Dates and Rates of Application

- 1 Perform seeding during the periods and at the rates specified in the seeding schedules in **Subsection 810.2.3**. The Contractor may perform seeding work throughout the year using the schedule prescribed for the given period. Do not conduct seeding work when the ground is frozen or excessively wet. Produce a satisfactory stand of grass meeting the requirements of **Subsection 810.4.3** regardless of the period of the year in which the work is performed.
- 2 Perform interseeding during the periods and at the rates specified in the interseeding schedule. Conduct the interseeding with a no-till drill calibrated to deliver the specified rate of seed per acre.

810.4.5 Preparation of Ground Before Seeding

- 1 Ensure that the areas seeded are uniform and conform to the finished grade and cross-section shown on the Plans or as otherwise directed by the RCE. Perform minor shaping and evening of uneven and rough areas outside the graded section as directed by the RCE in order to provide for more effective erosion control and ease of subsequent mowing operations.
- 2 Loosen the seedbed (including cut slopes) to a minimum depth of 3 inches before agricultural lime, fertilizer, or seed is applied. Clear the areas to be seeded of stones larger than 2½ inches in any dimension, roots, and other debris.
- 3 Temporarily seed slopes to coincide with the embankment work in 10-foot increments. When 10 feet of fill is in place, seed the slope. Track the slopes vertically to help hold the seed in place.

810.4.6 Applying Organic Topsoil

- 1 At areas to be grassed where the existing seedbed has little or no topsoil, topsoil may be furnished and placed on the seedbed to ensure a good stand of grass.

810.4.7 Applying Lime and Fertilizer

- 1 When called for in the Contract, spread lime and/or fertilizer uniformly over the designated areas and thoroughly mix with the soil to a depth of approximately 2 inches. Apply fertilizer at the rate of 1000 pounds per acre unless otherwise directed. Apply lime at the rate of 2000 pounds per acre, unless otherwise specified in the Special Provisions, or as authorized by the RCE. Unless otherwise provided, do not apply lime for temporary seeding. Adequately scarify steep slopes, which are inaccessible to power equipment and are subject to slides. Fertilizer may be applied as a mixture of fertilizer and seed by approved mechanical spreaders or by hydraulic methods. When fertilizer is applied in a combination seed and fertilizer drill, no further incorporation is necessary. Apply the fertilizer and seed together when the hydraulic method of seeding is used. Remove all stones larger than 2½ inches in any dimension, larger clods, roots, or other debris brought to the surface.
- 2 A fertilizer of a different analysis than that specified on the Plans may be substituted if approved by the RCE. If a different fertilizer is approved, apply the fertilizer at such a rate per acre to give at least the amount of nitrogen, phosphoric acid and potash as would have been accomplished had the originally specified fertilizer been used and applied at the specified rate. If the substitute fertilizer meets the minimum analysis of at least one or more of the three basic ingredients, do not consider the excess in calculating the required quantity of the substituted fertilizer. Payment is made for the number of tons of fertilizer which would have been required if the originally specified fertilizer had been used at the specified rate.
- 3 For Interseeding, apply fertilizer at the rate of 500 pounds per acre. Use 15-0-15 or 16-4-8 fertilizer.

810.4.8 Permanent Vegetation

- 1 Produce a satisfactory stand of perennial vegetation with a root system that is developed sufficiently to survive dry periods and winter weather, and is capable of re-establishment in the spring. The perennial vegetative cover must have a minimum coverage density of 70% for the seeded areas. Using the seed specified in **Subsection 810.2.3**, determine the rate of application necessary to produce the required stand of grass and follow the application procedures as specified herein.

810.4.9 Temporary Vegetation

- 1 Obtain a satisfactory stand of vegetation that is capable of erosion control. Using the seed specified in **Subsection 810.2.3**, determine the rate of application necessary to produce the required results. Ensure that the temporary vegetation provides minimum density coverage of 70% of the seeded area.

810.4.10 Temporary Seeding

- 1 Sow seed within 24 hours following the application of fertilizer and preparation of seedbed as specified in **Subsection 810.4.5**. Sow seed at the required rate by hand or by methods as outlined in **Subsection 810.4.11**. Compact or cover the seeded areas as specified in **Subsection 810.4.11**. On small areas inaccessible to machinery, the Contractor may cover the seed by hand rakes or other methods satisfactory to the RCE. Apply fertilizer at the rate of 500 pounds per acre or as directed by the RCE. Lime is not required in temporary seeding unless otherwise specified. No tackifiers or mulches are required for temporary seeding.
- 2 The Contractor may use temporary seeding in isolated problem areas or, where it is not feasible or practicable to bring an area to final slope, grade and finish so that the permanent seeding can be performed without subsequent serious disturbance by additional grading.

810.4.11 Seeding (Unmulched)

810.4.11.1 General

- 1 Ensure seeding without mulch (unmulched) conforms to Method A or B as prescribed below, except do not use Method A in urban areas or in areas adjacent to sidewalk, guardrail, curb, curb and gutter, or concrete median.

810.4.11.2 Method A: Seeding with Emulsified Asphalt Tackifier

- 1 Sow seed within 24 hours following the application of fertilizer and lime and preparation of the seedbed as specified in **Subsections 810.4.5** and **810.4.7**. Uniformly sow seed at the rate specified by the use of approved mechanical seed drills, rotary hand seeders, hydraulic equipment, or any other type of equipment that produces a uniform application of the seed.
- 2 Except on steep slopes where mechanical equipment cannot operate satisfactorily, compact all seeded areas by means of a cultipacker or light roller. Compaction is not necessary if seeds are planted by mechanical seed drills that perform a compaction procedure. On slopes that are inaccessible to

compaction equipment, cover the seed by dragging spiked-chains, by light harrowing, or by other methods satisfactory to the RCE.

- 3 Within 24 hours following compaction of the seeded areas, uniformly apply emulsified asphalt, diluted at the manufacturing plant with an equal amount of water, over the seeded areas at a rate of 0.15 to 0.32 gallon of the dilution per square yard. The RCE will determine the exact rate of application.
- 4 Before spraying emulsified asphalt, cover parts of bridges, culverts, guard-rail, signs, sidewalk, curb and gutter, catch basins, pipe ends, and other structures as necessary to prevent discoloration.

810.4.11.3 Method B: Seeding with Wood Fiber Mulch Tackifier, Cellulose Fiber Mulch Tackifier, or Wood/Cellulose Fiber Mix Tackifier

- 1 Apply lime and prepare the ground as shown on the Plans or as directed by the RCE in accordance with **Subsections 810.4.5** and **810.4.7**. Choose one of the following tackifiers: wood fiber tackifier, cellulose fiber tackifier, or wood/cellulose fiber mix tackifier and apply with a mixture of water, seed, and fertilizer at the rate of 1500 pounds per acre. Use hydraulic equipment for the application of slurry of water, fertilizer, seed, fiber, and tackifier. Use equipment with a built-in agitation system and an operating capacity sufficient to agitate, suspend, and homogeneously mix the slurry. Ensure that the slurry distribution lines are large enough to prevent clogs. Equip the discharge line with a set of hydraulic spray nozzles to provide even distribution of the slurry on the various areas seeded. Use a slurry tank with a minimum capacity of 1000 gallons.
- 2 Combine all of the seed, fertilizer, tackifier, and water into the slurry tank for distribution of all ingredients in one operation by the hydraulic seeding method specified herein. Combine the materials in a manner recommended by the manufacturer. Regulate the slurry mixture so that the amounts and rates of application result in a uniform application of all materials at rates not less than the amounts specified. Using the color of the slurry as a guide, spray the prepared seedbed with a uniform visible coat. Apply the slurry in a sweeping motion in an arched stream falling like rain and allow the slurry to build upon itself until an even coat is achieved.

810.4.12 Seeding (Mulched)

810.4.12.1 General

- 1 Ensure that seeding with mulch conforms to Method A, B, or C as prescribed below, except do not use Method A in urban areas or in areas adjacent to sidewalk, guardrail, curb, curb and gutter, or concrete median.

810.4.12.2 Method A: Seeding with Straw or Hay Mulch

- 1 Sow seed as specified in Method A of **Subsection 810.4.11**. Within 24 hours following covering of the seed, uniformly apply straw or hay mulch material at the rate of 2 tons per acre. Spread mulch by hand, by appropriate mechanical spreaders, or by blowers. Use mulch that allows sunlight to penetrate and air to circulate but also partially shades the ground and conserves

soil moisture. Use emulsified asphalt meeting the requirements of **Subsection 810.2.7.1**, or other approved tacking agent, to hold the newly laid mulch in place.

- 2 Ensure that the emulsified asphalt is diluted at the manufacturing plant with an equal amount of water. Uniformly apply the material as a film over the mulch at approximately 0.20 gallon of dilution per square yard. Make certain that the film is sufficient to bond together the mulch particles without giving a heavy coating of the asphalt material. Ensure that the film prevents wind erosion. Other tacking agents may be used and applied at the manufacturer's recommended rate. Replace displaced mulch.

810.4.12.3 Method B: Seeding with Straw and Hydroseeding Mulch

- 1 Apply seed as in Method A in **Subsection 810.4.11**, then cover with straw tacked with the manufacturer's recommended rate of wood, cellulose, or a wood/cellulose mix hydroseeding mulch; or straw tacked with manufacturer's recommended rate of a combination of tacking agent and any of the aforementioned hydroseeding mulches.

810.4.12.4 Method C: Hydroseeding

- 1 Hydroseed using 1500 pounds per acre of wood, cellulose, or a wood/cellulose mix hydroseeding mulch with the manufacturer's recommended rate of an approved tacking agent.

810.4.13 Application of Nitrogen

- 1 As soon as the plants show satisfactory growth, apply nitrogen evenly at the rate of 48 pounds per acre on the areas designated by the RCE. Unless otherwise permitted, apply the nitrogen in a solid form rather than in a liquid state. Do not apply nitrogen to stands of *sericea lespedeza*. Unless otherwise provided, do not apply nitrogen to temporary vegetation.

810.4.14 Mowing

- 1 Mow areas seeded or sodded under the Contract, or other areas as necessary, to maintain the project in a satisfactory manner. Perform mowing where directed by the RCE. Commence mowing within three business days following verbal notification by the RCE. Failure to comply with the above may be grounds for stopping work on the project or withholding payment of the next pay estimate.
- 2 Use mowing equipment equipped with safety devices designed to prevent injury or property damage caused by flying debris propelled from under the mowing equipment. Keep all mowing equipment in good operating condition and maintain to provide a clean, sharp cut of vegetation at all times. If the RCE determines the equipment is defective to the point that the quality of work or safety is affected, immediately repair or replace the equipment.
- 3 Ensure that mowing results in a vegetation height of 4 to 6 inches, unless otherwise directed by the RCE. Mow as closely as possible to all fixed objects, exercising care not to damage trees, plants, shrubs, signs, delineators,

or other appurtenances that are a part of the facility. Hand trim around such objects if required and to the satisfaction of the RCE.

- 4 Immediately remove and properly dispose of any debris thrown on the roadway by the mowing operation. Mowed grass is not normally removed unless it becomes a hazard as determined by the RCE.
- 5 Do not perform mowing when, in the opinion of the RCE, soil and weather conditions are such that rutting or other damage to the project may occur. The three-business day period noted above will be extended until the soil and weather conditions become suitable for mowing on the project.

810.4.15 Maintenance

- 1 Perform all maintenance necessary to keep seeded areas in a satisfactory condition until the work is finally accepted. This includes mowing, repairing washes, and additional applications of seed, fertilizer, and mulch to areas where a satisfactory stand of grass has not been achieved.

810.5 Measurement

- 1 The quantity for Permanent Vegetation, Temporary Vegetation, Temporary Seeding, Seeding (Unmulched), or Seeding (Mulched) is the ground surface area with acceptable vegetation or stand of grass and is measured by the one-thousand square yard (MSY) unit, complete, and accepted.
- 2 The quantity of Interseeding is the ground surface area acceptably interseeded and is measured by the one-thousand square yard (MSY) unit, complete, and accepted.
- 3 The quantity of Fertilizer or Lime is the weight of fertilizer or lime applied, and is measured by the ton (TON), complete, and accepted. The quantity of Nitrogen is the actual weight of nitrogen applied and is measured by the pound (LB), complete, and accepted. Weights are determined by approved scales or by guaranteed weight of sacks shown on the manufacturer's tag. Furnish invoices of the above materials received on the project to the RCE.
- 4 The quantity of Mowing is the area of ground surface area mowed at the direction of the RCE and is measured by the one-thousand square yard (MSY) unit, complete, and accepted. Separate measurements will be made and added to the quantity for payment each time the area is mowed.
- 5 The quantity of Organic Topsoil is the volume of organic topsoil placed on site and is measured by the cubic yard (CY), complete, and accepted.

810.6 Payment

- 1 Payment for the accepted quantity for each pay item, measured in accordance with **Subsection 810.5**, is determined using the contract unit bid price for the applicable pay item, and the payment includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Payment for Permanent Vegetation or Temporary Vegetation is full compensation for furnishing and placing vegetative materials (including fertilizer,

lime, and nitrogen when called for) as specified or directed and includes all other materials, labor, equipment, tools, supplies transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

- 3 Payment for Temporary Seeding, Seeding (Unmulched), or Seeding (Mulched) is full compensation for furnishing and placing all seeding materials (excluding fertilizer, lime, nitrogen, and selected material for shoulders and slopes) as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. Payment will not exceed 90% of the contract unit bid price for these items until a satisfactory stand of grass meeting the requirements of **Subsection 810.4.3** is established.
- 4 Payment for Interseeding is full compensation for interseeding an area as specified or directed and includes furnishing and placing seeds; aerating the existing turf; providing and applying herbicide and nonionic surfactant (if required with herbicide); and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 5 Payment for Fertilizer, Lime, or Nitrogen is full compensation for furnishing and applying fertilizer, lime, or nitrogen as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 6 Payment for Mowing is full compensation for mowing vegetation to an acceptable height in areas as specified or directed and includes all other materials, labor, equipment tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. No adjustment in unit price will be made in case of overruns or underruns of this item.
- 7 Payment Organic Topsoil is full compensation for furnishing and placing organic topsoil as specified or directed and includes all other materials, labor, equipment, tools, supplies and transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 8 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 9 Pay items for this section include the following:

Item No.	Pay Item	Unit
810001	Permanent Vegetation	MSY

(table continued on the next page)

(table continued from the previous page)

Item No.	Pay Item	Unit
8101000	Seeding (Mulched)	MSY
8102100	Seeding (Unmulched)	MSY
8102700	Interseeding	MSY
8103000	Temporary Seeding	MSY
8103100	Temporary Vegetation	MSY
8104100	Fertilizer (10-10-10)	TON
8104200	Fertilizer (8-8-8)	TON
8104300	Fertilizer (16-4-8)	TON
8104400	Fertilizer (15-0-15)	TON
8104410	Fertilizer (15-15-15)	TON
8105000	Lime	TON
8106000	Nitrogen	LB
8109900	Mowing	MSY
8101100	Organic Topsoil	CY

SECTION 811

FURNISH AND PLANT TREES, SHRUBS, VINES AND GROUND COVERS

811.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the furnishing, delivering, and planting of trees, shrubs, vines, and ground cover plants and their maintenance in conformity with the Plans and the Specifications or as directed by the RCE.

811.2 Materials

811.2.1 Plant Materials

811.2.1.1 Quality of Plant Materials

- 1 Provide plants that are first-class representatives of their normal species or varieties unless otherwise specified as street-tree, specimen, extra heavy, clump, or other of like import according to the particular exception.
- 2 Unless otherwise specified, provide plants that are nursery-grown stock that have been transplanted or root-trimmed two or more times according to the kind and size of plants. Ensure that the branch system has a normal development and free from disfiguring knots, sunscald, injuries, abrasions of the bark, dead or dry wood, broken terminal growth, or other objectionable disfigurements. Ensure that the trunks are undamaged. Provide trees that have reasonably straight stems and that are well branched, symmetrically shaped, and typical of their species.

811.2.1.2 Plant Names

- 1 Provide plants with names in conformance with scientific and common plant names found in *Standardized Plant Names*, as adopted by the American Joint Committee on Horticultural Nomenclature, the edition of which was in effect at the time of the project was advertised for bids. If a plant name is not included therein, provide a plant with a name that is general in conformance with the name accepted in the nursery trade.
- 2 Provide plants that are true to the name and are legibly tagged with the name and size of the plant. In all cases, botanical names take precedence over common names.

811.2.1.3 Substitutions

- 1 No substitutions, deletions, or additions are permitted without the approval of the RCE. The RCE may allow substitutions after award of the Contract only upon submission of proof that a plant is not obtainable within 400 miles of the site. The SCDOT Landscape Architect may authorize a change order providing the use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of contract unit price.

811.2.1.4 Grading Standards

- 1 Ensure grading of plants conforms to the *American Standard for Nursery Stock (ASNS)*, as approved by the American Nursery & Landscape Association (ANLA) in effect at the time the project was advertised for bids and to any further requirements that appear in the Special Provisions. This includes measuring, branching, grading, and quality of balling and burlapping standards.

811.2.1.5 Nursery Inspection & Plant Quarantine

- 1 Provide plants that are free from plant diseases and insect pests. Ensure that all shipments of plants comply with all nursery inspection and plant quarantine regulations of the State of origin and destination, as well as with federal regulations governing interstate movement of nursery stock. Ensure that a valid copy of the certificate of inspection accompanies each package, box, bale, truckload, or carload shipped or otherwise delivered.

811.2.1.6 Balled and Burlapped Plants

- 1 Provide balled and burlapped plants that have been dug to retain as many fibrous roots as possible and come from soil that forms a firm ball. Ensure that the soil in the ball is the original and undisturbed soil in which the plant was grown. Use plants that were dug, wrapped, transported, and handled in such manner that the soil in the ball is not so loosened that it causes stripping of the small and fine feeding roots or causes the soil to drop away from such roots.

811.2.1.7 Container Grown Plants

- 1 Provide plants in containers that are well rooted and established in the container in which they are shipped. Provide established container grown plants that have been transplanted into a container and grown in that container sufficiently long enough for the new fibrous roots to have developed a root mass that retains its shape and holds together when removed from the container. Do not remove the grown stock from containers until planting time. Plants that are severely root bound in the containers are unacceptable.

811.2.1.8 Bare Rooted Plants

- 1 Provide the minimum root system of bare rooted trees or shrubs that conform to the standards stated in the *ASNS*. Only dig bare rooted plants when the air temperature exceeds 35°F. Give particular attention to the fibrous roots. Ensure that the maximum time lapse between loading for shipment and delivery to the work or approved storage site is four days unless other shipping arrangements are approved by the RCE.

811.2.1.9 Collected Plants

- 1 When collected plants are specified in connection with any species or variety, provide plants that have not been nursery grown, but that have been grown under natural conditions at the location from which they were procured. Provide collected plants either balled and burlapped or bare rooted as speci-

fied in the plant list on the Plans. In either case, use collected material conforming to the applicable requirements given in the current edition of *ASNS* for quality, size, ball, and grade.

811.2.1.10 Forms, Shapes, and Condition of Plants

811.2.1.10.1 Vines and Ground Covers

- 1 Use vines and ground cover plants conforming to grades and specifications shown in the *ASNS* unless otherwise specified.

811.2.1.10.2 Plants

- 1 If approved by the RCE, plants that are larger than specified in the plant list may be provided, but furnishing of such plants does not increase the contract unit price. Ensure that plants designated on the Plans as street trees, specimen, extra heavy, clump, or of other like import conform to the standards as given in the *ASNS* for the special type specified.

811.2.1.10.3 Trees

- 1 Provide trees that have straight trunks, are well branched, and have symmetrical tops. Ensure that cuts in limbs over ¾-inch in diameter have completely healed over. Provide trees that have the top and root characteristics of their variety and growth that is typical of such trees in this region. Provide deciduous trees, unless otherwise specified, that have branching between 1/4 and 1/2 the distance of their height from the ground. Provide trees designated on the Plans as street-trees, specimen, extra heavy clump, bush form, or other special designation that conforms to the standards in the *ASNS* unless otherwise specified. When street trees are specified, provide trees of uniform branching height. When bush form is specified, provide trees with branching at the base of the plant or within 1 foot of the base. When clumps are specified, provide plantings that have three or more main leaders or trunks starting at the ground and at least two of these leaders are of the caliber specified.

811.2.1.11 Inspection

- 1 Plant materials are subject to inspection at any time during the Contract, and such inspection is not the final acceptance of the plants involved. The RCE will reject stock that does not conform to these specifications. Remove rejected stock from the project.
- 2 Notify the RCE in advance as to when the stakes are set to show position of holes for trees and shrubs; when holes are dug to receive trees, shrubs or vines; when the plant materials are assembled for inspection before planting; and when the planting is done.

811.2.1.12 Shipment

- 1 Take all precautions that are customary in good trade practice to ensure the arrival of the plants in good condition. Pack and cover plants in a manner that ensures adequate protection against damage while in transit. Carefully protect the roots of bare root plants with wet straw or other suitable material to

ensure the arrival at destination with the roots in a moist condition. When shipment is made in an enclosed vehicle, ensure that the vehicle is adequately ventilated to prevent overheating of the plants in transit.

811.2.1.13 Certificate of Compliance

- 1 Furnish certificates of compliance from all plant supply sources certifying that all plants provided comply with the requirements specified in these specifications.

811.2.2 Topsoil

- 1 Provide fertile, friable topsoil containing a normal amount of organic matter and is reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than 1 inch in size, coarse sand, noxious seeds, brush, litter, or other deleterious substances. Provide topsoil that is free from toxic amounts of either acid or alkaline elements and is capable of sustaining healthy plant life. Do not use topsoil that is stripped from below the average depth of fertility and in no case more than 12 inches. All topsoil is subject to inspection during the planting period. The RCE may reject all material that does not meet the specifications.

811.2.3 Fertilizer and Lime

- 1 Provide fertilizer and lime conforming to the requirements specified in **Subsections 810.2.5** and **810.2.6** respectively.

811.2.4 Super-phosphate

- 1 Provide super-phosphate composed of finely ground phosphate rock commonly used for agricultural purposes containing not less than 18% available phosphoric acid.

811.2.5 Mulch Materials

- 1 Provide mulch consisting of medium grade, pine bark, or shredded pine-wood containing bark, or other approved material. Do not use mulch that contains noxious weed seeds, soil, sawdust, or any substance toxic to plant growth.

811.2.6 Miscellaneous Material

811.2.6.1 Water

Provide water in the planting or care of vegetation that is free from oil, acids, alkalis, salts, or any substance injurious to plant life.

811.2.6.2 Stakes for Bracing and Anchoring

- 1 For bracing or supporting trees, use stakes of cedar, locust, oak, or other approved wood free from knots, rot, cross grain, or other defects that would impair the strength of the stake. Use stakes that are a minimum 2 inches square in cross-section and of adequate length. Paint or stain bracing stakes dark green.

811.2.6.3 Weed Control Cloth

- 1 Provide a weed control cloth that is an approved geotextile landscape fabric made of polypropylene, black in color, and UV stabilized. Ensure that the weed control cloth weighs from 4.8 to 5.3 ounces per square yard. Black plastic film is not acceptable.

811.2.6.4 Porous Material

- 1 For tree root protection, provide porous material that consists of gravel, crushed stone, slag, or other porous material varying in size from 1 to 3 inches. RCE approval of all porous material is required prior to use.

811.2.6.5 Pipe

- 1 Use pipe for underdrains that comply with **Subsection 802.2** of the size and type specified.

811.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

811.4 Construction**811.4.1 Clearing and Grubbing**

- 1 When clearing and grubbing is required in landscaping projects, perform the work in accordance with the requirements of **Subsection 201.4** with the following additions or exceptions: the RCE may require some selective thinning or removal of trees or plants and may require trimming on selected trees to remain in place.

811.4.2 Grading

- 1 Perform the required grading work in accordance with the requirements of **Subsection 203.4**, with the following addition:
 - A. Give special attention to the elimination or reduction of construction scars.
 - B. Grade the slopes with transitions blending into each other to give a pleasing appearance and to reduce cost of maintenance.
 - C. The first operation of grading is the stripping of topsoil as directed by the RCE and stockpiling it for convenient use in planting of grass, trees, shrubs, vines, etc. This material is subject to the requirements of **Subsection 104.9**.

811.4.3 Planting Season

- 1 It is the responsibility of the Contractor to coordinate all phases of planting. Plant all trees, shrubs, vines, etc. between the first of November and the middle of March. The RCE may permit planting at other times when necessary.

Do not plant when, in the judgment of the RCE, the weather and soil conditions are unfavorable.

811.4.4 Reception and Care of Plant Materials

- 1 Handle plants so that the roots are adequately protected at all times from drying out, freezing, or from other injury. If plants with balled and burlapped roots are not planted immediately on delivery, protect them with moist soil or other acceptable material and keep watered until planted. If bare rooted plants are not planted immediately on delivery, heel-in immediately in moist soil and keep watered until planted.
- 2 The Contractor is responsible for loss due to theft. Replace all plants lost due to theft at no additional charge to the Department, until the initial construction inspection is completed.

811.4.5 Locating Planting Pits

- 1 Place a stake where each planting is to be planted. Have the RCE approve staking before the planting pits are dug. The RCE may require variations from the Plans. Do not plant any plant material in drainage ditches or within the minimum clear distance from the edge of travelway.

811.4.6 Preparation of Planting Pits

- 1 Clear out all weeds, brush, etc. within a radius of 5 feet from the center of each plant.
- 2 Prepare planting pits and beds before or concurrently with excavation of the plants so that no delay occurs because the planting areas are not ready. Plant all plant materials in pits, except those specifically designated on the Plans to be planted in beds.
- 3 Construct all planting pits in a circular shape with vertical, roughened sides, and flat bottoms. Measure the depths of planting pits, specified below, from finished grade. Construct pits that are relatively shallow so that the root ball rests on undisturbed or tightly packed soil and the root collar/root flare (the location of the first main horizontal root) is 1 to 2 inches above existing grade after planting. Ensure that the diameter of pits for trees, shrubs, and vines are at least 2 feet greater than the diameter of the ball, container, or spread of roots. Ensure that the minimum depth of pits for all shrubs and vines is 16 inches and that the depth is increased as much as is necessary to accommodate the ball or roots when the plant is set to grade. Plant bare rooted shrubs and vines in pits at least 1 foot greater in diameter than the spread of roots.
- 4 During the excavation of planting pits, place any soil meeting the specifications for topsoil in piles separate from the poorer subsoil.
- 5 Verify that each excavated tree or shrub pit percolates (drains) before adding topsoil and installing the tree or shrub. Fill the bottom of the pit with 6 inches of water. Make certain that the water percolates within a 24-hour period. The RCE will check the accuracy and effect of percolation testing. If the soil at a given area does not drain properly, relocate the plantings or install a

PVC drain or gravel sump. If the soil is consistent throughout the project site, RCE may select representative tree or shrub pits to be tested for drainage.

- 6 If unsatisfactory surface or subsurface drainage conditions, soil depth, latent soils, hard pans, steam or other utility lines, or other conditions that jeopardize the health and vigor of the plants is encountered, advise the RCE in writing of the conditions prior to installing the plants. Otherwise, the Contractor warrants that the planting areas are suitable for proper growth and development of the plants installed.
- 7 Do not leave any excavation or planting pit unattended or open overnight, except pits for percolation tests, which should be covered or roped-off.
- 8 RCE approval of the suitability of planting pits is required before planting. After approval, partly fill and compact with a suitable backfill mixture to a depth of 6 inches. Perform the operation either before or after the depth of the pit is tested for the individual plant to go in it. Repeat the operation if the loose soil is removed to deepen the pit. Ensure that mixed soil in beds is moist but does not contain excessive water to cause puddling or un-due compaction at the time plants are set.

811.4.7 Preparation of Soil for Backfill

- 1 Use backfill mixture for filling plant pits that consists of 75% (by volume) of acceptable topsoil and 25% (by volume) of composted organic matter or other approved material. During planting, add 3 pounds of 4-12-12 or equivalent fertilizer to each cubic yard of backfill mixture. Thoroughly mix the topsoil, organic matter, and fertilizer before placing into the pits or beds. Slow-release fertilizer tablets may be used at rates according to manufacturer's instructions.

811.4.8 Special Acid Soil Mixture

- 1 Ensure that Rhododendron, Kalmia, Azalea, and other members of the Heath family (Ericaceae); Thea, Camellia, Gardenia, and other members of the Tea family (Theaceae); and other shrubs that require an acid soil have the notation in the tag legend "Require Acid Soil." Use "Woods Earth" backfill around them or a rich topsoil and leaf mold or rich topsoil and peat moss backfill mixture. Thoroughly mix 1 pound of cottonseed meal to each 5 cubic feet of backfill. Do not place any commercial fertilizer of unknown composition, bone meal, lime ashes, limestone soil, fresh manure, or other alkaline material around them.

811.4.9 Planting

- 1 Identify the root collar (root flare) in the root ball and remove soil above it so that the root collar is exposed at top of ball. Set plants at a level that, after settlement, ensures that they bear the same relation to the level of the surrounding ground as they bore to the ground from which they were dug. Plant them upright and faced to give the best appearance. When shrubs vary in height, place the larger shrubs in the center of the group or at its wider parts. In the case of balled and burlapped plants, remove all burlap, cloth, twine,

wire, etc. from the tops and sides of the balls but do not pull any burlap or cloth out from under the balls. Spread the roots of barerooted plants to approximately their original position and work in the prepared soil mixture carefully among them. Cut all broken or frayed roots cleanly. Add and tamp back-fill in successive 8-inch layers. When the hole is nearly filled, pour water in and allow soaking so that all voids or air pockets under or around the roots are eliminated. After the water has soaked down, fill the hole with the prepared soil. Place a mound of topsoil around the edge of each pit to form a shallow saucer capable of holding water.

- 2 Use pre-emergent herbicides unless otherwise indicated in the notes on the Plans or in the Special Provisions. After planting, treat tree, shrub, and ground cover beds with Ronstar G., Treflan, or a comparable pre-emergent herbicide, which does not harm the type plants installed in the beds. Use these herbicides strictly according to manufacturer's direction as to methods of application, quantity, and precautions for the safe and effective use of the product.

811.4.10 Mulching

- 1 Place mulch material, satisfactory to the RCE, as a top layer on the back-filled plant hole after all planting operations have been completed. Place the mulch in a "doughnut" shape with no mulch touching the trunk of the tree. In general, ensure that this layer of mulch may be up to 3 inches in depth, but vary it according to the climatic conditions and to the type of material used. The RCE will determine the appropriate depth for this material. Place mulch within 48 hours after planting.
- 2 Use weed control cloth meeting the requirements of **Subsection 811.2.6.3** unless otherwise specified on the Plans or in the Special Provisions.

811.4.11 Transplanting Selected Trees and Shrubs

811.4.11.1 General

- 1 Transplant plants on the project as indicated or listed on the Plans or in the Special Provisions. Transplant using the diameter of ball or root system, method of planting for each kind and size of plant, etc. as specified on the Plans or in the Special Provisions. Conform to requirements of the transplanting methods as specified in **Subsections 811.4.11.2** through **811.4.11.6** below.

811.4.11.2 Ball and Burlap

- 1 Excavate the plant with a ball of earth and securely wrap the ball in burlap. Ensure that the solidity of the ball is preserved. Use nursery workers experienced in this type of work. Employ this method for evergreens and other plants likely to be injured by moving without a ball.

811.4.11.3 Canvas and Platform

- 1 Excavate a large ball of earth and wrap its circumference in a canvas and rope apparatus made for the purpose and then place and fasten on a platform

made for the purpose. Use an apparatus and procedure that meets the approval of the RCE. Use nursery workers experienced in this type of work. A truck with a windlass may be required. Employ this method for plants with balls of earth weighing over 800 pounds.

811.4.11.4 Tree-Moving Machinery

- 1 Move trees over 6 inches in diameter with appropriate tree-moving slings and lifting equipment. Obtain the RCE approval of both the apparatus and procedure. Use equipment operators experienced in this type of work.

811.4.11.5 Loose Ball

- 1 Excavate and move the plant with as much dirt as practicable adhering to the roots but without wrapping the ball in burlap or necessarily keeping the ball solid. Excavate the plant without shaking the dirt from the roots and place it carefully on a piece of burlap. Carry the plant to the new position with two or more persons or in a wheelbarrow and carefully place it in the pit with or without taking it off the burlap. Ensure that the dirt does not fall off the roots. Use this method for most shrubs and some evergreens that do not have to be moved more than 200 feet.

811.4.11.6 Bare Root

- 1 Excavate and move the plant without keeping dirt on the roots. Use this method only for plants that are not ordinarily injured greatly by moving in this manner and that do not readily hold the dirt to their roots.

811.4.12 Wrapping

- 1 Do not wrap trees unless indicated in the plant list on the Plans or in the Special Provisions. If indicated, wrap trees as follows: promptly after planting, wrap the trunks of all deciduous thin-barked trees spirally from the ground line to the height of the second branches or to the height directed by the RCE using burlap or heavy crepe paper strips 6 to 10 inches wide, which is then securely tied with twine.

811.4.13 Top Pruning

- 1 Prune branches as directed by the RCE and in conformance with the following general principles of pruning:
 - Remove branches that are undesirable, weak or damaged, tend to cross the plant, detract from the appearance of the plant, and hang too low. Cut back enough of the branches to balance the roots that are cut on plants that usually undergo a severe setback when transplanted, such as Oaks (*Quercus*), Hawthorn (*Crataegus*), Firethorn (*Pyracantha*), etc.

811.4.14 Retaining Walls and Tree-Wells

- 1 Construct retaining walls around the roots of trees and shrubs and tree-wells around the trunks of trees and shrubs at the locations and to the shape and dimensions shown on the Plans or as otherwise directed. Use mortar and rubble masonry, dry rubble masonry, or other type of masonry that conforms to the requirements of **Section 718**. Only use dry rubble masonry in

any portion of tree-wells extending below the top of contiguous porous material used for tree root protection. Ensure that the inside face of a tree well is not less than 2 feet from the outside edge of the trunk of the tree or shrub. Do not place any material between the tree trunk and the wall of the tree-well.

811.4.15 Tree Root Protection

- 1 Where tree root protection is specified, protect the entire area of the root spread. Mark the limits of this area and, in general, make this area correspond to the area of the ground surface lying beneath the limb spread of the tree. First, thoroughly clean this area of all vegetation and debris. Next, place porous material as specified in **Subsection 811.2.6.4** uniformly over the area to a depth in proportion to the height of fill, varying proportionally from 3 inches for fills of 1 foot or less, 12 inches for fills of 4 feet or more, or such other depths as may be designated. Then place a layer of No. FA-12 or No. FA-13 sand or other approved material in sufficient quantity to choke the top layer of porous material.
- 2 Where the earth fill is less than 12 inches and tree root protection is specified without the construction of a tree-well, increase the thickness of the porous material at the tree trunk to the height of the fill and extend it outward from the tree trunk in collar form for a distance of 12 inches unless otherwise shown on the Plans. Use rubble aggregate as specified in **Section 718** for placement against the tree trunk.
- 3 Do not place fill over the root spread of any tree or shrub that is to be protected in the above manner until the required depth of porous material has been placed.

811.4.16 Pipe Underdrains

- 1 Place pipe underdrains to drain tree-wells or porous material placed for tree root protection as shown on the Plans or as directed by the RCE. Place these pipe underdrains in conformance with the applicable requirements of **Section 802**.

811.4.17 Staking

- 1 Stake all trees having a diameter of 2½ inches or less. Provide stakes that are approximately 8 feet in length and drive into firm ground at least 2 feet if driven outside the planting pit and at least 2½ feet if driven in the pit area. Tie trees to the stakes by garden hose through which wire has been strung or nylon strips with eyelets manufactured specifically for tree staking in a manner that does not injure the trees. Stake the trees in an approved manner so that they present the most satisfactory appearance.

811.4.18 Guying

- 1 Guy trees over 2½ inches in diameter with three guys consisting of two strands of No. 12-gauge galvanized wire placed at approximately equal distances from each other. Tighten guys by twisting the strands together. Ensure that wires are covered with rubber hose or heavy cloth padding at the point of contact of the guy with the tree. Locate the guy on the tree in a man-

ner to avoid pulling tree crotches apart. Run wires from the trunk of the tree at a point about 8 feet above the ground at an angle of about 45 degrees to stakes driven in the ground. As far as possible, place guys to avoid danger of persons tripping over them. Place brightly colored flagging uniformly on guys for easy sighting.

811.4.19 Clean-Up

- 1 At the conclusion of the work, remove and dispose of unused soil, sticks, stones, and other unsightly refuse as directed by the RCE. Fill and tamp holes left by relocating plants. Smooth and dress planted area. Regularly clean streets and paved areas to remove construction materials and other debris resulting from the work.

811.4.20 Inspection

811.4.20.1 Initial Construction Inspection

- 1 The RCE will perform the Initial Construction Inspection within 15 days after notification that all work including final cleanup has been completed. This inspection serves only to check workmanship and is not for the acceptance of plantings.

811.4.20.2 Final Inspection

- 1 The RCE will conduct the Final Inspection on or before the end of the establishment period. At that time, the RCE will determine which plants are rejected or missing and need replacing.

811.4.20.3 Replacements

- 1 Replace plants rejected or designated to be replaced by the RCE during the Final Inspection within 30 calendar days following the Final Inspection or during the next planting season as directed by the RCE.
- 2 Replace plantings using the methods and procedures outlined previously for initial plantings. Furnish, install, and care for the replacement plantings for a 90-day period without any additional compensation.
- 3 If any of the replacement plantings are defective, missing, or otherwise unsatisfactory at the end of the 90-day period, replace with satisfactory plantings.

811.4.20.4 Establishment Period Inspection

- 1 The RCE will make regular inspections throughout the plant establishment period. These serve as an inspection of the care and maintenance performed by the Contractor. Ensure that, after notification from the RCE of a problem with the care and maintenance, the problem is corrected within 10 working days. Failure to perform maintenance may result in a delay in the payment midway through the plant establishment period as specified in **Subsection 811.5**.

811.4.21 Establishment Period

- 1 The plant establishment period is the 12-month period following the Initial Construction Inspection.

811.4.22 Plant Establishment Work

- 1 Perform the following work during the plant establishment period: fertilizing and watering as necessary as described below, adding mulch to saucers, pruning, weeding, pest control, repair, adjustment of guys, stakes, and saucers, and any other work deemed necessary by the RCE.

- 2 Fertilize all ground covers, shrubs, and trees in mid-spring with 16-4-8 fertilizer as follows or as otherwise directed by the RCE:

- For ground cover beds and small shrubs, apply 2 pounds per 100 square yards.
- For medium and large shrubs, apply ½ cup to each shrub.
- For trees, apply at the rate of 1½ pounds per inch of trunk diameter.

Spread fertilizer evenly in the area under the end of the branches and thoroughly water the plants afterward.

- 3 Water plantings as follows:

Water trees, shrubs, and ground covers by filling plant saucers a minimum of once every two weeks during dry periods, which is a period of less than 1 inch of rain in one week, recorded weekly. When watered, ensure that each tree receives a minimum of 5 gallons of water and that each shrub receives a minimum of 2 gallons of water. Watering is required only during March, April, May, June, July, August, September, and October.

- 4 At the end of the plant establishment period, or when directed by the RCE, remove all stakes, wire, hoses, etc. used to stake trees. Dispose of all materials off-site.

811.5 Measurement

- 1 The quantity for the pay item Plant (*landscape planting*) is measured by each (EA) specified tree, shrub, ground cover, or vine transplanted or provided and planted, and established, complete, and accepted.
- 2 The quantity for Porous Material for Root Protection is the weight of the protective fill material provided in-place and is measured by the ton (TON), complete, and accepted.
- 3 The quantity for Drain Tile or Pipe is the length of the drain tile or pipe in-place and is measured by the linear foot (LF) along the center of the drain tile or pipe installed from end to end, complete, and accepted.
- 4 Herbicide, weed control cloth, mulch, and other items used in preparation of planting are considered incidental to the planting work and included in the unit bid price for each landscape planting item; and therefore, no separate meas-

urement is made for this work.

- 5 Work and materials for backfilling plant pits are considered as incidental to the planting work and included in the unit price for each landscape planting item; and therefore, no separate measurement is made for this work.
- 6 Plant establishment and maintenance work and materials is considered as incidental to the planting work and included in the unit price for landscape planting item; and therefore, no separate measurement is made for this work.
- 7 The measurement and payment for Rubble Masonry and Rubble Masonry Tree-Well, either grouted or dry, is as specified in **Subsections 718.5** and **718.6**, respectively.

811.6 Payment

- 1 Payment for the accepted quantity for each pay item, measured in accordance with **Subsection 811.5**, is determined using the contract unit bid price for the applicable pay item, and the payment includes all direct and indirect costs and expenses necessary to complete the work.
- 2 Payment for a *Landscape Planting* (of the specified type) is made in accordance with the following progress payment schedule:
 - Payment at 90% of the total payment for each landscape planting item is made when the tree, shrub, or vine has been completely planted to the satisfaction of the RCE. The remaining portion of the payment is reserved for maintenance and plant replacement required during the plant establishment period.
 - At the midway point of the plant establishment period, the RCE may approve an additional 5% of the total payment for each landscape planting item.
 - After the final inspection, payment is made of the unpaid balance such that the total amount paid does not exceed 100% of the total payment for each landscape planting item accepted during the final inspection.
 - Payment at 100% is made after all necessary replacements are planted and final acceptance is made by the RCE.
- 3 Final payment for a *Landscape Planting* (of the specified type) is full compensation for establishing a planting as specified or directed and includes providing viable plantings, preparing the planting pit, percolation testing; applying herbicide, fertilizer, lime, super-phosphates, and mulch; providing and installing weed control cloth; excavating and backfilling planting pits; staking, guying, anchoring and bracing shrubs and trees; watering plantings; pruning; maintaining plantings; removing and disposing of rejected plantings and debris; providing and establishing replacement plantings; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract, except for items set out as separate pay items in Contract, such as clearing and grubbing, grading, tree-

wall, and tree-wells.

- 4 Payment for Porous Material for Root Protection is full compensation for providing materials for root protection as specified or directed and includes furnishing, hauling, and placing approved porous materials and all other materials labor, equipment, tools, supplies transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 5 Payment for Drain Tile or Pipe is full compensation for furnishing and installing drain tile or pipe for landscape plantings as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 6 Pay items under this section include the following:

Item No.	Pay Item	Unit
8111XXX	<i>Landscape Planting</i>	EA
8114000	Porous Material for Root Protection	TON
8115X00	Drain Tile or Pipe, (<i>diameter</i>) Inches	LF

812

812

SECTION 812

SECTION NOT USED

SECTION 813

SODDING

813.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for sodding, which consists of furnishing and laying sod of perennial turf-forming grasses on slopes and shoulders and other areas in conformity with the Plans and the Specifications or as directed by the RCE.

813.2 Materials

813.2.1 Sod

- 1 Provide sod that consists of living, well-established growth, predominantly of the grass specified in the Special Provisions. Provide vigorous, well-rooted, healthy turf, free from disease, insect pests, weeds, other grasses, stones, and any other harmful or detrimental materials.

813.2.2 Fertilizer

- 1 Provide fertilizer conforming to the requirements of **Subsection 810.2.5**.

813.2.3 Lime

- 1 Provide lime conforming to the requirements of **Subsection 810.2.6**.

813.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

813.4 Construction

813.4.1 Advance Preparations

- 1 Perform the advance soil preparations specified in **Subsection 810.4.5**. Provide machine stripped sod with a uniform soil thickness of approximately 1 inch. The minimum acceptable soil thickness is $\frac{3}{4}$ inch. The measurement for thickness excludes top growth and thatch. Roll or fold sod before lifting. Handle sod in a manner that prevents tearing, breaking, drying, or any other damage.

813.4.2 Lime and Fertilizer

- 1 Apply lime and fertilizer as specified in **Subsection 810.4.7** or according to soil tests. Do not apply lime and fertilizer until one month after installation of sod.

813.4.3 Furnishing and Placing Topsoil

- 1 To ensure a good stand of grass in areas where the existing soil bed has little or no topsoil, furnish and place topsoil on the soil bed. Furnish the amount of topsoil as directed by the RCE.

813.4.4 Laying Sod

- 1 Lay sod on the prepared sod bed within 24 hours after cutting, except that sod may be stored in stacks or piles, grass to grass and roots to roots for not more than 5 days. Protect sod against drying from sun or wind and from freezing if necessary. Perform moving and laying of sod when weather conditions and soil moisture are favorable.
- 2 Lay the sod when the soil is moist. If necessary, moisten dry sod beds before sod is laid. Lay sections of solid sod edge to edge with staggered joints. Plug openings with sod or fill with acceptable loamy topsoil. Fill openings in joints with loamy topsoil. After laying sod and filling joints, roll or tamp with approved equipment to eliminate air pockets and provide an even surface.

813.4.5 Maintenance

- 1 Water the sod immediately after laying and keep the sod moist until final acceptance of the Contract. Perform all maintenance including watering, repairing washes, additional sodding, and fertilizing where a satisfactory stand of grass has not been achieved until the work is accepted. Do not fertilize centipede between August 1 and April 1.

813.4.6 Acceptance

- 1 When requested, the RCE will inspect sodded areas for acceptance. RCE acceptance is contingent on establishing a satisfactory stand of perennial grass. Sodded areas are acceptable when all requirements including maintenance are met and a healthy, evenly colored, viable stand of grass is established. A satisfactory stand of grass must have a root system that is sufficient to survive dry periods and winter weather and is capable of re-establishing in the spring.

813.5 Measurement

- 1 The quantity for Sodding is the surface area of the acceptable stand of grass and is measured by the one-thousand square yard (MSY) unit, complete, and accepted.
- 2 Fertilizer, lime, and other nutrients are considered as incidental items for the sodding work and are not measured for separate payment.
- 3 Topsoil furnished and applied is measured and paid for as Organic Topsoil in accordance with **Subsection 810.5** and **810.6**.

813.6 Payment

- 1 Payment for the accepted quantity for the pay item Sodding, measured in accordance with **Subsection 813.5**, is determined using the contract unit bid

price for the item. The payment is full compensation for laying and establishing grass sod as specified or direct and includes furnishing viable grass sod (including fertilizer, lime, and selected material for shoulders or slopes), labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract, except for organic top soil, which is a separate pay item.

2 Payment includes all direct and indirect costs and expenses necessary to complete the work.

3 Pay items under this section include the following:

Item No.	Pay Item	Unit
8131000	Sodding	MSY

SECTION 814

WATERPROOFING

814.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the waterproofing or damp proofing of Portland cement concrete surfaces in conformity with the Plans and the Specifications or as directed by the RCE.

814.1.1 Substructure Waterproofing – First Method

- 1 The First Method of waterproofing Portland cement concrete surfaces of substructures, unless otherwise indicated on the Plans or in the Special Provisions, is applicable for the protection of bents, piers, abutments, and other structures placed or constructed in salt water, excluding prestressed concrete piles.

814.1.2 Substructure Waterproofing – Second Method

- 1 The Second Method of waterproofing Portland cement concrete surfaces of substructures is applicable for protecting the inside of spandrel-filled arches, backs of abutments, retaining walls, etc. An alternate system for this method is also presented and may be used as an option.

814.1.3 Bridge Deck Waterproofing

- 1 Bridge deck waterproofing is placed on concrete bridge decks before placing an asphalt concrete overlay. This waterproofing system serves as a barrier against penetration of water, salt solutions, and other contaminants that cause the deterioration of bridge deck concrete.

814.2 Materials

814.2.1 Substructure Waterproofing - First Method

- 1 Use the following materials and coats for this method or waterproofing:
 - 3 creosote primer coats conforming to the requirements of ASTM D 43.
 - Coal tar pitch seal coat conforming to the requirements of ASTM D 450.

814.2.2 Substructure Waterproofing - Second Method

- 1 Use the following materials and coats for this method or waterproofing:
 - 1 asphalt primer coat conforming to the requirements of ASTM D 41.
 - 3 asphalt mop coats conforming to the requirements of ASTM D 449, Type A below ground and Type B above ground. Alternate mop coats with fabric applications.
 - 2 applications of waterproofing fabric conforming to the requirements of ASTM D 173

Ensure that the asphalt saturation conforms to the requirements of ASTM D 449, Type A below ground and Type B above ground.

814.2.3 Substructure Waterproofing – Second Method (Alternative)

- 1 Provide a waterproofing membrane that incorporates a cross-laminated, high-density polyethylene film adhered to a flexible, self-adhesive, rubberized asphalt in conjunction with a primer recommended by the membrane manufacturer for the membrane system being used.
- 2 Use membranes listed on the most recent edition of *SCDOT Qualified Product List 67* and meeting the following requirements when tested with the referenced test method:

Physical Property	Required Value	Test Method
Thickness	0.060 inches minimum	---
Thickness of polyethylene film	0.004 inches minimum	---
Tensile strength	250 psi	ASTM D 412 (Die C)
Ultimate elongation	200% minimum	ASTM D 412 (Die C)
Permeance	0.1 perms maximum	ASTM E 96, Procedure B
Cycling over crack at – 15°F	No effect after 100 cycles	Apply and roll membrane across two primed concrete blocks with no separation between the blocks. Open and close the crack from 0 to ¼ in. (6 mm).
Puncture resistance	40 pounds minimum	ASTM E 154
Pliability (180-degree bend over 1 inch mandrel at –25°F)	No cracks	ASTM D 146

- 3 Before installation, provide a manufacturer's certification to the RCE stating that the waterproofing membrane complies with these requirements.

814.2.4 Bridge Deck Waterproofing

- 1 Apply one of the waterproofing systems, in **Subsections 814.2.4.1** or **814.2.4.2** to the concrete bridge deck areas as specified on the Plans to serve as a barrier between the concrete and the asphalt concrete wearing course.
- 2 Use materials on the *SCDOT Qualified Product List 10*. For approval, submit test results to verify the materials meet the requirements of this specification. With each shipment of material, furnish a certification stating that the material complies with these requirements.

814.2.4.1 Type I - Reinforced Preformed Rubberized Asphalt Membrane

- 1 Provide reinforced preformed rubberized asphalt membrane consisting of a bottom layer of rubberized asphalt with adhesive qualities and a synthetic fabric reinforcement sheet as a top layer. Ensure that the membrane conforms to the physical properties in the following table.

Preformed Rubberized Asphalt Membrane		
Physical Property	Required Values	Test Method
Thickness (Minimum)	65 mils	---
Tensile Strength	50 pounds per inch width	ASTM D 882, modified for 1 inch opening, or ASTM D 1000 modified for 4 inch grip opening.
Permeance	0.10 perms	ASTM E 96, Method B
Puncture Resistance (Min.)	200 lb.	ASTM E 154
Pliability	No cracks or splits @ 180° bend. (Select one method)	½ inch Mandrel @ 0°F, or ½ inch Mandrel @ -10°F, or 1 inch Mandrel @ 125°F

814.2.4.2 Type II - Reinforced Coal-Tar Preformed Membrane

- 1 Provide preformed reinforced coal-tar membrane composed of coal tar modified with synthetic resins and reinforced with synthetic non-woven fabric. Ensure that the membrane conforms to the physical properties in the following table.

Preformed Reinforced Coal-Tar Membrane	
Physical Property	Required Values
Thickness	70 mils plus or minus 5
Water Penetration	Water penetration of the membrane is zero when tested under a hydrostatic head of 1 meter for 24 hours in accordance with ASTM D 583, Method 3.

(table continued on the next page)

(table continued from previous page)

Preformed Reinforced Coal-Tar Membrane			
Physical Property	Required Values		
Tensile Strength: (ASTM D 882, Crosshead speed 2 inches / minute, average of 3 samples)	Temp. at 0°F at 40°F at 120°F	Longitudinal 1500 psi 900 psi 400 psi	Transverse 1400 psi 700 psi 300 psi
Elongation: (ASTM D 882, Crosshead speed 2 inches / minute, average 3 samples, Method A, 1 inch wide strip.)	Temp. at 0°F at 40°F at 120°F	Longitudinal 30% 40% 50%	Transverse 25% 30% 35%
Softening Point	230°F minimum, in accordance with ASTM D 36		
Pliability	The membrane passes 1 inch mandrel bend test at minus 10°F when tested in accordance with ASTM D 146		
Density	The material does not weigh less than 0.45 lb./sq. ft.		

814.2.4.3 Type III: Reinforced Bituminous Resin Preformed Membrane

- 1 Provide preformed reinforced bituminous resin membrane consisting of a heat modified bituminous resin composition with inner layers of open weave fiberglass mesh and a top surface of polyester to bond to the wearing surfacing. Ensure that the membrane conforms to the physical properties in the following table.

Preformed Reinforced Bituminous Resin Membrane	
Physical Property	Required Values
Thickness	60 mils plus or minus 5
Color	Black
Softening Point	Ring & Ball – 240°F minimum, in accordance with ASTM D 36
Needle Penetration	40 to 50 mm at 77°F, 5 seconds, 100g, in accordance with ASTM D 5
Weight per Square Yard	2.6 lbs. minimum

814.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

814.4 Construction**814.4.1 Substructure Waterproofing - First Method**

- 1 Water-cure concrete surfaces for the period described in **Section 702** (curing compound not allowed) and then allow a drying period of approximately two days. Thoroughly coat with three coats of creosote primer coat for absorptive treatment. Apply primer coats cold with a brush and ensure that each coat is absorbed before the succeeding one is applied. After the absorption of the final coat, apply a tar pitch seal coat at a temperature of approximately 80°F and thoroughly brush into all surfaces. Allow the seal coat to dry for at least four days to harden before any water or earth is placed against it. Do not apply a coat when the concrete or the preceding coat is damp or during any time when moisture may fall on the surface. Avoid a drying period of longer than two days after the curing period and before the first application of the creosote for absorptive treatment whenever practicable.

814.4.2 Substructure Waterproofing - Second Method**814.4.2.1 Inspection and Delivery**

- 1 The RCE may request representative samples before shipment of the materials. Send properly identified samples to the RCE for testing when requested. Deliver all materials in original containers, plainly marked with the manufacturer's brand or label. The RCE will accept materials based on representative check samples taken after delivery.

814.4.2.2 Storage of Fabric

- 1 Store the fabric in a dry, protected place. Do not store the rolls on end.

814.4.2.3 Preparation of Surface

- 1 Protect the membrane from punctures by making all concrete surfaces reasonably smooth and free from projections or holes. Make certain that the surface is dry to prevent the formation of steam when the hot asphalt is applied. Clean the surface of dust and loose materials before the application of the waterproofing. Do not apply waterproofing in wet weather or when the temperature is below 35°F without special authorization from the RCE. If the surface of the concrete becomes damp, cover it with a 2-inch layer of hot sand and allow it to stand for 1 to 2 hours. Sweep the sand back, uncovering sufficient surface for beginning work and repeat the operation as the work progresses.

814.4.2.4 Application of Waterproofing of Large Areas

- 1 Thin the asphalt primer to a suitable consistency with an approved volatile solvent as directed by the RCE. Completely and thoroughly coat the surface being waterproofed with an asphalt primer. Allow the asphalt primer to set thoroughly before applying the first mop coat. Heat the asphalt for mop coat to a temperature of not less than 300°F and not more than 350°F. Equip the heating kettles with thermometers and stir frequently to avoid local overheating. Apply the first mop coat beginning at the low point of the surface being waterproofed. Also, begin applying the waterproofing fabric at the low so that when waterproofing application is completed, water will run over and not against or along the laps. Apply the first strip of fabric at half the width of the fabric being used; the second at full width lapped the full width of the first sheet; and the third and each succeeding strip at full width and lapped so that there are two layers of fabric at all points, with laps not less than 2 inches wide. Make all end laps at least 12 inches. Beginning at the low point of the surface, mop a section about 20 inches wide and the full length with the hot asphalt. Immediately following the mop, roll in the first strip of fabric of half width. Carefully press into place to eliminate all air bubbles and obtain close conformity with the surface. Mop hot asphalt over the first strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric being used. Roll a full width of the fabric to completely cover the first strip and press into place as before. Mop the second strip and an adjacent section of the concrete surface with hot asphalt and apply the third strip of fabric "shingled" to lap the first strip not less than 2 inches. Continue this process until the entire surface is covered, each strip of fabric lapping at least 2 inches over the last strip. Mop the entire surface with a final coat of hot asphalt after completing the application of the fabric. Complete the waterproofing by forming a firmly bonded membrane composed of an asphalt prime coat, two layers of fabric, and three mop coats of asphalt. Completely mop the surfaces with asphalt three times to prevent one layer of fabric from touching another layer or touching the primed concrete surface. Mop the primed concrete surface so that no gray spots appear and mop the fabric sufficiently heavy to completely conceal the weave. Use at least 12 gallons of mopping asphalt for each 100 square feet of finished work on horizontal surfaces, and use at least 15 gallons on vertical surfaces. Regulate the work so that all fabric receives the final mopping of asphalt by the close of a day's work. Take special care to thoroughly seal all laps.

814.4.2.5 Application of Waterproofing of Small Areas

- 1 Apply waterproofing to cracks or construction joints as specified for large areas, except do not lap the fabric as described. Apply the layers of fabric in width to extend beyond the joint or crack at least 12 inches each way. Lap the fabric at least 12 inches when the strips are lapped at ends. Apply the waterproofing using an asphalt prime coat and three mop coats of hot asphalt alternated with two layers of the asphalted fabric.

814.4.2.6 Requirements in Any Application

- 1 Make provisions to prevent water from getting under the waterproofing at the edges of the fabric and at any points where it is punctured by such appurtenances as drains or pipes.
- 2 Apply flashing at curbs and against girders, spandrel walls, etc. with separate sheets lapping the main membrane not less than 12 inches. Closely seal flashing either with a metal counter-flashing or by embedding the upper edges of the flashing in a groove poured full of joint filler.
- 3 Caulk essentially open joints that are not designed to provide for expansion with oakum and lead wool and then fill with hot joint filler.
- 4 At expansion and contraction joints, carry the membrane across the joint in a manner so that movement in the joint does not cause rupture of the membrane.
- 5 At the ends of the structure, carry the waterproofing well down on the abutments and make suitable provisions for all movement.

814.4.2.7 Damage Patching

- 1 Take care to prevent damage to the finished waterproofing. Patch damage that occurs. Apply a patch that extends at least 12 inches beyond the outermost damaged portion and then use a second ply extending at least 3 inches beyond the first.

814.4.3 Substructure Waterproofing – Second Method (Alternate)**814.4.3.1 Inspection and Delivery**

- 1 The RCE may request representative samples before shipment of the materials. Send properly identified samples to the RCE for testing when requested. Deliver all materials in original containers, plainly marked with the manufacturer's brand or label. The RCE will accept materials based on representative check samples taken after delivery.

814.4.3.2 Storage of Membrane

- 1 Store the membrane in a dry, protected place. Do not store the rolls on end.

814.4.3.3 Surface Preparation

- 1 Prime the concrete and apply the membrane only under the following conditions:
 - Air and concrete temperatures are above 40°F.
 - All surfaces are thoroughly dry.
 - Concrete is at least 14 days old.
- 2 Prepare the concrete as follows:
 - Fill all holes, cracks, and depressions in the concrete surface flush with mortar composed of one part approved Portland cement and

two parts approved sand and cure according to **Subsection 704.4.4.2**. If desired, use a commercially produced, fast setting, no sag grout approved by the RCE to expedite the work.

- Chip or grind smooth all high spots, sharp points, and edges.
- Thoroughly clean and dry the concrete surface.

814.4.3.4 Primer Application

- 1 After the concrete has been prepared, prime all areas receiving membrane and allow the areas to cure according to the manufacturer's recommendations or as directed by the RCE. Re-prime any areas not covered with membrane within 24 hours of priming.

814.4.3.5 Sealing of Openings and Structure Edges

- 1 Before placing the membrane, at openings for drains and pipes and at the edges of structures, construct a seal to prevent water from passing under the waterproofing. Apply a manufacturer-recommended edge seal to any area of the membrane permanently exposed to sunlight.

814.4.3.6 Waterproofing of Substructure Joints

- 1 Waterproof substructure joints by applying a double thickness of waterproofing membrane over properly sealed expansion, construction, or control joints. Pre-strip the joint with a 12-inch wide membrane strip before applying the main waterproofing. The surface of this pre-strip does not need to be primed.

814.4.3.7 Sealing of Seams

- 1 Make certain edge and end seams overlap at least 4 inches on all applications.

814.4.3.8 Application of Membrane

- 1 After the concrete has been prepared, the surface primed, edges and openings, and joints pre-stripped, apply the membrane as follows:
 - Rub the entire membrane firmly and completely as soon as possible to minimize bubbles caused by air out-gassing or water vapor from the concrete.
 - Slit all fish mouths, overlap the flaps, and repair with a patch pressed or rolled to make the seal. Seal the edges with mastic.
 - Patch misaligned or inadequately lapped seams with the membrane.

814.4.3.9 Protection and Patching of Membrane

- 1 When necessary, use a manufacturer-approved protection system to protect waterproofing membranes from damage caused by backfill material or other construction activities.
- 2 As soon as possible, patch all tears and inadequately lapped seams with waterproofing membrane. Slit fish mouths and repair with a patch extending 8 inches in all directions from the slit and seal the edges of the patch with

mastic.

814.5 Measurement

- 1 The work described and specified for Waterproofing - First Method is considered part of the subsidiary work pertaining to the various items of construction on which the waterproofing is applied; therefore, this work is not measured for payment as a separate item.
- 2 The quantity for the pay item Waterproofing - Second Method or Waterproofing (Bridge Deck) is the surface area over which the waterproofing is applied and is measured in the square yard (SY), complete, and accepted.

814.6 Payment

- 1 Direct payment is not made for work involved in the application of Waterproofing - First Method. This work is considered as subsidiary work pertaining to the various items of construction on which the waterproofing is applied. The cost for this work is considered included the contract unit bid price for the item on which the waterproofing is applied.
- 2 Payment for Waterproofing - Second Method or Waterproofing (Bridge Deck), measured in accordance with **Subsection 814.5**, is determined using the contract unit bid price for the applicable item. The payment is full compensation for furnishing and applying waterproofing as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for each item includes all direct and indirect costs and expenses necessary to complete the work.
- 4 Pay items under this section include the following:

Item No.	Pay Item	Unit
8142000	Waterproofing (Second Method)	SY
8143000	Waterproofing (Bridge Deck)	SY

SECTION 815

EROSION CONTROL

815.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the placement of temporary erosion control measures to prevent erosion and water pollution through the use of best management practices including the use of berms, silt basins, silt ditches, sediment dams, fiber roving, rolled erosion control products, silt fences, floating turbidity barriers, brush barriers, sediment tubes, inlet filters, bonded fiber matrix, flexible growth matrix, temporary flexible pipe slope drains, temporary seeding, and stabilized construction entrances in conformity with the Plans the Specifications, *SCDOT Standard Drawings*, or as directed by the RCE.

815.1.1 Erosion Control Device Applications

815.1.1.1 Rolled Erosion Control Products (RECP)

815.1.1.1.1 Temporary Erosion Control Blankets

- 1 Erosion control blanket will be designated on the Plans or by the RCE. The following criteria will be followed to select the type of blanket utilized:
- Install Type A temporary erosion control blankets on slopes 2H:1V or flatter only. For slopes greater than 2H:1V, use turf reinforcement matting (TRM).
 - Install Type B temporary erosion control blankets on channels or concentrated flow areas with a maximum calculated design shear stress less than or equal to 1.75 lbs/ft². For channels and concentrated flow areas with design shear stresses greater than 1.75 lbs/ft², use TRM.
 - Install Type C temporary erosion control blankets on areas where the establishment of temporary erosion control is critical and seeding needs additional reinforcement. Use temporary blankets for anionic polyacrylamide applications on slopes 2H:1V or flatter.

815.1.1.1.2 Turf Reinforcement Matting (TRM)

- 1 Turf reinforcement matting will be designated on the Plans or by the RCE. The following criteria will be followed to select the type of TRM utilized:
- Install a Type 1 TRM on slopes 2H:1V or flatter or in channels where the calculated design shear stress is 4.0 lbs/ft² or less and the design flow velocity reaches a value up to 10-ft/sec.
 - Install a Type 2 TRM on slopes 1.5H:1V or flatter or in channels where the calculated design shear stress is 6.0 lbs/ft² or less and a design flow velocity reaches a value up to 15-ft/sec.
 - Install a Type 3 TRM on slopes 1H:1V or flatter or in channels where the calculated design shear stress is 8.0 lbs/ft² or less and the de-

sign flow velocity reaches a value up to 20-ft/sec.

- Install a Type 4 TRM on slopes 1H:1V or greater or in channels where the calculated design shear stress is up to 12 lbs/ft² and the design flow velocity reaches a value up to 25-ft/sec, and when field conditions exist with high loading and/or high survivability requirements.

815.1.1.2 Sediment Tubes

- 1 Sediment tubes are temporary erosion control devices installed along contours, in drainage conveyance swales, and around drainage inlets to reduce the effects of soil erosion and to retain sediment. Locations for installation will be designated on the Plans or by the RCE.

815.1.1.3 Inlet Structure Filters

- 1 Inlet structure filters are temporary erosion control devices installed around pipe inlet structures to trap sediment and keep silt, sediment, and construction debris from entering pipe systems through open inlet structures. Additionally, inlet structure filters are used to prevent the silting-in of inlets, storm drainage systems, and receiving channels. Locations for installation will be designated on the Plans or by the RCE.
- 2 The criteria for the use of Inlet Structure Filter Types A, B, D, E, and F are identified in **Subsections 815.1.1.3.1 through 815.1.1.3.5**.

815.1.1.3.1 Type A Low Flow Inlet Filters

- 1 Install a Type A low flow inlet filter for inlets with a peak flow rate less than 1 ft³/sec, the inlet drain area grade is less than 5%, and the immediate drainage area (5-foot radius around the inlet) grade is less than 1%. Do not use for areas receiving concentrated flow.

815.1.1.3.2 Type B Medium Flow, Low Velocity Inlet Filters

- 1 Install a Type B medium flow, low velocity inlet filter for inlets with a peak flow rate less than 3 ft³/sec, the inlet drain area grade is less than 5%, and the flow velocity to the inlet does not exceed 3 ft/sec. Use this type of filter where an overflow capacity is not required to prevent excessive ponding around the structure.

815.1.1.3.3 Type D High Flow, High Velocity Inlet Filters

- 1 Install a Type D high flow, high velocity inlet filter for a drainage area up to 2 acres with peak flow rates greater than 3 ft³/sec, the inlet drain area grade is greater than 5%, and the flow velocity to the inlet may exceed 3 ft/sec. Use Type D1 filters for median applications. Use Type D2 for sump applications. Use Type D1 or D2 filters where an overflow capacity is required to prevent excessive ponding around the structure and to protect inlet structures not associated with curb inlets. Use to protect structure inlets such as Catch Basin Type 9, yard inlets, Drop Inlet 24 inches by 24 inches, Drop Inlet 24 inches by 36 inches, and manholes.

815.1.1.3.4 Type E Surface Course Curb Inlet Filters

- 1 Install a Type E surface course curb inlet filter to protect Catch Basin Types 1, 16, 17, and 18 after the road surface course is placed.

815.1.1.3.5 Type F Inlet Tubes

- 1 Type F inlet tubes are classified into two categories: weighted and non-weighted. Install a weighted Type F inlet tube to protect Catch Basin Types 1, 9, 12, 14, 15, 16, 17, and 18, Drop Inlet 24 inches by 24 inches, Drop Inlet 24 inches and 36 inches, manholes, and trench drains where drainage areas are less than 1 acre. Place the weighted inlet tube on gravel, concrete, asphalt, or other hard surfaces around drainage inlet. Install a weighted Type F inlet tube where construction traffic may occur around the inlet. All weighted Type F inlet structure filters are applicable as Type E inlet structure filters.
- 2 Use non-weighted Type F inlet tubes as inlet filters for Catch Basins Type 1, 16, 17, and 18 with drainage areas less than 1 acre. Place non-weighted Type F inlet tubes on subgrade and are applicable until the road base course is placed.
- 3 Use both weighted and non-weighted Type F inlet tubes as weep hole inlet filters. Use non-weighted Type F inlet tubes only where stakes can be driven into the ground or subgrade to secure the tube.

815.1.1.4 Stabilized Construction Entrance

- 1 Locate a stabilized construction entrance, which is a temporary stone-stabilized pad with a non-woven geotextile fabric underlining, at defined points of vehicular ingress and egress on construction sites to reduce the amount of mud, dirt, and rocks transported onto public roads by motor vehicles, equipment, and runoff. Taper the edges of the entrance out towards the road to prevent tracking of mud at the edge of the entrance, and so that long vehicles do not leave the stabilized area when turning onto or off the paved roadway.

815.1.1.5 Bonded Fiber Matrix (BFM)

- 1 Use a bonded fiber matrix (BFM) as an allowable substitution for mulch or in temporary seeding applications and seeding applications as outlined in **Section 810**.
- 2 Install BFMs in the following situations:
 - Enhancement of temporary seeding operations to reduce erosion and expedite seed germination.
 - A high performance mulch is required for permanent seeding.
 - Seeding application takes place on highly erodible soil or slopes.
 - Slopes up to 1H:1V.
 - The required functional longevity of soil protection is 6 months or less.
 - The soil is dry and rain is not expected within 48 hours after application.

- There is a high degree of certainty that heavy rains will not follow application.
- 3 Do not use a BFM as Type A temporary erosion control blanket, channel liners, or in areas receiving concentrated flow.

815.1.1.6 Flexible Growth Matrix (FGM)

- 1 Install a flexible growth matrix (FGM) in the following situations:
- As a Type A temporary erosion control blanket,
 - On slopes up to 2H:1V.
 - As an infill for a TRM on slopes greater than 2H:1V.
 - Environmentally sensitive wetlands and other wildlife areas not compatible for products containing netting.
 - The site requires strong mechanical and chemical bonds to withstand greater surface flow and/or severe slopes.
 - The required functional longevity of soil protection is up to 1-year.
 - The site requires immediate erosion protection and there is a risk of impending weather.
 - Fast vegetation establishment is required.
 - A high factor of design safety is required.
- 3 Do not use an FGM as a channel liner or for areas receiving concentrated flow.

815.2 Materials

815.2.1 Rolled Erosion Control Products (RECP)

815.2.1.1 Temporary Erosion Control Blankets

- 1 When not used with polyacrylamide slope applications, provide temporary erosion control blankets with a core composed primarily of biologically, photochemically or otherwise degradable constituents such as wheat straw, coconut fiber, straw-coconut blends, or aged curled excelsior wood fiber with longevity of approximately 1 to 3 years.
- 2 Ensure that the core is enclosed in double netted matting (i.e., matting with netting on both sides of the blanket) composed of non-organic, photodegradable, or biodegradable polypropylene netting. Ensure that the top netting consists of degradable polypropylene with a maximum mesh opening of 0.75 inch by 0.75 inch, and the bottom netting consists of degradable polypropylene with a maximum mesh opening of 0.50 inch by 0.50 inch. Ensure that netting is stitched together at not more than 2 inches on center. For blankets composed of aged curled excelsior wood fiber, ensure that both the top and bottom netting consist of degradable polypropylene with a maximum mesh opening of 1.0 inch by 1.0 inch and that it consists of aged curled excelsior wood interlocking fibers with 80% of the fibers a minimum of 6 inches long. Ensure that the netting is stitched together at not more than 2 inches on cen-

ter. Do not use jute netting.

- 3 Provide Class A and Class B temporary erosion control blankets with physical properties derived from quality control testing performed by a laboratory accredited by the Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP) and conforming to the following Minimum Average Roll Values (MARV) shown in the following table.

Temporary Erosion Control Blankets	
Physical Properties	MARV
Minimum mass per unit area (ASTM D 6475)	6 oz/yd ²
Minimum thickness (ASTM D 6525)	0.25 inch
Minimum initial grab tensile strength (ASTM D 6818)	75 x 75 lbs/ft
Minimum roll width	48 inches
Note: For Class B channel applications, a minimum unvegetated shear stress of 1.0 lbs/ft ² based on short-term peak flow duration of 0.5 hour is required.	

815.2.1.2 Temporary Erosion Control Blankets for Polyacrylamide Slope Applications

- 1 Provide a Class C temporary erosion control blanket for anionic polyacrylamide slope application that is a uniform organic temporary erosion control blanket composed of jute netting or curled excelsior wood fiber or coconut fiber blankets. Do not use blankets containing straw or straw/coconut blends. Ensure that slopes are 2H:1V or flatter for this application.
- 2 For a polyacrylamide slope application, provide a Type C temporary erosion control blanket with physical properties derived from quality control testing performed by a GAI-LAP accredited laboratory and conforming to the following Minimum Average Roll Values (MARV) shown in the following tables.

Jute Netting	
Uniform, open, plain weave netting using un-dyed and unbleached loosely twisted construction yarn that does not vary in thickness by more than 0.5 its normal diameter.	
Minimum roll width	48-inches
Minimum thickness (ASTM D 1777)	0.25 inch
Yarn Warp Count (ASTM D 3775)	19.5 minimum per 1 foot of width
Yarn Weft Count (ASTM D 3775)	14.0 minimum per 1 foot of width

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Jute Netting	
Minimum mass per unit area (ASTM D 3776)	6 oz/yd ²
Minimum dry grab tensile strength (ASTM D 4632)	300 x 175 lbs/ft
Minimum wet grab tensile strength (ASTM D 4632)	125 x 65 lbs/ft
Minimum open area	50%
Minimum openings	Approx. 0.5 to 1.0 inch in width and length
Excelsior Blankets	
Double-netted blanket consisting of curled excelsior wood interlocking fibers with 80% of the fibers a minimum of 6-inches long forming a degradable netting with a maximum mesh opening of 1.0 inch by 1.0 inch.	
Minimum roll width	48 inches
Minimum thickness (ASTM D 6525)	0.25 inches
Minimum mass per unit area (ASTM D 6475)	6 oz/yd ²
MD-Tensile strength (ASTM D 5035)	120 lbs/ft
TD-Tensile strength (ASTM D 5035)	70 lbs/ft
Maximum MD-Elongation (ASTM D 5035)	30%
Maximum TD-Elongation (ASTM D 5035)	20%
Coconut Blankets	
Double-netted blanket consisting of 100% coconut fiber forming degradable netting with a maximum mesh opening of 0.75 inch by 0.75 inch.	
Minimum roll width	48 inches
Minimum thickness (ASTM D 6525)	0.25 inches
Minimum mass per unit area (ASTM D 6475)	6 oz/yd ²
MD-Tensile strength (ASTM D 4595)	190 lbs/ft
TD-Tensile strength (ASTM D 4595)	190 lbs/ft
Maximum MD-Elongation (ASTM D 4595)	20%
Maximum TD-Elongation (ASTM D 4595)	20%

815.2.1.3 Turf Reinforcement Matting (TRM)**815.2.1.3.1 Type 1**

- 1 Provide a Type 1 TRM consisting of a web of mechanically or melt bonded polymer netting, monofilaments or fibers entangled to form a strong three-dimensional stable net structure utilizing bonding methods including polymer welding, thermal or polymer fusion or the placement of fibers between two high-strength biaxial oriented nets mechanically bound by parallel stitching with polyolefin thread. The RCE may allow a degradable fiber matrix to be used to provide immediate coverage for bare soil.

815.2.1.3.2 Type 2

- 1 Provide a Type 2 TRM consisting of a web of mechanically or melt bonded polymer netting, monofilaments or fibers that are entangled to form a strong three-dimensional stable net structure utilizing bonding methods including polymer welding, thermal or polymer fusion or the placement of fibers between two high-strength biaxial oriented nets mechanically bound by parallel stitching with polyolefin thread. The RCE may allow a degradable fiber matrix to provide immediate coverage for bare soil.

815.2.1.3.3 Type 3

- 1 Provide a Type 3 TRM consisting of a web of mechanically or melt bonded polymer netting, monofilaments or fibers that are entangled to form a strong three-dimensional stable net structure utilizing bonding methods including polymer welding, thermal or polymer fusion or the placement of fibers between two high-strength biaxial oriented nets mechanically bound by parallel stitching with polyolefin thread. Do not use a TRM manufactured from discontinuous or glued netting in this category. Ensure that the material is 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.

815.2.1.3.4 Type 4 (High Survivability)

- 1 Provide a Type 4 TRM consisting of a geosynthetic matrix that exhibits a very high interlock and reinforcement capacities with both soil and root systems, demonstrates a high tensile modulus, and is specially designed for erosion control applications on steepened slopes and vegetated waterways. Do not use a TRM manufactured from discontinuous netting, netting loosely held together by stitches or glue, or composites. Ensure that the material is 100% synthetic and resistant to biological, chemical, and ultraviolet degradation. Furnish a Type 4 TRM with high loading and/or high survivability capabilities for field conditions such as long term maintenance, structural backfills protecting critical structures, utility cuts, and traffic areas with the potential for high abrasion, higher required factors of safety, and/or general durability concerns.

815.2.1.3.5 Physical Properties

- 1 Ensure that TRM materials have Minimum Average Roll Values (MARV) derived from quality control testing performed by a GAI-LAP accredited labo-

ratory and conforming to the values shown in the following table.

Turf Reinforcement Matting					
Property	Test Method	MARV for Type 1	MARV for Type 2	MARV for Type 3	MARV for Type 4 ⁽⁵⁾
Mass per Unit Area	ASTM D 6475	6-8 oz/yd ²	8-10 oz/yd ²	10-12 oz/yd ²	12-14 oz/yd ²
Thickness	ASTM D 6525	0.25 inches	0.35 inches	0.40 inches	0.40 inches
Grab Tensile Strength ⁽¹⁾	ASTM D 6818	145 x 110 lbs/ft	170 x 130 lbs/ft	400 x 300 lbs/ft	3100 x 1500 lbs/ft
Tensile Elongation ⁽¹⁾	ASTM D 6818	50% (max)	50% (max)	50% (max)	55% (max)
UV Resistance ⁽²⁾	ASTM D 4355	80 % @ 1000 hrs	80 % @ 1000 hrs	80% @ 1000 hrs	90 % @ 1000 hrs
Ground Cover Factor ⁽³⁾	Light Projection Analysis	60%	70%	70%	75%
Slopes	--	2H:1V or Flatter	1.5H:1V or Flatter	1H:1V or Flatter	1H:1V or Greater
Short-term Vegetated Velocity ⁽⁴⁾	--	< 10 ft/sec	10 to 15 ft/sec	15 to 20 ft/sec	20 to 25 ft/sec
Shear Stress ⁽⁴⁾	--	0 – 4 lbs/ft ²	4 – 6 lbs/ft ²	6 – 8 lbs/ft ²	8 – 12 lbs/ft ²
<p>Notes:</p> <ol style="list-style-type: none"> 1. Values of both machine and cross machine directions, respectively, under dry or saturated conditions. 2. Tensile strength retained of structural components after exposure. 3. Ground cover factor represents "% shade" from lumite light projection test. 4. Maximum permissible design values based on short-term (0.5-hr), vegetated data obtained at SCDOT-approved independent hydraulics testing facility on an erodible soil bed and/or by Colorado state university hydraulics laboratory or the Texas DOT's Texas Transportation Institute (TTI) hydraulics and erosion control laboratory for "flexible channel liner applications." 5. High factor of safety and high survivability required. 					

815.2.1.4 Quality Assurance Sampling, Testing, and Acceptance

- 1 Ensure that the RECP meets the requirements of the standards given in this specification or the approved industry equivalent.
- 2 Sample and test the RECP to verify conformance with this specification. Sample in accordance with ASTM D 4354.
- 3 Acceptance of the RECP is granted in accordance with ASTM D 4759 based on testing performed by GAI-LAP accredited laboratory of either conformance samples obtained using Procedure A of ASTM D 4354 or based on the manufacturer's certification and testing of quality control samples obtained using Procedure B of ASTM D 4354.
- 4 Quality Assurance sampling and testing is waived for products manufactured at an ISO 9002 certified manufacturing facility. Provide documentation of ISO 9002 certification upon request.
- 5 Provide an RECP from the list in the most recent edition of **SCDOT Qualified Product Lists 55** and **56** in the appropriate category.

815.2.1.5 Manufacturing Quality Control

- 1 For TRM Types 1, 2, 3 and 4, perform the Manufacturing Quality Control (MQC) testing at a GAI-LAP accredited laboratory at the frequency in ASTM D 4354 with the exceptions indicated by the following minimum acceptable testing frequency in the following table.

Testing Requirements for TRM Type 1, 2, 3, and 4		
Property	Test Method	Test Frequency tests/m ² (tests/yd ²) of production
Mass Per Unit Area	ASTM D 6475	1/20,000 (1/24,000)
Tensile Strength	ASTM D 6818	1/20,000 (1/24,000)
Tensile Elongation	ASTM D 6818	1/20,000 (1/24,000)
Ground Cover Factor	Light Projection Analysis	1/20,000 (1/24,000)

- 2 Obtain and furnish to the RCE a certification signed by a responsible representative of the manufacturer within 24 hours of each truckload or shipment of material delivered to the construction site.

815.2.2 Fiber Roving**815.2.2.1 Type A Fiberglass Roving**

- 1 Provide fiberglass roving consisting of fiberglass material formed from continuous fibers drawn from molten glass, coated with a chrome-complex sizing compound, collected into strands, and lightly bound together into a roving without the use of a binding agent or other deleterious substances. Ensure that the roving is wound into a package such that the material can be continu-

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ously withdrawn using a compressed air ejector to expand the fiber roving into a mat on the soil surface.

- 2 Furnish an electrical grade fiberglass roving material meeting the requirements indicated in the following table.

Requirements for Type A Fiberglass Roving		
Physical Property	Limits	Test Methods
Strands / Rove	50 - 70	End Count
Fiber Diameter, inches (Nominal)	0.00035 - 0.00045	ASTM D 578
Yards/lb. of Rove	170 - 300	ASTM D 578

815.2.2.2 Type B Polymer Roving

- 1 Provide material formed from continuous strands of fibrillated polymer yarns, collected into a roving without the use of a binding agent or other deleterious substances. Fibrillation is defined as a net-like physical structure of the yarn created by splitting the yarn in a precise pattern during the manufacturing process. Provide roving that is packaged so that it can be continuously withdrawn using a compressed air ejector to expand the roving into a mat of polymer fibers on the soil surface.
- 2 Furnish Type B polymer roving that meets the physical property requirements indicated in the following table.

Requirements for Type B Polymer Roving		
Physical Property	Limits	Test Methods
Strands/Rove	20 - 30	End Count
Yards/lbs of Rove	170 - 520	ASTM D 1907
Organic Content % Max.	1.0	ASTM D 1907
UV Stability	70% Strength Retained	ASTM D 4355

815.2.3 Sediment Tubes

815.2.3.1 Sediment Tubes for Ditch Checks

- 1 Provide a sediment tube for ditch checks produced by a manufacturer experienced in sediment tube manufacturing. Ensure that the sediment tube is composed of compacted geotextile, curled excelsior wood fiber, natural coconut fiber, hardwood mulch, or a mixture of these materials enclosed by a flexible netting material and utilize an outer netting that consists of seamless, high-density polyethylene, photodegradable material treated with ultraviolet stabilizers or a seamless, high-density polyethylene, non-degradable material.

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- 2 Do not use straw, straw fiber, straw bales, pine needles and/or leaf mulch.
- 3 Do not use curled excelsior wood fiber or natural coconut fiber rolled erosion control products (RECP) rolled up to create a sediment tube device.
- 4 Furnish steel posts minimum of 48 inches long and meeting the minimum physical requirements specified in **Subsection 815.2.12**.
- 5 Provide sediment tubes for ditch check applications that meet the following minimum performance requirements indicated in the following table.

Minimum Performance Requirements for Sediment Tubes		
Property	Test Method	Value
Diameter	Field Measured	18.0 inch minimum 24.0 inch maximum
Mass per Unit Length	Field Measured	3.0 lbs/ft ± 10% for 18-inch diameter or 4.0 lbs/ft ± 10% for 24-inch diameter
Fiber Length	Field Measured	80% of the fiber materials at least 4 inches in length
Length per Tube	Field Measured	10 foot minimum *
Netting Unit Weight	Certified	0.35 oz/ft minimum
* Select a length to minimize the number of sediment tubes needed. If the ditch check length (perpendicular to the water flow) is 15 feet, then one 15-foot sediment tube is preferred over two overlapped 10-foot sediment tubes.		

815.2.3.2 Quality Assurance

- 1 Before installation of sediment tubes, provide the following information from the manufacturer:
 - Written Quality Control program conforming to the requirements of **Subsection 815.2.3.3**.
 - Documentation of field and/or laboratory testing that quantifies the erosion control and sediment retention performance of the products conforming to the requirements of **Subsection 815.2.3.3**.
 - Guarantee that the products perform to the minimum performance standards under the specific conditions stated in this specification.
- 2 Ensure that each sediment tube bears complete identification including, but not limited to, the following:
 - Manufacturer’s name and location,
 - Manufacturer’s telephone number and fax number,
 - Manufacturer’s e-mail address and web address, and

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- Sediment tube name, model, and/or serial number.

3 Furnish sediment tubes from the most recent edition of *SCDOT Qualified Product List 57*.

815.2.3.3 Quality Control

1 Before installation of sediment tubes, provide the following information from the manufacturer:

- Written description of the manufacturer's Quality Control program of field and/or laboratory testing that quantifies the performance of the product. Performance testing must take place at a laboratory accredited to perform tests required for the product tested.
- Instructions on the proper installation and maintenance of the sediment tube.
- Certification of the testing requirements upon request.

2 Provide verification of conformance with manufacturer's published specifications, the certification, which at a minimum, identifies the following:

- Independent qualified test facility,
- Manufacturer,
- Product ID,
- Test ID, and
- Test date.

815.2.4 Inlet Filters

815.2.4.1 Type A Low Flow Inlet Filters

815.2.4.1.1 Filter Fabric Inlet Protection

1 Provide filter fabric from the most recent edition of *SCDOT Qualified Product List 34*.

2 Furnish steel posts a minimum of 60 inches long and meeting the minimum physical requirements specified in **Subsection 815.2.12**.

3 Provide heavy-duty plastic ties to attach the fabric to posts.

815.2.4.1.2 Sediment Tubes

1 Refer to the **Subsection 815.2.3** for sediment tube material and performance requirements. Provide sediment tubes from the most recent edition of *SCDOT Qualified Product List 57*.

815.2.4.2 Type B Medium Flow, Low Velocity Inlet Filters

815.2.4.2.1 Hardware Fabric and Stone Inlet Protection

1 Provide hardware fabric or comparable wire mesh with maximum openings of 0.5 inch x 0.5 inch as the supporting material.

- 2 Furnish steel posts a minimum of 36 inches long and meeting the minimum physical requirements for steel post specified in **Subsection 815.2.12**.
- 3 Provide heavy-duty plastic ties to attach the wire mesh material to posts. Place aggregate No. 5 washed stone against the hardware fabric on all sides.

815.2.4.3 Type D High Flow, High Velocity Inlet Filters

- 1 Provide a Type D high flow, high velocity inlet filter composed of a geotextile fabric connected to a rigid structure that completely surrounds the inlet, where the geotextile fabric is non-biodegradable and resistant to degradation by ultraviolet exposure and to contaminants commonly encountered in storm water. Ensure that the rigid structure is composed of high molecular weight, high-density polyethylene copolymer with a UV inhibitor. Provide a rigid structure that is reusable and recyclable.
- 2 Provide an inlet filter using filter fabric constructed of 100% continuous polyester non-woven engineering fabric and conforms to the guidelines in ASTM D 1117. Ensure that the filter fabric is fabricated to provide a direct fit adjacent to the associated rigid structure and is capable of reducing effluent sediment concentrations by not less than 80% under typical sediment migration conditions.
- 3 Provide a Type D high flow, high velocity inlet filter that has a two-stage design. Ensure that the first stage conveys normal flows at a minimum clean water flow rate of 100 gallons per minute per square foot, and the second stage conveys high flow rates with a minimum apparent opening of 0.5 inch per square inch (No. 12 standard sieve opening). Ensure that the Type D1 inlet structure filter has a first stage with a minimum height of 9 inches and a maximum height of 12 inches in order to allow greater overflow capacity and to prevent ponding in the median.
- 4 Provide a filter fabric with the following Minimum Average Roll Values (MARV) properties as shown in the following table.

Type D Inlet Filters			
Property	Test Method	Units	MARV
Weight	ASTM D 3776	oz/yd ²	3.0
Grab Tensile Strength	ASTM D 4632	lbs	80
Grab Tensile Elongation	ASTM D 4632	%	50
Puncture Strength	ASTM D 4833	lbs	40

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Type D Inlet Filters			
Property	Test Method	Units	MARV
Mullen Burst Strength	ASTM D 3786	psi	150
Trapezoid Tear Strength	ASTM D 4533	lbs	30
Fabric Opening Size	ASTM D 4751	US Std Sieve (max)	50
Permittivity	ASTM D 4491	sec ⁻¹	1.5
Water Flow Rate	ASTM D 4491	gal/min/ft ²	100
Ultraviolet Resistance	ASTM D 4355 (500 hrs)	%	70

- 5 Provide a high-flow, high-velocity inlet filter that has lifting devices or structures to assist in the installation and to allow inspection of the storm water system.

815.2.4.4 Type E Surface Course Inlet Filters

- 1 Furnish a Type E surface course inlet filter that has a minimum height or diameter of 9 inches and a minimum length 2 feet longer than the length of the curb opening. Do not completely block the inlet opening with surface course inlet filters.
- 2 Provide a Type E surface course inlet filter constructed with a synthetic material that allows storm water to freely flow through while trapping sediment and debris. Ensure that the geotextile is non-biodegradable, resistant to degradation by ultraviolet exposure, and resistant to contaminants commonly encountered in storm water. Do not use straw, straw fiber, straw bales, pine needles, or leaf mulch as filter materials.
- 3 Provide a Type E surface course inlet filter with aggregate compartments for stone, sand, or other weighted materials or mechanisms to hold the unit in place.
- 4 Ensure that the filter fabric of the curb inlet filter is capable of reducing effluent sediment concentrations by no less than 80% under typical sediment migration conditions and has the following Minimum Average Roll Values (MARV) for physical properties shown in the following table.

Filter Fabric Properties for Curb Inlet Filters			
Property	Test Method	Units	MARV
Weight	ASTM D 3776	oz/yd ²	3.0
Grab Tensile Strength	ASTM D 4632	lbs	80
Grab Tensile Elongation	ASTM D 4632	%	50
Puncture Strength	ASTM D 4833	lbs	40
Mullen Burst Strength	ASTM D 3786	psi	150
Trapezoid Tear Strength	ASTM D 4533	lbs	30
Apparent Opening Size	ASTM D 4751	US Std Sieve (max)	50
Permittivity	ASTM D 4491	second ⁻¹	1.5
Water Flow Rate	ASTM D 4491	gal/min/ft ²	100
Ultraviolet Resistance	ASTM D 4355 (500 hrs)	%	70

815.2.4.5 Type F Inlet Tubes

815.2.4.5.1 Weighted Inlet Tubes

- 1 Provide a Type F weighted inlet tube produced by a manufacturer experienced in sediment tube manufacturing. Provide an inlet tube composed of compacted geotextile, age curled excelsior wood fiber, natural coconut fiber, hardwood mulch, or a mix of these materials, and enclosed by a flexible netting material. Do not use straw, straw fiber, straw bales, pine needles, or leaf mulch.
- 2 Ensure that the outer netting consists of seamless, high-density polyethylene, photodegradable material treated with ultraviolet stabilizers or seamless, high-density polyethylene, non-degradable material.
- 3 Do not use a curled wood excelsior fiber or a natural coconut fiber rolled erosion control product (RECP) rolled up to create an inlet tube device.
- 4 Provide a Type F weighted inlet tube that is a sediment tube capable of staying in place without external stabilization measures and has a weighted inner core or other weighting mechanism to keep it in place. Provide a weighted inlet tube that meets the minimum requirements shown in the following table.

Minimum Requirements for Weighted Inlet Tubes		
Property	Test Method	Value
Diameter	Field Measured	6.0 inch to 12.0 inch
Mass per Unit Length	Field Measured	6 inch = 6 lbs/ft min. 12 inch = 12 lbs/ft min.
Fiber Length	Field Measured	80% of the fiber materials at least 4-inches in length
Length per Tube	Field Measured	6 foot minimum
Netting Unit Weight	Certified	0.35 oz/ft minimum

815.2.4.5.2 Non-Weighted Inlet Tubes

- 1 Provide a Type F non-weighted inlet tube that is produced by a manufacturer experienced in sediment tube manufacturing, composed of compacted geotextile, curled excelsior wood fiber, natural coconut fiber, hardwood mulch, or a mixture of these materials, and enclosed by a flexible netting material. Do not use straw, straw fiber, straw bales, pine needles, or leaf mulch.
- 2 Provide a non-weighted inlet tube with outer netting that consists of seamless, high-density polyethylene, photodegradable material treated with ultraviolet stabilizers or seamless, high-density polyethylene, non-degradable material.
- 3 Do not use curled wood excelsior fiber or natural coconut fiber rolled erosion control products (i.e., RECP) rolled up to create an inlet tube device.
- 4 Provide stakes or other means to stabilize non-weighted inlet tubes to keep them safely in place. Secure non-weighted inlet tubes with wooden stakes (1 inch x 1 inch) or steel posts (1.25 lbs/linear ft) a minimum of 3 feet in length placed on 2-foot centers. Provide Type F non-weighted inlet tubes that meet the minimum requirements shown in the following table.

Minimum Requirements for Non-weighted Inlet Tubes		
Property	Test Method	Value
Diameter	Field Measured	6.0 inch to 12.0 inch
Mass per Unit Length	Field Measured	6.0 inch = 1.0 lbs/ft minimum 12.0 inch = 2.0 lbs/ft minimum
Fiber Length	Field Measured	80% of the fiber materials at least 4 inches in length
Length per Tube	Field Measured	6 feet minimum
Netting Unit Weight	Certified	0.35 oz/ft minimum

815.2.4.6 Quality Assurance

- 1 Before installation of inlet structure filters, provide the RCE with the following information from the manufacturer:
 - Written Quality Control program conforming to the requirements of **Subsection 815.2.4.7**.
 - Documentation of field and/or laboratory testing that quantifies the erosion control and sediment retention performance of the product conforming to the requirements of **Subsection 815.2.4.7**.
 - Guarantee that the product performs to the minimum performance standards under the specific conditions as stated in this specification.
- 2 Ensure that each inlet structure filter bears complete identification including, but not limited to, the following:
 - Manufacturer's name and location,
 - Manufacturer's telephone number and fax number,
 - Manufacturer's e-mail address and web address, and
 - Inlet structure filter, BMP, or Sediment Tube name, model, and/or serial number.
- 3 Provide an inlet structure filter from a manufacturer with a minimum of 3 years experience at manufacturing inlet structure filters for use as sediment control equipment and experienced in the installation of equivalent applications. Provide a list of at least 20 references of installations if requested by the RCE.
- 4 Provide inlet structure filters from the most recent edition of *SCDOT Qualified Product List 58* in the appropriate category.

815.2.4.7 Quality Control

- 1 Before installation of sediment tubes, provide the RCE with the following information from the manufacturer:
 - Written description of the manufacturer's Quality Control program of field and/or laboratory testing that quantifies the performance of the product. Performance testing must be at a laboratory accredited to perform such tests required for the product tested.
 - Instructions on the proper installation and maintenance of the inlet structure filter.
 - Certification of the testing requirements upon request.
- 2 Provide certification of the product's conformance with the required performance specifications, which at a minimum, identifies the following:
 - Independent qualified test facility,
 - Manufacturer,
 - Product ID,
 - Test ID, and

- Test date.

815.2.5 Silt Fences

1 Provide material for silt fence complying with the requirements specified herein, on the Plan details, or as approved by the RCE.

815.2.5.1 Posts

1 Furnish steel posts a minimum of 60 inches long and meeting the minimum physical requirements specified in **Subsection 815.2.12**.

2 When heavy clay soils are present on site, use the steel posts specified above with the addition of a metal plate welded near the bottom so that when the post is driven to the proper depth, the plate is below the ground level for added stability. In areas where conditions warrant, larger posts or reduced post spacing may be required to provide an adequate fence to handle the stress from sediment loading.

815.2.5.2 Filter Fabric

1 Provide a filter fabric from the most recent edition of *SCDOT Qualified Product List 34*. Ensure that the filter fabric is composed of fibers consisting of long chain, synthetic polymers composed of at least 85% by weight of polyolefins, polyesters, or polyamides. Ensure that the fibers are formed into a network so that the filaments or yarns retain dimensional stability relative to each other. Do not treat or coat the filter fabric, which might adversely alter its physical properties after installation. Do not use fabric with defects or flaws that significantly affect its physical and/or filtering properties. Provide a filter fabric with a minimum width of 36 inches.

2 Protect the filter fabric with a suitable wrapping for protection against moisture and extended ultraviolet exposure before placement.

3 Provide filter fabric meeting the following minimum physical requirements in the following table.

Minimum Requirements for Filter Fabric		
Physical Property*	Test Method	Required Value
Tensile Strength	ASTM D 4632	90 lbs.
Elongation	ASTM D 4632	<50% - fabric self supporting
Maximum Apparent Opening Size (AOS)	ASTM D 4751	0.60 mm maximum
Permittivity	ASTM D 4491	0.05 per second
Ultraviolet Stability (retained strength after 500 hrs of ultraviolet exposure)	ASTM D 4355	70%
* Unless otherwise indicated, numerical values represent the MARV.		

815.2.6 Floating Turbidity Barriers

- 1 Provide floating turbidity barrier for sediment protection for fill placed in water or areas affected by tidal flow. Provide floating turbidity barrier meeting the requirements in the following table.

Minimum Requirements for Floating Turbidity Barriers			
	Light Duty	Medium Duty	Heavy Duty
Fabric – Polyester Reinforced Vinyl (oz/yd ²)	18	22	22
Flotation ⁽¹⁾ (lbs/ft)	13	22	22
Top Load Cable	---	---	10,000 lbs (⁵ / ₁₆ inch, galvanized)
Stress Plates	---	---	⁵ / ₈ inch Polypropylene
Rope Retainer	⁵ / ₈ inch Polypropylene	⁵ / ₈ inch Polypropylene	⁵ / ₈ inch Polypropylene
Grommets	#4 Brass	#4 Brass	#4 Brass
Seams Heat Welded	Yes	Yes	Yes
Bottom Load Chain	0.63 lbs/ft (min) (¹ / ₄ inch, galvanized)	0.95 lbs/ft (min) (⁵ / ₁₆ inch, galvanized)	0.95 lbs/ft (min) (⁵ / ₁₆ inch, galvanized)
Connecting Hardware	Galvanized Steel	Galvanized Steel	Galvanized Steel
Standard Depth	5 ft.	5 ft.	5 ft.
Standard Length ⁽²⁾	50 & 100 ft.	50 & 100 ft.	50 & 100 ft.
Notes:			
(1) Flotation for barriers of depths greater than 10 feet is to be 60 pounds per foot. Flotation must be sufficient to maintain the top of the barrier at an elevation 3 inches above the water.			
(2) The maximum length for barriers of depth greater than 10 feet is 50 feet.			

- 2 If specified, provide buoys complying with the South Carolina Department of Natural Resources *Marine Law Enforcement Buoy Specifications* in conjunction with the floating turbidity barrier.

815.2.7 Corrugated Metal Pipe for Sediment Dams

- 1 Provide corrugated metal pipe complying with the applicable requirements of **Section 714**.

815.2.8 Temporary Seeding

- 1 Provide materials conforming to the applicable requirements of **Section 810**.

815.2.9 Stabilized Construction Entrance

- 1 Provide a stabilized construction entrance composed of the following materials:
 - Non-woven geotextile fabric.
 - No. 1 aggregate (see ASTM C 33) with the gradation in the following table.

Gradation Table for Stabilized Construction Entrance Material	
Nominal Size (Sieves With Square Openings)	Percent Passing
4 inch	100
3½ inch	90 to 100
2½ inch	25 to 60
1½ inch	0 to 15
¾ inch	0 to 5

- 2 Provide a non-woven geotextile fabric that meets the requirements of **Subsection 804.2.11**.

815.2.10 Bonded Fiber Matrix (BFM)

- 1 Provide a bonded fiber matrix (BFM) from the most recent edition of *SCDOT Qualified Product List 65* and is composed of long non-toxic, degradable, strand fibers held together by cross-linked hydrocolloid bonding agents that upon drying become insoluble and non-dispersible to eliminate direct raindrop impact on soil. Use a BFM that does not form a water-insensitive crust that can inhibit plant growth. Provide a BFM that is completely photodegrade or biodegrade. Do not use materials listed or used for hydro-mulching applications, or organic and mineral bonding agents such as dry polyacrylamide, starch, guar, and plantago mixed with fibers. Seed, lime, and fertilizer may be added to the BFM mixture according to the requirements of **Section 810**.
- 2 Provide a BFM meeting the following requirements:
 - Passed a free liquid quality control test when mixed as liquid slurry (liquids separate from fibrous solids no greater than 1-inch per minute as measured on a standard test board).

- Does not dissolve or disperse upon re-wetting.
- Has no holes greater than 1 mm in size.
- Has no gaps between the BFM and the soil.
- Has minimum water holding capacity of 1000g per 100g (1000%).
- Has no germination or growth inhibiting factors and does not form a water-resistant crust.

3 Furnish BFM components pre-packaged by the manufacturer to assure material performance and compliance with the following typical values in the following tables when applied at a rate of 3500 pounds per acre.

BFM Properties	
Property	Required Value
Wood Fiber by Weight	85% ± 5%
Bonding Agent/Crosslinked Hydro-Colloid Polymer Tackifiers	10% ± 1%
Moisture Content	12% ± 3%
Organic Matter	95% minimum
pH Range	4.8 ± 2
Color	Colored to contrast application area, does not stain concrete or painted surfaces

BFM Properties and Test Methods		
Property	Test Method	Required Value
Mass Per Unit Area	ASTM D 6566	11.5 oz/yd ²
Thickness	ASTM D 6525	0.10 inch minimum
Ground Cover	ASTM D 6567	99%
Water Holding Capacity	Proposed ASTM	1000%
Functional Longevity	Observed	Up to 6 months
Cover Factor (6 in/hr event)	ECTC Test Method #2	0.10 maximum
% Effectiveness	ECTC Test Method #2	90% minimum
Cure Time	ECTC Test Method #2	98% effective 48 hours after application
Vegetation Establishment	ECTC Test Method #4	350% minimum

4 Provide BFM from manufacturer listed on the most recent edition of *SCDOT Qualified Product List 65* and provide documentation of testing at an

approved independent laboratory demonstrating performance based on reduced water runoff, reduced soil loss, and enhanced plant germination.

815.2.11 Flexible Growth Matrix (FGM)

- 1 Provide a flexible growth matrix (FGM) that combines both chemical and mechanical bonding techniques to lock the engineered matrix in place. Provide a FGM that is hydraulically applied and is a flexible erosion control matrix composed of long strands of thermally processed wood fibers, crimped man-made and organic interlocking fibers, and performance enhancing additives that forms a lofty, interlocking matrix, which creates air space and water-absorbing cavities that improves seed germination, reduces the impact of raindrop energy, and minimizes soil loss.
- 2 Furnish a FGM that requires no curing period and, when applied, uses water insoluble tackifiers and flocculants to form an intimate bond with the soil surface to create a continuous erosion resistant matrix that allows rapid germination and accelerated plant growth. Do not use materials listed or used for hydro-mulching applications. Do not use organic and mineral bonding agents such as dry polyacrylamides, starch, guar, and plantago mixed with fiber.
- 3 Seed, lime, and fertilizer may be added to the FGM mixture according to **Section 810**. Furnished FGM components pre-packaged by the manufacturer to assure material performance and compliance with the following typical values when applied at a rate of 3500 pounds per acre.
- 4 Ensure that the FGM provided meets the requirements in the following tables.

Flexible Growth Matrix	
Property	Value
Wood Fiber by Weight	85% ± 3%
Cross-linked Hydro-Colloid Polymer Tackifiers	10% ± 1%
Crimped Inter-Locking Fibers	5% ± 1%
Moisture Content	12% ± 3%
Color	Colored to contrast application area, does not stain concrete or painted surfaces

Flexible Growth Matrix Properties and Test Methods		
Property	Test Method	Value
Mass Per Unit Area	ASTM D 6566	11.5 oz/yd ²

(table continued on the next page)

(table continued from the previous page)

Flexible Growth Matrix Properties and Test Methods		
Property	Test Method	Value
Thickness	ASTM D 6525	0.15 inch minimum
Ground Cover	ASTM D 6567	99%
Water Holding Capacity	Proposed ASTM	1500%
Flexural Rigidity (wet)	ASTM D 6575	5 oz-yd maximum
Functional Longevity	Observed	Up to 1 year
Cover Factor (6 in/hr event)	ECTC Test Method #2	0.01 maximum
% Effectiveness	ECTC Test Method #2	99% minimum
Cure Time	ECTC Test Method #2	98% effective 2 hours after application
Shear Stress	ECTC Test Method #3	0.75 lbs/ft ² minimum
Vegetation Establishment	ECTC Test Method #4	500% minimum

- 5 Provide a FGM from a manufacturer listed on the most recent edition of *SCDOT Qualified Product List 66* and provide documentation of testing at an approved independent laboratory demonstrating performance based on reduced water runoff, reduced soil loss, and enhanced plant germination.

815.2.12 Steel Posts

- 1 Provide steel posts for use with inlet structure filters, sediment tubes, and silt fences meeting the following minimum physical requirements:
- Composed of high strength steel with minimum yield strength of 50,000 psi.
 - Standard "T" cross-section with a nominal face width of 1.38 inches and nominal "T" length of 1.48 inches.
 - Weighs 1.25 pounds per foot ($\pm 8\%$)
 - Painted with water based baked enamel paint.

815.2.13 Temporary Pipe Slope Drains

- 1 Ensure that pipe for slope drains conforms to the requirements of **Subsection 803.2**.

815.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

- 2 Use the following equipment for applying fiber roving and asphalt:
 - Pneumatic ejector capable of applying fiber roving at the rate of 2 pounds per minute (approximately 8 square yards per minute),
 - Air compressor capable of applying 40 cubic feet per minute at 80 to 100 psi and acceptable air base for supplying air to areas inaccessible to compressor, and
 - Asphalt distributor with hoses and hand spray bar for areas inaccessible to distributor.

815.4 Construction

815.4.1 General

- 1 Promptly install temporary erosion control measures when problem conditions exist or when potential problems are anticipated in certain areas in order to minimize soil erosion and siltation. Properly maintain the temporary erosion control measures until permanent erosion control features are functioning properly.
- 2 Coordinate the temporary erosion control provisions with the permanent erosion control features provided elsewhere in these specifications to the extent practical to assure economical, effective, and continuous erosion control during construction. Permanent seeding, sodding, riprap, concrete gutter, asphalt gutter, slope drains, and concrete slope protection are considered permanent erosion control items and are covered in other sections of these specifications.
- 3 Coordinate erosion control measures with the grading operations throughout the duration of the project in accordance with **Subsection 107.26**.
- 4 Use temporary erosion control measures to correct conditions where problems are anticipated or to correct conditions that develop during construction.
- 5 Remove temporary erosion control items if no longer needed in an area after establishment of permanent vegetation and completion and proper functioning of other permanent erosion control items as directed by the RCE. Restore these areas to a condition similar to the surrounding areas after removal.

815.4.2 Rolled Erosion Control Products (RECP)

815.4.2.1 Site Preparation

- 1 Grade areas to be treated with RECP and compact as indicated or as directed by the RCE or the manufacturer's representative.
- 2 Remove large rocks, soil clods, vegetation, and other sharp objects that could keep the RECP from intimate contact with subgrade.
- 3 Prepare seedbed by loosening the top 2 to 3 inches of soil above final grade.

815.4.2.1

815.4.2.2.2

- 4 Select and apply soil amendments, lime, fertilizer, and seed required by the seeding plan or by the RCE or the manufacturer’s representative to a scarified soil surface prior to the installation of the RECP.

815.4.2.2 Installation of RECP

815.4.2.2.1 General

- 1 Follow the manufacturer’s installation procedures included with each RECP. If requested by the RCE, arrange for a manufacturer’s representative to be on-site to oversee and approve the initial installation. Provide a letter from the manufacturer approving the installation when requested by the RCE.
- 2 Install the RECP at the elevation and the alignment indicated on the Plans.
- 3 Use stakes, pins, or staples with a minimum length of 6 inches to secure temporary erosion control blankets. Use 12-inch anchors for specific erosion control blankets in sandy, loose, or wet soils or as directed by the RCE or the manufacturer’s representative.
- 4 Use stakes, pins, or staples with a minimum length of 12 inches to secure permanent TRM. Use longer anchors for specific permanent TRM in sandy, loose, or wet soils or as directed by the RCE or the manufacturer’s representative.
- 5 Use the following table to determine the minimum anchoring frequency.

TRM Anchoring Requirements	
Slope Grade	Anchoring Frequency
Up to 3H:1V	1 anchor/square yard
3H:1V to 2H:1V	1.5 anchors/square yard
2H:1V to 1H:1V	2 anchors/square yard
Steeper than 1H:1V and Channel Bottoms	2.5 anchors/square yard

- 6 Obtain RCE and manufacturer’s representative approval before execution of alternate installation methods to those specified herein.

815.4.2.2.2 Slope Installation

- 1 At the top of the slope, construct a 6-inch (deep) x 12-inch (wide) anchor trench to inhibit undermining from stray surface water. Extend the upslope terminal end of the RECP 30 inches past the anchor trench.
- 2 Use stakes or staples to fasten the RECP material into the upslope anchor trench on 12-inch centers. Backfill the trench with soil and compact. Apply seed to the backfill soil surface and cover this area with the remaining 12 inches of the RECP terminal end. Stake or staple the terminal end down slope of the anchor trench on 12-inch centers.

- 3 Securely fasten all RECP materials to the soil by installing stakes or staples at a minimum rate of 1.5 stakes per square yard. Select anchors that have sufficient ground penetration to resist pullout. Increase the anchoring frequency if the RCE or the manufacturer's representative deems it necessary due to site conditions (i.e., loose or wet soils).
- 4 Unroll the RECP parallel to the primary direction of water flow and place in direct contact with the soil surface. Do not stretch or allow the material to bridge over surface inconsistencies. Overlap the edges of adjacent (vertically down the slope) RECP a minimum of 3 inches with the upslope roll overlapping on top of the down slope roll in shingle style.
- 5 Overlap the edges of parallel (horizontal across the slope) blankets 3 to 6 inches depending on the type of RECP used.

815.4.2.2.3 Channel Installation

- 1 Excavate anchor trenches and/or staple check slots perpendicular to the flow direction across the entire width of the channel at 25-foot intervals and at the terminal end of the channel reach.
- 2 Construct a 6-inch (deep) x 12-inch (wide) beginning anchor trench. Extend the downstream end of the RECP 30 inches past the anchor trench and use the slack RECP material to cover the backfilled soil. Fasten the RECP material into the anchor trench on 12-inch centers.
- 3 Excavate 6 inch x 6 inch check slots every 25 feet along the length of the channel.
- 4 If directed by the RCE, replace excavated check slots with a double row of staples or stakes. For staple or stake check slots, place the two rows of stakes or staples 4 inches apart and install each row of staples or stakes on 12-inch centers. Drive all stakes and staples flush with the soil surface.
- 5 Beginning at the downstream end in the center of the channel, place the initial end of the first RECP in the anchor trench, and secure it with ground anchor devices at 12-inch intervals.
- 6 Position adjacent rolls in the anchor trench in the same manner, overlapping the proceeding roll a minimum 3 inches. Secure the RECP at 12-inch intervals along the anchor trench, backfill and compact with specified soil or as directed by the RCE or the manufacturer's representative.
- 7 Unroll center strip of RECP upstream over compacted trench. Stop at next check slot or terminal anchor trench. Unroll adjacent rolls of RECP upstream in similar fashion, maintaining a 3-inch overlap.
- 8 Fold and secure the RECP snugly into transverse check slots. Lay material in bottom of the slot, then fold the material back against itself. Anchor through both layers of RECP at 12-inch intervals. Backfill with soil and compact. Continue unrolling the RECP widths upstream over compacted slot to next check slot or terminal anchor trench.

- 9 Secure RECP to channel bottom with ground anchoring devices at a frequency of 2.5 anchors per square yard. Select anchors that have sufficient ground penetration to resist pullout. Increase the anchoring frequency if the RCE or the manufacturer's representative deems it necessary due site conditions (i.e., loose or wet soils).
- 10 Cut longitudinal anchor slots 4 inches x 4 inches at the top of each slope. Fasten the RECP material into the longitudinal anchor slots on 12-inch centers.

815.4.2.3 Delivery, Storage, and Handling

- 1 Follow the requirements of ASTM D 4873 for RECP labeling, shipment and storage. Ensure that product labels clearly show the manufacturer or supplier name, style name, and roll number. Include with each shipping document a notation certifying that the material is in accordance with the manufacturer's certificate.
- 2 Wrap each RECP roll with a material that protects the geotextile from damage due to shipment, water, sunlight, and contaminants. Maintain the protective wrapping during shipment and storage.
- 3 During storage, elevate the RECP rolls off the ground and adequately cover to protect them from the following: site construction damage, extended exposure to ultraviolet (UV) radiation, precipitation, strong acids or strong bases, flames including welding sparks, temperatures in excess of 160°F, and other environmental conditions that can damage the physical properties of RECP.

815.4.2.4 Inspection and Maintenance of RECP

- 1 Check areas protected by RECP for dislocation or failure every 7-calendar days.
- 2 Ensure that the pinning or stapling pattern is consistent with that shown on the manufacturer's installation sheet. If there is evidence that the RECP is not securely fastened to the soil, install extra pins or staples to inhibit the RECP from becoming dislodged.
- 3 Inspect regularly until grass or vegetation is firmly established.
- 4 Repair damaged areas immediately by restoring the soil on slopes or channels to its finished grade, re-applying fertilizer and seed, and replacing the appropriate RECP material as needed.

815.4.2.5 Acceptance

- 1 Obtain RCE acceptance and approval for RECP installations.

815.4.3 Brush Barriers

- 1 Install brush barriers as shown on the Plans or as directed by the RCE. Construct brush barriers from selected materials from the clearing and grubbing operation.

- 2 Construct brush barriers for erosion control measures as soon as brush is readily available from the clearing operation. Do not use the barriers in residential or commercial areas, or in areas where development is anticipated within the next few years. Construct brush barriers parallel to the toes of slopes of embankments constructed of erodible material to heights of 15 feet or more. Use brush barriers when natural ground is level or sloping away from project. Leave the brush barriers in place. Do not construct barriers at any site that has high visibility and detracts from the appearance of either the adjacent property or the completed highway.
- 3 Form the brush barriers by placing brush, limbs, small trees, and other vegetative growth in a small continuous ridge or piles as close as practicable not more than 15 feet outside of and generally parallel to the toe of the proposed embankment. Place some of the heavier material on top to secure the barrier. Intermingle the brush logs and tree limbs to prevent the formation of a solid dam and allow water to filter through it. If a gutter is proposed as a permanent erosion control measure along the toe of an embankment, place the brush barrier outside the construction limits of the gutter. Construct the barrier with mechanical equipment and "walk down" with a bulldozer to produce a barrier that is dense with relatively uniform height between 3 to 5 feet and width between 5 to 10 feet.

815.4.4 Fiber Roving

- 1 Place the fiber roving within 24 hours after performing seeding operations in accordance with **Section 810**, except do not apply mulch to the area where fiber roving is being placed.
- 2 Spread Type A fiberglass roving uniformly over the designated areas at a minimum rate of 0.30 pounds per square yard. Spread Type B polymer roving uniformly over the designated areas at a minimum rate of 0.15 pounds per square yard.
- 3 Immediately after placing the roving, anchor it to the ground with the same type asphalt material used in the seeding operation and meeting the requirements of **Section 810**. Apply the asphalt uniformly over the specified fibers at a rate of 0.25 to 0.35 gallons per square yard. At the upgrade and downgrade ends, bury the roving to a depth of 1 foot to ensure that water does not pass under the roving.

815.4.5 Sediment Tubes

815.4.5.1 Site Preparation

- 1 Remove all rocks, clods, vegetation, or other obstructions that would prevent the installed sediment tube from having direct contact with the underlying soil or surface.

815.4.5.2 Installation

- 1 If requested by the RCE, provide a manufacturer's representative on-site to oversee and approve the initial installation of sediment tubes. Provide a letter

from the manufacturer approving the installation if requested by the RCE.

- 2 Install the sediment tube by laying it flat on the ground. Construct a small trench to a depth that is 20% of the sediment tube diameter. Lay the sediment tube in the trench and compact the upstream sediment tube-soil interface. Do not completely bury the sediment tube during installation. Review all project specifications for special installation requirements. Install sediment tubes ensuring that no gaps exist between the soil and the bottom of the sediment tube. Lap the ends of adjacent sediment tubes a minimum of 6 inches to prevent flow and sediment from passing through the field joint. Never stack sediment tubes on top of one another.
- 3 Avoid damage to the sediment tube during installation. If a sediment tube becomes damaged during installation, place a stake on both sides of the damaged area, terminating the tube segment, and install a new tube segment. Perform field monitoring to verify that installation procedures do not damage sediment tubes. Replace sediment tubes damaged during installation as directed by the RCE or the manufacturer’s representative at no expense to the Department.
- 4 Install sediment tubes in swales or drainage ditches perpendicular to the flow of water and extend them up the side of the slopes a minimum of 1-foot above the design flow depth. Space sediment tubes according to the following table.

Sediment Tube Spacing	
Slope	Maximum Sediment Tube Spacing
Less than 2%	150 feet
2%	100 feet
3%	75 feet
4%	50 feet
5%	40 feet
6%	30 feet
Greater than 6%	25 feet

- 5 Install sediment tubes using wooden stakes (1-inch x 1-inch) or steel posts specified in **Subsection 815.2.3.1**. Space posts or stakes 2-foot centers and drive them into the ground to a minimum depth of 2.0 feet leaving less than 1-foot of stake above the exposed sediment tube.
- 6 Intertwine the posts or stakes with the outer mesh on the downstream side
- 7 An acceptable alternative installation is driving stakes on 2-foot centers on each side of the sediment tube and connecting them with natural fiber twine or steel wire to inhibit the sediment tube from moving vertically. Sediment

tubes can also be secured by installing the stakes on 2-foot centers in a crossing manner ensuring direct soil contact at all times.

- 8 Select the sediment tube length to minimize the number of sediment tubes needed to span the width of the drainage conveyance. If the required ditch check length (perpendicular to the water flow) is 15 feet, then one 15-foot sediment tube is preferred compared to two overlapping 10-foot sediment tubes.
- 9 Install sediment tubes for ditch checks over bare soil, mulched areas or erosion control blankets. Keep sediment tubes for ditch checks in place until fully established vegetation and root systems have completely developed and can survive on their own.

815.4.5.3 Delivery, Storage, and Handling

- 1 Follow the manufacturer's written storage and handling procedures for sediment tube labeling, shipment, and storage. Clearly show the manufacturer or supplier name, sediment tube diameter and length on product labels.
- 2 Store and cover sediment tubes off the ground and cover adequately to protect them from the following: construction damage, precipitation, extended exposure to ultraviolet radiation including sunlight, on-site chemicals, flames including welding sparks, excessive temperatures, and other environmental conditions that can damage the physical properties of sediment tubes.

815.4.5.4 Inspection and Maintenance of Sediment tubes

- 1 Inspect sediment tubes after installation to ensure that no gaps exist under the sediment tubes or between the joints of adjacent ends of the sediment tubes. Inspect sediment tubes every 7 days. Repair rills, gullies, and undercutting near the sediment tubes.
- 2 Remove sediment deposits that impair the filtration capability of a sediment tube when the sediment reaches one-third of the height of the exposed sediment tubes. Remove and/or replace installed sediment tubes as required to adapt to changing construction site conditions.
- 3 When the functional longevity of the sediment tubes is exceeded as determined by the RCE or the manufacturer's representative, remove them from the site. Gather and dispose of them in regular means as non-hazardous, inert material. Before final stabilization, backfill all trenches, depressions or all other ground disturbances caused by the removal of sediment tubes.

815.4.5.5 Acceptance

- 1 Obtain RCE acceptance and approval of sediment tube installations. When requested by the RCE, ensure that a manufacturer's representative is on site to oversee and approve the initial installation of sediment tubes. Obtain a letter from the manufacturer approving the installation when requested by the RCE.

815.4.6 Silt Fences

- 1 Construct the silt fence in accordance with Plans or *SCDOT Standard Drawings* or as approved by the RCE. Place silt fences before the major construction in an area is started.
- 2 Maintain the silt fence until its capacity has been reached or erosion activity in the area has stabilized. Remove sediment accumulated along the fence when it reaches approximately one-third of the height of the fence, especially if heavy rains are expected. Remove trapped sediment or stabilize on site.
- 3 Inspect the silt fence every 7 days. Immediately correct any deficiencies. Remove filter fabric and replace whenever it has deteriorated to such extent that it reduces the effectiveness of the silt fence. In addition, review daily the location of silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Install additional silt fences as directed by the RCE where deficiencies exist.
- 4 If a silt fence or portion of a fence is located in an area where removing the sediment is not possible, then install a second silt fence, if necessary, at the discretion of the RCE. In this case, payment for both silt fences and portions involved is made at the unit price for silt fence.
- 5 Remove silt fence within 30 days after final stabilization is achieved or after temporary Best Management Practices (BMP) are no longer needed. Permanently stabilize disturbed areas resulting from fence removal. The fence materials remains the property of the Contractor and may be used at other locations provided the materials meet the appropriate requirements contained in this specification and/or on the Plans.

815.4.7 Floating Turbidity Barriers

- 1 Place floating turbidity barrier at the location shown on the Plans and in accordance with the manufacturer's recommendations. Anchor the ends on the undisturbed shoreline with sufficient support to secure the barrier in place during turbulent conditions. Place vertical supports and/or anchors along the barrier as necessary to prevent the barrier from drifting. Maintain the floating turbidity barrier until all disturbed areas have stabilized sufficiently to control erosion.

815.4.8 Silt Basins

- 1 Construct silt basins by excavating in berm ditches, parallel roadway ditches, at culvert inlets and outlets, and other locations as directed by the RCE. Construct in accordance with the Plans and the *SCDOT Standard Drawings*. Remove sediment as necessary to ensure that the basin functions properly.

815.4.9 Silt Ditches

- 1 Construct temporary silt ditches in accordance with the Plans and the *SCDOT Standard Drawings* at locations shown on the Plans or as directed by

the RCE. Silt ditches are generally constructed adjacent and parallel to the toe of the slope in relatively rolling areas where there is a possibility of property damage from sheet-type erosion. This type ditch is not intended to carry large volumes of water, but to catch sediment from runoff.

815.4.10 Sediment Dams

- 1 Construct temporary sediment dams in accordance with the Plans and **the SCDOT Standard Drawings** at locations shown on the Plans or as directed by the RCE.

815.4.11 Inlet Structure Filters

815.4.11.1 Site Preparation

- 1 Remove all rocks, clods, vegetation, or other obstructions so that the installed pre-fabricated inlet protection BMP has direct contact with the underlying surface.

815.4.11.2 Installation

815.4.11.2.1 General

- 1 Install inlet structure filters in accordance with the manufacturer's written installation instructions, in compliance with these specifications and with all OSHA, local, state, and federal codes and regulations.

815.4.11.2.2 Type A - Low Flow Inlet Filters

815.4.11.2.2.1 Filter Fabric Inlet Protection

- 1 Excavate a trench 6 inches deep around the outside perimeter of the inlet unless the fabric is pneumatically installed. Extend the filter fabric a minimum of 12 inches into the trench. Backfill the trench with soil or crushed stone and compact over the filter fabric unless the fabric is pneumatically installed.
- 2 Install steel posts specified in **Subsection 815.2.4.1.1**. Space the posts around the perimeter of the inlet a maximum of 3 feet apart and drive them into the ground a minimum of 24 inches.
- 3 Install the filter fabric to a minimum height of 24 inches above grade. Cut the filter fabric from a continuous roll to the length of the protected area to avoid the use of joints. When joints are necessary, wrap filter fabric together only at a support post with both ends securely fastened to the post, with a minimum 6-inch overlap. Attach fabric to the posts with heavy-duty plastic ties. Attach four evenly spaced ties in a manner to prevent sagging or tearing of the fabric. In all cases, affix ties in not less than four places.

815.4.11.2.2.2 Sediment Tubes

- 1 Install sediment tubes in accordance with **Subsection 815.4.5.2**.

815.4.11.2.3 Type B - Medium Flow, Low Velocity Inlet Filters

815.4.11.2.3.1 Hardware, Fabric, and Stone Inlet Protection

- 1 Excavate a trench 6 inches deep around the outside perimeter of the inlet.

Use hardware fabric or comparable wire mesh with maximum openings 0.5 inch x 0.5 inch as the supporting material. Extend the fabric a minimum of 6 inches into the ground. Backfill the trench with soil or crushed stone and compact over the fabric.

- 2 Install steel posts specified in **Subsection 815.2.4.2.1**. Space the posts a maximum of 3 feet apart around the perimeter of the inlet and drive them into the ground a minimum of 18 inches.
- 3 Install the wire mesh fabric above grade a minimum of 18 inches without exceeding 24 inches. Use heavy-duty wire ties spaced a maximum of 6 inches apart to attach the wire mesh material to the steel posts. Place Aggregate No. 5 washed stone to a minimum height of 12 inches and a maximum height of 24 inches against the hardware fabric on all sides.

815.4.11.2.4 Type D - High Flow, High Velocity Inlet Filters

815.4.11.2.4.1 Rigid Inlet Filters

- 1 Install rigid inlet filters in accordance with the manufacturer's written installation instructions. Properly install rigid inlet protection so that the inlet is completely enclosed.

815.4.11.2.5 Type E - Surface Course Curb Inlet Filters

- 1 Use surface course inlet filters in conjunction with Catch Basin Types 1, 16, 17, and 18 after the placement of the road surface course. Place surface course inlet filters where sediment may spill over sidewalks and curbs.
- 2 Install surface course inlet filters in front of curb inlet openings. Ensure that the filter has a minimum height or diameter of 9 inches and a minimum length 2 feet longer than the length of the curb opening to allow sufficient length to cover the inlet with at least 1-foot of clearance beyond the inlet on both ends. Do not completely block the inlet opening with surface course inlet filters. Install surface course inlet filters in a manner to allow overflows to enter the catch basin. Fill the aggregate compartment to a level (at least half full) that keeps the surface course inlet filter in place and creates a seal between the surface course inlet filter and the road surface.

815.4.11.2.6 Type F - Inlet Tubes

815.4.11.2.6.1 Weighted Inlet Tubes

- 1 Weighted inlet tubes do not require posts or additional techniques to keep them in place. Install weighted inlet tubes lying flat on the ground with no gaps between the soil or underlying surface and the inlet tube. Never stack weighted inlet tubes on top of one another. Do not completely block inlets with weighted inlet tubes. Install weighted inlet tubes so that all overflow or overtopping water has the ability to enter the inlet unobstructed. To avoid possible flooding, two or three concrete blocks may be placed between the weighted inlet tubes and the inlet.

815.4.11.2.6.2 Non-Weighted Inlet Tubes

- 1 Install non-weighted inlet tubes immediately after grading and construction of Catch Basin Types 1, 16, 17, and 18 boxes. Maintain non-weighted inlet tubes during subgrade and base preparation until the base course is placed. Review all project specifications for special installation requirements. Install non-weighted inlet tubes using 1-inch x 1-inch wooden stakes or 1.25 lb./linear ft. steel posts a minimum of 36 inches in length, placed on 2-foot centers. Intertwine the stakes with the outer mesh on the downstream side of the inlet tube. Drive stakes in the ground to a minimum depth of 12 inches, leaving less than 12 inches of stake exposed above the non-weighted inlet tube.
- 2 An acceptable alternative installation is driving stakes on 2-foot centers on each side of the non-weighted inlet tubes and connecting them with a natural fiber twine or steel wire to inhibit the non-weighted sediment tube from moving vertically. Another acceptable alternative installation for non-weighted inlet tubes is installing stakes on 2-foot centers in a crossing manner maintaining direct soil contact at all times. Install non-weighted inlet tubes so that the top is below the top of the installed curb line to ensure that all overflow or overtopping water has the ability to enter the inlet unobstructed.

815.4.11.3 Delivery, Storage, and Handling

- 1 Follow the manufacturer's written procedures for inlet structure filter labeling, shipment, and storage. Ensure that the manufacturer or supplier name, the structure size, shape, and weight clearly show on product labels.
- 2 Store inlet structure filters off the ground and cover adequately to protect them from the following: construction damage, precipitation, extended exposure to ultraviolet radiation including sunlight, on-site chemicals, flames, including welding sparks, excessive temperatures, and other environmental conditions that can damage the physical properties of the inlet filters.

815.4.11.4 Inspection and Maintenance of Inlet Structure Filters**815.4.11.4.1 General**

- 1 Inspect inlet structure filters after installation for gaps that may permit sediment to enter the storm drainage system. Inspect inlet filters every 7 days. Immediately handle all damage or necessary repairs. Remove all accumulated sediment and debris from the surface and vicinity of inlet filters after each rainfall event or as directed by the RCE or the manufacturer's representative. Remove sediment when it reaches approximately one-third of the height of the inlet filter. If a sump is used, remove sediment when it fills approximately one-third of the depth of the hole. Maintain the pool area, always providing adequate sediment storage volume for the next storm event.
- 2 Remove, move, and/or replace inlet filters as required to adapt to changing construction site conditions. Remove inlet structure filters from the site when the functional longevity is exceeded as determined by the RCE or the manufacturer's representative. Dispose of inlet filters no longer in use at an appro-

ropriate recycling or solid waste facility. Before final stabilization backfill and repair trenches, depressions, and all other ground disturbances caused by the removal of inlet filters. Remove all construction material and sediment and dispose of them properly. Grade the disturbed areas to the elevation of the inlet structure crest. Stabilize all bare areas immediately.

815.4.11.4.2 Type A - Low Flow Inlet Filters

815.4.11.4.2.1 Filter Fabric Inlet Protection

- 1 Replace the fabric if it becomes clogged, or as directed by the RCE. Take care not to damage or undercut the fabric when removing the sediment.

815.4.11.4.2.2 Sediment Tubes

- 1 Inspect sediment tubes after installation for gaps under the sediment tubes and for gaps between the joints of adjacent ends of sediment tubes. Repair rills, gullies, and all undercutting near sediment tubes. Remove and/or replace installed sediment tubes as required to adapt to changing construction site conditions. Remove all sediment tubes from the site when the functional longevity is exceeded as determined by the RCE or the manufacturer's representative. Dispose of sediment tubes as non-hazardous, inert material.

815.4.11.4.3 Type B - Medium Flow Low Velocity Inlet Filters

815.4.11.4.3.1 Hardware, Fabric, and Stone Inlet Protection

- 1 If the stone becomes clogged with sediment, pull the stones away from the inlet and clean or replace them. Because cleaning gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.

815.4.11.4.4 Type D - High Flow, High Velocity Inlet Filters

815.4.11.4.4.1 Rigid Inlet Protection Device

- 1 Inspect Type D inlet filters after installation to ensure that no gaps exist that may permit sediment to enter the storm drain system. Remove and/or replace rigid inlet filters to adapt to changing construction site conditions. Clean the rigid inlet protection filter material when it becomes covered or clogged with deposited sediment. Replace the rigid inlet protection filter material as directed by the RCE.

815.4.11.4.5 Type E - Surface Course Curb Inlet Filters

- 1 Because ponding is likely if sediment is not removed regularly, inspect surface course curb inlet filters on a regular basis and immediately after major rain events. Clean the surface course curb inlet filter if a visual inspection shows silt and debris build up around the filter.

815.4.11.4.6 Type F - Inlet Tubes

815.4.11.4.6.1 Weighted Inlet Tubes

- 1 Weighted inlet tubes may be temporarily moved during construction as needed. Replace weighted inlet tubes damaged during installation as di-

rected by the RCE or the manufacturer's representative at no expense to the Department.

815.4.11.4.6.2 Non-Weighted Inlet Tubes

- 1 Non-weighted inlet tubes may be temporarily moved during construction as needed. Replace non-weighted inlet tubes damaged during installation as directed by the RCE or the manufacturers' representative at no expense to the Department.

815.4.11.5 Acceptance Criteria

- 1 Obtain RCE approval of inlet structure filter installations. When requested by the RCE, ensure that a manufacturer's representative is on-site to oversee and approve the initial installation of inlet structure filters. Obtain a letter from the manufacturer approving the installation when requested by the RCE.

815.4.12 Temporary Pipe Slope Drains

- 1 Construct optional temporary pipe slope drains as required or as directed by the RCE. Ensure that the flexible pipe is of sufficient size to carry the anticipated volume of water, but in no case less than 8 inches in diameter. Ensure that pipe conforms to the requirements of **Section 803**.
- 2 Install temporary slope drains as a part of the grading operation where applicable and adjust as directed by the RCE.
- 3 Construct an earth berm at the top of cut or fill sections to channel the water into the slope drain and to prevent collected water from spilling over the edge of the slope.
- 4 When the temporary slope drains are removed, dress and seed the area in accordance with **Section 810**. The removed pipe drain becomes property of the Contractor, and it may be used again at other temporary locations if the pipe is in a condition acceptable to the RCE.

815.4.13 Temporary Seeding

- 1 Perform Temporary Seeding in accordance with **Section 810** as applicable.

815.4.14 Stabilized Construction Entrance

815.4.14.1 Application

- 1 Install a stabilized construction entrance at all defined points where traffic enters or leaves a construction site and moves directly off or onto a public road. Use construction entrances in conjunction with the stabilization of construction roads to reduce the amount of mud picked up by vehicles.
- 2 Ensure that the stabilized construction entrance is a minimum of 24 feet wide by 100 feet long and modify as necessary to accommodate site constraints. Taper the edges of the entrance out towards the road to prevent tracking of mud at the edge of the entrance.
- 3 If washing is used, make provisions to intercept the wash water and trap the sediment before it is carried offsite. Require washdown facilities as

needed. In general, establish washdown facilities with crushed stone and drain into a sediment trap or sediment basin.

- 4 Remove all vegetation and any objectionable material from the foundation area. Divert all surface runoff and drainage from the stones to a sediment trap or basin. Install a non-woven geotextile fabric before placing any stone. If necessary, install a culvert pipe across the entrance to provide positive drainage. Place the aggregate at a minimum depth of 6 inches uniform on top of the geotextile fabric.

815.4.14.2 Inspection and Maintenance of Stabilized Construction Entrances

- 1 Inspect stabilized construction entrances every 7 days. Check for mud and sediment build-up and pad integrity. Wash, replace, or add stone whenever the entrance fails to perform effectively or as directed by the RCE. Wash or replace the stone in the entrance whenever the entrance fails to reduce the amount of mud being carried offsite by vehicle tires. Wash frequently to extend the useful life of the stone.
- 2 Re-shape stone pad as needed for drainage and runoff control. Brush or sweep up soil that has been tracked offsite immediately and properly dispose of it. Use flushing only when the water can be discharged to a sediment trap or basin. Maintain the stabilized construction entrance until the remainder of the construction site has been fully stabilized. Repair any broken pavement immediately.
- 3 For sites with wash racks at each site entrance, construct and maintain sediment traps for the life of the project.
- 4 If the aggregate material is being tracked offsite, limit larger vehicles from the construction site or use a larger diameter stone. If excessive sediment is being tracked onto the roadway, increase the length of the stabilized construction entrance.

815.4.14.3 Acceptance Criteria

- 1 Obtain RCE acceptance and approval for stabilized construction entrance installations and for the replacement of stone.

815.4.15 Bonded Fiber Matrix (BFM)

815.4.15.1 Application

- 1 Use BFM with all components pre-packaged by the manufacturer to assure material performance. Do not field mix materials, additives, or components.
- 2 Examine substrates and conditions before applying materials. Do not proceed with installation until unsatisfactory conditions are corrected. Apply BFM to geotechnically stable slopes that are constructed to divert runoff water away from the face of the slope eliminating damage to the slope face caused by the surface flow from above the slope.

- 3 Use personnel or subcontractors certified and trained by the manufacturer in the proper procedures for mixing and applying the BFM. Strictly comply with the manufacturer's mixing recommendations and installation instructions. Use approved hydraulic seeding/mulching machines with fan-type nozzle (50-degree tip) for BFM applications. Apply BFM from opposing directions to the soil surface in successive layers, reducing the "shadow effect" to achieve maximum coverage of all exposed soil. Do not apply the BFM immediately before, during, or after rainfall. Allow the BFM a minimum of 24 hours to dry after installation.
- 4 Do not exceed maximum slope length of 100 feet when slope gradients are steeper than 4H:1V. Install BFMs at a general application rate of 3500 pounds per acre.

815.4.15.2 Delivery, Storage, and Handling

- 1 Have BFM components delivered in factory labeled packages. Store and handle in strict compliance with the manufacturer's instructions and recommendations. Ensure that packaging is composed of UV resistant bags with a UV resistant pallet cover. Protect stored BFM from damage caused by weather, excessive temperatures, and construction operations. Clean all spills promptly.

815.4.15.3 Maintenance

- 1 Prepare a maintenance plan that includes the following:
 - Reapplication of BFM as directed by the RCE to disturbed areas that require continued erosion control.
 - Maintenance of equipment to provide uniform application rates.
 - Rinsing of all BFM mixing and application equipment thoroughly with water to avoid formation of residues and appropriate discharge of all rinse water.
- 2 Degradation of BFM can be expected to occur as a result of mechanical degradation, chemical, and biological hydrolysis, sunlight, salt, and temperature. Where necessary, reapply BFM in accordance with manufacturer's instructions. Reapplication is not required unless BFM treated soils are disturbed or turbidity or water quality shows the need for an additional application. If BFM-treated soils are left undisturbed, the necessity of reapplication will be determined by the RCE.

815.4.15.4 Acceptance Criteria

- 1 Obtain RCE acceptance and approval of BFM installations. When requested by the RCE, ensure that a manufacturer's representative is on-site to oversee and approve the initial installation of BFM. Obtain a letter from the manufacturer approving the installation when requested by the RCE.

815.4.16 Flexible Growth Matrix (FGM)

815.4.16.1 Application

- 1 Use flexible growth matrix (FGM) with components pre-packaged by the manufacturer to assure material performance. Do not field mix materials, additives, or components.
- 2 Examine substrates and conditions before materials are applied. Apply FGM to geotechnically stable slopes that constructed to divert runoff away from the face of the slope. Do not proceed with installation until satisfactory conditions are established.
- 3 Use personnel or subcontractor certified and trained by the manufacturer in the proper procedures for mixing and application of the FGM. Strictly comply with the manufacturer’s mixing recommendations and installation instructions. Use approved hydraulic seeding/mulching machines with fan-type nozzles (50-degree tip) for FGM applications. Apply FGM from opposing directions to the soil surface in successive layers, reducing the "shadow effect" to achieve maximum coverage of all exposed soil. FGM does not require a cure time and is effective immediately; therefore, FGM may be applied before, during or after a rainfall event. Install FGM materials at the general application rates in the following table.

Flexible Growth Matrix Application Rates	
Condition	Application Rate
Slope Applications	3500 pounds per acre
Below TRM	1500 pounds per acre

815.4.16.2 Delivery, Storage, Handling

- 1 Use FGM with components pre-packaged by the manufacturer to assure material performance. Have materials and products delivered in UV and weather resistant factory labeled packages. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from damage from weather, excessive temperatures, and construction operations. Clean all spills promptly.

815.4.16.3 Maintenance

- 1 Prepare a maintenance plan that includes the following:
 - Reapplication of FGM as directed by the RCE to disturbed areas that require continued erosion control.
 - Maintenance of equipment to provide uniform application rate.
 - Rinsing all FGM mixing and application equipment thoroughly with water to avoid formation of residues and appropriate discharge of rinse water.
- 2 Degradation of FGM can be expected to occur because of mechanical and chemical degradation and biological hydrolysis, sunlight, salt, and tempera-

ture. Reapply FGM in accordance with the manufacturer's instructions. Re-application is not required unless FGM treated soils are disturbed or turbidity or water quality shows the need for an additional application. If FGM-treated soils are left undisturbed, the necessity of reapplication will be determined by the RCE.

815.4.16.4 Acceptance Criteria

- 1 Obtain RCE acceptance and approval of FGM installations. When requested by the RCE, ensure that a manufacturer's representative is on-site to oversee and approve the initial installation of the FGM. Obtain a letter from the manufacturer approving the installation when requested by the RCE.

815.5 Measurement

- 1 The quantity of the pay item Fiber Roving Type (A or B) is the surface area covered by the roving including in anchor trenches and is measured by the square yard (SY) of fiber roving in-place, complete, and accepted.
- 2 The quantity of the pay item Turf Reinforcement Matting (TRM) Type (1, 2, 3, or 4) or Temporary Erosion Control Blanket (ECB) Class (A, B, or C) is the surface area covered by the rolled erosion control product, including seams, overlaps, anchor trenches, and wastage and is measured by the one-thousand square yard (MSY) unit of material in-place, complete, and accepted. Products damaged by the Contractor's operations are not included in the measurement.
- 3 The quantity for the pay item Sediment Tube is the length of sediment tube installed, including overlaps and wastage and is measured by the linear foot (LF) of sediment tube in-place, complete, and accepted. Sediment tubes damaged by the Contractor's operations are not included in the measurement. The installation of the sediment tubes may require written acceptance by the manufacturer's representative before the quantity is accepted.
- 4 The quantity for the pay item Silt Fence is the length of silt fence installed and maintained and is measured by the linear foot (LF) of silt fence in-place, complete, and accepted.
- 5 The quantity for the pay item Removal of Silt Retained by Silt Fence is the length of silt fence in front of which silt deposit was removed as ordered by the RCE and is measured by the linear foot (LF) along the line of the silt fence, complete, and accepted.
- 6 The quantity for Replace/Repair of Silt Fence is the length of silt fence repaired or replaced because of failure of the silt fence not the fault of the Contractor and is measured by the linear foot (LF) along the line of the silt fence, complete, and accepted.
- 7 The quantity for the item Floating Turbidity Barrier (Light, Medium, or Heavy Duty) is the length of floating turbidity barrier if the depth is specified in the Contract, or if the depth is not specified, then by the surface area of the floating turbidity barrier furnished, installed, maintained and is measured by either the linear foot (LF) or the square foot (SF) as applicable for type of barrier in-

place, complete, and accepted. Measurement of accumulated material removed and disposed of each time the device is cleaned out is included in the quantity for Cleaning Silt Basins.

- 8 The quantity for the pay item Silt Basins is the volume of material excavated for the construction and backfilling of silt basins and is measured by the cubic yard (CY) of material moved during each operation, complete, and accepted. Each operation is measured separately.
- 9 The quantity for the pay item Cleaning Silt Basins is the volume of sediment deposits removed from silt ditches and silt basins as directed by the RCE, measured by the cubic yard (CY) of material removed, complete, and accepted. The quantity also includes sediment deposits removed from erosion control devices as directed and approved by the RCE, except from in front of silt fences. Measurements will be taken each time sediment is removed. Proper disposal of the sediment removed is considered incidental work in this item and is not measured for payment.
- 10 The quantity for the pay item Silt Ditches is of material excavated for the construction and backfilling of silt ditches and is measured by the cubic yard (CY) of material moved, complete, and accepted. Each operation is measured separately.
- 11 The quantity for the pay item Inlet Structure Filter Type (B, D1, D2, E CBT-1, E CBT-16, E CBT-17, or E CBT-18) is measured by the each (EA) filter furnished and installed, complete, and accepted. The quantity for Inlet Structure Filter Type A, F (Weighted), or F (Non-weighted) is the length of inlet structure filter furnished and installed, including overlaps and wastage and is measured by the linear foot (LF) of filter in-place, complete, and accepted. Inlet structure filters damaged by the Contractor's operations are not included in the quantity. The proper removal and disposal of deposited sediment around inlet structure filters is included in the quantity for Cleaning Silt Basins.
- 12 The quantity for the pay item Filter Material for Inlet Structure Filter Type D1 or Filter Material for Inlet Structure Filter Type D2 is measured by each (EA) inlet structure filter around which the filter fabric is replaced not due to the fault of the Contractor's operations, complete, and accepted. This measurement only includes replacement filter fabric, not the replacement of the frame for the Type D1 or Type D2 inlet structure filters.
- 13 The quantity for the pay item Temporary Flexible Pipe Slope Drains - (diameter in inches) is the length of the flexible pipe drains furnished and installed, measured by the linear foot (LF) along of pipe in-place, complete, and accepted. This item includes any excavation necessary for the installation of the pipe drains; and therefore, no measurement is made for the excavation work.
- 14 The quantity for the pay item Stabilized Construction Entrance is the surface area of the stabilized construction entrance in-place and is measured by the square yard (SY), complete, and accepted. When replacement stone is authorized by the RCE, the area of replacement stone in the stabilized construction entrance is measured and added to the quantity for this item.

- 15 The quantity for the pay item Bonded Fiber Matrix (BFM) is the surface area covered by the bonded fiber matrix applied at the recommended rate and is measured by the one-thousand square yard (MSY) units of matrix in-place, complete, and accepted. The installation of the BFM may require written acceptance by the manufacturer's representative before acceptance for payment.
- 16 The quantity for the pay item Flexible Growth Matrix (FGM) is the surface area covered by the flexible growth matrix applied at the recommended rate and is measured by the one-thousand square yard (MSY) units of matrix in-place, complete, and accepted. The installation of the FGM may require written acceptance by the manufacturer's representative before acceptance for payment.
- 17 Brush barriers are not measured for payment. The material and labor to construct brush barriers are considered incidental to the clearing and grubbing operations.
- 18 The quantity for Temporary Seeding is measured in accordance with **Subsection 810.5**.
- 19 Temporary pipe slope drains installed are considered incidental to work of the erosion control items; and therefore, they are not measured for payment.

815.6 Payment

- 1 Unless otherwise noted, payment for the accepted quantity for each pay item, measured in accordance with **Subsection 815.5**, is determined using the contract unit bid price for the applicable item, and the payment includes all direct and indirect costs and expenses required to complete the work.
- 2 Payment for Fiber Roving Type (A or B) is full compensation for installing fiber roving as specified or directed and includes furnishing, spreading and maintaining fiber roving; application of asphalt tackifier; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 3 Payment for Turf Reinforcement Matting (TRM) Type (1, 2, 3, or 4) or Temporary Erosion Control Blanket (ECB) Class (A, B, or C) is full compensation for installing TRM or ECB as specified or as directed and includes furnishing, placing, and maintaining the erosion control matting or blankets; providing anchor devices and trenches; quality control testing; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 Payment for Sediment Tubes is full compensation for installing the sediment tubes as specified or directed and includes furnishing, placing, maintaining, inspecting, removing, and disposing of the sediment tubes; providing wooden stakes, steel posts, proper storage facilities, documentation of Quality Control and Quality Assurance programs; and all other materials, labor,

equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

- 5 Payment for Silt Fence is full compensation for installing silt fence as specified or directed and includes furnishing, placing, maintaining, inspecting, removing, and disposing of silt fences; providing filter fabric, posts, and ties; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 6 Payment for Replace/Repair of Silt Fence is full compensation for repairing or replacing damaged or malfunction silt fences as specified or directed and includes furnishing or repairing filter fabric, posts, and ties, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 7 Payment for Floating Turbidity Barrier (*Light, Medium, or Heavy Duty*) is full compensation for installing floating turbidity barriers as specified or directed and includes furnishing, installing, maintaining, removing and disposing of the floating turbidity barriers; providing attachments to the shore, anchors, vertical supports, anchor buoys, buoyed warning signs, and lighted buoys; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 8 Payment for Silt Basins is full compensation for constructing silt basins as specified or directed and includes excavating, grading, and backfilling of silt basins; disposing of surplus material; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 9 Payment for Cleaning Silt Basins is full compensation for removing and disposing of sediment deposits accumulated in silt basins as well as other sediment retention devices as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 10 Payment for Silt Ditches is full compensation for constructing silt ditches as specified or directed and includes excavating, grading, and backfilling of silt ditches; disposing of surplus material; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 11 Payment for Inlet Structure Filter (of the type required) is full compensation for installing the inlet structure filters as specified or directed and includes furnishing, installing, maintaining, inspecting, removing and disposing of the

inlet structure filters; providing posts, fabric, ties, anchor trenches, proper storage facilities, and documentation of Quality Control and Quality Assurance programs; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.

- 12 Payment for Stabilized Construction Entrance is full compensation for constructing stabilized construction entrances as specified or directed and includes furnishing, installing, inspecting, maintaining, reshaping, removing, and disposing of the stabilized construction entrance (and exit); providing wash-down facilities, drainage, and geotextile under the aggregate; sweeping adjacent roadway as necessary or directed; and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 13 Payment for Bonded Fiber Matrix (BFM) or Flexible Growth Matrix (FGM) is full compensation for installing BFM or FGM as specified or directed and includes furnishing, applying, and maintaining the erosion control matrix including testing and documentation of Quality Control and Quality Assurance programs and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 14 Brush barriers are not paid for directly, but are considered incidental to the clearing and grubbing operation. The cost for brush barriers is included in the contract lump sum bid price for Clearing and Grubbing.
- 15 The payment for Temporary Seeding is made in accordance with the applicable provisions of **Subsection 810.6**.
- 16 Pay items under this section include the following:

Item No.	Pay Item	Unit
8151000	Fiber Roving	SY
8151010	Bonded Fiber Matrix (BFM)	MSY
8151020	Flexible Growth Matrix (FGM)	MSY
8151101	Turf Reinforcement Matting (TRM) Type 1	MSY
8151102	Turf Reinforcement Matting (TRM) Type 2	MSY
8151103	Turf Reinforcement Matting (TRM) Type 3	MSY
8151104	Turf Reinforcement Matting (TRM) Type 4	MSY

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Item No.	Pay Item	Unit
8151111	Temporary Erosion Control Blanket (Class A)	MSY
8151112	Temporary Erosion Control Blanket (Class B)	MSY
8151113	Temporary Erosion Control Blanket (Class C)	MSY
8152004	Inlet Structure Filter - Type F (Weighted)	LF
8152006	Inlet Structure Filter - Type F (Non-Weighted)	LF
8152007	Sediment Tube	LF
8153000	Silt Fence	LF
8153090	Replace/Repair Silt Fence	LF
8153100	Floating Turbidity Barrier - Light Duty	SF
81531XX	Floating Turbidity Barrier - Light Duty ((X)' Deep)	LF
8153200	Floating Turbidity Barrier -Medium Duty	SF
81532XX	Floating Turbidity Barrier - Medium Duty ((X)' Deep)	LF
8153300	Floating Turbidity Barrier - Heavy Duty	SF
81533XX	Floating Turbidity Barrier - Heavy Duty ((X)' Deep)	LF
8154000	Silt Basins	CY
8154010	Cleaning Silt Basins	CY
8154050	Removal of Silt Retained by Silt Fence	LF
8155000	Silt Ditches	CY
8156205	Inlet Structure Filter - Type D1	EA
8156207	Filter Material for Inlet Structure Filter - Type D1	EA
8156210	Inlet Structure Filter - Type B	EA
8156211	Inlet Structure Filter - Type E (Catch Basin Type 1)	EA
8156212	Inlet Structure Filter - Type E (Catch Basin Type 16)	EA

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Item No.	Pay Item	Unit
8156213	Inlet Structure Filter - Type E (Catch Basin Type 17)	EA
8156214	Inlet Structure Filter - Type E (Catch Basin Type 18)	8156214
8156215	Inlet Structure Filter - Type D2	EA
8156217	Filter Material for Inlet Structure Filter - Type D2	EA
8156219	Inlet Structure Filter - Type A	LF
8156490	Stabilized Construction Entrance	SY

SECTION 816

SEDIMENT CONTROL BASINS AND STORM WATER DETENTION PONDS

816.1 Description

- 1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the construction of temporary and permanent sediment control basins and storm water detention ponds in conformity with the Plans, the Specifications, the *SCDOT Standard Drawings*, and as directed by the RCE.

816.1.1 Types of Structures

- 1 A Temporary and Permanent Sediment Control Basin is a sediment retention structure that consists of a basin storage area, a dam, sediment control structure, emergency spillway, and a security fence with gate.
- 2 A Storm Water Detention Pond is a permanent sediment retention structure that consists of a basin storage area, a sediment control structure, an emergency spillway, and a security fence with gate.
- 3 The Sediment Control Structure is the principal spillway of a sediment retention structure that consists of a riser connected to an outflow pipe.

816.2 Materials

- 1 Use materials conforming to the material requirements in the specifications referenced in the following table.

Material	Specification
Polyethylene Pipe	AASHTO M 294 & Section 714
Corrugated Aluminum Pipe	AASHTO M 196 & Section 714
Corrugated Steel Pipe	AASHTO M 36 & Section 714
Reinforced Concrete Pipe	AASHTO M 170 & Section 714
Class 2500 Concrete	Section 701
Riprap Class B	Section 804
Geotextile for Erosion Control Under Riprap	Section 804
FA-10 Fine Aggregate	Section 701
Dam Core Materials	AASHTO Classifications A-2-6, A-2-7, A-6, A-7
Woven Wire Fence, Type 1 without barbed wire, with gate	Section 806
Chain Link Fence with gate	Section 806

816.3 Equipment

- 1 Ensure that the equipment necessary for the proper construction of the work is on site, in acceptable working condition, and approved by the RCE as to both type and condition before the start of work under this section. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

816.4 Construction**816.4.1 General**

- 1 Construct the required sediment retention structures and devices in accordance with these specifications and the *SCDOT Standard Drawings* unless otherwise indicated on the Plans and in the Special Provisions or directed by the RCE.

816.4.2 Site Work

- 1 Locate and construct the sediment retention structures before performing other earthwork.
- 2 Clear and grub the entire area of the basin and spillway in accordance with the applicable requirements of **Section 201**. Turn the entire area to a depth of 6 inches with a disk harrow and compact it to 95.0% compaction. Fill all holes in the foundation area of the dam with suitable material and compact to 95.0% compaction.

816.4.3 Cutoff Trench

- 1 Excavate a cutoff trench to a depth of 4 feet or deeper with 1:1 side slopes for the entire length of the dam and into the original ground at the abutments. Use suitable material removed from the trench to construct the back one-third of the dam. Remove all water from the cutoff trench before plowing and compacting as described above. Backfill the cutoff trench in horizontal layers not exceeding 8 inches in depth and compact to 95.0% compaction. Ensure that the moisture content of the fill material is adequate for obtaining the required compaction.

816.4.4 Earth Dam

- 1 Construct the earth dam to the dimensions shown on the Plans. Construct the dam core to the dimensions shown on the Plans and to an elevation level with the flowline of the emergency spillway. Construct the core with a top width of 8 feet and 1:1 side slopes. Place fill adjacent to pipes or other structures in 4-inch layers and compact by hand or by manually directed tampers or plate vibrators. Place the fill over pipes to a minimum of 2 feet before using heavy equipment. Do not place fill around concrete structures until the concrete has cured sufficiently to support the load. As soon as final grades are reached, seed all areas in accordance with **Section 810**.

816.4.5 Aggregate Diaphragm

- 1 Construct an aggregate diaphragm, parallel to the dam, around the outlet pipe immediately at the outlet side of the cutoff trench. Construct The aggregate diaphragm to a depth of 2 feet extending three times the pipe diameter vertically and horizontally, and a minimum of 18 inches beneath the pipe. Use FA-10 fine aggregate. Place a minimum of 2 feet of fill material over the diaphragm.

816.4.6 Aggregate Drain

- 1 Construct an aggregate drain for the diaphragm, 1.5 times the diameter of the pipe or a minimum of 1 foot around the pipe, to the down stream edge of the dam. Use FA-10 fine aggregate for the aggregate drain. Where the drain and the outlet pipe exit the fill, place a riprap pad over a fabric filter. Extend the riprap pad at least 2 feet outside the aggregate drain in all directions. Use riprap meeting the requirements for Class B Riprap in **Subsection 804.2**.

816.4.7 Emergency Spillway

- 1 Construct an emergency spillway on original ground at the grades and locations shown on the *SCDOT Standard Drawings* unless otherwise shown on the Plans. Construct a spillway outfall channel to the main outfall channel as shown on the *SCDOT Standard Drawings* unless otherwise shown on the Plans. Seed the sides and bottom of the emergency spillway and spillway outfall channel as directed by the RCE and in accordance with **Section 810** unless otherwise specified on the Plans.

816.4.8 Temporary and Permanent Sediment Control Basins

- 1 Locate and construct the sediment control basin as shown in the Plans. Construct the bottom of the basin on a 0.5% slope. If the inflow into the basin is from a pipe or from a ditch with a flow line higher than the bottom of the basin, place riprap at the end of the pipe or ditch to prevent erosion. Place the riser pipe by anchoring in Class 2500 (or higher) concrete and attaching it with a wire strap to a 6-inch x 6-inch treated wooden post. Join all pipe sections so that the connections are watertight.
- 2 For temporary silt basins, use either polyethylene Type C or corrugated steel pipe for the riser and outflow pipe. For permanent silt basins, use either corrugated aluminum pipe or reinforced concrete pipe for the riser and outflow pipe. Use the pipe sizes shown on the Plans. Drill ¾-inch diameter holes in the riser pipe, starting 1 foot above the top of the outflow pipe. Space these holes at intervals of 1-foot horizontal and 1-foot vertical.
- 3 Place a trash rack and an anti-vortex plate over the top of the riser as shown on the Plans. Fabricate a de-watering orifice in the riser opposite and on the same grade as the outlet pipe. Cover the orifice with ½-inch hardware cloth and No. 5 aggregate to a depth of 6 inches above the top of the outlet pipe. Use the diameter indicated on the Plans for the orifice, the riser, and the outlet pipes.

- 4 Place the outflow pipe on a 0.5% slope. Line the outflow channel with riprap or install a stilling basin as indicated on the Plans. Use geotextile under the riprap.
- 5 Erect a Type 1 woven wire fence without barbed wire and with a 12-foot farm gate with locking device around the sediment control basin in accordance with applicable requirements of **Section 806** unless otherwise directed by the RCE.
- 6 When grading operations are complete and the permanent grassing is in place, restore the area occupied by the temporary sediment basin as nearly as practicable to the original ground line and seed the area.

816.4.9 Storm Water Detention Pond

- 1 Construct the sediment control structure using a riser consisting of either a pipe or a concrete box. If the riser is a pipe, install a trash rack and an anti-vortex plate. If the riser is a concrete box, install a grate. For both types of risers place a stub out de-watering pipe at the same flow line as the outlet pipe as shown on the Plans. For all pipes, use either reinforced concrete or aluminum alloy. Join all pipe sections so that the connections are watertight.
- 2 In rural areas, erect a Type 1 woven wire fence without barbed wire and with a 12-foot gate unless otherwise directed by the RCE. In urban areas, erect a standard 72-inch chain-link security fence in accordance with applicable requirements of **Section 806** unless otherwise directed by the RCE.

816.5 Measurement

- 1 The preparation of the area around the basins and ponds is included in the quantity for Clearing and Grubbing and is measured in accordance with **Subsection 201.5**.
- 2 The quantity of material excavated to form the basin storage area for temporary or permanent sediment control basins and storm water detention ponds is measured as Silt Basins as specified in **Subsection 815.5**. The quantity of accumulated material removed and disposed of to maintain basins and ponds is measured as Cleaning Silt Basins in accordance with **Subsection 815.5**. All backfilling and grading of temporary sediment control basins is measured as Silt Basins as specified in **Subsection 815.5**.
- 3 The quantity for the pay item Temporary Sediment Control Structure or Permanent Sediment Control Structure is measured by each (EA) sediment control structure with the specified inlet and outlet pipe size, complete, and accepted.
- 4 Concrete, reinforcing steel, trash rack, anti-vortex plate, hardware fabric, treated wood post, No. 5 aggregate, riser and 4 feet of outlet pipe, and the removal of the temporary structure (except for the riprap) are not measured for payment and are considered included in the work for the item Temporary Sediment Control Structure or Permanent Sediment Control Structure.

816.5**816.6**

- 5 The quantity for Aggregate Diaphragm is the volume FA-10 fine aggregate placed in aggregate diaphragm and aggregate drain and is measured by the cubic yard (CY), completed and accepted.
- 6 The quantity for Woven Wire Fence Type 1 without Barbed Wire or Chain-link Fence is measured in accordance with **Subsection 806.5**.
- 7 The quantity for Geotextile for Erosion Control Under Riprap is measured in accordance with **Subsection 804.5**.
- 8 The quantity for Pipe (of the size and type required), exclusive of the 4 feet of pipe included in the sediment control structure, is measure in accordance with **Subsection 803.5**.
- 9 The quantity for Riprap is measured in accordance with **Subsection 804.5**. The removal and disposal of riprap in temporary sediment control basins is measured as Silt Basins in accordance with **Subsection 815.5**.
- 10 The quantity for seeding operations is measured in accordance with **Subsection 810.5**.

816.6 Payment

- 1 Unless otherwise noted below, payment for the accepted quantity for each pay item, measured in accordance with **Subsection 816.5**, is determined using the contract unit bid price for the applicable item, and the payment includes all direct and indirect costs and expenses required to complete the work.
- 2 The payment for Temporary Sediment Control Structure or Permanent Sediment Control Structure is full compensation for constructing sediment control structures as specified or directed and includes furnishing and placing concrete, reinforcing steel, trash rack, anti-vortex plate, hardware fabric, treated wood post, No. 5 aggregate, riser, and 4 feet of outlet pipe and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract. Payment for Temporary Sediment Control Structure also includes removal of the structure, pipe and all appurtenances connected to the structure.
- 3 Payment for Aggregate Diaphragm is full compensation for furnishing and placing fine aggregate material in the aggregate diaphragm and aggregate drain as specified or directed and includes all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to fulfill the requirements of the pay item in accordance with the Plans, the Specifications, and other terms of the Contract.
- 4 The payments for the items in the following table are in accordance with the indicated section or subsection.

Work	Payments in Accordance with
Clearing and Grubbing	Subsection 201.6
Unclassified Excavation	Subsection 203.6
Pipe (not including 4 feet of outlet pipe)	Subsection 803.6
Geotextile for Erosion Control Under Riprap	Subsection 804.6
Riprap (Class B)	Subsection 804.6
All Seeding Operations	Subsection 810.6
Silt Basins	Subsection 815.6
Cleaning Silt Basins	Subsection 815.6

5 Pay items under this section include the following:

Item No.	Pay Item	Unit
81600X0	Temporary (<u>riser dia.</u>)" x (<u>outlet dia.</u>)" Sediment Control Structure	EA
81602X0	Permanent (<u>riser dia.</u>)" x (<u>outlet dia.</u>)" Sediment Control Structure	EA
8161100	Aggregate Diaphragm	CY

APPENDIX

Asphalt Surface Treatment - Double Treatment
Type I, 2, 3, 4, & 5 A-2

Asphalt Surface Treatment - Triple Treatment
Type 1 & 2 A-3

Gradation of Coarse Aggregates..... A-4

Gradation of Fine Aggregates..... A-5

Aggregate Applications..... A-6

Nomograph For Determining Rate Of Evaporation A-7

Schedule Of Pay Items A-8

Asphalt Surface Treatment - Double Treatment					
Sequence Of Operations	Quantities Per Square Yard				
	Type 1	Type 2	Type 3	Type 4	Type 5
Prime:					
Clean surface.					
Apply MC-30, MC-70, RC-30 or EA-P Special. (gallons)	0.25 – 0.28 ¹	--	--	--	--
Allow to cure, all types.					
First Layer:					
Apply CRS-2 or asphalt binder. (gallons) ⁴	0.35 - 0.40	--	--	--	--
Apply CRS-2. (gallons) ⁴	--	0.40 - 0.43	0.30 - 0.35	0.30 - 0.35	0.28 – 0.35
Spread immediately Aggregate No. 5. (lbs.) ²	40 - 50	40 - 50	--	--	--
Spread immediately Aggregate No. 6M. (lbs.)	--	--	28 - 32	28 - 32	--
Spread immediately Aggregate No. 89M. (lbs)	--	--	--	--	12 - 15
Roll immediately with steel wheel and pneumatic roller, all types.					
Second Layer: ³					
Apply CRS-2. (lbs.) ⁴	0.17 - 0.20	0.22 - 0.23	0.25 - 0.30	0.16 - 0.20	0.20 – 0.30
Spread immediately Aggregate No. 789. (lbs.)	22 - 24	22 - 24	18 - 22	--	--
Spread immediately Aggregate No. 89M. (lbs.)	--	--	--	14 - 16	--
Spread immediately FA-13 or washed screenings (lbs.)	--	--	--	--	10 - 12
Apply CRS-2. (lbs.) ⁴	0.30 - 0.32	0.35 - 0.37	--	--	--
Roll with steel wheel rollers as soon as possible, all types.					
TOTALS:					
Asphalt material (not including prime (lbs.)	0.82 - 0.92	0.97 - 1.03	0.55 - 0.65	0.46 - 0.55	0.48 – 0.65
Aggregate (lbs.)	62 - 74	62 - 74	46 - 54	42 - 48	22 - 27

¹ When the base consists of marine limestone, ensure that the prime rate is 0.10 to 0.15 gallons per square yard.

² Ensure that the amount spread is within these limits and is the amount necessary to obtain a complete and satisfactory cover.

³ The RCE or RME may direct a change in the sequence of operations as provided in this section.

⁴ CRS-2P may be used in lieu of CRS-2 as specified by the Contract.

Asphalt Surface Treatment - Triple Treatment		
Sequence of Operations	Quantities per Square Yard	
	Type 1	Type 2
Prime:		
Clean surface		
Apply MC-30, RC-30 or EA-P. (gallons) ¹	0.25 - 0.28	0.25 - 0.28
Allow to cure, all types.		
First Layer:		
Apply CRS-2. (gallons)	0.35 - 0.40	0.30 - 0.35
Immediately spread Aggregate No. 5. (lbs.) ²	40 - 50	---
Immediately spread Aggregate No. 6M. (lbs.)	---	28 - 32
Roll Immediately with steel wheel roller and pneumatic tired roller, all types.		
Second Layer:		
Apply CRS-2 (gallons)	0.20 - 0.23	0.16 - 0.20
Immediately spread Aggregate No. 789. (lbs.)	17-19	---
Immediately spread Aggregate No. 89M. (lbs.)	---	14 - 16
Third Layer:		
Apply CRS-2. (gallons)	0.30 - 0.32	0.25 - 0.30
Immediately spread Aggregate No. FA-13. (lbs.)	10-12	---
Immediately spread Aggregate No. FA-13 or washed screenings. (lbs.)	---	10 - 12
Roll with steel wheel and pneumatic rollers, broom, and continue alternating with pneumatic roller and broom, all types.		
TOTALS:		
Asphalt material (not including prime) (gallons)	0.85 - 0.95	0.71 - 0.85
Aggregate (lbs.)	67 - 81	52 - 60

¹ When the base consists of marine limestone, ensure that the prime rate is from 0.10 to 0.15 gallons per square yard.

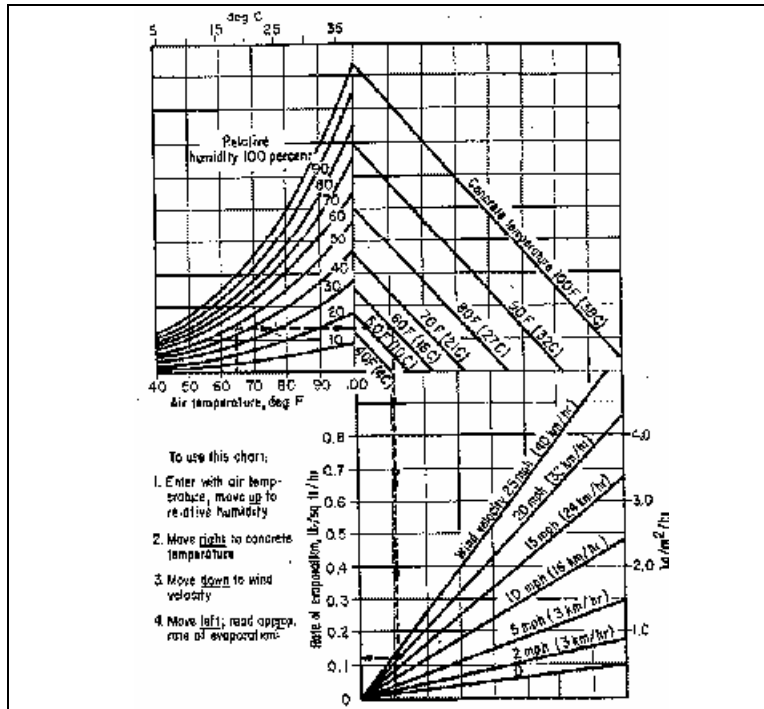
² Ensure that the amount spread is within these limits and is the amount necessary to obtain a complete and satisfactory cover.

Gradation of Coarse Aggregates										
Percentage by Weight Passing Sieves Having Square Openings										
Sieve Designation	Aggregate No.									
	CR-14	5	56	57	67	6M	8M	78	789	89M
2-inch	100	--	--	--	--	--	--	--	--	--
1½-inch	95 - 100	100	100	100	--	--	--	--	--	--
1-inch	70 - 100	90 - 100	90 - 100	95 - 100	100	100	--	--	--	--
¾-inch	--	20 - 55	40 - 85	--	90 - 100	90 - 100	100	100	100	--
½-inch	35 - 65	0 - 10	10 - 40	25 - 60	--	--	95 - 100	90 - 100	95 - 100	100
⅜-inch	--	0 - 5	0 - 15	--	20 - 55	0 - 20	75 - 100	40 - 75	80 - 100	98 - 100
No. 4	10 - 40	--	0 - 5	0 - 10	0 - 10	0 - 5	10 - 35	5 - 25	20 - 50	20 - 70
No. 8	--	--	--	0 - 5	0 - 5	--	--	--	--	2 - 20
No. 16	--	--	--	--	--	--	0 - 5	0 - 5	0 - 6	--
No. 100	--	--	--	--	--	--	0 - 2	--	0 - 2	0 - 3

Gradation of Fine Aggregates				
Percentage by Weight Passing Sieves Having Square Openings				
Sieve Designation	Aggregate No.			
	FA-10	FA-10M	FA-12	FA-13
½-inch	--	--	--	--
⅜-inch	100	100	100	100
No. 4	96 - 100	95 - 100	90 - 100	90 -100
No. 8	75 - 100	84 - 100	--	--
No. 16	55 - 98	45 - 95	50 - 86	40 - 80
No. 30	25 - 75	25 - 75	--	--
No. 50	5 - 30	8 - 35	2 - 20	0 - 10
No. 100	0 - 9	0.5 - 20	0 - 5	0 - 3
No. 200	0 - 3	0 - 10*	--	--

* Dust of fracture essentially free from clay or shale, final job site testing only.

Aggregate Applications	
Aggregate No.	Applications
5	Asphalt Surface Treatment - Double Treatment -Types 1 & 2 Asphalt Surface Treatment - Triple Treatment - Type 1
6M	Asphalt Surface Treatment - Single Treatment - Types 1 & 2 Asphalt Surface Treatment - Double Treatment - Types 3 & 4 Asphalt Surface Treatment - Triple Treatment - Type 2
57	Portland Cement Concrete for Structures
67	Portland Cement Concrete Pavement
89M	Asphalt Surface Treatment - Single Treatment Asphalt Surface Treatment - Double Treatment - Types 4 & 5 Asphalt Surface Treatment - Triple Treatment - Type 2
789	Aggregate underdrains Asphalt Surface Treatment -Single Treatment Asphalt Surface Treatment - Double Treatment - Types 1, 2, & 3 Asphalt Surface Treatment - Triple Treatment - Type 1 Pipe underdrains
CR-14	Soil-Aggregate Subbase
FA-10 FA-10M	Portland Cement Concrete for Structures Portland Cement Concrete Pavement
FA-12	Aggregate Underdrains
FA-13	Aggregate Underdrains Asphalt Surface Treatment - Double Treatment - Type 5 Asphalt Surface Treatment - Triple Treatment - Types 1 & 2



Nomograph for Determining Rate of Evaporation

This chart provides a graphic method of estimating the loss of surface moisture due to concrete and air temperatures, relative humidity, and wind velocity. To use the chart, follow the four steps outlined. If the rate of evaporation approaches 0.2 lbs./ft.²/hr., precautions against plastic shrinkage cracking are necessary.

Schedule Of Pay Items

Item No.	Pay Item	Unit
Division 100		
1031000	Mobilization	LS
1040010	Value Engineering (Contractor's Portion)	LS
105080X	Construction Stakes, Lines, and Grades	EA
105081X	Construction Stakes, Lines And Grades (For Bridge Only)	EA
1071000	Traffic Control	LS
Division 200		
2011000	Clearing and Grubbing within Right-of-Way	LS
2011001	Clearing and Grubbing within Right-of-Way	ACRE
2012000	Clearing and Grubbing within Roadway	LS
2012001	Clearing and Grubbing within Roadway	ACRE
2013050	Clearing and Grubbing Ditches	ACRE
2021000	Removal of Structures and Obstructions	LS
2021200	Removal and Disposal of Tank Contents	GAL
2021205	Removal and Disposal of Low-Level Contaminated Soil	TON
2021210	Removal and Disposal of High-Level Contaminated Soil	TON
2022000	Removal & Disposal Item No. <i>(number)</i>	LS
2023000	Removal & Disposal of Existing Pavement	SY
2024100	Removal & Disposal of Existing Curb	LF
2025000	Removal & Disposal of Existing Asphalt Pavement	SY
2027801	Removal of Existing Guardrail	LF
202810X	Removal & Disposal of Existing Bridge	LS
202850X	Removal & Disposal of Existing Culvert <i>(width)</i> ft. × <i>(height)</i> ft.	EA
2031000	Unclassified Excavation	CY
2031200	Site Excavation	LS
2032000	Rock Excavation	CY
2033000	Borrow Excavation	CY

Schedule Of Pay Items

Item No.	Pay Item	Unit
2034000	Muck Excavation	CY
2035000	Station Grading	STA
2041000	Structure Excavation for Culverts	CY
2041005	Structure Excavation for Retaining Walls	CY
2042000	Dry Excavation for Bridges	CY
2043000	Wet Excavation for Bridges	CY
2043500	Wet & Dry Excavation for Bridges	CY
2044000	Rock Excavation for Bridges	CY
2045000	Cofferdam	EA
2045010	Cofferdam - Type 1 (0 – 10,000 CF)	EA
2045020	Cofferdam - Type 2 (10,001 – 20,000 CF)	EA
2045030	Cofferdam - Type 3 (20,001 – 30,000 CF)	EA
2045040	Cofferdam - Type 4 (30,001 – 40,000 CF)	EA
2045050	Cofferdam - Type 5 (40,001 – 50,000 CF)	EA
2045060	Cofferdam - Type 6 (>50,000 CF)	EA
2047000	Temporary Shoring Wall	LF
2047210	Permanent Shoring Wall	LF
2061000	Embankment In-Place	CY
2071000	Overhaul	CYHM
2081001	Fine Grading	SY
2091000	Select Material for Shoulders and Slopes	CY
2103000	Flowable Fill	CY
Division 300		
3011XX0	Cement Modified Subbase (<i>(thickness)</i> " Uniform)	SY
3013000	Portland Cement for Cement Modified Subbase	TON
3021000	Soil Aggregate Subbase Course - Aggregate No. CR-14	TON
3022000	Aggregate No. CR-14	TON
30310XX	Sand-Clay Base Course (<i>(thickness)</i> " Uniform)	SY
30411XX	Coquina Shell Base Course (<i>(thickness)</i> " Uniform)	SY

Schedule Of Pay Items

Item No.	Pay Item	Unit
30501XX	Graded Aggregate Base Course <i>((thickness)" Uniform)</i>	SY
3050199	Graded Aggregate Base Course	TON
30633XX	Cement Modified Recycled Base <i>((thickness)" Uniform)</i>	SY
3064000	Portland Cement for Cement Modified Recycled Base	TON
3071XX0	Cement Stabilized Earth Base Course <i>((thickness)" Uniform)</i>	SY
3072000	Portland Cement for Cement Stabilized Earth Base Course	TON
3081XX0	Cement Stabilized Aggregate Base Course <i>((thickness)" Uniform)</i>	SY
3082000	Portland Cement for Cement Stabilized Aggregate Base Course	TON
30910X0	Asphalt Base Course Type C <i>((thickness)" Uniform)</i>	SY
3091100	Asphalt Base Course Type C	TON
30920X0	Asphalt Base Course Type D <i>((thickness)" Uniform)</i>	SY
3092100	Asphalt Base Course Type D	TON
31003X0	Asphalt Base Course Type <i>(A or B)</i>	TON
Division 400		
40110XX	Liquid Asphalt Binder PG <i>(grade)</i>	TON
4012XX0	Full Depth Asphalt Pavement Patching <i>(X)" Uniform</i>	SY
4013001	Surface Plane Asphalt Pavement	SY
4013XXX	Milling Existing Asphalt Pavement <i>(X)"</i>	SY
4013990	Milling Existing Asphalt Pavement Variable	SY
4019000	Milled-In Rumble Strip	MI
40203X0	HMA Intermediate Course Type <i>(A, B, or C)</i>	TON
40303X0	HMA Surface Course Type <i>(A, B, C, CM, D or E)</i>	TON
4037000	HMA Surface Course for Ditch Paving	TON
4041000	Cold Mix Asphalt Intermediate Course	TON

Schedule Of Pay Items

Item No.	Pay Item	Unit
405X000	Cold Mix Asphalt Concrete Surface Course (Type <i>(1, 2, or 3)</i>)	TON
4060010	Asphalt Surface Treatment (Single Treatment)	SY
407010X	Asphalt Surface Treatment (Double Treatment Type <i>(1, 2, 3, 4, or 5)</i>)	SY
408010X	Asphalt Surface Treatment (Triple Treatment Type <i>(1 or 2)</i>)	SY
4092000	Open-Graded Friction Course	TON
Division 500		
5011X00	Portland Cement Concrete Pavement <i>(thickness)</i> " Uniform	SY
5012X00	Portland Cement Concrete Pavement for Ramps <i>((thickness)</i> " Uniform)	SY
50210XX	Full Depth Concrete Pavement Patch - <i>(thickness)</i> "	SY
5029000	Portland Cement Concrete (Special Use)	CY
5031000	Grinding and Texturing Existing Concrete Pavement	SY
5041100	Clean and Seal Longitudinal Joints	LF
5041200	Clean & Seal Longitudinal Shoulder Joints	LF
5041300	Clean & Seal Transverse Joints	LF
5041400	Clean & Seal Transverse Joints at Bridge	LF
5051000	Rout, Clean, and Seal Cracks	LF
Division 600		
6041100	Barricade – Type I	LF
6041150	Barricade – Type II	LF
6041200	Barricade – Type III	LF
6051120	Permanent Construction Signs (Ground Mounted)	SF
6051125	Permanent Construction Signs (Barricade Mounted)	SF
6052120	Portable Terminal Impact Attenuator	EA
6052121	Portable Terminal Impact Attenuator – Test Level 2	EA

Schedule Of Pay Items

Item No.	Pay Item	Unit
6052122	Portable Terminal Impact Attenuator – Test Level 3 (60 mph)	EA
6052123	Portable Terminal Impact Attenuator – Test Level 3 (70 mph)	EA
6052124	Absorb 350 – Portable Attenuator - Moveable Barrier	EA
605212A	Anchor Kit – Portable Attenuator (Test Level 2)	EA
605212B	Anchor Kit – Portable Attenuator (Test Level 3) 60 mph	EA
605212C	Anchor Kit – Portable Attenuator (Test Level 3) 70 mph	EA
6053110	Temporary Concrete Barrier	LF
6053115	Temporary Concrete Barrier (Moveable)w/Non- Textured White Coating (Including TTV)	LF
6053120	Temporary Water Filled Polyethylene Barrier	LF
6062000	Construction Zone Electric Changeable Message Sign (Trailer Mounted)	EA
6082000	Temporary Glare Shields For Traffic Control	LF
608100A	Type A – Flashing Light	EA
608100B	Type B – Flashing Light	EA
608100C	Type C – Steady-Burn Light	EA
609105X	Pavement Markings (Temporary - <i>(material)</i>) - 4" <i>(color)</i> Broken Lines	LF
609110X	Pavement Markings (Temporary - <i>(material)</i>) - 6" <i>(color)</i> Broken Lines	LF
609115X	Pavement Markings (Temporary - <i>(material)</i>) - 4" <i>(color)</i> Solid Lines	LF
609120X	Pavement Markings (Temporary - <i>(material)</i>) - 6" <i>(color)</i> Solid Lines	LF
609125X	Pavement Markings (Temporary - <i>(material)</i>) - 8" <i>(color)</i> Solid Lines	LF
609130X	Pavement Markings (Temporary - <i>(material)</i>) - 12" <i>(color)</i> Solid Lines	LF
609135X	Pavement Markings (Temporary - <i>(material)</i>) - 24" <i>(color)</i> Solid Lines	LF
609160X	Pavement Markings (Temporary - <i>(material)</i>) -	EA

Schedule Of Pay Items

Item No.	Pay Item	Unit
	White Single Arrow	
609165X	Pavement Markings (Temporary - <i>(material)</i>) - White Combination Arrows	EA
609180X	Pavement Markings (Temporary - <i>(material)</i>) - White Word 'Only'	EA
609185X	Pavement Markings (Temporary - <i>(material)</i>) - Railroad Crossing Symbols	EA
6092100	Temporary Clear Pavement Markers Mono-Directional - 4"X 4"	EA
6092150	Temporary Yellow Pavement Markers Mono-Directional - 4"X 4"	EA
6092155	Temporary Yellow Pavement Markers Bi-Directional - 4"X 4"	EA
6250005	4" White Broken Lines (Gaps Excluded) - Fast Dry Paint	LF
6250007	6" White Broken Lines (Gaps Excluded) - Fast Dry Paint	LF
6250008	6" Black Broken Lines (Gaps Excluded) - Fast Dry Paint	LF
6250010	4" White Solid Lines (Pavement Edge Lines) - Fast Dry Paint	LF
6250012	6" White Solid Lines (Pavement Edge Lines) - Fast Dry Paint	LF
6250015	8" White Solid Lines (Crosswalk & Channelization) - Fast Dry Paint	LF
6250020	12" White Solid Lines - Fast Dry Paint	LF
6250025	24" White Solid Lines - (Stop/Diagonal Lines) - Fast Dry Paint	LF
6250030	White Single Arrow (Left, Straight, Right) - Fast Dry Paint	EA
6250031	White Single Bike Lane Arrow (Left, Straight, Right) - Fast Dry Paint	EA
6250035	White Word "Only" - Fast Dry Paint	EA
6250040	White Combination Arrow (Straight & Right or Straight & Left) - Fast Dry Paint	EA
6250043	White Lane Drop Arrow (Left or Right) - Fast Dry Paint	EA
6250045	Railroad Crossing Symbols - Fast Dry Paint	EA

Schedule Of Pay Items

Item No.	Pay Item	Unit
6250050	Handicap Symbol - Fast Dry Paint	EA
6250055	Bike Lane Symbol - Fast Dry Paint	EA
6250105	4" Yellow Broken Lines - (Gaps Excluded) - Fast Dry Paint	LF
6250107	6" Yellow Broken Lines - (Gaps Excluded) - Fast Dry Paint	LF
6250110	4" Yellow Solid Line - (Pavement Edge & No Passing Zone) - Fast Dry Paint	LF
6250111	6" Yellow Solid Line - (Pavement Edge & No Passing Zone) - Fast Dry Paint	LF
6250112	6" Yellow Solid Line on Curb/Median - Fast Dry Paint	LF
6250113	6" Yellow Solid Lines on 6" Concrete Curb (Top & Side) - Fast Dry Paint	LF
6250115	24" Yellow Diagonal Lines - Fast Dry Paint	LF
6262005	4" White Broken Lines - (Gaps Excluded) - Epoxy Paint	LF
6262007	6" White Broken Lines - (Gaps Excluded) - Epoxy Paint	LF
6262008	6" Black Broken Lines - (Gaps Excluded) - Epoxy Paint	LF
6262010	4" White Solid Lines - (Pavement Edge Lines) - Epoxy Paint	LF
6262012	6" White Solid Lines - (Pavement Edge Lines) - Epoxy Paint	LF
6262015	8" White Solid Lines – (Crosswalk & Channelization) - Epoxy Paint	LF
6262020	12" White Solid Lines (Gore Markings) Epoxy Paint	LF
6262021	12 " White Solid Lines (Diagonal Lines) - Epoxy Paint	LF
6262025	24" White Solid Lines (Stop Lines/Diagonal Lines) - Epoxy Paint	LF
6262030	White Single Arrows (Left, Straight, Right) - Epoxy Paint	EA
6262035	White Word Message "Only" - Epoxy Paint	EA
6262040	White Combination Arrow (Straight & Right or Straight & Left) - Epoxy Paint	EA

Schedule Of Pay Items

Item No.	Pay Item	Unit
6262043	White Lane Drop Arrow (Left or Right) - Epoxy Paint	EA
6262045	Railroad Crossing Symbols - Epoxy Paint	EA
6262105	4" Yellow Broken Lines (Gaps Excluded) Epoxy Paint	LF
6262110	4" Yellow Solid Lines (Pavement Edge & No Passing Zone) - Epoxy Paint	LF
6262112	6" Yellow Solid Lines (Pavement Edge & No Passing Zone) - Epoxy Paint	LF
6262114	12" Yellow Solid Lines (Diagonal Line) - Epoxy Paint	LF
6262115	24" Yellow Diagonal Line - Epoxy Paint	LF
6271005	4" White Broken Lines (Gaps Excluded) Thermoplastic - 90 mil.	LF
6271007	6" White Broken Lines (Gaps Excluded) Thermoplastic- 90 mil.	LF
6271010	4" White Solid Lines (Pavement Edge Lines) Thermoplastic - 90 mil.	LF
6271012	6" White Solid Lines (Pavement Edge Lines) Thermoplastic - 90 mil.	LF
6271015	8" White Solid Lines Thermoplastic - 125 Mil.	LF
6271020	12" White Solid Lines (Stop Lines) - Thermoplastic -125 mil.	LF
6271023	12" X 18" White Triangular Yield Bar (Gaps Excluded) Thermoplastic – 125 mil.	LF
6271025	24" White Solid Lines (Stop/Diagonal Lines) – Thermoplastic - 125 mil.	LF
6271030	White Single Arrows (Left, Straight, Right) - Thermoplastic - 125 mil.	EA
6271035	White Word Message "Only" - Thermoplastic - 125 mil.	EA
6271036	White Word Message "Stop Ahead" - Thermoplastic - 125 mil.	EA
6271037	White Word Message "School" - Thermoplastic - 125 mil.	EA

Schedule Of Pay Items

Item No.	Pay Item	Unit
6271040	White Combination Arrows (Straight & Right or Straight & Left) Thermoplastic – 125 mil.	EA
6271043	White Lane Drop Arrow (Left or Right) Thermoplastic – 125 mil.	EA
6271045	Railroad Crossing Symbols - Thermoplastic - 125 mil.	EA
6271050	Handicap Symbol - Thermoplastic - 125 mil.	EA
6271064	4" Yellow Broken Lines (Gaps Excluded) Thermoplastic - 90 mil.	LF
6271066	6" Yellow Broken Lines (Gaps Excluded) Thermoplastic - 90 mil.	LF
6271074	4" Yellow Solid Lines (Pavement Edge Lines) Thermoplastic - 90 mil.	LF
6271076	6" Yellow Solid Lines (Pavement Edge Lines) Thermoplastic - 90 mil.	LF
6271078	8" Yellow Solid Lines (Pavement Edge Lines) Thermoplastic - 90 mil.	LF
6271080	24" Yellow Solid Lines - Thermoplastic - 125 mil.	LF
6300005	Permanent Clear Pavement Markers Mono-Dir.- 4"X4"	EA
6300010	Permanent Clear Pavement Markers Mono-Dir.- 5"X2"	EA
6300029	Clear Mono-Direction Replacement Reflector	EA
6301005	Permanent Yellow Pavement Markers Mono-Dir.- 4"X 4"	EA
6301010	Permanent Yellow Pavement Markers Mono-Dir.- 5"X 2"	EA
6301100	Permanent Yellow Pavement Markers Bi-Dir.- 4"X4"	EA
6301110	Permanent Yellow Pavement Markers Bi-Dir.- 5"X2"	EA
6302001	Permanent Red/Clear Pavement Markers Bi-Dir. - 4"X 4"	EA
6319505	Removal of Pavement Markings	LF
6510105	Flat Sheet, Type III, Fixed Size & Message Sign	SF
6510106	Flat Sheet, Type III, Size Determined by Message	SF

Schedule Of Pay Items

Item No.	Pay Item	Unit
6510108	Flat Sheet, Type VIII or IX, Size Determined by Message - Overhead	SF
6520200	Extruded Panel Signs – Ground Mounted	SF
6520250	Extruded Panel Signs – Mounted Overhead	SF
6531205	U-Section Post for Sign Supports – 2P	LF
6531210	U-Section Post for Sign Supports – 3P	LF
6531215	U-Section Post for Sign Bracing – 2P	LF
6541005	Breakaway Sign Supports	LB
6541007	Refurbish Break-Away Sign Supports	EA
6541305	4" x 4" Treated Wood Post	LF
6541310	4" x 6" Treated Wood Post	LF
6541405	Removal of I-Beam Post	EA
6541415	Removal of Wood Post	EA
6551105	Square Tube Post for Sign Supports 12 Gauge 1½" x 1½" X 6'	LF
6551110	Square Tube Post for Sign Supports 12 Gauge 1¾" x 1¾" X 8'	LF
6551115	Square Tube Post for Sign Supports 12 Gauge 2" x 2" X 8'	LF
6551120	Square Tube Post for Sign Supports 12 Gauge 2¼" x 2¼" X 8'	LF
6551125	Square Tube Post for Sign Supports 12 Gauge 2½" x 2½" X 8'	LF
6551130	Square Tube Post for Sign Supports 14 Gauge 1¾" x 1¾" X 8'	LF
6551135	Square Tube Post for Sign Supports 14 Gauge 2" x 2" X 8'	LF
6551140	Square Tube Post for Sign Supports 14 Gauge 2¼" x 2¼" X 8'	LF
6562105	Delineator, Single, Mono-Directional, Including Supports	EA
6562107	Flexible Delineator 4"x12" Type 4 Sheeting Reflector	EA

Schedule Of Pay Items

Item No.	Pay Item	Unit
6562110	Delineator, Double, Mono-Directional, Including Supports	EA
6562115	Delineator, Single, Bi-Directional, Including Support	EA
6562205	Delineator, Single, Mono-Directional, Bridge, Wall, or Barrier Mounted	EA
6562210	Delineator, Double, Mono-Directional, Bridge, Wall, or Barrier Mounted	EA
6562215	Delineator, Single, Bi-Directional, Bridge, Wall, or Barrier Mounted	EA
6562220	Delineator, Flexible, 4"x 4" Bridge, Wall, or Barrier Mounted	EA
6573100	Overhead Sign Structure No. (XX)	EA
6573105	Modification of Overhead Sign Structure No. (XX)	EA
6573106	Refurbish Overhead Sign Structure No. (XX)	EA
6573115	Removal of Overhead Sign Structure No. (XX)	EA
6573200	Sign Lighting System No. (XX)	EA
6700000	Permanent Terminal Impact Attenuator	EA
Division 700		
7011XXX	Concrete for Structures – Class (class)	CY
7023200	Grooved Surface Finish	SY
7028000	Grinding and Texturing Concrete Bridge Deck	SY
7031100	Reinforcing Steel for Structures (Roadway)	LB
7031105	Reinforcing Steel for Structures (Retaining Wall)	LB
7031200	Reinforcing Steel for Structures (Bridge)	LB
7031210	Spiral Reinforcing Steel for Structures (Bridge)	LB
7031220	Hoop Reinforcing Steel for Structures (Bridge)	LB
7031400	Galvanized Reinforcing Steel for Structures (Bridge)	LB
704X000	Prestressed Concrete Beam (type)	LF
7045100	Prestressed Concrete Beam (Type V Modified)	LF
7045991	3'-0" x 1'-9" Cored Slab	LF

Schedule Of Pay Items

Item No.	Pay Item	Unit
7045992	3'-0" x 2'-0" Cored Slab	LF
7051000	Concrete Bridge Barrier Parapet	LF
7051005	Precast Concrete Barrier Parapet	LF
7051010	Concrete Bridge Barrier Parapet (Lightweight)	LF
7051100	Concrete Bridge Median Barrier	LF
7053000	Steel Bridge Railing	LF
70540XX	Concrete Bridge Railing Wall (<i>type or height</i>)	LF
7055010	Steel Handrail	LF
7055100	Metal Bicycle Handrail	LF
7081000	Hardware	LS
7082000	Hardware	LB
709110X	Structural Steel	LS
7091120	Structural Steel	LB
709120X	Structural Steel (Weathering Type)	LS
7101000	Cleaning and Painting Existing Structural Steel	LS
710100X	Cleaning and Painting Existing Structural Steel - Bridge #X	LS
7110001	Dynamic Pile Analyzer Test Set-Up	EA
7110010	Pile Driving Set-Up	EA
7110XX0	Prestressed Concrete Piling - (<i>size</i>)" Sq.)	LF
7110XX1	Pile Build-Up Preparation (<i>size</i>)" Sq.)	EA
7110XX2	Pile Load Test - Prestressed Concrete Piling (<i>size</i>)" Sq.)	EA
7110XX5	Prestressed Index Piling (<i>size</i>)" (<i>shape</i>)	LF
71104X0	Prestressed Concrete Octagonal Piling - (<i>size</i>)"	LF
71104X1	Prestressed Concrete Octagonal Pile Build-Up Preparation - (<i>size</i>)"	EA
71104X2	Pile Load Test - Prestressed Concrete Octagonal Pile - (<i>size</i>)"	EA
71111XX	Prestressed Pile Point - (<i>HP size</i>)	LF

Schedule Of Pay Items

Item No.	Pay Item	Unit
71113XX	Prestressed Pile Point - ((<i>pipe diameter</i>)") (<i>Extra Strong or Double Extra Strong pipe</i>)	LF
71115XX	Reinforced Pile Tips - ((<i>size</i>))	EA
71117XX	Reinforced Pile Tips - ((<i>pipe diameter</i>)") (<i>Extra Strong or Double Extra Strong</i>)	EA
7112XXX	Steel H-Bearing Piling - (HP(<i>size</i>)X(<i>weight</i>))	LF
7112XX1	Pile Load Test - Steel H-Piling (HP(<i>size</i>)X(<i>weight</i>))	EA
7112XX2	Steel H-Bearing Index Piling - (HP(<i>size</i>)X(<i>weight</i>))	LF
7113XX0	Steel Pipe Piling ((<i>diameter</i>)" Diameter)	LF
7113XX1	Pile Load Test - Steel Pipe Piling ((<i>dia.</i>)" Diameter)	EA
7113XX2	Steel Pipe Index Piling - ((<i>dia.</i>)" Diameter)	LF
7119100	Treated Timber Piling	LF
7119101	Pile Load Test - Treated Timber Piling	EA
7120006	Drilled Shaft Set-Up	EA
7120008	Drilled Pile Set-Up	EA
712002X	Soil Excavation for Drilled Pile Foundations - (<i>diameter</i>)" Diameter	LF
712006X	Rock Excavation for Drilled Pile Foundations - (<i>diameter</i>)" Diameter	LF
7120XX1	Drilled Shafts with Wet & Dry Excavation - (<i>diameter</i>)" Diameter	LF
7120XX2	Drilled Shafts with Rock Excavation - (<i>diameter</i>)" Diameter	LF
7120XX5	Construction Casing - (<i>diameter</i>)" Diameter	LF
7120500	Drilled Pile Foundation Concrete (Class 4000DS)	CY
7137005	MSE Retaining Wall Backfill	CY
7137006	MSE Retaining Wall Backfill (Granular)	CY
7137007	MSE Retaining Wall Backfill (Stone)	CY
7137008	MSE Retaining Wall Backfill (Temporary)	CY
7137010	MSE Retaining Wall (Roadway)	SF
7137050	MSE Retaining Wall (Bridge)	SF

Schedule Of Pay Items

Item No.	Pay Item	Unit
7137105	MSE Retaining Wall (Temporary) Roadway	SF
7137120	MSE Retaining Wall (Block Facing) Roadway	SF
7137130	MSE Retaining Wall (Panel Facing) Roadway	SF
7137190	Coping for MSE Retaining Wall (Roadway)	LF
7137205	MSE Retaining Wall (Temporary) Bridge	SF
7137220	MSE Retaining Wall (Block Facing) Bridge	SF
7137230	MSE Retaining Wall (Panel Facing) Bridge	SF
7137290	Coping for MSE Retaining Wall (Bridge)	LF
7158005	Corrugated Steel Pipe Arch - Temporary	LF
71580XX	<u>XX</u> " Corrugated Steel Pipe (CSP) - Temporary	LF
71590XX	<u>XX</u> " Corrugated High Density Polyethylene (HDPE) Pipe Type (<u>C or S</u>) - Temporary	LF
7181000	Brick Masonry	CY
7182000	Brick Masonry (Reinforced)	CY
7183000	Rubble Masonry	CY
7184000	Concrete Block Masonry	CY
7185000	Rubble Masonry Tree-Well	CY
7191XXX	Catch Basin (type)	EA
71920XX	Drop Inlet (<u>size</u>)	EA
7192105	Manhole	EA
71922XX	(<u>size</u>) Junction Box	EA
7192300	Spring Box	EA
71930XX	Precast Concrete Riser - (<u>size</u>)" Diameter	LF
71931XX	PC Drainage Base - (<u>size</u>)" Diameter	EA
71931XX	PC Transition Section (Flat Slab) - (<u>size</u>)" to (<u>size</u>)"	EA
719317X	PC Transition (Cone) - (<u>size</u>)" to (<u>size</u>)"	EA
7196000	Extra Depth of Box	LF
7197110	Adjust Catch Basin	EA
7197120	Adjust Manhole	EA

Schedule Of Pay Items

Item No.	Pay Item	Unit
7197130	Adjust Drop Inlet	EA
7197140	Adjust Utility Box	EA
7197150	Adjust Junction Box	EA
7201000	Concrete Curb (9" X 15")	LF
7201010	Concrete Bridge Curb (6")	LF
7201100	Concrete Transition Curb	LF
72020X0	Concrete Gutter Type <u>(X)</u>	LF
7203XX0	Concrete Curb and Gutter <u>(size)</u>	LF
7204100	Concrete Sidewalk (4" Uniform)	SY
7205X00	Concrete Driveway (<u>(thickness)</u> " Uniform)	SY
7206000	Concrete Median	SY
7212000	Asphalt Curb	LF
722XXXX	<u>(size)</u> P C Box Culvert <u>(type)</u> Fill Height = <u>(fill height)</u> *	LF
7232310	Deck Joint Strip Seal	LF
7243100	Elastomeric Bearing	EA
7260100	Removal of Epoxy, Bituminous, and Foreign Overlay	SY
7260200	Machine Preparation of Existing Surface	SY
7260300	Blast Cleaning	SY
7260400	Partial-Depth Removal of Unsound Concrete	SY
7260500	Concrete Overlay (Latex)	CY
7260600	Concrete Overlay (Portland Cement)	CY
7260700	Epoxy-Sand Slurry	SF
7260800	Concrete Class 4000 for Full-Depth Deck Patching	CY
7270010	Crosshole Sonic Logging Set-Up	EA
7280010	Temporary Detour Bridge No. <u>(XX)</u>	LS
Division 800		
8011XX0	Aggregate Underdrain (Aggregate No. <u>(X)</u>)	LF
8011XXX	Aggregate Underdrain (Aggregate No. <u>(X)</u>)	CY
80211XX	<u>(diameter)</u> " Pipe Underdrain	LF

Schedule Of Pay Items

Item No.	Pay Item	Unit
80212XX	<i>(diameter)"</i> Perforated Pipe Underdrain	LF
802180X	<i>(diameter)"</i> Perforated Corrugated Aluminum Alloy Pipe Underdrain	LF
80219XX	<i>(diameter)"</i> Polyvinyl Chloride (PVC) Pipe Underdrain	LF
80220X0	<i>(diameter)"</i> Corrugated Polyethylene Underdrain	LF
8034XX0	<i>(diameter)"</i> Pipe Slope Drain	LF
8035000	Metal Intake Spillway Assembly	EA
8041010	Rip-Rap (Class A)	TON
8041015	Rip-Rap (Class A)	CY
8041020	Rip-Rap (Class B)	TON
8041025	Rip-Rap (Class B)	CY
8041030	Rip Rap (Class C)	TON
8041035	Rip Rap (Class C)	CY
8041040	Rip-Rap (Class D)	TON
8041045	Rip-Rap (Class D)	CY
8041050	Rip-Rap (Class E)	TON
8041055	Rip-Rap (Class E)	CY
8041060	Rip-Rap (Class F)	TON
8041065	Rip-Rap (Class F)	CY
8041100	Hand Placed Riprap	TON
8041200	Hand Placed Riprap	CY
8042100	Foundation Riprap	TON
8042200	Foundation Riprap	CY
8043100	Dumped Riprap	TON
8043200	Dumped Riprap	CY
8043350	Sand Cement Rip-Rap	CY
8043370	Grouted Rip-Rap	SY
8043390	Precast Concrete Rip-Rap	SY
8044050	PVC Coated-Wire Enclosed Rock (Mattress)	CY

Schedule Of Pay Items

Item No.	Pay Item	Unit
8044100	PVC Coated-Wire Enclosed Rock (Gabion)	CY
8047040	Slope Protection - 4" Concrete	SY
8047041	Slope Protection 4" Concrete (Fiber Reinforced)	SY
80481XX	Geotextile for Erosion Control Under Riprap (Class 1) Type <i>(A, B, C, or D)</i>	SY
80482XX	Geotextile for Erosion Control Under Riprap (Class 2) Type <i>(A, B, C, or D)</i>	SY
8051100	Steel Beam Guardrail	LF
8051101	Adjustable Height Steel Beam Guardrail (Initial Installation)	LF
8051102	Adjustable Height Steel Beam Guardrail (2 Inch Adjustment)	LF
8051103	Adjustable Height Steel Beam Guardrail (Final Adjustment)	LF
8051200	Steel Beam Guardrail (Double Layered)	LF
8051300	Steel Beam Guardrail (Thrie)	LF
8051400	Steel Beam Guardrail (Thrie-Double Layered)	LF
8051600	Box Beam Median Barrier	LF
8051655	Median Cable Barrier	LF
8051656	Reset Median Cable Barrier	LF
8051800	Temporary Guardrail	LF
8051900	Reset Guardrail	LF
8052210	End Anchor - Type B	EA
8052220	End Anchor - Type B (Thrie Beam)	EA
8052300	End Terminal - Type T	EA
8052500	Cable Barrier End Anchor	EA
8052600	Thrie Beam Guardrail Bridge Connectors	EA
8053000	Additional Length Guardrail Post	LF
80581XX	Concrete Median Barrier (Type - <i>(1, 2, 3, 4, 5, or 6)</i>)	LF
8061XX0	Woven Wire Fence <i>(type)</i>	LF
8062X00	Barbed Wire Fence – <i>(1, 2, 3, 4, 5, or 6)</i> Strands	LF

Schedule Of Pay Items

Item No.	Pay Item	Unit
8063X00	<u>(height)</u> " Chain-link Fence	LF
806XXXX	<u>(width)</u> ' <u>(type)</u> Gate <u>(height)</u> " Height	EA
8066000	Additional Length of Post	LF
80681XX	Ornamental Steel Picket Fence – <u>(height)</u> "	LF
8071000	Reset Fence	LF
8072000	Reset Chain-Link Fence	LF
8081000	Moving Item No. <u>(schedule no.)</u>	LS
8090001	Right of Way Survey	LS
8090050	Right of Way Report	LS
8091000	Right of Way Marker (Reinforced Concrete)	EA
8091010	Right of Way Marker (Rebar & Cap)	EA
8092000	Reset Right of Way Marker	EA
8100001	Permanent Vegetation	MSY
8101000	Seeding (Mulched)	MSY
8102100	Seeding (Unmulched)	MSY
8102700	Interseeding	MSY
8103000	Temporary Seeding	MSY
8103100	Temporary Vegetation	MSY
8104XX0	Fertilizer <u>(analysis)</u>	TON
8105000	Lime	TON
8106000	Nitrogen	LB
8109900	Mowing	MSY
8101100	Organic Topsoil	CY
8111XXX	Plant <u>(landscape planting)</u>	EA
8114000	Porous Material for Root Protection	TON
8115X00	Drain Tile or Pipe, <u>(diameter)</u> Inches	LF
8131000	Sodding	MSY
8142100	Waterproofing (Second Method)	SY
8143000	Waterproofing (Bridge Deck)	SY

Schedule Of Pay Items

Item No.	Pay Item	Unit
8151000	Fiber Roving	SY
8151010	Bonded Fiber Matrix (BFM)	MSY
8151020	Flexible Growth Matrix (FGM)	MSY
815110X	Turf Reinforcement Matting (Type <i>(1, 2, 3, or 4)</i>)	MSY
815111X	Temporary Erosion Control Blanket (Class <i>(A, B or C)</i>)	MSY
8152004	Inlet Structure Filter - Type F (Weighted)	LF
8152006	Inlet Structure Filter - Type F (Non-Weighted)	LF
8152007	Sediment Tube	LF
8153000	Silt Fence	LF
8153090	Replace/Repair Silt Fence	LF
8153100	Floating Turbidity Barrier - Light Duty	SF
81531XX	Floating Turbidity Barrier - Light Duty (<i>(X)</i> ' Deep)	LF
8153200	Floating Turbidity Barrier - Medium Duty	SF
81532XX	Floating Turbidity Barrier - Medium Duty (<i>(X)</i> ' Deep)	LF
8153300	Floating Turbidity Barrier - Heavy Duty	SF
81533XX	Floating Turbidity Barrier - Heavy Duty (<i>(X)</i> ' Deep)	LF
8154000	Silt Basins	CY
8154010	Cleaning Silt Basins	CY
8154050	Removal of Silt Retained by Silt Fence	LF
8155000	Silt Ditches	CY
8156205	Inlet Structure Filter Type D1	EA
8156207	Filter Material for Inlet Structure Filter Type D1	EA
8156210	Inlet Structure Filter Type B	EA
815621X	Inlet Structure Filter - Type E (Catch Basin Type - <i>(1, 16, 17, or 18)</i>)	EA
8156215	Inlet Structure Filter Type D2	EA
8156217	Filter Material for Inlet Structure Filter Type D2	EA
8156219	Inlet Structure Filter Type A	LF

Schedule Of Pay Items

Item No.	Pay Item	Unit
8156490	Stabilized Construction Entrance	SY
8156XXX	Replacement stone for Stabilized Construction Entrance	SY
81600X0	Temporary (<i>riser dia.</i>)" x (<i>outlet dia.</i>)" Sediment Control Structure	EA
81602X0	Permanent (<i>riser dia.</i>)" x (<i>outlet dia.</i>)" Sediment Control Structure	EA
8161100	Aggregate Diaphragm	CY

TABLE OF EXTERNAL LINKS

There are references in the SCDOT Standard Specifications to specifications and requirements of other organizations. Listed below are links to those organizations.

Organization or <i>Publication</i>	Link
AASHTO Materials Reference Laboratory (AMRL)	http://www.amrl.net/
American Association of Highway and Transportation Officials (AASHTO)	http://www.aashto.org/
American Concrete Institute (ACI)	http://www.aci-int.org/
Americans with Disabilities Act (ADA)	http://www.usdoj.gov/crt/ada/adahom1.htm
American Institute of Steel Construction (AISC)	http://www.aisc.org/
American National Standards Institute (ANSI)	http://www.ansi.org/
American Nursery & Landscape Association (ANLA)	http://www.anla.org/
American Petroleum Institute (API)	http://www.api.org
American Standard for Nursery Stock (ASNS)	http://www.anla.org/applications/Documents/Docs/ANL_AStandard2004.pdf
American Society of Non-destructive Testing (ASNT)	http://www.asnt.org/
American Society for Testing and Materials (ASTM)	http://www.astm.org/
American Wood Preserver Association (AWPA)	http://www.awpa.com/
American Welding Society (AWS)	http://www.aws.org/
Associated General Contractors (AGC)	http://www.agc.org
Best's Insurance Report	http://www.ambest.com/
Coastal Zone Management Act	https://coast.noaa.gov/czm/act/
Code of Federal Regulations (CFR)	https://www.govinfo.gov/help/cfr

TABLE OF EXTERNAL LINKS (continued)

Organization or Publication	Link
Concrete Reinforcing Steel Institute (CRSI)	http://www.crsi.org/
Erosion Control Technology Council (ECTC)	http://www.ectc.org/
Environmental Protection Agency (EPA)	http://www.epa.gov/
Federal Highway Administration (FHWA)	http://www.fhwa.dot.gov/
FHWA Standard Highway Signs	http://mutcd.fhwa.dot.gov/ser-shs_millennium_eng.htm
Federal Water Pollution Control Act (Section 404)	http://www.epa.gov/region5/water/pdf/ecwa_t4.pdf
Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP)	http://www.geosynthetic-institute.org/gai/intro.html
Geosynthetic Institute (GSI)	http://www.geosynthetic-institute.org/
International Safety Equipment Association (ISEA)	http://www.safetyequipment.org/
National Concrete Masonry Association (NCMA)	http://www.ncma.org/
National Cooperative Highway Research Program (NCHRP)	https://www.trb.org/NCHRP/NCHRP.aspx
National Electrical Code (NEC)	http://www.nfpa.org
National Electrical Safety Code (NESC)	http://standards.ieee.org/nesc/
National Institute of Standards and Technology (NIST)	http://www.nist.gov/
National Pollutant Discharge Elimination System (NPDES) General Permit	https://www.epa.gov/npdes
National Ready Mixed Concrete Association (NRMCA)	http://www.nrmca.org/
National Transportation Product Evaluation Program (NTPEP)	http://www.ntpep.org/

TABLE OF EXTERNAL LINKS (continued)

Organization or Publication	Link
Occupational Safety & Health Administration (OSHA)	http://www.osha.gov/
Palmetto Utility Protection Service (PUPS)	http://www.sc1pups.org/
Prestressed Concrete Institute (PCI)	http://www.pci.org/intro.cfm
Resource Conservation and Recovery Act (RCRA)	http://homer.ornl.gov/nuclearsafety/nsea/oepa/rcra.html
SC Department of Agriculture (SCDA)	http://www.sca.state.sc.us/
Steel Structures Painting Council (SSPC)	http://www.sspc.org/standards/default.html
Society of Automotive Engineers SAE	http://www.sae.org/servlets/index
South Carolina Code of Laws	http://www.scstatehouse.net/code/statmast.htm
South Carolina Code of Regulations	http://www.scstatehouse.net/coderegs/statmast.htm
South Carolina Department of Agriculture (SCDA)	http://www.scda.state.sc.us/
South Carolina Department of Health and Environmental Control (SCDHEC)	http://www.scdhec.net/
South Carolina Department of Insurance (SCDOI)	https://www.doi.sc.gov/
South Carolina Department of Natural Resources (SCDNR)	http://www.dnr.state.sc.us/
South Carolina Mining Act	http://www.scstatehouse.net/code/t48c020.htm
Southern Pine Inspection Bureau (SPIB)	http://www.spib.org/
Underwriters Laboratories (UL)	http://www.ul.com/info/standard.htm
U.S. Army Corps of Engineers (USACE)	http://www.usace.army.mil/
U. S. Coast Guard (USCG)	http://www.uscg.mil/

TABLE OF EXTERNAL LINKS (continued)

Organization or <i>Publication</i>	Link
U. S. Department of Agriculture (USDA)	http://www.usda.gov/wps/portal/usdahome
USDA Natural Resources Conservation Service (NRCS)	http://www.nrcs.usda.gov/
U. S. Department of Transportation USDOT	http://www.dot.gov/

TABLE OF SCDOT LINKS

Listed below are links to SCDOT web pages and organizations.

Organization or Publication	Link
<i>Bid Tabulations</i>	http://info2.scdot.org/bidtabs/Pages/Home.aspx
<i>Construction Extranet</i>	http://www.scdot.org/doing/const_extranet.shtml
<i>Construction Manual</i>	http://www.scdot.org/doing/constructionmanual.shtml
<i>Current Letting List</i>	https://www.scdot.org/business/construction_letting-info.aspx
DBE Program Certification	http://www.scdot.org/doing/Dbe_certification.shtml
DBE Quarterly Reports	http://www.scdot.org/doing/DBE_quarterly.shtml
<i>Disadvantaged Business Enterprise (DBE) Directory</i>	http://www.scdot.org/doing/dbe_listing.shtml
<i>Engineering District Directory</i>	http://www.scdot.org/inside/engineering_directory.shtml
<i>Headquarters Directory</i>	http://webprod.cio.sc.gov/DirectWeb/classifiedSearch.do
<i>Inspector Certifications</i>	http://www.scdot.org/doing/InspectorCertification.shtml
<i>Lab Procedure Manual</i>	http://www.scdot.org/doing/OMR_LabProceduresManual.shtml
<i>Letting Schedule</i>	http://www.scdot.org/doing/letting_schedule.shtml
<i>List of Pay Items</i>	http://www.scdot.org/doing/pay_items.shtml
<i>Monthly Fuel and Asphalt Adjustments</i>	http://www.scdot.org/doing/monthlyindexes.asp
New Products Submission	http://www.clemson.edu/t3s/scdot/NewProductsFormInstr2.htm
Office of Disadvantaged Business Enterprise and Special Projects	http://www.scdot.org/doing/dbe.shtml
Office of Materials and Research (OMR)	http://www.clemson.edu/t3s/scdot/index.htm
<i>Prime Contractor Prequalification</i>	http://www.scdot.org/doing/prequalified.shtml
SCDOT Home Page	http://www.scdot.org/

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<i>SCDOT Qualified Product Lists</i>	http://info2.scdot.org/Materials/Pages/QualifiedProd.aspx
<i>SCDOT Qualified Product Policies</i>	http://info2.scdot.org/Materials/Pages/QualifiedProd.aspx
<i>SCDOT Standard Drawings</i>	https://www.scdot.org/business/standard-drawings.aspx
<i>Supplemental Specifications</i>	http://www.scdot.org/doing/supspecs.shtml
<i>Tentative Letting List</i>	http://www.scdot.org/doing/tentlettings.shtml
<i>Traffic Engineering Manuals</i>	http://www.scdot.org/doing/trafficengineering.shtml
<i>Utilities Accommodation Policy</i>	http://www.scdot.org/doing/ua_policy.shtml

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