South Carolina Department of Transportation

# 2025

# STANDARD

# SPECIFICATIONS

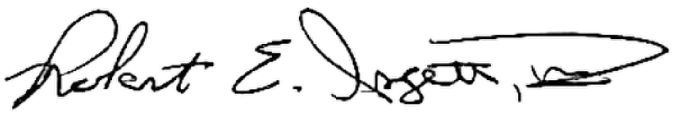
# FOR

# HIGHWAY

# CONSTRUCTION

The South Carolina Department of Transportation 2025 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,



Robert E. Isgett III, P.E.
Chief Engineer of Alternative Delivery & Construction

I hereby certify that The South Carolina Department of Transportation 2025 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.

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Construction Metrics Engineer

# SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

# 2025 STANDARD SPECIFICATIONS

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# DIVISION 100
# GENERAL PROVISIONS

## Section 101 — Definitions and Terms

### 101.1 General

1 The titles or headings of the sections and subsections of the Standard Specifications are in bold type 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 SCDOT Testing Procedures, SCDOT Supplemental Specifications, SCDOT Supplemental Technical Specifications, and specifications 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 the 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 of the sentence "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 are 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 Where the abbreviations and acronyms in the following tables are used in the *Standard Specifications*, the Supplemental Specifications, the Supplemental Technical Specifications, the Special Provisions, or on the Plans, take them to represent the respective expressions in the following tables.

## Organizations or Publications

| Acronym | Full Name or Meaning |
|---|---|
| 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 |
| AISC | American Institute of Steel Construction |
| ANLA | American Nursery & Landscape Association |
| ANSI | American National Standards Institute |
| API | American Petroleum Institute |
| ASME | American Society of Mechanical Engineers |
| ASNS | American Standard for Nursery Stock |
| ASNT | American Society for Nondestructive Testing |
| ASTM | American Society for Testing and Materials |
| AWPA | American Wood Protection Association |
| AWS | American Welding Society |
| CFR | Code of Federal Regulations |
| 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 |
| ISSA | International Slurry Surfacing Association |
| MASH | Manual for Assessing Safety Hardware |
| MUTCD | Manual on Uniform Traffic Control Devices |
| NCHRP | National Cooperative Highway Research Program |
| NCMA | National Concrete Masonry Association |
| NEC | National Electrical Code |
| NESC | National Electrical Safety Code |
| NIST | National Institute of Standards and Technology |

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### Organizations or Publication

| Acronym | Full Name or Meaning |
|---|---|
| NPDES | National Pollutant Discharge Elimination System (General Permit) |
| NRMCA | National Ready Mixed Concrete Association |
| NSBA | National Steel Bridge Alliance |
| 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 |
| SCDES | South Carolina Department of Environmental Services |
| 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 | Society for Protective Coatings |
| UL | Underwriters Laboratories, Inc. |
| USACE | United States Army Corps of Engineers |
| USCG | United States Coast Guard |
| USDA | United States Department of Agriculture |
| USDOT | United States Department of Transportation |

### SCDOT Officials and Offices

| Acronym | Full Name or Meaning |
|---|---|
| AME | Asphalt Materials Engineer |
| BCE | Bridge Construction Engineer |
| DES | Director of Engineering Support |
| DEA | District Engineering Administrator |
| DOC | Director of Construction |
| GDSE | Geotechnical Design Support Engineer |
| DSE | Deputy Secretary for Engineering |

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## SCDOT Officials and Offices

| Acronym | Full Name or Meaning |
|---|---|
| GME | Geotechnical Materials Engineer |
| MRE | Materials and Research Engineer |
| OMR | Office of Materials and Research |
| RCE | Resident Construction Engineer |
| RME | Resident Maintenance Engineer |
| SME | Structural Materials Engineer |
| SOT | Secretary of Transportation |

## Pay Units

| Abbreviation | Full Name or Meaning |
|---|---|
| ACRE | Acre |
| BALE | Bale |
| CF | Cubic Foot |
| CY | Cubic Yard |
| CYHM | Cubic Yard Half-Mile |
| EA | Each |
| GAL | Gallon |
| HR | Hour |
| LaMi | Lane Mile |
| LB | Pound |
| LF | Linear Foot |
| LS | Lump Sum |
| MBF | 1000 Board Feet |
| MI | Mile |
| MSY | One-Thousand Square Yards |
| SF | Square Foot |
| STA | Station (100 feet) |
| SY | Square Yard |
| TON | Ton (2000 pounds avoir) |

## 101.3 Terms and Definitions

1 Where in the Specifications or other Contract documents the following terms and definitions are used, interpret the intent and meaning as set forth in this Subsection:

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

**Addendum**. A revision issued between Advertisement and opening of the Bid Proposal.

**Advertisement**. The official notice published that publicly announces a letting of highway construction projects, invites bids, and carries information concerning the date and time of the opening of bids and other pertinent information.

**Affiliates**.

A. Any owner, shareholder, member, equity member, partner or joint venture member of Contractor;

B. Any person that directly or indirectly through one or more intermediaries' controls, or is controlled by, or is under common control with, the Contractor or any of its shareholders, members, partners, or joint venture members; and

C. Any person for which 10% or more of the equity interest in such person is held directly or indirectly, beneficially or of record by (i) Contractor, (ii) any of the shareholders, members, partners, or joint venture members of Contractor, or (iii) any Affiliate of Contractor under clause B of this definition.

For this definition, the term "control" has the broadest possible meaning including, but not limited to, the possession, directly or indirectly, of the power to cause the direction of the management of a person, whether through voting securities, by Contract, family relationship, or otherwise.

**Award**. An official letter from the SCDOT notifying the successful 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 ensure 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.

**Bid Item**. A specifically described unit of work for which a price is requested in the proposal.

**Bid Proposal**. The offer of the bidder, properly submitted and guaranteed in the prescribed manner, to perform the work and to furnish the labor and materials at the prices quoted therein.

**Bidder**. 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.

**Bridge.** A structure, including supports, erected over a depression or an obstruction, such as water, highway, or railroad; 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 ft.

The length of a Bridge is the overall length measured along the longitudinal centerline between under copings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes. The length 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 bottoms of curbs measured at right angles to the longitudinal centerline.

**Calendar Day**. Every day shown on the calendar, beginning and ending at midnight.

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

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

A Change Order may include written agreement made and entered into by and between the Contractor and the Department, covering alterations and unforeseen work necessary 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.

**Channel**. A natural or artificial watercourse.

**Commission**. Refers to the Commission of the South Carolina Department of Transportation.

**Construction Estimate**. 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.

**(SCDOT) Construction Manual**. 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.

**Contract**. Executed written 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.

The Contract consists of multiple subparts including, but not limited to the following, all of which are incorporated by reference:

A. The Contract form,

B. All bonds including the Payment Bond and the Performance and Indemnity Bond,

C. *Standard Specifications*,

D. *Standard Drawings*,

E. Supplemental Specifications, and

F. Supplemental Technical Specifications.

The Contract also consists of the following attachments to the physical and electronic document:

A. Special Provisions,

B. General and detailed Plans and Strip Maps,

C. Award Letter, and

D. Notice to Proceed.

The Contract also includes all 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.

**Contract Claim**. A formal, written notification certified by the Contractor to the Department, asserting or justifying a demand for an adjustment to the Contractor's compensation; or to the Contract time for costs, expenses, or other damages; or seeking any entitlement available under the Contract. This notification must be made within the specified time, in the designated form, and pursuant to the provisions for Contract claims specified in the Contract Documents.

**Contract Item (or Pay Item or Bid Item)**. Specific work unit for which the Contract provides a price.

**Contract Time**. Time in calendar days allowed for the Substantial Completion of the work specified in the Contract, including authorized time extensions. Contract Time begins on the Notice to Proceed date and ends on the Substantial Completion of Work date.

**Contract Completion Date**. The date specified in the Contract for Substantial Completion of the work. This date may be adjusted when justified as determined by the RCE. The adjusted date is the Adjusted Completion Date.

**Contractor**. 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.

**County**. One of the 46 counties in the State of South Carolina.

**Crossover**. A traveled way connecting two traveled ways of a divided highway and provides for the movement of traffic across or between the traveled ways.

**Culvert**. A structure not classified as a bridge 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.

**Days**. Calendar days.

**Department**. The South Carolina Department of Transportation (SCDOT).

**Engineer**. The Deputy Secretary for Engineering (DSE) of the SCDOT, acting directly or through a duly authorized representative, such representative acting within the scope of particular assigned duties or authority.

**Engineer of Record**. The Professional Engineer or Engineering Firm licensed and registered in South Carolina that performs the engineering design and analysis and is responsible for the plans and specifications for the project.

**Engineering District**. One of the 7 SCDOT Engineering Districts.

**Equipment**. 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.

**Extension or Contract Extension**. Additional work added to a Contract outside of the limits of the original Contract.

**Extra Work**. 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.

**Force Account Work Order**. A written order of the SCDOT directing the Contractor to perform additional work or furnish additional materials.

**Force Majeure Event**. An excusable delay or excusable failure of performance caused by any act of God, governmental act, act of terrorism, war, fire, flood, earthquake, hurricane, or other natural disaster, pandemic, explosion, or civil disturbance, as defined in **Subsection 105.18.1**.

**Highway**. 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."

**Inspector**. The authorized representative of the RCE or OMR assigned to make detailed inspections of materials and/or Contract performance.

**Interim Completion**. That time or date as set forth in the Special Provisions or as revised by authorized extensions by which it is required that the portion of work set forth in the Contract be satisfactorily completed.

**Laboratory**. An accredited materials and testing laboratory acceptable to the Department. The Office of Materials and Research (OMR) is the SCDOT materials and testing laboratory.

**Letting**. The public opening of sealed bids for highway construction work.

**Liquidated Damages**. The agreed daily amounts set forth in the Contract to cover additional costs incurred by the Department or public because of the Contractor's failure to complete the work within the time required by the Contract.

**Lump Sum**. A bidding unit that includes the total cost to complete all work described under a single Contract item (pay item).

**Materials**. All substances or products specified for use in the construction of the project and its appurtenances.

**Median**. The portion of a divided highway between the traveled ways of traffic in opposite directions.

**Notice to Proceed**. A written notice to the Contractor authorizing the prosecution of work.

**Pavement Structure**. The combination of the surface course, intermediate course, base course, and when specified, subbase, placed on a subgrade to support the traffic load and distribute it to the roadbed. The following defines the components of the pavement structure:

- **Surface Course**. The top layer (or riding surface) of the pavement structure.
- **Intermediate Course**. The layer or layers of specified material of a designated thickness or rate of application placed on a base course to support the surface course of the pavement structure.

- **Base Course**. 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.
- **Subbase**. The layer or layers of specified or selected material of designated thickness or rate of application placed on the subgrade to support subsequent layers of the pavement structure.
- **Subgrade**. The top 18 in. of roadbed upon which the pavement structure and shoulders are constructed.

**Payment Bond**. 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 according to the terms of the Contract. The penal sum of the bond is 100% of the Contract amount.

**Performance and Indemnity Bond**. The security or bond furnished in the approved form by the contractor to guarantee the completion of the work according to the terms of the Contract. The penal sum of the bond is 100% of the Contract amount.

**Plans or Design Plans**. The official approved engineering drawings including profiles, cross sections, strip maps, and supplemental drawings 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.

**Preconstruction Conference**. The conference held following the award and before the start of construction to be attended by a duly authorized representative of the SCDOT and by the responsible officials of the prime contractor and other affected parties.

**Prequalification**. For prime contractors, the procedure established and administered by the SCDOT 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 SCDOT construction Contracts.

**Project**. Refers to the work on a specific section or sections of highway together with all appurtenances to be performed under the Contract.

**Proposal (or Contract Proposal)**. The electronic or paper documents provided by the Department that the bidder uses to develop his electronic or paper offer to perform the work at the designated bid prices.

**Proposal Guaranty**. Also referred to as the Bid Bond. 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.

**Qualified Products List (QPL)**. Materials evaluated by the SCDOT that have been prequalified for use on construction and maintenance projects as specified in the applicable specifications. When use of a product from a QPL is specified, this refers to the list that is the most recent edition available on the SCDOT website at the time of the material's incorporation into the work.

**Ramp**. A connecting traveled way between two intersecting highways, usually at a highway grade separation. Entrances to properties may also be referred to as ramps.

**Right-of-Way**. An easement (temporary or permanent) or fee simple title to real property acquired by SCDOT for the construction, maintenance, operation, and improvement of the work devoted to transportation purposes.

**Road**. 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."

**Roadbed**. 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.

**Roadside**. The portion of the highway outside the roadway.

**Roadway**. That portion of the highway lying within the limits of construction.

**Secretary of Transportation**. Implements the policies of the SCDOT Commission and oversees the day-to-day operations of the Department.

**Shop Plans**. Plans prepared by the Contractor that contain manufacturing details or supplementary design plans of an item that will become a permanent part of the project, such as structural steel fabrication drawings, prestressed concrete beam drawings, or any other supplementary plans or similar data.

**Shoulder**. The 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.

**Sidewalk**. Portion of the right-of-way constructed exclusively for pedestrian use.

**South Carolina Test Procedures**. The SCDOT's designation for sampling and testing methods and procedures, expressed in the form of SC-T-XXX.

**Special Provisions**. The Specifications in the Contract revising or supplementing the *Standard Specifications*, Supplemental Specifications, and Supplemental Technical Specifications for conditions specific to the individual project.

**Specifications**. The general term that includes the *Standard Specifications*, 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.

**(SCDOT) Standard Drawings**. Issued by the Department and are considered part of the Contract documents.

**Standard Specifications**. A reference to this document entitled the SCDOT *Standard Specifications for Highway Construction*. Consider these *Standard Specifications* to be included in the general term "the Specifications."

**State**. The State of South Carolina.

**Street.** 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."

**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.

**Subcontractor**. An individual, company, or corporation to whom the Contractor sublets any part of the Contract work.

**Substantial Completion**. The point in the project when work has been constructed to the typical section in the Plans over the entire length of the project including tie-ins, all pay items have been installed in reasonable conformance with the Plans and Specifications over the entire length of the project, all lanes of traffic are open to the public in their final configuration with the final applications of pavement markings and raised pavement markers, and the only remaining work to be performed being punch list items.

**Substructure**. Generally, the part of the structure below the bridge seats or below the spring lines of concrete arches.

**Superintendent**. The Contractor's authorized representative in responsible charge of the work regardless of the company's title for this individual.

**Superstructure**. The part of the bridge above the substructure or above the spring lines of concrete arches.

**Supplemental Specifications**. Specifications adopted by the SCDOT after the publication of the *Standard Specifications* that constitute a part thereof and of the Contract.

**Supplemental Technical Specifications**. The designation of a Supplemental Technical Specification to these Specifications, expressed in the form of SC-M-XXX (MM/YY). The Supplemental Technical Specifications are a part of the Contract when applicable.

**Surety**. The corporation, partnership, or individual bound with and for the Contractor for the full and complete performance of the Contract and for the payment of all debts pertaining to the work.

**Temporary Structure**. 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.

**Traffic Lane**. The portion of a traveled way for the movement of a single line of vehicles.

**Traveled Way**. The portion of the roadway for the movement of vehicles exclusive of the shoulders.

**Unit Price**. The cost for a unit of measure of a Contract item (pay item).

**Utility**. A public, private, cooperative, municipal, and/or government line, facility, or system used for the carriage, transmission, and/or distribution of cable television, electric power, heat, telephone, telegraph, water, gas, oil, petroleum products, steam, chemicals, hydrocarbons, telecommunications, sewage, stormwater not connected with the drainage of the project, and similar substances that directly or indirectly serve the public. The term “Utility” or “utility” specifically excludes:

- Stormwater facilities providing drainage for the project ROW,
- Traffic signals,
- ITS facilities, and
- Water wells held for private use.

Any service line up to and including the meter, connecting directly to a utility is considered an appurtenance to that utility, regardless of the ownership of the service line.

The necessary appurtenances to each utility facility are considered part of such utility.

**Work**. 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 execution of all duties and obligations imposed by the Contract. The scope of the work is defined in the Contract.

**Working Drawings**. Sketches, calculations, etc., prepared by the Contractor for temporary structural features that may include Erection Plans, falsework plans, cofferdam plans, temporary structure plans, or any other supplementary plans or similar data.

# Section 102 — Bidding Requirements and Conditions

## 102.1 Prequalification

1 Before submitting a bid on Department work let to contract, all bidders must be prequalified according to South Carolina Code of Regulations, Section 63.300.

2 To become prequalified, submit a Prime Contractor Prequalification Application for consideration by the Department. Upon approval of prequalification, the Department will issue a Certificate of Prequalification to the Contractor. Submission of an updated Prime Contractor Prequalification Application is required annually within one month of the renewal thereafter to renew the certificate.

3 Providing false or misleading information on the Prime Contractor Prequalification Application is cause for the denial of prequalification or revocation a previously granted prequalification.

4 As part of the prequalification process, Contractors will receive a Contractor Performance Score (CPS) according to the SCDOT Contract Performance System (CPES) as specified in the Prime Contractor Prequalification Application.

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 are 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.

## 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 all addenda. 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, a list of pay items and estimated quantities, 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 according to the Contract. The quantities of work to be performed and materials to be furnished may be increased, decreased, or omitted as hereinafter provided, without 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*, the *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 the performance of the work and as to the requirements of the Plans, the *Standard Drawings*, the Specifications, and other pertinent documents.

2 The Contractor is responsible for understanding 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.

## 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, if the Bidders 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 suspected to contain unbalanced bid prices.

C. There is reason to believe that the Bidder, or one of its employees, owners, or managers, has an economic interest in more than one bid on the same project or that there has been collusion among the bidders, or one of its employees, owners or managers. This provision does not prohibit the participation by a Bidder, or one of its employees, owners, or managers, as a subcontractor on another Bid Proposal.

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 that 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 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 for 5% of the submitted bid. Ensure that the Proposal guaranty is prepared 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 Alert Services*; 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 if 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. As-read results will be posted on the Department's Internet web site.

## 102.12 Disqualification of Bidders

1 Contractors may be disqualified as Bidders according to 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, or one of its employees, owners or managers, has an interest in more than one bid Proposal for a single project is cause for the rejection of all bids in which such bidder, or one of its employees, owners or managers, is believed to have an interest. This provision does not prohibit the participation by a Bidder, or one of its employees, owners, or managers, as a subcontractor on another Bid Proposal.

3 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 perform the work properly.

## 102.13 Escrow Bid Documentation

### 102.13.1 Scope and Purpose

1 If specified in the Proposal, when notified of award, submit bid documentation used to prepare the bid for the Contract to the Department. The Escrow Agent will place the documentation in escrow with a banking institution or other bonded document storage facility that is preserved by the institution/facility as specified.

### 102.13.2 Bid Documentation

1 The term "bid documentation" is defined as all writings, working papers, and all other data compilations that contain or reflect information, data, and calculations

used by the Contractor to determine the bid in bidding for the project. The term "bid documentation" includes, but is not limited to, Contractor equipment rates, Contractor overhead rates, labor rates, efficiency or productivity factors, and quotations from subcontractors and material suppliers to the extent that such rates and quotations were used by the Contractor in formulating and determining the amount of the bid. The term "bid documentation" also includes any manuals which are standard to the industry used by the Contractor in determining the bid for this project. Such manuals may be included in the bid documentation by reference. Such reference includes the name and date of the Publication and the Publisher. The term does not include bid documents provided by the Department for use by the Contractor in bidding on this project.

### 102.13.3 Affidavit

1 In addition to the bid documentation, an affidavit, signed under oath by an individual authorized by the Contractor to execute bidding proposals shall be included. The affidavit shall list each bid document with sufficient specificity so a comparison may be made between the list and the bid documentation to ensure that all of the bid documentation listed in the affidavit has been enclosed. The affidavit shall attest to the following:

- The affiant has personally examined the bid documentation.
- The affidavit attests to the documents used by the Contractor to determine the bid for this project.
- All such bid documentation has been included.

### 102.13.4 Submittal of Bid Documentation

1 The Contractor shall submit the bid documentation to the Department, in electronic or paper format in a package suitable for sealing, no later than 20 days following award of the Contract by the Department. The package shall be clearly marked "Bid Documentation" and shall also show on the face of the package the Contractor's name, the date of submittal, the File Number, the Project Number, and the County. The Department will, in the presence of the Contractor's representative, place the bid documentation and affidavit in the package and seal it. The Escrow Agent will deliver the sealed package to a banking institution or other bonded document storage facility selected by the Department for placement in a safety deposit box, vault, or other secure accommodation.

### 102.13.5 Duration and Use

1 The bid documentation and affidavit shall remain in escrow during the life of the Contract or until such time as the Contractor files a Contract Claim or initiates litigation against the Department related to the Contract. Receipt of the Contract

Claim, or litigation against the Department, shall be sufficient evidence for the Department to obtain the release and custody of the bid documentation only if the bid documents are associated with the Contract Claim and litigation as determined by the Department. If no such Contract Claim is received or litigation initiated, and the Final Estimate for the Contract has been paid, the Department instructs the banking institution or other bonded document storage facility to release the sealed package to the Contractor.

2 The Contractor agrees that the sealed package placed in escrow contains all bid documentation used to determine the bid and that no other bid documentation shall be used by the Contractor in litigation over Contract Claims arising out of the Contract.

### 102.13.6 Refusal or Failure to Provide Bid Documentation

1 The Department may retain the bid bond if the Contractor refuses to provide adequate documentation. This will be considered material breach of the Contract, and the Contractor will be declared in default of the Contract. The Department may, at its discretion, terminate the Contract for default. This remedy is not exclusive, and the Department may exercise such action as available under the law.

### 102.13.7 Confidentiality of Bid Documentation

1 The bid documentation and affidavit in escrow are, and will remain, the property of the Contractor. The Department has no interest in, or right to, the bid documentation and affidavit other than to verify the contents and legibility of the bid documentation, unless a Contract Claim is received or litigation ensues between the Department and Contractor or the Contractor does not retrieve the bid documents within 60 days of the Contract closeout letter from the Department. If such Contract Claim or litigation, or the failure by the Contractor to retrieve the bid documents after the Contract closeout letter from the Department, the bid documentation and affidavit shall become the property of the Department.

2 SCDOT will rely on the Contractor's designation of bid documentation as a "Trade Secret." Contractor shall be prepared upon request to provide justification of why such materials shall not be disclosed under the South Carolina Freedom of Information Act, Section 30-4-10, et seq., South Carolina Code of Laws (1976) as amended. Contractor will indemnify, defend, and hold harmless SCDOT if any third party files an action challenging Contractor's designation of "Trade Secret."

### 102.13.8 Cost and Escrow Instructions

1 The cost of escrow will be borne by the Department. The Department will provide escrow instructions to the banking institution or other bonded document storage facility consistent with this Specification.

### 102.13.9 Escrow Agreement

1 A copy of the Escrow Agreement will be provided to the successful Bidder (Contractor). If the Contractor fails to sign the Escrow Agreement, when presented, the Department will retain the bid bond, and the Contractor may be declared in default of the Contract.

### 102.13.10 Payment

1 There will be no separate payment for compilation of the data, package, or cost of verification of the bid documentation. All costs shall be included in the overall Contract bid price.

# Section 103 — Award and Execution of Contracts

## 103.1 Consideration of Bid Proposals

1 After Bid Proposals are opened and read, the Department compares the Bid Proposals 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 the comparison are available to the public only after the Contract has been awarded. If a discrepancy exists between unit bid prices and extensions, the unit bid price governs.

2 The Department reserves the right to reject any or all Bid Proposals, to waive or modify technicalities, or to advertise for new bids, if 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 requirements prescribed. The award of the Contract will be made within 30 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 that the guaranty 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 The successful Bidder must maintain an acceptable Payment Bond, Performance and Indemnity Bond, and Certificates of Insurance for the duration of the Contract.

3 Provide the bonds according to the requirements of South Carolina Code of Laws, Sections 57-5-1660 and 29-6-250, as amended.

4 The Department will only accept a Performance and Indemnity Bond written on SCDOT Form 672A and a Payment Bond written on SCDOT Form 673. Bond forms are available through the Contracts Administration office.

5 Criteria that are necessary for surety or sureties to be satisfactory to the Department, include, but are not limited to, the following:

- The surety or sureties are licensed for surety authority by the Chief Insurance Commissioner of the South Carolina Department of Insurance.
- The surety or sureties are assigned a rating of "A" or better by A.M. Best Company in its most recent *Best's Alert Services*.

## 103.6 Execution of the Contract

1 After receiving the Contract prepared by the Department, sign and return the Contract, with an acceptable Payment Bond, Performance and Indemnity Bond, and Certificates of Insurance, to the Contracts Administrator within 20 days from the date the Contract was provided 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 days after the Department has transmitted the Contract 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 The successful Bidder must provide and maintain an acceptable Payment Bond, Performance and Indemnity Bond, and Certificates of Insurance for the duration of the Contract for one year after the completion of the project or the end of the warranty period, whichever is longer. 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 as a result of the Contractor's operations under the Contract. This includes any operations performed by the Contractor, by a subcontractor, or by any party directly or indirectly employed by the Contractor or subcontractor or by any party for whose acts any of the parties may be liable:

A. Workers' Compensation and Employer's Liability Insurance.

Coverage A: Statutory workers' compensation as required by the State of South Carolina or applicable federal laws.

Coverage B: Employer's Liability with minimum limits of $1,000,000 bodily injury by accident; $1,000,000 bodily injury by disease; and $1,000,000 policy limit by disease.

B. Commercial General Liability Insurance.

Commercial General Liability Insurance coverage shall be at least as broad as the most recently promulgated version of ISO Form CG 0001 (Occurrence-Basic Coverage). The policy shall also include coverage for premises and operations, broad form property damage, products, and completed operations per South Carolina law, independent contractors, personal injury, contractual liability coverage provisions that offer protection against all risks, and exposures including the following: The general aggregate limit should apply on a per project basis, and there shall be no exclusion for claims arising from explosion, collapse, or underground work (X, C, and U Exclusions). There shall be no exclusion for work within 50 ft of a railroad.

C. Automobile Liability Insurance.

Automobile Liability Insurance coverage shall be at least as broad as the most recently promulgated version of ISO Form CA 0001 including coverage for any auto (owned, non-owned, and hired) as appropriate. If any vehicle shall be used for hazardous waste transportation, such insurance shall include an MCS-90 Endorsement.

D. Umbrella/Excess Liability Insurance.

Umbrella/excess liability insurance coverage shall be at least as broad as the underlying primary commercial general liability, automobile liability, and employer's liability insurance policies.

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 §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 | Minimum Limits |
|---|---|
| Worker's Compensation Insurance: | |
| Coverage A | Statutory |
| Coverage B – Employer's Liability: | |
| Bodily Injury by Accident | $1,000,000 |
| Bodily Injury by Disease | $1,000,000 |
| Disease, Policy Limit | $1,000,000 |
| 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/Excess Liability | $10,000,000 |
| Other Insurances | Specified in the Proposal |

4 The Contractor will cause each subcontractor employed by Contractor to purchase and maintain appropriate and reasonable insurance coverage and minimum insurance limits to cover each of the subcontractor's liabilities given the scope of work and the services being provided herein. All liability insurance policies (except Workers' Compensation) provided by the subcontractor(s) must include the Additional Insureds and/or Indemnified Parties as required herein.

5 Ensure that General Liability and Excess Liability policies contain a per project general aggregate endorsement. SCDOT shall be named as an additional named insured on a primary and non-contributory basis on General Liability, Automobile Liability, and Excess Liability.

6 General Liability shall include coverage for Completed Operations as evidenced by endorsement CG 20 37(10 01) or its equivalent. Ensure that all policies waive rights of subrogation against SCDOT. Contractor's deductibles shall not exceed $1,000,000 without written consent of SCDOT.

7 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 all policies contain a provision that coverage afforded under the policies cannot be cancelled or reduced by the Contractor, unless at least 30 days prior written notice has been provided to SCDOT, and that the policies cannot be cancelled for non-payment of premiums until at least 10 days prior written notice has been provided to SCDOT. Send Notices of Cancellation to the Director of Construction, Room 330, PO Box 191, Columbia, SC 29202. Ensure that the policies are endorsed to reflect this requirement.

8 For claims covered by the insurance required under the Contract, said insurance coverage shall be primary and noncontributory insurance with respect to the additional insureds, their directors, officers, employees, and agents. Any insurance or self-insurance that is maintained by an additional insured, their directors, officers, employees, or agents, or consultants shall be excess of such insurance required by the Contract. The insurance shall apply separately to each insured and additional insured against whom a claim is made or if suit is brought except with respect to the limits of the insurer's liability. Any additional insured policy shall include the defense of SCDOT as to such claims.

9 By execution of the Contract, the Contractor accepts the responsibility to provide the liability insurance policies and endorsements as specified herein. Failure of SCDOT to identify a deficiency in the Certificate of Insurance submitted by the Contractor's insurance agent as evidence of the specified insurance or to request other evidence of full compliance with the liability insurance specified shall not be construed as a waiver of the Contractor's obligation to provide and maintain the required insurance for the duration of the Contract.

## 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 the Bidder's 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 contendre.

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, if such an 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

### 103.11.1 Mobilization

1 Mobilization is paid at the lump sum price bid. The 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 these 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 50% of the lump sum price for Mobilization, subject to the limits 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 The completion of the 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 precludes or limits any of the provisions of partial payments otherwise provided for by the Contract or these Specifications.

### 103.11.2 Bonds and Insurance

1 Bonds and Insurance consists of all Bonds and Insurance required of the Contractor unless specified elsewhere. A maximum allowable amount of 3.0% of the total Contract amount will be paid on the first pay estimate after work begins. If there is a remaining amount of the lump sum price for Bonds and Insurance after payments are made according to the limit above, then the remaining amount will be paid on the final estimate.

2 No maximum limit will apply to insurance required by the Contract provisions deemed necessary to protect against a specific peril such as builder's risk insurance or pollution.

### 103.11.3 Railroad Insurance

1 Railroad Insurance consists of all insurance required by the Railroad specified in the Contract Documents. Provide Certificates of Insurance acceptable to the Department as verification that the required insurance has been obtained. Payment for the lump sum bid will be included on the first construction estimate following receipt of all Railroad Insurance documents by the RCE.

### 103.11.4 Pay Items

1 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 1031000 | Mobilization | LS |
| 1032010 | Bonds and Insurance | LS |
| 1033000 | Railroad Insurance | 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 of the work described and contemplated. Furnish all materials, labor, equipment, tools, supplies, transportation, services, and fuel required to complete the work according to the terms of the Contract.

## 104.2 Alteration of Plans or Character of Work

### 104.2.1 General

1 The Department reserves the right, at any time, to increase or decrease the 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 When 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 before 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 assume responsibility for any materials purchased in advance of the apparent need for such materials or assume responsibility for losses by the Contractor for furnishing an excess of materials, except where the excess is the result of alterations of the Plans that the Contractor could not reasonably foresee.

3 Do not begin work until a Change Order is executed or a Force Account Work 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.

4 The above provisions do not apply to any remaining materials due to changes in substructures (i.e., end bents, interior bents) caused by foundation conditions varying from those assumed or shown.

### 104.2.2 Significant Changes in the Character of Work

1 If the alterations or changes in quantities significantly change the character of the work under the Contract, whether such alterations or changes are in themselves significant changes to the character of the work or, by affecting other work, cause the other work to become significantly different in character, an

adjustment, excluding anticipated profit, will be made to the Contract. The basis for the adjustment shall be agreed upon before the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the RCE may determine to be fair and equitable.

2 If the alterations or changes in quantities do not significantly change the character of the work to be performed under the Contract, the altered work will be paid for as provided elsewhere in the Contract.

3 The term "significant change" shall be construed to apply only to the following circumstances:

A. When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction; or

B. When an item of work is increased in excess of 125% or decreased to less than 75% of the original Contract quantity. Any allowance for an increase in quantity will apply only to that portion in excess of 125% of the original Contract item quantity or, for a decrease below 75%, to the actual amount of work performed. The RCE will determine if unit prices may be adjusted because of the increases or decreases.

4 Alterations of Plans or to 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 according to **Subsection 104.4**.

5 An increase or decrease in the quantities of work in no way invalidates the unit bid or Contract prices except as stated in paragraph 3.B above. No Contract 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.

6 Payment for work occasioned by changes or alterations will be made according to **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 the time adjustment is made according to **Subsection 108.6**.

### 104.2.3 Differing Site Conditions

1 During the progress of work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the Contract or if 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 before the site is disturbed and before the affected work is performed.

2 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 according to **Subsection 104.5**. If the Contractor and the Department are unable to reach an agreement concerning prices, then the work will be performed according to **Subsection 109.5**.

3 If the RCE does not find that the conditions differ substantially and do not cause a substantial increase or decrease in the cost and/or time required to perform the work, submit a notice of differing site condition to the RCE before performing additional work resulting from the claimed differing site condition. Submit notification on SCDOT Form No. 100.04, *Contractor Notice of Contract 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 (Contract Claim) for additional time and/or compensation. Submit the Contract Claim according to **Subsection 105.18**.

4 No Contract adjustment that results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

## 104.3 Value Engineering

1 This Specification provides the Contractor with an incentive to initiate, develop, and present to the Department for consideration any proposal 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 a reduction in the construction time without increasing the total cost of construction. The impacts of the proposal may involve, but are not limited to, the following 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 alternative 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 accept or transmit to the Department proposals by its subcontractors. The Contractor may choose any arrangement for the subcontractor's Value Engineering payments provided that these payments do not reduce the Department's share of the savings resulting from the Value Engineering Proposal.

6 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.

7 If a final Value Engineering Proposal is submitted to the RCE, ensure that it contains, as a minimum, the following:

A. Proposal Statement. Statement that the request for the modification is being made as a Value Engineering Proposal.

B. Revisions. Description of the difference between the existing Contract requirements and the proposed modifications, including the comparative advantages and disadvantages of each.

C. Revised Drawings. Complete and accurate drawings of the details involved in the proposed modifications and the supporting design computations. Ensure that new designs, revisions, or modifications are prepared and sealed by a South Carolina licensed and registered Professional Engineer. Further, the Department may require a review

and possibly the redesign to be performed 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 requirement for preparing 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. Contract Requirements. Present an itemized list of the Contract requirements that would be modified and a recommendation of how to make each modification.

E. Cost Estimate. Prepare a detailed estimate of the cost of performing the work involved in the proposed modification.

F. Approval Timing. Provide a 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.

8 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.

9 The DOC will be the sole judge of the acceptability of a Value Engineering Proposal requested according to 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 7 above.

10 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.

11 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.

12 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.

13 Subsequent change documents affecting the modified bid items, but not related to the Value Engineering Proposal, are excluded from the determination of net savings unless agreed to otherwise by the Department. The Department and the Contractor will each bear the cost of their own 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.

14 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 use 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 the Value Engineering Proposal on other projects are not valid.

15 Except as otherwise precluded by this Specification, the Contractor may submit a previously approved Value Engineering Proposal from another project.

16 Unless and until a Change Order is executed and issued by the Department, the Contractor remains obligated to perform the work according to the terms of the existing Contract.

17 Acceptance of the modification and its implementation does not modify the completion date of the Contract unless specifically provided for in the Change Order.

18 The Contractor is entitled to additional compensation for alterations in the Plans or in the details of construction pursuant to the Value Engineering Proposal.

19 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.

20 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 according to the terms of the negotiated agreement.

21 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 The Department, with SOT approval and written agreement with the Contractor, may extend work beyond the limits of the Contract or add additional road(s). Upon execution of a Change Order, perform the extended work at the same unit prices as in the original Contract. The Contractor may negotiate new unit prices if the Department determines that the character of the extended work is different than the work in the original Contract. If there is no unit price for an item(s) in the original Contract, the unit price of such item(s) is established in the Change Order.

## 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 according to the Specifications and as directed, a Change Order will be entered into or a Force Account Work Order specified in **Subsection 109.5** will be issued before any Extra Work is started.

2 In a Change Order, the 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 must be maintained on detour roads or structures, the pay items for construction and maintenance of such detours are included in the Contract. If detour roads or structures are not shown on the Plans or provided for in the Contract, the Contractor is responsible for providing 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 practical 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 Maintenance of Traffic

1 Unless otherwise provided, keep existing facilities that are undergoing improvements open to all traffic. Keep the portion of the project being used by public, pedestrian, and vehicular traffic in such condition that all traffic will be safely and adequately accommodated and is free from irregularities and obstructions that could present a hazard or annoyance to traffic.

2 Maintain the work, project site, construction area, and roadway from the time permanent construction signs are installed and uncovered until final acceptance with all exceptions cleared. Perform maintenance with adequate equipment and forces to keep the roadway and structures in a safe and satisfactory condition at all times and to ensure the continuous and effective day by day prosecution of the work. As determined by the RCE, SCDOT will be responsible for any maintenance of items outside the scope of the Contract. Where maintenance is necessary within the project limits but outside the scope of the Contract, the RCE may authorize the Contractor to perform the maintenance work according to **Subsection 104.5**.

3 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 a waiver of the Contractor's responsibility as set forth herein or elsewhere in the Contract.

4 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.

5 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.

6 The Contractor is responsible for the cost of repairs for issues that arise and that are within the scope of the Contract.

7 If permanent construction signs are not required on a particular road, then the start of the Contractor's obligations begins when the Contractor installs temporary signs and ends when the particular road is accepted.

## 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. When materials are stored upon the highway, the Contractor is responsible for their 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 as directed by the RCE.

2 Remove an existing structure, unless otherwise specified, if any part of the structure 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 When necessary to remove, reset, or rearrange any building or structure outside the limits of the roadway, if not provided for in the Contract, the RCE may require the Contractor 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 the material where it can be readily loaded onto 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 that has been damaged during the prosecution of the work. 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, and 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 that are to be paid for under the Contract.

2 The RCE has the authority to suspend or direct the work by written order, 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; or for conditions considered unsuitable for the prosecution of the work. No additional compensation is paid or extension of time granted 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 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 provide 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 in 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. The Contractor may make additional borings and investigations, including test piles, as desired 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 adjustment 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 foundations and/or substructures as the RCE may determine.

4 Submit all required Working Drawings, Shop Plans, and Erection Plans to the Department for review and acceptance. Do not perform any work on the items involved until these plans have been accepted. Any work performed 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 **Section 725**.

6 The Contract price of an item includes the cost of furnishing Shop Plans, Working Drawings, and Erection Plans 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 Specifications that may be required by the exigencies of construction will be determined by the RCE and authorized in writing.

2 If 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 Specifications, but that reasonably acceptable work has been produced, the RCE will determine if the work can be accepted and remain in place. In this case, 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 If the RCE finds that 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, the Contractor shall remove and replace or otherwise correct the work or materials without additional compensation.

## 105.4 Coordination of Plans, Specifications, and Special Provisions

1 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. If there is any discrepancy, the order of precedence is as follows:

A. Special Provisions

B. Plans

- Calculated dimensions unless obviously incorrect
- Scaled dimensions

C. *Standard Drawings*

- Calculated dimensions unless obviously incorrect
- Scaled dimensions

D. Supplemental Technical Specifications

E. Supplemental Specifications

F. Standard Specifications

G. Questions and Answers issued by Addendum

2 Do not take 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 Give the work the attention necessary to facilitate the progress thereof, and cooperate with the RCE, the RCE's authorized representatives and inspectors, and other Contractors as necessary. Ensure 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 a Superintendent irrespective of the amount of work sublet.

## 105.6 Cooperation with Utilities

1 The Department will endeavor to notify all utility companies, all facility owners, or other parties affected by the work, and endeavor to have all necessary adjustments of the public or private utility fixtures, facilities, and other

appurtenances within or adjacent to the limits of construction, made as soon as practical. 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 with cooperation from the SCDOT. 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 from the SCDOT.

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 or on the Plans.

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 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 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 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 practical completion of the work.

2 In good faith, cooperate and coordinate the performance of the work with other projects or work that may affect the project or the work, including all subcontractors.

3 Schedule and sequence the work as reasonably necessary to accommodate the projects and work of such contractors.

4 Conduct work, dispose of the materials, and perform all obligations under the Contract.

5 Satisfactorily join work and in proper sequence with the work of other contractors.

6 Ensure that all planning or modification to an existing plan facilitates efficient completion of the work by all parties.

### 105.7.1 Interference by other Contractors, Resolution by the Department

1 If Contractor asserts that any other contractor performing work for the Department has caused damage to the work, immediately notify the RCE so that the RCE can seek recourse against the responsible contractor. Request a Change Order for the repair and delay costs to assist the Department in recovering these amounts.

2 Contractor may request the RCE to resolve a conflict between Contractor and any other contractor where work being performed by other contractors and Contractor is in conflict that cannot be resolved by those parties if:

A. Contractor reasonably believes for any other reason that the Department's other contractor will not undertake or permit a schedule modification in a manner consistent with the timely completion of the Contract; or

B. Contractor becomes aware that other contractor is not cooperating in a timely manner to provide agreed-upon or necessary work, approvals, or other cooperation; or

C. Contractor asserts the existence of a dispute unrelated to a direct claim for interference between Contractor and other contractor with respect to the Contract.

3 The RCE will resolve any conflict between Contractor and other contractors in the exercise of good faith discretion and determine whether either party is entitled to relief of a Department caused delay upon Contractor demonstrating all of the following:

A. The schedule conflict is of such a nature that both projects cannot proceed to substantial completion (i.e., critical path).

B. Contractor has made diligent efforts to avoid the conflict by altering, amending, or otherwise revising its own schedule such as:

- Contractor has used diligent efforts to obtain the cooperation of other contractors as necessary to avoid a schedule conflict;
- Contractor is unable (or anticipates it will be unable), after diligent efforts, to reach agreement with other contractors to avoid schedule conflict within a reasonable time.

C. Provide written notice to the Department and the other contractor seeking the Department's assistance in resolving the dispute or in otherwise obtaining timely cooperation. Include in the notice information relating to Contractor's attempts to resolve the scheduling dispute, other contractor's failure to cooperate and other contractor's responses to Contractor's position on the schedule conflict.

4 Other contractor has an opportunity to respond in writing to the RCE within 7 days of Contractor's notice to the RCE.

5 The respective rights of the various interests involved will be established by RCE to secure the completion of the various portions of the work in general harmony. RCE may assess costs to Contractor and/or the other contractor to remediate the conflict if RCE determines that the parties refused to resolve the conflict in good faith.

6 The failure of Contractor to satisfactorily prove entitlement to relief for a Department-caused delay does not relieve Contractor from its obligation to abide by RCE's decision regarding the resolution of the conflict.

## 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 interior bents and end bents, a benchmark 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 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 benchmarks, 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 that is discovered after the work has been fully or partially completed in compliance with the erroneous stakes, the Contractor will be paid for any additional work as required because of the 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. The assistance is that usually furnished by holding a survey rod.

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

#### 105.8.2.1 Construction Work

1 Provide all layouts necessary to construct the project elements and accommodate all utility relocations. The Department will provide adequate reference points to the centerline of survey and benchmarks 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. After performing a surveying function, provide a copy of the field notes to the RCE no less than once a month or at the request of the RCE.

2 Before construction begins, field verify the location of all control points and benchmarks shown on the Plans or as provided by the RCE. Notify the RCE of any discrepancies.

3 If using a Global Positioning System (GPS) site calibration/localization, establish supplemental control points and benchmarks to envelop the work site. Provide the RCE with a report at least 14 days before starting work that includes the following information:

- Coordinates for all supplemental control points and benchmarks;
- A map of the control points used for site calibration/localization and control points used for verification; and
- Description of site calibration/localization procedures that include the horizontal and vertical residuals and the ellipsoid, data transformation, geoid model, and projection parameters.

4 Provide field personnel and set all additional stakes and marks for the project that 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. Ensure that the station number is clearly visible on project stakes. The Contractor is not required to determine the property line between properties.

5 Ensure that all field notes and computations of survey work required in the execution of the project are verified by a Professional Land Surveyor or Professional Engineer licensed and registered in South Carolina. Ensure that the field notes and computations submitted are accompanied by the designated Professional Land Surveyor or Professional Engineer seal and signature.

6 Before commencing bridge construction at the site, submit written verification to the RCE confirming the tops of underpass roadway or bridge surfaces and tops of rail grades at railroad crossings, as shown on the Plans. Submit written documentation to the RCE showing the measurements to include station, offset, and elevation from the reference centerline. Further, take actual measurements

of minimum clearances and submit to the RCE in writing when bridge substructure and superstructure elements are in place.

7 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. The RCE will make random checks of the Contractor's staking to determine if the work is in substantial conformance with the Plans. The RCE will advise the Contractor in writing of any alignment discrepancies related to the work. Any inspection or checking of the Contractor's layout by the RCE and the acceptance of all or part of the layout does not relieve the Contractor of the responsibility to secure the proper dimensions, grades, and elevations of the various parts of the work.

8 Preserve stakes and benchmarks and reset them 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.

9 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, 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 RCE will provide the resulting adjustments 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 adjustment to the staking or for any delays due to adjustments to the staking.

#### 105.8.2.2 Stakeless Instrumentation

1 For stakeless instrumentation for all or part of the project, follow the control point and benchmark specifications as outlined in **Subsection 105.8.2.1**.

2 Additionally, submit to the RCE, at least 30 days before using stakeless instrumentation, the final 3D surface model in LandXML format and linework in DGN, DWG, or DXF format. Provide all 3D break lines as profiles in LandXML format. Due to evolving data exchange formats, the RCE can approve other formats.

3 With the surface model submissions, submit a written stakeless work plan that includes the following:

- Location and scope of work to be completed using stakeless layout;
- A description of the manufacturer, model, and software for all equipment using stakeless layout (e.g., the GPS/GNSS system, laser system, sonic system, robotic total stations);

- A written verification procedure to ensure that the equipment is calibrated and operating correctly;
- The name of a single staff member as the primary contact for stakeless staking technical correspondence; and
- A Professional Engineer or Professional Land Surveyor seal and signature on all submittals.

### 105.8.2.3 Measurement and Payment

1 The quantity for Construction Stakes, Lines, and Grades is measured by each (EA) project site and each bridge site where the layout work is complete and accepted by the RCE.

2 The payment for each portion of this item is proportional to the amount of the relevant work completed. The sum of all payments for this item must not exceed the total bid amount for Construction Stakes, Lines, and Grades. Payment for the accepted quantity is full compensation for furnishing all material, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

3 Pay items under this Subsection include the following:

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

## 105.9 Authority and Duties of the RCE Representatives

1 Authorized representatives of the RCE may inspect all work performed and all materials furnished. This 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 according to the requirements of the Contract. The RCE representative has the authority to reject defective material and to suspend any work being improperly performed until the issues can be referred to and decided by the RCE. The RCE 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 Contract. The RCE representative will not act as superintendent or perform other duties for the Contractor or interfere with the management of the work by the Contractor. Do not construe advice given by the RCE representative as 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 according to 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 these portions of the work to the standard required by the Specifications. Should the work 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, if the work 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 performed or materials used without the knowledge of or inspection by the RCE or the RCE representative may be ordered removed and replaced at the Contractor's expense. Failure to reject any defective work or material does not prevent later rejection when a defect is discovered nor does it obligate the Department to provide final acceptance.

2 When a unit of government or political subdivision, public utility company, or railroad company will pay a portion of the cost of the work covered by the Contract, its representatives have the right to inspect the work. This inspection does not make the unit of government or political subdivision, public utility company, or railroad company a part of the Contract and does not interfere 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 **Subsection 105.3**.

2 Immediately remove unacceptable work unless otherwise directed by RCE, 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, perform no work without lines and grades. Unauthorized work is any work performed contrary to the instructions of the RCE, beyond the lines shown on the Plans, or as given except as herein specified or any Extra Work performed without authority. This work will not be paid for under the provisions of the Contract and 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 order that unacceptable work be corrected or removed and replaced or that unauthorized work be removed. The cost of this work will be deducted from any monies due

or that may become due to the Contractor. If no monies are due or available, the expenses 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 that results from the moving of materials or equipment.

2 Do not operate equipment of a weight or load that will 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 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 permission from the RCE.

## 105.13 Bridge Inspection Access

1 Allow Department personnel (or their designee) access to all existing bridges within the project limits to perform periodic bridge condition evaluations. The evaluations may include routine, underwater, fracture critical, or special inspections. The Department (or its designee) will provide 2 weeks' notice to the Contractor of planned inspections.

2 Notify the RCE 4 weeks before opening any new, widened, stage constructed, rehabilitated, or temporary bridge to traffic. Allow an initial bridge condition evaluation, an inventory inspection, and an inventory underwater inspection (if needed), while the bridge is closed.

## 105.14 Failure to Maintain Roadway or Structure

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

## 105.15 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. The reasons for termination include, but are not be limited to, the following:

- A Force Majeure event;
- 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 an 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 the 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 that have not been incorporated into the project, 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 Contract Claim for additional damages or costs not covered above or elsewhere in the Specifications. The Contract Claim may include cost items such 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 the original Contract.

The loss of anticipated profits will not be allowed as damages.

5 Make cost records available as 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 Contract Claims arising out of the work performed.

## 105.16 Acceptance and Final Inspection

### 105.16.1 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. Partial acceptance neither voids nor alters any Contract term nor waives any other remedy to which the Department is entitled by law or in equity.

### 105.16.2 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 has been completed to the RCE's satisfaction, that inspection constitutes the final inspection, and the RCE notifies the Contractor in writing of final acceptance.

2 If the work is not acceptable to the RCE at the time of the inspection, the Contractor is advised of the corrective work necessary before final acceptance.

## 105.17 Auditing of Contractor Records

1 The Department has the right to audit the Contractor's records at any time during the project and for up to 3 years after the Contract closeout letter is issued, regardless of whether or not a Contract 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. Include a similar audit clause in all subcontract agreements allowing the Department to audit subcontractor's records. The Contractor, subcontractors, and suppliers shall cooperate with the auditors. If the Contractor fails to make all documents requested by the Department or its Consultants available within 10 days of request, then the Department may withhold all payments to the Contractor, and 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 the 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 that reflect the Contractor's actual profit and overhead during the years the project was being performed and for each of the 5 years before the commencement of the 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 Contract Claim together with all documents that support the amount of damages as to each Contract Claim;

X. Worksheets used to prepare the Contract Claim and establishing the cost components for items of the Contract Claim including, but not limited to, labor, benefits and insurance, materials, equipment, subcontractors, and all documents that establish the time periods, the individuals involved, the hours, and the rates for the individuals;

Y. All documents relating to Contract schedules including, but not limited to, all electronic scheduling data, data bases, updates, interim schedules, look ahead schedules, and scheduling programs; and

Z. All electronic data relating in any way to the Contract.

3 Failure of the Contractor, subcontractors, and suppliers to maintain and retain sufficient records to allow the Department's auditor to verify the Contract Claim constitutes a waiver of that portion of such Contract Claim that cannot be verified and bars recovery thereunder.

## 105.18 Contract Claims for Adjustment and Disputes

1 When the Contractor determines that it is or will be entitled to additional compensation for any reason, follow the procedures in this Subsection.

### 105.18.1 Force Majeure Event

1 A Force Majeure Event is a delay or failure of performance that materially and adversely affects the performance of the Contractor that does not constitute a breach of the Agreement if and to the extent such delays or failures of performance result in a delay to the Contract completion date. Each of the foregoing are not included in the definition of a "Force Majeure Event":

A. Any breach of Contract by the Contractor or any person or entity for whom the Contractor is legally responsible including by nor limited to subcontractors and material suppliers; or

B. Any act or omission by the Contractor or any person or entity; or

C. Any negligence, recklessness, willful misconduct, fraud, or violation of laws by the Contractor or any such person or entity; or

D. Any event that could reasonably have been avoided by the Contractor or any such person or entity by the exercise of caution, due diligence, or reasonable efforts.

2 A Force Majeure Event is defined as or are caused by:

A. Acts of God or public enemy;

B. A change in law or regulation after the effective date directly and substantially affecting project performance;

C. Acts of war (including civil and revolutionary); invasion, armed conflict, violent acts of a foreign enemy, military or armed blockade; military or armed takeover of the project or the site;

D. Declaration or order from either the President of the United States and/or the Governor of the State of South Carolina that mandates or requires the evacuation of the project area;

E. Acts of rebellion, terrorism, riot, insurrection, civil commotion or sabotage that causes direct physical damage to, or otherwise directly causes, interruption to construction or direct losses during maintenance of the project;

F. Earthquakes, including all foreshocks and aftershocks, where such earthquakes include ground shaking, liquefaction, settlement, or ground movements that directly impact and cause damage to temporary or permanent works of the project;

G. Hurricanes and tornados that cause direct physical damage to or otherwise directly causes interruption to construction or direct losses during project maintenance;

H. Extreme weather events, ice storms, snow, fires (except intentionally set fires), floods, landsides, or sinkholes caused by natural events that directly impact physical improvements of the project or the Contractor's performance of the work, if the damage caused by the event was not reasonably foreseeable and preventable by the Contractor's exercise of ordinary care, exercise of caution, or due diligence or to reasonable efforts to abate, prevent, or otherwise mitigate the risk of the event;

I. Explosions, nuclear explosions, including radioactive contamination that triggers the Contractor's obligations pertaining to hazardous materials hereunder and in each case directly impacting the physical improvements of the project or performance of the Contractor's scope of work;

J. Unavailability or shortage of materials caused directly or indirectly by any other Force Majeure Event, whether it occurs within South Carolina or whether it occurs in the area where the materials are produced, manufactured, and/or mined;

K. Embargos directly affecting materials required to perform the Contractor's work as reflected in the then-current project schedule;

L. Quarantine or suspension by the President of the United States, the Governor of South Carolina, or other authority acting on behalf of or with the authority of the same, or declared epidemic or pandemic, in each

case, directly affecting the Contractor's performance of the scope of the work;

M. Declared state of emergency by the President of the United States the Governor of the State of South Carolina, or regional authority having jurisdiction over the project or the Contractor's performance of the scope of the work; or

N. Strikes (both national or regional strikes) or other concerted acts of workmen not arising out of or related to the Contractor or any person or entity for which the Contractor is responsible.

3 A Contractor shall bear the burden of proving that a Force Majeure Event exists, that it impacts the critical path of the project, and that the Contractor could not have reasonably worked around the condition, including by resequencing, relocating, or redeploying its forces to other portions of the project or other activities unrelated to its work so as to avoid additional delay or cost. A Force Majeure Event is an excusable delay event and not a compensable event.

4 Any expense attributable to such occurrence of a Force Majeure Event shall not entitle the Contractor to additional compensation; these events shall be covered under the Contractor's appropriate insurance policy. The duration of delay to the critical path identified in the current project schedule directly caused by a Force Majeure Event shall be added to the Contract time.

### 105.18.2 Delay Claims

1 The term "delay" means any event, action, force, impact, or factor that extends the Contractor's time of performance. 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, submit to the Department written notice of the intention to file a Contract Claim for delay damages. Submit notification to the Department on SCDOT Form No. 100.04, *Contractor Notice of Contract Claim*.

3 The Department has no liability for any delay damages that accrued more than 15 days before the filing of this notice. Failure of the Contractor to provide written notice in a timely fashion is grounds for denial of the Contract 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 providing the Department with the notice of intention to file a Contract 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 providing notice of intention to file a Contract Claim for delay damages, 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 the 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, model year, 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.

### 105.18.3 Contract Claims for Acceleration

1 The Department has no liability for acceleration. If the Department provides express written direction to the Contractor to accelerate its effort, then both parties execute a Change Order as defined in **Subsection 101.3**.

### 105.18.4 Other Contract 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 from which the claim arises. Submit notification to the Department on SCDOT Form No. 100.04, *Contractor Notice of Contract Claim*. If this notification is not provided, the Contractor waives its right to any additional compensation.

2 The liability of the Department for these Contract Claims is limited to those items of damages that are specifically identified as payable in connection with delay claims as set forth in **Subsection 105.18.5**. For these Contract 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 105.18.6**.

### 105.18.5 Recoverable Damages

1 Only the following items may be recovered by the Contractor with respect to Delay Claims or other Contract Claims. The Department has no liability for damages beyond the following documented items:

A. Additional job site direct labor costs.

B. Additional material costs.

C. Additional equipment costs according to **Subsection 109.5**.

D. Documented costs of extended job site overhead during the delay period including costs incurred at the job site that are incidental to performing the work, such as on-site supervisory personnel, vehicles, timekeeping, clerical, job site trailer, utility, telephone, computers, portable toilets, and supplies.

E. An additional 10% of the total of items A, B, 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 will be deducted from the additional 10% if the work occurs during the same period of delay. No subcontractor costs will be included in this markup.

F. Additional bond and insurance costs.

G. Subcontractor costs determined by and limited to those items identified as payable under items A, B, C, D, E, and F above.

### 105.18.6 Non-Recoverable Damages

1 The parties agree that, in any Contract 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 105.18.5**;

B. Loss of profit or anticipated profit;

C. Labor and equipment inefficiencies;

D. Acceleration costs in excess of that provided in **Subsection 105.18.3**;

E. Home office overhead in excess of that provided in item E of **Subsection 105.18.5**;

F. Consequential damages including, but not limited to, loss of bonding capacity, loss of bidding opportunities, and insolvency;

G. Interest and any other indirect costs or expenses of any nature other than those allowable under item D of **Subsection 105.18.5**;

H. Attorneys' fees, claims preparation expenses, or costs of litigation;

I. Prejudgment interest on any amounts the Contractor may be found to be entitled for any claim; and

J. Any and all costs associated with a delay caused by a Force Majeure Event.

### 105.18.7 Required Contents of Contract Claims

1 Submit all Contract Claims in writing and in sufficient detail to enable the RCE to ascertain the basis and the amount of each Contract Claim. All information submitted to the Department under this Subsection is used solely for analyzing and resolving the Contract Claim. At a minimum, provide the information listed below to the extent such information is applicable:

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, critical path method (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 Contract Claim providing all necessary dates, locations and items of work affected by the Contract Claim.

D. The date on which actions resulting in the Contract Claim occurred or conditions resulting in the Contract Claim became evident.

E. A copy of the SCDOT Form 100.04, *Contractor Notice of Contract Claim* filed for the specific Contract 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 Contract 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 Contract Claim.

H. The name, function, and activity of any other person not included in F or G above, involved in or knowledgeable about facts that gave rise to such Contract Claim.

I. The specific provisions of the Contract that support the Contract Claim and a statement of the reasons why such provisions support the Contract Claim.

J. The identification of any pertinent documents, and the substance of any material oral communication relating to such Contract Claim.

K. 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.

L. The amount of additional compensation sought and a breakdown of that amount into the categories specified as payable under **Subsection 105.18.5** above.

M. If an extension of time is also sought, the specific days for which it is sought and the basis for such Contract 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.

### 105.18.8 Required Certification of Contract Claims

1 When submitting the Contract Claim, certify in writing and under oath according to the formalities required by South Carolina law as to the following:

A. The Contract 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 Contract Claim accurately reflects what the Contractor in good faith believes to be the Department's liability.

2 Use the CERTIFICATE OF CONTRACT CLAIM form, which can be obtained from the Department, to comply with the requirements.

### 105.18.9 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. If any legal action is instituted against the Department by the Contractor because of any Contract 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 **Subsection 105.18.5**. The parties agree that all relevant statutes 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.

### 105.18.10 Contract Claims Procedure

#### 105.18.10.1 Scope of Procedure

1 The following Contract Claims procedure covers all Contract Claims arising under the Contract. The Contract Claims procedure is binding and is a condition precedent to litigation or any other form of dispute resolution. All communications, testimony, and documents prepared for this procedure by either party from the time of filing the CERTIFICATE OF CONTRACT CLAIM, per **Subsection 105.18.8** to the conclusion of the procedure shall be deemed to be settlement negotiations and not admissible in litigation or any other dispute resolution procedure. If at the conclusion of this procedure, the Contract Claim has not been resolved, litigation may be pursued through the South Carolina Circuit Court for Richland County. The Contractor waives all rights to a jury trial and agrees that all litigation shall be heard non-jury and that the venue for any action shall be in Richland County, South Carolina.

#### 105.18.10.2 Continuation of Work

1 At all times during the pendency of a Contract Claim under this procedure, the Contractor shall continue work pursuant to the Contract and as directed by the RCE as provided by the Contract. If the Contractor fails to continue work, it may be declared delinquent in its work as provided by **Subsection 108.8**.

#### 105.18.10.3 Submission of Contract Claim

1 Submit the Contract Claim according to **Subsection 105.18.7**. The notice of claim does not trigger this claims procedure. This procedure is initiated when the Contractor submits a written, fully detailed CERTIFICATE OF CONTRACT CLAIM to the RCE. The Contractor must submit 3 hard copies and one electronic copy of the Contract Claim to the RCE. The Contract Claim shall contain, at a minimum, the information required by **Subsection 105.18.7**. The RCE will immediately forward a copy of the Contract Claim to the DEA for resolution. If the DEA is unable to resolve the Contract Claim within 30 days of receipt, the DEA will forward it immediately to the DOC, together with documents supporting the Department's position. The DEA will also submit the supporting documents to the Contractor at this time. The DOC will investigate the Contract Claim and attempt to resolve it by mutual agreement with the Contractor. If the Contract Claim cannot be resolved, then the DOC will make a decision and forward the decision to the Contractor no later than 60 days after receipt by the DOC. The Contractor shall notify the DOC within 10 days of receipt of receipt of the DOC's decision whether the Contractor accepts or rejects the decision.

2 For all Contract Claims under $50,000.00, the DOC's decision shall be final and shall conclude the Contract Claims procedure. For the purpose of determining if a time-only Contract Claim may be submitted to the Dispute Review Board (DRB), the value of a time-only Contract Claim shall be deemed to be the number of days requested multiplied by the Contract daily rate for liquidated damages. The Contractor does not have a right to submit Contract Claims under $50,000.00 to the DRB. If the Contractor does not accept the DOC's decision on its Contract Claim of less than $50,000.00, then its remedy is litigation in the South Carolina Circuit Court for Richland County as set forth in Paragraph 1 of **Subsection 105.18.10.1** or other mutually agreeable dispute resolution procedures.

3 For all Contract Claims in excess of $50,000.00, if the Contractor rejects the DOC's decision, the DOC will forward the Contract Claim to the DRB.

### 105.18.10.4 Dispute Review Board

1 A Standing DRB has been established and shall be maintained. The Standing DRB shall consist of one member selected by the Department, one member selected by the Director of Heavy and Highway Division of the Associated General Contractors (Carolina's AGC), and a third member selected by the first two members. The third member shall be the chairperson of the Standing DRB. The selection of qualified Standing DRB members shall be made according to the DRB rules and procedures according to **Subsection 105.18.10.6**. Each member shall serve a 3-year term and the terms shall be staggered. Each member is limited to 2 terms. All DRB Members shall be neutral and unbiased. No party shall have any *ex parte* communication with any DRB Member.

### 105.18.10.5 Hearing Procedure

1 The Contractor shall provide an additional 3 hard copies of its Contract claim and 3 portable storage devices (thumb drives) containing its Contract claim for the DRB's use. The Department will provide 3 hard copies and 3 portable storage devices (thumb drives) containing its response to the Contract Claim for the DRB's use. The DOC will send both the Contractor's claim and the Department's response to the Contract Claim to the DRB within 45 days of the Contractor's rejection of the DOC decision.

2 Within 15 days of notice of submission of the Contract Claim to the Board, the Contractor may submit to the DOC 5 copies of any additional documentation supporting its Contract Claim. The DOC will immediately forward 3 copies to the Board, 1 copy to the DEA, and the DOC will keep 1 copy.

3 Within 15 days of receipt of the Contractor's supplemental documentation, the DEA may submit to the DOC 5 copies of its additional documentation. The DOC will immediately submit 3 copies to the DRB, 1 copy to the Contractor, and the DOC will keep 1 copy.

4 The DRB shall review all documents and notify the parties of what additional documents, if any, it requires. The DRB shall schedule a hearing at either party's request or may schedule a hearing at its own discretion. However, if a hearing is requested, it must be held no later than 60 days after the DOC submits the Contract Claim to the DRB. The location of the hearings shall be determined by the DRB. While extensions of these deadlines are discouraged, the DRB shall have authority to extend any of the above deadlines for just cause.

5 The DRB shall have full authority to establish guidelines and procedures for the investigation of a Contract Claim. The entire process is intended to be flexible, and the DRB is encouraged to adapt the process to individual circumstances presented by particular disputes.

6 In the interest of timely resolution of all Contract Claims, the DRB shall conduct all hearings and issue its final decision within 90 days of receipt of the Contract Claim.

7 The DRB Chairperson shall direct all meetings and hearings. Presentation of evidence shall be according to the DRB's rules and shall not be bound by judicial rules of evidence. Documents and testimony shall be presented in the order, manner, and degree of detail that the DRB deems most efficient and probative. Each party shall be allowed to make a brief initial presentation and to rebut any factual assertion by another party; however, the DRB shall determine when enough evidence has been presented, and it may limit the presentation of any documentation or testimony that it deems not relevant or redundant. At the DRB's option, testimony may be required to be given under oath, and the oath shall be administered by the Chairperson.

8 Legal counsel for either party may be present at meetings or hearings as observers only. If a party intends to have its counsel present at a hearing, it must provide at least 10 days' notice before the meeting or hearing. Legal counsel may not speak on behalf of a party, unless requested by the DRB. Counsel may not examine or cross-examine witnesses, object to questions or statements during meetings, or make legal motions or arguments during meetings or hearings. The DRB, by majority vote, may suspend legal counsel's privilege to attend meetings or hearings.

9 The DRB shall issue to the Contractor and the Director of Construction a written recommendation with an explanation of the results as soon as reasonably possible following the conclusion of the hearing. However, in no event shall the DRB take more than 90 days from receipt of Contract Claim to conduct hearings and issue a recommendation. The DRB is encouraged to reach a unanimous decision; however, it may provide a majority recommendation. The minority DRB Member may provide a written explanation of his position. The DRB shall provide further explanation of its decision if requested by either party within 10 days of the receipt of the decision. Issuance of the DRB's recommendation concludes the Contract Claims procedure.

10 The parties may settle at any time during the procedure. If the dispute is resolved before issuance of a recommendation, the DOC shall immediately notify the DRB.

11 Within 60 days of issuance of the DRB's recommendation, each party shall notify the other in writing whether or not they accept the Board's decision.

12 If at the conclusion of this procedure the Contract Claim has not been resolved, litigation may be pursued in South Carolina Circuit Court for Richland County as set forth in Paragraph 1 in **Subsection 105.18.10.1**.

13 The DRB members shall not be compelled to testify, give any type of statements, nor produce any documents or evidence submitted at the DRB hearing in any subsequent proceedings or litigation.

### 105.18.10.6 DRB Rules and Procedures

#### 105.18.10.6.1 Qualifications of DRB Members

1 All DRB Members shall have substantial experience in highway or bridge design and construction. This experience may be technical, administrative, or legal. The goal is to have a DRB with the technical and administrative skills and experience that will promote confidence in its decisions.

2 No DRB Member shall be employed currently or within the last 3 years with the Department, any Contractor (currently or in the past pre-qualified with the Department), or any design consultant that has worked for the Department within the last 3 years.

3 No DRB Member shall have any financial or ownership interest in any party to the Contract nor any design consultant or major subcontractor.

#### 105.18.10.6.2 Selection of DRB Members

1 The selection process for DRB Members shall begin at the appropriate time to allow completion of the Member selection by the beginning of the term. The selection process shall be as provided in **Subsection 105.18.10.4**.

#### 105.18.10.6.3 Replacement of DRB Members

1 Each party may elect to replace its DRB Member at any time with a showing of reasonable justification. The Chairperson of the DRB may be replaced at any time with the consent of both parties. If any DRB Member is replaced, the new member shall be selected in the same manner in which the original appointment had been made.

2 If disputes are pending at the end of a Member's term, the existing DRB shall complete its hearing on the disputes and issue a decision.

### 105.18.10.6.4 Costs

1 DRB Members shall be paid a reasonable hourly rate or salary for their services. Each party shall negotiate the fee arrangements with the Member it selects; however, the other party must agree on the rate. Both parties shall agree on the fee arrangement for the Chairperson.

2 DRB Members shall be reimbursed for out-of-pocket expenses including, but not limited to, travel, copying, telephone, clerical services, and mailings. The DRB Members shall be allowed reimbursement of actual expenses for meals up to the daily maximums set forth in the Department's Regulations for Reimbursement of Travel and Subsistence Expenses and actual lodging costs provided that they stay in hotels approved by the Department and they obtain a government rate. DRB Members must provide documentation for all expenses.

3 The parties shall share all DRB Members' fees and expenses equally. The total fees and expenses to hear each Contract Claim shall not exceed the following maximum amounts unless otherwise agreed to by both parties in writing (one Contract Claim shall constitute all issues submitted to the DRB at one time):

| Contract Claim Amount | Cumulative Total |
|---|---|
| $50,000 - $499,999.99 | $ 25,000.00 |
| $500,000.00 - $999,999.99 | $ 50,000.00 |
| $1 million - $4,999,999.99 | $ 100,000.00 |
| > $5 million | $ 200,000.00 |

4 The Department will pay the DRB Members and deduct the Contractor's share from monies owed to the Contractor. If monies owed are not sufficient, the Contractor shall pay the Department directly for its share of the fees and expenses.

## 105.19 General Design Features

1 When the Contractor is requested to furnish details of the design not shown on the Plans, or otherwise specifically covered herein and when any requirements of the Plans or the Specifications are 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 Use only materials that meet Contract requirements. Notify the RCE of the proposed source of materials to be used before their delivery. The RCE may conditionally approve materials at the supply source. Correct, to the satisfaction of the RCE, or remove any conditionally approved materials incorporated into the work that subsequently fail to meet Contract requirements. Unless otherwise specified, use new materials for the work.

2 All Qualified Products Policies and Qualified Products Listings referenced to hereinafter are available from the Department's website. Unless otherwise designated, the Department will perform testing at its expense using the most recent Department standard test methods or AASHTO or ASTM tests in effect at the time of material use in the work.

## 106.2 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 these 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 performed by and at the expense of the Department unless otherwise noted in the Specifications or other Contract documents. Tests are performed according to the methods prescribed in the AASHTO, ASTM, SCDOT Test Procedures, or other methods that are specified and are current on the date that the material is tested for use in the work. Materials to be used in the work may be inspected or tested at any time during their manufacture, preparation, or use.

## 106.3 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 will be granted access 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.

## 106.4 Field Laboratory

1 If required, provide a field laboratory for the Department's inspector, and ensure that it is fully equipped according to the applicable Specifications at no additional cost to the Department.

## 106.5 Storing and Handling of Materials

1 Store and handle materials to preserve their quality and fitness for the work. Transport bulk materials in a manner that prevents loss or segregation after loading and measuring.

2 For purposes of this Specification, flammable materials are defined as those materials capable of being easily ignited and of burning quickly. Combustible materials are those materials capable of producing a usually rapid chemical process that creates heat and usually light. Do not store any flammable, combustible, explosive, or hazardous materials within 20 ft of a structure, including but not limited to bridges. Store such materials in accordance with applicable regulations.

3 Store materials so that they can be easily inspected and retested as specified. Obtain approval to store materials and Contractor's plant and equipment on the right-of-way.

4 Additional storage space is at the Contractor's expense and option. Obtain owner's or lessee's written permission before storing material on private property. Furnish copies of the permission to the RCE, if requested.

5 Restore storage and plant sites to their original condition at no additional cost to the Department.

## 106.6 Unacceptable Material

1 Reject all materials not conforming to the requirements of the 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 according to the requirements of the Specifications within the time indicated in writing, the RCE has the authority to direct that the unacceptable or defective materials or work be removed and replaced or corrected. Any expense incurred by the Department in making these removals, replacements, or corrections that 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.

## 106.7 Material Guaranty

1 When required by the Specifications, provide the 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 designated 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.

## 106.8 Material Pit Acquisition and Testing

1 When required to furnish materials from pits, obtain any samples necessary for evaluating the pit material and submit the samples to an AASHTO accredited laboratory for the appropriate tests.

## 106.9 South Carolina Mining Act

1 The South Carolina Mining Act enacted by the General Assembly in 1973 requires that the Department adopt reclamation standards to govern activities of the Department and any person acting under contract with the Department on right-of-way or material pits maintained solely in connection with the construction, repair, and maintenance of the public road system in South Carolina. This Subsection presents the requirements for the "Standard Plan for the Reclamation of Excavated Areas Adopted by the South Carolina Department of Transportation."

2 Reclamation plans shall include all areas disturbed in excavations of borrow and material pits, except planned inundated areas.

3 The final side slopes of areas excavated for borrow and material pits shall remain at an angle that minimizes erosion and the possibility of slides. The minimum slope in every case shall be not less than 3H:1V.

4 Small pools of water that are, or are likely to become noxious, odious, or foul, should not be allowed to collect or remain on the borrow pit. Suitable drainage ditches, conduits, or surface gradients shall be constructed to avoid collection of

noxious, odious, or foul pools of water unless the borrow pit will be reclaimed into a lake or pond.

5 Borrow pits reclaimed to a lake or pond must have an adequate supply of water to maintain a water level sufficient to maintain a minimum water depth of 4 ft on at least 50% of the surface area of the lake or pond.

6 Excavated areas will be drained where feasible unless otherwise requested by the property owner where, in such instances, the property owner may wish to develop the excavated area for recreational use or for the raising of fish or for other uses in compliance with the South Carolina Mining Act.

7 Where material is stripped from the ground surface in relatively thin layers, the area, after excavation has been completed, will be thoroughly scarified and terraced and planted to establish satisfactory vegetation necessary to control erosion. Vegetative cover should be established on a continuing basis to ensure soil stability appropriate to the area. Conservation practices essential for controlling both on-site and off-site erosion and siltation must be established. A minimum of 75% vegetative ground cover, with no substantial bare spots, must be established and maintained into the second growing season.

8 Seed both the drained area and the side slopes of the excavated areas to establish a satisfactory vegetative cover.

9 The DSE, or duly appointed representative, will make a final inspection of the reclaimed area and maintain a permanent record of his approval thereof. A map or sketch providing the location and approximate acreage of each pit used on the project will be provided to the RCE for inclusion in the final plans.

10 Comply with all applicable regulations of agencies and statutes relating to the prevention and abatement of pollution in the performance of the Contract.

11 Comply with the provisions of the plan that are applicable to the project as determined by the RCE. Seeding or other work necessary to comply with the plan on pits furnished by the Contractor shall be at the expense of the Contractor. For seeding, comply with **Section 810**.

## 106.10 Source of Production of Iron and Steel Products and Construction Materials

1 All iron and steel permanently incorporated into federal-aid projects must be produced in the United States. All manufacturing processes, from the initial melting stage through the application of coatings, must occur in the United States. When steel and iron materials are used in a project, the requirements of this Section do not prevent a minimal use of foreign steel and iron materials if the cost of such materials used does not exceed one-tenth of one percent (0.1 percent) of the total contract cost or $2,500, whichever is greater. For purposes of this paragraph, the cost is that shown to be the value of the steel and iron product. Do not incorporate any foreign steel or iron materials into the

project before RCE approval. Proper tracking of the foreign materials must be done to the satisfaction of the RCE to ensure that the maximum allowance is not exceeded.

2 A material certification (one per shipment) certifying compliance with this Specification must be submitted to the RCE before incorporating any steel and iron materials into the project. This includes the certification of steel and iron components of manufactured products (e.g., steel wire mesh or steel reinforcing components of a precast reinforced concrete pipe).

3 All construction materials permanently incorporated into federal-aid projects must be produced in the United States. All manufacturing processes must occur in the United States and include at least the final manufacturing process and the immediately preceding manufacturing stage for the construction material. "Construction materials" includes an article, material, or supply that is or consists primarily of:

- Non-ferrous metals;
- Plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables);
- Glass (including optic glass);
- Fiber optic cable (including drop cable);
- Optical fiber;
- Lumber;
- Drywall; or
- Engineered wood

4 Cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives are excluded from this requirement. There is no minimum use allowance of foreign construction materials.

5 Any construction material permanently incorporated into a federal-aid project must have a material certification certifying compliance with this Specification, submitted to the RCE before incorporation into the project unless the material is already identified as meeting this Specification for federal-aid projects on a QPL.

# Section 107 — Legal Relations and Responsibility to Public

## 107.1 Laws to be Observed

1 Remain 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 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 these laws.

3 Fines charged against the Department or additional mitigation costs required by any regulatory agencies as the result of the Contractor's non-compliance or violation of any regulations will be paid by the Department and will subsequently be deducted from any monies due or that may become due to the Contractor. If no monies are due or available, the fines or mitigation costs incurred will be charged against the Contractor's Surety.

## 107.2 Permits, Licenses, and Taxes

1 Unless otherwise specified, obtain all permits and licenses, pay all charges, fees, and taxes, and provide 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 the 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 all claims for infringement by reason of the use of 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 that 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 within the right-of-way, or grant permits at any time is expressly reserved by the Department. The Contractor is not entitled to any damages either for making the openings within the right-of-way or for any delay occasioned thereby.

2 Only allow parties bearing such permits to make openings within the right-of-way. When ordered by the RCE or RME, make all necessary repairs due to the openings in an acceptable manner. The necessary work is paid for as Extra Work as provided for in **Subsection 104.5** and is subject to the same conditions as the original work performed.

## 107.5 Federal Participation

1 When the United States government pays all or a portion of the cost of a project, observe the federal laws authorizing federal participation and rules and regulations made pursuant to these laws. When any federal laws, rules, or regulations conflict with provisions of a federally assisted Contract, the federal requirements prevail. These requirements take precedence and are in force over the conflicting provisions. The work is under the supervision of the Department but subject to the inspection of the appropriate federal agency. Federal 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 SCDES or of other authorities having jurisdiction.

2 Comply with applicable 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 SCDES 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 Department of Plant Industry within the Regulatory Services Division of Clemson University and the USDA for plant and insect pest control as they pertain to pest quarantine. Keep informed as to the counties or areas within the State in which the quarantine is imposed.

2 Vegetation, vegetative debris, soil, and associated equipment operating in regulated areas is subject to pest quarantine regulations. In general, these regulations provide guidance to prevent pests from being moved from regulated areas. Complete information may be secured from the Department of Plant Industry at Clemson University and the USDA.

## 107.9 Public Convenience and Safety

1 At all times, conduct the work so 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 practical 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 the materials so as to minimize the obstruction to the traveling public. Conform to the requirements for storage of material equipment in **Subsection 601.2.**

## 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 regulatory agency permit.

2 All work over, on, or adjacent to navigable waters shall abide by State Regulation 19-450 for construction in State Navigable Waters and/or Sections 9 and 10 of the Rivers and Harbor Act.

## 107.11 Correcting Low Shoulder Conditions

### 107.11.1 Identifying Pre-Existing Low Shoulders before the Commencement of the Roadway Surface Work

1 Pre-existing low shoulders is defined as areas with a grade elevation difference of 3 in. or more between the surface of the edge of the pavement and the surface of the earth shoulder immediately adjacent to the edge of pavement.

2 Before beginning the roadway surface work and in coordination with the RCE, inspect the roads within the project to identify pre-existing low shoulders. On each roadway, complete the corrective shoulder work to eliminate the pre-existing low shoulder before beginning the roadway surface work.

### 107.11.2 Correction of Pre-Existing Low Shoulders before the Commencement of the Roadway Surface Work

1 Correct pre-existing low shoulders by spreading borrow material where its placement is considered an acceptable corrective action, unless an alternative corrective action is deemed necessary and agreed upon by the Contractor and the RCE. For each roadway, complete all work to correct pre-existing low shoulders before starting the roadway surface work on that roadway. Payment for the corrective actions implemented by the placement of borrow material will be at the Contract unit bid price for Borrow Excavation according to the requirements of **Section 203**. Alternative corrective actions and/or any corrective actions without a unit bid price item in the Contract should be implemented and payment made through a Change Order.

2 The RCE will inspect the correction of pre-existing low shoulders. If additional corrective action is determined necessary, the RCE will direct and notify, in writing, the need for additional corrective actions. Complete the additional corrective actions within 72 hours of receipt of this written notification from the RCE.

## 107.12 Railroad/Highway Provisions

1 If the Plans require that materials be hauled across the tracks of any Railroad Company, arrange with the Railroad 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 so as not to interfere with the movement of trains or traffic upon the track of the Railroad Company. Avoid accidents, damage, delay, or interference with the Railroad Company's trains or other property.

3 Reimburse the Railroad Company directly under terms mutually arranged for all charges by the Railroad Company for the construction or use of a new or existing private crossing and its subsequent removal and all charges for services of railroad personnel at the crossings. Ensure that payment is made to the Railroad Company before the final acceptance of the project.

4 Conduct all operations that occur on or over the right-of-way of any Railroad Company within the rules, regulations, and requirements of the Railroad Company and according to any agreement made between the Department and the Railroad Company that is part of the Contract.

5 If railroad issues delay the critical path of the project, the delay, in its entirety or portions thereof, may be considered excusable if the delay occurred without the fault of the Contractor and the Contractor can demonstrate that appropriate coordination efforts have been made with the railroad company. The delay shall not be a compensable event unless the actions of the Department contributed to the delay.

## 107.13 Use of Explosives

1 When the use of explosives is necessary for the prosecution of the work, do not endanger life or property, including the new work. The Contractor is responsible for all damage resulting from the use of explosives. Store all explosives securely to comply with all laws, ordinances, and regulations.

2 Comply with all laws and ordinances, including Title 29CFR, Part 1926, "Safety and Health Regulations for Construction (OSHA)." If discrepancies exist, use the most restrictive with respect to the use, handling, loading, transportation, and storage of explosives and blasting agents.

3 Notify each public utility company that owns structures in proximity to the work site of the intention to use explosives and provide sufficient notice to enable the utility to protect their property from damage. This notice does not relieve the Contractor of responsibility for any damage resulting from blasting operations.

## 107.14 Preservation and Restoration of Property, Trees, Monuments, etc.

1 Do not enter upon private property 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 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 public or private property is damaged by 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, the property to a condition similar or equal to the original condition by repairing, rebuilding, or otherwise restoring as directed, or make good on the damage in an acceptable manner. If the Contractor fails to rectify the situation, the RCE may, upon 48 hours' notice, proceed to repair, build, or otherwise restore the property as deemed necessary. The cost will be deducted from any monies due, or that may become due, to the Contractor under the Contract. If no such monies are available, the expenses 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 to adapt the property to the new work, cooperate with the property owners on the rearrangement by:

- Providing advance notice of the necessary work to the owners,
- Providing temporary supports during the rearrangement,
- Installing utility supporting devices in concrete formwork, and
- Permitting access by the owners' personnel.

## 107.15 Forest Protection

1 In performing work within or adjacent to state or national forests, comply with all regulations of the state or federal authority having jurisdiction governing the protection of forests and the performance of work within forests. Maintain the areas in an orderly condition and dispose of all refuse according to regulations. Obtain permits for the construction and maintenance of all construction camps, stores, warehouses, latrines, cesspools, septic tanks, and other structures according to 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 regarding 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 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.

2 Abide by all rules related to the *Threatened & Endangered Species Act* in the area. Forest officers will provide clear direction on where the Contractor can stage equipment.

## 107.16 Responsibility for Third Party Damage Claims, etc.

1 Take charge and custody of the work. Conduct all operations to protect adjoining property owners, the traveling public, residents near the Project, workers engaged in or on the work, and representatives of the State and Federal Government while they are engaged in duties connected with the work. This responsibility also extends to the protection of public and private property (both real and personal) under all circumstances. Contractor shall cause all subcontractors and suppliers to conduct their operations with the same level of care and concern.

2 Indemnify and hold harmless and defend the State, the Department, the County, municipal government (City, Town, or other incorporated area), where the work is performed and all of their officers, agents, and employees from all suits, actions, demands, costs, expenses, actual attorneys' fees, losses, liabilities (in law or in equity) or claims of any character, kind or description brought for or on

account of any injuries or damages received or sustained by any person, persons, or property, in whole or in part, arising out of, relating to, resulting from or are in any manner connected with:

A. The performance of the work or the work itself; or

B. Contractor's operations, or work supervised by the Contractor or any subcontractor or sub-subcontractor on the Project; or

C. Because of or in consequence of any neglect in safeguarding the work; or

D. Through the use of unacceptable materials or workmanship in constructing the work; or

E. Because of any act or omission, neglect, or misconduct of the Contractor or any subcontractor or sub-subcontractor; or

F. Because of any claims or amounts recovered from any infringements of patent, trademark, or copyright; or

G. 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 the construction of the work under the Contract; or

H. From any claims or amounts arising or recovered under the Workmen's Compensation Act; or

I. From any claims or amounts arising or recovered under any other law, ordinance, or decree.

3 Contractor's defense and indemnity obligation shall extend to claims arising after the work is completed and accepted if the claims arise out of, relate to, result from or are in any manner connected with Contractor's performance of the work or are directly related to alleged acts or omissions by the contractor, subcontractor, supplier or sub-subcontractor that occurred during the course of the work. Any inspection of the work by the State is not a waiver of full compliance with these requirements.

4 Contractor's indemnity obligation applies even if the State, the Department, the County, municipal government and their officers, agents, and employees are negligent in part and responsible for a portion of the injuries or damages. This indemnity obligation does not apply if the State, the Department, the County, municipality government, and their officers, agents and employees are solely responsible for the injuries or damages.

5 Contractor's obligation to defend and indemnify is not excused because of inability to evaluate liability or because the contractor's evaluation determined that it is not liable.

6 The Contractor must respond within 15 days to the tender of any claim for defense and indemnity by the Department, unless an extension has been granted in writing by the Department.

7 The Department may elect to conduct its own investigation of and pay any Claim for Third Party damage if Contractor fails to respond to the tender of claim for defense and indemnity. The Department's decision to pay any Claim does not waive or excuse Contractor's duty to indemnify and defend the Department.

8 Money due the Contractor under and by virtue of the Contract and is considered necessary by the Department will be retained for the use of the Department to pay claims as determined by the Department as may arise during the performance of the work. Department shall withhold a maximum of 5% from each successive monthly progress payment until the Department has withheld the full amount paid to satisfy the third party claim.

9 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.

## 107.17 Third Party Liability

1 No part of the *Standard Specifications* are intended 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 the Specifications, to maintain a suit for personal injury or property damage otherwise than as authorized and provided by law.

## 107.18 Opening of Section of Highway to Traffic

1 At the request of Contractor, the RCE will determine if any bridge, roadway, or portion thereof is in acceptable condition for travel. With RCE's approval, the Contractor may open the facility to traffic as directed. The opening is not considered 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, 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 placement of the surface courses or other work, open the incomplete portions of the work to traffic when directed by the RCE, and provide maintenance on any incomplete sections. Make any repairs necessary to incomplete and unaccepted sections without any additional compensation.

## 107.19 Contractor's Responsibility for the Work

1 Until final acceptance of the work by the RCE in writing, the Contractor has the charge and care thereof. Take every precaution against damage to any portion

of the work by weather or from any other cause, whether arising from the execution or from the non-execution of the work. Unless otherwise provided in the Specifications, rebuild, restore, and repair any damages to any portion of the work before final acceptance and bear the expense thereof, except for damage to the work due to a Force Majeure Event and without the fault or negligence of the Contractor.

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 to the Contractor or any of its subcontractors.

3 For suspension of work from any cause, 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.

## 107.20 Contractor's Responsibility for Utility Property and Services

1 It is the responsibility of the Contractor to inspect the site for potential utility conflicts and to contact SC811 before commencing work so that existing utilities can be properly marked.

2 Before commencing work, arrange to protect the properties of railroad, communication, power companies, or other utility property from damage.

3 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.

4 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.

5 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 to revise the Plans or make structural changes to accommodate this installation. The provisions of **Subsection 104.2** apply to any changes in quantities of work.

## 107.21 Furnishing Right-of-Way

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

## 107.22 Personal Liability of Public Officials

1 In implementing the provisions of these Specifications or in exercising power or authority granted by or within the scope of the Contract, there is no liability upon the Department employees who are authorized 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.

## 107.23 No Waiver of Legal Rights

1 Upon completion of the work, the Department will expeditiously make final inspection and notify the Contractor of acceptance. However, final acceptance does not preclude or stop the Department from correcting any measurement, estimate, or certificate made before or after completion of the work; nor is the Department precluded or stopped 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.

## 107.24 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, asphalt, chemicals, soil sedimentation, or other harmful materials, and prevent pollution of the atmosphere from particulate and gaseous matter.

2 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 sq ft without prior approval by the RCE. Consider the location of the project, nature of the soil, topographic features, and proximity to watercourses when setting these limitations.

3 Conduct construction operations consistent with good erosion control practices to minimize soil erosion and, as practical, prevent sediment from leaving the site. Throughout the life of the project, control erosion and prevent the deposition of sediment into adjacent rivers, streams, wetlands, and impoundments. Implement 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 until permanent drainage facilities and erosion control features are completed and operative.

5 When included in the Contract, incorporate permanent erosion control devices or measures in the construction with the least possible delay. Seed cut and fill slopes as the excavation proceeds as determined by the RCE as desirable or practical in conformance with **Section 810**.

6 Once work begins on a cut or fill section, grade the section to the typical section with the least amount of delay, and promptly install all erosion control measures.

7 Conform to the following practices and controls:

A. Erosion Control. When the material is excavated from pits, control erosion of the pit site both during and after completion of the work so 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 to prevent sediment from entering streams.

B. Stream Crossings. Do not permit fording of live streams. Use temporary bridges or other structures when 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. Sediment Prevention. When work areas are located adjacent to live streams, perform the work so as to prevent sediment from entering a flowing stream.

D. Removal of Temporary Construction Items. Clear all waterways of falsework, piling, debris, or other obstructions placed during construction operations that are not a part of the finished work as soon as practical.

E. Pollutants. Do not discharge pollutants such as fuels, lubricants, asphalt, 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. Pollution Regulations. Comply with applicable regulations of agencies and statutes relating to the prevention and abatement of pollution in the performance of the Contract.

8 In addition to the requirements above, comply with specific project limitations and requirements included in the Contract.

## 107.25 Hazardous and/or Toxic Waste

1 If during construction operations, any abnormal condition that may indicate the presence of 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 that could be a possible indication of hazardous and/or toxic waste.

Treat the conditions with extraordinary caution. Do not resume operations until so directed by the RCE.

3 If a building is razed, the Contractor is responsible for securing the necessary permits according to the SCDES requirements.

## 107.26 Required Media Notification for Construction Projects

1 Coordinate with SCDOT's Office of Public Engagement and engage directly with the news media when required by the Department. Notify SCDOT's Office of Public Engagement and/or the news media at least 72 hours before beginning disruptive activities such as lane closures, pacing operations, and detours if the Department determines that the operations will cause disruptions to the public.

## 107.27 Crane Safety

### 107.27.1 General

1 Submit all applicable items in **Subsection 107.27.2** to the RCE before initiating any crane operations. If any personnel or equipment is changed or added, update and resubmit all applicable items to the RCE before continuing with crane(s) operations.

2 Comply with the manufacturer's specifications and limitations applicable to the operation of all cranes and derricks. Ensure that all prime Contractors and subcontractors comply with the OSHA regulations, ANSI and ASME crane

standards, and other applicable standards. This includes compliance with the following partial list:

- OSHA 29 CFR 1926 Subpart CC “Cranes and Derricks in Construction”
- OSHA 29 CFR 1926.251 “Rigging Equipment for Material Handling”
- ASME B30.5 “Mobile and Locomotive Cranes”
- ASME B30.8 “ Floating Cranes and Floating Derricks”
- ASME B30.22 “Articulating Boom Cranes”
- ASME B30.26 “Rigging Hardware”

### 107.27.2 Submittal List

#### 107.27.2.1 Crane Operators

1 Ensure that all crane operators are certified by the National Commission for the Certification of Crane Operators (NCCCO) or National Center for Construction Education and Research (NCCER).

2 Submit a copy of the NCCCO or NCCER certification for each crane operator before performing any crane operations on the job site. Ensure that the original certification card is available for review upon request and remains current within a 5-year expiration date for the duration of the job. Ensure that Contractors with a crane operator-in-training on the jobsite comply with all OSHA Subpart CC requirements.

3 Submit a copy of the crane operator’s current Commercial Driver’s License medical card or a current USDOT Medical Examiner’s Certificate card (2-year expiration). Ensure that the original medical card or equivalent for all crane operators is available for review upon request.

#### 107.27.2.2 Competent Person

1 Ensure that the named Competent Person has the responsibility and authority to stop any work activity due to safety concerns.

2 Submit the name and qualifications of the Competent Person as defined by OSHA Subpart CC who will be responsible for all crane safety and lifting operations.

# 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, the Contractor shall perform with its own organization and with workers under its immediate supervision an amount of work not less than 30% of the combined value of all items of work 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. These 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.

4 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 Contract between the Contractor and the subcontractor and lower tier subcontractors. For any conflict, the required Contract provisions prevail.

5 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.

6 No subcontract entered into by the Contractor will impose any obligation or liability upon SCDOT for any such subcontractor or any of its employees.

7 The Contractor shall also include the following terms and conditions in all contracts with all subcontractors for work that is sublet, assigned, or otherwise disposed of in any way:

a. Expressly state that there is no contractual relationship between SCDOT and any subcontractor of the Contractor;

b. Require the purchase of insurance coverages in compliance with **Subsection 103.8** with the following changes:

i. Requiring the policy to name the Contractor as an additional insured on a primary and noncontributory basis,

ii. Optionally naming SCDOT as an additional insured on a primary and noncontributory basis, and

iii. Insurance limits as may be determined by the Contractor and subcontractor;

c. Incorporate the documents listed in **Subsection 105.4** into the Contract by reference;

d. Impose duties to cooperate with SCDOT, the Contractor, and other subcontractors, contractors, and their subcontractors performing work for other parties within the project area and utility companies as set forth in **Subsections 105.5**, **105.6**, and **105.7**;

e. Include provisions setting forth terms and conditions the same or substantially similar to those set forth in **Subsection 105.17**;

f. Responsibility for Third Party Damage claims, including indemnification, as set forth in **Subsection 107.16**;

g. Impose the same or similar duties as set forth in **Subsection 107.19**;

h. Not be assignable by the subcontractor to any person other than SCDOT (or its assignee) without the Contractor's and SCDOT's prior consent as set forth in **Subsection 108.1**;

i. Include default and termination conditions as set forth in **Subsection 108.10**; and

j. Contain no waiver of the prompt payment protections for the subcontractor as set forth in **Subsection 109.10**.

8 When an agent performs work under a subcontractor, all requirements applicable to subcontractors apply.

9 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.

10 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.

## 108.2 Preconstruction Conference

1 After receipt of the notice of award and before the beginning of construction, contact the DCE of the Engineering District in which the work will take place, and establish a mutually agreeable date for a Preconstruction Conference. Ensure that the project Superintendent and other representatives or responsible officials involved in the construction of the project are present at the Preconstruction Conference, 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 so 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 topics such 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.

## 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 performed before execution of the Contract. The Department is not responsible for payment to the Contractor for any work performed, costs, expenses, or any damages relative to or resulting from the Department's decision not to execute the Contract.

2 Provide sufficient materials, equipment, and labor to complete the project according to the Plans and the Specifications within the time set forth in the Contract. If the prosecution of the work is 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 a manner and sequence as practical that minimizes interference with traffic. Have due regard to the location of detours and the provisions for accommodating 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.

## 108.5 Character of Workers, Methods, and Equipment

1 Employ sufficient labor and equipment at all times for prosecuting the 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. Ensure that workers engaged in special work or skilled work have sufficient experience in the 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 If the Contractor fails to remove such person or persons as required above or fails 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 condition to meet the requirements of the work and to produce a satisfactory quality of work. Ensure that the equipment used on any portion of the project causes no damage to the roadway, adjacent property, or other highways from its use.

6 When these Specifications require that the construction be performed by the use of certain methods or equipment, use these methods or equipment unless otherwise authorized by the RCE. If the Contractor desires to use a method or type of equipment other than those specified, request this in writing and gain approval from the RCE to do so. Before considering or granting a request, the RCE may require that the Contractor 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.

7 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 the specified quality or take other corrective action as the RCE may direct at no cost to the Department. No change is made in the basis of payment for the construction items involved or in the Contract because of approval of a change in methods or equipment as specified herein.

8 The approval for use of particular methods or equipment on any project is not considered as an approval of the use of these 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 alternative 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. The Contractor will not be entitled to monetary compensation for weather related delays.

5 If the Contractor finds it impossible, because of the occurrence of a Force Majeure Event, 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 the reasons that the Contractor believes justify the granting of its request. That insufficient time was specified is not a valid reason for an extension of time. If the RCE finds that the work was delayed because of a Force Majeure event 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 project schedule. The extended time for completion is then in full force 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 those 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,
- For the convenience of the State, or
- The occurrence of a Force Majeure Event.

2 Work suspensions do not constitute grounds for Contract Claims for damages or extra compensation by the Contractor, except (a) suspension for the convenience of the State; or (b) suspensions for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry).

3 If the Contractor believes that additional compensation and/or Contract time is due as a result of the exceptions noted above, submit to the RCE in writing a request for adjustment within 7 days of receipt of the notice to resume work. The request shall set forth the reasons and support for such adjustment.

4 Upon receipt, the Department will evaluate the Contractor's request. If the Department agrees that the cost and/or time required for the performance of the Contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier and not caused by weather, the Department will make an adjustment (excluding profit) and modify the Contract in writing accordingly. The Contractor will be notified of the Department's determination whether or not an adjustment of the Contract is warranted.

5 No Contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed.

6 No Contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided or excluded under any other term or condition of this Contract.

7 If it becomes necessary to stop work for an indefinite period, make the necessary provisions to maintain accommodations *fo*r and safeguard traffic in as satisfactory a manner as practical. Store materials so that they do not obstruct or impede the traveling public or become damaged. 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 completion date, the Contractor is liable for liquidated damages. Liquidated damages will be assessed for each day beyond the Contract completion date that the project is not substantially complete. The date of substantial completion is determined by the RCE. Days to be charged for liquidated damages will not stop due to seasonal restrictions. The daily liquidated damages rate is determined from the following schedule. This table does not apply if a different amount for liquidated damages is specified in the Contract Special Provisions.

| Schedule of Liquidated Damages for Each Day Overrun in Contract Time | | |
|---|---|---|
| **Original Contract Amount** | | **Daily Charge per Day at Fixed Rate** |
| **From More Than** | **To and Including** | |
| $0.00 | $500,000.00 | $600.00 |
| $500,000.00 | $1,000,000.00 | $800.00 |
| $1,000,000.00 | $2,000,000.00 | $1,000.00 |
| $2,000,000.00 | $5,000,000.00 | $1,200.00 |
| $5,000,000.00 | $10,000,000.00 | $1,700.00 |
| $10,000,000.00 and above | | $2,200.00 |

2 The punch list must be completed within 30 days of the final inspection unless another time frame is agreed upon by the RCE and Contractor at the final inspection. Seasonal restrictions and temperatures may be considered for individual items. Failure to complete the punch list may result in the RCE charging liquidated damages at the specified rate for any punch list item remaining incomplete beyond 30 days. Liquidated damages will be charged daily until all punch list items are complete. If a final inspection is held before the Contract completion date, liquidated damages shall not be charged before the Contract completion date for incomplete punch list items.

## 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 the work;
- Failure to perform work according to 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 30 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 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, at the discretion of the RCE, in which to get the work underway. This procedure does not 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 the 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 with an area of 9 sq ft 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 used 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 All materials that are measured and proportioned by weight will be weighed on accurate, calibrated scales by competent, qualified personnel at locations designated or approved by the RCE. 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 deemed 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 RCE. If the RCE 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.

10 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, the 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 lb 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.

11 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.

12 When requested by the Contractor and approved by the RCE in writing, material that is specified to be measured by the cubic yard may be weighed and converted to cubic yards for payment. 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.

13 Asphalt material measured by volume will be measured in gallons in tank cars, distributor tanks, and storage tanks. Volumes are measured at 60ºF or are corrected to the volume at 60ºF using Table 1 in SC-T-86. Asphalt material paid for directly will be weighed and paid for by the ton.

14 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.

15 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.

16 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 Order, transportation to the project will be according to **Subsection 109.5**.

17 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 this 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 107.23**.

2 If the "Payment" clause in the Specifications relating to any unit price in the bid schedule requires that the unit price cover and be considered full compensation for certain work or material essential to the item, this work or material is not also measured and paid for under any other pay item that 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 does not affect 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 these defects. The responsibility of the Contractor for all damages due to such defects is determined according to **Subsection 107.19**.

5 If the Contractor's progress is judged to be delinquent or portions of the work are defective, the Department reserves the right to withhold retainage. The total amount retained will be sufficient to cover anticipated liquidated damages and the cost to correct defective work.

## 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 Force Account Work

1 The Department may require the Contractor to perform the work on a force account basis. Payment for force account work will be according to the following:

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 the labor and personnel are actually engaged in the work. An amount equal to 45% will be added to the total labor cost to cover the Contractor's payroll burden costs.

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. Only equipment authorized for use on the project by the RCE will be allowed. Payment for equipment will include only those hours or portion of hours that the equipment was actually used in the work. Payment will not be made for time spent in moving equipment to and from job sites or idle time.

i. Contractor Owned Equipment. For purposes of computing 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, including overhead and profit at 10%, will not be allowed in excess of those in the Rental Rate Blue Book produced by Equipment Watch. To develop an hourly rate, divide the monthly Equipment Watch rate by 176 after the monthly rate has been adjusted by the regional and model year adjustment factors. The time of an operator will not be included. Use the rates that were available during the time at which the work occurred or the date when force account work was ordered. For any equipment not listed in the Rental Rate 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.

ii. Equipment Not Owned by the Contractor. For equipment rented from a third party not owned by the Contractor or an affiliate of the Contractor, payment will be made at the invoice daily rental rate for each day the equipment is needed for the work. The Department

reserves the right to limit the daily rate to comparable FHWA rental rates found in the Rental Rate Blue Book produced by Equipment Watch multiplied by the regional and model year adjustment factors. When the invoice specifies that the rental rate does not include fuel, lubricants, repairs, and servicing, the Rental Rate Blue Book hourly operating cost for each hour the equipment is operated will be added. When the invoice specifies equipment operators as a component of the equipment rental, payment will be made at the invoice rate for each operator for each day the equipment is needed for the work.

Equipment standby rates will be paid at 50% of the monthly Equipment Watch rate after the regional and model year adjustment factors have been applied. Recovery of operating costs, for equipment on standby, will not be allowed. Calculate the standby rate as follows:

Standby rate = (FHWA hourly rate – operating costs) × 50%

No more than 8 hours of standby will be paid during a day, and no more than 40 hours of standby will be paid per week. Standby costs will not be allowed during periods when the equipment would have otherwise been idle.

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 will 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 will 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; and
- Quantities of materials, prices, and extensions.

G. 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 the 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 found unnecessary for the proper completion of the work, the RCE may eliminate these items from the Contract, and this action does not invalidate the Contract. When a Contractor is notified of the elimination of items, it will be reimbursed for actual work performed and all costs incurred, including mobilization of materials before the notification. Any such materials may be purchased by the Department according to **Subsection 104.2**.

## 109.7 Partial Payments

1 Partial payments will be made at least once each month as the work progresses. If the Contractor earns more than $250,000 within a monthly pay period, the Contractor may request an intermediate estimate once earnings exceed $250,000 for the month. The intermediate estimate is paid at the discretion of the RCE. These payments will be based upon the RCE's estimate of the value of work performed and materials completed in place according to the Contract and for materials delivered (stockpiled) according to **Subsection 109.8**. The Department will issue monthly partial payment for periods that end at the end of the 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 according to 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; and

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 subbase, 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 Rails | 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 that the total invoice price of these materials is in excess of $10,000.

## 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 105.16**, 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 sufficient 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 FHWA for Contract closeout.

## 109.10 Payment Clause

1 Subject to the provisions on retainage provided in Paragraph 2 of this Subsection, when a subcontractor has satisfactorily performed a work item of the subcontract, the Contractor must pay the subcontractor for the work item within 7 days of the Contractor's receipt of payment from SCDOT. A subcontractor is considered to have "satisfactorily performed a work item of the subcontract" when the SCDOT pays the Contractor for that work item. For a second or third tier subcontractor, the 7-day time period begins to run when the 1st tier subcontractor receives payment from the Contractor or when the 2nd tier subcontractor receives payment from the 1st tier subcontractor.

2 The Contractor may withhold as retainage up to 5% of a subcontractor's payment until satisfactory completion of all work items of the subcontract. "Satisfactory completion of all work items of the subcontract" means when the SCDOT accepts the last work item of the subcontract. The Contractor must release to the subcontractor any retainage withheld within 7 days from the date the Contractor receives payment from SCDOT for the last work item of the subcontract or within 7 days from SCDOT's acceptance of the last work item of the subcontract, whichever is the latest to occur. However, upon documentation of good cause provided by the Contractor and written concurrence by the DOC, the Contractor may continue to withhold the 5% retainage.

3 Before receiving payment of each monthly estimate, (a) certify to SCDOT that the construction estimate is complete and that its subcontractors have been paid for work covered by previous estimates, for which they are entitled to be paid, according to Paragraphs 1 and 2 of this Subsection, and (b) submit verification that the Contractor has received similar certifications or evidence from its subcontractors that lower tier subcontractors have been paid according to Paragraph 1. No payment will be made to the Contractor unless such documentation/certification is received or unless SCDOT has issued written approval for delayed payment and required status reports as follows:

- The obligation to promptly pay subcontractors (all tiers) or to release retainage does not arise if there is a legitimate subcontract dispute with 1st tier and/or lower tier subcontractors. If there is a subcontract dispute, the Contractor may submit a written request to SCDOT to approve a delay in payment to the subcontractor that explains the nature of the

dispute and identify relevant subcontract provisions as support. The explanation may include those reasons set forth in the SC Prompt Pay Act (S.C. Code §29-6-40). Do not withhold payment to subcontractors without prior SCDOT written approval.

- Submit a status report of the dispute in each monthly progress payment that contains:
  - Justification for the continuation of nonpayment in the form of a pending judicial proceedings, alternative dispute resolution (ADR) process, or administrative proceedings, as evidence of why the delay must continue; or
  - A certification that the matter is resolved and payment has been issued to the subcontractor (1st tier and/or lower tier subcontractors).

4 Failure to comply with any of the above provisions shall constitute a material breach of the Contract and shall result in one or more of the following sanctions: (1) no further payments to the Contractor unless and until compliance is achieved; (2) monetary sanctions; and/or (3) the Contractor being declared in default and being subject to termination pursuant to **Subsection 108.10**.

5 Any subcontractor who believes it is due payment according to the Prompt Payment Clause may request information from the RCE as to whether and when payment for the subcontractor's work has been made to the Contractor. If payment has been made to the Contractor, and a subcontractor certifies to the RCE that the subcontractor has not been paid within 7 days of SCDOT's payment to the Contractor or paid as provided in Paragraph 1 of this Subsection for subtiers, the RCE will notify the DOC. If SCDOT has not approved the delay in payment pursuant to Paragraph 3 of this Subsection, appropriate remedies set forth in Paragraph 4 will be applied. On federally funded projects, the subcontractor may contact FHWA if SCDOT fails to address the non-payment issue.

6 The Contractor agrees by submitting a Bid Proposal that it will include this Subsection without modification in all subcontracts with its subcontractors. The Contractor is responsible for requiring all of its subcontractors to include this Subsection in all lower tier subcontracts If the Contractor knowingly enters or knowingly allows a subcontractor or lower tier subcontractor to enter into a subcontract without the PROMPT PAYMENT CLAUSE, SCDOT may apply the appropriate remedies set forth in Paragraph 4 of this Subsection or pursue other available remedies, including breach of Contract.

# DIVISION 200
# EARTHWORK

## Section 201 — Clearing and Grubbing

### 201.1 Description

1 Clear, grub, remove, and dispose of vegetation, obstructions, and debris within designated limits.

### 201.2 Materials

1 None specified.

### 201.3 Construction

#### 201.3.1 General

1 Perform clearing and grubbing work before initiating other construction work in the same general area. The RCE will designate any trees, shrubs, plants, and other items to remain. Prevent damage or defacement to 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.

2 Perform clearing and grubbing work by removing and disposing of all vegetation, trees, grass, 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 necessary to satisfactorily complete the work. If trees will remain, trim trees that overhang the roadway to provide a clear height of 18 ft. Clear and grub the entire right-of-way at roadway intersections, traffic interchanges, and bridge sites. When the NPDES line is shown on the Plans, extend clearing and grubbing operations to that line.

3 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 ft and pile the trees 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 property owner the rights to the timber, the Contractor is responsible for the timber for 30 days after it is available for removal. If the property 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.

4 In areas to be excavated or where embankments will be constructed, clear and grub the ground of all living or dead trees, brush, roots, weeds, leaves, and all other objectionable material. Where embankments will be constructed to a

height of 5 ft or less, clear and grub the area of all stumps. If stumps are allowed to remain under embankments, do not allow them to extend more than 8 in. above the ground line or low water level.

5 Except in areas to be excavated, backfill all stump holes and other holes from which obstructions are removed with suitable and compacted material.

6 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.

### 201.3.2 Clearing and Grubbing within Right-of-Way

1 Where clearing and grubbing within the 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.

### 201.3.3 Clearing and Grubbing within Roadway

1 Where clearing and grubbing within the 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.

2 Where clearing and grubbing within the 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.

### 201.3.4 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 in. of the ground or to low water in the full width of the right-of-way for a distance of 75 ft beyond the beginning and end of the proposed bridge. Grub the area at the 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 ft beyond the outside

edges of the proposed bridge and 10 ft beyond the beginning and end of the proposed bridge.

3 Clear but do not grub the area to the bridge construction access line. Also, clear but do not grub additional areas as needed for construction or safety reasons.

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.

### 201.3.5 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.

### 201.3.6 Removal and Disposal of Clearing and Grubbing Material

1 Remove all materials created by the clearing and grubbing operations by burning or otherwise disposing of the removed materials as specified. Perform all burning under constant watch of competent guards and according to applicable laws and ordinances and as provided in **Subsection 107.7**. If necessary, at no cost to the Department, obtain disposal sites and secure any applicable federal, state, county, or municipal permits that are required. Submit completed Forms 200.04 for all acquired disposal sites. Stumps and logs may be disposed of by depositing them off the right-of-way where they are not visible from any public road.

2 Re-cut any brush, weeds, and other designated vegetation immediately before final inspection if instructed by the RCE.

## 201.4 Measurement

1 The quantity for Clearing and Grubbing within Roadway or Clearing and Grubbing within Right-of-Way is measured according to 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 this work.

## 201.5 Payment

1 Payment for the accepted quantity for Clearing and Grubbing (all types) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 The expense for clearing and grubbing pits is 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 incidental to the various items of work in the Contract. No separate or additional compensation is made for this work.

4 When the Department owns the timber on the property, the Contract will include a credit for the value of the merchantable timber in the Contract unit bid price for Clearing and Grubbing items. The Contractor assumes the title to the timber and will remove the timber.

5 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 Raze, remove, dispose of, or salvage buildings, fences, guardrail, structures, pavements, abandoned pipe lines or utilities, underground storage tanks, and other obstructions designated for removal. Backfill the resulting cavities.

## 202.2 Materials

1 None specified.

## 202.3 Construction

### 202.3.1 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 these items are indicated on the Plans as items to be demolished.

2 If an asbestos report is not provided in the Proposal, bid as if there is no asbestos in the structure. Inspect the structure upon award. If asbestos is located, the provisions of **Subsection 107.25** apply. Direct questions about the permit to the SCDES 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, 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. Re-facing is not required.

4 Remove, cap, or seal utility service connections, such as sewers, water lines, electrical connections, gas lines, etc., that remain in place after the removal of the structure (buildings) and obstructions, at the right-of-way line, at the edge of the existing pavement, or at the existing mains. Store and protect utility materials unless the owner does not desire them. In this case, the material becomes the property of the Contractor. Where a structure or obstruction has been previously removed and the existing utility connections have not been terminated and capped, comply with these provisions for utility service connections.

5 When structures (buildings) and other obstructions are designated to be cut off at the right-of-way or to be removed in their entirety, the structure (building) and all appurtenances and the material removed becomes the property of the Contractor except utility materials as provided above.

6 Destroy unusable perishable material. 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 ft below natural ground. Within construction limits, remove foundations to a depth of not less than 2 ft below subgrade elevation. Break up basement floors to prevent water retention. Backfill basements or cavities left by structure removal with material approved by the RCE and compact according to **Subsection 205.3.6**.

8 Before blasting in any stream, river, or lake, coordinate plans and operations with the local SCDNR District Fisheries Biologist and District Law Enforcement Captain.

### 202.3.2 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 the structures or to traffic.

2 At least 14 days before the demolition work of any bridge structure begins, submit an approved *Notice of Demolition* from SCDES and a *Demolition Plan* prepared by a Professional Engineer licensed and 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. Fully detail the method of demolition and the amount and type of equipment to be used. Include in the Demolition Plan any necessary temporary bracing to adequately prevent overturning of the member(s) during demolition.

3 Unless otherwise directed, completely remove and dispose of the superstructure, approach slabs, wing walls, abutments, end bents, pavement overlays, guardrail, utility conduit, and all other components, in-place materials, and attachments located within the limits of the existing structure. 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 ft below natural ground surface. Where substructure elements remain in conflict with the new structure after partial removal as directed herein, further

remove them as necessary to accommodate the construction of the proposed structure.

4 The material in the structure removed becomes the property of the Contractor. Remove this material from the work site before completion of the work. If the Plans or the Special Provisions designate the material in the structure removed to remain the property of the Department, dismantle steel or wood structures without damage. Match-mark steel members and store all salvaged material as directed by the RCE.

5 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.

6 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.

7 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 ft below the bottom of the top slab or to a point where the sidewalls are a minimum of 3 ft below the subgrade 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.

8 All concrete removed becomes the property of the Contractor.

### 202.3.3 Removal and Disposal of Pipe and Tile Drains

1 Remove pipe and tile and neatly store them at locations designated by the RCE if the pipe or tile will 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 conflicts with the installation of a new drainage structure.

### 202.3.4 Removal of Existing Guardrail

#### 202.3.4.1 General

1 Remove bolts securing existing guardrail and remove guardrail elements. Remove all materials from the roadway immediately to eliminate any obstacles for the traveling public. Store materials according to **Subsection 601.2**. The removed guardrail components become the property of either the Department or the Contractor as stated in the Contract. Backfill postholes with suitable compacted material.

#### 202.3.4.2 Guardrail that Becomes the Property of the Contractor

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

### 202.3.5 Removal and Disposal of Pavements, Sidewalks, and Curbs

1 If so designated, remove and dispose of the following items unless the 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; and
- Asphalt concrete pavement or asphalt curb.

2 If suitable and approved by the RCE, this material may be used to construct embankments.

3 Sawcut pavement to produce a uniform line between the pavement to be retained and to be removed.

### 202.3.6 Removal and Disposal of Underground Storage Tank

1 Remove and dispose of all underground storage tanks and any associated contaminated soil. Conduct the work according to the applicable SCDES regulations. Submit to the SCDES, and copy the RCE, any forms as required by SCDES.

2 Submit all paperwork involving the closure of an UST to SCDES within 30 days after the UST closure is complete. Visit the SCDES 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.

### 202.3.7 Obliterate Existing Roadway

1 Remove any existing pavement as directed. Fill or grade and shape the entire roadway to a degree that will blend with the adjacent topography and is suitable for the application of vegetative cover.

## 202.4 Measurement

1 The pay items Removal of Structures and Obstructions, Removal and Disposal Item No. *(number)*, and Removal and Disposal of Existing Bridges are paid for on a lump sum (LS) basis. The pay item Removal and Disposal of Existing Bridges includes the removal and disposal of the bridge and approach slabs including all components, in-place materials, and attachments located within the limits of removal for existing structures and substructures as defined by **Subsection 202.3.2**.

2 The pay item for Removal and Disposal of Designated Portions of Existing Bridge is paid for as lump sum (LS). The pay item includes the removal and disposal of portions of the existing bridge as designated in the Plans and Contract documents or as required to complete any new construction or rehabilitation work for the existing bridge.

3 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 according to **Subsection 203.4**.

4 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, 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 included in Contract unit bid prices of the various other pay items in the Contract.

5 The pay item for Culvert Extension Preparation is paid for as each (EA). The pay item includes the removal and disposal of portions of culvert barrel(s), headwalls, wing walls, aprons, and cut-off walls as designated in the Plans and Contract documents. The pay item also includes any work necessary to prepare the remaining portions of culvert to receive the new culvert extensions as noted in the Plans and Contract documents.

6 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 according to **Subsection 203.4**. No measurement is made for the removal of pipe, tile drains, and other drainage devices 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.

7 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;
- Concrete, brick, or sidewalks;

- 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; and
- Portland cement stabilized base with asphalt concrete overlay.

8 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 in. or greater removed from the project and is measured by the square yard (SY) of area before removal, complete and accepted.

9 Areas of asphalt pavement with a total thickness less than 2 in., 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 according to **Subsection 203.4**.

10 The quantity for the pay item Removal and Disposal of Existing Curb is the length of existing stone, asphalt, or concrete curb removed from the project and is measured by the linear foot (LF) along the curb before removal, complete and accepted.

11 When the Plans specify that existing pavement or curb will 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 the quantity for the pay item Unclassified Excavation according to **Subsection 203.4**.

12 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, complete and accepted.

13 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 according to SCDES regulations and is measured by the gallon (GAL), complete and accepted.

14 The quantity for the pay item Removal and Disposal of Contaminated Soil is the weight of the contaminated soil (as determined by SCDES regulations) removed from around an underground storage tank properly and disposed of according to SCDES regulations and is measured by the ton (TON), complete and accepted.

15 For Obliterating Existing Roadway, removal of asphalt or concrete pavement will be measured according to this Subsection (paragraphs 7 and 8). All other materials excavated in obliterating the roadway will be measured as Unclassified Excavation according to **Subsection 203.4**.

## 202.5 Payment

1 Payment for the accepted quantity for Culvert Extension Preparation or any removal items at the Unit Price or Lump Sum, is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Include the entire cost for the 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 this pay item.

3 If there is no pay item for the removal and disposal of a structure or obstruction specified, no direct payment is made for work necessary to remove and dispose of the structure or obstruction, and the cost for the work is included in the Contract unit bid price of other pay items in 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 according to **Subsection 203.5**. 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.

5 Any backfill required is paid for as Unclassified Excavation or Borrow Excavation as applicable according to **Subsection 203.5**.

6 Payment for the 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. 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.

7 If the Contract contains the lump sum pay item Clearing & Grubbing within Right-of-Way, then in addition to the work required by **Section 201**, payment includes the cost of removing and disposing of items within the clearing and grubbing area according to **Section 202**, except for those items specifically designated as separate pay items in the Contract or as otherwise noted.

8 No separate or additional payment will be made for grading necessary to obtain proper drainage.

9 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 Content | GAL |
| 2021205 | Removal and Disposal of Contaminated Soil | TON |
| 2022000 | Removal and Disposal Item No. *(schedule number)* | LS |
| 2023000 | Removal and Disposal of Existing Pavement | SY |
| 2024100 | Removal and Disposal of Existing Curb | LF |
| 2025000 | Removal and Disposal of Existing Asphalt Pavement | SY |
| 2027801 | Removal of Existing Guardrail | LF |
| 202810X | Removal and Disposal of Existing Bridges | LS |
| 202820X | Removal and Disposal of Designated Portions of Existing Bridge | LS |
| 202850X | Removal and Disposal of Existing Culvert *(width)* ft. × *(height)* ft. | EA |
| 2028605 | Culvert Extension Preparation | EA |

# Section 203 — Roadway and Drainage Excavation

## 203.1 Description

1 Excavate, haul, dispose of, place, recycle or reuse, and compact specified materials necessary to construct the project.

## 203.2 Materials

### 203.2.1 Classification

#### 203.2.1.1 Site Excavation

1 Site excavation includes all excavation necessary to construct the roadway to the typical sections. If excavation beyond the typical section line is required, perform the work according to **Subsection 109.4**. Unless otherwise provided, no separate payment is made for the removal and disposal of surplus material.

#### 203.2.1.2 Unclassified Excavation

1 Unclassified excavation includes roadway and drainage excavation performed under this Section regardless of the materials encountered or the method of removal and includes the work described in **Subsections 203.2.1.3** through **203.2.1.8**. 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, or undercutting, includes the removal and satisfactory disposal of unsuitable materials indicated in the plans and additional waste areas identified by the RCE. Do not dispose of unsuitable materials within the SCDOT right-of-way, unless prior written approval has been obtained from the RCE. Ensure that the final depth of Muck Excavation does not exceed 5 ft. Contact the RCE if Muck Excavation exceeds 5 ft, and the limit of Muck Excavation has not been specified in the Plans or Specifications. If the item Muck Excavation is not included in the Contract, the unsuitable material is considered Unclassified Excavation for the first 500 cu yd encountered; any additional Muck Excavation required will be considered extra work.

#### 203.2.1.4 Stripping

1 Stripping includes excavating and stockpiling material from the ground surface within the roadway that is beneficial to the establishment of permanent, subsequent vegetation.

### 203.2.1.5 Surplus Material

1 Surplus material includes the material excavated 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." Dispose of any surplus material that cannot be accommodated by widening embankments and flattening slopes. Ensure 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 requirements have been met before placing any material in a disposal area. Seed disposal areas according to **Section 810** or as required by permit provisions or other pertinent regulations.

### 203.2.1.6 Watercourse and Drainage Ditch Excavation

1 Watercourse and drainage ditch excavation includes removing and disposing of material excavated from ditches or stream channels, inlets, and outlets to drainage structures. All watercourse and drainage ditch excavation is considered Unclassified Excavation.

### 203.2.1.7 Rock Excavation

1 Rock excavation includes 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 cu yd or more as determined by physical or visual measurement. If the item Rock Excavation is not included in the Contract, the material is measured and paid for as Unclassified Excavation.

### 203.2.1.8 Borrow Excavation

1 Borrow includes 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 specified 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 Borrow Excavation do not apply. When it is necessary to transport material from outside of the right-of-way, the work is covered by the item Borrow Excavation, and the material requirements of Borrow Excavation apply to all material acquired from outside the right-of-way. The requirements of Borrow Excavation are not applicable to in situ subgrade material.

2 Borrow Excavation includes hauling, clearing and grubbing pits, securing necessary permits, and haul roads. Restore pits and haul roads to a condition

satisfactory to property owners and in compliance with the South Carolina Mining Act, as specified in **Subsection 106.9**.

3 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 specified Borrow Excavation for completing the project.

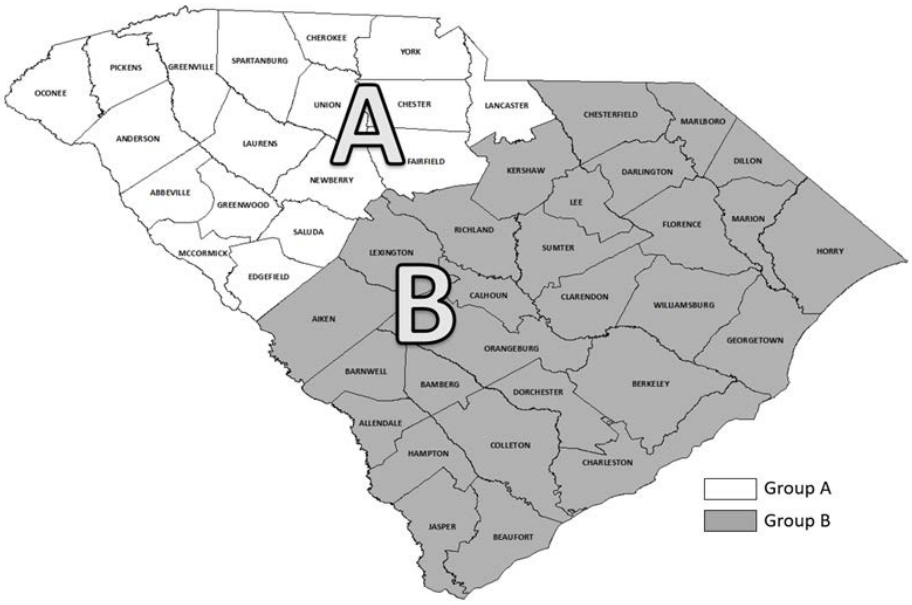
4 Use borrow material with a maximum dry density of not less than 100 lb/cu ft at optimum moisture when tested according to **SC-T-29** in the top 5 ft of any embankment. Do not use any soil for embankment with optimum moisture content greater than 25.0% according to **SC-T-29**.

5 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 the density, and/or moisture requirements. Approval to use such materials in no way relieves the Contractor from any responsibility for meeting the requirements for proof rolling, compaction, or stability.

6 In addition to compaction tests, proof roll each layer of embankment material with an elevation that is 5 ft or less below the finished subgrade elevation. Perform proof rolling as directed by the RCE according to **Section 211**.

7 Soils that are acceptable for use in embankment and as subgrade vary by county. The counties are divided into two groups, Group A and Group B, as shown in the map below. The Department will test soil according to **SC-T-34** and classify it according to AASHTO M 145 to determine suitability when required. Acceptable borrow material for embankment and subgrade is shown below. The acceptability of the material 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.

**Soil Groups in the State of South Carolina**




8 The following restrictions apply to borrow material for work conducted in counties in Group A:

- Below the top 5 ft of embankment, any soil that does not meet the description of muck may be used to form embankments if it is stable when compacted to the specified density; and
- In the top 5 ft of embankment, only the following soil types are acceptable:

  A-1, A-2, A-3, A-4, A-5, and A-6.

9 The following restrictions apply to borrow material for work conducted in counties in Group B:

- In the top 18 in. of the embankment, only the following soil types are acceptable:

  A-1, A-2-4, A-2-5, A-3, A-4(0), and A-2-6(0).

- Below the top 18 in. of the embankment, only the following soil types are acceptable:

  A-1, A-2, A-3, A-4, and A-5.

- Below the top 5 ft. of the embankment, A-6 soil may be used.
- Do not use A-7 soil.

#### 203.2.1.9 Station Grading

1 Station Grading includes all material excavation within the project limits, including intersections, driveways, private entrances, or other miscellaneous excavation, necessary to construct the roadway to the specified lines, grades, and/or typical section(s) as shown in the plans or as directed by the RCE.

2 If borrow material is necessary to bring embankments up to the specified grade, the borrow material is paid for at the Contract bid price for Unclassified Excavation. 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. Likewise, when necessary to remove unsuitable material in fill sections before the embankment is constructed, the material excavated is measured and paid for as Unclassified Excavation. Excavation that is removed from inlet or outfall ditches or stream channels, or from inlets and outlets of structures, is measured and paid for as Unclassified Excavation.

### 203.3 Construction

#### 203.3.1 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 to comply with **Subsection 107.24**. Conduct all operations consistent with good erosion control practices to minimize soil erosion and to prevent sediment from leaving the site. Perform all work 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 and may require that partially completed slopes are reworked to meet the specified slope and that the seeding be performed according to **Section 810**.

4 Comply with the provisions of any required permits for the project that limit the surface area of exposed erodible material.

5 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 according to **Section 201**.

6 Notify the RCE a sufficient time in advance of beginning excavation so 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.

7 After the 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.

8 Use all suitable excavated materials as practical in the formation of embankment, subgrade, shoulders, and at other places as directed. Preserve the best materials for use in constructing the top portion of embankments as practical. Where not practical or if the material in the balance is unsuitable, the RCE may require the use of suitable material from other balances.

9 Use excavated rock to form embankments where the depth of fill is sufficient to properly contain the rock. Place the rock according to **Subsection 205.3.3**. 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 according to **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 such that it causes damage to adjacent property. Do not impair the appearance or symmetry of the roadway.

10 When rock is encountered in the subgrade, excavate to a depth of 6 in. 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 ft below subgrade for the specified width. 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 for Rock Excavation is included, in which case the 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 according to **Subsection 203.2.1.8**.

11 Where unstable or other material that the RCE determines is unsuitable for foundation, subgrade, or other roadway applications occurs within the limits of the roadway, remove and dispose of the material to the specified cross section or as directed by the RCE, and backfill the excavation with suitable material.

12 When it is 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 extended 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

the borrow pits so that water does not collect or stand. After taking the final cross sections, terrace the pits if directed by the RCE.

13 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 will 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 are measured and paid for as Unclassified Excavation in addition to payment under the appropriate item for which the material is used.

14 Construct watercourses as shown on the Plans or where directed and to the lines, grades, and cross section. 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 specified section. If the RCE determines 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 ft of the edge of the watercourse. Spread the excavation or spoil uniformly. Construct ditches or gutters emptying from embankment cuts to avoid erosion of the embankment.

15 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.

### 203.3.2 Excavating Rock

1 If material encountered during roadway excavation appears to belong in the classification of rock excavation in **Subsection 203.2.1.7**, excavate the rock 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 specified slope lines, unless different slope lines are established during construction. Ensure that the final slopes are reasonably smooth and uniform with all loose and overhanging rock removed. Ensure that no rock projects more than 1 ft beyond the final established slopes.

3 Excavate rock to the required elevation for the specified full width of the roadway. 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 Ensure 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 confirm that the hole spacing,

charge, and resulting blast provide 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 in. from the front line of the drill holes nor more than 12 in. from the back line except where the RCE determines that the character of the rock being pre-split will unavoidably result in irregularities.

## 203.4 Measurement

1 The quantity for Unclassified Excavation, Rock Excavation, or Borrow Excavation is the volume of material excavated as 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;
- Stripping;
- 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. The volume does not include excavation necessary to construct the bridge foundations, but 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. Revisions to the computed Plan quantity is made according to the following provisions:

A. Where rock is removed from the subgrade as outlined in **Subsection 203.3.1**, measurements include 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 203.3.2**, the volume is computed from cross-section data taken in the field. Measurements are taken only where rock removal is indicated on the Plans, where it was authorized by the RCE, or where unavoidable over-breakage occurred. The volume of over-breakage that, as determined 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 203.3.1**, the quantity is computed from cross-section data taken in the field only where removal of unstable material is authorized by the RCE or indicated on the Plans. Where necessary to replace unstable material with borrow, the volume is computed for material removed and for the borrow material to replace the unsuitable material.

D. Where 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 ft from the grade shown on the Plan. If the final grade changes are greater than 0.3 ft, or at the discretion of the RCE, revised quantities are obtained by the method outlined in D. above.

G. In addition to any of the reasons stated above, the RCE may order a recheck of the Plan quantity for Unclassified Excavation before making final payment. The results of the rechecking may result in an increase or a decrease. The results of the recheck are used as the final quantity of Unclassified Excavation.

4 The quantity for 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 the length of the roadway where material excavated at intersections, driveways, private entrances, or other miscellaneous excavation is necessary for the roadway construction, as measured by the station (STA) along the length of the centerline of the road,

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 For Site Excavation, the Contractor is responsible for inspecting the site to determine the quantities of material necessary to construct the roadway to the specified typical section. No field measurement is made for this item because payment is made on a lump sum (LS) basis.

## 203.5 Payment

1 Payment for the accepted quantity for material excavated and placed at the Unit Price is full compensation for performing the prescribed earthwork, furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified. The payment also includes hauling of the material within the free haul limit of 3000 ft. Material hauled beyond the free haul limit is paid according to **Section 207**. No payment is made for any material that is excavated beyond the slope stakes set for construction unless the excavation is required to form the embankment or is specifically ordered by the RCE.

2 For surplus material, the Contract unit bid price for the initial excavation of the material is full compensation for excavating, hauling, disposing, and seeding any surplus material.

3 The accepted quantities for Muck Excavation are only paid for once. No additional payment is made for necessary re-excavation.

4 No payment is made for excavation of rock to a depth greater than 6 in. 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.

5 When the Contract includes the item Station Grading, include all excavation, embankment material, and work required for the construction of the road. Payment for the accepted 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.

6 The lump sum payment for Site Excavation is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

7 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 Excavate and backfill for all structures (e.g., foundations and substructures for bridges and box culverts, pipe culverts, storm drains).

## 204.2 Materials

### 204.2.1 General

1 Excavation for structures, except for box culverts and bridge foundations, is Unclassified Excavation. Excavation for structures performed in connection with foundations of box culverts and bridges are classified in **Subsections 204.2.2** through **204.2.6**.

### 204.2.2 Structure Excavation for Culverts

1 The 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**.

### 204.2.3 Dry Excavation for Bridges

1 The item Dry Excavation for Bridges includes all materials excavated above the specified water elevation, except as provided under **Subsection 204.2.6**.

### 204.2.4 Wet Excavation for Bridges

1 The item Wet Excavation for Bridges includes all materials excavated below the specified water elevation and above the foundation, except as provided under **Subsection 204.2.6**.

### 204.2.5 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 204.2.6**.

### 204.2.6 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 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. If rock excavation is not included in the contract, all materials encountered are classified as wet, dry, or wet and dry excavation.

## 204.3 Construction

### 204.3.1 General

1 Use all materials excavated for structures for backfilling around the structure and in the formation of embankments as specified where 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 these measurements are taken.

3 Do not place 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 according to **Subsection 105.2**.

### 204.3.2 Preparation of Foundations

1 Excavate foundations to sufficient size to permit the placing of the specified full width and length of the footings. Do not round or undercut corners and edges of footings.

2 When concrete is placed on rock, free all 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, do not disturb the bottom of the excavation. Fine grade the bottom of the foundation just before placing the reinforcing steel and concrete.

### 204.3.3 Cofferdams and Shoring Walls

1 Construct cofferdam according to **SC-M-204-1**. Construct temporary shoring according to **SC-M-204-2**.

### 204.3.4 Backfill

1 Ensure that the backfill for structures conforms to **Subsection 205.3.2**.

## 204.4 Measurement

1 The pay items for structural excavation for bridge foundations are determined by the classification of the material excavated as set forth in **Subsection 204.2**. The quantities are the volumes of materials 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 in. 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 The quantity for the pay item 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 ft outside of and parallel to the outside neat lines of the culvert barrel and extending to 2 ft 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 203.3** is not limited to the area described above. Measurement does not include water or other liquid removed.

3 If material for backfill is required because the removal of unstable material below grade is obtained from the roadway or material pits, the material 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 203.4**. No direct allowance is made for overhaul or shrinkage for material to backfill undercut areas.

4 The quantity for the pay item 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 in. outside of and parallel to the neat lines of the footings and is measured by the cubic yard (CY), complete and accepted.

## 204.5 Payment

1 Payment for the accepted quantity for each excavation pay item at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified**.**

2 If it is necessary and approved by the RCE to extend a foundation more than 5 ft, but not more than 10 ft 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 necessary and approved by the RCE to extend a foundation more than 10 ft below Plan elevation for any individual footing, payment for the excavation work performed below the elevation of the waterline is made at an 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 any necessary re-excavation.

4 Payment for Structure Excavation for Culverts or Retaining Wall is full compensation for excavating of material necessary for construction as specified or directed and includes removing and disposing of unstable material and backfill material obtained from sources outside the limits of the roadway.

5 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 |
| 2043500 | Wet & Dry Excavation for Bridges | CY |
| 2044000 | Rock Excavation for Bridges | CY |

# Section 205 — Embankment Construction

## 205.1 Description

1 Prepare embankment foundations, and place and compact approved material in embankments. Dispose of unsuitable material.

## 205.2 Materials

1 Construct embankments with materials meeting the requirements of **Sections 203** and **204**.

## 205.3 Construction

### 205.3.1 General

1 Comply with the provisions of project permits that limit the surface area of the exposed erodible material.

2 Perform work under this Section that ensures compliance with **Subsection 107.24**. Conduct operations consistent with good erosion control practices that minimize soil erosion and, as practical, 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 graded to the specified slope and that seeding be performed at that time according to **Section 810.**

4 Do not place rocks, broken concrete, or other solid materials in embankment areas where piling will be driven. Do not construct the top 6 in. of embankments with any material larger than can pass a 3-in. sieve.

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.

6 Maintain the embankment as provided in **Subsections 104.7** and **205.3.7.**

7 Complete all clearing and grubbing according to **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 in. in depth (loose measurement) for the full width of the cross section, except as specified in **Subsection 205.3.3** where the depth may exceed 8 in. Perform compaction

according to **Subsection 205.3.6**. 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 in. Do not use dragline casting in constructing embankments unless the material can be placed in layers and compacted as specified.

### 205.3.2 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 approved by the RCE. Do not backfill to full height behind new structures that results in 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 specified strength. When backfilling around box culverts, once the backfill is brought higher than one-half of the height of the box, continue backfilling immediately to provide a cover of not less than 12 in. 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 Prevent wedging action of filling material against structures. If directed, modify back slopes of excavation by stepping or serration.

### 205.3.3 Rock Embankment

1 Where excavated rock is used for embankments according to **Subsection 203.3**, 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 ft of the embankment just below the subgrade elevation of suitable

material placed in layers not exceeding 8 in. (loose measurement) and compacted to the specified density.

2 Where the depth of an embankment exceeds 5 ft and consists entirely of rock, deposit the rock in lifts not to exceed the maximum size of the material being placed, but do not exceed 4 ft. For any particular lift, deposit the rock on the lift being constructed and push over the end of the lift. Do not dump rock over the end of any lift directly from hauling equipment. If the voids in 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 ft 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 do not exceed 2 ft. Choke each layer thoroughly with broken stone or other suitable material and compact to the specified density or as directed.

4 When a rock fill is placed over a structure, first cover the structure with a minimum of 2 ft of properly compacted earth or other approved material before the rock is placed. Place this covering according to **Subsection 205.3.2**.

### 205.3.4 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 on the slope of the existing ground or embankment. When the existing slope is steeper than 3H:1V measured at right angles to the roadway, bench the area continuously in not less than 12-in. 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.

### 205.3.5 Embankment Over Existing Roadbeds

1 If the embankment for a new pavement is placed over existing pavement (rigid or flexible) and the top is within 24 in. of the new subgrade elevation, remove all pavement according to the requirements of **Section 202**. Removal of pavement includes concrete base with asphaltic concrete overlay, cement stabilized bases with asphaltic concrete pavement, or brick or cobblestone pavement with or without asphaltic concrete overlay.

### 205.3.6 Embankment Compaction

1 Compact each layer of embankment to not less than 95.0% of maximum density before successive layers are applied. Compact by using suitable construction procedures while the material is at suitable moisture content. Use **SC-T-29** to determine the maximum densities.

2 Where the base and pavement are scheduled for construction under a later contract, compact each layer of embankment specified above.

### 205.3.7 Maintenance and Stability

1 Until final acceptance, maintain the stability of all embankments made under the Contract and replace any portion that, as determined by the RCE, has become displaced or damaged. If 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.

2 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, as determined by the RCE, payment is made at the Contract unit bid price for the items necessary in making the repairs or replacement.

### 205.3.8 Bridge Lift Materials

1 Place bridge lift materials according to **SC-M-205-3**.

## 205.4 Measurement

1 Embankments are not measured for payment and are incidental to the work for pay items included in **Sections 203** and **204**.

## 205.5 Payment

1 There is no payment for embankments. Payment is made for items in **Sections 203** and **204**, which are used in the construction of embankments. The payment for these items is full compensation for providing all material, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work.

2 No direct payment is made for plowing, scarifying, or benching. Include those costs in the various pay items of the Contract.

## Section 206

*This Section has been Reserved for Future Use.*

# Section 207 — Overhaul

## 207.1 Description

1 Perform overhaul, which is the hauling of locally excavated material more than 3000 ft in performance of the work in the Contract.

## 207.2 Materials

1 None specified.

## 207.3 Construction

1 None specified.

## 207.4 Measurement

1 If the item Overhaul is not included in the Contract, the cost is included in other items of work. The quantity for the pay item Overhaul is the product of the volume of 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 ft in which no overhaul is measured or paid. The distance 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 ft. In other words, the first half-mile unit of overhaul applies to material hauled more than 3000 ft but less than 5640 ft. The second half-mile unit of overhaul applies to material hauled more than 5640 ft but less than 8280 ft, etc. The overhaul distance is based on the shortest feasible route. Any part of the overhaul distance not determined 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 for measuring the volume of earthwork material for payment.

4 When the Plan quantity for Overhaul of roadway excavation has been computed and is 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 roadway Overhaul by the final roadway excavation, and then dividing this result by the original roadway excavation. When the Contract contains more than one roadway, each is considered separately. according to the following formula:

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

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.

## 207.5 Payment

1 Payment for the accepted quantity for Overhaul at the Unit Price is full compensation for all costs for hauling designated material beyond the free haul limit of 3000 ft and includes all direct and indirect costs and expenses required to satisfactorily complete the work as specified.

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 ft from Plan grade, the adjusted quantity of Overhaul is computed according to **Subsection 207.4**.

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.

4 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 2071000 | Overhaul | CYHM |

# Section 208 — Subgrade

## 208.1 Description

1 Shape and compact subgrade before placing a base or surface course.

## 208.2 Materials

1 None specified.

## 208.3 Construction

### 208.3.1 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 in. below the surface of the subgrade. Fill all holes, ruts, or depressions in the subgrade with approved material, elevate the subgrade to the required line and grade, and properly compact. If the subgrade is too dry to compact properly, sprinkle with water to wet, if determined necessary by the RCE, for proper compaction.

2 Compact the subgrade between lines 18 in. 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 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.

### 208.3.2 Protection and Maintenance

1 Maintain the subgrade in a smooth and fully compacted condition, free from ruts and depressions, and adequately drained. Do not store or stockpile materials directly on the subgrade without the prior approval of the RCE.

2 Do not place any base, surface course, or pavement before the subgrade is checked and approved by the RCE.

3 Do not place any base, surface course, or pavement on frozen, muddy, or unstable subgrade.

### 208.3.3 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 RCE, 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. 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 prepare the subgrade material into the required final shape and compaction. The area considered for fine grading is the area described in **Subsection 208.3.1**, which extends laterally 18 in. beyond the pavement structure.

## 208.4 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 measured by the square yard (SY), complete and accepted. The bid quantity will be considered the full amount to be paid unless work requiring fine grading is deleted, or additional work is added to the project that was not required by the original bid documents.

2 If the pay item Fine Grading is not included in the Contract, subgrade work is not measured for payment directly and is considered included in the Contract unit bid price of the various other items of work. When Fine Grading is included in the Contract, the subgrade work for areas under previously existing pavement, unpaved shoulders, driveways, curbs, gutters, sidewalks, multi-use paths, temporary pavement, and slopes is not measured for payment directly and is considered included in the Contract unit bid price of the various other items of work.

## 208.5 Payment

1 Payment for the accepted quantity for Fine Grading at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 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 Excavate, haul, and place the approved materials on shoulders, cut and fill slopes, or other designated areas. Maintain the shoulders until final acceptance.

2 Construct shoulders and slopes with the appropriate materials to ensure the establishment of permanent vegetation and minimize the effects of erosion on the project.

## 209.2 Materials

1 Obtain the materials used in the construction of shoulders and slopes from one of 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, and
- Areas of watercourse and ditch excavation.

2 Selected material for shoulders or slopes includes 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 so that, when compacted, resists erosion and is capable of supporting vehicles when relatively wet.

3 Salvage material from the roadway as practical. Furnishing material from outside of the right-of-way 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 so 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*. See **Subsection 106.9**.

6 Provide the material pits and necessary haul roads.

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 Construction

### 209.3.1 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 in. adjacent to the base or surface course.

3 For 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 before 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 according to the standard practices as recommended by the USDA Natural Resources Conservation Service (NRCS).

### 209.3.2 Maintenance

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

## 209.4 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 specified lines, grades, and cross section and is measured by the cubic yard (CY) of material, complete in-place, and accepted.

2 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 25.0% 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 according to **Subsection 203.4**. 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 in.

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 includes ordinary roadway or drainage excavation, the material is measured as Unclassified Excavation.

## 209.5 Payment

1 Material in shoulders and slopes is paid under this item only when the selected material placed includes material described and measured as provided in **Subsection 209.4**.

2 Payment for the accepted quantity for Select Material for Shoulders and Slopes at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified. 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. Overhaul, if applicable, is paid as specified in **Section 207**.

3 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 Furnish flowable fill as an alternative to compacted soil. Applications for this material include beddings, encasements, and closures for tanks and pipe and general backfill for trenches and abutments.

## 210.2 Materials

### 210.2.1 General

1 Flowable fill consists of a mixture of Portland cement, fly ash, fine aggregate, air entraining admixture, and water. Flowable fill is intended to contain a low cementitious content for reduced strength development.

2 Use materials that meet the requirements of **Division 700** with the following exceptions:

- Fine Aggregate – Any clean fine aggregate from an SCDOT-qualified source, as shown on *Qualified Products List 1*, with 100% passing a ⅜ sieve and no more than 15% passing a No. 200 sieve may be used. All other fine aggregate gradation requirements are waived.
- Air Entraining Admixtures – If desired, high air generators or foaming agents meeting the requirements of ASTM C869 when tested using ASTM C796 may be used. Use foaming agents appearing on *Qualified Products List 31*. Admixtures on *Qualified Products List 5* may also be used in flowable fill.

### 210.2.2 Mix Design

1 Submit mix designs to the SME for review a minimum of 12 days before use. Submit the mixes on the appropriate OMR form approved by the SME. After successful review by the SME, provide a copy of the mix design showing the SME's stamp to the RCE before supplying that mix to the project. Once the mix has been reviewed by the SME, that mix is valid for a period of 3 years and can be supplied to any SCDOT project requiring that mix type, provided that the mix ingredients are not changed.

2 Flowable fill is available in either excavatable or non-excavatable proportions as specified by the RCE. The following table lists mix design proportion ranges for both types of flowable fill.

**Mix Designs for Flowable Fill**

| | Excavatable | | Non-Excavatable |
|---|---|---|---|
| | **Air Entrained** | **Non-Air Entrained** | **Non-Excavatable** |
| Type 1 Portland Cement* | 50 - 100 lb/cu yd** | 20 - 40 lb/cu yd | 75 - 150 lb/cu yd |
| Fly Ash | 0 - 600 lb/cu yd | 250 - 600 lb/cu yd | 150 - 600 lb/cu yd |
| Water | See Note 1 | See Note 1 | See Note 1 |
| Air*** | 15% - 35% | Not applicable | 5% - 20% |
| 28-day Compressive Strength*** | 150 psi Maximum | 150 psi Maximum | 150 psi Minimum |

*Note 1: Select water content as necessary to produce a consistency that will result in a flowable, self-leveling product at the time of placement.*

* *Other types of Portland cement meeting the requirements of **Division 700** may be used with prior approval from the SME.*

** *When using less than 75 lb/cu yd of Portland cement, the combined quantity of Portland cement and fly ash must be at least 100 lb/cu yd.*

*** *The requirements for air and 28-day compressive strength are for laboratory design only and are not jobsite acceptance requirements.*

3 When low density flowable fill is specified, use an approved high air generator or foaming agent as shown on *Qualified Products List 31* and the following mix proportions:

**Mix Designs for Low Density Flowable Fill**

| | |
|---|---|
| Type 1 Portland Cement* | 60 lb/cu yd Minimum |
| Air** | 20% - 40% |
| 28-day Compressive Strength** | 50 psi - 145 psi |

* *Other types of Portland cement meeting the requirements of **Division 700** may be used with prior approval from the SME.*

** *The requirements for air and 28-day compressive strength are for laboratory design only and are not jobsite acceptance requirements.*

4 Because of its high air content, the ability to pump low density flowable fill while maintaining the required air content is limited. Ensure that the flowable fill

supplier is aware of any planned pumping of this material well in advance of placement.

5 Flowable fill may also be specified as Rapid Set (RS) or Normal Set (NS). A minimum compressive strength of 35 psi is required at 16 hours for Type RS or at 48 hours for Type NS when cured under standard laboratory conditions. Report the laboratory compressive strength at these times as part of the mix design submittal.

## 210.3 Construction

### 210.3.1 Equipment

1 All delivery, storage, and handling requirements are provided in **Division 700**, except that the revolution counter requirements are waived. Deliver flowable fill using concrete construction equipment. Place flowable fill by chute, pumping, or other methods approved by the RCE. When placing through water, use a tremie.

### 210.3.2 Preparation and Placement

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

2 The RCE will select the appropriate type of mix. 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. Ensure 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 accepted by the RCE. Place the mix either in lifts or as 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 acceptance by the RCE. If the flowable fill is not proceeding satisfactorily, the RCE may rescind the acceptance 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 ⅛ in. 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 specified 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 allow 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 can support foot traffic.

### 210.3.3 Delivery to Work Site

1 Furnish a delivery ticket to the RCE for each load of flowable fill delivered to the work site. Ensure that each ticket contains the following information:

- Project designation,
- Date,
- Time,
- Class and quantity of flowable fill, and
- Quantity of water withheld.

## 210.4 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 in the Contract or directed by the RCE, complete and accepted.

## 210.5 Payment

1 Payment for the accepted quantity for Flowable Fill at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 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 Furnish and operate, at the direction of the RCE, heavy, pneumatic-tire equipment for testing the roadway embankment and subgrade for stability and uniformity of compaction.

## 211.2 Materials

1 None specified.

## 211.3 Construction

### 211.3.1 Equipment

1 Use equipment for proof rolling that includes a fully loaded tandem axle dump truck or an equivalent accepted by the RCE. Use only equipment with air-filled pneumatic 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.

### 211.3.2 Operation

1 Proof roll each lift of embankment and subgrade that has an elevation of 5 ft or less below the finished subgrade elevation before placement of subsequent lifts, or as directed by the RCE. 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 ft per minute. Make a minimum of five passes over each area proof rolled. Correct areas that are unstable or non-uniform. After correction of these deficient areas, repeat the proof rolling operation.

## 211.4 Measurement

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

## 211.5 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 Modify an existing subgrade by adding Portland cement to form a prepared subbase for a pavement structure.

### 301.2 Materials

#### 301.2.1 Portland Cement

1 Use Portland cement that conforms to **Subsection 701.2.1** with the allowable maximum alkali content ($Na_2O + 0.658K_2O$) increased to 1.0%.

#### 301.2.2 Water

1 Use water conforming to **Subsection 701.2.11**.

#### 301.2.3 Soil

1 Use soil consisting of the material in the existing subgrade prepared according to **Section 208**.

#### 301.2.4 Asphalt Material

1 Use an asphalt curing coat that conforms to **Subsection 401.2.1.3**.

### 301.3 Construction

#### 301.3.1 General

1 Comply with the following responsibilities:

- Regulate the sequence of work to process the necessary quantity of material to provide the specified full depth of modification,
- Use the proper amount of Portland cement,
- Maintain the work, and
- Rework the base and subbase courses as necessary to meet the requirements of this specification.

2 Use 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.

### 301.3.2 Preparation of Roadbed

1 Grade and shape the roadbed as required to construct the Cement Modified Subbase using material in-place. Remove unsuitable soil or material and replace it with acceptable soil.

### 301.3.3 Pulverization and Scarification

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

### 301.3.4 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. 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 vehicular speed to obtain the required spread rate. A tolerance of ±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. Apply cement to ensure that all operations are continuous and completed in daylight, unless adequate artificial light is provided, and within 6 hours of the initial 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. Do not exceed the specified optimum moisture content for the soil-cement mixture. Do not allow equipment, 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 40ºF in the shade and rising. Do not perform the work on a frozen or excessively wet subgrade.

### 301.3.5 Mixing and Processing

1 Optionally use either Method A or B specified in **Subsections 301.3.5.1** and **301.3.5.2**.

#### 301.3.5.1 Method A (Multiple-Pass Traveling Mixing Plant)

1 After the cement has been applied, dry-mix the cement 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. Provide a sufficient supply of water to ensure the continuous application of the required amount of water to sections being processed within three hours of application of the cement. Ensure proper moisture distribution at all times. After the last increment of water has been added, continue mixing until a uniform mix has been obtained.

#### 301.3.5.2 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.
- Leave the mixture 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 the condition. Ensure that the mixer operator can 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.

### 301.3.6 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 moisture content and that it is 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 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. Use **SC-T-29** 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 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, 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-tire 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% of the specified optimum moisture content during finishing operations.

### 301.3.7 Reconstruction

1 If 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.

### 301.3.8 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 as specified in **Subsection 401.2.1.3** applied at a minimum rate of 0.15 gal/sq yd of asphalt and 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.

### 301.3.9 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. 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.

### 301.3.10 Surface Smoothness

1 Ensure that the finished surface of the modified subbase varies from a straight edge 10 ft long not more than ⅜ in. when applied parallel to the centerline of the road nor more than ½ in. from the typical cross section. 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. 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 will receive as the next component of the pavement structure. If this leveling material is considered unsatisfactory by the RCE, the RCE will specify the material to use. Provide the necessary materials and perform the corrective work without any additional compensation.

### 301.3.11 Thickness Tolerance of Subbase

1 The thickness of the completed cement modified subbase will be measured at staggered intervals not to exceed 500 ft in length for two-lane roads. The depth measurement is made by test holes through the subbase course. Correct areas where the modified subbase is less than the specified thickness by more than 1 in.

2 Where the measured thickness exceeds the specified thickness by more than 1 in., it is considered as the specified thickness plus 1 in. 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 ½ in., 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.

### 301.3.12 Traffic

1 Local traffic may use completed portions of the cement modified subbase if the subbase has hardened sufficiently to prevent marring or damaging of the surface by this usage. After the curing period, traffic may use the subbase if 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.

### 301.3.13 Maintenance

1 Within the limits of the Contract, maintain the cement modified subbase in good condition until all work has been completed and accepted, including immediate repairs of any defects that may occur. Perform this work without any additional compensation and repeat as often as 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.

## 301.4 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 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.

## 301.5 Payment

1 Payment for the accepted quantity for Cement Modified Subbase at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Payment for the accepted quantity for Portland Cement for Cement Modified Subbase at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

3 Cement Modified Subbase that is deficient in thickness is paid at the adjusted unit price determined according to **Subsection 301.3.11**.

4 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

*This Section has been Reserved for Future Use.*

# Section 303

*This Section has been Reserved for Future Use.*

# Section 304

*This Section has been Reserved for Future Use.*

# Section 305 — Graded Aggregate Base

## 305.1 Description

1 Construct an aggregate base course for a prepared foundation (subgrade or subbase).

## 305.2 Materials

1 When the Contract specifies a graded aggregate base course, the following base courses may appear on the proposal as alternatives:

- Macadam base course,
- Marine limestone base course, or
- Recycled Portland cement concrete base course.

2 When alternatives appear in the proposal, select the intended bid alternative and provide unit bid prices only on that alternative.

### 305.2.1 Macadam Base Course

1 Use base course material composed of crushed stone, excluding marine limestone, filled and bound with screenings obtained from an appropriate source listed on *Qualified Products List 2*. 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 Marine limestone aggregate 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.

2 Use limestone base course materials produced from a single source or deposit that yields a satisfactory mixture conforming to all requirements and listed on *Qualified Products List 2* as suitable for use in Marine Limestone Base. 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.

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 unacceptable debris.

3 When recycled Portland cement concrete base course is selected, inspect, sample and test the source, and submit for the approval by the MRE and RCE in writing before using the material. Allow a minimum of 4 weeks for the 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 that the minimum weight for crushed slag used in macadam base course, when dry and rodded, is 70 lb/cu yd. Use crushed slag consisting 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 for 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 a mining or crushing operation. Do not use sand 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.

### 305.2.6 Composite Mixture

#### 305.2.6.1 Gradation

1 After the base course material is spread on the subgrade, mixed, and shaped, but before the beginning of compaction operations, ensure that the composite mixture conforms to the requirements in the table on the next page.

#### 305.2.6.2 Maintenance Stone

1 Use maintenance stone that conforms to the gradation requirements of **Subsection 305.2.6.1** or to the gradation specified for Aggregate No. CR-14.

### 305.2.7 Asphalt Materials

1 Use material that conforms to **Subsection 401.2.1.3**.

| **Macadam Base Course** | |
|---|---|
| **Sieve Designation** | **Percentage by Weight Passing** |
| 2 in. | 100 |
| 1½ in. | 95 – 100 |
| 1 in. | 70 – 100 |
| ½ in. | 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** | |
| 2 in. | 100 |
| 1½ in. | 95 – 100 |
| 1 in. | 70 – 100 |
| ½ in. | 50 – 85 |
| No. 4 | 30 – 60 |
| No. 30 | 17 – 38 |
| No. 200* | 0 – 20 |
| Liquid Limit | 25 Max. |
| Plasticity Index | 6 Max. |
| **Recycled Portland Cement Concrete Base Course** | |
| 2 in. | 100 |
| 1½ in. | 95 – 100 |
| 1 in. | 70 – 100 |
| ½ in. | 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.*

## 305.3 Construction

### 305.3.1 Equipment

1 Use a steel wheel roller capable of developing a pressure of 250 to 350 lb/in. of roller width in the compression wheel for compaction. If necessary, use other rollers in conjunction with the steel wheel roller. Other acceptable rollers are self-propelled or tractor drawn pneumatic-tire rollers or vibratory rollers. Use a combination of the above rollers as necessary to produce a finished product that complies with the specifications.

### 305.3.2 Preparation of Subgrade

1 Construct the foundation for the graded aggregate base course according to the requirements in **Section 208**. Roll and compact the subgrade for at least 500 ft ahead of placing the base course materials.

2 Construct shoulders according to the requirements of **Section 209**, accurately trimmed to the alignment and grade of the base course to form the required trench or channeled section.

### 305.3.3 Placing of Base Course Material

1 Deliver base course materials with the necessary fine aggregate already included. However, provide material with a final gradation that meets the requirements in **Subsection 305.2.6**.

2 Place the base course aggregate on the prepared foundation. Perform the spreading so that the finished base course conforms to the required lines, grades, dimensions, and typical cross sections.

3 When the required compacted thickness is 10 in. or less, construct the base course in one layer. Where the required thickness is more than 10 in., 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 exceed 10 in. Construct and compact each layer as specified before placing the succeeding layer.

4 Prevent segregation of the fine aggregate 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, repair the affected section by removing the unsatisfactory foundation material and replacing it with acceptable foundation material. Reconstruct the foundation to the required compaction and shape, and then continue placement of the base course at the required cross section, grade, and compaction.

### 305.3.4 Sampling and Testing

1 Each 24,000-sq ft section of base or fraction thereof will be considered a lot for acceptance and payment. When the base is ready for sampling (after mixing, shaping, and correction of any visibly segregated areas but before initial compaction), notify the RCE. The SCDOT inspector will use **SC-T-100** to determine three random sampling locations along the length of that lot. The longitudinal coordinate of the sample will be determined by **SC-T-100**. The first sampling location determined will be the acceptance sample for that lot. The remaining two samples will be the check samples for that lot.

2 Provide a SCDOT-certified earthwork and base technician to obtain samples according to **SC-T-1** at the locations determined by the SCDOT inspector. Do not take samples from edges or joints where segregation can occur. The SCDOT inspector will take possession of all samples immediately upon completion of sampling. Only samples taken under the direct observation of the SCDOT inspector are acceptable.

3 Samples obtained after compaction has been initiated will be considered invalid for acceptance or check sample purposes. Once the material has been initially sampled, no changes to the composition of the material will be considered in determining specification compliance of the gradation of the material. Compaction of that lot may proceed at the risk of the gradation testing resulting in a removal and replacement outcome.

### 305.3.5 Compaction, Rolling, and Finishing

1 After the base course material is spread, maintain the required section until the base course is thoroughly compacted. Compact each layer using the equipment specified in **Subsection 305.3.1**. If the foundation becomes unstable after the base course has been placed and compacted, 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 replace the base course material to the required cross section, grade, and compaction.

2 Wet the base course when necessary. Extend rolling over the edges of each layer of base course materials for a distance of 2 ft on the shoulders. Continue blading and rolling until a dense, smooth, unyielding, and well-bonded base course is obtained. If at any time the RCE determines that the base course is unstable, proof roll the section to the limits prescribed by the RCE according to **Section 211**.

3 If the initial compaction has been performed and the voids are not filled, place fine aggregate on the base course in an amount sufficient only 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 to the required density for the full depth. Continue rolling until the entire base course is compacted to not less than 100% of maximum density as determined by **SC-T-140**. When the total compacted thickness of the graded aggregate base course is more than 10 in., place the materials in layers as specified in **Subsection 305.3.3,** 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 work, protect all structures.

### 305.3.6 Surface Smoothness

1 Ensure that the finished surface of the base course varies not more than ⅜ in. from a straight edge 10 ft long when applied parallel to the centerline of the road, nor more than ½ in. from the typical cross section. Provide the necessary materials and repair any deviations exceeding these limits at no additional cost to the Department.

### 305.3.7 Thickness Tolerance of Base Course

1 The thickness of the completed base course will be measured at staggered intervals not to exceed 250 ft for two-lane roads. 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 in., correct the areas by scarifying, adding base course material, and recompacting.

### 305.3.8 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 according to **Subsection 401.3.13**. 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 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/sq yd) | |
|---|---|---|
| | 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 the material and performing the work is included in the price of the base course or other items of work and no direct payment is made.

### 305.3.9 Weight Tickets

1 When pay item is measured by the ton, record in duplicate the net weight of each load of aggregate and the accumulated net weight of the loads for the day on forms suitable to the RCE. Weigh according to **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 the directives at no additional cost to the Department.

### 305.3.10 Maintenance

1 Machine the base course as often as is necessary to maintain a smooth surface, true to grade and cross section, 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.

## 305.4 Measurement

1 The quantity of Graded Aggregate Base of the required uniform thickness is the surface area of base course in-place, complete and accepted, and is measured by the square yard. The area of base course constructed outside the area designated is disregarded in computing the quantity.

2 If the acceptance sample specified in **Subsection 305.3.4** complies with the specifications, the Lot of Graded Aggregate Base material is measured for payment. If the acceptance sample does not comply with the specifications, the check samples will be tested. If both check samples for that lot comply with the specifications, the aggregate base material is measured for payment.

3 Measurement of Prime Coat is according to **Subsection 401.4**.

4 Measurement for Maintenance Stone is by the ton according to **Subsection 305.3.9**.

## 305.5 Payment

1 Payment for the accepted quantity for Graded Aggregate Base at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Payment for the accepted quantity for Maintenance Stone at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

3 Any Graded Aggregate Base measurement that exceeds the specified thickness by more than ½ in. is considered as the specified thickness plus ½ in. 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 in., 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.

4 When the Contract includes more than one road, each road is considered separately.

5 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.

6 If one or both check samples do not comply with **Subsection 305.3.4**, then the total absolute deviation from the specifications for all sieve sizes of the acceptance and the check samples will be determined. A price reduction for the Contract unit price per square yard will be applied to the unit price for that lot based on the total absolute deviation from the specifications according to the following chart:

| Price Reduction for Total Absolute Deviation from Specifications | |
|---|---|
| **Combined Range from Specifications** | **Reduction in Unit Price per Square Yard** |
| 2.0 – 9.9 | 5.0% |
| 10.0 – 21.9 | 10.0% |
| 22.0 – 36.9 | 25.0% |
| 37.0 – 51.9 | 50.0% |
| 52.0+ | Remove and Replace |

7 Payment for Prime Coat is according to **Subsection 401.5**.

8 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 |
| 3059900 | Maintenance Stone | TON |

## Section 306 — Cement Modified Recycled Base

1 Ensure that all types of cement modified recycled bases conform to the requirements of the Special Provisions and the applicable SCDOT Supplemental Specifications, OMR Standard Method of Tests, and Supplemental Technical Specification **SC-M-306**.

## Section 307 — Cement Stabilized Earth Base

1 Ensure that all types of cement stabilized earth bases conform to the requirements of the Special Provisions and the applicable SCDOT Supplemental Specifications, OMR Standard Method of Tests, and Supplemental Technical Specification **SC-M-307**.

## Section 308 — Cement Stabilized Aggregate Base

1 Ensure that all types of cement stabilized aggregate bases conform to the requirements of the Special Provisions and the applicable SCDOT Supplemental Specifications, OMR Standard Method of Tests, and Supplemental Technical Specification **SC-M-308**.

# DIVISION 400
# ASPHALT PAVEMENTS

## Section 401 — Asphalt Pavement

### 401.1 Description

1 Construct an asphalt pavement on a prepared foundation.

2 Perform milling, surface planing, and full depth patching of asphalt pavement.

### 401.2 Materials

#### 401.2.1 Binder and Additives

##### 401.2.1.1 Performance Graded (PG) Binder

1 Use PG 64-22 or PG 76-22 binder that conforms to AASHTO M 320. Do not use any combination of air blown asphalt binders. Ensure that the asphalt binder supplier lists all types of modifiers and additives used in the production of the PG binders, including the source of:

- Re-refined engine oil bottoms (REOB),
- Polymers,
- Ground tire rubber (GTR),
- Polyphosphoric acid (PPA),
- Silicone, and
- Liquid anti-stripping agent (LASA).

2 Ensure that the additives used for compaction aides or anti-strips, such as silicones, warm mix asphalt (WMA) additives, and LASA products, are listed on the Bill of Lading (BOL). Use PG asphalt binders and modifiers that are heat and storage stable. Blend the composite materials at the asphalt terminal before being loaded into the transport vehicle. Asphalt terminals that either supply or produce PG binders must be able to store multiple tanker loads of PG, and, before transferring or shipping, certify on the BOL that the products meet AASHTO M 320 and that all modifiers and additives are compatible. Only use PG 64-22 and PG 76-22 binder from sources listed on *Qualified Products List 37*.

##### 401.2.1.2 Modified Performance Graded Binder

###### 401.2.1.2.1 General

1 When specified, use modified binder consisting of a neat binder modified with a polymer or other modifier producing a binder that complies with PG 76-22 as specified in AASHTO M 320 with the addition of the Multiple Stress Creep Recovery (MSCR) test using AASHTO T 350. Ensure that acceptable

elastomeric polymer is used by using Non-recoverable Creep Compliance values plotted against Percent Recovery provided in Figure 1 in AASHTO R 92 using RTFO aged material. Ensure that the MSCR test is performed at 64°C using the Very Heavy Traffic V Grade requirement in AASHTO M 332. Use elastomer polymer or modifier consisting of:

- A styrene-butadiene (SB),
- Styrene-butadiene-styrene (SBS),
- Styrene-butadiene-rubber (SBR), or
- Ground tire rubber (GTR).

2 Polyphosphoric Acid (PPA) may also be added to the binder but must not exceed 0.5% by weight of the asphalt binder. Varying blends of SB, SBS, SBR, GTR (7.0% min.), and PPA (0.5% max.) may be used at the discretion of the AME, if the end product meets all requirements for the PG 76-22. Perform the storage stability separation test, ASTM D7173, to ensure that the asphalt binder is homogenous. Ensure that all storage tanks on the asphalt plant site are clearly marked to prevent cross contamination of different PG binders.

#### 401.2.1.2.2 Ground Tire Rubber (GTR) in Performance Graded Binder

1 Ensure that Ground Tire Rubber (GTR) is terminally (no exceptions) blended with the neat asphalt to create a homogenous and storage stable PG 76-22 that meets all criteria as stated in **Subsection 401.2.1.1**, with the exception of the solubility requirement (AASHTO T 44). Do not blend the GTR modified binder at the asphalt plant during asphalt mix production. Use a 2.0-mm gap setting when using the dynamic shear rheometer (DSR) according to AASHTO T 315 and AASHTO T 350. Ensure that GTR materials are free from excessive moisture when received from the tire recycling facility and stored in a dry location at the terminal to prevent blending issues with the binder modification process. Provide a letter of compliance from the tire recycling facility and the asphalt terminal stating that the GTR blend will meet this specification. Ensure that the GTR is free from loose metal particles and other foreign contaminating materials, with the exception of embedded metal particles in the rubber. Mineral powder may be added to reduce sticking and caking of the GTR particles. Stabilizing or compatibility additive(s) can be used to achieve better particle distribution. Ensure that any additives used for this purpose are not detrimental to the performance of the asphalt binder or mixture performance. Ensure that the GTR supplier provides certificates of compliance with each shipment certifying that all requirements of this specification are met for each production lot number and that the end product is homogenous and shows no signs of separation or coagulation. If the terminal changes the supply sources of the GTR type of grind (ambient or cryogenic) or particle size, certify that the asphalt terminal has performed a complete binder analysis on its revised product.

2 Identify all sources of GTR and grind type in the asphalt terminal's QC plan. The Department may obtain samples of the GTR particles, base binder, or finished GTR-modified asphalt binder to ensure specification compliance.

| Physical Test | Test Procedure | Specification |
|---|---|---|
| Sampling of the GTR | ASTM E105<br>ASTM E122 | According to random sampling procedures |
| GTR Supply | ASTM D5603 | Ambient or Cryogenic Grind |
| Dosage of GTR | Per COA<br>& Supplier's QC Plan | Minimum of 7.0% by weight of the PG 64-22 base asphalt binder |
| GTR Specific Gravity | ASTM D5603 | 1.06 – 1.20 |
| GTR Particle Distribution | ASTM D5644 | 30 Mesh<br>Maximum of 2.0% Retained |
| GTR Metal Content | ASTM D5603 | Maximum 0.01% |
| GTR Fiber Content | ASTM D5603 | Maximum 0.50% |
| GTR Moisture Content | ASTM D1509 | Maximum 0.75% |
| Mineral Filler –Talcum Powder (Optional) | ASTM M17 | Maximum of 4.0% |
| Stabilizing Additives (Optional) | — | Maximum of 4.5% by wt. of GTR |

| Chemical Test | Test Procedure | Specification |
|---|---|---|
| Acetone Extract | ASTM D297 | Maximum 25.0% |
| Rubber Hydrocarbon Content | | 40.0 – 60.0% |
| Ash Content | | Maximum 8.0% |
| Carbon Black Content | | 20.0 – 40.0% |
| Natural Rubber | | 16.0 – 45.0% |

### 401.2.1.2.3 Asphalt Plant Storage Requirements When Using Ground Tire Rubber

1 Use a dedicated storage tank for terminal blended GTR asphalt binder at the asphalt plant. Ensure that this tank provides continuous mixing and recirculation of the GTR asphalt binder as needed. Ensure that the tank is heated and can

maintain the temperature of the homogeneous blend of asphalt binder and GTR at 300°F to 350°F. Ensure that GTR-modified binders are not mixed with other modified PG 76-22 binder.

### 401.2.1.3 Asphalt Emulsions

1 Use asphalt emulsions listed in the following table for various applications, including prime coat, tack coat, single-, double-, and triple-surface treatments, and micro surfacing.

| Applications | EAP Special | Emulsified Trackless Track | HFMS-1 | CRS-1 | CRS-2 | CRS-2P | CQS-1hP | Hot Applied Trackless | PG 64-22 |
|---|---|---|---|---|---|---|---|---|---|
| Specification | SCDOT | | AASHTO M 140 | AASHTO M 208 | | AASHTO M 316 | | SCDOT | |
| Cement Modified Subbase | * | * | | | * | | | | |
| Graded Aggregate Base | * | * | | | | | | | |
| Cement Modified Recycled Base | * | * | | | * | | | | |
| Micro-Surfacing | | | | | | | * | | |
| CMRB (Single Treatment – Temp) | | | | | * | * | | | |
| Single Treatment | | | | | | * | | | |
| Double Treatment | * (1) | * | | | * | | | | |
| Triple Treatment | * (1) | * | | | * | | | | |
| Asphalt Mixture Tack Coat | | * | * | * | * | | * | * | * |

*Note (1): If prime coat is required*

2 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 *Qualified Products List 38*.

3 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 | — |

#### 401.2.1.4 Liquid Anti-Stripping Agent

1 When permitted, use LASA as an asphalt anti-stripping additive in the asphalt mixture according to the requirements of **SC-M-402** and **SC-M-406**. Use LASA listed on *Qualified Products List 104.* Use a LASA that has been blended at the binder supplier's terminal at the percentage recommended by the supplier for the LASA and verified during the Department's job mix formula approval process.

#### 401.2.1.5 Hydrated Lime

1 Use hydrated lime as an asphalt anti-stripping additive in asphalt mixes according to the requirements of **SC-M-402,** unless a LASA is permitted and used according to **Subsection 401.2.1.4**. Use hydrated lime conforming to AASHTO M 303, Type 1 from suppliers listed on *Qualified Products List 39*.

#### 401.2.1.6 Crack Sealing Asphalt Binder

1 Use hot-poured rubber binder that conforms to ASTM D6690 Type I.

### 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 that complies with **SC-M-402**. 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 of the total aggregate passing a No. 4 sieve.

#### 401.2.2.2 Mineral Filler

1 Use mineral filler that conforms to 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 on *Qualified Products List 1*. Use fine aggregate that is uniformly graded from coarse to fine, is free from lumps of clay, loam, or other foreign matter, and does not have a coating of an injurious material. The RCE may 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 contains any clay, ensure that 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 35.0% 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.

#### 401.2.2.4 Coarse Aggregate

1 Use coarse aggregate from sources that appear on *Qualified Products List 2* and are shown as approved for asphalt mixtures 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 vegetative 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 lb/cu ft.

#### 401.2.2.5 Recycled Asphalt Pavement (RAP)

1 Ensure that the RAP complies with **SC-M-407**.

#### 401.2.2.6 Recycled Asphalt Shingles (RAS)

1 Ensure that the RAS complies with **SC-M-407**.

### 401.2.3 Composition of Mixture

#### 401.2.3.1 Submission of Materials and Job Mix Formula

1 Provide all asphalt job mix formulas for approval by the AME as specified in **SC-M-400**.

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. The binder percentage is the percentage recovered by **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 into the mixture.

3 Submit the proposed job mix formula in writing and obtain the approval of the AME for the intended source of materials before starting any work or producing any mixture for acceptance.

4 The AME may adjust the submitted job mix formula and, if so, will provide advice on its use.

#### 401.2.3.2 Gradation Test Method

1 Determine the gradation of Asphalt Mixture as specified in **SC-M-400**.

#### 401.2.3.3 Tolerances

1 Conform mixtures controlled and accepted according to the standard procedure to the tolerances in **SC-M-402**. 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.

#### 401.2.3.4 Moisture Susceptibility

1 Comply with **SC-M-402** for job mix formula. Comply with **SC-M-400** and **SC-M-406** for checking for moisture susceptibility in the field.

#### 401.2.3.5 Dust to Asphalt Ratio

1 Comply with **SC-M-402** for dust to asphalt ratio.

#### 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 in the job mix formulas. 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 the job mix formula and field problems related to air voids, dust to asphalt ratio, and gradation as specified in **SC-M-402**. Do not use less than 3.0% of any given aggregate type in any mix, with the exception of hydrated lime and baghouse fines.

#### 401.2.3.8 Rutting Susceptibility

1 Comply with **SC-M-402** for rutting susceptibility.

### 401.3 Construction

#### 401.3.1 General

1 Construct the base, intermediate, or surface course consisting of one or more courses of the approved asphalt mix on the prepared surface. Conform the courses to the required lines, dimensions, thickness, and typical cross section or specified rate of application.

#### 401.3.2 Equipment

#### 401.3.2.1 Mixing Plants for Asphalt Mixture Production

1 Comply with **SC-M-401** for equipment requirements not covered in **Subsection 401.3.2**.

#### 401.3.2.2 Hauling Equipment

1 Use trucks for hauling asphalt mixtures that have tight, clean, smooth, metal beds. To prevent the mixture from adhering to the bed, thinly coat the truck bed with an asphalt release agent on *Qualified Products List 17*. Do not use petroleum-based products to prevent asphalt mixtures from adhering to the beds. After spraying with solution, always raise truck beds so that excess material drains before placing the mixture in the truck. Place a hole at a suitable

location on each side of the truck bed for checking the temperature of the mixture. Install a cover made of canvas or other suitable material on vehicles that provides a weather-tight enclosure to protect the mixture from inclement weather or where there is evidence of a crust forming. Do not use mesh tarps for covers.

#### 401.3.2.3 Pavers

1 Spread the asphalt mixture using a mechanical self-powered paver that can spread and finish the asphalt mixture without segregation to the depth and width required, true to line, grade, and cross section. 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 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 for leveling and has an indicating level attached.

2 Use a paver that can operate at variable speeds consistent with the uniform and continuous laying of the mixture. Avoid stop and go operations of the paver.

3 On projects of sufficient length, 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.

#### 401.3.2.4 Rollers

##### 401.3.2.4.1 General

1 At the job site, provide the RCE with the manufacturer's literature for the rollers being used, so that the RCE can determine if the rollers conform to the specifications.

##### 401.3.2.4.2 Steel Wheel Rollers

1 Use steel wheel rollers that weigh between 8 tons and 12 tons. Develop a minimum pressure of 250 lb/in. of roller width in the compression wheel for the rollers under working conditions. Use rollers that are 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.

#### 401.3.2.4.3 Pneumatic-Tire Rollers

1 Use pneumatic-tire rollers that are self-propelled and have an effective rolling width of not less than 60 in. Equip the rollers with pneumatic tires of equal size and diameter that can exert uniform contact pressures. Pressures in the range of 60 psi to 80 psi are recommended. Check the tire pressure in the pneumatic-tire rollers upon request. 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-in. overlap of the tracking wheels and ensure that the wheels do not wobble. Adjust 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 psi. 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 to obtain contact pressures that result in adequate compaction.

#### 401.3.2.4.4 Vibratory Rollers

1 Use vibratory rollers that weigh at least 8 tons and have either one or two vibrating wheels. Operate the roller at a speed, frequency, and amplitude that yields maximum compaction and a smooth pavement.

### 401.3.2.5 Field Laboratory and Equipment

1 Provide and maintain a fully equipped field laboratory, meeting the requirements of **SC-M-404**, and furnish all supplies necessary for performing the quality control inspection and testing at the asphalt plant. Furnish all necessary electricity, fuel, and gas and furnish and maintain all necessary piping and valves. Provide full and ready access for the RCE and AME during all production and testing. Make immediately available all records related to the production and testing of the asphalt mixture to the RCE and AME at the asphalt plant upon request. Permit the RCE and AME to perform tests as deemed necessary. Provide a substantial platform, constructed to the proper height, for use by the RCE and AME in obtaining asphalt mixture samples and inspecting mixtures in truck beds. The AME will inspect and approve all testing equipment and supplies.

### 401.3.2.6 Equipment for Milling Existing Asphalt Pavement

1 Use a milling machine capable of performing the work to the specified width, depth, and cross slope.

### 401.3.2.7 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. Ensure 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.

### 401.3.3 Plant Production

1 Ensure that the asphalt mix production conforms to **SC-M-400**.

2 If there is suspicion that the asphalt mixture 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 asphalt mix material from the paver, delivery truck, or roadway cores.

### 401.3.4 Paving from Multiple Plants

1 To avoid intermixing the asphalt mixture, do not pave the same lane using mix from more than one plant during a day's production.

### 401.3.5 Weather, Seasonal, and Temperature Restrictions

1 Do not apply the asphalt mixture when the existing surface is wet or frozen. Place the mix according to 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 asphalt surface courses during the months of December, January, or February, except with written permission of the DCE.

### 401.3.6 Asphalt Mixture Plant Operation

1 Comply with **SC-M-400** and **SC-M-401**.

### 401.3.7 Milling Existing Asphalt Pavement

1 Mill the existing asphalt pavement to the specified width, depth, and cross slope at the required locations. Monitor the milled surface to ensure smoothness and to reduce excess scarification marks or other damage. Establish the longitudinal profile of the milled surface by using a skid sensor on the side of the cut. Dispose of the milled material. 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.

### 401.3.8 Planing Existing Asphalt Surfaces

1 Conduct planing operations that produce a uniform, finished surface of the required texture, grade, and cross slope. Conduct planing operations continuously to ensure uniformity. Do not conduct frequent halting of the planing operations to load and unload trucks.

2 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 5.0% of the total treated area. Ensure 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 areas that retains water on the roadway surface.

3 Before commencing work, construct a test section of at least 500 ft in length. Determine the appropriate forward speed for the planing equipment and 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 ¼ in. 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 ⅛ in.

5 After completion of the planing process, test the ground pavement surface transversely and longitudinally with a 10-ft straightedge. 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 on all areas with high or low spots in excess of ⅛ in. or 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 remove debris using appropriate equipment. Use a vacuum sweeper if required.

### 401.3.9 Asphalt Pavement Full Depth Patching

1 The RCE will determine the limits of distressed pavement and will mark the width and length of patches. The RCE will inspect the road to ensure that drainage is adequate and no additional work needs to be performed to the ditches and shoulders to promote proper drainage. The RCE may elect to obtain random cores if needed to determine the proper depth of the distressed area to be patched. Construct patches with a minimum size of 6.5 ft × 6.5 ft with at least 25 ft between patches. Ensure that longitudinal joints are not in the wheel paths.

2 Remove the pavement to the specified depth, ensuring that the face of the cut is straight and vertical, with the exception of tapers that are required to move equipment in and out of the patched area. If unstable material is encountered, remove additional material as directed by the RCE. Backfill the volume of the material removed below the patch with material meeting the requirements of **Section 305** and thoroughly compact in layers not exceeding 4 in. with a vibratory compactor. Thoroughly tack the sides of the existing pavement before placing the asphalt patch material in the hole.

3 Place the patch material in uniform layers equal to the numbers of lifts in the table below. Ensure that the patch material is selected from the table below. Ensure the thickness for each lift is between 3 in. and 5 in. when using Intermediate B Special. For all other mixture types, ensure the thickness for each lift is between 2 in. and 4 in.

| **Full Depth Patching (FDP) Materials** | | |
|---|---|---|
| **Depth of FDP** | **Select Mixture Type Below Based on Depth of FDP** | |
| | **Mixture Type** | **Number of Lifts** |
| 4 in. or Less | Surface Type B/C | Two Lifts |
| | Intermediate B | |
| | Intermediate C | |
| 6 in. | Surface Type B/C | Two Lifts |
| | Intermediate B | |
| | Intermediate C | |
| 8 in. | Intermediate B Special | Two Lifts |
| | Intermediate B | Three Lifts |
| | Intermediate C | Three Lifts |
| 10 in. | Intermediate B Special | Two Lifts |
| | Intermediate B | Three Lifts |
| | Intermediate C | Three Lifts |
| 12 in. or More | Consult with the RCE | |

4 Compact each layer with a vibratory compactor and a pneumatic-tire roller. Allow lifts to cool down before placing the next lift, especially when performing multiple patches in the same area. The 175°F requirement between lifts in **Subsection 401.3.14** does not apply to full depth patching (FDP). Conduct the work so that patches are opened and filled each day, with the roadway open to traffic by the end of each day's operation. Ensure that the finished patch has a smooth ride by using a straight edge. Temperature and seasonal restrictions in **Subsection 401.3.5** do not apply; however, no FDP will be permitted if the area is wet or frozen before removing the old pavement.

### 401.3.10 Conditioning of Subgrade

1 Before placing any asphalt base course mixture, prepare the subgrade according to **Section 208**.

### 401.3.11 Surface Preparation and Leveling

#### 401.3.11.1 General

1 Prepare base courses as specified in the applicable sections of **Division 300**.

2 Sweep the base course, old pavement, or existing surface so that it is clean and free from dust and foreign material. Maintain the surface until the asphalt base course mixture is placed.

3 Remove irregularities in the surface of the existing pavement or old base (including widened shoulders where settled) by providing a uniform contour by leveling with asphalt mixture. Place the leveling mix in a separate operation from the specified depth of surface course. Compact the leveling asphalt mixture until it conforms to the surrounding surface.

#### 401.3.11.2 Sealing Asphalt Pavement Cracks

1 Seal longitudinal and transverse asphalt pavement cracks with hot-poured rubber binder at locations as directed by the RCE. Clean all pavement cracks in excess of ¼ in. using a hot compressed air lance and then seal the cracks with hot-poured rubber binder.

2 Provide the RCE with a sealant manufacturer's certification for each project. Ensure that the sealant is packaged in polyethylene bags and placed in boxes that have a uniform weight of approximately 35 lb each. For storage, place the boxes on pallets and protect them with a weatherproof covering.

3 Do not apply the sealant when the surface temperature is below 32°F as measured using **SC-T-84**. Apply crack sealant between October 1st and April 30th. Ensure that the sealant completes a watertight bond with a high degree of elasticity, with maximum flexibility and longevity under extreme temperature

ranges. Use a hot compressed air lance at all times to blast out any vegetation, dirt, dampness, and loose materials from the cracks. Ensure that asphalt pavement cracks are forced open, cleaned, warm, and dry in preparation for the application of the pre-heated sealant.

4 Preheat the sealant to 370°F to 420°F using the oil or air jacketed flow method to prevent the burning of the modified rubber in the sealant. Perform the preheating with a trailer-mounted kettle with a minimum capacity of 125 gal. Ensure that the kettle is a safety-tested, crack-sealant, pre-heater melter with a full-sweep paddle agitator.

5 Apply the sealant in the prepared cracks at 370°F to 420°F using a 2-in. pressure screed shoe to completely fill the crack. Follow the sealant application with a V-shaped binder squeegee leaving a sealed 2-in. overband. After the crack is sealed, remove any surplus sealer remaining on the pavement. Do not permit excessive overbanding or wasting of sealant. Ensure that all sealed cracks have a minimum of ⅛-in. depth of sealant installed. Ensure that all sealant has cured sufficiently to prevent damage from traffic.

### 401.3.12 Transportation and Delivery of Mixes

1 Transport the asphalt mixture from the plant to the point of use in vehicles meeting the requirements of **Subsection 401.3.2.2**. Before dispatching any load of asphalt from the plant, ensure that the load can be spread, finished, and compacted during daylight, unless an approved artificial lighting system is provided for nighttime operations. Ensure that asphalt mixtures containing the asphalt binder grades in the table below are produced and delivered to the jobsite within the acceptance range listed, with the exception that Bases C and D mixtures will be produced and delivered at a temperature range of 240ºF to 275ºF. The RCE will check the mix temperatures using **SC-T-84**. Ensure that the asphalt mixtures are held within the acceptance range based on binder performance grade in the job mix formula. Deliver mixture within the acceptance range for temperature to assist in obtaining density requirements that provide a smooth riding pavement with uniform texture.

| Binder Performance Grade | Acceptance Range (ºF) |
|---|---|
| PG 64-22 | 265º – 325º |
| PG 76-22 | 300º – 350º |

*Note: Refer to **SC-M-408** for warm mix temperature requirements.*

### 401.3.13 Application of Prime or Tack Coat

1 If the asphalt mixture will be placed directly on a graded aggregate base course, and the priming of which is not otherwise provided, apply a prime coat meeting

the requirements of **Subsection 401.2.1.3**. A prime coat is not required when the asphalt mixture is placed directly on the subgrade.

2 Before laying any asphalt 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 gal/sq yd 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. Where it is impractical to use distributor spray bars, such as crossovers, small areas, etc., it is permissible to apply the material by use of the handheld nozzle. In both cases, apply the actual rate of application as directed by the RCE. The acceptable grades of emulsified asphalt are listed in **Subsection 401.2.1.3**. Select emulsified asphalt may be diluted when used as prime coat materials, if necessary, but only at the manufacturing plant.

3 In all cases, regardless of the type of tack material used, ensure that the existing pavement or unsealed asphalt surface treatment course is dry and cleaned before applying the tack material.

4 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 asphalt is placed on the contact surface.

5 Apply the tack coat as outlined above in a sufficient length of time in advance of the laying of the asphalt to permit drying but not so far in advance or over such an area to cause the tack coat to lose its adhesiveness.

### 401.3.14 Spreading and Finishing

1 Attach to the paver a minimum 30-ft long mobile stringline, a 30-ft long ski, or an electronic leveling device with the mobile stringline or ski reference used to establish the longitudinal profile. Use a grade-following sensor that can follow the taut string, wire, or other rigid grade reference produced by the leveling device. Use an automatic cross-slope device that is adjustable and can obtain the proper superelevation traversing curves and maintain the required superelevation within curves. When tying into an existing layer of material, use the existing material as the grade reference for the grade following sensor.

2 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 work day, provided that the 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.

3 Spread and strike off true to the specified line, grade, and cross section and the applicable loose depth for each successive course so that, when the work is completed, the specified thickness or weight per square yard is achieved. Determine asphalt placement rates using **SC-T-85**. Deliver and spread all asphalt mix while in a workable condition and free from lumps. Handle material to reduce segregation. Dump the mix in the center of the hoppers and avoid overloading and spilling material.

4 If tracks, indented areas, or other permanent blemishes appear, discontinue the use of the equipment and provide other satisfactory spreading and finishing equipment.

5 Correct irregularities in asphalt mix courses while the mixture is still hot. Provide special attention to the straight edging of construction joints immediately following the final rolling.

6 Immediately after a course is placed and before roller compaction is started, check the surface and adjust any inequalities. Remove all high spots and irregular areas and replace with satisfactory material. Correct irregularities in alignment and grade along the outside edge by the addition or removal of asphalt mixture before the edge is rolled.

7 Do not allow the compacted thickness of any single constructed course to exceed the following thicknesses:

- 4½ in. for asphalt aggregate base course,
- 3 in. for asphalt intermediate course, or
- 2 in. for asphalt surface course.

8 Overlap the joints in the layers a minimum of 6 in.

9 When multiple lifts are being placed in a single day, ensure that the interior mat temperature of the previous lift is less than 175ºF when measured at the mid-point of the depth of mat with a calibrated thermometer, complying with **SC-T-84**.

10 Where necessary 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 asphalt mix by standard methods, use approved spreading equipment or acceptable hand methods. When necessary to improve the profile and cross section of an existing pavement before placing the additional normal layer of asphalt mix, the RCE may require that the material be spread with a blade grader or other type of construction equipment that will yield the desired results. Do not dump the loads faster than the material can be properly handled. Perform the raking to avoid segregation so that, after the first pass of the roller over the raked asphalt, minimal back-patching is required.

11 Keep all small tools clean and free from accumulations of asphalt material.

12 Locate the finished surface of surface courses placed adjacent to curbs, gutter, manholes, etc., approximately ¼ in. above the edges of these structures.

### 401.3.15 Paving of Driveways

1 Resurface or surface all hard-surfaced driveways that have been previously paved or surface treated and all earthen driveways as directed by the RCE. Quantities for the resurfacing or surfacing of driveways are those necessary to pave to the right-of-way line. The RCE may adjust these limits as necessary.

### 401.3.16 Compaction (Standard)

1 Ensure that compaction is obtained by complying with **SC-M-400**.

2 Ensure that the intermediate rolling is completed before the mat temperature drops below 175ºF.

3 To prevent adhesion of the asphalt mix to the steel-wheel roller, keep the wheels moistened but without using excess water. Do not use oil.

4 For ditches or along forms, curbs, headers, and walls not accessible for the operation of rollers, 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 asphalt surface after compaction is smooth and true to the specified crown and grade. Remove any mixture that becomes loose and broken, mixed with dirt, or is defective, and replace the areas with fresh asphalt mix. Compact the fresh mix to conform to the surrounding area.

6 Maintain roller speeds that yield the required compaction and a smooth pavement.

### 401.3.17 Compaction Monitoring

1 Comply with **SC-M-400**.

### 401.3.18 Weak Base or Poor Surface Conditions

1 If 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.

### 401.3.19 Joints

#### 401.3.19.1 General

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 in. to 2 in. 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 to provide a uniform joint when rolled.

2 Construct and compact transverse joints to provide a smooth riding surface. Straightedge or stringline joints to ensure true alignments.

3 Construct longitudinal and transverse joints and present the same texture, density, and smoothness as other sections of the course.

4 Construct joints between old and new pavements or between successive strips to ensure proper bond between the old and new surface for the full depth of the course. Coat the joints, transverse and longitudinal, with an asphalt tack coat material, before placing the adjacent material. If an unsatisfactory joint is raveled, damaged, or unfit, cut back to sound asphalt.

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 in. Construct the width of each lane in the top layer the same as the width of the design travel lanes.

#### 401.3.19.2 Sloped Edge Longitudinal Shoulder Joints

1 Use a sloped edge longitudinal shoulder joint attachment for the asphalt paver to create a sloped edge profile between the newly placed asphalt mixture and an existing roadway shoulder.

2 All surface mixtures placed at 150 lb/sq yd or greater require a sloped edge joint device. The device can be removed if it is deemed unnecessary in locations that do not require a sloped edge profile, such as roadway sections with curbs or other confined edges.

3 Use devices listed on *Qualified Products List 75*. Ensure that the sloped edge device is designed to be attached to the paver. Ensure that the device confines the material at the end gate and extrudes the asphalt material so that a consolidated wedge shape pavement edge of between 25 degrees and 35 degrees is produced. Ensure that the device constrains the asphalt material by reducing the area by 10.0% to 15.0%. Do not use a conventional single plate strike off.

### 401.3.20 Requirements for Recycled Asphalt Pavement (RAP)

1 Ensure that the road is properly swept or vacuumed clean of any foreign debris to prevent the collected millings (RAP) from being contaminated.

### 401.3.21 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.

### 401.3.22 Finished Surface Requirements

#### 401.3.22.1 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.

#### 401.3.22.2 Variability

1 When checked with a 10-ft straightedge applied parallel to the centerline of the pavement, ensure that the finished surface of the intermediate course does not vary more than ¼ in. and that the finished surface course does not vary more than ⅛ in. as measured from the bottom of the straightedge to the top of the finished surface. Repair or, if necessary, replace the intermediate or surface courses that do not meet the finished surface requirements.

#### 401.3.22.3 Ride Quality

1 In addition to meeting the specified surface tolerances, ensure that the intermediate and surface asphalt courses meet the satisfactory riding requirements.

### 401.3.23 Segregation Identification and Correction

1 Segregation is defined as areas of non-uniform distribution of coarse and fine aggregate particles in a compacted asphalt mixture.

2 Conduct the necessary production, storage, loading, placing, and handling procedures to prevent segregation.

3 Correct segregated areas in asphalt courses. Meet all compaction and rideability requirements on roads with corrected segregated areas.

4 Correct segregated asphalt courses that are not considered riding courses by removing and replacing segregated areas for the full depth of the course and extend to at least 10 ft on either side of the segregated areas for the full width of the paving lane.

5 Correct all segregated asphalt riding courses and segregated courses placed immediately below open graded friction courses by removing and replacing the segregated areas for the full depth of the riding course and extend to at least 300 ft on either side of the segregated areas.

6 If more than 25.0% of the final roadway surfaces are segregated, mill and replace the entire roadway.

### 401.3.24 Rideability

1 Ensure that pavement rideability meets the requirements of **SC-M-403**.

### 401.3.25 Plant Tickets for Asphalt Mixtures

1 Ensure that asphalt plant ticketing meets the requirements of **SC-M-409**.

## 401.4 Measurement

1 The quantity for all Asphalt Pavement Courses is the weight of the material placed determined by using approved scales with no deduction made for the weight of asphalt materials, hydrated lime, LASA, or any other admixtures. The quantity is measured by the ton (TON) of material, complete and accepted.

2 The quantity for Clean and Seal Cracks In Asphalt Pavement is measured by the number of lane miles for which the asphalt pavement cracks have been satisfactorily sealed.

3 The quantity for Liquid Binder (of the performance grade specified) in the asphalt mixture is measured by the ton (TON) of liquid asphalt binder contained in the work and accepted, as determined by **SC-T-75** or, at the option of the RCE, from the amounts printed on the load tickets using an approved ticket printer. To check scale accuracy when using a ticket printer for the measurement of binder, perform periodic extraction tests (not for pay purposes) on the asphalt mixture other than those that contain marine limestone or slag.

4 The 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 asphalt mixture is the percentage of binder determined at the field laboratory.

6 Asphalt mixture wasted or lost due to negligence, asphalt mixture or binder applied in excess of the rate specified or directed in writing, or asphalt mixture applied beyond the limits of the work is deducted from the pay quantity.

7 The quantity for Milling Existing Asphalt Pavement is the surface area of asphalt pavement milled to the specified depth measured and is measured by the square yard (SY), complete 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 into 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 the 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 according to **Subsection 305.4**.

10 The measurement of Prime Coat is the number of gallons (GAL) of asphalt material applied to the completed and accepted base course.

## 401.5 Payment

1 Payment for the accepted quantity for Prime Coat, Clean and Seal Cracks in Asphalt Pavement, Liquid Asphalt Binder, Milling Existing Asphalt Pavement, Full Depth Asphalt Pavement Patching, or Surface Plane Asphalt Pavement at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Base course material used in the full depth asphalt pavement patching work is paid for as Maintenance Stone according to **Subsection 305.5**.

3 Adjustments in the Contract unit bid prices for asphalt courses are determined according to **SC-M-400**.

4 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 4010005 | Prime Coat | GAL |
| 4011004 | Liquid Asphalt Binder PG64-22 | TON |
| 4011008 | Liquid Asphalt Binder PG76-22 | TON |
| 4012XX0 | Full Depth Asphalt Pavement Patching XX″ Uniform | SY |
| 40130XX | Surface Plane Asphalt Pavement (XX)″ | SY |
| 4013XXX | Milling Existing Asphalt Pavement (*X*)″ | SY |
| 4013990 | Milling Existing Asphalt Pavement (Variable) | SY |
| 4015111 | Clean and Seal Cracks in Asphalt Pavement | LaMi |

# Section 402 — Asphalt Base Course

## 402.1 Description

1 Construct an asphalt base course on a prepared foundation.

## 402.2 Materials

### 402.2.1 General

1 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 that the composition by weight of the finished asphalt is within the limits set forth in **Subsection 401.2.3** and **SC-M-402**.

## 402.3 Construction

### 402.3.1 Equipment

1 The equipment requirements specified in **Subsection 401.3.2** also apply to asphalt base course.

### 402.3.2 Preparation of Subgrade

1 Before placing the asphalt base course, prepare the subgrade according to **Section 208**.

### 402.3.3 Application of Tack Coat

1 When multiple lifts of asphalt base course are required, apply a tack coat conforming to **Subsection 401.3.13**. No direct payment is made for the necessary tack coat.

## 402.4 Measurement

1 Measurement of the quantity for Asphalt Base Course is determined according to **Subsection 401.4**.

2 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 the work is indicated on the Plans as Unclassified Excavation, in which case, it is measured and paid for according to **Section 203**.

## 402.5 Payment

1 Payment for the accepted quantity for Asphalt Base Course at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Payment for Liquid Asphalt Binder PG64-22 is paid according to **Subsection 401.5**.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 4020310 | Asphalt Base Course Type A | TON |
| 4020320 | Asphalt Base Course Type B | TON |
| 4021100 | Asphalt Base Course Type C | TON |
| 4022100 | Asphalt Base Course Type D | TON |

# Section 403 — Asphalt Intermediate Course

## 403.1 Description

1 Construct an asphalt intermediate course on a prepared foundation.

## 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 asphalt is within the limits set forth in **Subsection 401.2.3** and **SC-M-402**.

## 403.3 Construction

1 Construct asphalt intermediate course according to the requirements specified in **Subsection 401.3**.

2 Use equipment meeting the requirements in **Subsection 401.3.2**.

## 403.4 Measurement

1 Measurement of the quantity for Asphalt Intermediate Course is determined according to **Subsection 401.4.**

## 403.5 Payment

1 Payment for the accepted quantity for Asphalt Intermediate Course is determined according to **Subsection 401.5**.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 4030310 | Asphalt Intermediate Course Type A | TON |
| 4030320 | Asphalt Intermediate Course Type B | TON |
| 4032321 | Asphalt Intermediate Course Type B - Special | TON |
| 4030330 | Asphalt Intermediate Course Type C | TON |

# Section 404 — Asphalt Surface Course

## 404.1 Description

1 Construct asphalt surface course, spread and compacted on a prepared foundation.

## 404.2 Materials

### 404.2.1 General

1 Use materials that meet the applicable requirements of **Subsection 401.2** and **SC-M-402**.

### 404.2.2 Composition of Mixture

1 Combine the mineral aggregates and binder in such proportions that the composition by weight of the finished asphalt is within the limits set forth in **SC-M-402**.

2 Use asphalt surface course Type C or D for Ditch Paving.

## 404.3 Construction

1 Construct asphalt surface course according to the requirements specified in **Subsection 401.3**.

2 Use equipment meeting the requirements of **Subsection 401.3.2**.

## 404.4 Measurement

1 Measurement of the quantity for asphalt surface course is determined according to **Subsection 401.4** with the following addition:

- When the item of Asphalt Surface Course for Ditch Paving is included in the Contract, the binder in the ditch paving mixture is not measured for separate payment.

## 404.5 Payment

1 Payment for the accepted quantity for Asphalt Surface Course at the Unit Price is determined according to **Subsection 401.5** with the following addition:

- When the item Asphalt 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 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 4040310 | Asphalt Surface Course Type A | TON |
| 4040320 | Asphalt Surface Course Type B | TON |
| 4040340 | Asphalt Surface Course Type C | TON |
| 4040350 | Asphalt Surface Course Type D | TON |
| 4040360 | Asphalt Surface Course Type E | TON |
| 4047000 | Asphalt Surface Course for Ditch Paving | TON |
| 4047210 | Driveway Paving Surface Type B | TON |
| 4047220 | Driveway Paving Surface Type C | TON |
| 4047230 | Driveway Paving Surface Type D | TON |

# Section 405 — Open-Graded Friction Course

## 405.1 Description

1 Construct a permeable open-graded friction course (OGFC), mixed in an approved asphalt plant.

## 405.2 Materials

### 405.2.1 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. PG 76-22 and hydrated lime are required.

### 405.2.2 Aggregate

1 Use crushed coarse aggregate having an abrasion loss of not more than 52.0% when tested according to AASHTO T 96 (C Grading). If the aggregate abrasion loss is greater than 42.0% but less than or equal to 52.0%, test the Micro-Deval abrasion value of the material according to 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 90.0%, based on count, according to AASHTO T 61, and a Sodium Sulfate Soundness loss not greater than 15.0% when subjected to five alterations according to AASHTO T 104. When fly ash is used as a mineral filler material in an OGFC design, ensure that it is from a source listed on *Qualified Products List 3*.

### 405.2.3 Additives

1 Use a chemical additive that is listed on *Qualified Products List 77* and is terminally blended with the asphalt binder. The use of stabilizing fibers is not required.

### 405.2.4 Composition of Mixture

1 Submit a job mix formula according to **SC-T-88**. Ensure that job mix formulas are accepted by the AME before use on Department work. Ensure that the job mix formulas are prepared in a laboratory accepted by the AME according to **SC-M-405** and by technicians certified as a SCDOT Level 2 Asphalt Mix Technician. Ensure a minimum retention coating of 99.5% following **SC-T-91**. Ensure that the abrasion resistance (Cantabro) of the OGFC mixture is less than 15.0% using **SC-T-127**. Ensure that porosity measurements on the job mix formula specimens are equal to or greater than 13.0% according to **SC-T-128**. Design and set target job mix formula gradations within the master range listed

in the following table. Field tolerances are not permitted to extend outside of the ranges for each designated sieve.

| Sieve Designation | 12.5-mm OGFC % Passing | 9.5-mm OGFC % Passing |
|---|---|---|
| ¾ in. | 100.0 | 100.0 |
| ½ in. | 85.0 – 100.0 | 95.0 – 100.0 |
| ⅜ in. | 55.0 – 75.0 | 80.0 – 100.0 |
| No. 4 | 15.0 – 30.0 | 20.0 – 50.0 |
| No. 8 | 5.0 – 15.0 | 5.0 – 20.0 |
| No. 200 | 0.00 – 4.00 | 0.00 – 4.00 |
| Range for % Binder | 5.50 – 7.00 | 5.50 – 7.00 |

## 405.3 Construction

### 405.3.1 Ambient Air Temperature Limitations

1 Place the OGFC on a clean, dry, properly tacked surface only during favorable weather conditions. Ensure that ambient air temperature during placement of OGFC is 55ºF or above when measured using **SC-T-84**. Do not place OGFC when the ambient temperature is below freezing the day before to ensure proper bond to existing pavement surface.

### 405.3.2 OGFC Paving Plan

1 Provide a detailed paving plan to the RCE a minimum of 5 days before the pre-paving meeting. Alter the paving plan as necessary to maintain schedule and to provide a consistent OGFC mixture.

#### 405.3.2.1 Hauling – Trucking Operations

1 Ensure that the paving plan includes a trucking schedule showing exactly how many trucks will be used for each milepost of the project for the paving operation to be accomplished continuously without waiting for the asphalt mixture and to eliminate excess standing idle time with loaded hauling trucks.

#### 405.3.2.2 Mix Delivery Temperature

1 Ensure that the paving plan includes a mixture temperature range that will be maintained in the haul trucks or material transfer vehicles (MTVs) before load

out into the asphalt paver. Produce the OGFC mix so as to not exceed the maximum temperature specified on the job mix formula.

#### 405.3.2.3 Paver Operations

1 Ensure that the paving plan includes the desired optimum paver speed in feet per minute to eliminate inconsistent movement (reduce paver stops) of the paving operations, provide a more uniform finished mixture, and ensure that the OGFC is properly seated to the underlying surface.

#### 405.3.2.4 Compaction Operations

1 Provide a list of static rollers that will be used to compact the OGFC mixture. Submit a diagram of the roller pattern to be used for the construction project. Ensure that the diagram includes the distance or range in feet where the rollers will be located behind the paver during compacting operations.

#### 405.3.2.5 Production

1 Produce the OGFC mix so as not to exceed the maximum temperature stated on the OGFC job mix formula to prevent unnecessary drain-down of the asphalt binder and ensure that the mixture temperature is no less than 225ºF. To avoid cross contamination, do not produce other mixes during OGFC production. Clean out the plant before production to prevent the excess buildup of aggregate fines from being discharged. Ensure that all loads of OGFC produced are monitored for mix temperature before leaving the plant according to the paving plan and that trucks are tarped and strapped to minimize heat loss of the OGFC mixture.

### 405.3.3 Additional Quality Control Testing

1 Perform drain-down testing using **SC-T-90** at least one time during the first day's production, then at least once every 7 production days thereafter. If a drain-down test produces a resulting retention coating of less than 95.0%, conduct drain-down testing at least once every 3 production days thereafter until a result of 95.0% or greater is obtained. If a drain-down test produces a resulting retention coating of less than 90.0%, immediately stop production and contact the AME.

### 405.3.4 Placement Operations

#### 405.3.4.1 Tack Coat

1 Use a less tracking hot applied bond coat that is listed on *Qualified Products List 38*. Ensure that the tack coat is applied uniformly to create a bonding layer between the existing riding surface and the OGFC. Ensure that the product is

placed at a minimum of 0.08 gal/sq yd or as is otherwise deemed necessary by the RCE. A PG 64-22 binder may be applied in lieu of hot applied bond coats. Adjust distributors accordingly to apply hot applied products uniformly, and ensure that all safety precautions are taken before production.

#### 405.3.4.2 Placement of OGFC

1 One half load of OGFC can be sent to the jobsite to preheat the paving equipment (MTV and or paver if necessary), but then discard and dispose of this mixture and do not use it on the mainline paving. The Department will pay for the half load to prevent contamination and improve construction of the transverse joint. Ensure that, once the half load is discarded, the material is not used in the spread rate calculations. Ensure that the temperature of the mix when placed on the roadway is not less than 225ºF. Unless otherwise permitted by the RCE, place OGFC mix within 90 minutes of loadout-discharge at the plant.

2 Submit a written explanation for any paver stops that exceed 15 minutes to the RCE before the next day's production. More than two paver stops exceeding 30 minutes in the same production day will require stopping operations and determining a path forward to eliminate paver stops. Revision to the paving plan may be necessary to continue operations. Paver stops do not require any special equipment to monitor time or thermal segregation; however, the stops are not recommended.

3 Spread the OGFC at the required rate shown and promptly roll with an 8-ton to 10-ton tandem steel wheel roller conforming to **Subsection 401.3.2.4**. Cease rolling as soon as the OGFC is properly seated to the underlying surface. Ensure that not more than three passes (total) of the rollers are applied to the OGFC. If aggregate breakdown is observed, make adjustments in the rollers used or to the roller pattern to eliminate the breakdown.

4 Do not permit the 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 ft on each side, and replace at no additional expense to the Department.

### 405.4 Measurement

1 Measurement of the quantity for Open-Graded Friction Course is determined according to **Subsection 401.4**.

### 405.5 Payment

1 Payment for the accepted quantity for Open-Graded Friction Course at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Pay items under this Section include the following:

| Item No. | Item | Pay Unit |
|---|---|---|
| 4051000 | Open-Graded Friction Course – 9.5 mm | TON |
| 4052000 | Open-Graded Friction Course – 12.5 mm | TON |

# Section 406 — Asphalt Surface Treatment – Single Treatment

## 406.1 Description

1 Construct an asphalt surface treatment – single treatment on a prepared foundation.

## 406.2 Material

### 406.2.1 Asphalt Material

#### 406.2.1.1 Modified Emulsified Asphalt

1 Use a cationic emulsified asphalt of the grade designated as CRS-2P in **Subsection 401.2.1.3**. Do not perform any post blending or acid modification of the CRS-2P.

### 406.2.2 Aggregate

1 Use aggregates consisting of clean, washed, dry, durable particles of crushed stone, crushed gravel; free from soft, thin, elongated or laminated pieces, disintegrated particles, vegetation, or other deleterious substances; and from a source listed on *Qualified Products List 1* or *Qualified Products List 2,* as applicable. Do not use marine limestone.

2 Ensure that aggregates are within the required gradation limits provided in **Appendices A-2** and **A-3**.

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).

4 When specified, use lightweight aggregates in surface treatment provided that the aggregate comes from a source listed on *Qualified Products List 2* and complies with AASHTO M 195, Lightweight Aggregates for Structural Concrete (with the exception of any references to concrete samples or concrete strength).

5 Use lightweight aggregate that also meets the physical properties in the following table.

**Physical Properties of Lightweight Aggregate**

| Property | Test Procedure | Specification (Max.) |
|---|---|---|
| Dry Loose Weight | AASHTO T 19 | 60 lb/cu ft* |
| Sodium Sulfate Soundness | AASHTO T 104 (Loss at five 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.*

6 Use lightweight aggregate that is non-corrosive and meets the gradation requirements within the ranges in the following table.

**Gradation Range of Lightweight Aggregate**

| Sieve | Percent Passing, % |
|---|---|
| ½ in. | 100.0 |
| ⅜ in. | 95.0 – 100.0 |
| No. 4 | 5.0 – 30.0 |
| No. 8 | 0.0 – 10.0 |
| No. 16 | 0.0 – 5.0 |

7 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 is obtained.

## 406.3 Construction

### 406.3.1 Equipment

#### 406.3.1.1 Distributors

1 Ensure that all distributors are mounted on pneumatic-tire rollers 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. Ensure that 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. To prevent lapping at the junction of two applications, ensure that the distributor is equipped with a positive shut-off control. Calibrate distributors according to **Subsection 406.3.4.1** immediately before use on the project.

#### 406.3.1.2 Aggregate Spreaders

1 Use aggregate spreaders that are approved, self-propelled, mechanical type spreaders hooked onto the supply truck or tailgate spreaders. Ensure that the spreaders are accurately controlled to distribute the aggregate uniformly and at the required rate. Calibrate the spreaders according to **Subsection 406.3.4.2** immediately before use on the project.

#### 406.3.1.3 Rollers

##### 406.3.1.3.1 Steel Wheel Roller

1 Use steel wheel rollers weighing a minimum of 8 tons that are in good working condition. Ensure that the rollers are equipped with smooth tires to prevent tracking, adjustable scrapers to keep the rollers clean, and a means to keep the wheels wet to prevent mixes from sticking to the rollers.

##### 406.3.1.3.2 Pneumatic-Tire Rollers

1 Use pneumatic-tire rollers that are self-propelled, have an effective rolling width of not less than 60 in., and are equipped with pneumatic-tire rollers of equal size and diameter. Ensure that the minimum tire pressure is 90 psi, not varying more than 5 psi between tires. Ensure that the wheels of the rollers are placed so that one pass will provide total coverage equal to the rolling width of the machine. Ensure that there is a minimum of a ¼-in. overlap of the tracking wheels, the wheels do not wobble, and the contact pressure is uniform for all wheels. Ensure that the pneumatic-tire roller has sufficient ballast space to provide a minimum gross weight of 5 tons. Use enough pneumatic-tire rollers to complete uniform coverage.

#### 406.3.1.4 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 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 that the aggregates in the truck bed

be leveled so 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 the trucks. The cost of this work is considered included in the Contract unit price for surface treatment.

### 406.3.2 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 60ºF, or when weather conditions are anticipated not to meet these requirements within a 12-hour period.

### 406.3.3 Cleaning of Surface

1 Ensure that the surface of the roadbed to be treated is dry and clean of all dust, dirt, clay, and deleterious matter when the surface treatment is applied. Clean the roadbed surface with power sweepers, hand brooms, mechanical brooms, or other acceptable equipment.

### 406.3.4 Calibration of Equipment

#### 406.3.4.1 Distributor

1 Before starting work and when requested, calibrate the distributor by obtaining a dry weight of a 1 sq yd 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/sq yd
w = weight of emulsion on paper, lb/sq yd
D = density of emulsion at 60°F, lb/gal

2 Determine the rate at the spraying temperature by dividing R by the temperature-volume correction factor from the *Temperature-Volume Corrections For Emulsified Asphalt* table in **SC-T-86**.

#### 406.3.4.2 Aggregate Spreader

1 Within the first 1000 ft of the project and then once per week, calibrate the spreader by obtaining a dry weight of a 1 sq yd 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, lb/sq yd
w = weight of aggregate in pan, lb
A = area of pan, sq yd

### 406.3.5 Sequence of Operations

1 Apply the surface treatment using quantities and the sequence of operations as indicated 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 (lb) | 15 – 20 |
| *OR* immediately spread Aggregate No. 89M (lb) | 12 – 15 |
| *OR* immediately spread Lightweight Aggregate (lb) | 6 – 12 |
| 4. Roll with pneumatic-tire rollers in tandem | |
| 5. Continue rolling with pneumatic-tire rollers until aggregate is firmly sealed | |
| 6. Remove excess aggregate | |

*Note: No. 789 or 89M is only used for temporary purposes, not as a final riding surface.*

2 The assumed pounds of aggregate are based on 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 quantity of pounds required per square yard to ensure a uniform coverage.

### 406.3.6 Application of Asphalt Materials

1 Do not apply the asphalt material until the base or surface on which the material will be placed is properly cured, firm, intact, clean, dry, and compacted.

2 Apply the asphalt material uniformly with 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. If the material is applied to a partial width at a time, provide 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. Adjust and operate the distributing machine to obtain a uniform distribution of the asphalt material. 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 to the satisfaction of the RCE. In applying the asphalt material, protect adjacent structures from discoloration. Determine the speed of the application of asphalt material according to the number of rollers and the speed at which they are permitted to operate. Provide a means to verify the distributor's calibration.

3 Use an asphalt emulsion according to **Subsection 401.2.1.3**. Spray at a temperature between 140ºF and 185ºF.

### 406.3.7 Spread of Aggregate

1 Ensure that the aggregate is available at the site of the work loaded in trucks or is delivered so that the emulsion is immediately covered in a continuous operation. Ensure that spreading the aggregate occurs within 200 ft of the application of the emulsion. Uniformly spread the required amount of aggregate with approved spreaders. Ensure that the emulsion is covered with aggregate before the wheels pass over the emulsion. 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 yield a complete cover. If determined necessary by the RCE, provide a spotter truck to follow the spreader to fill in any uncovered areas.

### 406.3.8 Rolling

1 Use a minimum of two pneumatic-tire rollers in tandem to ensure that 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. Allow the rolling speed to determine the production speed. 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.

### 406.3.9 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 using 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 the material.

### 406.3.10 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 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 impractical 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.

### 406.3.11 Maintenance

1 In addition to the maintenance required 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 to restore a uniform surface and to ensure the durability of the portion repaired.

## 406.4 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 and accepted. Material placed outside of the designated treatment area is disregarded in computing the quantity.

2 To verify the rates of application and measuring materials that have been authorized that are at a rate greater or lesser than that required by these specifications, the following rules apply:

- Measurement in all cases is based on material properly incorporated into the surface treatment and excludes loss as determined by the RCE.
- The quantities of emulsion are based on the volume of the material at the temperature of 60ºF. Correct the volumes measured at higher or lower temperatures to the volume of the material at 60ºF using the table entitled *Temperature-Volume Corrections for Emulsified Asphalt* in **SC-T-86**.

## 406.5 Payment

1 Payment for the accepted quantity for Asphalt Surface Treatment – Single Treatment at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 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 Construct an asphalt surface treatment – double treatment on a prepared foundation.

## 407.2 Materials

### 407.2.1 Emulsified Asphalt

1 Use emulsified asphalt of the grade designated conforming to the specifications in **Subsection 401.2.1.3**.

### 407.2.2 Aggregates

1 Use aggregates that comply with **Subsection 406.2.2.**

## 407.3 Construction

### 407.3.1 Equipment

1 Use equipment conforming to **Subsection 406.3.1**.

### 407.3.2 Weather and Seasonal Limitations

1 Adhere to the weather and seasonal limitations in **Subsection 406.3.2**.

### 407.3.3 Cleaning of Surface

1 Clean the surface according to **Subsection 406.3.3**.

### 407.3.4 Calibration of Equipment

1 Ensure that all equipment is calibrated according to **Subsection 406.3.4**.

### 407.3.5 Sequence of Operations

1 Apply double treatment using the quantities and sequence of operations outlined in the table below.

**Asphalt Surface Treatment – Double Treatment**

| Sequence of Operations | Quantities Per Square Yard | | |
|---|---|---|---|
| | **Type A** | **Type B** | **Type C** |
| **Surface Preparation:** | | | |
| Clean surface | | | |
| **First Layer:** | | | |
| Apply CRS-2 (gal)[1] | 0.30 – 0.35 | 0.30 – 0.35 | 0.28 – 0.35 |
| Spread immediately Aggregate No. 6M (lb) | 28 – 32 | 28 – 32 | -- |
| Spread immediately Aggregate No. 89M (lb) | -- | -- | 12 – 15 |
| Roll immediately with steel wheel and pneumatic-tire roller, all types. | | | |
| **Second Layer:** | | | |
| Apply CRS-2 (lb)[1] | 0.25 – 0.30 | 0.16 – 0.20 | 0.20 – 0.30 |
| Spread immediately Aggregate No. 789 (lb) | 18 – 22 | -- | -- |
| Spread immediately Aggregate No. 89M (lb) | -- | 14 – 16 | -- |
| Spread immediately FA-13 or washed screenings (lb) | -- | -- | 10 – 12 |
| Roll with steel wheel rollers as soon as possible, all types. | | | |
| **TOTALS:** | | | |
| Asphalt material (not including prime (lb) | 0.55 – 0.65 | 0.46 – 0.55 | 0.48 – 0.65 |
| Aggregate (lb) | 46 – 54 | 42 – 48 | 22 – 27 |

[1] *CRS-2P may be used in lieu of CRS-2 as specified by the Contract.*

### 407.3.6 Application of Asphalt Materials

#### 407.3.6.1 General

1 Apply asphalt material as specified in **Subsection 406.3.6.**

### 407.3.6.2 Prime Coat

1 Do not permit any traffic on the primed base until the asphalt material has penetrated and dried sufficiently so that it does not pick-up under traffic. Where it is impractical to detour traffic and if directed by the RCE, spread 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 by the RCE, roll the primed base until the loose material is bonded.

### 407.3.7 Spreading of Aggregate

1 Ensure that the aggregate is available at the job site and loaded in trucks or is delivered so 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 beneath the wheels of the vehicles. After the aggregate has been spread, smooth uniformly by light brooming with drag or rotary brooms during 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 only that needed to provide a complete cover.

### 407.3.8 Rolling

1 Roll the aggregate applications for the entire width as specified in the table in **Subsection 407.3.5**. Repeat rolling and light brooming as necessary to obtain a 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 half the width of the roller. Permit traffic to use the road as soon as the mat aggregate is rolled.

2 If the aggregate is sufficiently embedded in the asphalt material, remove all loose excess cover material from the surface.

### 407.3.9 Sweeping and Cleaning

1 Perform sweeping and cleaning according to **Subsection 406.3.9**.

### 407.3.10 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.

### 407.3.11 Maintenance

1 Perform the maintenance to comply with **Subsection 406.3.11**.

## 407.4 Measurement

1 The quantity for the pay item Asphalt Surface Treatment (Double Treatment Types A, B, or C) is the surface area of the roadway with double treatment asphalt surfacing and is measured by the square yard (SY), complete and accepted. Material placed outside of the area designated for treatment is disregarded when computing the quantity.

2 Verify the rates of applications as specified in **Subsection 406.4**.

## 407.5 Payment

1 Payment for the accepted quantity for Asphalt Surface Treatment – Double Treatment at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 4070103 | Asphalt Surface Treatment (Double Treatment Type A) | SY |
| 4070104 | Asphalt Surface Treatment (Double Treatment Type B) | SY |
| 4070105 | Asphalt Surface Treatment (Double Treatment Type C) | SY |

# Section 408 — Asphalt Surface Treatment – Triple Treatment

## 408.1 Description

1 Construct an asphalt surface treatment – triple treatment on a prepared foundation.

## 408.2 Material

### 408.2.1 Asphalt Materials

#### 408.2.1.1 Emulsified Asphalt

1 Use emulsified asphalt conforming to **Subsection 401.2.1.3**.

### 408.2.2 Aggregate

1 Use Aggregate No. 6M and No. 89M conforming to **Subsection 406.2.2**.

2 Use Aggregate No. FA-13 listed on *Qualified Products List 1* 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 listed on *Qualified Products List 1* 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 Screening**

| Sieve Designation | Percentage by Weight Passing, % |
|---|---|
| ⅜ in. | 100.0 |
| No. 4 | 90.0 – 100.0 |
| No. 8 | 80.0 – 100.0 |
| 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 Ensure that the variation in materials conforms to **Subsection 406.2.2**.

## 408.3 Construction

### 408.3.1 Equipment

1 Use equipment conforming to **Subsection 406.3.1.** In addition, when Aggregate No. FA-13 or washed screenings are used, use a spreader equipped with a mechanical device that spreads the Aggregate No. FA-13 or washed screenings at a uniform rate.

### 408.3.2 Weather and Seasonal Limitations

1 Adhere to the weather and seasonal limitations specified in **Subsection 406.3.2**.

### 408.3.3 Cleaning of Surface

1 Perform cleaning of the surface conforming to **Subsection 406.3.3**.

### 408.3.4 Sequence of Operations

1 Apply asphalt surface treatment using quantities and a sequence of operations as outlined in the table below.

**Asphalt Surface Treatment – Triple Treatment**

| Sequence of Operations | Quantities per Square Yard |
|---|---|
| **Prime:** | |
| Clean surface | |
| Apply EA-P Special (gal)[1] | 0.25 – 0.28 |
| Allow to cure | |
| **First Layer:** | |
| Apply CRS-2 (gal) | 0.30 – 0.35 |
| Immediately spread Aggregate No. 6M (lb) | 28 – 32 |
| Roll immediately with steel wheel roller and pneumatic-tire roller | |
| **Second Layer:** | |
| Apply CRS-2 (gal) | 0.16 – 0.20 |
| Immediately spread Aggregate No. 89M (lb) | 14 – 16 |

(table continued on the next page)

(table continued from the previous page)

| Sequence of Operations | Quantities per Square Yard |
|---|---|
| **Third Layer:** | |
| Apply CRS-2 (gal) | 0.25 – 0.30 |
| Immediately spread Aggregate No. FA-13 or washed screenings (lb) | 10 – 12 |
| Roll with steel wheel and pneumatic-tire rollers and broom, and continue alternating with pneumatic-tire roller and broom | |
| **Totals:** | |
| Asphalt material (not including prime) (gal) | 0.71 – 0.85 |
| Aggregate (lb) | 52 – 60 |

[1] *When the base consists of marine limestone, ensure that the prime rate is from 0.10 to 0.15 gal/sq yd.*

### 408.3.5 Application of Asphalt Materials

1 Apply the asphalt material as specified in **Subsection 406.3.6** or **407.3.6**.

### 408.3.6 Weight of Aggregate

1 Determine truck weights as specified in **Subsection 406.3.1.4**.

### 408.3.7 Spreading of Aggregate

1 Ensure that the spreading of aggregate conforms to **Subsection 407.3.7**. Spread the Aggregate No. FA-13 using equipment specified in **Subsection 408.3.1**.

### 408.3.8 Brooming and Rolling

1 Except for the spreading of Aggregate No. 89M applied for the second layer, roll each layer of aggregate following spreading as directed by the RCE. Perform rolling with a steel wheel tandem and pneumatic-tire roller. Repeat rolling and light brooming with drag or rotary brooms as 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 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 a 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 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.

### 408.3.9 Sweeping and Cleaning

1 Perform sweeping and cleaning according to **Subsection 406.3.9**.

### 408.3.10 Maintenance

1 Perform maintenance as specified in **Subsection 406.3.11**.

## 408.4 Measurement

1 The quantity for the pay item Asphalt Surface Treatment – Triple Treatment is the surface area of the road with a triple treatment asphalt surface and is measured by the square yard (SY), complete 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 406.4**.

## 408.5 Payment

1 Payment for the accepted quantity for Asphalt Surface Treatment – Triple Treatment at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 4080102 | Asphalt Surface Treatment<br>(Triple Treatment) | SY |

# Section 409 — Microsurfacing

## 409.1 Description

1 Construct microsurfacing on an existing road surface.

## 409.2 Materials

### 409.2.1 Aggregate

1 Use aggregate screenings conforming to **Subsection 401.2.2**, except as modified in this Subsection. Ensure that aggregates shipped to the project are crushed mineral aggregate screenings that are uniform, do not require blending or pre-mixing at the storage area before use, meet the appropriate gradation as shown in the table in **Subsection 409.2.7**, and have a sand equivalent value that is not less than 65 when tested according to AASHTO T 176.

2 Do not use limestone aggregate in the mixture.

### 409.2.2 Mineral Filler

1 Use either Portland cement or hydrated lime meeting the following requirements:

- Portland cement, Type I or Type 1L — **Subsection 701.2.1**
- Hydrated lime — **Subsection 401.2.1.5**

### 409.2.3 Emulsified Asphalt

1 Use emulsified asphalt of the grade designated in **Subsection 409.2.7** conforming to the requirements of **Subsection 401.2.1.3**.

### 409.2.4 Asphalt Tack Coat

1 Use a cationic emulsion that conforms to AASHTO M 208 and **Subsection 401.2.1.3**.

### 409.2.5 Water

1 Use potable water free from any contaminants detrimental to the mixture for microsurfacing mixture.

### 409.2.6 Other Additives

1 Provide other additives as required by the International Slurry Surfacing Association (ISSA) requirements to control the set time of the mixture in the field.

### 409.2.7 Composition of Mixture

1 Develop the job mix formula in a laboratory using a technician with microsurfacing experience. Supply a certified job mix formula to the AME that includes the following information:

- Aggregate test properties,
- Aggregate target gradation,
- Results of the design requirements in the table below, and
- Design asphalt residue and mineral filler percentages based on the dry weight of the aggregate.

2 Include information relative to sources, type of materials, and project number. Do not begin microsurfacing work until the AME has reviewed and accepted the submitted design.

3 Provide uniform mixture of aggregate, CQS-1hP emulsion, mineral filler, water, and other additives to control set time in the field. Ensure a compatible emulsion and aggregate to obtain a complete, uniform coating of the aggregate in the mixing unit and sufficient working time is present to allow for proper placement at the existing ambient temperature and humidity. The RCE may require that the mixture be redesigned if replacement of a constituent or change in gradation is needed to produce an acceptable mixture. Proportion the constituents to produce a uniform mixture according to the table below. Do not use any mixture, with or without the tolerances, that falls outside of the ranges for aggregate grading requirements and optimum residual asphalt content in the tables below.

| Mixture Control Tolerances | Grading Requirements (AASHTO T 27) | Range |
|---|---|---|
| ± 0.0 | % Passing ⅜-in. Sieve | 100.0 |
| ± 6.0 | % Passing No. 4 Sieve | 90.0 – 100.0 |
| ± 5.0 | % Passing No. 8 Sieve | 65.0 – 90.0 |
| ± 5.0 | % Passing No. 30 Sieve | 30.0 – 55.0 |
| ± 4.0 | % Passing No. 100 Sieve | 10.0 – 25.0 |
| ± 3.0 | % Passing No. 200 Sieve | 5.0 – 15.0 |

| Mixture Control Tolerances | Test Procedures | Range |
|---|---|---|
| N/A | Optimum Moisture Content of Aggregate | 2.5% – 3.5% |
| ± 0.50 | Range for Residual Asphalt (by weight of dry aggregate) | 5.00% – 10.50% |
| N/A | Range for Mineral Filler (by weight of dry aggregate) | 0.5% – 3.0% |
| | Wet Track Abrasion Loss (Maximum)<br><br>ISSA TB100 1 hour soak<br>ISSA TB100 6 day soak | <br><br>538 g/m²<br>807 g/m² |
| | Lateral Displacement (Maximum)<br>ISSA TB147A or 147C | 5.0% |
| | Excess Asphalt by LWT (Maximum)<br>ISSA TB109 | 538 g/m² |
| | Mixing Time Test, @ 25° C<br><br>ISSA TB113<br>*Double shaft, multi-bladed mixers and fully agitated spreaders.<br><br>**Conventional mixing and spreading equipment | <br><br><br>60 seconds minimum*<br><br>90 – 120 seconds** |
| | Set Time Test, 30 minutes<br>ISSA TB139 | 12 kg-cm minimum |
| | Early Rolling Traffic Time, 60 minutes<br>ISSA TB139 | 20 kg-cm minimum |

*Note 1: ISSA TB notation is a reference to the specifications of the International Slurry Surfacing Association Technical Bulletins.*

## 409.3 Construction

### 409.3.1 Equipment

1 Do not attempt to use equipment that is malfunctioning or not in excellent working condition. The RCE can order that the work be discontinued if sufficient equipment and tools are not in use to place the materials satisfactorily.

#### 409.3.1.1 Mixing Equipment

1 Blend the paving mixture by a self-propelled microsurfacing mixing machine by means of a continuous flow mixing unit capable of accurately delivering and

proportioning the aggregate, emulsion, mineral filler, field control additives, and water to a revolving multi-blade, twin shaft mixer and discharge the mixed product. Thoroughly blend the mixture so that no uncoated aggregate is visible upon discharge from the mixing unit. Equip the machine with self-loading devices that provide for the loading of all materials while continuing to lay microsurfacing to minimize construction joints.

2 Ensure that the machine is equipped with opposite side driving stations to optimize longitudinal alignment and allow the operator to have full hydrostatic control of the forward and reverse speed during the application of the microsurfacing material. Equip the mixing machine with a water pressure system and nozzle type spray bar to provide a water spray ahead of and outside of the spreader box when required. Ensure that a spray nozzle is readily available on the spreader unit to assist with cleaning equipment and strike-offs.

#### 409.3.1.2 Proportioning Devices

1 Equip the mixing machine with a computer system that can record, display, and print the following information:

- Individual sensor counts for emulsion, aggregate, cement, water, and additive;
- Aggregate, emulsion, and cement output in lb/min;
- Ground travel distance by use of a radar ground metering device or similar to measure distance;
- Spread rate in lb/sq yd;
- Percentages of emulsion, cement, water, and additive;
- Cumulative totals of aggregate, emulsion, cement, water, and additive; and
- Scale factor for all materials.

2 Ensure that the computer system is functional before beginning the work, and continues to be functional during the performance of the work. If printers or other computer controls are not functioning correctly, the RCE may be provided manual readouts from the equipment every 2000 ft for the remainder of the day. The RCE will determine if paving will continue based on sufficient data and effort to correct the computer system malfunction before beginning paving the next day. All information collected by the RCE must be available throughout the day and, if any rate is outside of tolerance, production will be stopped immediately.

3 Ensure that the:

- Mixing machine includes controls for proportioning and calibrating the aggregate feed.

- Aggregate feed device is equipped with a revolution counter so that the amount of aggregate used can be determined at any time and will have a positive locking feed gate.
- Emulsion pump is of the positive displacement type and will be equipped so that the amount of emulsion used can be determined at any time.
- Emulsion pump meter and piping is arranged to calibrate the meter by weighing a metered volume.
- Pump delivers the emulsion to the mixer box at a uniform rate that will not vary more than 2.0% from the required quantity.

4 Truck-mounted machines may be substituted if the roads are under 1200 ft in total length to prevent unnecessary joints in the finished surface. Ensure that truck-mounted machines have computer control systems installed.

5 Equip the water pump with a minimum of two valves — one valve to establish the required water flow and the other valve to be a quick acting valve to start and stop the water flow. Equip the mixing machine with sight gauges to indicate the material storage tanks for the asphalt emulsion and water. Equip the mixing machine with metering devices so that it can be accurately calibrated and the quantities of materials used during any time can be closely estimated. If the metering devices stop working properly, cease using the mixing machine until necessary repairs have been made. Calibrate each mixing unit before initiating work. Once calibrated, do not change the aggregate and emulsion flows without the approval of the RCE. Adjust the water and additive in the field to control the mix properties to produce an acceptable mix.

### 409.3.1.3 Spreading Equipment

1 Spread the microsurfacing mixture uniformly by use of a mechanical type spreader box attached to the mixer, equipped with augers, paddles, or other devices to agitate and spread the materials throughout the box. Design the paddles to maintain sufficient turbulence in the mixture to prevent the material from setting-up in the box or causing side buildup and lumps. Provide a front seal to ensure no loss of the mixture at the road contact surface. Equip the rut filling equipment with an adjustable steel strike-off plate to ensure a level surface and a rear seal to act as an adjustable strike-off plate. Maintain the spreader to prevent the loss of the paving mixture in surfacing superelevated curves.

### 409.3.1.4 Strike-Offs

1 Operate the spreader box and rear strike-off so that a uniform consistency is achieved to produce a free flow of material to the rear strike-off without causing skips, lumps, or tears in the finished surface. Ensure that the spreader box provides lateral movement or has side shift abilities to ensure proper alignment with the roadway. Ensure that the secondary strike-off provides improved

surface texture. Acceptable secondary strike-offs include urethane or poly strike-off and burlap cloth. The use of burlap is permitted; however, if excessive longitudinal lines are found in the finished mat, suspend the use of burlap and use a urethane or poly strike-off. Wash clean the secondary strike-off frequently or replace when excessive build-up is evident to provide consistent mat texture.

#### 409.3.1.5 Auxiliary Equipment

1 Provide a pressure distributor, power broom, and power blower and sufficient hand tools and power equipment for cleaning the roadway surface before the application of the asphalt tack coat.

#### 409.3.1.6 Stockpiling and Storage

##### 409.3.1.6.1 Aggregate Storage

1 If the mineral aggregates are stored or stockpiled, handle the aggregates to prevent segregating, mixing of the various materials or sizes, or contaminating with foreign materials. Ensure that the grading of aggregates proposed for use is uniform. Use suitable equipment of acceptable size to maintain the stockpiles and prevent segregation of aggregates. Pass the aggregate over a scalping screen immediately before transferring to the microsurfacing mixing machine to remove oversized material. Blending of aggregates may be necessary to meet job mix formula criteria. The RCE will obtain samples of the aggregate for specification compliance. If aggregates are blended together, ensure that any samples taken for gradation testing are sampled from the blended material stockpile and not individual stockpiles. Assume that the moisture is at optimum (3.0%) and add water as necessary.

##### 409.3.1.6.2 Storage of Asphalt Material

1 Provide adequate means of storage to meet the requirements of the production rate for the asphalt material. Maintain all equipment used in the storage and handling of asphalt material in a clean condition at all times and operate so that there will be no contamination with foreign matter.

### 409.3.2 Weather Limitations

1 Ensure that the ambient temperature is 50°F and rising when placing microsurfacing. Use **SC-T-84** to measure ambient temperature at the application site. Do not place any mixture if temperatures are forecasted to drop below 32°F within 24 hours after application.

### 409.3.3 Surface Preparation

1 Clean the area to be surfaced of any vegetation, loose aggregate, or soil and all cracks before overlay. Remove all pavement markings flush with the existing surface before micro Surfacing. When conditions require pre-wetting the surface, spray water ahead of and outside of the spreader box at a rate to dampen the surface without any free flowing water ahead of the spreader box.

### 409.3.4 Test Section

1 Construct a test section to verify the job mix formula and system performance for acceptability. The system used for the test section must be identical to all parts of the proposed system.

2 At the discretion of the RCE, instead of construction of a test section, evidence may be submitted indicating successful construction of a test section on another Department project using the same job mix formulas, equipment, and procedures. The project must have been constructed during the same construction season and time of day and be accepted by the RCE.

3 Construct a minimum 1000-ft long, one-lane width test section to be evaluated for acceptance by the RCE. Construct the test section during the same time of day as the rest of the work is scheduled. When multiple machines are used, lay a test section with each machine to compare to the other machines for variances in surface texture and appearance. Ensure that the microsurfacing test section can carry normal traffic within 1 hour after application without any damage. Full production may begin after the RCE accepts the test section. Locate the test section within the limits of the project and in a location acceptable to the RCE. Do not permit the temperature of the emulsion to exceed 125ºF. If the emulsion is above the temperature limit, postpone the construction of the test strip until the emulsion temperature is under 125ºF. Construct a new test section when the system changes or job mix changes or if there is field evidence that the system is out of control. The system includes the following:

- Emulsion,
- Aggregate supplier,
- Type of mineral filler, and
- Lay down machine.

4 Construct the test section at no additional cost to the Department. Upon acceptance of the test section, the quantities applied during the construction will be included in the total project quantities. If the test section is not accepted by the RCE, remove the section. Reconstruct the test section until the RCE deems the job mix formula acceptable. Only quantities applied on *accepted* test sections will be included and paid for in the total project quantities. Time allotted for the construction of the test section(s) will be included in the Contract completion time, which will not be adjusted upon failure of the test section.

### 409.3.5 Tack Coat

1 Use an asphalt emulsion meeting the requirements of **Subsection 401.2.1.3**, and dilute at the rate of one part emulsion and three parts water and apply with an asphalt distributor. Ensure an application rate of 0.05 to 0.10 gal/sq yd of diluted emulsion. Apply the tack coat according to **Subsection 401.3.13**. A tack coat is not required between the leveling (scratch) course and the surface course provided that the surface course is placed within 30 days of the leveling (scratch) course.

### 409.3.6 Application

1 Spread the paving mixture on the prepared surface to leave a uniformly finished surface. Do not allow excess crowning or overfilling of the rut areas. Use squeegees and lutes to spread the mixture in areas inaccessible to the spreader box and areas requiring hand spreading. Carry a sufficient amount of material at all times in all parts of the spreader box to ensure complete coverage. Ensure that all strike offs are cleaned by washing off with water spray hose after stopping operations or when the mat appearance is noticeably affected by material buildup adhered to the strike offs.

2 Adjust additives, if necessary, to provide a slower setting time when hand spreading is needed. Pour a small windrow along one edge of the surface to be covered, and then spread uniformly by a hand squeegee or lute. Ensure a smooth, neat seam where two passes meet. Remove excess material immediately from the ends of each run.

### 409.3.7 Traffic Control

1 Prohibit traffic on the microsurfacing mixture until it has cured sufficiently to prevent pick up and/or marring of the surface. The RCE may approve the allowance of light, straight-slow flow traffic to proceed after 1 hour of placing mixture. If traffic needs to be established quickly (e.g., at intersections or driveways), apply a light dusting of additional aggregate to the surface to help prevent damage to the finished mixture. Maintain traffic control as necessary to prevent damage to the mixture. Repairs to any such damage done by traffic to the mixture is at no additional cost to the Department.

### 409.3.8 Rut Filling and Leveling (Scratch) Course

1 When required before the final surface course is placed, use preliminary microsurfacing materials to fill ruts, utility cuts, depressions in the existing surface, etc. Conduct rut filling greater than ½-in. in depth and any additional leveling/scratch courses as directed by the RCE. Construct each full width leveling/scratch course by using a full width spreader box with a steel strike-off. Open the leveling (scratch) course to traffic for a minimum of 3 hours before

placement of the final surface. Do not cover rut filling with final surface for at least 12 hours to ensure that all water is dissipated from the mixture. Allow traffic on rut-filled areas for a minimum of 3 hours.

### 409.3.9 Workmanship

1 Do not allow excessive buildup, uncovered areas, or an unsightly appearance on longitudinal or transverse joints. Place longitudinal joints on lane lines and ensure that excessive overlap does not occur. Ensure that straight lines are made along all longitudinal and transverse joints. Keep lines straight at intersections to provide a neat and uniform appearance.

#### 409.3.9.1 Finished Surface

1 Ensure that the finished microsurfacing has a uniform texture free from excessive scratch/tear marks or other surface irregularities. Excessive scratch/tear marks are considered four marks that are ½ in. wide or wider and 6 in. or more in length per 100 sq yd or any marks 1 in. wide or wider or 4 in. in length.

#### 409.3.9.2 Joints and Seams

1 Ensure that longitudinal and transverse joints are neat in appearance and uniform. Construct transverse joints as butt-type joints. Do not allow excessive buildup, uncovered areas, or unsightly appearance on longitudinal or transverse joints. Ensure that longitudinal and transverse edge lines are neat and straight in areas such as curbs, driveways, and intersections. Gaps between applications are prohibited. Joints are acceptable if no more than a ½-in. vertical space exists between the pavement surface and a 4-ft straight edge placed perpendicular on the longitudinal joint and no more than ¼ in. for a transverse joint.

#### 409.3.9.3 Hand Work

1 Use hand tools to provide complete and uniform coverage in areas that cannot be reached with the mixing machine. Clean and lightly dampen the areas before mix placement. Ensure that the finished surface is uniform in texture, dense, and of an overall neat appearance comparable to that produced by the spreader box. Microsurfacing material required to repair deficiencies due to unsatisfactory workmanship will be at no additional cost to the Department.

### 409.3.10 Acceptance

1 Maintain the gradation of the microsurfacing design or as established by the RCE within the listed Mixture Control Tolerances in **Subsection 409.2.7**.

Ensure that additives are maintained or adjusted as needed to provide a stable or uniform mixture during lay down operations. Ensure that the cured mixture adheres fully to the underlying surface. Based upon a visual examination or test results, the RCE may reject any work due to poor workmanship, loss of texture, raveling, or apparent instability. Ensure that residual asphalt emulsion rate and spread rate are calculated as shown in the table below.

| Test | Initial Testing 1st 1000 ft | Additional Testing Every 2000 ft | Mix Control Tolerances |
|---|---|---|---|
| Calculated Residual Asphalt Percent | Contractor Test | Contractor Test | See Job Mix Target |
| Calculated Mixture Spread Rate | Contractor Test | Contractor Test | 20 – 22 lb/sq yd |

2 Make all calculations immediately available to the RCE for review of test data and submit all test data to the RCE immediately upon completion of each day's production. Calculations will be taken from the mixing unit's automated system for continuous operations and calculated manually when truck mounted units are permitted.

## 409.4 Measurement

### 409.4.1 Microsurfacing

1 Microsurfacing Surface Course is measured by the square yard.

### 409.4.2 Rut Filling and Leveling (Scratch Course)

1 Measure and accept rut filling and leveling (scratch) course by the ton of total mix used, including asphalt emulsion.

## 409.5 Payment

1 The RCE will compute the daily average deviation of Contractor test results at the end of the day and, if the results are outside of the Mixture Control Tolerances for asphalt emulsion, the RCE will apply a reduction in Unit Price of 2.0% for each 0.1% the residual asphalt content is outside of the Tolerances. Base all calculations for residual asphalt at 62.0% if Bill of Landing (BOL) tickets are not made available to the RCE for every load of emulsion. Make adjustments as necessary in the mixing operation to maintain production within the tolerances given.

2 The RCE will apply a 5.0% reduction in Unit Price for each pound of aggregate per square yard less than 20 lb/sq yd for each day's placement of material. In lieu of a pay reduction, overlay the deficient area with an additional lift of 20 lb/sq yd at no additional expense to the Department. Control the target spread rate for all microsurfacing based on the weight of dry aggregate. Do not continue operation and placement of materials outside the spread rate tolerances.

3 Payment for Removal of Existing Pavement Markings is under **Section 631**.

4 Payment for the accepted quantity for Microsurfacing Surface Course or Microsurfacing Leveling/Rut Fill at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

5 Payment items under this Section include the following:

| Item No. | Description | Units |
|---|---|---|
| 4090200 | Microsurfacing Surface Course | SY |
| 4090205 | Microsurfacing Leveling/Rut Fill | Ton |

# Section 410 — Preventative Maintenance Thin Lift Seal Course

## 410.1 Description

1 Construct the preventative maintenance thin lift seal course.

## 410.2 Materials

1 Ensure that all materials conform to **SC-M-402**.

## 410.3 Construction

1 Perform all work according to **Section 401,** except where noted in this specification. Place and compact the preventative maintenance thin lift seal course to provide the desired in-place compaction and to produce a smooth riding surface.

### 410.3.1 Roadway

#### 410.3.1.1 Tack Coat

1 Apply approved emulsified asphalt to the surface on which the asphalt thin lift seal course will be placed. Use tack coat materials and application that conforms to **Subsection 401.3.13**. The tack rate may be adjusted to a rate outside of the specified range if the RCE deems necessary.

#### 410.3.1.2 Temperature Requirements

1 Conform to all temperature restrictions in **Section 401**.

#### 410.3.1.3 Spreading, Finishing, and Compaction

1 Spread the preventative maintenance surface treatment to ensure that a minimum loose mat thickness of ¾ in. is achieved directly behind the asphalt paver. The RCE will measure the loose mat thickness every 200 ft paved in the middle of the paving width to check the minimum thickness requirement. The loose compaction depth will be measured using a loose compaction depth gauge provided by the Contractor. Verify that the depth gauge is set correctly before beginning paving each day. The RCE will notify the Contractor if the pavement fails to meet minimum depth requirements. If a total of three or more 200-ft sections do not meet the depth requirements for a day's production, no pay will be given for all sections not meeting depth requirements. All sections not meeting this requirement will be milled and replaced at no additional cost to the Department if the pavement shows signs of raveling or scaling related to low pavement thickness. Ensure that the mixture is rolled with an 8-ton to 12-ton

tandem steel-wheel roller (minimum of two passes). Cease rolling as soon as the mixture is properly seated to the underlying surface.

## 410.4 Measurement

1 Measure this work as specified in **Subsection 401.4**.

## 410.5 Payment

1 This work will be paid for as specified in **Subsection 401.5**. Acceptance of this mixture will be based on **SC-M-400** following the stipulations for Surface Type E.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 4106305 | Preventative Maintenance Thin Lift Seal Course | SY |

# DIVISION 500
# CONCRETE PAVEMENT

## Section 501 — Portland Cement Concrete Pavement

### 501.1 Description

1 Construct a Portland cement concrete pavement on a prepared subbase or base course.

### 501.2 Materials

#### 501.2.1 Portland Cement Concrete Pavement

1 Provide Portland cement concrete materials that conform to **SC-M-501** and **Subsection 701.2**.

##### 501.2.1.1 Joint Fillers

1 Use filler for preformed or sawed joints of the type specified and placed according to joint details shown in the Plans.

###### 501.2.1.1.1 Preformed Expansion Joint Fillers

1 Use preformed joint filler that conforms to **Subsection 723.2.1** and is listed on *Qualified Products List 81.* 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 in. below the surface of the slab.

###### 501.2.1.1.2 Silicone Sealant

1 Use silicone sealant of low modulus and furnished in a one-part silicone formulation. Ensure that the sealant is compatible with the surface to which it is applied. Use silicone sealants that do not require heat or primers to attain a bond to the joint walls. Do not use acid cure silicone sealants on Portland Cement Concrete. Use silicone sealants listed on *Qualified Products List 8* and meeting the requirements of ASTM D5893. 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 with 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's statement that the material meets the Department's specifications and is essentially the same as that on *Qualified Products 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 safety data sheet with each shipment.

#### 501.2.1.1.3 Hot Poured Joint Sealant

1 When specified, use hot poured joint sealant conforming to AASHTO M 324 or ASTM D6690, 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 D6690, Type II. No pre-certification or pre-approval of hot pour joint sealant material is necessary.

#### 501.2.1.1.4 Bond Breaker

1 Use a bond breaker that is compatible with silicone or hot pour sealant, as appropriate, that prevents the sealant from bonding to the bottom of the joint. Provide bond breakers that are chemically inert and resistant to oils, gasoline, and 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 in the Contract documents.

2 Provide properly sized backer rod of circular cross section and consisting of closed cell polyethylene foam that is 25% greater in diameter than the saw cut width, unless otherwise shown on the Plans.

3 Where specified, provide bond breaker tape with a 0.005-in. 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. Ensure that the certification indicates which type of sealant (hot pour or silicone) that the bond breaker is compatible with.

#### 501.2.1.2 Reinforcing Steel

1 Use steel reinforcing bars in concrete pavement of the type, length, size, spacing, and quantity shown on the Plans and that conform to **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, Type S or W, Grade 40 or 60. For dowel bars, use plain round bars conforming to AASHTO M 31, Type S or W, Grade 60 or AASHTO M 322, 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 in. (±¼ in.) of the dowel, having a closed end and having a suitable stop to hold the end of the sleeve at least 1 in. from the end of the dowel bar.

3 Where specified, use wire conforming to **Section 703**.

#### 501.2.1.3 Curing Material

##### 501.2.1.3.1 Burlap Cloth Made from Jute or Kenaf

1 Provide material conforming to the requirements of AASHTO M 182, Class 3 (10 oz/yd) or Class 4 (12 oz/yd).

##### 501.2.1.3.2 Sheet Materials for Curing Concrete

1 Provide waterproof paper, polyethylene film, or white burlap-polyethylene sheet conforming to the requirements of AASHTO M 171.

##### 501.2.1.3.3 Liquid Membrane-Forming Compounds

1 Provide Type 2, white pigmented, liquid curing compounds that conform to **Subsection 702.2.3**. Use materials from sources listed on *Qualified Products List 33*.

#### 501.2.2 Stained Concrete Pavement

1 Use Class 5000 concrete meeting the requirements of **Section 701**.

2 Add coloring to the concrete mix according to the manufacturer's recommendations to achieve an integral color that is uniform throughout the depth of the concrete.

3 Use approved color matched caulking compound for joint sealing.

## 501.3 Construction

1 Submit a Process Control Plan according to **SC-M-505** to the RCE for approval before paving. Keep a copy of the Process Control Plan available for reference on the project at all times. Periodic updates may be required by the RCE.

### 501.3.1 Equipment

#### 501.3.1.1 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 specified lines, grades, and cross sections. Do not use scratch planers with spikes or teeth.

#### 501.3.1.2 Batching Plant and Equipment

##### 501.3.1.2.1 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. Use a batch plant equipped with an accurate non-resettable batch counter that correctly indicates the number of batches proportioned. The batching plant may be manually controlled or automatically controlled.

2 Ensure 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.

##### 501.3.1.2.2 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 the means to enable the removal of overloads before being charged into the mixer. Ensure that weighing hoppers can eliminate accumulations of tare materials and can 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.

#### 501.3.1.2.3 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 ±0.5% when used for cement and ±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. Ensure 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 that 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. Inspect, calibrate, and seal the scales at least every 6 months or sooner if deemed necessary by the RCE. Inspect and calibrate scales according to **Subsection 701.3.1.2.**

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 so that the batch weights required are within a tolerance of ±1.0% for cement and water and ±2.0% for aggregates. Use meters for measuring water that operate within a tolerance of ±1.0%.

4 Provide separate devices in the system for measuring the amounts of chemical admixtures added to each batch that are accurate within ±3.0%, easily adjustable, and satisfactory to the RCE.

### 501.3.1.3 Mixers

#### 501.3.1.3.1 General

1 Mix concrete in central mix plants except when the RCE authorizes the use of truck mixers. Ensure that each mixer has a manufacturer's plate, attached in a prominent location, that presents the capacity of the drum, defined as the volume of mixed concrete, and provides the recommended speed of rotation for the mixing drum or blades.

2 Examine mixers daily for the 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 the dimensions and arrangement of blades in reference to the original height and depth. Repair or replace the blades when they are worn down 1 in. or more from their original dimension.

#### 501.3.1.3.2 Central Mixing Plant

1 Provide central mixing plants that conform to **Subsection 701.3.1.3**. If the plant is a pre-existing ready-mix concrete producer, ensure that the plant is listed on *Qualified Products List 28*. If the plant has been proposed for use to exclusively provide material for a paving project, do not start production until the SME has inspected and accepted the plant.

#### 501.3.1.3.3 Truck Mixers

1 Provide truck mixers meeting the requirements in **Subsection 701.3.1.4**.

### 501.3.1.4 Transporting Vehicles

#### 501.3.1.4.1 Non-Agitator Trucks

1 Use non-agitating hauling equipment for centrally mixed concrete with bodies that are metal with rounded internal corners. If the RCE allows, square-cornered trucks can be used if a washout station is provided to remove build-up. Use trucks equipped with vibrators and capable of discharging the concrete at a satisfactorily controlled rate without segregation. Do not start work until the RCE has inspected trucks to confirm that the vibrators are installed.

2 Dump truck bodies without rounded internal corners may be used if an approved washout station is provided with sufficiently high water pressure and volume to remove all accumulated concrete residue between loads. Remove from service any hauling equipment with accumulated residue until the residue is removed. Include the washout station provisions in the Process Control Plan as defined in **SC-M-505** if equipment without rounded internal corners will be used.

#### 501.3.1.4.2 Truck Mixers and Truck Agitators

1 Use truck mixers for mixing and hauling concrete meeting the requirements in **Subsection 701.3.1.4**.

### 501.3.1.5 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;

- Capable of spreading, consolidating, screeding, and floating the concrete to the required depth 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; and
- Equipped with the necessary electronic or hydraulic devices to control the finished elevation of the pavement. Check and adjust paver guidance equipment during paving to ensure uninterrupted placement to the specified alignment and grade. The RCE may require the use of these controls on a portion or all of the paving work.

#### 501.3.1.6 Forms

1 Use forms to ensure that:

- The sides are straight with sufficient thickness to maintain the true cross section;
- The form sections are not shorter than 10 ft in length;
- The depth is equal to at least the prescribed edge thickness of the concrete pavement without a horizontal joint and a base width not less than 8 in;
- For curves with a 150-ft radius or less, the forms are flexible or curved, of an acceptable design, and of the proper radius;
- Adequate devices for secure setting and mounting are provided to ensure that the forms, once in place, can withstand the impact and vibration of the consolidating and finishing equipment without displaying visible spring or settlement;
- The flange braces extend outward on the base not less than ⅔ the height of the form;
- The top surfaces are not battered;
- The forms are not bent, twisted, or broken;
- The forms are not repaired forms unless inspected and approved by the RCE;

- The forms are not built-up forms except where the total area of pavement of any specified thickness on the Project is less than 3000 sq yd. Built-up forms may extend the form depth up to 25%. Ensure that the build-up is securely attached to the bottom of the form;
- The top face does not vary from a true plane by more than ⅛ in. in 10 ft;
- The upstanding leg does not vary more than ¼ in; and
- The forms are equipped to lock the ends of abutting form sections together tightly for secure setting.

#### 501.3.1.7 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.

#### 501.3.1.8 Finishing Equipment

##### 501.3.1.8.1 Finishing Machine

1 For stationary side-forms, use finishing machines equipped with at least two oscillating type transverse screeds.

##### 501.3.1.8.2 Vibrators

1 Use vibrators for the full-width vibration of concrete paving. Provide vibrators to consolidate the concrete for the full width. Use either the surface pan type (limited to pavements 8.0 in. thick or less) or the internal type with either immersed tube or multiple spuds. Ensure that the vibrators are attached to the spreader or finishing machine or mounted on a separate carriage. Do not touch joints, load transfer devices, the subgrade, or side forms. Limit the minimum vibration frequency to 3500 vpm, tube vibrators to 5000 vpm, and spud vibrators to 7000 vpm, unless otherwise authorized by the RCE. Maintain a minimum vibration frequency of 3500 vpm when using spud-type internal vibrators next to the forms. Do not allow the vibrators to contact with load transfer devices, subgrade, or side forms.

2 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 minimum frequency of 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.

#### 501.3.1.9 Transverse Groover

1 Unless the pavement is intended to receive a diamond ground surface as the final finish, produce a surface texture as required in **SC-M-502**.

#### 501.3.1.10 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 approved by the RCE, apply curing compound by hand for small or irregular areas.

#### 501.3.1.11 Concrete Saws

1 Provide sawing equipment in adequate quantity and sufficient 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 equipment on site in working order before beginning each workday and continuously during concrete placement.

#### 501.3.1.12 Equipment to Install Joint Filler

##### 501.3.1.12.1 Hot Pour Elastic Joint Filler

1 Use equipment capable of producing conforming joint seals by cleaning the joint and heating and installing sealant in joints according to the manufacturer's recommendations.

##### 501.3.1.12.2 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 PTFE (commonly referred to as Teflon™) or equivalent and hoses lined with PTFE 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.

#### 501.3.1.13 Field Office and Laboratory

1 Conform field offices and laboratories to the requirements of **SC-M-501**.

### 501.3.2 Preparation of Subgrade, Subbase, and Base

1 Complete base placement operations at least 2500 ft 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 in. in width extending beyond the edges of the concrete pavement 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 ft in width extending beyond the back of the curb and gutter. Complete the base and subbase for at least 2500 ft in advance of concrete placing operations when this distance is available.

### 501.3.3 Conditioning of Subgrade or Base Course

#### 501.3.3.1 Compaction

1 Thoroughly compact the subgrade, subbase, and base as specified. Maintain all specified compaction levels until 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.

#### 501.3.3.2 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 a condition that will drain readily. Do not place any overlying layer until the subbase or base has been tested and approved by the RCE.

#### 501.3.3.3 Finish for Base

1 Before paving begins, bring the subbase to the proper cross section. Repair any areas that do not meet the specified cross section by a method approved by the RCE. This repair work may include trimming high areas to proper elevation. Either fill and compact low areas to a condition similar to that of the 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 the specified thickness of the finished pavement. Ensure that the grader has the capacity of cutting the surface without reducing compaction. Recondition the surface as necessary for a sufficient distance ahead of the placement of concrete to allow the necessary inspection and testing of the subbase or base.

### 501.3.4 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 as 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 ft, and the maximum length is 20 ft.

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 that 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.

### 501.3.5 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 RCE approval. Buildup stockpiles in layers of not more than 3 ft in thickness. Ensure that each layer is completely in place before beginning the next layer. Do not allow subsequent layers to cone down over the previous layer. Under no circumstances will the 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 where materials will be stockpiled, and ensure that the surface is smooth, firm, and well drained.

2 Move aggregates from stockpiles or other sources to the batching plant so as 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. If the aggregate contains a 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 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. Ensure that the volume of the auxiliary tank is at least equal to that of the measuring tank.

6 Use methods and equipment for adding the air-entraining agent or other admixtures into the batch that complies with **Subsection 701.3.4.4**. Do not use equipment that does not accurately and continuously dispense the correct amount of admixture.

### 501.3.6 Weather and Lighting Conditions

1 Do not pave when any of the following conditions exist:

- A descending air temperature at the location of the concrete paving operation and away from artificial heat reaches 35°F. Note: paving may resume when the National Weather Service Forecast for the construction area is projected to reach a high of 40°F on the day's operation, and the ambient air temperature in the shade and away from artificial heat is at least 35°F and rising.
- The subgrade or base is frozen.
- Aggregates to be used in the mix contain frozen particles.

- Air temperature in the shade is 90°F and rising or the concrete temperature is greater than 95°F.

2 Cease concrete operations when the temperature is expected to drop to 32°F within 4 hours. If the temperature falls below 32°F before the concrete has hardened sufficiently to resist damage from frost action during the early curing stages, provide sufficient insulated curing blankets to cover the vulnerable areas. Regardless of the temperature at the time of placement, remove and replace any concrete damaged by frost action at no additional cost to the Department.

3 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.

### 501.3.7 Mixing Concrete

1 Mix the concrete in a central-mix plant. Truck mixers may be used when allowed by the RCE.

#### 501.3.7.1 Central Plant Mixing

1 Conduct plant operations to comply with **Subsection 701.3.5.4** and the additional requirements or changes below.

#### 501.3.7.2 Mixing Time

1 When using a mixer having a rated capacity greater than 2 cu yd, 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.

#### 501.3.7.3 Overload

1 The RCE may permit overloads up to 10% above the mixer's nominal capacity provided that the concrete strength test data is satisfactory, a uniform consistency is achieved, and no segregation or spillage of concrete occurs.

#### 501.3.7.4 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 45 minutes when the concrete is hauled in non-agitating trucks, or 75 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 provided that 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.

#### 501.3.7.5 Truck Mixing

1 Use truck mixers that comply with **Subsection 701.3.5.5**.

### 501.3.8 Stained Concrete Pavement

1 Before beginning work on the stained concrete, provide an approximately 2 ft × 2 ft sample, poured on site, for approval by the RCE. Ensure that the sample remains on site for the duration of the Project for comparison purposes. Dispose of the sample after the RCE accepts the Project.

2 Provide the specified color as shown in the Contract. Ensure that a representative of the manufacturer is on site during the construction of the stained concrete area.

3 Apply curing agents over the stained concrete area. Seal the surface of the slab after the initial curing period according to the manufacturer's recommendations. Caulk joints with an approved color matched compound.

### 501.3.9 Placing Concrete

1 Dampen the base or subgrade with a fine water mist immediately before placing concrete. Do not permit free-standing water to puddle on the surface.

2 Do not place concrete on any surface with a temperature of 120°F or greater.

3 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.

4 Deposit the batches with 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. Keep concrete free of mud, soil, or any other foreign matter.

5 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.

6 Place concrete over and against the joints to ensure that joints, dowel bars, and load transfer assemblies are retained in the correct position.

7 Perform continuous placement between transverse joints without the use of intermediate bulkheads, except as provided below for construction joints.

8 Thoroughly consolidate concrete against the faces of all forms and joints, including concrete in a previously constructed lane of pavement, with vibrators inserted in the concrete. Use vibrators that meet the requirements specified in **Subsection 501.3.1.8.2**. Do not permit vibrators to contact a joint assembly, the grade, or a side form. Do not operate vibrators more than 15 seconds in any one location. Do not operate vibrators in a way that brings excess mortar to the surface or causes segregation in the mix.

9 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 501.2.1.1**.

10 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 field cured compressive strength of 3000 psi shown by tests of 6 in. by 12 in. cylindrical specimens. On areas where hand methods of placing and finishing are allowed in **Subsection 501.3.15**, 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 40ºF. 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.

11 Do not re-temper concrete by adding water or by any other means. Do not use concrete that is outside of 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.

12 To protect the concrete against the 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.

### 501.3.10 Slabs Adjacent to Bridge Ends and Bar Mat

1 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 the 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 according to the Plans. For measurement, 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.

### 501.3.11 Tapers at Acceleration and Deceleration Lanes

1 Use the method of widening for tapers shown on the Plans or as approved by the RCE.

### 501.3.12 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. When 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. Submit 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.

### 501.3.13 Slipform Concrete Paving

#### 501.3.13.1 Slipform Method

1 Use a slipform-paving machine unless the area to be paved is inaccessible or as otherwise permitted by the RCE. Do not allow wheeled equipment that disturbs the track line for other equipment or does not perform satisfactorily in the paving train.

2 Do not allow vehicular traffic or mixing equipment on the completed base without the permission of the RCE.

#### 501.3.13.2 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. Ensure that slumping of the concrete does not exceed ⅜ in. from a

typical cross section. Ensure that slump at longitudinal construction joints does not exceed ¼ in. 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 minimum stopping and starting of the machine. If 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 the devices and procedures 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 according to **Subsection 501.3.14**.

### 501.3.14 Fixed Form Concrete Paving

#### 501.3.14.1 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 ½ in. or less for a distance of 18 in. on each side of the base of the form, and compact thoroughly. Correct imperfections or variations above grade by tamping or by cutting. Except for 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.

#### 501.3.14.2 Form Setting

1 After the forms have been set to the correct grade, thoroughly tamp the subbase 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 Ensure that the form sections are tightly locked such that the forms are free from play or movement in any direction. Ensure that the forms do not deviate from true line by more than ¼ in. 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 ft in advance of the point of depositing concrete when that distance is available.

### 501.3.14.3 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. Do not 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 one part Portland cement to two parts fine aggregate by weight. Remove and replace any major honeycombed areas. Immediately after the forms have been removed, spray the sides of the slab with curing compound at the appropriate rate.

## 501.3.15 Final Strike-Off, Consolidation, and Finishing

### 501.3.15.1 Consolidation and Strike-Off

1 As soon as the concrete has been 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 to prevent 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 conditions, such as equipment breakdown, prevent machine finishing, 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 impractical; or
- When other conditions warrant hand methods and are permitted by the RCE.

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 two, and at intervals that produce the desired results. Carry a slight excess of concrete ahead of the cutting edge.

### 501.3.15.2 Floating

1 After the concrete has been struck-off and consolidated, further smooth and true the surface.

#### 501.3.15.2.1 Hand Methods

1 Use hand methods only if specifically permitted by the RCE. Use hand-floats not less than 14 ft long and 6 in. wide, properly stiffened to prevent warping and flexibility, and reasonably light to prevent the float from working into the surface.

#### 501.3.15.2.2 Transverse Smoothing Float

1 Provide a machine-operated transverse smoothing float with the floats suspended from and guided by a rigid frame. Ensure that the forms carry the frame and that it has a minimum effective wheelbase of 14 ft. Ensure that the length of the float is approximately 2 in. 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 so that 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.

#### 501.3.15.2.3 Additional Floating Requirements

1 If necessary, following one of the preceding methods of floating, use long-handled floats having blades no less than 5 ft long and 6 in. 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-ft long by 4-in. to 6-in. wide float.

### 501.3.15.3 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. Ensure that the surface is smooth and free from irregularities when checked with a 10-ft or longer straightedge.

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. 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 with approved equipment.

### 501.3.15.4 Final Finishing

1 Conform to **SC-M-502** for requirements on final finishing.

### 501.3.15.5 Edging at Forms and Joints

1 Produce ¼-in., well-defined, flush, and neat joints before initial set, including radius joints.

2 Broom the surface at all joints to eliminate tool marks without disturbing the corner radius. Remove all concrete on top of the joint filler.

3 Check all joints with a straightedge before the concrete has set. Ensure that both sides of the joint are uniform.

### 501.3.16 Curing

1 Immediately after the finishing operations and after the surface water has disappeared, mechanically apply a uniform coating of white pigmented curing compound to the entire surface and vertical faces.

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 with a power-operated pressure spraying or distributing equipment at the manufacturer’s recommended rate, but not less than 0.06 gal/sq yd 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 100ºF. 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 falls 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 perform 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.

### 501.3.17 Joints

#### 501.3.17.1 General Requirements

1 Apply materials according to the manufacturer's recommendations regarding the preparation of joint walls, application temperatures, and the necessary equipment to ensure proper placement of material. Submit all documentation to the RCE for approval a minimum of 12 days before using the materials.

2 Cut all joints using a diamond-bladed saw; parting strips and tooling are not acceptable.

3 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. Do not allow the edges of the pavement, including longitudinal joints, to deviate from the specified line by greater than ½ in. at any point.

4 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.

5 When deformed steel bars are used 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 the required locations. 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.

7 Hold dowels in position, parallel to the surface and centerline of the pavement, either with an approved metal dowel support that will remain in the pavement or an automatic dowel bar inserter. Ensure that the dowel bar alignment, materials, and equipment conform to the requirements of **SC-M-504**. Ensure that the dowels are coated with a bond breaking coating as required in **Subsection 501.2.1.2** to permit free horizontal movement at the transverse joint.

8 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 501.2.1.2**.

9 Use preformed expansion material in expansion joints that is prepared according to **Subsection 501.2.1.1.1** and placed perpendicular to the pavement surface.

### 501.3.17.2 Longitudinal Joints

#### 501.3.17.2.1 General

1 Construct longitudinal joints in all concrete pavement 16 ft or more in width. If a specific 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.

#### 501.3.17.2.2 Longitudinal Sawed Joints

1 Cut longitudinal sawed joints using approved concrete saws to the required depth, width, and line. 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 501.3.18**.

#### 501.3.17.2.3 Longitudinal Weakened Plane Joints

1 Weakened plane joints (parting strips) are not permitted.

### 501.3.17.3 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, according to the requirements in **Subsection 501.3.17.1**. 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.

3 Ensure that the expansion joint filler is held in a position normal to the surface. Use an approved installation 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 ¼ in. 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 in.

### 501.3.17.4 Transverse Contraction Joints

1 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 a concrete saw approved by the RCE. 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 so that the sawing process can prevent uncontrolled shrinkage cracking.
- If sharp-edged joints are being obtained, expedite the sawing process until some raveling is observed.
- Continue this process non-stop 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.

### 501.3.17.5 Transverse Construction Joints

1 The following applies to transverse construction joints:

- General. Construct transverse construction joints using an approved form and header board at the end of each day's operation (planned joint) or when placing concrete is suspended for more than 30 minutes (emergency joint).

- Planned Transverse Construction Joints. Locate this type of joint at the same spacing required for contraction joints. Use dowel bars of the size and spacing as specified.
- Emergency Transverse Construction Joints. Use this type of joint when placing concrete is suspended for more than 30 minutes. Use tie bars of the size and spacing as specified. Do not change the spacing of contraction joints due to emergency construction joints. Locate the emergency construction joints at least 6 ft from any contraction joint or planned construction joint.

2 When the concrete placement operation has been resumed, remove the header board and remove any surplus concrete from 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; just neatly finish the joint.

### 501.3.18 Sealing Joints

#### 501.3.18.1 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. Ensure that the final sealed surface width of all newly constructed longitudinal and transverse contraction joints is ⅜ in. ±1/16 in. 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 the joint in one direction to prevent re-contamination.

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 in. to 2 in. 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 and the 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 that can remove 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 that all joints to be sealed are sound, clean, dry, and frost free. 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.

### 501.3.18.2 Installation of Sealants

1 Select a sealant type according to **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. Ensure that the backer rod or other bond-breaker is compatible with the sealant. Use installation methods and equipment according to 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 with 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 according to 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 according to this specification at no additional cost 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 any joints fail to perform properly, as determined by the RCE, during the 180-day period due to defects in workmanship or materials, repair the joints as specified above.

5 Immediately remove any material spilled on the pavement. Do not use solvents to remove spills.

### 501.3.18.3 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 has 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.

### 501.3.19 Protection of Pavement

1 Exclude all vehicular 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 one-half of the actual time.

2 Alternatively, cure concrete for a period of 48 hours as specified or until field-cured test specimens indicate a 3000 psi per ASTM C31 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 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. Ensure that these crossings are adequate for traffic and satisfactory to the RCE.

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.

6 If a rain shower occurs during construction, have available at all times a mechanical device with an appropriate supply of rolled polyethylene that can span the pavement along with the paving equipment. Ensure that the device can mechanically unroll the polyethylene over the portion of the slab that has not set sufficiently to resist the rain.

### 501.3.20 Requirements for Smoothness and Rideability

1 Ensure that smoothness and rideability conform to the requirements in **SC-M-502**.

### 501.3.21 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 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 the required width of through-lane pavement constructed and is measured by the square yard (SY), complete 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 and accepted.

3 The quantity for the pay item Stained Concrete Pavement (of the uniform thickness specified) is measured by the square yard (SY), complete and accepted.

4 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.

5 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.

## 501.5 Payment

1 Payment for the accepted quantity for Portland Cement Concrete Pavement (of the uniform thickness specified), Portland Cement Concrete Pavement for Ramps (of the uniform thickness specified), or Stained Concrete Pavement at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 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.

3 No compensation is made for the materials or labor involved in the removal, repair, or replacement of defective slabs.

4 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 |
| 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 |
| 5019010 | Stained Concrete Pavement (8″ Uniform) | SY |

# Section 502 — Full Depth Concrete Pavement Patching

## 502.1 Description

1 Construct full depth patches of Portland cement concrete pavement.

## 502.2 Materials

### 502.2.1 General

1 Use materials that meet the requirements of **Sections 305, 501**, **701**, and **703**.

### 502.2.2 Portland Cement Concrete

1 Use Portland cement Type I, Type III, or Type 1L from an approved source listed on *Qualified Products List 6*. Ensure that the minimum cement content for patching concrete is 800 lb/cu yd 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 *Qualified Products 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 3.0% to 6.0% when tested according to AASHTO T 152.

2 Submit mix designs to the SME according to **Subsection 701.2.12**, except as modified by the mix requirements of this Section. 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, as determined by the Contractor, so that the patch may be opened to traffic within 6 hours of placement. Replace any patch that develops cracking or deformation within 45 days after opening to traffic at no additional cost to the Department.

### 502.2.3 Reinforcing Steel

1 Provide tie bars and dowel bars as specified in the patching detail that conform to **Subsection 501.2.1.2**.

### 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 C881, 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 lb.

### 502.2.5 Maintenance Stone

1 Where maintenance stone is required, use aggregate that meets the requirements of **Subsection 305.2.6.2**.

## 502.3 Construction

### 502.3.1 General

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. The boundaries of the patch area will be of sufficient width and length to ensure that all distressed concrete is removed. Transverse boundaries are not necessarily perpendicular to the shoulder in all cases but are at least 18 in. away from transverse cracks in the good concrete.

2 Place pavement replacement slabs where distressed concrete has been removed. The replacement slabs range in size from 12 ft wide by a minimum of 6 ft long up to the full slab length for jointed concrete pavements. Patches of continuously reinforced concrete pavements have a minimum dimension of 6 ft in both length and width. The depth is nominally equivalent to the depth of the existing pavement.

3 Conduct the full depth concrete pavement patching work when conditions offer 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 501.3.6**.

### 502.3.2 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.

### 502.3.3 Removal of Existing Pavement

1 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 in. of the transverse limits of the patch. Prepare the deteriorated pavement slab for removal by either of the following procedures:

Procedure 1. Make a ¼-in. 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.

Procedure 2. Make a sawcut in the shoulder at a distance of 12 in. parallel to the pavement/shoulder longitudinal joint. Sawcut the length of the required pavement patch plus enough distance to accommodate formwork.

2 Use Procedure 1 on patches 6 ft to 12 ft 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.

3 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 will be placed later, repair the shoulder area with temporary material that consists of thoroughly compacted Maintenance Stone and topped with an asphalt surface course selected by the RCE. If no drains are required, repair the shoulder area as specified in **Subsection 502.3.10**.

4 During the removal of the deteriorated pavement and the placement of new concrete, prevent damage to the vertical sawcut in the existing pavement or to the base material.

5 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, leaving the shear steel. If the shear steel is inadvertently removed or damaged, re-establish the steel by drilling into the terminal end, and epoxy new shear steel equivalent in area to the old shear steel.

6 Dispose of the concrete pavement that has been removed in a proper manner. Do not allow saw-water from the pavement removal operations to deteriorate compacted base material in the replacement area.

### 502.3.4 Base Preparation

1 After the deteriorated pavement has been removed, prepare the base and compact it to the depth of the existing pavement. If poor materials are encountered when removing any existing base material, remove additional material and establish a new grade depth as directed by the RCE. Use Maintenance Stone 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. Correct any deterioration of the base before placing new concrete.

### 502.3.5 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.

### 502.3.6 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 specified.

2 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.

### 502.3.7 Concrete Finishing

1 Apply to 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 702.2.3**.

### 502.3.8 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.

### 502.3.9 Joints

1 Seal joints according to **Section 504**.

### 502.3.10 Repair of Shoulders

#### 502.3.10.1 General

1 Where it is necessary to place side forms adjacent to the shoulder, repair the damaged shoulder. Use a repair method conforming to the following requirements based on the type of shoulder material.

#### 502.3.10.2 Asphalt Shoulder

1 Repair damaged shoulder with Maintenance Stone and Hot Mix Asphalt Surface Course – Type C overlay as directed by the RCE.

### 502.3.10.3 Portland Cement Concrete Shoulder

1 Repair Portland Cement Concrete shoulder with the 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 to bond fresh concrete to old concrete and certified to meet ASTM C881, 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.

### 502.3.11 Opening Pavement to Traffic

1 Open the patched pavement to traffic when the concrete has developed sufficient strength, as determined by the Contractor. If the concrete patch develops any distress or distortion within 45 days after opening to traffic, remove and replace the patched pavement.

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. Begin grinding operations at a distance before the patch equal to the patch length or 25 ft, 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.

## 502.4 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 and accepted. Patches constructed outside the area designated to be patched are disregarded in computing the quantity for payment.

2 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 measured separately. The cost of this work is included in the Contract unit bid price for the concrete patching pay item.

3 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 placed and accepted is converted into equivalent square yards of the depth of patching as shown on the Plans.

4 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 directed by the RCE and is measured by

the cubic yard (CY) to the level of the bottom of the concrete pavement, complete and accepted. If Maintenance Stone is used for this purpose, it is measured and paid for as specified in **Subsections 305.4** and **305.5**.

5 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.

## 502.5 Payment

1 Payment for the accepted quantity for Full Depth Concrete Pavement Patching (of the thickness specified) or Portland Cement Concrete (Special) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 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 Patch – 8.5″ | SY |
| 5021020 | Full Depth Concrete Patch – 9″ | SY |
| 5021025 | Full Depth Concrete Pavement Patch – 10″ | SY |
| 5021030 | Full Depth Concrete Pavement Patch – 11″ | SY |
| 5021035 | Full Depth Concrete Patch – 12″ | SY |
| 5021037 | Full Depth Concrete Patch – 13″ | SY |
| 5029000 | Portland Cement Concrete (Special Use) | CY |

# Section 503 — Grinding and Texturing Concrete Pavement

## 503.1 Description

1 Grind and texture Portland cement concrete pavement longitudinally.

## 503.2 Materials

1 Conform to **SC-M-502**.

## 503.3 Construction

1 Conform to the construction and equipment requirements pertaining to grinding and texturing concrete pavement in **SC-M-502**.

## 503.4 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.

## 503.5 Payment

1 Payment for the accepted quantity for Grinding and Texturing Existing Concrete Pavement at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 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 PCCP

## 504.1 Description

1 Perform the rehabilitation of joints and cracks in Portland cement concrete pavements by cleaning, preparing, and placing the specified sealant.

## 504.2 Materials

### 504.2.1 General

1 Use materials that meet the requirements of **Section 501**. Select sealant material according to the following table.

| Application | ASTM D6690, Type II Sealant | Silicone Sealants | |
|---|---|---|---|
| | | Non-Sag | Self-Leveling |
| Old concrete pavement with transverse and lane longitudinal joints[1], uniform joint widths[3] – no overlay | | ✓ | ✓ |
| Old concrete pavement with transverse and lane longitudinal joints[1], non-uniform joint widths[3] – no overlay | | ✓ | |
| Old concrete pavement with 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] | ✓ | | ✓ |
| 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 **Subsection 501.2.1.1.2**.

## 504.3 Construction

### 504.3.1 Equipment

1 When silicone sealant is required, use equipment conforming to **Subsection 501.3.1.12.2**. When hot-poured sealant is required, use equipment conforming to **Subsection 501.3.1.12.1**.

### 504.3.2 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 in. to 2 in. 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, and 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 is 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.

### 504.3.3 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 according to 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 according to **Subsection 501.3.18.3**.

2 Place the sealant in the joint according to 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 according to 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 according to this specification. 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 the RCE determines that any joints fail to perform properly during the 180-day period due to defects in workmanship or materials, repair the joints as specified above.

5 Immediately remove any material spilled on the pavement. Do not use solvents to remove spills.

### 504.3.4 Installation of Hot Poured Sealants

#### 504.3.4.1 General

1 When hot poured sealant, as specified in **Subsection 501.2.1.1.3** is used, handle and apply as indicated in this Subsection and **Subsection 504.3.4.2**.

2 Do not store the sealant material in direct sunlight or in an ambient temperature over 100ºF. Store the material under cover or roof with adequate ventilation. 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.

### 504.3.4.2 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.

### 504.3.4.3 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 45ºF 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.
- Discharge the first gallon of material at the beginning of the day 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 in. below the lower top of joint surface.

## 504.4 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.

## 504.5 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 at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 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 — Repairing Random Cracks in PCCP

## 505.1 Description

1 Route, clean, and seal 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 ⅛ in. or more and are greater than 10 ft 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**.

## 505.3 Construction

### 505.3.1 General

1 Prepare cracks by removing any existing sealant, re-facing and cleaning the crack, installing blocking medium as needed, and sealing the crack.

### 505.3.2 Equipment

1 Use sealing equipment according to **Subsection 501.3.1**. Use a concrete saw with a pivotal small diameter blade that follows the crack to provide a reservoir for the sealant material.

### 505.3.3 Preparation of Cracks

1 Remove old sealant, re-face, and clean cracks according to **Subsection 504.3.2**. Widen the cracks to the widths and depths shown in the Plans or as directed by the RCE.

2 For cracks ⅜ in. 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. Do not stretch the rods during installation.

3 For cracks less than ⅜ in. wide, the use of a blocking medium is optional if the seals produced are satisfactory. If the seals prove to be unsatisfactory, the RCE may require subsequent crack rehabilitation to include installation of a blocking medium.

### 505.3.4 Installation of Sealant

1 Install sealant according to **Section 504**.

## 505.4 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.

## 505.5 Payment

1 Payment for the accepted quantity for Route, Clean, and Seal Cracks at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 5051000 | Route, Clean, and Seal Cracks | LF |

# DIVISION 600
# MAINTENANCE AND CONTROL OF TRAFFIC

## Section 601 — Work Zone Traffic Control Devices

### 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 right-of-way in conformity with the Plans, the Specifications, or as directed by the RCE.

2 The Department has adopted the FHWA *Manual on Uniform Traffic Control Devices* (MUTCD) as the official source for traffic control guidelines for SCDOT policies and procedures for installing and maintaining signs, markings, and signals. The MUTCD provides the minimum requirements for installation, operation, and maintenance of all traffic control devices.

3 The Contractor is not required to provide traffic control on any portion of the highway outside of the work specified in the Contract. 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 erected by the Department within the limits of the project.

4 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. If the permanent construction signs are omitted, install temporary signs while the work is in progress.

5 All signs in the MUTCD have an identification number. A full-scale drawing of each sign is available for sign fabricators from the Director of Traffic Engineering.

#### 601.1.2 Traffic Management Plan

##### 601.1.2.1 General

1 *The Policy for South Carolina Department of Transportation and Rule on Work Zone Safety and Mobility: Implementation, Maintenance, and Safety Guidelines* (i.e., the Policy) requires development of a set of coordinated strategies, hereinafter known as the Transportation Management Plan (TMP), to manage the work zone impacts for each project. The Policy describes the development, design, and implementation requirements for a TMP.

2 The possible TMP components are:

- Temporary Traffic Control Plan (TTC),
- Transportation Operations Plan (TO), and
- Public Information Plan (PI).

3 A TMP will always have a TTC component.

4 To change any component of a TMP, submit an alternative TMP according to the requirements of the Policy for review and acceptance a minimum of 21 days in advance of the anticipated implementation to allow for adequate review time. No adjustment in compensation or extension of the completion date(s) will be allowed due to the review time of the alternative. If an alternative TMP is implemented, the Contractor is responsible for any unanticipated changes to subsequent phases and steps.

### 601.1.2.2 Temporary Traffic Control Plan

1 Provide a TTC for the maintenance and control of traffic during work within the right-of-way. This includes work by the Contractor, subcontractor, sub-subcontractor, supplier, or anyone working within the right-of-way. Ensure that the TTC includes procedures and guidelines for the safe passage of traffic through and/or around the project area to minimize the inconvenience to the traveling public. Ensure that the TTC conforms to the requirements of the Plans, the *Standard Drawings*, the Specifications, the manufacturer's requirements and specifications, the MUTCD, and the RCE.

2 Ensure that the TTC includes provisions for the installation, maintenance, repair, replacement, relocation, and removal of all traffic control devices used for regulating, warning, or directing traffic. All traffic control devices remain the property of the Contractor unless otherwise indicated in the Specifications or on the Plans.

3 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 according to the TTC.

4 When the Specifications or Plans do not cover a necessary traffic control condition, design, develop, and provide a TTC to address the traffic control condition to the RCE and obtain the RCE's approval of the TTC before beginning the work relative to the traffic control condition in question. Ensure that the TTC meets the design and development requirements in **Subsection 601.3.1** and the Policy.

5 The RCE is responsible for initiating the request of the assistance from 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

#### 601.1.3.1 General Restrictions

1 The Department reserves the right to restrict the installation of lane closures, road closures, shoulder closures, ramp closures, pacing and mobile operations, or any other operations that will impact the efficient flow of traffic or hinder normal traffic operations on state highway system routes during peak travel hours and/or days, holidays, holiday weekends, extended holiday periods, weekends, special events, or any time traffic volumes are high. Lane closures on high volume highways during peak traffic periods or at any time traffic volumes exceed the numerical values determined to be acceptable by the Department are PROHIBITED. Lane closures on routes with high volume commuter traffic during peak traffic periods are PROHIBITED.

2 Special events are events generating excessive traffic as determined by the Department.

3 The Department reserves the right to suspend a lane closure, road closure, shoulder closure, pacing operation, or any other operation if the RCE determines a delay or a resulting traffic backup is excessive. Observe and maintain all project specific time restrictions as specified by the Plans, the Specifications, and the RCE. Install and remove any traffic flow restricting operations within the time restrictions including all relative traffic control devices and signs. Coordinate this work according to all restrictions.

4 Installation and maintenance of a lane closure is PROHIBITED when not actively engaged in work activities specific to the location of the lane closure unless otherwise specified and approved by the RCE. Ensure that the length of the lane closure does not exceed the length of roadway anticipated to be subjected to the proposed work activities within the work shift time frame or the maximum lane closure length specified within the Contract, unless otherwise specified and approved by the RCE. A maximum lane closure length specified in the Contract does not warrant installation of the specified lane closure length when the length of the lane closure necessary for conducting the work activity is less. Obtain the RCE's approval for each lane closure length and duration. The length and duration of each lane closure may be reduced by the RCE if the work zone impacts generated by a lane closure are deemed excessive or unnecessary.

5 The presence of temporary signs, portable sign supports, traffic control devices, trailer-mounted equipment, truck-mounted equipment, personnel, and vehicles relative to the installation or removal of a closure is PROHIBITED within the clear zone during the prohibited hours.

#### 601.1.3.2 Holiday Restrictions

1 The Department prohibits lane closures, road closures, shoulder closures, mobile operations, pacing operations, or any other operations that will impact

the efficient flow of traffic on interstate highways during holiday weekends and extended holiday periods as defined in the table below unless otherwise directed by the RCE. Holidays observed on a Monday will include the weekend that is considered a holiday weekend.

| | Day of Week | Lane Closure Duration | |
|---|---|---|---|
| | | **From** | **To** |
| Monday Holiday Weekend | | 6:00 am of the Friday before the weekend | 6:00 am of the Tuesday after the holiday |
| Easter | | 12:00 noon of the Thursday before Easter | 6:00 pm of the Monday after Easter |
| Thanksgiving | | 12:00 noon of the Wednesday before Thanksgiving Day | 6:00 am of the Monday after Thanksgiving Day |
| Independence Day | Monday | 6:00 am Friday, July 1st | 10:00 pm Tuesday, July 5th |
| | Tuesday | 6:00 am Monday, July 3rd | 10:00 pm Wednesday, July 5th |
| | Wednesday | 6:00 am Tuesday, July 3rd | 10:00 pm Thursday, July 5th |
| | Thursday | 6:00 am Wednesday, July 3rd | 10:00 pm Friday, July 5th |
| | Friday | 6:00 am Thursday, July 3rd | 10:00 pm Monday, July 7th |
| | Saturday | 6:00 am Thursday, July 2nd | 10:00 pm Monday, July 6th |
| | Sunday | 6:00 am Friday, July 2nd | 10:00 pm Tuesday, July 6th |
| Christmas Holiday | Monday | 6:00 am Friday, December 22nd | 10:00 pm Wednesday, January 3rd |
| | Tuesday | 6:00 am Friday, December 21st | 10:00 pm Thursday, January 3rd |
| | Wednesday | 6:00 am Friday, December 20th | 10:00 pm Friday, January 3rd |
| | Thursday | 6:00 am Tuesday, December 23rd | 10:00 pm Sunday, January 4th |
| | Friday | 6:00 am Wednesday, December 23rd | 10:00 pm Sunday, January 3rd |
| | Saturday | 6:00 am Thursday, December 23rd | 10:00 pm Monday, January 3rd |
| | Sunday | 6:00 am Friday, December 23rd | 10:00 pm Tuesday, January 3rd |

### 601.1.3.3 Waiver of Restrictions

1 Waiver or modification of the restrictions or the established hourly lane closure prohibition hours require approval from either the Deputy Secretary of Engineering or designee(s). When requesting a waiver or modification of these restrictions, submit the request to the RCE no less than 30 days before the day in question. The Department reserves the right to approve, deny, and/or rescind waivers at its discretion. The Department reserves the right to suspend a lane closure, road closure, shoulder closure, pacing operation or any other operation if the RCE determines that a delay or a resulting traffic backup is excessive.

## 601.1.4 Contractor's Responsibility

1 These Specifications set forth specific procedures and requirements and do not relieve the Contractor of any responsibilities for complying with the Policy, the manufacturer's specifications, the MUTCD, and the RCE.

2 Implement the TMP as required by the Specifications, the *Standard Drawings*, the MUTCD, and the RCE. Observe all requirements of the TMP, and ensure that all subcontractors working on the project site observe all requirements of the TMP.

3 Ensure that a trained employee as specified in **Subsection 610.3.2** with proper authority is present on the job site at all times when construction activities are in progress to confirm the intended implementation and necessary maintenance of the TMP. Ensure that an "on-call" person is available 24 hours a day to take corrective actions if a performance failure of traffic control devices or an emergency occurs. The "on-call" person will ensure that the temporary traffic control is performing correctly. If a situation requires higher authority than available to the "on-call" person (e.g., an accident or emergency), immediately notify a superior who can authorize the necessary actions to coordinate and restore temporary traffic control to its pre-event condition.

4 Provide the RCE Form 600.01 before starting work. This notification documents the Contractor's intent to accept the TMP included in the Contract as is. If an alternative TMP is accepted per **Subsection 601.1.2**, submit an updated Form 600.01. Acquire, provide, and install all items necessary to implement all components included in the TMP specific to the project.

5 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 regulations set forth by the Specifications, each Contractor, subcontractor, sub-subcontractor, or anyone working on contiguous and overlapping projects must coordinate work activities.

6 Maintain the travel patterns directed by the TMP and execute the construction schedules expeditiously. Provide the RCE with not less than 14 days 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.

7 The TMP may require installation and maintenance of detour signs outside the immediate project limits. In such cases, the Contractor is responsible for installing and maintaining the detour signs as required by the Plans, the Specifications, and the RCE.

8 The Contractor is responsible for the maintenance of traffic from the time the Contractor installs the permanent or initial temporary construction signs until the project is accepted by the Department. Conduct weekly daytime inspections of the project traffic control devices and configuration to determine the adequacy, effectiveness, and maintenance requirements of the TMP. Conduct a monthly nighttime inspection and an inspection when the traffic pattern changes. 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.

9 The Contractor is responsible for the installation, maintenance, and performance of all traffic control devices. Install, maintain, and ensure the performance of the traffic control devices as required by the Plans, the Specifications, and the device manufacturer's specifications.

### 601.1.5 Temporary Traffic Control Plan by Contractor

1 When unforeseen conditions arise, the Contractor may be required to develop, design, and install a TTC according to the roadway characteristics, the work duration, the SCDOT *Procedures and Guidelines for Work Zone Traffic Control Design Manual,* and **Subsection 601.1.2**.

### 601.1.6 Coordination with Work Zone Intelligent Transportation System Implementation

1 If required by the TMP, coordinate with and provide the work zone ITS company with a 30 day advance work schedule with updates provided every 14 days. The Department will consider failure to coordinate with the work zone ITS company as failure to provide traffic control as required according to these Specifications, resulting in immediate suspension of all work activities requiring traffic control until the condition is corrected.

### 601.1.7 Work Zone Traffic Control Training Requirements for Contractors/Subcontractors

#### 601.1.7.1 Description

1 Provide documentation to substantiate successful completion and attainment of a passing score of a prescribed training course conducted by an SCDOT approved provider by those employees whose job duties categorize them as "designated trainees" as defined hereinafter.

#### 601.1.7.2 Designated Trainees

1 Ensure that an employee whose job duties include any of the following responsibilities regarding the TMP successfully completes an advanced work zone traffic control training program conducted by an SCDOT approved work zone traffic control training provider:

- Supervision of the field installation of any component of the TMP,
- Supervision of the maintenance of any component of the TMP,
- Supervision of the removal of any component of the TMP,
- Design and development of revisions to an existing TMP,
- Design and development of a new or alternative TMP, and
- Any decision-making responsibilities regarding the TMP.

2 Those employees whose job duties do not include responsibilities relative to the TMP as stated above are not required to attend an advanced work zone traffic control training program. However, all employees whose job duties place them on the job site within the right-of-way within 30 ft or less of a travel lane open to traffic should attend a basic work zone traffic control training course.

3 Ensure that an employee whose job duties include "flagger" successfully completes a Flagger Training course. However, for an employee whose job duties includes "flagger" but does not involve any of the responsibilities listed above, successful completion of a Flagger Training course is the only mandatory work zone traffic control training course required for the employee; other work zone traffic control training courses are elective.

#### 601.1.7.3 Approved Work Zone Traffic Control Training Providers

1 Approved work zone traffic control training providers conduct work zone traffic control training in compliance with the MUTCD and reference requirements specific to the Department. For a listing of the approved work zone traffic control training providers and the approved courses, see the document found on the Department's website, *Approved Work Zone Traffic Control Training Guidelines Training Providers/Course for Contractors/Subcontractors*.

2 Work zone traffic control training conducted by affiliates of the SCDOT approved providers in other states will be considered acceptable if the training is comparable to the employee's job duty responsibilities. For example:

- The South Carolina Chapter of the National Safety Council is listed as an acceptable work zone traffic control training provider for SCDOT. Comparable work zone traffic control training conducted in Texas by the Texas Chapter of the National Safety Council will also be considered acceptable. This scenario applies to each approved work zone traffic control provider who also conducts training outside of South Carolina.

3 Specific course material for work zone traffic control training courses designated as Basic, Advanced, Supervisor, or Flagger and any additional training courses not specified here is determined by the work zone traffic control training course provider and has undergone review and received acceptance by the Department. The passing score for each training course is determined by the work zone traffic control provider.

### 601.1.7.4 Training Requirements/Qualifications

1 Successful completion of an advanced work zone traffic control training program is defined as achieving a passing score in all courses, including any prerequisite courses, to attain a level considered a higher level course, such as "advanced," "supervisor," or any other relative term as designated by the provider to ensure that the trainee has an understanding of the course material inclusive of design, implementation, and maintenance of work zone traffic control scenarios. Upon successful completion of the program, the trainee should also possess an understanding for determining the need for and developing and implementing adjustments as necessary when applying typical work zone traffic control applications to non-typical work site conditions and scenarios.

2 Ensure that the employee whose job duty responsibilities mandate successful completion of an advanced work zone traffic control training program does so before undertaking any job duties related to any component of the design, development, revision, decision-making, supervision, or field installation of a TMP.

3 Ensure that an employee whose job duties mandate successful completion of a Flagger training course does so before performing any job duties relative to flagging traffic.

4 Ensure that each employee who has successfully completed an approved advanced work zone traffic control training program or a Flagger training course attends and completes a refresher course relative to the employee's job duties at least every 5 years.

### 601.1.7.5 Documentation

1 Provide to the RCE a copy of the certificate of training from the organization for the employees specified in **Subsection 601.1.7.4**. Ensure that refresher training is completed no later than 60 days beyond the 5 year anniversary date of the employee's certificate date of completion.

2 Failure to provide the required documentation as specified will prevent the Department's acceptance of the employee as properly trained and acceptable for conducting those job duties that necessitate the prescribed work zone traffic control training.

3 Proof of completion of a basic work zone traffic control training course by employees whose job duties require their presence on the job site within the right-of-way but exclude any responsibilities relative to the TMP is not required.

## 601.2 Materials

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 are available, store material and equipment at the greatest possible distance from the near edge of the adjacent travel lane.

2 On non-interstate roadways, store material and equipment not closer than 15 ft from the near edge of the adjacent travel lane when space is available. Where space is limited and the 15-ft 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-ft intervals. Do not substitute the portable plastic drums with 42-in. oversized traffic cones.

3 On interstate highways, do not store material and equipment closer than 30 ft from the near edge of the adjacent travel lane. The 30-ft distance requirement applies to all ramps and interstate mainline travel lanes.

4 Avoid gore areas adjacent to deceleration lanes for storage of material and equipment due to high susceptibility for encroachment by errant vehicles. Do not store materials and equipment within the inner limits of a circular entrance or exit ramp or access a storage area from a circular ramp due to sight distance limitations for the access point.

5 Do not store materials and equipment within 100 ft of the near edge line of an intersecting roadway to avoid obstruction of the sight distance at the intersection.

6 Do not store materials and equipment within the clear zone of a median area unless the storage area is within the construction limits and protected by guardrail or temporary concrete barrier wall.

7 Use areas protected by guardrail or temporary longitudinal barrier when available according to **Subsection 605.3.3**.

8 The Contractor is responsible for the storage of existing signs removed from the project site before beginning work and for the prevention of bending, defacing, or other damage to the signs during storage. Replace any 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.

9 These requirements for the storage of material and equipment also apply to parking employee's personal vehicles and storage of portable sign supports and other traffic control devices when not in use.

## 601.3 Construction

### 601.3.1 General Work Zone Requirements

1 Before beginning work or implementation of the TTC, conduct an inspection with the RCE of the project and/or project impact area to determine the necessity for removal or relocation of existing signs and the number of signs and their locations. Remove, relocate, or cover existing permanent signs in conflict with changes in the traffic patterns or speed limits due to the requirements of the TTC. 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. Perform the necessary removal, relocation, storage, protection, and re-erection of existing signs located within the scope of the project. Re-erect the signs as directed by the RCE. Consider removal, storage, and re-erection of the signs incidental to the item Traffic Control.

2 Supplement and delineate the shoulder edges through work zones with traffic control devices to provide motorists with a clear and positive travel path. Use portable plastic drums unless otherwise directed by the RCE. Vertical panels may be used where specified by the Plans and directed by the RCE. Install traffic control devices in areas immediately adjacent to a travel lane open to traffic that have been altered by any work activities, such as grading, milling, etc. Install the traffic control devices promptly upon initiating any alterations to the areas immediately adjacent to or within 15 ft of the near edge line of the adjacent travel lane. When sufficient space is available, place the traffic control devices no closer than 3 ft from the near edge of the traffic control device to the near edge line on the adjacent travel lane. When sufficient space is unavailable, place the traffic control devices at the maximum distance from the near edge of the adjacent travel lane.

3 When working adjacent to or over travel lanes, ensure that dust, debris, tools, and equipment from the operation do not endanger motorists. When working over traffic, provide suitable safety platforms to catch falling materials, equipment, or objects. Arrange the safety platforms so that they do not encroach on the vertical clearance necessary in the areas as determined by the Department.

4 When no longer required, remove all traffic control devices, including but not limited to signs, portable sign supports, traffic cones, portable plastic drums, and trailer-mounted advance warning arrow panels from within 15 ft of a travel lane on a non-interstate route and from within 30 ft of a travel lane on an interstate highway. Ensure that all portable sign supports lie flat with the legs in the retracted position when not in use.

5 Install changeable message signs as specified. Ensure that the pre-programmed messages comply with the *Standard Drawings*, the special provisions, and the RCE's directions 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. Ensure that the messages displayed on a changeable message sign do not duplicate the legends on the permanent construction signs.

6 When conditions requiring the operation of a changeable message sign are absent for a period exceeding 3 days, remove the changeable message sign from the roadway, or store the sign according to **Subsection 601.2**.

7 Provide advance warning arrow panels during the closure of a travel lane of a multilane roadway. Install advance warning arrow panels as specified by the *Standard Drawings*, the special provisions, the Plans, and the RCE. The locations may require adjustments due to field conditions. When space is unavailable, such as when a sidewalk or other obstruction is present, place the first arrow panel to the inside of the taper as near to the first traffic control device as practical while remaining to the inside of the taper.

8 When installing a lane closure, select a location for the taper section that will provide sufficient stopping sight distance in advance of the taper. The locations may require adjustments due to horizontal and vertical alignments or due to some other physical obstruction that may prevent attaining adequate stopping sight distance. For this application, consider adequate stopping sight distance as the distance from the first traffic control device a motorist will encounter at the beginning of the taper to the point in the roadway where the motorist is able to initially recognize the presence of the traffic control device and have sufficient time to safely conduct decisive actions such as change travel lanes or stopping the vehicle. Ensure that the location of the taper section of the lane closure installation provides sufficient stopping sight distance equal to or greater than the stopping sight distance based upon the posted regulatory speed limit of the roadway before beginning any work as provided in the following table. Consider using the truck stopping sight distances on roadways with high truck volumes.

| Stopping Sight Distance | | |
|---|---|---|
| **Posted Regulatory Speed Limit** | **Passenger Car** | **Truck** |
| ≤ 35 mph | 250 ft | 350 ft |
| 40 mph to 55 mph | 500 ft | 750 ft |
| 60 mph to 70 mph | 750 ft | 1100 ft |

9 On non-interstate routes, where a stationary work zone in the shoulder area requires personnel, tools, equipment, materials, vehicles, etc., to encroach within 1 ft of the near edge line of an adjacent travel lane, conduct the work under a lane closure setup instead of a shoulder closure.

10 On interstate routes, where a stationary work zone in the shoulder area requires personnel, tools, equipment, materials, vehicles, etc., to encroach within 10 ft of the near edge line of an adjacent travel lane, conduct the work under a lane closure setup instead of a shoulder closure.

11 During, but not limited to, widening projects, where two-lane, two-way traffic is separated and results in a vacant travel lane between the two lanes, install portable plastic drums within the vacated travel lane immediately upon the traffic relocation. Install portable plastic drums in the same manner as required for a lane closure as indicated by the *Standard Drawings* and directed by the RCE. Do not allow multiple lanes of traffic to travel in the same direction on adjacent travel lanes separated by yellow centerline pavement markings.

12 Conduct inspections of the project as specified **Subsection 601.1.4** to determine the adequacy, effectiveness, and maintenance requirements 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. Replace damaged signs and traffic control devices. Within 3 days, correct deficiencies and replace or repair traffic control devices that do not comply with the Specifications unless otherwise directed.

### 601.3.2 Daytime and Nighttime Work

1 The Department defines the conditions of daytime and nighttime according to 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 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; this primarily pertains to those motorists driving in the direction opposing the direction the lighting is being targeted toward. Perform ride-through inspection(s) when installing lighting facilities to evaluate the impacts to motorists' visibility.

3 Illuminate the work area by any combination of portable lights, standard electric lights, existing streetlights, etc., which 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 ft Ahead/Behind) | Milling, Paving, Rolling, etc. | 108 (10) |

### 601.3.3 Grade Elevation Differences/Drop-offs

1 Grade elevation differences/drop-offs specified in this Subsection apply to those grade elevation differences and drop-offs less than 18 in. that are continuous longitudinally adjacent to the roadway. Grade elevation differences and drop-offs less than 18 in. adjacent to a travel lane open to traffic may remain in place during those times the Contractor is present and actively conducting work activities directly related to and in the immediate vicinity of the grade elevation difference. Eliminate all non-acceptable grade elevation differences or drop-offs before the end of each workday/work shift unless otherwise directed by the RCE. See **Subsection 601.3.4** for those requirements regarding grade elevation differences and drop-offs of 18 in. and greater.

2 Ensure that there is only one acceptable grade elevation difference between and/or adjacent to travel lanes open to traffic in the same direction unless otherwise approved by the RCE.

3 Acceptable grade elevation differences may remain in place for a maximum of 3 days from the time the work creates the grade elevation difference in a specific location unless otherwise approved by the RCE. Begin procedures to eliminate the acceptable grade elevation differences within 3 days of creating the grade elevation difference in a specific location unless otherwise approved by the RCE.

4 Eliminate all grade elevation differences between or adjacent to the travel lanes of an interstate highway before entering a restricted holiday time period as specified in **Subsection 601.1.3.2** unless otherwise approved by the RCE.

### 601.3.3.1 Grade Elevation Differences within Traveled Way

1 The acceptable grade elevation differences between travel lanes open to traffic are specified in the table below.

| Operation | | Acceptable Grade Elevation Difference |
|---|---|---|
| Paving | | ≤ 2 in. |
| Surface Planing and Milling | OGFC | ≤ 1.5 in. |
| | Non-OGFC | ≤ 1 in. |

2 Grade elevation differences may extend up to 3 in. when the Contractor uses a beveling process approved by the RCE to eliminate the 90-degree vertical pavement edge generated by surface planing and milling operations. Ensure that the beveling process replaces the 90-degree vertical pavement edge with a 1H:1V or flatter slope (no greater than 45 degrees).

3 Coordinate with the RCE on a proposed beveling process before conducting any work that will exceed the grade elevation difference restrictions. Conduct a field test of the proposed beveling process as directed by the RCE. The RCE will evaluate the field test results to determine the acceptability and approval of the proposed beveling process. The Department will consider and evaluate proposals for a beveling process during surface planing and milling operations only.

### 601.3.3.2 Grade Elevation Differences Adjacent to Traveled Way

#### 601.3.3.2.1 Paving Operations

1 During implementation of the roadway surface work, a grade elevation difference of 3 in. or less between the surface of the edge of pavement and the surface of the earth shoulder immediately adjacent to the edge of pavement is an acceptable temporary condition. The acceptable temporary grade elevation difference of 3 in. or less may remain in place until the final corrective shoulder work is implemented as defined in **Subsection 611.3.1**.

#### 601.3.3.2.2 Grading Operations

1 Grade elevation differences greater than 2 in. between the edge of pavement and the earth shoulder immediately adjacent to the pavement edge are prohibited when the Contractor is not present and actively conducting work

activities directly related to and in the immediate vicinity of the grade elevation difference.

2 Eliminate all grade elevation differences greater than those specified as acceptable before the end of each workday/work shift unless otherwise directed by the RCE. Before creating the grade elevation difference, obtain the RCE's approval for the procedures to eliminate a grade elevation difference immediately adjacent to the edge of pavement of a travel lane open to traffic, including placement of an approved material next to the pavement edge at a 6H:1V slope.

### 601.3.3.3 Grade Elevation Differences by Route Types

#### 601.3.3.3.1 Non-Interstate Routes

1 The acceptable grade elevation differences within the shoulder area adjacent to travel lanes that are open to traffic on non-interstate routes are specified in the table below.

| Paved Shoulder Width | Grade Elevation Difference Location | Acceptable Grade Elevation Difference |
|---|---|---|
| 0 – 2 ft | Within 6 ft of an adjacent travel lane unless the beginning of the front slope of an adjacent ditch is within 6 ft of the travel lane | ≤ 2 in. |
| > 2 ft | Within 10 ft of the adjacent travel lane unless the beginning of the front slope of an adjacent ditch is within 10 ft of the travel lane | ≤ 2 in. adjacent to the pavement edge of a paved shoulder |

2 When a grade elevation difference is greater than specified in the table above, maintain a standard shoulder closure according to the *Standard Drawings* during a work shift when the Contractor is present and actively conducting work activities directly related to and in the immediate vicinity of the grade elevation difference.

#### 601.3.3.3.2 Interstate Routes

1 The acceptable grade elevation differences within the shoulder areas adjacent to travel lanes that are open to traffic on interstate routes are specified in the table below.

| Operation | | Grade Elevation Difference Location | Acceptable Grade Elevation Difference | Required Action |
|---|---|---|---|---|
| Grading | | Adjacent to the right paved shoulder, left paved shoulder and/or earth shoulder(s) | ≤ 2 in. | None. Acceptable without the presence of a standard lane closure or shoulder closure |
| Paving | | Within a paved shoulder ≤ 10 ft wide | | |
| Surface Planing and Milling | OGFC | Within a paved shoulder | ≤ 1.5 in. | |
| | Non-OGFC | Within a paved shoulder | ≤ 1 in. | |

2 The table below specifies the required actions based on grade elevation differences and operations within the shoulder areas adjacent to travel lanes that are open to traffic on interstates.

| Operation | | Grade Elevation Difference Location | Grade Elevation Difference | Required Action |
|---|---|---|---|---|
| Surface Planing and Milling | OGFC | Within a paved shoulder ≤ 10 ft wide | ≥ 1.5 in. and ≤ 3 in. | • Beveling process per **Subsection 601.3.3.1***; or<br>• Close the shoulder with a standard shoulder closure*; or<br>• Install temporary concrete barrier wall according to the *Standard Drawings* |
| | Non-OGFC | Within a paved shoulder ≤ 10 ft wide | ≥ 1 in. and ≤ 3 in. | |

(table continued on the next page)

(table continued from the previous page)

<table>
<tr><th>Operation</th><th colspan="2">Grade Elevation Difference Location</th><th>Grade Elevation Difference</th><th>Required Action</th></tr>
<tr><td>Paving</td><td colspan="2">Within a paved shoulder ≤ 10 ft wide</td><td>> 2 in. and ≤ 3 in.</td><td rowspan="3">• Close the shoulder with a standard shoulder closure*; or<br>• Install temporary concrete barrier wall according to the Standard Drawings</td></tr>
<tr><td rowspan="5">Any</td><td colspan="2">Left shoulder</td><td>> 2 in.</td></tr>
<tr><td colspan="2">Within 15 ft of an adjacent travel lane without guardrail (including the opposing travel lane) **</td><td>> 3 in.</td></tr>
<tr><td colspan="2">> 15 ft and ≤ 30 ft of the near edge of an adjacent travel lane without guardrail</td><td>> 3 in.</td><td>Case by case as determined by the RCE.</td></tr>
<tr><td rowspan="2">Between a cable barrier and an adjacent travel lane on left shoulder</td><td>Cable barrier is ≤ 15 ft from the adjacent travel lane</td><td>> 2 in.</td><td>Close the adjacent travel lane</td></tr>
<tr><td>Cable barrier is > 15 ft and ≤ 30 ft from the adjacent travel lane</td><td>> 2 in.</td><td>Close the adjacent shoulder</td></tr>
</table>

* *Begin procedures to eliminate the grade elevation difference (within 3 days) of creation of the grade elevation difference and according to the requirements of these specifications, the special provisions, the Plans, and the RCE. However, the shoulder closure prohibition restrictions take precedence over the 3-day restriction, thereby reducing the 3 days to a period of time compliant with the shoulder closure prohibition restrictions.*

** *Eliminate within 14 days unless otherwise approved by RCE.*

### 601.3.4 Excavations Adjacent to Traveled Way

1 The clear zone in the work zone is defined as the immediate area adjacent to the travel lane where roadside hazards are required to be protected by guardrail, concrete barrier wall, or another similar device. The clear zone is 15 ft on routes with posted speed limits of 45 mph or less and 30 ft for posted speed limits of 50 mph or greater.

2 Excavations specified in this Subsection apply to those grade elevation differences and drop-offs 18 in. or greater or any grade elevation differences that

cannot be eliminated with placement of pavement or a 6H:1V slope before the end of each workday/work shift.

3 Ensure that excavations are delineated according to Standard Drawing 601-205-01.

4 Minimize the presence of open excavations within the clear zone on all roadways. All requirements regarding the clear zone also apply to the opposing travel lane when the excavation occurs within the clear zone of the opposing travel lane. Locations where the presence of guardrail or concrete barrier wall or similar devices separate an open excavation from an adjacent travel lane are acceptable unless otherwise determined by the RCE. An excavation may remain open during those times the Contractor is present and actively conducting work activities directly related to and in the immediate vicinity of an excavation. The requirement for a shoulder closure or lane closure depends on the distance of the excavation and the work activities from the near edge of the adjacent travel lane as specified in **Subsection 610.3.4**, **Subsection 610.3.5**, and as directed by the RCE.

5 Provide metal protective cover plates capable of sustaining vehicular traffic for excavations (e.g., catch basins) that the RCE determines to be susceptible to contact with errant vehicles.

6 For paved medians, close the median area to traffic where an open excavation and work activities relative to the excavation are present as specified in **Subsection 610.3.4**, **Subsection 610.3.5**, and as directed by the RCE.

7 For interstates, do not construct excavations within 10 ft or less of the near edge of an adjacent travel lane without the presence of guardrail or concrete barrier wall or similar device to separate the excavation from the adjacent travel lane unless otherwise directed by the Department.

8 For shoulder areas of interstates, delineate each excavation beyond 10 ft but within 30 ft of the near edge of an adjacent travel lane with two or more 3-ft Type II barricades or 4 or more portable plastic drums where no guardrail or concrete barrier wall or similar device is present to separate the excavation from the adjacent travel lane.

### 601.3.5 Structures Adjacent to Traveled Way

1 Structures, as defined in **Subsection 101.3**, will apply to those items that exist within or protrude above the adjacent and/or surrounding surface area that may support vehicular traffic and may pose an obstacle to vehicular traffic. The presence of a structure where the adjacent travel lane is separated by guardrail, concrete barrier wall, or similar device does not require delineation of the structure unless otherwise determined by the RCE.

2 Where no guardrail or concrete barrier wall or similar device is present to separate the structure from the adjacent travel lane, delineate each structure

with 2 or more Type II barricades or 4 or more portable plastic drums for the areas shown in the table below.

| Posted Speed Limit | Distance between Structure and the Near Edge of an Adjacent Travel Lane |
|---|---|
| ≤ 45 mph | ≤ 15 ft |
| > 50 mph | ≤ 30 ft |

3 For paved medians, close the median area to traffic where a structure and work activities relative to the structure are present without the presence of guardrail or concrete barrier wall or similar device to separate the structure from the adjacent travel lane as specified in **Subsection 610.3.4**, **Subsection 610.3.5**, and as directed by the RCE.

4 All requirements regarding the clear zone also apply to the opposing travel lane when a structure is present within the clear zone of the opposing travel lane.

### 601.3.6 Construction Vehicles

#### 601.3.6.1 General

1 When the Contractor's vehicles are operating within travel lanes open to public travel, ensure that the Contractor's vehicles travel in the same direction as the roadway traffic.

2 When the Contractor's vehicles operate within a closed travel lane or a closed shoulder area, the vehicles may travel in either direction as necessary. When the Contractor's vehicles travel in the direction opposed to traffic in the adjacent travel lane open to roadway traffic, operate the work vehicle as far away from the near edge of the adjacent travel lane open to traffic as practical. When operating within a closed travel lane or a closed shoulder area during the hours of darkness, minimize traveling in the opposite direction of roadway traffic to reduce the impact on motorists' visibility.

3 Ensure that flaggers are available to control all construction vehicles entering or crossing the travel lanes of non-interstate routes. The RCE will determine the necessity of the flaggers for control of the construction vehicles. The RCE will consider sight distance, vertical and horizontal curves on the roadway, prevailing speeds of roadway traffic, frequency of construction vehicles entering or crossing the roadway, and other site conditions that may impact the safety of the workers and motorists when determining the necessity of these flaggers. Ensure that the flaggers do not stop roadway traffic, cause roadway traffic to change lanes, or impact roadway traffic. Ensure that the Contractor's vehicles do not disrupt the normal flow of roadway traffic or enter the travel lane of the roadway until a sufficient gap is present.

4 When working within the right-of-way of access-controlled roadways with posted regulatory speed limits of 55 mph or greater and average daily traffic volumes

(ADT) of 10,000 vehicles per day or greater, all construction and work vehicles possessing any one or more or combination of the vehicular characteristics listed below are only permitted to enter a travel lane open to traffic from a work area during the presence of active lane closures unless otherwise directed by the RCE. Shoulder closures are unacceptable and insufficient methods for control of traffic at ingress/egress areas for these vehicles. The restrictive vehicular characteristics include the following:

- Over 6 tires;
- Tandem rear axles;
- A base curb weight greater than 8000 lb;
- A gross vehicular weight greater than 12,000 lb unless performing duties as a shadow vehicle while supporting a truck-mounted attenuator; and
- A trailer in tow except under the following conditions:
    - Trailers transporting traffic control devices (including but not limited to standard and 42-in. oversized traffic cones, portable plastic drums, signs, portable sign supports, U-section and square steel tube sign posts) relative to the installation of lane closures, shoulder closures, or other traffic control operations approved by the RCE; or
    - Trailer-mounted traffic control devices (including but not limited to advance warning arrow panels, changeable message signs, temporary traffic signals, highway advisory radios, work zone intelligent transportation systems, and trailer towed truck-mounted attenuators).

### 601.3.6.2 Auxiliary Warning Lights for Vehicles and Equipment

1 Supplement all construction and/or construction-related vehicles and equipment that operate in a stationary or mobile work zone within or adjacent to a roadway within the right-of-way with AMBER or YELLOW colored high intensity rotating, flashing, oscillating, or strobe type auxiliary warning light devices. AMBER or YELLOW warning light may be supplemented with CLEAR warning lights. Auxiliary warning lights of a color other than CLEAR, AMBER, or YELLOW are unacceptable and prohibited. Use, install, operate, and maintain a single or multiple lighting devices as necessary to provide visibility to approaching motorists.

2 Ensure that all auxiliary warning light models meet the Society of Automotive Engineers (SAE) Class I standards, SAE Standard J575, and these specifications.

3 Ensure that the amber/yellow color of the dome/lens of an auxiliary warning light device meet SAE Standard J578 for amber/yellow color specifications.

4 Ensure that auxiliary warning lights have rotating parabolic reflectors that rotate around a halogen lamp at a rate to produce approximately 175 flashes per minute. Ensure that the parabolic reflector produces a minimum 80,000 candle power and a minimum 54,000 candela through an SAE Standard J846 approved amber dome.

5 Equip strobe type flashing auxiliary warning light devices with photosensitive circuit controls to adjust the lighting intensity in response to changes in ambient light conditions such as from day to night. Use lights that have a double-flash capability rated at approximately 80 double flashes per minute and produce a minimum 24 joules of flash energy at the highest power level setting.

6 Use auxiliary warning light models that provide sufficient light output to be clearly recognizable at a minimum distance of 1750 ft.

7 Mount all auxiliary warning light devices intended to function as the auxiliary warning light system or as an element thereof on vehicles and equipment at locations no less than 3 ft above the ground and in conspicuous locations to provide visibility to approaching motorists.

8 Auxiliary warning light models that mount in the locations of the standard vehicle lighting system are unacceptable as the specified auxiliary warning light system alone due to restrictive simultaneous visibility capabilities from multiple sight angles.

9 Standard vehicle hazard warning lights are only permitted as supplements to the specified auxiliary warning light devices.

## 601.4 Measurement

1 The quantity for the pay item Traffic Control is paid for on a lump sum basis and no specific measurements are made for this item.

2 Traffic control needed during work activities that do not include specific pay items for traffic control devices and procedures incidental to the work as specified is included in the item Traffic Control.

3 Traffic control needed during repair or replacement of damaged or malfunctioning traffic control devices is considered incidental work for the item Traffic Control.

4 Traffic control needed during application of temporary or permanent pavement markings is considered incidental work for the item Traffic Control.

## 601.5 Payment

1 The lump sum payment for Traffic Control is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Payment for Traffic Control does not include any work related to permanent construction signs, temporary concrete barrier, portable terminal impact attenuators, changeable message signs, pavement markings, temporary pavement markers, or any other item specified as a bid item with a Contract unit bid price.

3 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 |

4 Payment is made according to the above schedule if the adequacy of the traffic control measures are satisfactory within the guidelines set forth by the Plans, the *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.

5 The RCE will notify the Contractor when traffic control has not been 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.

6 When the Contract requires payment for Traffic Control on more than one project, each project is considered separately.

7 The pay item for Traffic Control is as follows:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6011000 | Traffic Control | LS |

# Section 602 — General Requirements for Providing and Maintaining Traffic Control Devices in the Work Zone

## 602.1 Description

1 Install all traffic control devices as specified for the safe maintenance of traffic during work.

## 602.2 Materials

### 602.2.1 General

1 Only those work zone traffic control devices included on the current *Approved Products List for Traffic Control Devices in Work Zones* are considered acceptable for use on highway construction work in South Carolina. The A*pproved 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. Ensure that all hardware manufactured on or after January 1, 2020, complies with the AASHTO *Manual for Assessing Safety Hardware* (MASH). Hardware that does not comply with MASH but that is included on the *Approved Products List for Traffic Control Devices in Work Zones* and manufactured before this date may be used for its normal service life.

2 Considering the function and weight of each device, FHWA has divided work zone traffic control devices into four categories for determining the level of effort needed to demonstrate crashworthiness. Ensure that all Category I, II, and III devices comply with FHWA requirements for crash worthiness. The compliance date for Category IV devices will be determined at a later date.

3 Category I includes small and lightweight channelizing and delineating traffic control devices such as plastic cones, portable plastic drums, and tubular markers without attachments such as signs or warning lights.

4 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 lb or less are included in this category.

5 Category III includes traffic control devices that are expected to cause significant vehicular velocity changes to impacting vehicles. These devices weigh more than 100 lb. 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.

6 Category IV includes advanced warning arrow panels, changeable message signs, portable traffic signals, automated flagging assistance devices (AFAD), and portable lighting equipment.

7 Category I devices do not require FHWA approval for crashworthiness. A Category I device supplemented with a sign or warning light requires approval from the FHWA Office of Engineering and inclusion on an FHWA acceptance letter to certify crashworthiness of the device.

8 The Department reserves the right, as granted by 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:

- Differing interpretation of the test results;
- Insufficient test results, which may require additional testing;
- Insufficient field data, which may require in-service evaluation; and
- State specific requirements.

### 602.2.2 Reflectorization

1 Use approved reflectorizing materials on traffic control devices. Use reflectorizing materials listed on *Qualified Products List 20*.

2 Use approved retroreflective roll-up sign materials included on the *Approved Products List for Traffic Control Devices in Work Zones*.

3 When reflectorizing traffic control devices and signs, apply the sheeting material evenly to surfaces so that the sheeting is smooth and adheres firmly. Do not apply the retroreflective sheeting over a pre-existing layer of retroreflective sheeting.

4 Reflectorize oversized traffic cones and portable plastic drums with 4 retroreflective bands — 2 orange and 2 white. Alternate the orange and white retroreflective bands, with the top band always being orange. Ensure that each retroreflective band is not less than 6 in. wide. Use Type III Microprismatic retroreflective sheeting for reflectorization unless otherwise directed by the Department. Separate each retroreflective band with less than a 2-in. non-reflectorized area.

5 Reflectorize temporary surface mounted flexible delineator posts with Type IX or Type XI Microprismatic retroreflective sheeting unless otherwise directed by the Department. Ensure that each post has retroreflective sheeting with an area no less than 3 in. × 12 in. applied to each post. Ensure that the color of the retroreflective sheeting on each post matches the color of the adjacent edge line — white on traveled way right and yellow on traveled way left.

6 Reflectorize all Category II devices with Type IX or XI Microprismatic retroreflective sheeting unless otherwise directed by the Department. Provide retroreflective sheeting that consists of alternating orange and white stripes 6 in. wide sloping downward at a 45-degree angle in the direction of passing traffic.

7 Reflectorize any orange areas of a rigid multi-colored advance warning sign with approved Type VIII, Type IX, or Type XI Microprismatic fluorescent orange retroreflective sheeting. Reflectorize any white areas of a rigid multi-colored advance warning sign with an approved Type III or greater Microprismatic white retroreflective sheeting. Type III glass beaded retroreflective sheeting is not approved for reflectorization of any white or orange areas of a rigid multi-colored advance warning sign. Overlays are prohibited on all rigid signs. Either reverse screen or direct apply the legends and borders on all rigid signs.

8 Do not splice retroreflective sheeting during application of the sheeting to channelizing and delineation traffic control devices. Splicing retroreflective sheeting is ONLY acceptable when applying the sheeting to a sign larger than the widest piece of material available from the sheeting manufacturer. When splicing of the sheeting is necessary, splice the sheeting according to the manufacturer's recommendations for type of material used.

### 602.2.3 Work Zone Signs

1 Signs in the MUTCD and on the traffic control drawings in the *Standard Drawings* each have an identification number. Detailed drawings of each sign are available from the Director of Traffic Engineering.

2 Fabricate each sign assembly, including the sign, the sign support, and all hardware relative to a sign assembly from materials included on the *Approved Products List for Traffic Control Devices in Work Zones.*

#### 602.2.3.1 Work Zone Sign Substrates

1 Fabricate each sign from one the following types of sign substrates:

A. Aluminum sign blanks that meet the requirements of **Section 651** (0.080 in. or 0.100 in. thick),

B. Aluminum laminated composite material (0.075 in. maximum thickness) included on the *Approved Products List For Traffic Control Devices in Work Zones*, or

C. Roll-up retroreflective fabric material fabricated with a background material constructed of an approved retroreflective fabric material substrate attached to two or more fiberglass battens.

2 On each rigid sign, attach a label made of a durable material capable of retaining its legibility for the life of the sign to the back of each sign. Imprint the name of the manufacturer of the sign sheeting and the date of fabrication on the label.

#### 602.2.3.2 Work Zone Sign Supports

1 Ensure that all ground embedded sign post installations comply with the requirements for breakaway supports in the latest AASHTO *Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals*. Use approved breakaway assemblies found on the *Approved Products List for Traffic Control Devices in Work Zones*.

2 Provide ground embedded sign supports according to the *Standard Drawings*.

3 Provide customized mounting hardware where necessary when mounting signs on bridge parapet walls or concrete barrier walls or similar structures. All customized mounting hardware is subject to RCE approval before installation.

4 All portable sign supports included on the *Approved Products List for Traffic Control Devices in Work Zones* are approved for supporting signs fabricated from approved roll-up retroreflective fabric materials.

5 Only those portable sign supports specified and approved for the support of rigid signs fabricated from approved aluminum laminated composite material substrates and included on the *Approved Products List for Traffic Control Devices in Work Zones* are acceptable for supporting rigid signs.

### 602.3 Construction

#### 602.3.1 General

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 is not limited to, replacement of damaged traffic control devices and those that have completed their functional service life. When not in use, remove all traffic control devices in conflict with the roadway conditions to prevent confusion to 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. Compromising the performance level of a traffic control device to meet FHWA crash worthiness requirements is unacceptable. A substandard performance level disqualifies a traffic control device for use in South Carolina.

3 Repair or replace damaged or failed traffic control devices according to 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 according to 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.

### 602.3.2 Sign Mounting/Installation Requirements

1 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.

2 Mount rigid signs mounted on ground embedded sign supports or portable sign supports according to the *Standard Drawings.* Ensure that the rigid signs are straight and level and with the face of the signs perpendicular to the surface of the roadway.

3 When mounting signs on multiple ground embedded sign supports, ensure that each post is the same type. Combining and installing both ground embedded U-section and square steel tube posts within the same sign assembly is prohibited. Do not combine a sign support/ground support post combination and a direct driven post on the same sign assembly installation that contains two or more sign supports.

4 When sufficient shoulder space is available, install signs mounted on ground embedded sign supports 6 ft to 12 ft from the near edge of an adjacent travel lane to the nearest edge of the sign if no paved shoulder is present. Where paved shoulders are present, install these signs no less than 2 ft from the near edge of the paved shoulder. Where curb and gutter is present, install these signs no less than 2 ft from the face of the curb.

5 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. Do not attach any other type of rigid sign substratum to a Type III barricade.

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 ft from the ground to the bottom edge of the sign according to the MUTCD. The minimum 7-ft mounting height for a temporary “EXIT” sign applies to installation both on ground embedded posts and portable sign supports.

7 Provide special sign mounting assemblies, when necessary, in areas of double-layered guardrail, concrete median barrier, or bridge parapet walls. All customized mounting hardware is subject to RCE approval before installation.

8 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 specified retroreflectivity requirements.

9 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 TTC. 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 project limit. 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. The removal, storage, and re-erection of the signs are incidental to the item Traffic Control.

10 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.

### 602.3.3 Covering/Temporary Removal of Signs

1 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.

2 When installing ground embedded signs before beginning work, cover the signs and maintain the sign coverings. Uncover the signs before the beginning work activities.

3 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 due to potential damage to the reflectivity of the sign. 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.

4 Maintain the sign coverings, including repair and/or replacement of the sign coverings, as directed by the RCE.

5 Completely remove and properly dispose of sign coverings upon uncovering the sign. Ensure that removed coverings do not remain around the post or become jobsite litter.

6 When a work zone sign mounted on a portable sign support is not in use, store these signs and the portable sign supports in a designated storage area

approved by the RCE. Ensure that the portable sign supports lie flat with the legs in the retracted position in storage within the right-of-way.

7 Coordinate installation, relocation, and removal of the signs at the adjoining termini of contiguous projects as directed by the RCE.

### 602.3.4 Specific Construction Signs

1 On multilane roadways with earth medians, comply with the same guidelines as applied to all other advance warning signs on multilane roadways, and install two sign assemblies, one on each side of the roadway and at each sign location when roadway conditions warrant.

2 Install "GROOVED PAVEMENT" signs (W8-15-48) supplemented with the "MOTORCYCLE" plaque (W8-15P-30) in advance of milled or surface planed pavement surfaces. Install these signs no further than 500 ft in advance of the beginning of this pavement condition. Install these signs immediately upon creation of the pavement condition and maintain the signs until the pavement condition is eliminated.

3 Install "STEEL PLATE AHEAD" signs (W8-24-48) in advance of an area of roadway where temporary steel plates are present. Install these signs no further than 300 ft in advance of locations where steel plates are present. Install the signs immediately upon installation of a temporary steel plate and maintain the signs until the temporary steel plates are removed.

4 Install and maintain any necessary detour signing as specified by the typical traffic control standard drawings designated for detour signing, Part VI of the MUTCD, detour signing plans when provided, and as directed by the RCE.

### 602.3.5 Maintenance

1 The Contractor has the option to use an electrical power source for various traffic control devices on long-term projects. 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 ft 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.

2 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 hazardous condition immediately. Initiate replacement or repair operations of the defective or damaged equipment immediately upon discovery or notification of a failure.

3 When a portable terminal impact attenuator suffers a strike by an errant vehicle, eliminate the resulting hazardous conditions promptly. Initiate replacement or repair operations of the damaged equipment within the first 2 hours upon discovery or notification of the damage.

4 Conduct repair or replacement of those traffic control devices designated by the RCE within 3 days unless otherwise directed by these specifications or the RCE.

## 602.4 Measurement

1 There are no measurements for traffic control devices under this Section. Measurements of specific traffic control devices are specified elsewhere in **Division 600**.

## 602.5 Payment

1 There is no payment made for traffic control devices under this Section. Payment for specific traffic control devices are specified elsewhere in **Division 600**.

# Section 603 — Category I Traffic Control Devices

## 603.1 Description

1 Provide, install, and maintain Category I traffic control devices.

## 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 in. and a maximum height of 36 in. Use standard traffic cones on the interstate system that have a minimum height of 36 in. Only those standard traffic cones supplemented with retroreflective collars are acceptable for use during the hours of darkness. Ensure that the reflectorization of standard traffic cones complies with **Subsection 602.2.2**.

### 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 in. and a maximum height of 50 in.

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 in. at the top of the cone and not less than 7½ in. 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. Ensure that the flange is no less than 10½ in. 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 lb and that the maximum width of the base is not greater than 18 in. Ensure that the diameter of the hole in the center of the base is ½ in. larger than the diameter of the cone cylinder at the bottom of the cone and not less than 2½ in. smaller than the cone flange.

6 Ensure that the reflectorization of the oversized traffic cones complies with **Subsection 602.2.2**.

7 Ensure that oversized traffic cones 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 in. and minimum width of 18 in. 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 or water. 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 Ensure that the reflectorization of portable plastic drums complies with **Subsection 602.2.2**.

### 603.2.4 Temporary Surface Mounted Flexible Delineator Posts

1 Use temporary surface mounted flexible delineator posts listed on *Qualified Products List 50*.

2 Ensure that the temporary surface mounted flexible delineator post has a minimum width of 3 in. and a minimum height of 36 in. from the surface of the pavement to the top of the post. Ensure that the reflectorization of temporary surface mounted flexible delineator posts complies with **Subsection 602.2.2**.

## 603.3 Construction

1 When delineating the edge line of a travel lane and if sufficient space is available, place the traffic control devices no closer than 3 ft from the near edge of the traffic control device to the near edge line on the adjacent travel lane. When sufficient space is unavailable, place the traffic control devices at the maximum distance from the near edge of the adjacent travel lane available.

2 Maintain all Category I traffic control devices in good condition. Replace and do not use any devices that exhibit dents, cuts, scrapes, scratches, faded plastic, or those that have completed their functional service life. For devices with reflective sheeting, replace when reflective sheeting is faded, peeling, contaminated, or damaged in a way that reduces reflectivity or reflective area.

### 603.3.1 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 *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. Provide, install, and maintain each cone as specified herein.

2 Only during emergencies is the use of standard traffic cones during the hours of darkness permitted. Reflectorize all standard traffic cones used during emergencies during the hours of darkness. Use of non-reflectorized standard traffic cones during emergencies during the hours of darkness is prohibited.

### 603.3.2 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 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 pavement delineation or channelization application on a roadway widening project, nighttime shoulder closures, or delineation of excavations or structures.

3 Ensure that oversized traffic cones comply with all regulations and requirements of the *Standard Drawings* that apply to portable plastic drums used within lane closures and daytime shoulder closures. 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 *Standard Drawings* for lane closures and daytime shoulder closures.

4 Ensure that oversized traffic cones and standard traffic cones are not used interchangeably. Oversized traffic cones may be substituted for standard traffic cones, but ensure that the standard traffic cones are not substituted for the oversized traffic cones or for portable plastic drums.

### 603.3.3 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 traffic control device adjacent to a traveled way during the hours of darkness.

### 603.3.4 Temporary Surface Mounted Flexible Delineator Posts

1 Use temporary surface mounted flexible delineator posts to delineate travel lanes and channelize traffic. Use temporary surface mounted flexible delineator posts to separate two-way traffic on four lane roadways with paved medians reduced to two-lane, two-way operations. Use of temporary surface mounted flexible delineator posts to separate two-way traffic on four lane roadways with earth medians reduced to two-lane, two-way operations is prohibited. Provide, install, and maintain each post as specified herein.

2 Install each temporary surface mounted flexible delineator post in an upright position at or near a 90-degree angle to the horizon.

3 Replace and do not use temporary surface mounted flexible delineator posts that are incapable of remaining upright in approximately a 90-degree position.

## 603.4 Measurement

1 Unless otherwise specified, Category I Traffic Control Devices, are not measured for separate payment but are included in the contract lump sum bid price for the item Traffic Control as specified in **Subsection 601.4**.

## 603.5 Payment

1 Payment for Category I traffic control devices is included in the lump sum price for the item Traffic Control as specified in **Subsection 601.5**. The payment is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

# Section 604 — Category II Traffic Control Devices

## 604.1 Description

1 Provide, install, and maintain Category II traffic control devices.

## 604.2 Materials

### 604.2.1 Vertical Panels

1 Surface mounted vertical panels are Category II devices. These devices consist of a plastic sign panel attached to an approved surface mounted flexible delineator post installed on a pavement surface with a bituminous or epoxy adhesive per manufacturer's specifications.

2 Fabricate each sign panel of a lightweight flexible polycarbonate plastic material with a surface area of 12 in. × 36 in. and a thickness of approximately 1/16 in. Do not use sign panels fabricated from aluminum sign substrate or aluminum laminated composite material substrate to attach a Category II surface mounted vertical panel.

### 604.2.2 Type I and Type II Barricades

1 Use Type I and Type II barricades included on the *Approved Products List For Traffic Control Devices In Work Zones.*

2 Ensure that the reflectorization for Type I and Type II barricades complies with **Subsection 602.2.2**.

### 604.2.3 Type III Barricade

1 Use Type III barricades included on the *Approved Products List For Traffic Control Devices In Work Zones*. The minimum width of acceptable Type III barricades is 6 ft.

2 Ensure that the reflectorization for Type III barricades complies with **Subsection 602.2.2**.

### 604.2.4 Portable Sign Supports

1 Use portable sign supports included on the *Approved Products List For Traffic Control Devices In Work Zones*.

2 Provide portable sign supports fabricated of steel and/or aluminum components. Ensure that each portable sign support has retractable support legs.

3 Ensure that each sign support provides a minimum mounting height of 5 ft from the ground to the bottom edge of the sign with the retractable legs in a flat position in full contact with the ground surface underneath the sign support.

## 604.3 Construction

### 604.3.1 Maintenance

1 Maintain Category II traffic control devices in good condition. Replace and do not use barricades that contain broken panels; faded, peeling, contaminated, or damaged reflective sheeting that reduces reflectivity or reflective area; or those that have completed their functional service life.

### 604.3.2 Vertical Panels

1 Use vertical panels to delineate travel lanes and channelize traffic where a traffic control device securely anchored in position may be beneficial for both safety and maintenance. Vertical panels may be used as an alternative to portable plastic drums when specified in the Plans and/or the Special Provisions. Otherwise, only use vertical panels when approved by the RCE before installation of the panels.

2 Install each vertical panel in an upright position at an approximately or near 90-degree angle to the horizon. Replace and do not use vertical panels that are unable to remain upright in an approximately 90-degree position.

3 When delineating the right edge line of a travel lane and sufficient space is available, install the vertical panels no less than 3 ft from the near edge of the vertical panel to the near edge of an adjacent travel lane to minimize contact with vehicles unless otherwise directed by the RCE. When space is limited and the 3-ft buffer area is unavailable, install the vertical panels at the greatest distance available or as directed by the RCE.

4 Ensure that the installation of a Category II vertical panel provides for a minimum overall height of 42 in. from the surface of the adjacent travel lane to the top of the panel. When the vertical panel apparatus is surface mounted on pavement adjacent to the travel lane, measure the required minimum 42-in. height from the pavement surface to the top of the panel.

### 604.3.3 Type I and Type II Barricades

1 Use Type I and Type II barricades to develop tapered sections and channelize traffic into lane closures, delineate travel lanes, and delineate excavations and structures.

2 Use Type II barricades not less than 3 ft wide when used 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 (e.g., catch basins, completed drop inlets, any structure that can be an obstruction to a vehicle).

### 604.3.4 Type III Barricade

1 Erect Type III barricades to close the roadway to traffic and to prevent traffic from entering a construction area.

### 604.3.5 Portable Sign Supports

1 Use portable sign supports to support regulatory and warning signs to provide the necessary traffic information to motorists.

2 Use only signs with an approved aluminum laminate composite rigid sign substrate specified in **Subsection 602.2.3.1** for attachment to portable sign supports on and/or adjacent to interstate highways. Do not use portable sign supports approved for roll-up signs only to support rigid signs.

3 Provide portable sign supports that meet the minimum sign heights specified in the *Standard Drawings*. Raising or placing the retractable legs in an angled position or placing the portable sign support on another object or objects to assist the sign in achieving the minimum sign mounting height is prohibited.

4 When sufficient shoulder space is available, install signs mounted on portable sign supports no less than 4 ft from the near edge of an adjacent travel lane to the nearest edge of the sign if no paved shoulder wider than 2 ft is present. Where paved shoulders wider than 2 ft are present, install the signs no less than 6 ft from the near edge of the adjacent travel lane. Where curb and gutter is present, install the signs no less than 2 ft from the face of the curb.

5 Maintain portable sign supports in good condition. Replace and do not use a portable sign support that exhibits broken or damaged legs, springs, or mast. Do not use a portable sign support incapable of supporting the attached sign at the minimum height requirement with the legs placed in a flat position in full contact with the earth or pavement surface underneath the portable sign support. Replace and do not use portable sign supports that are damaged or have completed their functional service life.

## 604.4 Measurement

1 The quantity for Category II traffic control devices including the pay items Type I, Type II, and Type III barricades, Vertical Panels, and Portable Sign Supports are included in the lump sum item Traffic Control as specified in **Subsection 601.4**.

2 If the Contract includes a separate pay item for Barricade – Type 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.

## 604.5 Payment

1 Payment for the accepted quantity for Barricade – Type III at the Unit Price is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6041200 | Barricade – Type III | LF |

# Section 605 — Category III Traffic Control Devices

## 605.1 Description

1 Provide, install, and maintain Category III traffic control devices.

## 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* that comply with **Subsection 602.2.3**.

2 Permanent construction signs include regulatory, warning, and guide signs erected, installed, and maintained at the termini of a project or activity before work begins and maintained in place until the project is completed unless otherwise directed by the RCE. Consider all other signs temporary unless otherwise directed by the Department.

3 Temporary construction signs include regulatory, warning, and guide signs installed on a temporary basis when conducting work within the right-of-way. Install and maintain these temporary construction sign assemblies for various durations or different stages of a project or activity.

### 605.2.2 Work Zone Attenuators

#### 605.2.2.1 General

1 Ensure that each attenuator complies with MASH or *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 an impacting vehicle's kinetic energy. When struck on the approach end of the unit, provide units that decelerate an impacting vehicle to a safe and controlled stop in compliance with FHWA crashworthiness requirements.

2 Ensure that each truck complies with the attenuator manufacturer's requirements. If the addition of supplemental weight to the vehicle as ballast is necessary, contain the material within a structure constructed of steel. Construct the steel structure with a minimum of four sides and a bottom to contain the ballast material in its entirety. A top is optional. Ensure that the steel structure is securely bolted to the truck's frame using an adequate number of fasteners.

Use either dry loose sand or steel reinforced concrete for ballast material within the steel structure to achieve the necessary weight. Ensure that the ballast material remains contained within the confines of the steel structure and does not protrude from the steel structure.

3 A direct truck-mounted attenuator is mounted and attached to brackets or similar devices directly connected to the frame of a truck. Ensure that the truck has a minimum gross vehicular weight (GVW) of 15,000 lb (actual weight) unless otherwise directed within the "Remarks" column of the *Approved Products List for Traffic Control Devices in Work Zones*.

4 A trailer towed truck-mounted attenuator is a trailer type attenuator towed from behind and attached to the frame of a truck via a standard pintle hook/hitch. Ensure that the truck has a minimum GVW of 10,000 lb (actual weight) unless otherwise directed within the "Remarks" column of 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 Provide a truck-mounted attenuator designed, constructed, and tested to comply with **Subsection 605.2.2.2.2.2** or **Subsection 605.2.2.2.2.3** according to the test level required for an impact from an errant vehicle.

##### 605.2.2.2.2.2 Test Level 2

1 Ensure that each truck-mounted attenuator has the capability to decelerate and stop test-prescribed vehicles during head-on impacts at 43 mph. During the impact of a small car into the unit, ensure that the truck-mounted attenuator complies with the occupant risk criteria requirements of *NCHRP Report 350* or MASH, Test 50.

##### 605.2.2.2.2.3 Test Level 3

1 Ensure that the truck-mounted attenuator performs under Test 3 conditions according to the following requirements:

A. Decelerate and stop test-prescribed vehicles 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 *NCHRP Report 350* or MASH, Test 50.

B. Decelerate and stop test-prescribed vehicles 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 *NCHRP Report 350* or MASH, Test 51.

C. *NCHRP Report 350* or MASH 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* or MASH.

#### 605.2.2.2.3 System Description

##### 605.2.2.2.3.1 General

1 Provide and maintain each unit in optimum operational condition at all times. Furnish each truck-mounted attenuator 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 that comply with applicable South Carolina motor vehicle laws, including turn signals, dual tail lights, and brake lights. Maintain visibility of the lights in both the raised and lowered positions of the attenuator.

##### 605.2.2.2.3.3 Color

1 Use industrial grade enamel paint to cover the metal aspects of the unit. Provide and attach supplemental striping to the rear face of the unit with a minimum Type III high intensity retroreflective sheeting unless otherwise directed by the Department. Use 4 in. to 8 in. black and yellow stripes in a 45-degree alternating pattern that forms an inverted “V” at the center of the unit that slopes down and to the sides of the unit in both directions from the center.

##### 605.2.2.2.3.4 Types of Truck-Mounted Attenuators

##### 605.2.2.2.3.4.1 Cartridge Type

1 This type of truck-mounted attenuator uses a cartridge typically composed of an energy absorbing material or structure contained within a rigid shell. Each unit consists of an expendable (crushable) cartridge type structure, a backup structure, and a mounting assembly.

##### 605.2.2.2.3.4.2 Mechanical Type

1 This type of truck-mounted attenuator uses a mechanical apparatus typically composed of a metal frame structure with a bracket assembly attached to a bumper assembly. Ensure that the metal 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 decelerates 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 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.

3 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 installation location. Provide roads signs that conform to the *Standard Drawings*.

#### 605.2.2.3.2 Performance Requirements

1 Provide portable terminal impact attenuators meeting the test requirements for *NCHRP Report 350* or MASH for re-directive, non-gating terminals and crash cushions. Ensure that all attenuators meet either Test Level 2, Test Level 3 - 60 mph, or Test Level 3 - 70 mph requirements depending on the traffic speeds at the site location. FHWA acceptance for Test Level 3 requirements for 70 mph is required for units installed on roadways with legal posted speed limits of 65 mph and 70 mph. For test level classification, mathematical computations are unacceptable alternatives to actual crash test results. Determine the speed requirements for all attenuators based on the legal posted speed limit of the roadway before beginning construction.

2 Ensure that each portable terminal impact attenuator has the capability to decelerate and stop vehicles weighing (1800 lb to 4400 lb according to *NCHRP Report 350*; 1800 lb to 5000 lb according to MASH) during head-on impacts. Ensure that each attenuator meets the occupant risk and vehicle trajectory criteria as required by *NCHRP Report 350* or MASH Tests 30, 31, 32 and 33.

3 Ensure that each portable terminal impact attenuator has the capability to redirect vehicles weighing (1800 lb to 4400 lb according to *NCHRP Report 350*; 1800 lb to 5000 lb according to MASH) that impact the unit along the side at angles of 20 degrees – *NCHRP Report 350*; angles of 25 degrees – MASH for both right-way and wrong-way impacts. These impact angles are determined by measurement from the longitudinal centerline of the unit. Ensure that each

attenuator meets the requirements of *NCHRP Report 350* or the MASH Tests 36, 37, 38, and 39, which are used to evaluate the occupant risk and vehicle trajectory criteria, re-directional capability, structural adequacy of the attenuator, potential for snagging, and performance during a reverse hit.

4 Ensure that each portable terminal impact attenuator contains all debris from the unit itself during an impact within the design parameters to prevent posing a potential hazard to the vehicle occupants, other traffic, pedestrians, or workers present in the immediate area.

5 The last 4 ft of the portable terminal impact 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 mph up to the maximum design speeds of the unit for vehicles in the weight range of (1800 lb to 4400 lb according to *NCHRP Report 350*; 1800 lb to 5000 lb according to MASH). Ensure that the attenuator prevents lateral penetration with a subsequent impact against the stationary hazard at or near the "coffin corner."

#### 605.2.2.3.2.1 Types of Portable Terminal Impact Attenuators

##### 605.2.2.3.2.1.1 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, or exposed internal material or attempt to repair the defective cartridges with rivets, screws, etc. In addition, do not allow such defective cartridges on the project site. Replace all defective cartridges before installation of the unit.

##### 605.2.2.3.2.1.2 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 that are properly aligned. Replace all defective parts before installation of the unit.

### 605.2.3 Temporary Longitudinal Barriers

#### 605.2.3.1 General

1 Ensure that all temporary longitudinal barrier walls comply with *NCHRP Report 350* or MASH.

### 605.2.3.2 Temporary Concrete Barrier

1 Use temporary concrete barrier walls fabricated by fabricators or producers included on *Qualified Products List 54*.

2 Ensure that the design and shape of the concrete barrier wall meet all requirements in the *Standard Drawings*.

3 Ensure that each section of temporary concrete barrier wall has a recessed approval stamp according to the *Standard Drawings*. Only recessed approval stamps are acceptable unless otherwise directed by the RCE. Painted on stamps are not acceptable. Ensure that the stamp includes the producer's product code and date of qualification as provided by the SME.

4 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 or repaired according to the *Standard Drawings*.

5 Remove all disqualified sections of barrier wall specified in the *Standard Drawings* from the project site.

6 Only those temporary concrete barrier walls not otherwise disqualified with defects less than 6 in. in all three directions (width, height, and depth) that do not expose reinforcing steel qualify for repair according to the following requirements.

7 For defects determined acceptable for repair by the RCE, repair the defect with a premanufactured patching material specifically fabricated for patching structural concrete with minimum Class 3000 concrete. Perform the repair procedures according to all requirements and instructions from the manufacturer of the patch material. Use a bonding compound between the patch material and the concrete unless specifically stated by the manufacturer that a bonding compound is not recommended. If the manufacturer states that application of a bonding compound is optional, then apply a bonding compound compatible with the patch material. If cracking occurs within the patched area, remove the patch material completely and repeat the repair process. Submit documentation to the RCE stating that all repairs have been made according to these requirements before installing any temporary concrete barrier walls with repairs. The use of temporary concrete barrier walls with repairs requires approval by the RCE before installation.

8 Color all temporary concrete barrier walls bright white. 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 before placement on the job site. Maintain the location and length of the barrier wall in conformity with the Plans, 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 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.

2 Ensure that the fabrication, installation, and maintenance of each temporary polyethylene water-filled barrier wall system conform to the requirements of the Plans, Specifications, the manufacturer's specifications, and the RCE.

3 Supplement the top of the water-filled barrier with large delineators. Ensure that the large delineators have a minimum reflective area of not less than 50 sq in. Install the large delineators according to the *Standard Drawings*. Due to the polyethylene material of the water-filled barrier, use an alternative system other than the mechanical anchors for anchoring the large delineators.

#### 605.2.3.3.2 Performance Requirements

##### 605.2.3.3.2.1 Performance Criteria

1 Ensure that the design and construction of each water-filled barrier wall system allows the system to prevent 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* or MASH guidelines.

2 Ensure that each "run" or installation of temporary polyethylene water-filled barrier wall equals or exceeds the MLON found in the "DESCRIPTION" column of the *Approved Products List for Traffic Control Devices in Work Zones* for each approved temporary polyethylene water-filled barrier wall system.

3 Provide an approved temporary polyethylene water-filled barrier wall system with the capability to prevent vehicle penetration, vaulting, and under riding during impacts from errant vehicles within the Operational Length of Need (OLON). Ensure that the temporary polyethylene water-filled barrier wall has the capability to decelerate errant vehicles impacting the barrier wall within the OLON area to a controlled stop near the impact area or redirect the errant vehicles during shallow angle impacts. Ensure that all lateral deflection of the temporary polyethylene water-filled barrier wall conforms to the design criteria during impacts when the barrier wall is installed on clean asphalt or concrete surface with less than a 5% cross slope.

4 Provide an approved temporary polyethylene water-filled barrier wall system with the capability to decelerate an errant vehicle impacting within the OLON area at angles of 25 degrees or less to a controlled stop or redirected at a shallow angle.

#### 605.2.3.4 Temporary Structural Steel Barrier

1 Provide temporary structural steel barrier walls fabricated from hot-dipped galvanized steel. Ensure that individual sections of steel barrier walls interconnect and function as a temporary structural steel barrier wall system.

2 Ensure that the fabrication, installation, and maintenance of each temporary structural steel barrier wall system conform to the requirements of the Plans, Specifications, manufacturer's specifications, and RCE.

### 605.2.4 Ground Mounted Vertical Panels

1 Ground mounted vertical panels (post mounted on ground embedded posts) are considered Category III devices. These devices are composed of a sign panel attached to an approved ground embedded sign post apparatus installed on earth according to the requirements for ground embedded sign posts.

2 Provide Category III, ground mounted vertical panels that use sign panels fabricated of either a lightweight flexible polycarbonate plastic material, a standard aluminum sign substrate, or an approved aluminum laminated composite material substrate. Ensure that the aluminum sign substrates comply with **Section 651**. Only those aluminum laminated composite material substrates included on the *Approved Products List for Traffic Control Devices in Work Zones* are acceptable.

## 605.3 Construction

### 605.3.1 Construction Signs

#### 605.3.1.1 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, maintain, and remove signs attached to ground embedded sign supports and Type III barricades according to **Section 602**.

2 Install construction signs mounted on ground-mounted posts according to the *Standard Drawings*. Install work zone traffic control signing as specified. Do not omit or substitute for these signs unless otherwise permitted by the Specifications or directed by the RCE.

#### 605.3.1.2 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 of the permanent construction signs at the project termini when work activities that require lane closures are being conducted near or at the project termini at no additional cost to the Department.

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 before 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 at no additional cost to the Department.

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.

6 During projects that do not impact the riding surface or the adjacent shoulder of the roadway or the performance of the work is not apparent to motorists when the Contractor is not present, the permanent construction signs may be mounted on portable sign supports to permit removal from the roadway when the Contractor is not present.

### 605.3.2 Work Zone Attenuators

#### 605.3.2.1 General

1 Use attenuators on or adjacent to roadways to aid in providing shielding of hazards and work zones from errant vehicles.

2 Use the legal posted regulatory speed limit of the roadway before the presence of a work zone, a temporary speed limit or an unforeseen roadway hazard to determine the test level requirements for each work zone attenuator installed.

3 Install, maintain, repair, or replace as necessary, and relocate each attenuator as directed by the Plans, the Specifications, the manufacturer's specifications, the *Standard Drawings,* and the RCE. Ensure that each attenuator has the capability to function within the requirements as detailed by these Specifications and the manufacturer's specifications.

4 Truck-mounted attenuators and portable terminal impact attenuators are not interchangeable.

5 Truck-mounted attenuators are most effective when used during short term and short duration work activities and mobile operations due to their mobility.

6 A buffer space is required to the front of the vehicle supporting a truck-mounted attenuator to allow the vehicle to roll ahead in case the attenuator is struck by an errant vehicle. Maintain the buffer area, free of personnel, equipment, materials, etc., for no less than 100 ft in front of the vehicle unless otherwise directed by the *Standard Drawings* or the RCE.

7 Portable terminal impact attenuators are stationary and most effective when used during long term stationary and intermediate term stationary work durations. Only non-gating and re-directive portable terminal impact attenuators are considered acceptable for use with stationary temporary concrete barrier walls, polyethylene water-filled barriers, structural steel barriers, and guardrail.

8 Only specific gating and non-redirective portable terminal impact attenuators are permitted for use with moveable temporary concrete barrier walls specifically designed and fabricated for relocation of a continuous interconnected line of barrier wall by machine.

#### 605.3.2.2 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 Ensure that a truck used as a shadow vehicle to support or tow a truck-mounted attenuator does not convey materials, equipment, etc., while operating within a travel lane or shoulder area.

3 Use the legal posted regulatory speed limit of the specified roadway before the presence of a work zone, a temporary speed limit or an unforeseen roadway hazard to determine if a Test Level 2 or Test Level 3 truck-mounted attenuator is required.

4 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 Test

Level 2 truck-mounted attenuators on interstate highways or roadways with posted speed limits of 50 mph or greater.

5 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.

6 Always provide a clear zone of 100 ft 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.

7 Do not use a trailer towed truck-mounted attenuator during operations that will require backing of the truck; i.e., a truck with a "PREPARE TO STOP" sign maintaining a distance of 2000 ft in advance of a traffic queue.

#### 605.3.2.3 Portable Terminal Impact Attenuators

##### 605.3.2.3.1 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 Determine if a portable terminal impact attenuator is suitable for a specific roadway based on the legal posted regulatory speed limit of the roadway before the presence of a work zone, a temporary speed limit, or an unforeseen roadway hazard.

3 Restrict the use of a Test Level 2 portable terminal impact attenuator to only those roadways with legal posted speed limits of 45 mph or less.

4 Restrict the use of a Test Level 3 - 60 mph portable terminal impact attenuator to only those roadways with legal posted speed limits of 60 mph or less.

5 A Test Level 3 - 70 MPH portable terminal impact attenuator, rated for 70 mph, may be used on all roadways.

##### 605.3.2.3.2 Field Installations

###### 605.3.2.3.2.1 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 Specifications and manufacturer's specifications.

#### 605.3.2.3.2.2 Site Location

1 Install attenuators according to the *Standard Drawings*. When a unit is placed in a gore area, install the unit parallel to the mainline traffic flow.

2 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 according to 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 ft to 10 ft wide (perpendicular to the roadway). Excavate and clear all obstructions from the immediate site location as necessary. Remove obstructions within 3 ft of either side of the unit. Dress and clear the immediate surrounding area and the approach area 50 ft 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. Ensure that all approach areas in advance of the site location are reasonably smooth and flat for not less than 100 ft. 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 Use an approved transition panel for the attenuator when the site location is adjacent to a two-lane, two-way roadway. Use a transition panel on the backside of the unit where the near edge of the backside rear of the unit is within 30 ft of the near edge line of a travel lane carrying traffic in the opposing direction and may be approached by an errant vehicle from the opposing direction at an angle of 25 degrees or less. Place the attenuator on the site location to minimize exposure of the rear of the unit to all opposing traffic and the possibility of a vehicle snagging the rear of the unit. Install and attach each transition panel to the attenuator and to the hazard 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. Ensure that all attachments of the transition panel according to the manufacturer's specifications.

#### 605.3.2.3.2.3 Foundation and Anchoring

1 Construct each foundation for anchoring of an attenuator according to 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 an 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. If the manufacturer's specifications do not provide specified anchor length and embedment depth, install the anchors as follows:

- Asphalt concrete – Use a ¾ in. × 18 in. threaded rod embedded to a minimum depth of 16½ in.
- Portland cement concrete – Use a ¾ in. × 7 in. long steel stud embedded to a minimum depth of 5½ in.

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 in. × 24 in. Ensure that the pad is at least 8 in. thick, 4 ft wide, and at least 2 ft longer than the length of the attenuator it supports. Ensure that the anchors used with the portable pad have a length of 6.5 in. to 7.5 in. with a minimum embedment of 5.5 in. Comply with these requirements unless otherwise directed by the manufacturer's specifications and approved by the RCE.

6 When using 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 the fill to stabilize the unit and to remain stable and absent of voids for the duration the unit remains in place.

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 anchors and anchor system components are subject to RCE approval before 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 Use a two-part polyester epoxy or resin for grouting the anchors according to the manufacturer's specifications.

#### 605.3.2.3.3 Maintenance

1 Maintain all portable terminal impact attenuators in a condition to properly function as designed and in compliance with *NCHRP Report 350* or MASH requirements. Repair or replace any unit with damage sustained due to a strike by an errant vehicle or any damage-causing incident. Regardless of how minor the damage may appear, repair the damage to ensure that the unit remains functional within the requirements of Specifications and the manufacturer's specifications. Initiate refurbishment or total replacement of a damaged unit, as necessary, within 2 hours after discovery or notification of an impact. Complete repairs or replacement of a damaged unit within 24 hours of discovery or notification of a damage-causing incident.

2 Monitor all parts of an attenuator, including the anchors and foundation, for the duration the unit remains in place. Keep the area underneath a unit clear at all times. Do not allow silt, soil, debris, etc., to collect underneath the unit. Keep the area immediately adjacent to the unit clear of materials, tools, debris, etc.

3 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.

4 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.

### 605.3.3 Temporary Longitudinal Barriers

#### 605.3.3.1 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 manufacturer's specifications, the Plans, the *Standard Drawings*, the Specifications, and the RCE.

3 Ensure that all temporary longitudinal barriers installed in a continuous line have the same shape, length, and connection type.

#### 605.3.3.2 Temporary Concrete Barrier

1 Use temporary concrete barrier walls on the roadway to prevent traffic from entering a work area, to separate two-way traffic, to act as a temporary bridge

parapet wall, or to shield against a hazard. Anchor the barrier wall to the bridge deck when there is 8 ft or less of bridge deck between the face of the barrier wall nearest the edge of the bridge deck and the edge of the bridge deck. Install, maintain, repair, or replace as necessary, and relocate the barrier wall as specified herein.

2 Do not store material or equipment within 6 ft 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. Install temporary concrete barrier walls according to the *Standard Drawings.* When connecting the end of a line of temporary concrete barrier wall behind a semi-rigid structure such as a steel W-beam guardrail, install the connection to the semi-rigid structure according to the *Standard Drawings*. Stabilization of the last 2 sections of barrier walls in the line of barrier wall is neither required nor recommended when connecting to a semi-rigid structure. Install and attach thrie beam guardrail, a thrie beam terminal connector, and a thrie beam to W-beam guardrail transition section according to the *Standard Drawings*. When connecting to a thrie beam guardrail installation, the thrie beam to W-beam transition section is not required.

### 605.3.3.3 Temporary Polyethylene Water-Filled Barrier

#### 605.3.3.3.1 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. Ensure that all temporary polyethylene water-filled barrier walls installed in a continuous line are the same model and fabricated by the same manufacturer.

2 A temporary polyethylene water-filled barrier wall system has a much greater deflection than temporary concrete barrier wall. Obtain all information from the manufacturer regarding the deflection values of the water-filled barrier, and furnish this information to the RCE before 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.

#### 605.3.3.3.2 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 required for water-filled barrier, place the water-filled barrier to accommodate the projected amount of deflection in case 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 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. Where the posted speed limit before 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 ft away from the near edge of the adjacent travel lane. Where the posted speed limit before 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 ft 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**.

6 When tapering the end of the temporary polyethylene water-filled barrier wall system or using a portable terminal impact attenuator is impractical, usually due to space limitations or business and residential access requirements, the use 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 a crashworthy end treatment meet the criteria for a Test Level 2 non-redirective crash cushion for impact conditions of 1800 lb to 4400 lb 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 and permit a limited controlled penetration of the barrier wall system, contained and redirected or a combination of these possible scenarios.

7 Install additional temporary polyethylene water-filled barrier in the approach and downstream areas flanking the OLON area according to the manufacturer's specifications to ensure proper function and acceptable deflection values of the system within the OLON area. Do not install the temporary polyethylene water-filled barrier adjacent to a work area 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.

8 Ensure that each installation of a temporary polyethylene water-filled barrier wall system equals or exceeds the MLON required for each approved temporary polyethylene water-filled barrier wall system. Determine the LON based on

specific site requirements and methods of providing end protection for each installation of temporary polyethylene water-filled barrier wall.

#### 605.3.3.4 Temporary Structural Steel Barrier

##### 605.3.3.4.1 General

1 Use temporary structural steel barrier walls on the roadway to prevent traffic from entering a work area, to separate two-way traffic, or to shield against a hazard. Install, maintain, repair, or replace as necessary, and relocate the steel barrier wall as specified herein.

##### 605.3.3.4.2 Field Installations

1 Install approach tapers for temporary structural steel barrier walls to minimize the severity of an impact from an errant vehicle and the violent impact forces an errant vehicle will likely encounter upon impact into a steel barrier wall. Taper the approach area of a steel barrier wall placed near a travel lane away from the travel lane at the first practical opportunity. Taper the approach end of the steel barrier wall according to the legal posted regulatory speed limit of the adjacent roadway before the presence of the work zone or a temporary speed limit or placement of the steel barrier wall. Install an approach taper as follows:

| Speed Limit | Taper Rate |
|---|---|
| 40 mph or Less | 8:1 |
| 45 mph or Greater | 10:1 |

2 Minimize the potential hazard the end of a line of temporary structural steel barrier wall may present to an errant vehicle by terminating the line of the steel barrier wall to ensure that the blunt end of the steel barrier wall is inaccessible to vehicles. Select from the following options a suitable method for termination of a line of steel barrier wall:

- On or adjacent to a roadway with roadside slopes of 10H:1V or flatter and a legal posted regulatory speed limit of 40 MPH or less before the presence of the work zone or a temporary speed limit or placement of the steel barrier wall, terminate a line of the steel barrier wall with a minimum clearance distance of 15 ft from the near side of the steel barrier wall end to the near edge of the opposing travel lane by tapering the approach end of the steel barrier wall at an 8:1 taper rate.
- On or adjacent to a roadway with roadside slopes of 10H:1V or flatter and a legal posted regulatory speed limit of 45 MPH or greater before the presence of the work zone or a temporary speed limit or placement of the steel barrier wall, terminate a line of the steel barrier wall with a

minimum clearance distance of 30 ft from the near side of the steel barrier wall end to the near edge of the opposing travel lane by tapering the approach end of the steel barrier wall at a 10:1 taper rate.

- The end of a line of steel barrier wall may be made inaccessible to vehicles by extending the line of steel barrier wall behind a tree line or other natural occurring obstruction or by extending the line of the steel barrier wall into a cut slope or behind a pre-existing manmade structure. When terminating the steel barrier wall behind a guardrail or a bridge rail, attach the barrier wall to the guardrail or bridge rail per the manufacturer's specifications unless otherwise directed by the Department. Placement of non-compacted fill dirt in front of the end of a line of steel barrier wall for protection is unacceptable.

- Use a portable terminal impact attenuator to supplement the end of a line of steel barrier wall where available space limitations or work requirements require termination of the line of steel barrier wall at a location near a vehicular travel path where minimum clearance distance requirements as defined above or other acceptable alternative methods of protection are unavailable.

3 In the event of a high speed impact at an angle of 20 degrees or greater by an errant vehicle into a line of temporary structural steel barrier wall, deflection of those sections of steel barrier walls at the site of the impact is likely to occur. Do not store material or equipment within 6 ft of the back of a line of temporary structural steel barrier wall when alternative storage space is available. Do not brace, attach, or rest material on, against, or immediately adjacent to or place equipment immediately adjacent to a temporary structural steel barrier wall that may restrict the designed crash performance of the steel barrier wall in the event of an impact by an errant vehicle.

4 Upon completion of the project, the temporary structural steel barrier walls will remain the property of the Contractor unless otherwise specified.

### 605.3.4 Ground Mounted Vertical Panels

1 Use vertical panels to delineate travel lanes and channelize traffic where a traffic control device securely anchored in position may be beneficial for safety and maintenance purposes. Vertical panels may be used as an alternative to portable plastic drums when directed by the Plans and/or special provisions. Otherwise, acquire approval from the RCE for use of vertical panels before their installation. Provide, install, and maintain each vertical panel as specified herein.

2 Install each vertical panel in an upright position at an approximate or near 90-degree angle to the horizon.

3 Ensure that the installation of a Category III vertical panel provides for a minimum overall height of 42 in. from the surface of the adjacent travel lane to the top of the panel. When the vertical panel apparatus is ground embedded on an earth shoulder adjacent to the travel lane, measure the required minimum 42-in. height from the grade elevation of the near edge of the adjacent travel lane to the top of the panel.

4 When delineating the right edge line of a travel lane and sufficient space is available, install the vertical panels no less than 3 ft from the near edge of the vertical panel to the near edge of an adjacent travel lane to minimize contact with vehicles unless otherwise directed by the RCE. When space is limited and the 3-ft buffer area is unavailable, install the vertical panels at the greatest distance available or as directed by the RCE.

5 Maintain all vertical panels in good condition. Replace and do not use vertical panels that are unable to remain upright in an approximately 90-degree position or contain retroreflective sheeting that is faded, peeling, or contaminated by any substance or material that reduces the required reflectivity. Replace vertical panels with retroreflective sheeting that is cut, scratched, or damaged. Replace and do not use those vertical panels that have completed their functional service life.

## 605.4 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 The quantities for temporary construction signs and vertical panels are included in the lump sum item Traffic Control as specified in **Subsection 601.4**. No separate measurement is made for temporary construction signs or vertical panels 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. Revisions 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.

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 for 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 is measured 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, Temporary Concrete Barrier (Moveable), Temporary Concrete Barrier with Anchorage, or Temporary Structural Steel Barrier is the length of functional 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 *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 or for relocating the barrier wall included in the Plan quantity and indicated on the Plans or in the Specifications. This 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 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 *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 Contract 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 or for relocating the barrier included in the Plan quantity and indicated on the Plans or in the Specifications. This work is considered incidental to the work for the water-filled barrier item. No measurement is made for 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. These items and work are considered incidental to the water-filled barrier.

9 Measurement for additional or relocated temporary barrier is made only if all of the following conditions are met:

- Only those sections of barrier provided are in addition to the original Plan quantity.
- The additional quantity is provided as directed by the RCE.
- 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 **Subsection 601.4**. If the Contract includes a separate pay item for Truck-Mounted Attenuator, the measurement is by each (EA).

11 Other Category III traffic control devices not herein specified for measurement are included in the lump sum item Traffic Control as specified in **Subsection 601.4**. No separate measurement or payment is made for these items unless the Contract includes specific bid items for these devices.

## 605.5 Payment

1 Payment for the accepted quantity for each Category III Traffic Control Device pay item (except temporary longitudinal barriers) at the Unit Price is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 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 Change Order. Payment for replacement of the spare parts used 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.

3 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).

4 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, including all materials, labor, equipment, tools, supplies, transportation and incidentals required for each anchor kit specified.

5 Payment for the accepted quantity for Temporary Concrete Barrier Wall, Temporary Concrete Barrier Wall (Moveable), Temporary Concrete Barrier with Anchorage, Temporary Polyethylene Water-Filled Barrier, or Temporary Structural Steel Barrier at the Unit Price is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

6 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.

7 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 **Subsection 601.5**. Payment is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

8 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 |
| 6052110 | Truck-Mounted Attenuator | EA |
| 6052120 | Portable Terminal Impact Attenuators | EA |
| 6052121 | Portable Terminal Impact Attenuator – Test Level 2 | EA |
| 6052122 | Portable Terminal Impact Attenuator – Test Level 3 | 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 |

(table continued on the next page)

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| Item No. | Pay Item | Unit |
|---|---|---|
| 6053112 | Temporary Concrete Barrier (with Anchorage) for Bridge Decks | LF |
| 6053115 | Temporary Concrete Barrier (Moveable) w/Non-Textured White Coating (including TTV) | LF |
| 6053120 | Temporary Water Filled Polyethylene Barrier | LF |
| 6053130 | Temporary Structural Steel Barrier | LF |
| 6052110 | Truck-Mounted Attenuator | EA |

# Section 606 — Category IV Traffic Control Devices

## 606.1 Description

1 Provide, install, and maintain Category IV traffic control devices.

## 606.2 Materials

### 606.2.1 Trailer and Accessories

1 Ensure that each trailer-mounted arrow panel complies 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 Provide a trailer with an axle weight capacity rated for no less than 2000 lb. Fabricate and equip the trailer with a single axle, springs, arrow panel support assembly, and 4 leveling or adjustable stabilizer jacks. Ensure that the unit includes a manual crank or hydraulic system to permit one person to raise the traffic control device into its operating position.

3 Ensure that the trailer-mounted devices can remain stable in winds up to 80 mph when in the operating position.

### 606.2.2 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 panel device. Equip each panel device that uses 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 panel device 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 can operate the changeable message sign as required by the Plans, the Specifications, and the MUTCD.

### 606.2.3 Power Source

#### 606.2.3.1 Solar Assisted Power Source

1 Provide 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.

#### 606.2.3.2 AC Power Source

1 Provide 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 to comply with UL approved equipment and methods. Ensure that all power attachments comply with all OSHA regulations and the *National Electrical Code*.

#### 606.2.3.3 Diesel Power Source

1 Diesel or gasoline engine powered generators are unacceptable and prohibited for use.

### 606.2.4 Trailer-Mounted Advance Warning Arrow Panels

#### 606.2.4.1 Panel Face

1 Ensure that each advance warning arrow panel has a rectangular shaped panel face that is at least 48 in. vertically, 96 in. horizontally, and finished with a black non-reflectorized surface. Equip each panel with 5-in. 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 the 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.

#### 606.2.4.2 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.

### 606.2.4.3 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.

### 606.2.4.4 Rear of Panel

1 Ensure that each arrow panel is equipped with 3 lamps located on the rear of the panel that will indicate the message mode being displayed.

### 606.2.4.5 Power System, Illumination and Intensity

1 Provide a power system as specified in **Subsection 606.2.2**.

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 can 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 the system maintains lamp intensity at a constant and even intensity level throughout all lamps operating in unison.

### 606.2.4.6 Power Sources

1 Provide electrical power for the arrow panel from one of the power sources specified in **Subsection 606.2.3**.

#### 606.2.4.7 Trailer

1 Provide trailer and accessories as specified in **Subsection 606.2.1**. For each trailer-mounted arrow panel, provide a minimum height of 7 ft from the bottom of the arrow panel to the surface on which the unit is placed when the arrow panel is raised into its operating position.

### 606.2.5 Trailer-Mounted Changeable Message Sign

#### 606.2.5.1 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 ft.

#### 606.2.5.2 Sign Panel

1 Ensure that the sign panel is approximately 76 in. vertically by 113 in. horizontally. Ensure that the sign panel can provide message updates in less than 400 milliseconds.

#### 606.2.5.3 Three-Line Display

1 Ensure that a three-line sign has at least eight individual modules per line. Ensure that each module has a matrix size of not less than 5 in. × 7 in. message components and can provide a character height of not less than 18 in.

#### 606.2.5.4 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 × 28 message components. The exact matrix size may vary from manufacturer to manufacturer but cannot exceed ±5%.

#### 606.2.5.5 LED Display

1 Ensure that message components are light emitting diodes (LED) elements and that each pixel contains no less than 4 LED elements.

#### 606.2.5.6 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 a compatible personal computer. Ensure that this unit has a LCD display screen that allows the operator to review messages before displaying the message on the sign.

2 Ensure that the controller can store 199 factory preprogrammed messages and up to 199 additional messages created by the user. Ensure that the controller stores the messages such that it 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.

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 provides "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 sign with remote communications that allows the operator to revise or modify the message selection from a remote location. Provide protection to prohibit unauthorized access to the controller (i.e., password protection).

#### 606.2.5.7 Power System

1 Provide a power system as specified in **Subsection 606.2.2**.

#### 606.2.5.8 Power Source

1 Provide power sources as specified in **Subsection 606.2.3**.

#### 606.2.5.9 Trailer and Accessories

1 Provide trailer and accessories as specified in **Subsection 606.2.1**.

2 Ensure that the sign rotates 360 degrees on a vertical axis to permit positioning for transport or for operation.

3 Ensure that the trailer-mounted sign panels can remain stable in winds up to 80 mph when in the operating position.

### 606.2.6 Portable Traffic Signal System

#### 606.2.6.1 General

1 Provide, install, and maintain each trailer-mounted portable traffic signal system as specified herein.

2 A portable traffic signal system is a temporary traffic control device for controlling the flow of traffic in single lane, two-way traffic locations and at intersections. Ensure that the system has no less than two individual units linked together through either radio controlled, hard wired, or microwave communications to comprise the system.

3 Ensure that the portable traffic signal system can operate according to MUTCD requirements. Install and use the portable traffic signal system as specified and directed by the Specifications, the Plans, and the RCE.

### 606.2.6.2 Signal Heads

1 Ensure that each trailer-mounted portable traffic signal contains two signal heads that include standard ITE approved signal indications with a minimum diameter of 12 in. Ensure that each signal indication, including the arrow indications, can be independently illuminated and can emit a single color — red, yellow, or green. Illuminate each signal indication with LED. Ensure that the typical arrangement of the signal indications complies with the MUTCD.

### 606.2.6.3 Signal Head Placement

1 Ensure that the bottom of a signal head and any related attachments located over a travel lane have a minimum distance of 15 ft above the pavement. Ensure that the top of the signal head does not exceed a distance of 25.5 ft above the pavement.

2 Ensure that the bottom of the signal head of the lower signal has a minimum distance of 8 ft above the grade elevation of the travel lane.

### 606.2.6.4 Controller

1 Provide a controller that 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 a compatible personal computer. Provide a unit that has a LCD display screen that allows the operator to review the status of the system.

2 Ensure that all radio communications between multiple trailer-mounted units comply with all FCC regulations.

3 Ensure that the controller provides default modes (“Red Flash” and “Yellow Flash”) for the system during operation when necessary. Ensure that a failure of the controller, such as a power loss and total shut down of the system, results in removal of the signal system from the roadway. When the system enters into a default mode or total shut down, ensure that the system can immediately provide notification to the personnel responsible for the system status.

4 Ensure that each controller is equipped with a Malfunction Management System (MMS) conforming to the National Electrical Manufacturers Association (NEMA) TS-5 performance standards. Ensure that each signal within the signal system is equipped with a minimum of 2 malfunction units to ensure redundancy within the MMS.

#### 606.2.6.5 Power Source

1 Provide power sources as specified in **Subsection 606.2.3**.

#### 606.2.6.6 Trailer and Accessories

1 Provide trailer and accessories as specified in **Subsection 606.2.1**.

#### 606.2.6.7 Operational Requirements

1 Ensure that the portable signal system can operate in either a fixed timed mode, a vehicle actuation mode, or a remote control mode. In the fixed timed mode, the system operates according to preset times programmed into the controller by the operator. In the vehicle actuation mode, the system operates according to information inputs received from vehicle detectors. In the remote control mode, the system operates according to information inputs received from a manual radio remote control unit.

2 When operating in the actuation mode, ensure that the system has the capability for pre-timed operation, traffic actuated operation, a variable green time interval dependent upon vehicle actuations, and programmable yellow clearance and red clearance intervals.

### 606.2.7 Trailer-Mounted Automated Flagger Assistance Device System (AFAD)

#### 606.2.7.1 General

1 An AFAD system is a temporary traffic control device system for controlling the flow of traffic through temporary traffic control areas. Provide an automated flagger assistance device system that consists of no less than two individual AFAD units linked and remotely controlled by wireless communications.

2 Install, operate, and maintain each AFAD unit according to the MUTCD, the South Carolina *Flagger's Handbook*, the manufacturer's specifications, the Specifications, the *Standard Drawings*, the special provisions, the Plans, and the RCE.

3 Provide an AFAD system that is either a Type I "RED/YELLOW" lens system or a Type II "STOP/SLOW" sign system.

#### 606.2.7.2 Operational Requirements

##### 606.2.7.2.1 General

1 AFAD systems are only permitted for use on two-lane, two-way roadways where opposing traffic is required to use and share one common travel lane. Do not use AFAD as temporary traffic control signals.

2 Ensure that the AFAD system includes a fail-safe system with a conflict monitor or similar device to prevent the display of conflicting indications between units. Ensure that the system provides indicators to notify the operators of power loss that may impede proper operation of the system.

#### 606.2.7.2.2 Operator

1 Ensure that the operator of an AFAD system has successfully completed a flagger training course according to **Subsection 601.1.7**. Ensure that the operators of the AFAD system successfully complete the manufacturer-provided training on system operation. Provide documentation to the RCE no less than 7 days before placing an AFAD system into operation.

2 Ensure that the operator can control the AFAD system from a location with an unobstructed view of the AFAD unit and an unobstructed view of the approaching traffic. If a single operator is controlling more than one unit, ensure that the operator has an unobstructed view of traffic from both directions. At no time is the operator permitted to leave the AFAD unattended when the AFAD system is operating.

### 606.2.7.3 System Requirements

#### 606.2.7.3.1 General

1 Provide an AFAD system that consists of a main AFAD unit and a remote AFAD unit, linked and remotely controlled by wireless communications. Ensure that the individual trailer-mounted units have nesting capabilities to permit towing of both units in a single trailer configuration. When nested, ensure that all lights including stop, tail, and turn signal lights of both units operate uniformly.

#### 606.2.7.3.2 Power Sources

1 Provide power sources as specified in **Subsection 606.2.3**.

#### 606.2.7.3.3 Remote Control

1 Equip each AFAD unit with a controller that can receive and implement instructions through wireless communications from a handheld transceiver to permit operation of the individual unit or the system by an operator or operators from remote locations. Ensure that the system provides the capability for total system operation and control of both units by one operator from a primary handheld transceiver and allows independent unit operation by one operator per unit from unit specific handheld transceivers.

2 Monitor and verify data transmissions used to control the AFAD units. Ensure that the AFAD system uses digitally encoded signal transmissions to minimize interference. Comply with all applicable FCC requirements. If communications

are disrupted or lost, ensure that the system goes into a “fail safe” mode and displays the “Circular Red”/”STOP” indications and lowers the gate arms.

#### 606.2.7.3.4 Gate Arm

1 Equip each AFAD unit with an automated gate arm that descends to a down position across the travel lane where approaching traffic is operating when the AFAD unit displays the condition for approaching traffic to stop. Ensure that the automated gate arm ascends to an upright position when the AFAD unit displays the condition to allow stopped traffic to proceed.

2 To achieve acceptable operation of the gate arm, require the gate arm to begin descent to the down position within 2 to 4 seconds after the AFAD unit signals approaching traffic to stop. Ensure that the gate arm begins its ascent to the upright position within 1 to 2 seconds after the AFAD unit signals approaching traffic to proceed.

3 Provide a gate arm that measures no less than 8 ft in length and has a minimum vertical height of 4 in. when placed in the down position. Reflectorize both sides of the gate arm with a Type III Microprismatic retroreflective sheeting with vertical alternating red and white stripes at 16-in. intervals.

4 If an errant vehicle strikes the gate arm, ensure that the gate arm has the capability to deflect and then return to a functional position after the errant vehicle clears the gate arm.

#### 606.2.7.3.5 Trailer

1 Provide trailer and accessories as specified in **Subsection 606.2.1**.

### 606.2.7.4 Type I “RED/YELLOW” Lens System

1 Provide a Type I “RED/YELLOW” lens AFAD system that alternately displays a steadily illuminated circular RED lens and a flashing circular YELLOW lens to control traffic. Ensure that the RED lens illuminates when approaching traffic is required to stop and that the YELLOW lens illuminates when stopped or when approaching traffic is permitted to proceed.

2 Provide a “RED/YELLOW” lens AFAD unit that has no less than one set of circular RED and circular YELLOW lenses in a vertical configuration with diameters no less than 12 in. Arrange the lenses to place the RED above the YELLOW. Provide a minimum height of 7 ft from the bottom of the apparatus housing the YELLOW lens to the surface on which the AFAD unit is placed when in its operating position. However, if the lenses are located over any portion of a travel lane in which traffic is operating and traffic may pass underneath the lenses, ensure a minimum of 15 ft vertical clearance from the bottom of the apparatus housing the YELLOW lens over the roadway.

3 Install a “STOP HERE ON RED” sign (R10-6-36) or (R10-6a-30) on the right side of the approach at the point at which motorists are expected to stop.

#### 606.2.7.4.1 Transition between RED and YELLOW Conditions

##### 606.2.7.4.1.1 Transition to Circular RED Condition

1 Ensure that the flashing circular YELLOW lens enters into a minimum 5 second steady illumination phase before transitioning to the steady illuminated circular RED condition.

##### 606.2.7.4.1.2 Transition to Circular YELLOW Condition

1 Ensure that the steady illuminated circular RED lens transitions to the flashing circular YELLOW lens.

### 606.2.7.5 Type II “STOP/SLOW” Sign System

1 Provide a Type II “STOP/SLOW” sign AFAD system that has a “STOP/SLOW” sign that alternately displays the “STOP” (R1-1-36) face and the “SLOW” (W20-8-36) face of a “STOP/SLOW” paddle to control traffic. Ensure that the STOP sign face displays when approaching traffic is required to stop and that the SLOW sign face displays when stopped or approaching traffic is permitted to proceed.

2 Ensure that the “STOP/SLOW” sign, fabricated from a rigid material, has an octagonal shape with a minimum face size of 36 in. × 36 in. Reflectorize the STOP face of the sign with a red Type III high intensity microprismatic retroreflective sheeting. Reflectorize the SLOW face of the sign with a fluorescent orange retroreflective sheeting. Reflectorize each face of the sign with a retroreflective sheeting included on *Qualified Products List 20*. Provide a STOP sign face that has a red background with white letters and border and a SLOW sign face that has a diamond shaped orange background with black letters and border. Ensure that the letters have a minimum height of 8 in. and that the sign faces have a minimum mounting height of 7 ft from the bottom of the sign to the surface on which the AFAD unit is placed when in its operating position.

3 Supplement the Type II “STOP/SLOW” sign AFAD unit with active conspicuity devices. Include a steady illuminated RED lens beacon to illuminate when the STOP sign face is displayed and a flashing YELLOW lens beacon to illuminate when the SLOW sign face is displayed. Ensure that each beacon has a 12-in. signal lens. Mount the RED lens beacon no more than 24 in. above the top of the STOP sign face and the YELLOW lens beacon no more than 24 in. above the top or to the side of the SLOW sign face.

4 Type B warning lights are PROHIBITED as alternatives to the 12-in. signal lens beacons.

5 Install a “WAIT ON STOP” sign (R1-7-30) and a “GO ON SLOW” sign (R1-8-30) either on the same support structure as the AFAD unit or immediately adjacent to the AFAD unit.

#### 606.2.7.5.1 Transition between STOP and SLOW Conditions

##### 606.2.7.5.1.1 Transition to STOP Condition

1 Ensure that the RED lens beacon enters into a “flashing mode” no less than 5 seconds before transitioning from the SLOW sign face to the STOP sign face. Immediately upon completion of the transition to a complete display of the STOP sign face, ensure that the “flashing mode” of the RED lens beacon transitions to a steady illuminated condition.

##### 606.2.7.5.1.2 Transition to SLOW Condition

1 Ensure that the STOP sign face begins the transition to the SLOW sign face. Ensure that the RED lens beacon ceases to illuminate and the flashing YELLOW lens beacon begins to illuminate immediately upon completion of the transition of the STOP sign face to the SLOW sign face and the ascent of the gate arm to its completed upright position.

### 606.3 Construction

1 Ensure that the trailer-mounted Category IV traffic control devices remain stationary when operating. Do not tow trailer-mounted Category IV traffic control devices while operating.

2 Do not place, attach, or mount a trailer-mounted Category IV traffic control device on or to the bed, body, etc., of a truck to act as a truck-mounted device.

3 The Department will consider failure to conduct traffic control operations properly within all requirements as set forth by the Specifications, the Plans, the MUTCD, and the RCE as failure to provide the traffic control as required and shall result in immediate suspension of all work activities requiring the Category IV traffic control devices until the condition is corrected.

4 Provide daily maintenance of each Category IV traffic control devices. 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 may 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 may 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 require repair and

immediate replacement with a unit in good operating condition. Do not place a defective, deficient, or damaged unit on the roadway.

### 606.3.1 Trailer-Mounted Advance Warning Arrow Panels

#### 606.3.1.1 General

1 Use trailer-mounted advance warning arrow panels to provide additional advance warning and directional information to assist motorists through a work zone. Provide the warning devices for advance directional information in lane closures, shoulder closures, and other work activities as necessary. Install, maintain, and operate each arrow panel as specified herein.

#### 606.3.1.2 Operational Requirements

1 Mount advance warning arrow panels to provide a minimum height of 7 ft from the bottom of the sign to the surface of the roadway.

2 Do not use a Sequential Stem Arrow or similar mode. Use the Flashing Arrow Modes, the Sequencing Chevron Modes, or the Caution Mode.

3 Use the Caution Mode to alert motorists that they are approaching an area impacted by work activities. Use the Caution Mode at locations and during operations that do not mandate relocation of traffic to an adjacent travel lane. The Caution Mode requires a pattern of 4 lamps with 1 lamp in each corner flashing simultaneously (referred to as the “4 Corners” pattern). Do not use arrow panels incapable of producing this pattern. Do not display a bar, alternating diamond(s), or any other symbol other than the required four corners during those times the Caution Mode is required.

4 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 and various other traffic control devices as specified by the Plans, the Specifications, the MUTCD, and the RCE.

5 Do not use advance warning arrow panels as an element of a flagging operation to direct vehicles into lanes used by opposing traffic. Arrow panels in a flagging operation may compromise the flagger’s authority and control of traffic and therefore is prohibited within flagging operations.

6 Where the shoulders are narrow or site conditions, such as the presence of a sidewalk or other physical obstruction, is present, place the arrow panel in the closed area behind the channelizing traffic control devices as near to the beginning of the taper as practical. Place the arrow panel at the beginning of the taper when sufficient shoulder space is available unless otherwise directed by the RCE. Do not allow the arrow panel to block the motorist’s visibility of any channelizing traffic control devices within the taper.

### 606.3.2 Trailer-Mounted Changeable Message Sign

#### 606.3.2.1 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 *Standard Drawings*, the Specifications, and the Plans.

#### 606.3.2.2 Operational Requirements

1 Use changeable message signs in all lane closures installed on high-volume, high-speed roadways. Use of changeable message signs in lane closures 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 *Standard Drawings.*

2 When a lane closure is non-operational for more than 3 days, remove the changeable message sign from the roadway. If stored on site, place the sign in a predetermined area, approved by the RCE, where the sign is not visible to passing motorists.

3 Use pre-programmed messages according to the *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 ft 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 ft 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 ft 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.

5 Do not substitute a trailer-mounted changeable message sign for the truck-mounted changeable message sign required for “PREPARE TO STOP” notification if a traffic queue develops during a stationary lane closure.

### 606.3.3 Portable Traffic Signal System

1 Use a trailer-mounted portable traffic signal system to control the flow of traffic in single lane, two-way traffic operation and at intersections. Consider a trailer-mounted portable traffic signal system where complete closure is not an option and maintaining traffic flow is required.

2 Conduct all traffic signal operations according to the Specifications, the *Standard Drawings*, the MUTCD, and the RCE.

### 606.3.4 Automated Flagger Assistance Device Systems (AFAD)

1 Use AFAD systems in typical flagging operations upon approval by the RCE. Conduct all AFAD flagging operations according to **Section 610**, the *Standard Drawings*, and the RCE.

2 Replace the gate arm if it is incapable of returning to a functional position.

#### 606.3.4.1 Site Location

1 When sufficient shoulder space is available, place and position the AFAD unit on the shoulder of the roadway no closer than 1 ft from either the near edge line or the near edge of pavement when an edge line is absent to the near edge of the trailer when the gate arm is in the upright position. Where sufficient shoulder space to attain the minimum 1-ft requirement is unavailable, minimal encroachment of the unit upon the adjacent travel lane as determined acceptable by the RCE is permitted.

2 Place and position the AFAD unit to allow the end of the gate arm, when in the down position, to reach the center of the adjacent travel lane being controlled by the unit. When the gate arm is in the down position, encroachment by the gate arm to a point less than to the center of the adjacent travel lane or beyond the center of the roadway into the opposing travel lane is PROHIBITED.

3 Install advance warning signs required for typical flagging operations on each approach. The required advance warning signs for each approach are “BE PREPARED TO STOP” (W3-4-48), “Flagger” symbol (W20-7-48), “ONE LANE ROAD AHEAD” (W20-4-48-A), and “ROAD WORK AHEAD” (W20-1-48-A).

#### 606.3.4.2 Nighttime AFAD Flagging Operations

1 During nighttime operations, illuminate each AFAD unit station with any combination of portable lights, standard electric lights, existing street lights, etc., to provide a minimum illumination level of 108 Lx or 10 fc.

2 Ensure that the operators are equipped with PPE as specified in **Section 612**.

3 Supplement the array of advance warning signs with a changeable message sign on each approach during nighttime AFAD flagging operations. Changeable message signs are not required during daytime operations. Install the changeable message signs 500 ft in advance of the advance warning sign arrays. Messages should be “FLAGGER AHEAD” and “PREPARE TO STOP.”

## 606.4 Measurement

1 Unless otherwise specified, Category IV traffic control devices are included in the lump sum item for Traffic Control according to **Subsection 601.4**.

2 If included as a pay item, the quantity for the pay item Construction Zone Electric Changeable Message Sign (Trailer-Mounted) is measured by each (EA) message sign 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 *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.

## 606.5 Payment

1 In addition to **Subsection 601.5**, 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, including all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Payment for the accepted quantity for Construction Zone Electric Changeable Message Sign (Trailer-Mounted) at the Unit Price is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

3 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 Provide, install, and maintain truck-mounted traffic control devices. Truck-mounted advance warning arrow panels and truck-mounted changeable message signs are not included in any category as an individual traffic control device since these devices are supplemental to the vehicles.

## 607.2 Materials

### 607.2.1 Truck and Accessories

1 Mount truck mounted traffic control devices as a permanent fixture to the truck to provide a minimum height of 7 ft from the bottom of the panel face to the surface on which the truck is operating when the device is in its operating position. Attach the unit to the frame of the truck through use of a sufficient number of fasteners to prevent the structure from detaching from the frame of the truck during an impact from an errant vehicle. Do not place or attempt to mount a trailer-mounted unit on a truck.

### 607.2.2 Power System

1 Provide a 12-volt electrical system powered from a 12-volt DC power source or an adaptable 110-volt or 120-volt AC power source to operate truck-mounted devices. Equip each unit powered by a DC electrical power source with an automatic lamp intensity regulator to maintain constant power outputs during battery voltage variances and a voltage indicator or warning device to indicate when the batteries require recharging. Locate the lamp intensity regulator and the voltage indicator in a convenient location for easy access and visibility for reading by the operator.

2 Obtain operating power for the truck-mounted device from the vehicle, a truck-mounted generating plant, solar assisted facilities, or an adaptable 110-volt or 120-volt AC power source. Use of a portable generator for a power source is unacceptable. Regardless of the source, provide a supply of electrical energy capable of operating the device as required by the Specifications, the *Standard Drawings*, the Plans, and the MUTCD.

### 607.2.3 Power Sources

#### 607.2.3.1 Vehicle Based Power

1 Operating the truck-mounted device 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 with prior RCE approval. However, 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. Do not use a portable generator for a power source.

#### 607.2.3.2 Solar Assisted Power

1 Power the truck-mounted device with a battery bank charged by photovoltaic solar panels and supplemented with a built-in 110-volt, 20-amp battery charger. Contain and house the battery bank in a lockable heavy-duty, steel, weatherproof box. Equip the power control unit with two current meters, one to indicate amperage generated by the battery charger and the other for amperage generated by the solar panels.

#### 607.2.3.3 AC Power

1 Power the truck-mounted device with an adaptable 110-volt or 120-volt AC power source and equip the unit with ground fault interrupting circuit (GFIC) breakers. Use UL compliant equipment and methods to implement all AC power adaptations. Fabricate and conduct all power attachments in compliance with all OSHA regulations and the *National Electrical Code*.

### 607.2.4 Truck-Mounted Advance Warning Arrow Panels

#### 607.2.4.1 Sign Panel

1 Ensure that each advance warning arrow panel has a rectangular shaped panel face that is at least 48 in. vertically and 96 in. horizontally and is finished with a black non-reflectorized surface. Equip each panel with 5-in. minimum sized yellow or amber lamps (15 or 25 lamps) that produce sufficient light output to provide message modes legible at a minimum distance of 1 mile. Supplement each lamp with a visor encompassing the top portion of the lamp for not less than 180 degrees of the lamp circumference. Ensure that each arrow panel is able to produce the message modes specified when operating.

#### 607.2.4.2 15-Lamp Arrow Panel Message Modes

1 Ensure that each advance warning arrow panel with a 15-lamp configuration has the capability to produce the following 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.

### 607.2.4.3 25-Lamp Arrow Panel Message Modes

1 Ensure that each advance warning arrow panel with a 25-lamp configuration has the capability to produce the following 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.

### 607.2.4.4 Rear of Panel

1 Equip each advance warning arrow panel with 3 lamps located on the rear of the panel to provide a directional indication of the message mode.

### 607.2.4.5 Power System, Illumination, and Intensity

1 Provide a power system as specified in **Subsection 607.2.2**.

2 Ensure that the system provides between 25 and 40 complete operating cycles or flashes per minute during each of the specified message modes. 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 can 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 the system maintains lamp intensity at a constant and even intensity level throughout all lamps operating in unison at all times.

### 607.2.5 Truck-Mounted Changeable Message Sign

#### 607.2.5.1 Sign Panel

1 Provide a sign panel that is approximately 42 in. vertical by 76 in. horizontal. Specific measurements may vary from manufacturer to manufacturer. Ensure that the sign panel has full matrix capability and the capability to display two message lines with 7 characters per line at a character height of 18 in. Ensure that the sign panel can provide message updates in less than 400 milliseconds.

#### 607.2.5.2 LED Display

1 Ensure that message components are LED elements and that each pixel contains a minimum of 2 LED elements and is readable at a distance of 600 ft.

#### 607.2.5.3 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 a unit that has a jack that allows direct communications between the on-board controller and a compatible personal computer. Ensure that this unit has a LCD display screen that allows the operator to review all messages before displaying the message on the sign.

2 Ensure that the controller can store a minimum of 100 factory preprogrammed messages and a minimum of 50 additional messages created by the user in a manner that does not require a battery to recall the messages. Ensure that the controller allows the operator the capability to program the system to display multiple messages in sequence.

3 Provide a controller with a selector switch to allow the operator to control the brightness or intensity level of the light source of the sign panel. Ensure that the selector switch includes “bright,” “dim” and “automatic” modes; inclusion of additional modes is permissible. When the selector switch is in the “automatic” mode, ensure that a photosensitive circuit controls the brightness or intensity level of the light source in response to changes in ambient light 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 including revision or modification of the message from inside the cab of the vehicle. Provide protection to prohibit unauthorized access to the controller (i.e., password protection).

#### 607.2.5.4 Power Source

1 Provide a power source as specified in **Subsection 607.2.3**.

## 607.3 Construction

1 Do not tow an operating trailer-mounted device in place of using a truck-mounted device.

2 Do not place, attach, or mount a trailer-mounted device on or to the bed, body, etc., of a truck to act as a truck-mounted device.

### 607.3.1 Truck-Mounted Advance Warning Arrow Panels

#### 607.3.1.1 General

1 Use truck-mounted advance warning arrow panels to provide additional advance warning and directional information to assist motorists through a work zone. Provide these warning devices for advance directional information in lane closures, shoulder closures, mobile operations, or other work activities as necessary. Install, operate, and maintain each arrow panel as specified herein.

#### 607.3.1.2 Operational Requirements

1 Do not use a Sequential Stem Arrow or similar mode. Use the Flashing Arrow Modes, the Sequencing Chevron Modes, or the Caution Mode.

2 Use the Caution Mode to alert motorists that they are approaching an area impacted by work activities. Use the Caution Mode at locations and during operations that do not mandate relocation of traffic to an adjacent travel lane. The Caution Mode requires a pattern of 4 lamps with 1 lamp in each corner flashing simultaneously (referred to as the “4 Corners” pattern). Do not use arrow panels incapable of producing this pattern. Do not display a bar, alternating diamond(s), or any other symbol other than the required four corners during those times the Caution Mode is required.

3 Provide truck-mounted advance warning arrow panels with the capability to operate while the vehicle is moving and produce all message modes as listed herein.

4 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 with other various traffic control devices as specified by the Plans, the Specifications, the *Standard Drawings,* the MUTCD, and the RCE.

5 During stationary lane closures, supplement the truck-mounted attenuator placed beyond the downstream end of the taper with an advance warning arrow panel. If this truck is advanced beyond the initial location, as specified by the *Standard Drawings*, change the message mode from the Flashing Arrow Mode to the Caution Mode.

6 Do not use advance warning arrow panels as an element of a flagging operation to direct vehicles into lanes used by opposing traffic. Arrow panels in a flagging operation may compromise the flagger's authority and control of traffic and therefore is prohibited within flagging operations.

#### 607.3.1.3 Maintenance

1 Maintain the advance warning arrow panel according to **Subsection 606.3**.

### 607.3.2 Truck-Mounted Changeable Message Sign

#### 607.3.2.1 General

1 Use truck-mounted changeable message signs on or adjacent to roadways to provide information to motorists and to provide additional advance warning and directional information to assist motorists through a work zone.

#### 607.3.2.2 Operational Requirements

1 Use pre-programmed messages according to the *Standard Drawings* when changeable message signs are used as part of the traffic control setup. 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.

2 Install, maintain, and operate each truck-mounted changeable message sign, and use these signs to supplement lane closures, mobile operations, or other work activities as necessary according to the *Standard Drawings*, the Specifications, the Plans, and the RCE.

3 Mount the truck-mounted changeable message sign on a truck equipped with an approved truck-mounted attenuator when used during mobile operations for "EXIT" notification during lane closures or when the sign is required to operate within the limits of a travel lane, open or closed to traffic.

4 Provide a truck-mounted changeable message sign to display the "PREPARE TO STOP" message in advance of a traffic queue during a stationary lane closure. When using 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:

- The sign is mounted on a vehicle with a gross vehicular weight (GVW) of 5000 lb or less.
- 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, except to relocate with extreme caution through an area with insufficient shoulder width such as a bridge structure.

5 Do not substitute the truck-mounted changeable message sign required for "PREPARE TO STOP" notification if a traffic queue develops during a stationary lane closure with a trailer-mounted changeable message sign.

#### 607.3.2.3 Maintenance

1 Maintain the changeable message sign according to **Subsection 606.3**.

### 607.4 Measurement

1 Truck-mounted advance warning arrow panels and truck-mounted changeable message signs are included in the lump sum item Traffic Control as specified in **Subsection 601.4**.

### 607.5 Payment

1 Payment for truck-mounted advance warning arrow panel and truck-mounted changeable message signs is included in the lump sum price for Traffic Control as specified in **Subsection 601.5**.

# Section 608 — Supplemental Traffic Control Devices

## 608.1 Description

1 Provide, install, and maintain all supplemental traffic control devices. 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 the lights comply with the MUTCD. Ensure that all warning lights, including Types A, B, and C, are lightweight and do not exceed 3.3 lb according to the requirements of *NCHRP Report 350* or MASH.

2 When using warning lights that exceed the maximum allowable weight of 3.3 lb, ensure that the lens is detachable to permit placement of the battery pack on the ground or pavement surface while allowing placement of the operating lens at the minimum operating height of 30 in. according to **Subsection 608.3.1**. Any portion of a warning light exceeding the maximum allowable weight of 3.3 lb not resting or placed on the ground or pavement surface is prohibited.

3 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 in. or greater than 9 in. and a minimum height of 24 in. Ensure that the blades used on any continuous run have a uniform 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.

### 608.2.3 Temporary Rumble Strips

1 Provide temporary rumble strips within the limits or in advance of a work zone to create a visual, audible, and physical notice to motorists of a reduction in the speed limit or a change in the traffic pattern or to draw motorists' attention to specific signing.

2 Temporary rumble strips may be either stationary or portable. Do not mix stationary and portable rumble strips within the same installation.

#### 608.2.3.1 Stationary

1 Fabricate stationary temporary rumble strips from a temporary pavement marking tape fabricated from a polymer material. Include a pre-applied high tack polymeric adhesive backing to the tape to provide a secure bond to asphalt and concrete road surfaces. Ensure that the adhesive backing permits removal of the tape without necessity for conventional pavement marking removal equipment or tools and without damaging the surface or texture of the pavement.

2 Fabricate the temporary pavement marking tape to be orange with a minimum width of 4 in. and a minimum thickness of 0.300 in. (300 mil).

#### 608.2.3.2 Portable

1 Fabricate portable temporary rumble strips from engineered polymers. Ensure that each rumble strip has a minimum installed length of 11 ft. The dimensions of a typical installation will be approximately 135 in. long, 13 in. wide with a thickness from ⅝ in. to ¾ in.

2 During the installation of portable temporary rumble strips, do not use any type of adhesive that would remain in place.

3 Ensure that the portable temporary rumble strips has the capability to withstand vehicles weighing up to 80,000 lb and vehicular speeds up to 80 mph with minimal movement.

## 608.3 Construction

### 608.3.1 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, Specifications, *Standard Drawings*, MUTCD, and TTC.

2 Install all warning lights at a minimum height of 30 in. from the bottom of the lens of the light to the travel lane surface when placed in a roadway or to the grade elevation of the near edge of the adjacent travel lane when placed adjacent to a roadway.

3 Use Type A Low-Intensity Flashing, Type C Steady-Burn, and Type D 360-Degree Steady-Burn warning lights during nighttime hours. Ensure that these lights are visible on a clear night from a distance of 3000 ft.

4 Use Type B High-Intensity Flashing warning lights during daytime and nighttime hours. Ensure that these lights are visible on a sunny day when viewed without the sun directly on or behind the light from a distance of 1000 ft.

### 608.3.2 Temporary Glare Shields

1 Use temporary glare shields installed on top of temporary longitudinal barriers that separate two-way traffic. In most cases, the temporary longitudinal barriers are temporary concrete barrier walls. Provide, install, and maintain temporary glare shields as specified herein and by the Plans, Specifications, *Standard Drawings*, MUTCD, and the TTC.

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.

### 608.3.3 Temporary Rumble Strips

1 Install the temporary rumble strips to the roadway perpendicular to the direction of traffic to generate a “rumble” sound and vibration to the motorist. Provide, install, and maintain temporary rumble strips according to the Specifications, *Standard Drawings*, Plans, and RCE.

#### 608.3.3.1 Stationary

1 Ensure that each installation consists of 3 sets of stationary temporary rumble strips. Install the sets of temporary rumble strips at 500-ft intervals between each set unless otherwise directed by the Plans and/or the RCE.

2 Ensure that each set of stationary temporary rumble strips consists of 10 lines. Install the lines of rumble strips within each set in lengths that will place the ends of each line within 6 in. of each edge of the travel lane.

3 Within each installation of the stationary temporary rumble strips, ensure that each set of lines of rumble strips has a unique spacing interval between the lines of rumble strips. Ensure that Set “One,” the first set encountered by motorists, has a spacing interval of 10 ft between the lines of rumble strips. Ensure that Set “Two,” the second set encountered by motorists, has a spacing interval of 5 ft between the lines of rumble strips. Ensure that Set “Three,” the third and last set encountered by motorists, has a spacing interval of 18 in. between the lines of rumble strips.

4 Ensure that the roadway surface is completely dry. Do not apply stationary rumble strips to a pavement surface within the first 24 hours after a rainfall or when anticipating rainfall within 24 hours after installation.

5 Install stationary temporary rumble strips when the air and pavement surface temperatures are not less than 50ºF.

6 Install stationary temporary rumble strips on pavement surfaces that are free of contaminants such as oils, grease, sand, dirt, dust, loose aggregate, curing compounds, mud, soil, or salt.

7 Do not install stationary temporary rumble strips over deteriorating pavement markings or on deteriorating pavement surfaces.

8 Tamp each line of stationary temporary rumble strips in the same direction of application with a minimum load of 200 lb or according to the manufacturer's specifications. Butt splices are acceptable when splicing is necessary.

#### 608.3.3.2 Portable

1 Ensure that each installation consists of 3 sets of portable temporary rumble strips. Install the sets of portable temporary rumble strips at 500-ft intervals between each set unless otherwise directed by the Plans and/or the RCE.

2 Ensure that each set of portable temporary rumble strips consists of 3 lines.

3 Within each set of portable temporary rumble strips, space each rumble strip at a uniform spacing interval of 6 ft to 10 ft, measured from the centers.

### 608.4 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 **Subsection 601.4**.

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, the 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.

4 Temporary rumble strips items are included in the lump sum item Traffic Control as specified in **Subsection 601.4**. No separate measurement is made for Temporary rumble strips items.

## 608.5 Payment

1 Payment for the accepted quantity for traffic warning lights, either included in the pay item Traffic Control as specified in **Subsection 601.5** or as pay item Type (A, B, or C) – (Flashing or Steady Burn) Light, at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, mounting hardware, transportation, and incidentals necessary to complete the work as specified.

2 Payment for the accepted quantity for Temporary Glare Shields for Traffic Control at the Unit Price is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

3 Payment for temporary rumble strips is included in the lump sum bid price for Traffic Control as specified in **Subsection 601.5**.

4 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 Provide, install, and maintain temporary 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 single component hybridized polymer for temporary pavement markings that are white or yellow in color as required by the Plans and that conform to the applicable Specifications, the *Standard Drawings*, and the MUTCD.

2 Ensure that fast dry paint complies with **Subsection 624.2**. Ensure that epoxy pavement markings comply with **Subsection 626.2**. Ensure that thermoplastic pavement markings comply with **Subsection 627.2**. Ensure that single component hybridized polymer pavement markings comply with **Subsection 628.2**.

3 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 MUTCD.

2 Ensure that retroreflectivity of temporary pavement markings conform to Department requirements. Ensure that the glass beads applied comply with those sections of the Specifications for the application of glass beads to permanent applications of fast dry paint, thermoplastic, epoxy, and single component hybridized polymer 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 Construction

### 609.3.1 Temporary Pavement Markings

#### 609.3.1.1 Application Requirements

##### 609.3.1.1.1 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 project stages indicated in the Plans, the Specifications, the MUTCD, and by the RCE. Apply new temporary pavement markings as the pavement markings 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 before beginning work or where the width of the pavement is 24 ft or greater. When 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 before 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 in. in 100 ft. Any greater deviation 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. Before 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 single component hybridized polymer to a pavement surface within 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-in. double yellow lines for the centerlines and 4-in. 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 non-interstate routes, use 4-in. wide temporary solid lines for edge lines and center lines, and 4 in. wide by 10 ft long with a 30-ft gap for broken center lines unless otherwise specified. On interstate highways, use temporary solid edge lines that are 6 in. wide and temporary broken center lines that are 6 in. wide by 10 ft long with a 30-ft gap unless otherwise specified. For all other solid lines, use 8-in., 12-in., or 24-in. wide pavement markings in conformity with the Plans.

10 On non-interstate roadways, application of a 4-in. wide solid line used for an edge line adjacent to an earth shoulder, white or yellow, may be delayed up to 3 days after eradication of the original line when the length of the eradicated line at a single location is no longer than 250 ft. In the event of multiple locations along the same line, each location must be separated from the adjacent location by at least 250 ft with a cumulative total distance of eradicated line of no more than 1300 ft within any continuous 1-mile length of roadway measured from a selected location. If the above conditions are not met, replace the eradicated line(s) before reopening the adjacent travel lane to traffic.

11 On all roadways, apply and place white stop bars and white triangle yield bars in all locations where previous stop bars and triangle yield bars have been eradicated by the work. Place white stop bars and white triangle yield bars at intersections controlled by stop and yield signs within 3 days of the eradication of the original pavement marking. Place white stop bars at signalized intersections controlled by traffic control signals and at railroad crossings before reopening a closed travel lane to traffic.

12 Within the limits of existing turn lanes on all roadways, place white arrows in all locations where previous arrows have been eradicated by the work unless otherwise directed by the RCE. Place white arrows within 3 days of the eradication of the original pavement markings. In newly constructed turn lanes, place white arrows as directed by the RCE.

13 Within the limits of existing lane-drop sites on all roadways, place white arrows in all locations where previous arrows have been eradicated by the work before the end of each day's work or shift or reopening of the closed travel lane to traffic. In newly constructed lane-drop sites, place white arrows within the travel lane to be terminated before opening the travel lane to traffic and as directed by the RCE.

14 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 TTC. As the traffic control stages progress, tie each new temporary pavement marking scheme to the existing pavement markings.

15 Apply no passing zone markings as specified by the Plans, the Specifications, the MUTCD, and/or the RCE.

16 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 surface treatment, including the final pavement course at the end of each day's work.

#### 609.3.1.1.2 Waterborne Fast Dry Paint

1 Apply fast dry 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 fast dry paint may be applied to a final surface course if the markings conform to 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. Apply fast dry paint according to **Subsection 624.3**.

#### 609.3.1.1.3 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.

#### 609.3.1.1.4 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.

### 609.3.1.2 Removal of Temporary 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 before revising the traffic patterns.

2 Remove obsolete pavement markings and any residue resembling a previous pavement marking scheme. The Contractor is responsible for any damages to the roadway surface by the pavement marking removal process. If the roadway surface is damaged, repair the damaged roadway surface or resurface the roadway as directed by the RCE at no additional cost to the Department.

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, or
- 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 ft of a travel lane open to traffic or in an area where 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 alternative method

approved by the RCE. Provide all safety and protective measures required by the Department and federal, state, and local laws.

### 609.3.2 Temporary Raised Pavement Markers

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-ft intervals to supplement the yellow center line pavement markings. On primary and secondary multilane roadways, install the temporary pavement markers at 40-ft intervals to supplement the yellow center line pavement markings. On all multilane roadways including interstate highways, install the temporary pavement markers at 80-ft 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-ft intervals to supplement the broken white auxiliary line.

3 At the beginning of a project, install temporary pavement markers on the existing pavement that conform to 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 that conform to the Pavement Marking Plans each time the traffic control scheme or the traffic patterns change. The RCE may waive the 30-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-days on jobs with permanent pavement markers. Apply the permanent pavement markers to the roadway to conform to the Pavement Marking Plans.

## 609.4 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 for removal of pavement markings. 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 traffic control during application and removal of pavement markings. The costs of traffic control is included 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 each (EA) temporary raised pavement marker installed, complete and accepted.

## 609.5 Payment

1 Payment for the accepted quantity for all Pavement Marking types in **Section 609** at the Unit Price is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Payment for the accepted quantity for Temporary (Clear or Yellow) Pavement Markers (Mono-Directional or Bi-Directional) – 4 in. × 4 in. at the Unit Price is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, and incidentals necessary to complete the work as specified.

3 Pay items for under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 609105X | Pavement Markings (Temporary–*(material)*) – 4″ (*color)* Broken Lines | LF |
| 609110X | Pavement Markings (Temporary–*(material)*) – 6″ (*color)* Broken Lines | LF |
| 609115X | Pavement Markings (Temporary–*(material)*) – 4″ (*color)* Solid Lines | LF |
| 609120X | Pavement Markings (Temporary–*(material)*) – 6″ (*color)* Solid Lines | LF |

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| Item No. | Pay Item | Unit |
|---|---|---|
| 609125X | Pavement Markings (Temporary–*(material)*) – 8″ (*color)* Solid Lines | LF |
| 609130X | Pavement Markings (Temporary–*(material)*) – 12″ (*color)* Solid Lines | LF |
| 609135X | Pavement Markings (Temporary–*(material)*) – 24″ (*color)* Solid Lines | LF |
| 609160X | Pavement Markings (Temporary–*(material)*) – White Single Arrow | EA |
| 609165X | Pavement Markings (Temporary–*(material)*) – White Combination Arrows | EA |
| 609180X | Pavement Markings (Temporary–*(material)*) – White Word “Only” | EA |
| 609185X | Pavement Markings (Temporary–*(material)*) – Railroad Crossing Symbols | EA |
| 6092100 | Temporary Clear Pavement Markers Mono-Directional – 4″ × 4″ | EA |
| 609105X | Temporary Yellow Pavement Markers Mono-Directional – 4″ × 4″ | EA |
| 609110X | Temporary Yellow Pavement Markers Bi-Directional – 4″ × 4″ | EA |

# Section 610 — Work Zone Traffic Control Procedures

## 610.1 Description

1 Perform the work as necessary to comply with the work zone traffic control procedures.

2 For the following work zone traffic control procedures, the Department will determine the specific requirements for each procedure regarding the 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 Use a 24 in. × 24 in. “STOP/SLOW” paddle with 8 in. high letters that is mounted on a rigid handle not less than 7 ft long. Reflectorize the STOP face of the paddle with a red Type III high intensity microprismatic retroreflective sheeting unless otherwise directed by the Department. Reflectorize the SLOW face of the paddle with a fluorescent orange retroreflective sheeting. Reflectorize each face of the “STOP/SLOW” paddle with a retroreflective sheeting included on *Qualified Products List* 20.

2 Do not use flags in place of “STOP/SLOW” paddles except during emergency situations. When necessary, use emergency flags that are red or fluorescent orange/red with a minimum size of 24 sq in securely fastened to an approximately 36-in. (+/-) long staff.

## 610.3 Construction

### 610.3.1 Equipment

1 Ensure that personnel are equipped with personal protection equipment (PPE) as specified in **Section 612**.

### 610.3.2 Requirements for Presence of Trained Employee

1 A trained employee is a person whose job duties require successful completion of an advance work zone traffic control training program according to **Subsection 601.1.7**. Ensure that a “trained employee” is present on the site during the installation and removal of lane closures, shoulder closures, road closures, detours, and the initial implementation of any traffic relocation.

2 For work operations that occupy a location up to 1 hour, ensure that a “trained employee” is present on the site for the entire duration of the work.

3 For mobile operations that move continuously at speeds of 3 mph or greater at all times without any stops, ensure that a “trained employee” remains with the

vehicle train at all times that the vehicle train is performing work for the entire duration of the work shift.

4 For flagging operations, ensure that a "trained employee" is present during the initialization, relocation, and removal of each flagging operation.

### 610.3.3 Flagging Operations

1 Flagging operations are planned installations for specified traffic control devices and personnel to temporarily 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.

#### 610.3.3.1 Installation/Operational Restrictions

1 Observe all hourly, holiday, and other installation restrictions designated for lane closures for flagging operations and as directed by the RCE.

2 Ensure that flagging operations direct traffic around the work activities while controlling and minimizing impacts to the traffic flow. Do not stop traffic for time durations greater than those listed in the table below unless otherwise directed by the RCE. If the work activities require traffic to be stopped for periods greater than the time specified in the table below, consider alternative work methods and conducting work activities during times of lowest traffic volumes such as during the hours of darkness or road closure with a detour installation.

| Length of Closure | Maximum Time Duration for Stopped Traffic |
|---|---|
| 1 mile or less | 5 minutes |
| 1 mile to 2 miles | 7½ minutes |

#### 610.3.3.2 Operational Requirements

1 Erect all signs relative to a flagging operation immediately before initiating the operation. Immediately remove or cover the signs upon termination of the operation. Install all signs, including the changeable message signs, at spacing intervals according to the posted regulatory speed limit of the road before beginning any work per the *Standard Drawings.*

2 Ensure that flaggers conduct themselves and the operation as directed by the Specifications, the MUTCD, the *Standard Drawings*, and the RCE. The Department will consider failure by the flaggers to conduct the operation properly or without the flagger as signs of failure to provide proper traffic control.

3 The South Carolina Code of Laws (§56-5-950) stipulates that only law enforcement can supersede a traffic signal for control of traffic within a signalized intersection operating in "normal operational status." When uniformed law enforcement officers are not present, place the traffic signal in the flash mode, also known as normal flashing operations.

4 Ensure that flaggers do not direct traffic through signalized intersections while the traffic signal is operating in "normal operational status." Place the traffic signal in the "flash" mode ("normal flashing operations") when necessary for flaggers to control traffic entering and passing through a signalized intersection. Conduct these operations as directed by the *Standard Drawings*, the Specifications, and the RCE. Return the traffic signal to "normal operational status" upon relocation of the work train from within the limits of the intersection.

### 610.3.4 Lane Closures

1 Provide and install a specific array of traffic control devices to channelize traffic during closure of a travel lane on a multilane roadway and to delineate the travel lanes open to traffic.

#### 610.3.4.1 Requirements

1 Install and maintain all lane closures according to the Specifications, the *Standard Drawings*, the MUTCD, the Plans, the special provisions, and the RCE.

2 Restrict the maximum length of a lane closure to a distance of not more than 2 miles unless otherwise specified or approved by the RCE. On interstate highways, use a lane closure procedure to conduct work or to place equipment in the shoulder within 10 ft of the near edge of the adjacent traveled way.

3 On non-interstate roads, use a lane closure procedure to conduct work or to place equipment in the shoulder within 1 ft of the near edge of the adjacent traveled way.

4 The interval restrictions between lane closures apply to lane closures on the same project, contiguous projects, and projects that overlap and apply to all entities, including the Department, the Contractor, subcontractors, utility companies, municipalities, etc. Failure to observe these interval restrictions is considered as failure to provide traffic control as required.

5 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.

### 610.3.5 Shoulder Closures

1 Provide and install the specific array of traffic control devices to close the shoulder area of a roadway to traffic.

#### 610.3.5.1 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 are 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 ft of the near edge of an adjacent travel lane. Adhere to all shoulder closure restrictions as directed by the Plans, the *Standard Drawings,* the Specifications, and the RCE.

2 Do not substitute oversized traffic cones for portable plastic drums during nighttime shoulder closures.

### 610.3.6 Mobile Operations

1 Use specific traffic control devices and 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. Observe all specified hourly, holiday, and other installation restrictions designated for lane closures.

2 Use traffic control setups for mobile operations during the application and removal operations for pavement markings and raised pavement markers, installation of milled-in rumble strips, or any operation capable of being conducted while continuously moving at speeds of 3 mph or greater at all times without any stops.

#### 610.3.6.1 Requirements

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 *Standard Drawings*, the Plans, and the RCE.

2 Maintain functional, two-way radio communications between all vehicles in the mobile operation train.

### 610.3.7 Road Closures

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.

2 Use an extended road closure of an existing roadway on an existing roadway open to traffic. The traffic during extended road closures may be detoured when

required by the Department. Install and maintain all detours according to **Subsection 610.3.9** and the RCE.

#### 610.3.7.1 Extended Road Closures

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 the manufacturer's specifications, the Plans, the *Standard Drawings*, the Specifications, the MUTCD, and the RCE.

##### 610.3.7.1.1 Extended Road Closure of Existing Roadway

1 Use the specific array of traffic control devices to close an existing roadway alignment that has been open to traffic according to the *Standard Drawings*. Bridge replacements and realignments of existing roads are typical work activities that require these closures.

##### 610.3.7.1.2 Extended Road Closure of New Roadway Alignment

1 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 ft 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. 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 *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.

#### 610.3.7.2 Temporary Road Closure

1 Observe all hourly, holiday, and other installation restrictions specified for lane closures. Temporary road closures are brief closures of a roadway for brief periods not to exceed 20 minutes and preferably shorter. These closures are planned installations of specified traffic control devices and advance warning

signs implemented with assistance from law enforcement officers to temporarily close a roadway.

2 Use temporary road closures for removal or installation of overhead structures such as bridge beams or sign bridges, relocation of large equipment such as cranes, and other activities that maintaining the traffic flow without disruption will not permit.

3 Use pacing operations to control the traffic during temporary road closures unless otherwise directed by the Department and the RCE. Conduct the pacing operations according to **Subsection 610.3.8** and the RCE.

4 Provide the RCE with prior notice of the intended temporary road closure for approval at least 14 days before the planned date of the closure.

5 Request assistance from the South Carolina Highway Patrol when necessary to stop traffic. Coordinate the traffic control with the RCE and the Highway Patrol.

6 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.

### 610.3.8 Pacing Operations

1 Use the array of traffic control devices specified herein, law enforcement officers, and law enforcement vehicles to temporarily 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.

2 Pacing operations are only permitted on full access controlled roadways such as interstate highways unless otherwise directed by the RCE.

#### 610.3.8.1 Requirements

1 Provide the RCE with a notice of intent to implement a pacing operation for approval at least 14 days before the planned event.

2 Assistance from the South Carolina Highway Patrol is required when implementing a pacing operation. Law enforcement officers from other law enforcement agencies may provide assistance. The South Carolina Highway Patrol is the lead law enforcement agency in pacing operations. Coordinate the traffic control with the Highway Patrol, the RCE, and any other law enforcement agencies providing assistance.

3 Use Highway Patrol troopers to 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 affected 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 Arrange all equipment and crews to conduct and complete the necessary work tasks before 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 before initiating a subsequent pacing operation. Make all reasonable efforts to expedite the work and minimize interference with traffic.

5 Conduct all pacing operations as directed by these Specifications 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.

6 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 ft 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.

### 610.3.9 Detours

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 alternative route and returning the traffic to the closed route beyond the closed portion of the roadway.

2 Install and maintain any necessary detour signing as specified by the *Standard Drawings*, the Specifications, the MUTCD, and the RCE.

#### 610.3.9.1 Requirements

1 Select roads for a detour route that have a structure and geometry to safely sustain the type and amount of detoured traffic. Ensure that all detour routes have adequate sight distance at intersections, no bridges with posted weight limitations, travel lanes with adequate lane widths to accommodate the detoured traffic, adequate pavement markings, and good pavement surfaces. During the detour route selection process, consider factors such as school locations,

emergency services access, areas of reduced speed limits, intersection geometry, and traffic control at intersections impacted by the detour.

2 Maintain all detour signing. Correct any insufficiencies that may arise while the detour is in place.

3 Monitor the detour during the operation to identify any areas of concern that may arise due to the additional detoured traffic. If areas of concern are identified, implement corrective actions as directed by the RCE to minimize or eliminate the identified areas of concern.

## 610.4 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 in **Subsection 601.4**. No specific measurements are made for items required for these traffic control operations unless the Contract includes specific pays items for the work.

2 For an extended road closure of an existing roadway, as specified in **Subsection 610.3.7.1.1**, 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 according to **Subsection 604.4**. Permanent construction signs both ground and barricade mounted (regardless of the type of sign stratum) installed and accepted are measured according to **Subsection 605.4**. Type B flashing warning lights installed and accepted are measured according to **Subsection 608.4**.

## 610.5 Payment

1 Payment for the pay item Traffic Control as specified in **Subsection 601.5** is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 For an extended road closure of an existing roadway, as specified in **Subsection 610.3.7.1.1**, a separate payment is made for the accepted quantities for Type III barricades, permanent construction sign, and Type B flashing warning lights. Type III barricades are paid according to **Subsection 604.5**. Permanent construction signs both ground and barricade mounted (regardless of the type of sign stratum) are paid according to **Subsection 605.5**. Type B flashing warning lights are paid according to **Subsection 608.5**.

3 There are no pay items included under this Section.

# Section 611 — Work Zone Traffic Control Procedures for Specific Operations

## 611.1 Description

1 Perform the work as necessary to comply with the work zone traffic control procedures for special operations.

## 611.2 Materials

1 None specified.

## 611.3 Construction

1 Determine the necessity for lane or shoulder closures relative to the construction requirements to accomplish the work. Use flagging operations on two-lane, two-way facilities and lane closures on multilane facilities. Provide and maintain lane closures and shoulder closures as specified in these Specifications, in the MUTCD, and on the *Standard Drawings*, unless otherwise specified on the Plans, in the Special Provisions, or by the RCE.

### 611.3.1 Paving and Resurfacing Operations

1 Ensure that grade elevation differences do not exceed the requirements in **Subsection 601.3.3**.

2 Before beginning any roadway surface work that will alter the grade elevation of the edge of pavement of the roadway, install “LOW SHOULDER” signs (W8-9) where the temporary grade elevation difference between the surface of the edge of pavement and the surface of the earth shoulder immediately adjacent to the edge of pavement will exceed 2 in. but remain less than or equal to 3 in. The signs may be mounted on ground mounted or portable sign supports.

3 Install the “LOW SHOULDER” signs in each direction throughout the length of the roadway intended for the roadway surface work at intervals not to exceed 1 mile with the initial sign encountered by motorists installed at a location no further than 150 ft beyond the beginning of the project limits of the roadway subject to the roadway surface work. Install “LOW SHOULDER” signs in each direction no further than 150 ft beyond intersections with side roads.

4 Maintain all “LOW SHOULDER” signs within the termini of the project until the shoulder conditions have been dressed and contoured to an acceptable final cross-slope profile to the satisfaction of the RCE.

5 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 in. between adjacent travel lanes does not exceed 4 miles, unless otherwise directed by the RCE.

6 The presence of a grade elevation difference greater than 3 in. requires corrective action by the Contractor. Upon discovery of a grade elevation difference greater than 3 in., the RCE will provide notification to the Contractor within 24 hours of the discovery. The notification will include identification of the location(s) in need of corrective actions. Install "SHOULDER DROP OFF" signs (W8-17-48) in advance of these locations and maintain the temporary sign installations in place until the condition is corrected. These signs may be ground mounted or portable sign supports. Complete the corrective action at the identified location(s) within 3 days of receipt of notification of discovery of the condition from the RCE.

7 When travel lanes with acceptable grade elevation differences are open to traffic, provide "UNEVEN LANES" signs (W8-11-48). Install the signs adjacent to the uneven travel lanes at intervals no greater than 2600 ft. Do not use a temporary construction sign with the "UNEVEN PAVEMENT" legend.

8 Within 3 days of completion of applying the final riding surface to a roadway, begin the corrective action to eliminate the temporary shoulder conditions. Make reasonable efforts, weather permitting, to continue the corrective shoulder work until the temporary shoulder conditions are eliminated to the satisfaction of the RCE.

9 Implement corrective actions to eliminate the temporary shoulder conditions, to ensure that the final grade elevation of the earth shoulder immediately adjacent to the edge of pavement is "flush" or "near flush" with any grade elevation difference no greater than 1 in. between the surface of the edge of pavement and the surface of the earth shoulder immediately adjacent to the edge of pavement. Ensure that the surface of the earth shoulder immediately adjacent to the edge of pavement does not exceed the grade elevation of the surface of the edge of pavement. Where earth shoulders are 6 ft wide or wider, as measured from the edge of pavement to the beginning of the front slope of an adjacent ditch or fill slope, ensure that the final cross-section profile of the earth shoulder adjacent to the edge of pavement exhibits a slope no steeper than 12H:1V according to the SCDOT *Roadway Design Manual*. In those areas where the earth shoulders are less than 6 ft wide, as measured from the edge of pavement to the beginning of the front slope of an adjacent ditch or fill slope, dress the final cross-section profile of the earth shoulder from the edge of pavement to the beginning of the front slope of the adjacent ditch or fill slope.

10 Situations may arise that require cutting of the shoulder to attain an acceptable final cross-section profile of the earth shoulder adjacent to the edge of pavement as required by these specifications. When the required cutting of the shoulder is sufficient to also require hauling of the cut material from the site, pay for this work according to **Subsection 203.2.1.2**.

11 Notify the RCE within 3 days of completing the corrective action for elimination of the temporary shoulder conditions for each road. If additional corrective action is determined necessary, the RCE will direct, in writing, additional corrective actions.

12 Remove "SHOULDER DROP OFF" and "LOW SHOULDER" signs within 7 days of completion of corrective work to eliminate these conditions.

13 Do not allow traffic onto travel lanes without pavement markings where pavement markings existed before beginning the paving operations.

### 611.3.2 Milling and Surface Planing Operations

1 Ensure that grade elevation differences do not exceed the requirements in **Subsection 601.3.3**.

2 In 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 in. before removal of the lane closure.

3 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 in. does not exceed 4 miles, unless otherwise directed by the RCE.

4 Sweep milled lanes clean of debris and mark with temporary pavement markings before reopening the travel lanes to traffic.

5 When travel lanes with acceptable grade elevation differences are open to traffic, provide "UNEVEN LANES" signs (W8-11-48). Install the signs adjacent to the uneven travel lanes at intervals no greater than 2600 ft. Do not use a temporary construction sign with the "UNEVEN PAVEMENT" legend.

### 611.3.3 Guardrail Replacement Operations

1 Provide and maintain lane closures and shoulder closures as specified in these Specifications, in the MUTCD, and on the *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.

### 611.3.4 Installation or Removal of Permanent Ground-Mounted Signs and Supports

1 Provide and maintain all lane closures and shoulder closures according to the *Standard Drawings*, the Specifications, the MUTCD, and the RCE.

### 611.3.5 Installation and Removal of Overhead Signs and Structures

1 Provide lane closures, shoulder closures, temporary or short-term road closures, pacing operations, or detours relative to the requirements of the work activities to accomplish the work and as approved by the RCE.

2 Provide the RCE with a notice of intent to implement these work activities no less than 14 days before the planned date of the event.

## 611.4 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 **Subsection 601.4**. 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.

## 611.5 Payment

1 Providing and maintaining the work zone traffic control procedures specified in this Section are included in the lump sum price for the pay item Traffic Control as specified in **Subsection 601.5**. Payment is full compensation for furnishing all materials, labor, hardware, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Unless otherwise specified and included in the Contract, there are no pay items for work under this Section.

# Section 612 — High-Visibility Safety Apparel

## 612.1 Description

1 Provide high-visibility personal protective apparel required and worn by personnel present within the right-of-way within a work zone.

2 Ensure that all high-visibility safety apparel worn by workers within the work zone complies with the MUTCD, the Specifications, and as directed by the RCE.

## 612.2 Materials

1 Ensure that the color of the background material for all high-visibility safety apparel is either fluorescent orange-red or fluorescent yellow-green.

### 612.2.1 Performance Class 2

1 The minimum area of the background material of Performance Class 2 high-visibility safety apparel is 775 sq in.

2 The minimum width of the retroreflective bands supplementing the background material of Performance Class 2 high-visibility safety apparel is 1⅜ in., providing a minimum retroreflective area of 201 sq in.

3 The types of garments considered acceptable for Performance Class 2 high-visibility apparel include the following options:

- The standard vest, or
- Tee shirt.

### 612.2.2 Performance Class 3

1 The minimum area of the background material of Performance Class 3 high-visibility safety apparel is 1240 sq in.

2 The minimum width of the retroreflective bands supplementing the background material of Performance Class 3 high-visibility safety apparel is 2 in., providing a minimum retroreflective area of 310 sq in.

3 The types of garments considered acceptable for Performance Class 3 high-visibility apparel include the following options:

- Combination of the standard Class 2 vest with the Class E pants,
- Short sleeved jacket, or
- Coverall/jumpsuit.

### 612.2.3 Hard Hat

1 Use a minimum 1 in. wide reflective bands that provide a minimum retroreflective area of 10 sq in.

## 612.3 Construction

### 612.3.1 General

1 Provide, maintain, and furnish each worker with the proper high-visibility safety apparel according to the worker's specific job duties, the Specifications, the Performance Class 2 or Class 3 requirements of the ANSI/ISEA 107–2010 High-Visibility Safety Apparel publication, *American National Standard for High-Visibility Safety Apparel and Headwear*, or equivalent revisions and labeled as meeting the ANSI/ISEA 107 standard performance for Class 2 or Class 3 risk exposure as necessary and as directed by the RCE.

### 612.3.2 Performance Class 2 Requirements

1 Ensure that all workers within the right-of-way who are exposed either to traffic (vehicles using the highway for purposes of travel) or to work vehicles and construction equipment within a work zone wear high-visibility safety apparel that meets the ANSI/ISEA 107–2010 High-Visibility Safety Apparel Performance Class 2 requirements or latest revision unless otherwise directed by these specifications.

2 All workers who perform job duties as a "Flagger" during daytime flagging operations may wear Class 2 high-visibility safety apparel.

### 612.3.3 Performance Class 3 Requirements

1 Ensure that all workers who perform job duties as a "Flagger" during nighttime flagging operations wear hard hats and high-visibility safety apparel that meets the ANSI/ISEA 107–2010 High-Visibility Safety Apparel Performance Class 3 requirements.

## 612.4 Measurement

1 Providing high visibility safety apparel is included in the lump sum pay item Traffic Control as specified in **Subsection 601.4**. Measurements of specific traffic control devices are specified elsewhere in **Division 600**.

## 612.5 Payment

1 Providing high visibility safety apparel is included in the lump sum price for the pay item Traffic Control as specified in **Subsection 601.5**.

## Section 613 Through Section 623 — Sections Not Used

*These Sections have been Reserved for Future Use*

# Section 624 — Fast Dry Waterborne Paint

## 624.1 Description

1 Furnish and place fast drying, waterborne paint for pavement markings according to the Contract documents and the *Manual on Uniform Traffic Control Devices* (MUTCD).

2 The work also includes the determination of passing/no passing zones on two lane facilities according to the MUTCD where existing passing/no passing zones have not been established. Provide the Department with data used in establishing passing/no passing zones.

## 624.2 Materials

### 624.2.1 General

1 Use pavement marking that consists of traffic paint complying with this Subsection, upon which spherical glass beads are applied by dropping immediately following paint application. If required, clean the pavement surface according to **Subsection 624.3.2** before application.

### 624.2.2 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.

#### 624.2.2.1 General Requirements

1 Provide white and yellow paint that meets all of the following general requirements:

- Formulated and manufactured from top grade materials and free from defects and imperfections that might adversely affect the serviceability of the finished product.
- Formulated and processed specifically for service as a suitable binder for glass beads for use on traffic-carrying pavements, including Portland cement concrete, asphalt pavement, and brick.
- Dries to an elastic adherent finish that does not darken after exposure to sunlight, does not show appreciable discoloration with age, and does not darken under service such that the color or visibility to the reflectorized marking is impaired. Ease and uniformity of application and covering properties.
- Free of heavy metals as defined in **Subsection 624.2.2.4.11**.

- Provides the proper anchorage and refraction for glass beads when both binder and spheres are applied in the specified quantities with specialized equipment using pressurized bead guns.
- Manufactured and sealed in containers so 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.
- Does not show evidence of skinning when received in sealed containers.

#### 624.2.2.2 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.

#### 624.2.2.3 Testing and Production Variation

1 When minimum or maximum values are provided in these specifications, they represent values that are reliably obtained from testing. The values do not represent acceptable mean production values. Ensure that the manufacturer considers variations in production and between testing laboratories when setting manufacturing tolerances.

#### 624.2.2.4 Detailed Requirements

##### 624.2.2.4.1 Viscosity

1 Use paint with a viscosity of 80 to 95 K.U. when tested at 77ºF according to ASTM D562.

##### 624.2.2.4.2 Drying Time

###### 624.2.2.4.2.1 Laboratory Drying Time

1 Test paint according to ASTM D711 at a wet film thickness of 15 mils (±1 mil) to determine time to no-pick-up condition. Conduct the test in a standard laboratory atmosphere during which the relative humidity is maintained at 50% (±5%), and the temperature is maintained at 73.5ºF (±3.5ºF), and air flow is maintained at a rate of 2.2 mph (±0.45 mph). Use paint that will dry to a no-pick-up condition in 8 minutes or less.

#### 624.2.2.4.2.2 Field Drying Time

1 Provide paint that, when applied at a wet film thickness of 15 mils and a bead application rate of 6 lb/gal, dries to a no-track condition in the following times under the specified conditions:

**Relative Humidity ≤ 85%, Surface Temperature ≥ 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 ft.

#### 624.2.2.4.3 Flexibility

1 Cast a 5-mil wet film of the paint on a clean 30-gauge tin panel approximately 3 in. × 6 in. Air dry the panel at room temperature for 18 hours (±2 hours), and then bake at 122°F (±4°F) for 2 hours (±0.25 hour). Allow the panel to cool at room temperature for 30 minutes (±10 minutes), and then bend around a 0.5-in. 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.

#### 624.2.2.4.4 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 according to ASTM D2805.

#### 624.2.2.4.5 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 according to ASTM E1347.

#### 624.2.2.4.6 Abrasion Resistance

1 Provide paint that passes the following abrasion resistance test.

2 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 105ºC for 18 hours (±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 exceed 50mg per plate. Operate the Taber Abrader with a weight of 500g and CS-10 wheels.

#### 624.2.2.4.7 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.

#### 624.2.2.4.8 Bleeding

1 Use a paint that has a minimum bleeding ratio of 0.98 when tested according to the method given in Federal Specification TT-P-1952B.

#### 624.2.2.4.9 Total Non-Volatile, Vehicle Solids and Flash Point

1 Provide paint with volatile organic compounds 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 1 hour at 877ºF (±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 according to ASTM D3723. Provide paint that has a closed cup flash point that is greater than or equal to 140°F.

#### 624.2.2.4.10 Composition

1 Use a white paint that contains a minimum of 1.0 lb/gal of titanium dioxide in the white pigment. For all colors, conform the titanium dioxide to ASTM D476, Types II, III, or IV.

#### 624.2.2.4.11 Lead Content

1 For yellow heavy metals free binder, use a finished binder that does not exceed the legal limit of 0.06% 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.

### 624.2.2.4.12 Color

1 Use paint that can maintain its original color throughout the life of the line (approximately 2 years). Use paint with color that complies with 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 | 0.393 | 0.340 | 0.520 | 0.479 |
| 4 | 0.274 | 0.329 | 0.438 | 0.472 |

### 624.2.2.4.13 Distinguishable Color

1 Use yellow color that is 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.

### 624.2.2.4.14 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.

### 624.2.2.4.15 Settling

1 Test the pigmented binder for settling by the following method:

A. Use full pint, triple-sealed, friction top paint cans lined with an appropriate material designed to be non-reactive with waterborne paints.

B. Fill the cans to the bottom of the friction seal lip and place in an inverted position for 1 hour to ensure a complete seal between the cover and body of the can.

C. At the end of 1 hour, place the filled can in an upright position for at least 1 hour before being placed in an air temperature of 122ºF (±2ºF). Place the can or cans in a single tier.

D. Store the cans free of vibration at an air temperature of 122ºF (±2ºF) for a period of 5 days.

E. After a heating period of 5 days, cool the cans at room temperature for 4 to 5 hours, and evaluate the degree of settling according to ASTM D869.

2 Provide paint that exhibits no dense or hard settling and has a degree of settling rating of 6 or better when evaluated according to ASTM D869.

#### 624.2.2.4.16 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 than those expressly mentioned here before its use. Ensure that the supplier does not change resins during the life of the Contract without prior approval from the RCE. If low pH water is used to manufacture the finished binder, pH buffers may be used to obtain the minimum pH factor.

#### 624.2.2.4.17 Solvents

1 Use potable water from a public water supply as the solvent for the binder manufactured according to these specifications.

### 624.2.2.5 Control Tolerances

#### 624.2.2.5.1 Percent Pigment

1 Use total pigment solids that are 58.00% to 63.00% by weight, reported to the nearest one hundredth of a percent, when tested according to ASTM D3723.

#### 624.2.2.5.2 Volumetric Weight

1 Use pigmented binders that have a density of 14.0 lb/gal (±0.3 lb/gal) for white and 13.7 lb/gal (±0.3 lb/gal) for yellow. Determine the weight per gallon according to ASTM D1475.

#### 624.2.2.5.3 Vehicle Solids and Total Non-Volatile

1 Provide paint that complies with **Subsection 624.2.2.4.9**.

2 As noted in **Subsection 624.2.2.3**, ensure that the manufacturer considers testing and production variation when selecting mean production values. Ensure that the vehicle solids are 1% to 2% higher than the specified minimum values.

#### 624.2.2.5.4 Viscosity

1 Use paint that complies with **Subsection 624.2.2.4.1**.

#### 624.2.2.5.5 Drying Time

1 Use paint that meets the requirements for laboratory drying time in **Subsection 624.2.2.4.2.1**.

### 624.2.2.6 Required Testing and Certification

#### 624.2.2.6.1 Production Control Tests

1 Perform laboratory tests on each batch of paint produced under **Section 624** to ensure compliance with these specifications.

#### 624.2.2.6.2 Material Acceptance

1 Before shipment or use, submit the following items to the RCE for each type and color of paint supplied:

- Manufacturer's testing results for the batches of paint supplied. Provide testing results that minimally include the items given in **Subsection 624.2.2.5** of these specifications and the brand and type of resin used.
- Manufacturer's statement of compliance with all requirements of **Section 624**. The statement must explicitly document that the paint provided is essentially free of lead, cadmium, and other heavy metals.
- Safety Data Sheets, essentially similar to Form OSHA-20, for the material provided.
- Shipment record form including the following information:
    - Date,
    - Consignee,
    - Shipped to,
    - Type of paint,
    - No. of gallons shipped, and
    - Batch number.

#### 624.2.2.6.3 Department Samples

1 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.

### 624.2.3 Glass Beads

1 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 comply with AASHTO M 247, Type 1 with moisture resistant coating.

## 624.3 Construction

1 Inventory and document the existing marking configurations before beginning any resurfacing project. Collect information sufficient to replace the markings in the existing configuration. Unless otherwise directed by the RCE, place the final new markings in the documented configuration.

### 624.3.1 Equipment

#### 624.3.1.1 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 to produce a uniform application of paint. Use a spray-type paint machine that can satisfactorily apply the paint under pressure with a uniformity of feed through nozzles spraying directly upon the pavement. Use a machine that applies 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 that can apply broken or skip lines automatically. Ensure that the controls allow the operator to override the 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 that 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.

#### 624.3.1.2 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 such that the underlying pavement is not damaged.

#### 624.3.1.3 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 transverse markings and stenciled symbols.

### 624.3.2 Surface Preparation

1 Ensure that the pavement is dry and free of glaze, oil, dirt, grease, or other foreign contaminants. When directed by the RCE, remove any existing markings that conflict with the Pavement Marking Plans before the application of painted pavement marking. Use approved removal methods, which are shot blasting, sand blasting, water blasting, or grinding.

2 Where the existing symbol markings (e.g., arrows, ONLY) differ from or conflict with the Plans, the MUTCD, or the *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 in. 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 using a separate vacuum equipped vehicle or other approved system to prevent its dispersal and to properly dispose of the 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 additional cost 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, ensure that the pavement surface is free of dust, dirt, oil, grease, and any remaining loose or flaking existing marking material.

### 624.3.3 Application of Markings

#### 624.3.3.1 Maximum Temperature and Heat Exchanger Dwell Time

1 When waterborne paint is used, 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 Ensure that the exchanger temperature is reduced to 120ºF or that heat to the exchanger and lines is turned off if the material is not to be applied within 1 hour.

### 624.3.3.2 Alignment of Markings

1 Ensure that the markings are straight or uniform in curvature and conform uniformly to tangents, curves, and transitions. Ensure that symbols match the dimensions shown in the Plans and the *Standard Drawings*. Ensure that markings match the dimensions shown on the Pavement Marking Plans and the *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 that the lateral deviations do not exceed 2 in. in 100 ft. 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 *Standard Drawings*.

### 624.3.3.3 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.

### 624.3.3.4 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:

- Moisture or foreign matter is present on the surface,
- The air temperature is below 50ºF, or
- 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.

### 624.3.3.5 Rate of Application

1 Provide all markings with a wet film thickness of 15 mils. Place glass beads at a minimum rate of 6 lb/gal of paint.

### 624.3.3.6 Protective Measures

1 When marking operations are conducted under traffic, take protective measures as outlined in the TMP. At the discretion of the RCE, repair and correct markings damaged by traffic or markings tracked by crossing traffic as specified in **Subsection 624.3.3.8**.

### 624.3.3.7 Tolerance and Appearance

1 Ensure that markings are applied at the dimensions shown on the Plans and the *Standard Drawings*. Markings less than the specified width will not be accepted. Lengths of painted segment of skip lines less than 10 ft will not be accepted. Gaps between the painted segments that vary more than ±6 in. 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 624.3.3.8**.

### 624.3.3.8 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. When it is necessary to remove paint, remove the paint by means that are satisfactory to the RCE and that do not damage the underlying pavement.

## 624.4 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, 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 used 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 according to **Subsection 601.4**.

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, the 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.

## 624.5 Payment

1 Payment for the accepted quantity for each type of pavement marking at the Unit Price is full compensation for furnishing all materials, labor, equipment, supplies, and incidentals necessary to complete the work as specified.

2 Removal of existing pavement markings is incidental to the other items of work, and no 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 surface preparation and the application and/or removal of pavement markings is included in the item Traffic Control according to **Subsection 601.5**.

4 The determination of the no passing zones for two-lane facilities and providing the Department with the data is incidental to the other various items of work, and no separate payment is made for this work.

5 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6240005 | 4″ White Broken Lines (Gaps Excluded) – Fast Dry Paint | LF |
| 6240007 | 6″ White Broken Lines (Gaps Excluded) – Fast Dry Paint | LF |
| 6240008 | 6″ Black Broken Lines (Gaps Excluded) – Fast Dry Paint | LF |
| 6240010 | 4″ White Solid Lines (Pavement Edge Lines) – Fast Dry Paint | LF |
| 6240012 | 6″ White Solid Lines (Pavement Edge Lines) – Fast Dry Paint | LF |
| 6240015 | 8″ White Solid Lines (Crosswalk & Channelization) – Fast Dry Paint | LF |
| 6240020 | 12″ White Solid Lines – Fast Dry Paint | LF |
| 6240025 | 24″ White Solid Lines – (Stop/Diagonal Lines) – Fast Dry Paint | LF |
| 6240030 | White Single Arrow (Left, Straight, Right) – Fast Dry Paint | EA |

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| Item No. | Pay Item | Unit |
|---|---|---|
| 6240031 | White Single Bike Lane Arrow (Left, Straight, Right) – Fast Dry Paint | EA |
| 6240035 | White Word Message “Only” – Fast Dry Paint | EA |
| 6240040 | White Combination Arrow (Straight & Right or Straight & Left) – Fast Dry Paint | EA |
| 6240043 | White Lane Drop Arrow (Left or Right) – Fast Dry Paint | EA |
| 6240045 | Railroad Crossing Symbols – Fast Dry Paint | EA |
| 6240050 | Handicap Symbol – Fast Dry Paint | EA |
| 6240055 | Bike Lane Symbol – Fast Dry Paint | EA |
| 6240105 | 4″ Yellow Broken Lines – (Gaps Excluded) – Fast Dry Paint | LF |
| 6240107 | 6″ Yellow Broken Lines – (Gaps Excluded) – Fast Dry Paint | LF |
| 6240110 | 4″ Yellow Solid Line – (Pavement Edge & No Passing Zone) – Fast Dry Paint | LF |
| 6240111 | 6″ Yellow Solid Line (Pavement Edge & No Passing Zone) – Fast Dry Paint | LF |
| 6240112 | 6″ Yellow Solid Line on Curb/Median – Fast Dry Paint | LF |
| 6240113 | 6″ Yellow Solid Lines on 6″ Concrete Curb (Top & Side) – Fast Dry Paint | LF |
| 6240115 | 24″ Yellow Diagonal Lines – Fast Dry Paint | LF |

# Section 625 — Permanent Pavement Markings

## 625.1 Description

1 Furnish and place permanent pavement markings according to the Contract documents and the *Manual on Uniform Traffic Control Devices* (MUTCD).

2 The work also includes the determination of passing/no passing zones on two lane facilities according to the MUTCD where existing passing/no passing zones have not been established. Provide the Department with data used in establishing passing/no passing zones.

## 625.2 Materials

### 625.2.1 Permanent Pavement Marking Materials

1 Use one of three binder materials — thermoplastic, fast cure epoxy, or polyurea. Apply thermoplastic or fast cure epoxy markings that meet the binder material requirements of **Section 626** and **Section 627**. Apply polyurea pavement marking materials from the following approved suppliers — Epoplex - LS 90, 3M - Stamark LPM Series 5000, or other manufacturer's materials under project specific, conditional approval.

### 625.2.2 Drop-on Glass Beads

1 Use drop-on glass beads for thermoplastic and fast cure epoxy markings meeting the material requirements of **Sections 626** and **627** for AASHTO Type I beads. Use drop-on glass beads for polyurea pavement markings that comply with **Section 626** for AASHTO Type I beads.

2 In addition, comply with the following material requirements for AASHTO Type I beads:

- Ensure that drop-on glass beads contain less than 200 ppm (total) arsenic, 200 ppm (total) antimony, or 200 ppm (total) lead when tested to EPA Methods 3052 and 6010B.
- Ensure that 20% by volume of the Type I drop on glass beads have a refractive index of 1.9 or greater. The beads may be applied to the permanent marking in a uniform blend or using a double drop application.

3 Ensure that all beads have the appropriate performance enhancing coatings recommended by the bead manufacturer for the type of binder material selected.

## 625.3 Construction

1 Inventory and document the existing marking configurations before beginning any resurfacing project. Collect information sufficient to replace the markings in the existing configuration. Unless otherwise directed by the RCE, place the new markings in the documented configuration.

### 625.3.1 Equipment

1 Use equipment to apply the permanent pavement markings that meet the requirements of **Subsection 626.3.1** (fast cure epoxy and polyurea) and **Subsection 627.3.1**.

### 625.3.2 Application of Permanent Pavement Markings

1 Apply the permanent pavement markings to comply with **Subsection 626.3.3** (Fast Cure Epoxy and Polyurea) and **Subsections 627.3.4** and **627.3.5**.

2 Do not apply thermoplastic pavement markings on Portland cement concrete pavement.

3 Immediately before the application of the new pavement marking material, clean the pavement surface and/or rumble strips with a broom and/or jet of compressed air. Ensure that the pavement surface is free of all dust, dirt, and any other loose material immediately before the marking application.

### 625.3.3 Application of Drop-on Glass Beads – Permanent Markings

1 Use a single drop application of AASHTO Type I glass beads for all marking materials.

2 Mechanically apply Type I beads to the surface of the pavement marking material immediately after the material is applied to the pavement surface and while the marking material is still wet or, for thermoplastic, in a molten state. Ensure that the beads are held by, and mechanically embedded in, the surface of the marking material. Ensure that the beads are uniformly distributed over the entire surface of the marking using a single drop application. Uniformly apply the Type I glass beads at a rate of 8 lb to 10 lb per 100 sq ft of marking.

3 For fast cure epoxy markings, consider the application of additional AASHTO Type III or IV beads that comply with **Section 626** using a double drop method to aid in reducing the no-track time. If using a double drop method, uniformly apply the large beads first at a rate of 8 lb to 10 lb per 100 sq ft of marking immediately followed by the application of the small beads. Ensure that all beads are properly embedded at 60% of their diameter. When using the double drop large/small bead combination, the 20% by volume mix of high index beads requirement of **Subsection 625.2.2** will be waived.

4 Ensure that all beads have the appropriate performance enhancing coatings for the type of material selected.

### 625.3.4 Retroreflectivity Requirements

1 Measure marking retroreflectivity using either a hand held or mobile retroreflectometer that uses 30-m CEN geometry. If a hand held unit is used, take measurements for all long lines in the direction of travel at intervals determined by the RCE. Ensure that the mobile measurements comply with **Section 629**.

2 Ensure that the markings achieve the initial minimum retroreflectance values shown in the following table. Ensure that the values are obtained within 20 days of marking placement. Ensure that the finished markings are uniformly retroreflective as determined by visual inspection.

| **Retroreflectivity (mcd/lux/m$^2$)** | | |
|---|---|---|
| **Drop-on Glass Beads** | **White** | **Yellow** |
| Single Drop | 400 | 300 |

3 Ensure that the markings maintain the minimum retroreflectance values shown in the following table for a period of 180 days. Take measurements within 20 days of the end of the observation period.

| **Retroreflectivity (mcd/lux/m$^2$)** | | |
|---|---|---|
| **Drop-on Glass Beads** | **White** | **Yellow** |
| Single Drop | 350 | 250 |

4 Immediately replace any markings failing to meet the initial minimum retroreflectivity requirements by more than 50 mcd/lux/m² at no additional cost to the Department. Any markings failing to meet the initial requirements by less than 50 mcd/lux/m² may be reevaluated at the time of the 180-day evaluation unless the defect causing the lower readings is obvious to the RCE.

5 The retroreflectivity requirements do not increase if a double drop system is used to aid in reducing the no-track time of epoxy markings.

## 625.4 Measurement

1 Measurement of permanent pavement markings is on a linear foot basis of the actual line applied for each individual line.

2 The quantities for permanent pavement marking symbols (e.g., arrows, word, railroad crossing symbol) are measured by each (EA) symbol in-place, complete and accepted. A railroad-crossing symbol consists of "X RR."

## 625.5 Payment

1 Payment for the accepted quantity for each type of permanent pavement marking at the Unit Price is full compensation for furnishing all materials, labor, equipment, supplies, and incidentals necessary to complete the work as specified. Payment for symbols or work messages will be on a per each basis.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6251005 | 4″ White Broken Lines (Gaps Excluded) – Permanent Pavement Marking | LF |
| 6251007 | 6″ White Broken Lines (Gaps Excluded) – Permanent Pavement Marking | LF |
| 6251010 | 4″ White Broken Lines (Gaps Excluded) – Permanent Pavement Marking | LF |
| 6251012 | 6″ White Broken Lines (Gaps Excluded) – Permanent Pavement Marking | LF |
| 6251015 | 8″ White Solid Lines – Permanent Pavement Markings | LF |
| 6251020 | 12″ White Solid Lines – Permanent Pavement Markings | LF |
| 6251022 | 18″ White Solid Lines – Permanent Pavement Markings | LF |
| 6251023 | 12″ × 18″ White Triangle Yield Bar (Gaps Excluded) – Permanent Pavement Marking | LF |
| 6251025 | 24″ White Solid Lines (Stop/Diagonal Lines) – Permanent Pavement Marking | LF |
| 6251030 | White Single Arrows (Left, Straight, Right) – Permanent Pavement Marking | EA |
| 6251031 | White Single Fish Hook Arrow – Permanent Pavement Marking | EA |
| 6251034 | White Word Message "Yield" – Permanent Pavement Marking | EA |
| 6251035 | White Word Message "Only" – Permanent Pavement Marking | EA |

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| Item No. | Pay Item | Unit |
|---|---|---|
| 6251036 | White Word Message “Stop Ahead” – Permanent Pavement Marking | EA |
| 6251037 | White Word Message “School” – Permanent Pavement Marking | EA |
| 6251038 | White Word Message “Lane Ends × Feet” – 3 Lines – Permanent Pavement Marking | EA |
| 6251039 | White Word Message “Stop” – Permanent Pavement Marking | EA |
| 6251040 | White Combination Arrows (Straight & Right Or Straight & Left) – Permanent Pavement Marking | EA |
| 6251041 | White Combination Fish Hook Arrow – Permanent Pavement Marking | EA |
| 6251043 | White Lane Drop Arrow (Left or Right) – Permanent Pavement Marking | EA |
| 6251045 | Railroad Crossing Symbols – Permanent Pavement Marking | EA |
| 6251050 | Handicap Symbol – Permanent Pavement Marking | EA |
| 6251064 | 4″ Yellow Broken Lines (Gaps Excluded) – Permanent Pavement Marking | LF |
| 6251066 | 6″ Yellow Broken Lines (Gaps Excluded) – Permanent Pavement Marking | LF |
| 6251074 | 4″ Yellow Solid Lines (Pavement Edge Lines) – Permanent Pavement Marking | LF |
| 6251076 | 6″ Yellow Solid Lines (Pavement Edge Lines) – Permanent Pavement Marking | LF |
| 6251078 | 8″ Yellow Solid Lines (Pavement Edge Lines) – Permanent Pavement Marking | LF |
| 6251079 | 12″ Yellow Solid Lines – Permanent Pavement Marking | LF |
| 6251080 | 24″ Yellow Solid Lines – Permanent Pavement Marking | LF |

# Section 626 — Epoxy Pavement Markings

## 626.1 Description

1 Furnish and place epoxy pavement markings according to the Contract documents and the *Manual on Uniform Traffic Control Devices* (MUTCD).

2 The work also includes the determination of passing/no passing zones on two lane facilities according to the MUTCD where existing passing/no passing zones have not been established. Provide the Department with data used in establishing passing/no passing zones.

## 626.2 Materials

### 626.2.1 Epoxy Pavement Marking Materials

1 Provide epoxy pavement markings that are permanent retroreflective (white or yellow) and non-retroreflective (black) pavement marking materials of the color and pattern indicated in the Contract. Provide markings consisting of a two-component, 100%-solids epoxy coating material that can be applied by truck-mounted spray equipment at a minimum ambient air temperature of 40ºF. Provide markings that can retain 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 that Part A material is within the following limits:

| Pigments | | White | Yellow | Non-Lead Yellow | Black |
|---|---|---|---|---|---|
| Titanium Dioxide* | Fast Cure | 18% – 25% | — | 14% – 17% | — |
| | Slow Cure | 33% – 38% | — | 9% – 15% | — |
| Chrome Yellow** (Fast and Slow Cure) | | — | 23% – 30% | — | — |
| Organic Yellow | Fast Cure | — | — | 7% – 8% | — |
| | Slow Cure | — | — | 5% – 8% | — |
| Black (Fast and Slow Cure) | | — | — | — | 18% – 25% |
| **Binder:** | | | | | |
| Epoxy Resin | Fast Cure | 75% – 82% | 70% – 77% | 75% – 79% | 75% – 82% |
| | Slow Cure | 62% – 67% | 70% – 77% | 77% – 86% | 75% – 82% |

*Notes:*

* *ASTM D476, Type II & III*
** *ASTM D211, 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 Federal Standard Number 595B for the following colors:

White: 17925
Yellow: 13538
Black: 37038

2 Apply the mixed epoxy compound, white, yellow and black, to 2 sets of 3-in. × 6-in. 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 according to ASTM G53. Conduct the test for 75 hours at 122°F, 4 hours at the specified 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 D1925)

1 Check for compliance for all of the following:

- Cure 72 hours after sample preparation.
- Take yellow index reading, XYZ C/2 degrees, following the 72-hour cure and preceding QUV (ASTM G53).
- Maximum before QUV:
  - Fast cure – 10.0
  - Slow cure – 7.0
- Place sample in QUV for 72 hours.
- Maximum after QUV, 15.0.

| 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 E97)

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 weight per epoxy equivalent (WPE) values are within the ranges shown in the table below as determined by ASTM D1652.

| Material Type | Resin Type | Color | WPE | |
|---|---|---|---|---|
| | | | Pigment Free Basis | Method B |
| Fast Cure | Epoxy | White, yellow, black Component A | 250 ± 50 | -- |
| Slow Cure | Hybridized Epoxy | White Component A | 210 ± 50 | 290 ± 50 |
| | | Yellow, black | 190 ± 50 | 230 ± 50 |

#### 626.2.1.1.7 Amine Number

1 Ensure that the amine number of the curing agent (Component B) is within the ranges shown in the table below as determined by ASTM D2074.

| Material Type | Amine Number |
|---|---|
| Fast Cure | 450 (±50) |
| Slow Cure | 425 (±50) |

#### 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 (±0.5 mil) wet film thickness at 75°F (±2°F) and with the proper saturation of glass spheres, exhibits no tracking time less than 15 minutes for fast cure and 30 minutes for slow cure when tested according to ASTM D711.

#### 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 a higher degree of adhesion to the specified concrete (4000 psi minimum) surface such that it results in a 100% concrete failure in the performance of the 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 D2240, 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 Evaluate 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 C501. Ensure that the wear index for the catalyzed material is not more than 80 for fast cure material and 55 for slow cure material. 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 D638. Cast the Type IV in a suitable mold and pull at a rate of 0.25 in. 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 D695, 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. Ensure that the rate of compression of the samples is not more than 0.25 in. 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 3, and Type 4 glass beads comply with AASHTO M 247 with the following exceptions. Glass beads are a minimum of 80% true spheres when tested according to ASTM D1155 and meet the gradation requirements when tested according to ASTM D1214 shown in the following table.

**Percent By Mass Passing Designated Sieve (ASTM D1214)**

| Grading Designation (AASHTO M 247) | | | |
|---|---|---|---|
| **Sieve Size** | **Type 1** | **Type 3** | **Type 4** |
| No. 8 | — | — | — |
| No. 10 | — | — | 100 |
| No. 12 | — | 100 | 95 – 100 |
| No. 14 | — | 95 – 100 | 80 – 95 |
| 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 | — | — |

### 626.2.2.4 Bead Coating

1 Ensure that all beads are embedded and moisture proof coated with Potters Industries AC-100 series or an equivalent coating that ensures performance. Test the embedment coating by the Dansyl Chloride Method. Test the moisture proof coating by the following method:

A. Equipment.

- Teaspoon
- 500 ml beaker

B. Procedure.

- Place approximately 400 ml of cold water in the beaker.
- Fill a spoon with the coated beads and gently immerse them into the water.
- Tap the spoon to force the mass of beads to fall to the bottom of the beaker. The material should maintain its initial shape for at least 1 hour. Some beads may fall from the agglomerated mass; however, there should not be considerable dropping of beads before 1 hour.

### 626.2.3 Certification

1 Obtain from the manufacturer of the epoxy material a final certification that each batch of material furnished complies with these specifications. Obtain from the manufacturer of the glass beads certifications that each batch of material furnished complies with these specifications. Ensure that the certifications provided for the marking material or glass beads indicate the batch numbers used and include the manufacturer's production control tests for each batch. Ensure that the certifications also include the manufacturer's 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 used 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 Construction

1 Inventory and document the existing marking configurations before beginning any resurfacing project. Collect information sufficient to replace the markings in the existing configuration. Unless otherwise directed by the RCE, place the new markings in the documented configuration.

2 Place slow cure epoxy markings on all interstate routes and other control-of-access facilities. Place fast cure epoxy on all other routes unless otherwise specified in the Contract.

### 626.3.1 Equipment for Epoxy Pavement Markings

1 Use truck-mounted equipment for applying the epoxy material that can mix the two material components in the proportions recommended by the manufacturer, and apply the material at the manufacturer's recommended application temperature. Ensure that the equipment can automatically dispense beads immediately following application of the epoxy material using a double drop system.

2 Use marking equipment that can apply the epoxy material at a uniform thickness up to 25 mils and, in addition, can dispense beads at a constant rate of 25 lb/gal of marking material.

3 Ensure that the application equipment can distribute glass beads as required in **Subsection 626.3.4.1**.

4 Ensure that 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 that the equipment can cleanly cut 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 allow the operator to override set automatic cycles to extend a line or to begin a new cycle at any selected point.

6 Use equipment that can produce markings of varying widths as indicated in the Pavement Marking Plans, the MUTCD, the *Standard Drawings*, or the Contract specifications.

7 Ensure 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 Ensure 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 sprays 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 Surface Preparation

1 Ensure that the pavement is dry and free of glaze, oil, dirt, grease, or other foreign contaminants. When directed by the RCE, remove any existing markings that conflict with the Pavement Marking Plans before the application of epoxy material. Use approved removal methods, which are shot blast, sand blast, water blast, or grinding.

2 Where the existing symbol markings (e.g., arrows, words) differ from or conflict with the Plans, the MUTCD, or the *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 epoxy 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 in. 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 using a separate vacuum equipped vehicle or other approved system to prevent its dispersal. Properly dispose of the captured 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 of 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 additional cost 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, ensure that the pavement surface is free of dust, dirt, oil, grease, and any remaining loose or flaking existing marking material.

### 626.3.3 Application of Markings

#### 626.3.3.1 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. These markings, as well as transverse markings, may be applied with a portable unit.

2 Ensure that markings are sharp, well defined, uniformly retroreflective (except black markings), and free of uneven edges, overspray, or other readily visible defects that, as determined by 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 cost to the Department, including furnishing materials. Remove and reapply improperly located markings in the correct location at no additional cost to the Department, including furnishing materials.

3 Ensure that the markings are straight or uniform in curvature and conform uniformly to tangents, curves, and transitions. Apply symbols of dimensions shown in the *Standard Drawings*. Ensure that line markings match 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 in. in 100 ft. Remove and correct line markings with deviations greater than 2 in. in 100 ft at no additional cost to the Department. Remove and correct any symbol markings not meeting the dimensional requirements of the Pavement Marking Plans and the *Standard Drawings* at no additional cost to the Department.

5 Protect the markings until dry by placing guarding or warning devices as necessary. If any vehicle crosses the wet marking, re-apply the marking and

remove any tracking lines made by the moving vehicle to the satisfaction of the RCE.

6 If 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.

### 626.3.3.2 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 performed 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 less than 1 gal per 80 sq ft of marking surface (20 mil thickness). The following table provides the application rate on a linear foot basis for shorter lengths of markings (gore markings and stop bars).

**Linear Foot of Line Per Gallon of Material**

| Line Width (inches) | Solid Line Length (feet) |
|---|---|
| 8 | 120 |
| 12 | 80 |
| 24 | 40 |

4 Heat the epoxy to the manufacturer's recommended temperature before application to the pavement surface.

### 626.3.4 Glass Beads

#### 626.3.4.1 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 according to **Subsection 626.3.4.2**.

2 Apply the large beads first, and immediately follow with the application of the small beads. Ensure that the beads adhere to the cured epoxy or cease all marking operations until corrections are made.

#### 626.3.4.2 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** that 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 lb/gal of material. Immediately follow the application of the large beads with application of the smaller spheres at a rate of 12 lb/gal of material.

4 Ensure that the beads are properly imbedded and adhered to the cured epoxy line; if not, cease all marking operations until corrections are made.

5 Ensure that the marking is uniformly retroreflectorized upon cooling.

### 626.3.5 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 45ºF or greater, and the air temperature is 40°F or greater. No work is allowed when any moisture is visible on the pavement surface.

2 Provide each work crew with a hand-held infrared non-contact thermometer with a temperature range of 0ºF to 1000ºF 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, as determined by 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 14 days before marking application. Remove the curing compound on new Portland cement concrete surfaces before application using an approved method.

### 626.3.6 Retroreflectivity Requirements

1 Measure marking retroreflectivity using either a hand held or mobile retroreflectometer that uses 30-m CEN geometry. If a hand held unit is used, take measurements for all long lines in the direction of travel at intervals determined by the RCE. Ensure that the mobile measurements comply with **Section 629**.

2 Ensure that the markings achieve the initial minimum retroreflectance values shown in the following table. Ensure that the values are obtained within 20 days of marking placement. Ensure that the finished markings are uniformly retro-reflective as determined by visual inspection.

| **Retroreflectivity (mcd/lux/m$^2$)** | | |
|---|---|---|
| **Drop-on Glass Beads** | **White** | **Yellow** |
| Double Drop (Fast Cure) | 450 | 350 |
| Double Drop (Slow Cure) | 800 | 500 |

3 Ensure that the markings maintain the minimum retroreflectance values shown in the following table for a period of 180 days. Take measurements within 20 days of the end of the observation period.

| **Retroreflectivity (mcd/lux/m$^2$)** | | |
|---|---|---|
| **Drop-on Glass Beads** | **White** | **Yellow** |
| Double Drop (Fast Cure) | 400 | 300 |
| Double Drop (Slow Cure) | 700 | 400 |

4 Immediately replace any markings failing to meet the initial minimum retroreflectivity requirements by more than 50 mcd/lux/m² at no cost to the Department. Any markings failing to meet the initial requirements by less than 50 mcd/lux/m² may be reevaluated at the time of the 180-day evaluation unless the defect causing the lower readings is obvious to the RCE.

### 626.3.7 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 requirements have been met. Remove and replace markings that fail to have satisfactory appearance in either daytime or nighttime conditions at no additional cost 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, as determined by 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.

## 626.4 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 (e.g., arrows, word, 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 used 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 according to **Subsection 601.4**.

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.

## 626.5 Payment

1 Payment for the accepted quantity for each type of epoxy pavement marking at the Unit Price is full compensation for furnishing all materials, labor, equipment, supplies, and incidentals necessary to complete the work as specified.

2 Removal of existing pavement markings is considered incidental to the other items of work, and no separate payment is made for the 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 according to **Subsection 601.5**.

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 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6261005 | 4″ White Broken Lines - (Gaps Excluded) — Epoxy Paint Slow Cure | LF |
| 6261007 | 6″ White Broken Lines - (Gaps Excluded) — Epoxy Paint Slow Cure | LF |
| 6262108 | 6″ Black Broken Lines - (Gaps Excluded) — Epoxy Paint Slow Cure | LF |
| 6261009 | 12″ White Broken Lines - Lane Drop Pattern — Epoxy Slow Cure | LF |
| 6261010 | 4″ White Solid Lines (Pavement Edge Lines) — Epoxy Paint Slow Cure | LF |
| 6261012 | 6″ White Solid Lines (Pavement Edge Lines) — Epoxy Paint Slow Cure | LF |
| 6261015 | 8″ White Solid Lines - Crosswalk & Channelization — Epoxy Paint Slow Cure | LF |
| 6261020 | 12″ White Solid Lines (Gore Markings) — Epoxy Paint Slow Cure | LF |
| 6261021 | 12″ White Solid Lines (Diagonal Lines) — Epoxy Paint Slow Cure | LF |

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| Item No. | Pay Item | Unit |
|---|---|---|
| 6261023 | 12″ × 18″ White Triangle Yield Bar (Gaps Excluded) — Epoxy Paint Slow Cure | LF |
| 6261024 | 24″ × 36″ White Triangle Yield Bar (Gaps Excluded) — Epoxy Paint Slow Cure | LF |
| 6261025 | 24″ White Solid Lines (Stop Lines/ Diagonal Lines) — Epoxy Paint Slow Cure | LF |
| 6261030 | White Single Arrows (Left, Straight, Right) — Epoxy Paint Slow Cure | EA |
| 6261035 | White Word Message “Only” — Epoxy Paint Slow Cure | EA |
| 6261040 | White Combination Arrow (Straight & Right Or Straight & left) — Epoxy Paint Slow Cure | EA |
| 6261043 | White Lane Drop Arrow (Left Or Right) — Epoxy Paint Slow Cure | EA |
| 6261045 | Railroad Crossing Symbols — Epoxy Paint Slow Cure | EA |
| 6261105 | 4″ Yellow Broken Lines (Gaps Excluded) — Epoxy Paint Slow Cure | LF |
| 6261110 | 4″ Yellow Solid Lines - Pavement Edge & No Passing Zone — Epoxy Paint Slow Cure | LF |
| 6261112 | 6″ Yellow Solid Lines - Pavement Edge & No Passing Zone — Epoxy Paint Slow Cure | LF |
| 6261114 | 12″ Yellow Solid Lines-Diagonal Line — Epoxy Paint Slow Cure | LF |
| 6261115 | 24″ Yellow Diagonal Line — Epoxy Paint Slow Cure | LF |
| 6262005 | 4″ White Broken Lines - (Gaps Excluded) — Epoxy Paint Fast Cure | LF |
| 6262007 | 6″ White Broken Lines - (Gaps Excluded) — Epoxy Paint Fast Cure | LF |
| 6262008 | 6″ Black Broken Lines - (Gaps Excluded) — Epoxy Paint Fast Cure | LF |
| 6262009 | 12″ White Broken Lines - Lane Drop Pattern — Epoxy Paint Fast Cure | LF |
| 6262010 | 4″ White Solid Lines (Pavement Edge Lines) — Epoxy Paint Fast Cure | LF |

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| Item No. | Pay Item | Unit |
|---|---|---|
| 6262012 | 6″ White Solid Lines (Pavement Edge Lines) -— Epoxy Paint Fast Cure | LF |
| 6262015 | 8″ White Solid Lines - Crosswalk & Channelization — Epoxy Paint Fast Cure | LF |
| 6262020 | 12″ White Solid Lines (Gore Markings) — Epoxy Paint Fast Cure | LF |
| 6262021 | 12″ White Solid Lines (Diagonal Lines) — Epoxy Paint Fast Cure | LF |
| 6262023 | 12″ × 18″ White Triangle Yield Bar (Gaps Excluded) — Epoxy Paint Fast Cure | LF |
| 6262024 | 24″ × 36″ White Triangle Yield Bar (Gaps Excluded) — Epoxy Paint Fast Cure | LF |
| 6262025 | 24” White Solid Lines (Stop Lines/ Diagonal Lines) — Epoxy Paint Fast Cure | LF |
| 6262030 | White Single Arrows (Left, Straight, Right) — Epoxy Paint Fast Cure | EA |
| 6262035 | White Word Message “Only” — Epoxy Paint Fast Cure | EA |
| 6262040 | White Combination Arrow (Straight & Right Or Straight & left) — Epoxy Paint Fast Cure | EA |
| 6262043 | White Lane Drop Arrow (Left Or Right) — Epoxy Paint Fast Cure | EA |
| 6262045 | Railroad Crossing Symbols - Epoxy Paint Fast Cure | EA |
| 6262105 | 4″ Yellow Broken Lines (Gaps Excluded) — Epoxy Paint Fast Cure | LF |
| 6262110 | 4″ Yellow Solid Lines - Pavement Edge & No Passing Zone — Epoxy Paint Fast Cure | LF |
| 6262112 | 6″ Yellow Solid Lines - Pavement Edge & No Pass. Zone — Epoxy Paint Fast Cure | LF |
| 6262114 | 12″ Yellow Solid Lines - Diagonal Line — Epoxy Paint Fast Cure | LF |
| 6262115 | 24″ Yellow Diagonal Line — Epoxy Paint Fast Cure | LF |

# Section 627 — Thermoplastic Pavement Markings

## 627.1 Description

1 Furnish and place thermoplastic pavement markings according to the Contract documents and the *Manual on Uniform Traffic Control Devices* (MUTCD).

2 The work also includes the determination of passing/no passing zones on two lane facilities according to the MUTCD where existing passing/no passing zones have not been established. Provide the Department with data used in establishing passing/no passing zones.

## 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.

### 627.2.2 Thermoplastic Binder Compound

#### 627.2.2.1 General

1 Ensure that the thermoplastic binder compound complies with 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.

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. Ensure 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 the material does not contain more than 3 ppm of lead by weight in a cured state and not more than 100 ppm of total heavy metals as defined by the Resource Conservation and Recovery Act (RCRA), including lead and hexavalent chromium when tested according to Environmental Protection Agency (EPA) Methods 3050 and 6010.

Ensure that the yellow thermoplastic contains the proper amounts of pigment to produce a material that is weather fast and heat stable and meets the yellow color, reflectance, color stability (accelerated weathering), and retroreflectivity requirements specified herein. Ensure 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. 13538 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) | (0.5300, 0.4560) |
| (x2, y2) | (0.5100, 0.4850) |
| (x3, y3) | (0.4550, 0.4440) |
| (x4, y4) | (0.4720, 0.4000) |

*Reflectance (Y) is 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 complies with ASTM G155, Table X3.1, Cycle I for 1500 hours total exposure time. Prepare sample by dipping an aluminum sheet panel into the molten thermoplastic and removing the sample to obtain a 1.5-mm to 3.0-mm coating thickness of thermoplastic on the panel. Place the panel in the weathering apparatus for 1500 hours.

2 After accelerated weathering, measure the Yellow Color or Yellowness Index of the unbeaded material as stated in AASHTO M 249. Material must meet the color stability requirements below after this exposure:

- White – ASTM E313 – Yellowness Index, max. 20
- Yellow – Measured chromaticity coordinates fall within a color box defined by the following four (x, y) pairs on a C.I.E. 1931 chromaticity diagram:

| | |
|---|---|
| (x1, y1) | (0.5300, 0.4560) |
| (x2, y2) | (0.5100, 0.4850) |
| (x3, y3) | (0.4350, 0.4290) |
| (x4, y4) | (0.4490, 0.3770) |

### 627.2.2.4 Color Stability of In-Service White and Yellow Thermoplastic

1 The daytime color of the applied white and yellow thermoplastic pavement marking material (with drop-on beads) must meet the color requirements in **Subsection 627.2.2.3**. 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

1 Measure the hardness according to ASTM D2240, except condition the sample for 2 hours in a 115ºF water bath before measuring the hardness. Condition the Durometer at 115ºF 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. Ensure that the hardness is a minimum of 40 and a maximum of 70.

### 627.2.2.6 Flash Point

1 Ensure that the flash point of the thermoplastic pavement marking is a minimum of 475°F (245°C) when tested according to ASTM D92**.**

### 627.2.3 Glass Beads

1 Ensure that Type 1, Type 3, and Type 4 glass beads comply with AASHTO M 247 with the following exceptions:

Glass beads are a minimum of 80% true spheres when tested according to ASTM D1155 and meet the following gradation requirements when tested according to ASTM D1214:

**Percent by Mass Passing Designated Sieve (ASTM D1214)**

| Grading Designation (AASHTO M 247) | | | |
|---|---|---|---|
| **Sieve Size** | **Type 1** | **Type 3** | **Type 4** |
| No. 8 | — | — | — |
| No. 10 | — | — | 100 |
| No. 12 | — | 100 | 95 – 100 |
| No. 14 | — | 95 – 100 | 80 – 95 |
| No. 16 | 100 | 80 – 95 | 10 – 40 |

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**Percent by Mass Passing Designated Sieve (ASTM D1214)**

| Grading Designation (AASHTO M 247) | | | |
|---|---|---|---|
| **Sieve Size** | **Type 1** | **Type 3** | **Type 4** |
| 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 according to 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 AASHTO M 249 for each batch or lot of material furnished, including a final certification that the material furnished complies with the Department's specifications. Also, obtain from the manufacturer of the drop-on glass beads a certification stating that the material furnished meets all requirements of the Contract specifications. Furnish copies of the above-described certifications to the RCE.

## 627.3 Construction

1 Inventory and document the existing marking configurations before beginning any resurfacing project. Collect information sufficient to replace the markings in the existing configuration. Unless otherwise directed by the RCE, place the new markings in the documented configuration.

### 627.3.1 Application Equipment

1 Use equipment that enables the installation of thermoplastic pavement markings by methods according to AASHTO M 249 and the following additional 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. Ensure that the operator has controls that allow the override of pre-set automatic cycles 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 that consists of a special kettle for melting and heating the composition. Ensure that the heating of kettles and melters is performed by controlled heat transfer systems that are oil jacketed or indirect flame air jacketed. Do not use direct flame heating equipment. Ensure 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. Ensure 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 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. Ensure that the applicators have a means for cleanly cutting off square ends.

6 Ensure that the applicators can produce the various widths of traffic markings required in the MUTCD and/or on the Plans. Ensure 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 Surface Preparation

1 Ensure that the pavement is dry and free of glaze, oil, dirt, grease, or other foreign contaminants. When directed by the RCE, remove any existing markings that conflict with the Pavement Marking Plans before the application of thermoplastic material. Use approved removal methods, which are shot blasting, sand blasting, water blasting, or grinding.

2 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.

3 Where the existing symbol markings (e.g., arrows, ONLY) differ from or conflict with the Plans, the MUTCD, or the *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.

4 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 in. 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.

5 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 using a separate vacuum equipped vehicle or other approved system to prevent its dispersal and to properly dispose of the 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.

6 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 additional cost to the Department.

7 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.

### 627.3.3 Application of Primer Sealer

1 Where required, spray the primer-sealer on the pavement surface where the lines will 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.

### 627.3.4 Application of the Thermoplastic Pavement Marking Material

1 Except for preformed 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.

2 Except when directed or approved by the RCE, place all longitudinal markings with a truck-mounted applicator that complies with **Subsection 627.3.1**. 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.

3 Ensure that the markings are straight and uniform in curvature and conform uniformly to tangents, curves, and transitions. Ensure that symbols match the dimensions shown in the *Standard Drawings*. Ensure that markings match 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 cost to the Department.

4 Ensure that the finished line pavement markings are free from waviness and that the lateral deviation does not exceed 2 in. in 100 ft. Any greater deviation is sufficient cause for removal and correction of such markings at no additional cost to the Department. Remove and correct symbol pavement markings not meeting the dimensional requirements shown in the *Standard Drawings*. Protect the pavement markings until dry by placing protective 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 cost to the Department.

5 Place pavement markings only when the pavement is dry as determined by visual inspection or other approved method and the pavement temperature is 50ºF or greater. No work is allowed when any moisture is visible on the pavement surface or when the pavement is wet. Provide each work crew with a

hand-held infrared, non-contact thermometer with a temperature range of 0ºF to 1000ºF to verify the minimum surface temperature. Measure pavement temperature away from heat generating equipment.

6 In Districts 2, 3, and 4, do not apply thermoplastic pavement markings between December 15 and March 15 unless approved by the RCE. Additionally, the RCE may disallow application on any day when the weather is cold and/or rainy and there is some concern as to whether the surface temperature will be above 50ºF for a period adequate to obtain quality pavement markings. Application may also be disallowed on any day when, as determined by the RCE, moisture conditions are not satisfactory for obtaining quality pavement markings.

7 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.

8 Provide an adequate number of personnel experienced in the handling and application of this type of material to ensure that the work is performed properly. Run the marking machine only in the direction of normal traffic flow during marking operations.

9 Apply the thermoplastic pavement marking material at a temperature between 390ºF and 420ºF 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 in. or less in width with a die that equals the width of the line. Extruded lines greater than 12 in. may be applied with two dies with a combined width equal to the width of the line.

### 627.3.5 Rate of Application of Thermoplastic Material

1 Apply the thermoplastic material at the specified widths and at the rate of new dry material thickness specified as follows:

- 90 mils for edge lines and median lines including:
  - 4-in. solid white lines,
  - 4-in. solid yellow lines,
  - 4-in. broken yellow lines,
  - 6-in. solid white lines, and
  - 6-in. solid yellow lines.

- 90 mils for lane lines including:
  - 4-in. broken white lines, and
  - 6-in. broken white lines.

- 90 mils for center lines on two-lane roads including:
  - 4-in. broken yellow lines, and
  - 4-in. solid yellow lines.

- 125 mils for all symbols, words, or other lines not listed above.

### 627.3.6 Application of Glass Beads

#### 627.3.6.1 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. Ensure that the beads are uniformly distributed over the entire surface of the marking using 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. Ensure that the beads are embedded at 60% of their diameter and at a rate of 8 lb to 10 lb per 100 sq ft. Ensure that Type I glass spheres used for single-drop applications have a dual coating for adhesion promotion and moisture resistance.

#### 627.3.6.2 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 in **Subsection 627.2.3**.

3 Use large glass beads meeting the gradation for Type 3 or 4 in **Subsection 627.2.3**.

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 lb to 10 lb per 100 sq ft of material. Immediately follow the application of the large beads with application of the smaller spheres at a rate of 8 lb to 10 lb per 100 sq ft 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 Ensure that the marking is uniformly retroreflectorized upon cooling.

### 627.3.7 Retroreflectivity Requirements

1 Measure marking retroreflectivity using either a hand held or mobile retroreflectometer that uses 30-m CEN geometry. If a hand held unit is used,

take measurements for all long lines in the direction of travel at intervals determined by the RCE. Ensure that mobile measurements comply with **Section 629**.

2 Ensure that the markings achieve the initial minimum retroreflectance values shown in the following table. Ensure that the values are obtained within 20 days of marking placement. Ensure that the finished markings are uniformly retroreflective as determined by visual inspection.

| Retroreflectivity (mcd/lux/m$^2$) | | |
|---|---|---|
| **Drop-on Glass Beads** | **White** | **Yellow** |
| Single Drop | 375 | 250 |
| Double Drop | 450 | 350 |

3 Ensure that the markings maintain the minimum retroreflectance values shown in the following table for a period of 180 days. Take measurements within 20 days of the end of the observation period.

| Retroreflectivity (mcd/lux/m$^2$) | | |
|---|---|---|
| **Drop-on Glass Beads** | **White** | **Yellow** |
| Single Drop | 325 | 200 |
| Double Drop | 400 | 300 |

4 Immediately replace any markings failing to meet the initial minimum retroreflectivity requirements by more than 50 mcd/lux/m² at no additional cost to the Department. Any markings failing to meet the initial requirements by less than 50 mcd/lux/m² may be reevaluated at the time of the 180-day evaluation unless the defect causing the lower readings is obvious to the RCE.

### 627.3.8 Inspection and Departmental Sampling

1 In addition to initial acceptance, thermoplastic material may be sampled and tested for acceptance by the Department or its 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 complies with AASHTO M 249 as amended herein for each type of thermoplastic material. No thermoplastic material may be used or 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 lb and less than 44,000 lb of thermoplastic material. A batch is that amount of thermoplastic that was manufactured and packaged in a single operation. Ensure that thermoplastic material from the same lot is palletized, stretch-wrapped, and 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 RCE a manufacturer's test report showing actual laboratory test results on each lot of thermoplastic material demonstrating that the material meets the requirements of AASHTO M 249. The Department reserves the right to retest any batch/lot of thermoplastic material after delivery. Results from the 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 replace at no additional cost to the Department, including all costs for handling, retesting, and shipping.

### 627.3.9 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 specified quality of the product.

2 The Department may require the manufacturer to fully disclose details of the systems and processes in its QC/QA Program.

### 627.3.10 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 cost to the Department.

2 The final acceptance of the thermoplastic 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. The Contractor is responsible for the maintenance and performance of pavement markings during the 180-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, as determined by the RCE, have not performed satisfactorily during the 180-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.

## 627.4 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, 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 used 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 according to **Subsection 601.4**.

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.

## 627.5 Payment

1 Payment for the accepted quantity for each type of thermoplastic pavement marking at the Unit Price is full compensation for furnishing all materials, labor, equipment, supplies, and incidentals necessary to complete the work as specified.

2 Removal of existing pavement markings is considered incidental to the other items of work, and no 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 according to **Subsection 601.5**.

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 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 |
| 6271020 | 12″ White Solid Lines (Stop Lines) Thermoplastic – 125 mil. | LF |
| 6271023 | 12″ × 18″ White Triangular Yield Bar (Gaps Excluded) Thermoplastic – 125 mil. | LF |
| 6271025 | 24″ White Solid Lines (Stop/Diagonal Lines) Thermoplastic – 125 mil. | LF |

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| Item No. | Pay Item | Unit |
|---|---|---|
| 6271030 | White Single Arrows (Left, Straight, Right)<br>Thermoplastic – 125 mil. | EA |
| 6271035 | White Word Message “Only”<br>Thermoplastic – 125 mil. | EA |
| 6271036 | White Word Message “Stop Ahead”<br>Thermoplastic – 125 mil. | EA |
| 6271043 | White Land Drop Arrow (Left or Right)<br>Thermoplastic – 125 mil. | EA |
| 6271045 | Railroad Crossing Symbols<br>Thermoplastic – 125 mil. | EA |
| 6271050 | Handicap Symbol – Thermoplastic – 125 mil. | EA |
| 6271064 | 4″ Yellow Broken Lines (Gaps Excluded)<br>Thermoplastic – 90 mil. | LF |
| 6271066 | 6″ Yellow Broken Lines (Gaps Excluded)<br>Thermoplastic – 90 mil. | LF |
| 6271074 | 4″ Yellow Solid Lines (Pavement Edge Lines)<br>Thermoplastic – 90 mil. | LF |
| 6271076 | 6″ Yellow Solid Lines (Pavement Edge Lines)<br>Thermoplastic – 90 mil. | LF |
| 6271078 | 8″ Yellow Solid Lines (Pavement Edge Lines)<br>Thermoplastic – 90 mil. | LF |
| 6271080 | 24″ Yellow Solid Lines<br>Thermoplastic – 125 mil. | LF |

# Section 628 — Single Component Hybridized Polymer Pavement Markings

## 628.1 Description

1 Furnish and place single component hybridized polymer pavement markings according to the Contract documents and the *Manual on Uniform Traffic Control Devices* (MUTCD).

2 The work also includes the determination of passing/no passing zones on two lane facilities according to the MUTCD where existing passing/no passing zones have not been established. Provide the Department with data used in establishing passing/no passing zones.

## 628.2 Materials

### 628.2.1 Single Component Hybridized Polymer Pavement Marking Material

1 Provide single component hybridized polymer pavement markings that are durable retro-reflective (white or yellow) and non-retroreflective (black) pavement marking materials of the colors and patterns indicated on the Plans or Special Provisions. Supply all necessary equipment and materials for proper surface preparation and correct application of the pavement marking material.

2 Provide markings consisting of a single component hybridized polymer coating material that can be applied by truck-mounted spray equipment. Ensure that the material can be applied at a minimum ambient air temperature of 38°F. Ensure that the material is capable of retaining glass bead systems to provide specified values of retroreflectivity. Provide material that is suitable for application on all types of concrete and asphalt pavement surfaces.

3 Provide a material that will not separate or settle in original packaged form for a period of not less than 6 months from date of manufacture.

4 Provide a single component hybridized polymer that may be reapplied over the original single component hybridized polymer material without requiring the removal of the original residual material, provided that the original material shows no signs of failure due to poor adhesion to the pavement surface.

### 628.2.2 Single Component Hybridized Polymer Coating Material

#### 628.2.2.1 Formulation

1 Provide a durable single component material that can produce a rapid no-track condition. Ensure that the material is free of heavy metals. Provide a flexible, UV stable material that may be applied at a typical wet film thickness of 25 mils.

### 628.2.2.2 Composition

1 Ensure that the pigments for single component hybridized polymer material fall within the following limits:

| Pigments | White | Non-Lead Yellow | Black |
|---|---|---|---|
| Titanium dioxide* | 18% – 25% | 14% – 17% | — |
| Organic yellow | — | 7% – 8% | — |
| Black | — | — | 18% – 25% |
| Single component hybridized polymer resin | 75% – 82% | 75% – 79% | 75% – 82% |

** ASTM D476, Types II & III*

### 628.2.2.3 Color

1 Ensure that the single component hybridized polymer 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: 13538
Black: 37038

2 Apply the single component hybridized polymer compound, white, yellow and black, to 2 sets of 3-in. × 6-in. steel plates at 20 mils (±1 mil) in thickness, without glass beads as specified. Expose the prepared samples according to ASTM G154 Cycle 1. Ensure that the color of the single component hybridized polymer materials is within 5 units of the Federal Standards shown above.

### 628.2.2.4 Yellowness Index (ASTM G154 Cycle 1)

1 Check for compliance as follows:

- Cure 72 hours after sample preparation.
- Take yellow index reading, Lab C/2 degrees, following the 72-hour cure and the preceding QUV (ASTM G154 Cycle 1).
- Maximum before QUV, 6.0.
- Place sample in QUV for 72 hours.
- Maximum after QUV, 9.0.

### 628.2.2.5 Directional Reflectance (ASTM E1347)

1 The Directional Reflectance after QUV using C/2 degrees is as follows:

White: 85 Minimum
Yellow: 50 Minimum

### 628.2.2.6 Elongation

1 Ensure that the single component hybridized polymer provides an elongation of greater than 40% when tested according to ASTM D638, Type IV, average of 3 at 7 days.

### 628.2.2.7 Toxicity

1 Provide material that does not exude fumes that are toxic or injurious to persons or property when heating to the application temperature.

### 628.2.2.8 Viscosity

1 Ensure that the formulation is such that the viscosity, when tested to ASTM D562, provides Krebs Unit (KU) measurement of 90 – 105.

### 628.2.2.9 Drying Time

1 Ensure that the single component hybridized polymer marking material, when applied at 20 mils (±0.5 mil) wet film thickness at 75°F (±2°F) and with the proper saturation of glass spheres, exhibits no-track time of less than 5 minutes when tested according to ASTM D711.

2 Ensure that the single component hybridized polymer marking material, when applied in the field at 25 mils (±0.5 mil) wet film thickness between 38° – 110°F and with proper saturation of glass spheres, exhibits no-track time of less than 10 minutes.

### 628.2.2.10 Curing

1 Ensure that the single component hybridized polymer materials can fully cure under a constant pavement surface temperature of 32ºF or above.

### 628.2.2.11 Adhesion to Concrete

1 Ensure that the single component hybridized polymer 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.

#### 628.2.2.12 Hardness

1 Ensure that the single component hybridized polymer pavement marking materials, when tested according to ASTM D2240, have a Shore D Hardness greater than 30. Cure samples at room temperature for a minimum of 24 hours and a maximum of 72 hours before performing the tests indicated.

#### 628.2.2.13 Abrasion Resistance

1 Evaluate the abrasion resistance on a Taber Abrader with a 1000-gram load and CS-10 wheels at a duration of 1000 cycles. Calculate the wear index based on ASTM C501. Ensure that the wear index for the catalyzed material is not more than 50. Run the tests on cured samples of material that 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.

### 628.2.3 Glass Beads

#### 628.2.3.1 Composition

1 Ensure that the silica content of the beams is not less than 60%.

#### 628.2.3.2 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.

#### 628.2.3.3 Gradation

1 Ensure that Type 1 and Type 4 glass beads meet the requirements of AASHTO M 247 with the following exceptions.

2 Glass beads are a minimum of 80% true spheres when tested according to ASTM D1155 and meet the gradation requirements when tested according to ASTM D1214 shown in the following table.

**Percent by Mass Passing Designated Sieve (ASTM D1214)**

| Grading Designation Sieve Size (AASHTO) | Type 1 | Type 4 |
|---|---|---|
| No. 8 | — | — |
| No. 10 | — | 100 |
| No. 12 | — | 95 – 100 |
| No. 14 | — | 80 – 95 |
| No. 16 | 100 | 10 – 40 |
| No. 18 | — | 0 – 5 |
| No. 20 | 95 – 100 | 0 – 2 |
| No. 25 | — | — |
| No. 30 | 75 – 95 | — |
| No. 40 | — | — |
| No. 50 | 15 – 35 | — |
| No. 80 | — | — |
| No. 100 | 0 – 5 | — |

### 628.2.3.4 Bead Coating

1 Ensure that all beads are embedded and moisture proof coated with Potters 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. Place approximately 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 of the beaker. The material should maintain its initial shape for at least

1 hour. Some beads may fall from the agglomerated mass; however, there should not be a considerable dropping of beads before 1 hour.

### 628.2.4 Certification

1 Obtain from the manufacturer of the single component hybridized polymer 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 used and include the manufacturer's production control tests for each batch. Ensure that certifications also include the manufacturer's safety data sheets. Furnish copies of the certifications to the RCE before the work commences.

### 628.2.5 Department Samples

1 The Department reserves the right to perform in-plant sampling of the finished single component hybridized polymer material or glass beads during packaging operations and/or sampling of the packaged single component hybridized polymer material or glass beads after they are received. The Department, as deemed necessary, may test the samples. Department inspectors or its 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.

### 628.2.6 Marking and Packaging

1 Provide all materials used in the performance of the 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).

## 628.3 Construction

1 Inventory and document the existing marking configurations before beginning any resurfacing project. Collect information sufficient to replace the markings in the existing configuration. Unless otherwise directed by the RCE, place the new markings in the documented configuration.

### 628.3.1 Equipment for Single Component Hybridized Polymer Pavement Markings

1 Use equipment for applying the single component hybridized polymer material that is truck-mounted and can apply the material at the manufacturer's recommended application temperature. Ensure that the equipment can automatically dispense beads immediately following application of the single component hybridized polymer material using a double drop system.

2 Use marking equipment that applies the single component hybridized polymer material at a uniform thickness of up to 25 mils and, in addition, can dispense beads at a constant rate of 25 lb/gal of marking material.

3 Ensure that the application equipment can distribute glass beads as required in **Subsection 628.3.4.1**.

4 Ensure that 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 that the equipment can cleanly cut off square stripe ends and can provide 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 to extend a line or to begin a new cycle at any selected point.

6 Use equipment that can produce markings of varying widths as indicated in the Pavement Marking Plans, the MUTCD, the *Standard Drawings*, or the Contract.

7 Ensure 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 Ensure 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 sprays 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.

### 628.3.2 Surface Preparation

1 Ensure that the pavement is dry and free of glaze, oil, dirt, grease, or other foreign contaminants. When directed by the RCE, remove any existing markings that conflict with the Pavement Marking before the application of single component hybridized polymer material. Use approved removal methods, which are shot blasting, sand blasting, water blasting, or grinding.

2 Where the existing symbol markings (e.g., arrows, words) differ from or conflict with the Plans, the MUTCD, or the *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 single component hybridized polymer 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 single component hybridized polymer material. Make the width of the removal 2 in. 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 using a separate vacuum equipped vehicle or other approved system to prevent its dispersal and to properly dispose of the 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 excess or waste materials away from the project site.

5 Ensure that the removal of 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 additional cost 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, ensure that the pavement surface is free of dust, dirt, oil, grease, and any remaining loose or flaking marking material.

### 628.3.3 Application of Markings

#### 628.3.3.1 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, including transverse markings, may be applied with a portable unit.

2 Ensure that markings are sharp, well defined, uniformly retroreflective (except black markings), and free of uneven edges, overspray, or other readily visible defects that, as determined by 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 cost to the Department, including furnishing of materials. Remove and reapply improperly located markings in the correct location at no additional cost to the Department, including furnishing of materials.

3 Ensure that the markings are straight or uniform in curvature and conform uniformly to tangents, curves, and transitions. Apply symbols of dimensions shown in the *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 in. in 100 ft. Remove and correct line markings with a deviation greater than 2 in. in 100 ft at no additional cost to the Department. Remove and correct any symbol markings not meeting the dimensional requirements of the Pavement Marking Plans and the *Standard Drawings* at no additional cost to the Department.

5 Protect the markings until dry by placing protective or warning devices as necessary. If a vehicle crosses the wet marking, re-apply the marking and remove any tracking lines made by the moving vehicle to the satisfaction of the RCE.

6 If 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. Remove all marking material from the reflector unit, or remove and replace the damaged marker.

### 628.3.3.2 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 performed properly.

2 Apply the single component hybridized polymer marking materials at the rate specified in the following table to produce a uniform 25 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 | 27.5 | 6.875 |
| 6 | 41.25 | 10.375 |
| 8 | 55 | — |
| 12 | 82.5 | — |
| 24 | 165 | — |

3 Ensure that the application rates for solid lines in gore areas are not less than 1 gal per 64 sq ft of marking surface (25 mil thickness). The following table gives the application rate on a linear foot basis for shorter lengths of markings (gore markings and stop bars).

| Linear Foot of Line per Gallon of Material | |
|---|---|
| **Line Width (inches)** | **Solid Line Length (feet)** |
| 8 | 96 |
| 12 | 64 |
| 24 | 32 |

Heat the single component hybridized polymer to the manufacturer's recommended temperature before application to the pavement surface.

### 628.3.4 Glass Beads

#### 628.3.4.1 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 single component hybridized polymer 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 into the surface of the single component hybridized polymer material. Ensure that the beads are uniformly distributed over the entire surface of the marking material according to **Subsection 628.3.4.2**.

2 Apply the large beads first and immediately follow with the application of the small beads. Ensure that the beads adhere to the cured single component hybridized polymer, or cease all marking operations until corrections are made.

### 628.3.4.2 Double Drop Method

1 Use small glass beads meeting the gradation for Type 1 required in **Subsection 628.2.3.3**.

2 Use large glass beads meeting the gradation for Type 4 required in **Subsection 628.2.3.3**.

3 Apply large beads uniformly to the surface of the single component hybridized polymer material so that the beads are embedded at 60% of their diameter at a rate of 12 lb per gal of material. Immediately follow the application of the large beads with application of the smaller spheres at a rate of 12 lb per gal of material.

4 Ensure that the beads are properly imbedded and adhere to the cured single component hybridized polymer line; if not, cease all marking operations until corrections are made.

5 Ensure that the marking is uniformly retroreflectorized upon cooling.

### 628.3.5 Weather, Seasonal, and Other Limitations

1 Place single component hybridized polymer 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 if the 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 that can accurately measure air temperature. Measure air temperature away from heat generating equipment.

3 Application of markings may be disallowed on any day when, as determined by the RCE, moisture or temperature conditions are not satisfactory for obtaining quality pavement markings.

4 Do not apply single component hybridized polymer pavement markings between December 15 and March 15, inclusive.

5 Ensure that new asphalt concrete surfaces are in place a minimum of 14 days before marking application. Remove the curing compound on new Portland cement concrete surfaces before application.

### 628.3.6 Inspection and Acceptance

1 All single component hybridized polymer 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 cost to the Department.

2 The final acceptance of the single component hybridized polymer 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, as determined by 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.

### 628.3.7 Retroreflectivity Requirements

1 Measure marking retroreflectivity using either a hand held or mobile retroreflectometer that uses 30-m CEN geometry. If a hand held unit is used, take measurements for all long lines in the direction of travel at intervals determined by the RCE. Ensure that mobile measurements comply with **Section 629**.

2 Ensure that the markings achieve the initial minimum retroreflectance values shown in the following table. Ensure that the values are obtained within 20 days of marking placement. Ensure that the finished markings are uniformly retroreflective as determined by visual inspection.

| **Retroreflectivity (mcd/lux/m$^2$)** | | |
|---|---|---|
| **Drop-on Glass Beads** | **White** | **Yellow** |
| Double Drop | 375 | 250 |

3 Ensure that the markings maintain the minimum retroreflectance values shown in the following table for a period of 180 days. Take measurements within 20 days of the end of the observation period.

| **Retroreflectivity (mcd/lux/m$^2$)** | | |
|---|---|---|
| **Drop-on Glass Beads** | **White** | **Yellow** |
| Double Drop | 325 | 200 |

4 Immediately replace any markings failing to meet the initial minimum retroreflectivity requirements by more than 50 mcd/lux/m² at no additional cost to the Department. Any markings failing to meet the initial requirements by less than 50 mcd/lux/m² may be reevaluated at the time of the 180-day evaluation unless the defect causing the lower readings is obvious to the RCE.

## 628.4 Measurement

1 The quantities for single component hybridized polymer 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 single component hybridized polymer pavement marking in-place, complete and accepted. The measurement is the length of the single component hybridized polymer pavement marking only and excludes spaces between broken lines.

2 The quantities for single component hybridized polymer pavement marking symbols (arrows, word, 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 used during the performance of single component hybridized polymer pavement marking work is not measured under items covered by this Section but is included in the item Traffic Control according to **Subsection 601.4**.

4 Unless included in other bid items in the Contract, the work required to remove existing pavement markings is considered incidental work for single component hybridized polymer 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.

## 628.5 Payment

1 Payment for the accepted quantity for each type of single component hybridized polymer pavement marking at the Unit Price is full compensation for furnishing all materials, labor, equipment, supplies, and incidentals necessary to complete the work as specified.

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 according to **Subsection 601.5**.

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 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6282005 | 4″ White Broken Lines - (Gaps Excluded) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282007 | 6″ White Broken Lines - (Gaps Excluded) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282008 | 6″ Black Broken Lines - (Gaps Excluded) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282010 | 4″ White Solid Lines - (Pavement Edge Lines) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282012 | 6″ White Solid Lines - (Pavement Edge Lines) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282015 | 8″ White Solid Lines - (Crosswalk & Channelization) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282020 | 12″ White Solid Lines (Gore Markings) Single Component Hybridized Polymer – 25 mils | LF |
| 6282021 | 12″ White Solid Lines (Diagonal Lines) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282025 | 24″ White Solid Lines (Stop Lines/Diagonal Lines) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282030 | White Single Arrows (Left, Straight, Right) - Single Component Hybridized Polymer – 25 mils | EA |
| 6282035 | White Word Message “Only” - Single Component Hybridized Polymer – 25 mils | EA |

(table continued on the next page)

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| Item No. | Pay Item | Unit |
|---|---|---|
| 6282040 | White Combination Arrow (Straight & Right or Straight & Left) - Single Component Hybridized Polymer – 25 mils | EA |
| 6282043 | White Lane Drop Arrow (Left or Right) - Single Component Hybridized Polymer – 25 mils | EA |
| 6282045 | Railroad Crossing Symbols - Single Component Hybridized Polymer – 25 mils | EA |
| 6282105 | 4″ Yellow Broken Lines (Gaps Excluded) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282110 | 4″ Yellow Solid Lines (Pavement Edge & No Passing Zone) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282112 | 6″ Yellow Solid Lines (Pavement Edge & No Passing Zone) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282114 | 12″ Yellow Solid Lines (Diagonal Line) - Single Component Hybridized Polymer – 25 mils | LF |
| 6282115 | 24″ Yellow Diagonal Line - Single Component Hybridized Polymer – 25 mils | LF |

# Section 629 — Mobile Evaluation of Retroreflectivity

## 629.1 Description

1 Evaluate the retroreflectivity of the pavement markings as specified.

## 629.2 Material

1 None specified.

## 629.3 Construction

1 Within 20 days of initial application, arrange for an independent party to evaluate the retroreflectivity of the pavement markings using a mobile retroreflectometer using a 30-m CEN geometry that can collect data at highway speeds, such as the Delta LTL-M or equivalent. Conduct a second evaluation within 20 days before the end of the 180-day observation period. If the permanent markings are snowplowed during the 180-day observation period, ensure that the lines meet the minimum retroreflectivity values shown in the table below at the time of the second evaluation.

| Material Description | Color | Initial Reading | 180 Reading | Snow Plow Reading |
|---|---|---|---|---|
| Thermoplastic – Single Drop Beads | White<br>Yellow | 375<br>250 | 325<br>200 | 200<br>150 |
| Thermoplastic – Double Drop Beads | White<br>Yellow | 450<br>350 | 400<br>300 | 200<br>150 |
| Fast Cure Epoxy | White<br>Yellow | 450<br>350 | 400<br>300 | 200<br>150 |
| Slow Cure Epoxy | White<br>Yellow | 800<br>500 | 700<br>400 | 375<br>250 |
| Polyurea | White<br>Yellow | 800<br>500 | 700<br>400 | 375<br>250 |
| Preformed Tape | White<br>Yellow | 800<br>500 | 700<br>400 | N/A<br>N/A |
| Single Component Hybridized Polymer | White<br>Yellow | 375<br>250 | 325<br>200 | 200<br>150 |
| Profiled Thermoplastic | White<br>Yellow | 375<br>250 | 325<br>200 | 200<br>150 |
| Rumble Stripes | White<br>Yellow | 375<br>250 | 325<br>200 | 200<br>150 |
| Permanent Pavement Markings | White<br>Yellow | 400<br>300 | 350<br>250 | 200<br>150 |

2 For non-interstate or non-control of access routes, measure all long lines in the direction of travel. For two-lane roadways, ensure that the independent party evaluates the center line markings in the direction of marking application if

known. Ensure that the independent party conducting the measurements furnishes directly to the Department a report detailing the average of the readings over one-tenth of a mile segments for each type of long line (white edge line, white lane lines, yellow edge lines) along the length of the project.

3 For interstate or other control of access routes, measure all long lines on the interstate mainline, collector/distributor routes, and ramps in the direction of travel. Ensure that the independent party conducting the measurements furnishes directly to the Department a report detailing the average of the readings over two-tenth of a mile segments for each type of long line (white edge line, white lane lines, yellow edge lines) along the length of the project.

4 Interstate mile markers may be used for beginning and ending points on the mainline and collector/distributor routes, with the first and last segments in each direction being less than two tenths of a mile in length. Reference each ramp individually with the white edge line reading to the point where the ramp taper joins the mainline edge line.

5 Ensure that the minimum 180-day and minimum snow plow retroreflectivity values for various types of materials are:

- All retroreflectivity readings in millicandelas/lux/meter squared; and
- Immediately replace any markings failing to meet the initial minimum retroreflectivity requirements by more than 50 mcd/lux/m² at no cost to the Department. Any markings failing to meet initial requirements by less than 50 mcd/lux/m² may be reevaluated at the time of the 180-day evaluation unless the defect causing the lower readings is obvious to the RCE.

## 629.4 Measurement

1 The quantity for the pay item Evaluation of Pavement Marking Retroreflectivity is paid for on a lump sum basis and, therefore, no specific measurements are made for this item.

## 629.5 Payment

1 The lump sum payment for Evaluation of Pavement Marking Retroreflectivity is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

| Item No. | Pay Item | Unit |
|---|---|---|
| 6290001 | Evaluation of Pavement Marking Retroreflectivity | LS |

# Section 630 — Permanent Raised Pavement Markers

## 630.1 Description

1 Furnish and place permanent raised pavement markings according to the Contract documents and the *Manual on Uniform Traffic Control Devices* (MUTCD).

## 630.2 Materials

### 630.2.1 General

1 Provide RPMs manufactured by either a potted or injection molded process that conforms to the provisions of this Subsection and complies with ASTM D4280. The RPM Drawings in the Plans are for illustration only and are not intended to specify any specific product.

### 630.2.2 Shape and Color

1 Provide RPMs with a 4 in. × 4 in. base, ⅝ in. in height, and 35-degree sloping sides (nominal dimensions). Ensure that the outer surface of the marker is smooth and that all corners and edges exposed to traffic are rounded. Provide RPMs of the color(s) indicated on the Plans and with either one or two reflective faces as required. When illuminated by automobile headlights, ensure that the reflective faces redirect light of the required color as specified herein. Ensure that the color of the reflectors when illuminated and when not illuminated is similar. The color of the 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 RPMs with a shell with a smooth exterior surface that contains one (mono-directional) or two (bi-directional) prismatic or micro-prismatic reflector faces, as specified in the Contract, molded to reflect incident light and having a minimum surface area of 2.50 sq in. Ensure that the minimum surface area of the base of the marker is 12 sq in.

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 the units with two colors are exempt from this requirement.

3 Ensure that the abrasion resistant surface of the reflector lens can withstand radial cracking, and shows only concentric cracks when damaged by impact of hard objects embedded in vehicle tires.

#### 630.2.3.1 Manufacturer's Certification and Q/C Test Report

1 Submit to the RCE or their designee a manufacturer's certification for each LOT of markers sent to the project. Include the manufacturer's statement that all markers in the LOT meet the requirements of ASTM D4280 and the requirements of **Subsection 630.2.3** in the certification.

2 Include the manufacturer's QC test results and specification limits for the LOT on the manufacturer's certification. Include at a minimum the following test results as performed pursuant to ASTM D4280:

- New coefficient of luminous intensity,
- Abraded coefficient of luminous intensity,
- Longitudinal flexural strength,
- Compressive strength, and
- Lens impact strength.

### 630.3 Construction

1 Before the installation of new RPMs, remove existing markers using a pneumatic chisel or other method approved by the RCE. Repair any damage to the pavement surface at no additional cost to the Department.

#### 630.3.1 Installation of RPM

#### 630.3.1.1 Color and Orientation of RPM

1 Install the color used for the RPMs for lane lines, center lines, paved medians, and entrance/exit ramp channelization markings oriented as illustrated in the Plans and *Standard Drawings*.

#### 630.3.1.2 Method of Bonding RPM to Pavements

##### 630.3.1.2.1 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 50ºF for use of the epoxy method or 40ºF for use of the bituminous adhesive method of bonding.

#### 630.3.1.2.2 Epoxy Method

1 If the epoxy method of bonding the RPM to the pavement is selected, use an epoxy adhesive that complies with AASHTO M 237, Type 1. Furnish the RCE with a certification stating that the epoxy complies with AASHTO M 237, Type 1. In addition to the manufacturer's recommendations, comply with the following requirements:

- Maintain the temperature of the adhesive components at 60ºF to 100ºF before mixing.
- Just before use, mix Components A and B according to the manufacturer's recommendations.
- Clean the road surface by sandblasting the area to which the marker will be bonded. Ensure that the sand is clean and dry. Ensure that the road surface where markers will be placed is thoroughly dry before applying epoxy.
- When markers are placed over existing traffic paint stripes, remove all old paint and primer down to bare concrete or asphalt.
- Ensure that the machine mixer and applicator are capable of accurately and uniformly proportioning Component A to Component B in a volume ratio according to the manufacturer's recommendations.
- 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.
- Ensure that voids in a cured undisturbed sample 1/16 in. thick from the extrusion nozzle do not exceed 4%.
- 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.

#### 630.3.1.2.3 Bituminous Adhesive Method

1 If the bituminous adhesive method of bonding the RPM to the pavement is selected, use a bituminous type, hot-melt adhesive that complies with these specifications. Furnish the RCE with a certification stating that the bituminous adhesive complies with 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 40ºF to 160ºF. Ensure that the composition of the adhesive is such that its properties do not deteriorate when heated to and applied at temperatures up to 425ºF 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 lb or 60 lb and weighs within 2 lb of the stated weight. Ensure that the packaging has self-releasing

cardboard dividers that separate each package into sections weighing not more than 15 lb each. Ensure that 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.

#### 630.3.1.2.4 Prequalification of Adhesive

1 Use adhesives from manufacturers listed on *Qualified Products List 42*.

### 630.3.1.3 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 cost 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, as determined by the RCE, has not performed satisfactorily during the 180-day period due to defective materials and workmanship in manufacture and application at no additional cost to the Department.

## 630.4 Measurement

1 The quantity for the pay item Permanent (Clear, Yellow, or Red/Clear) Pavement Markers (Mono-Directional or Bi-Directional) – (4 in. × 4 in.) 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 Traffic control used 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 according to **Subsection 601.4**.

3 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.

## 630.5 Payment

1 Payment for the accepted quantity for Permanent (Clear, Yellow, or Red/Clear) Pavement Markers (Mono-Directional or Bi-Directional) – (4 in. × 4 in.) at the

Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, and incidentals necessary to complete the work as specified.

2 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 according to **Subsection 601.5**.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6300005 | Permanent Clear Pavement Markers Mono-Dir. – 4″ × 4″ | EA |
| 6301005 | Permanent Yellow Pavement Markers Mono-Dir. – 4″ × 4″ | EA |
| 6301100 | Permanent Yellow Pavement Markers Bi-Dir. – 4″ × 4″ | EA |
| 6302001 | Permanent Red/Clear Pavement Markers Bi-Dir. – 4″ × 4″ | EA |

# Section 631 — Removal of Existing Pavement Markings

## 631.1 Description

1 Remove existing pavement markings and capture the removed material as specified.

## 631.2 Material

1 None specified.

## 631.3 Construction

1 Remove the existing long lines (edge lines, lane lines, 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, ensure 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 and ensure that there are no conflicts with the new pavement markings. On open-graded asphalt or grooved concrete surfaces, remove the existing lines so 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 using a separate vacuum equipped vehicle or other approved system to prevent its dispersal, and properly dispose of the material. No visible marking material debris may remain on the pavement shoulders. Ensure that the recovery system is within a maximum of 75 ft 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 do 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 Where the existing symbol markings (arrows, words, etc.) differ from or are in conflict with the Plans or the *Standard Drawings*, the RCE will determine which to follow. For symbol marking relocation or replacement, remove 95% of the conflicting markings (and ensure that there are no conflicts with the new pavement 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.

6 For non-interstate routes, replace pavement edge lines, center lines, median marking lines, and lane lines the same day that they are removed. Replace all arrows, words, symbols, and stop bars the same day that they are removed. For interstate routes, replace all mainline and ramp edge lines (white and yellow) and entrance and exit gore markings within 3 days of removal. Replace all mainline lane lines the same day that the existing lines are removed. Replace all arrows, words, symbols, and stop bars the same day that they are removed.

7 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.

## 631.4 Measurement

1 The quantity for the pay item Removal of Line Pavement Markings is the length of the existing longitudinal and transverse pavement markings to be removed and is measured by the linear foot (LF). Measure pavement edge lines and lane lines of widths up to 8 in. along the marking centerline, excluding spaces between broken lines.

2 For double yellow centerlines or two-way left turn median lines, pay separately for each line (e.g., 300 ft of double yellow centerline = 600 LF of removal). For each broken line removed, tally a minimum quantity of 10 LF of removal, regardless of the length of the broken line. The exception will be 2-ft skip lines. In this case, tally 2 LF of removal for each skip line removed.

3 For wider markings, such as 12-in. gore markings on interstates, multiply the measured length of the line to be removed by a factor of 2 (e.g., 300 ft of 12-in. line = 600 LF of removal). Similarly, for 24-in. wide stop bars, multiply the measured length of the line to be removed by a factor or 4.

4 The quantity for the pay item Removal for Arrows, Word Messages, and Symbols is measured on a per each (EA) basis. Tally each word, arrow, or symbol separately. Removal of railroad symbols includes removal of the two Rs and the accompanying X. Due to the nature of this item, railroad symbols have its own removal pay item, Removal of Railroad Symbols. Tally the transverse 24-ft lines and stop bar associated with railroad symbols using the method previously outlined for line markings in this Subsection.

## 631.5 Payment

1 Payment for the accepted quantity for each type of removal of existing pavement markings at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation and incidentals necessary to complete the work as specified.

2 Traffic control for removal of existing pavement markings is included in the pay item Traffic Control according to **Subsection 601.5**.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6319505 | Removal of Existing Line Pavement Markings | LF |
| 6319506 | Removal of Existing Arrow, Word Message and Symbol Markings | EA |
| 6319507 | Removal of Existing Railroad Crossing Symbols | EA |

# Section 632 — Milled-In Rumble Strips

## 632.1 Description

1 Install milled-in rumble strips (MIRS) according to the Contract documents and the *Manual on Uniform Traffic Control Devices* (MUTCD).

## 632.2 Materials

1 Not applicable.

## 632.3 Construction

### 632.3.1 Interstate Routes and other Control-of-Access Facilities with Paved Shoulders

1 Where specified, install MIRS in the mainline paved shoulder only. Do not place MIRS on ramp shoulders.

2 Use a rotary type cutting head for MIRS. Use a head with a maximum outside diameter of 24 in. and a minimum width of 16 in. Equip the cutting head with the cutting tips arranged in a pattern that provides a relatively smooth cut. Ensure that the cutting head(s) is mounted on an 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 a consistent alignment for each cut relative to the roadway and to provide uniformity and consistency throughout the project.

3 Construct MIRS with finished dimensions as shown on Standard Drawing 632-105-01 and installed according to Standard Drawing 632-105-02.

### 632.3.2 Non-Interstate Routes – Application of Rumble Stripes

1 Place MIRS for rumble stripe application along the edge lines and centerlines (if specified) of 2-lane roadways. For rumble stripe applications on 4-lane roads with a divided median, place MIRS along both inside shoulders (yellow edge line) and outside shoulders (white edge line). Ensure that all MIRS dimensions conform to Standard Drawing 632-205-01.

2 Use equipment that meets **Subsection 632.3.1** having a rotary type cutting head capable of producing a variable width of 4 in. to 12 in. for edge line MIRS and 12 in. to 16 in. for centerline MIRS.

3 Terminate installation of the MIRS before intersections as illustrated in Standard Drawing 632-205-01. Do not install MIRS on or across concrete bridge decks or approach slabs.

### 632.3.3 Debris Removal and Disposal

1 Provide a positive means to control dust and prevent an accumulation of debris resulting from the milling operation. Capture and remove the milled asphalt material using a separate vacuum equipped vehicle or other system approved by the RCE to prevent dispersal along the roadway. Dispose of debris material at a site approved by the RCE. Do not dispose of debris within the right-of-way. Accomplish milling and debris removal in a single mobile operation.

2 If desired, use removed pavement material suitable for recycling on the project or for other operations at no additional cost to the Department.

## 632.4 Measurement

### 632.4.1 Interstate Routes and other Control-of-Access Facilities with Paved Shoulders

1 The quantity for Milled-In Rumble Strip is the sum of the length of the segments of the required rumble strips milled into the asphalt pavement and is measured by the mile (MI), complete and accepted. Measure the length of the segment 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.

### 632.4.2 Non-Interstate Routes

1 Measure the length of MIRS separately for each edge line and/or centerline from the beginning point of the project to the endpoint of the project. The quantity for Milled-In Rumble Strip is the sum of the lengths of each MIRS, in miles, installed along the roadway mainline. Do not deduct gaps for various MIRS patterns and intersections from the measured length.

## 632.5 Payment

1 Payment for the accepted quantity for Milled-In Rumble Strip at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6321000 | Milled-In Rumble Strip | MI |

## Section 633 Through Section 649 — Sections Not Used

*These Sections have been Reserved for Future Use*

# Section 650 — General Regulations for Installation of Permanent Traffic Signs

## 650.1 Description

### 650.1.1 General

1 Fabricate, install, and maintain traffic signs and supports as specified in the Contract and the MUTCD and as directed by the RCE.

### 650.1.2 Existing Appurtenances

1 The Contractor is responsible for continuity of any existing utility service and for maintaining a safe and satisfactory operating condition for all overhead, surface, or subsurface utilities. Contact the Palmetto Utility Protection Service (SC811) at 1-811-721-7877 at least 3 days before any excavation or driving of posts. Contact the District Mechanical Engineer and the SCDOT ITS Office 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 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 the 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 using any non-conforming materials not specified herein or not included on a *Qualified Products List*.

2 Use the sign face layouts, details, and general descriptions with specified background and finish legend as shown in the Plans, the *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 and samples of the items in question.

4 Use ready mix concrete from ready mix concrete plants listed on *Qualified Products 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 I-beam breakaway supports, U-section posts, or square tube posts as indicated on the Plans and the *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 that comply with **Section 709**.

2 Provide a zinc-galvanized coating on all exposed ferrous surfaces of overhead sign structures, I-beam breakaway posts, U-section posts, or square tube posts

before 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 of 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 fabrication inspection of material and workmanship may be required for any new overhead sign structures. Material and workmanship of other items may be inspected if deemed necessary by the SME before being shipped to the project. Schedule the necessary inspections with the SME 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 Construction

### 650.3.1 Clearing

1 Remove trees, limbs, underbrush, and debris at locations directed by the RCE to provide a 1200-ft sight distance according to Standard Drawing 650-115-00 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 in. below the ground line elevation.

2 Remove vegetation on crossing routes as determined by the RCE to provide for adequate sight distance for the signs.

### 650.3.2 Fabrication

1 Shear, blank, saw, mill, or thermal cut materials according to the AASHTO/AWS D1.5, *Bridge Welding Code*.

2 Install bolt holes as specified in **Section 709**.

### 650.3.3 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, asphalt or concrete pavement, sidewalks, curbs and gutters, paved or stabilized shoulders, final grading, seeding and mulching, and replacing shrubbery and trees in affected areas.

### 650.3.4 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.

## 650.4 Measurement

1 There are no items measured for payment under this Section.

## 650.5 Payment

1 There are no items paid for under this Section. Payment for specific permanent traffic signs and supports are made under other sections of the 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 Furnish, fabricate, and install flat sheet signs.

## 651.2 Materials

### 651.2.1 Sign Blanks

1 Fabricate sign blanks from aluminum that complies with ASTM B209, Alloys 6061-T6, 5052-H38, or 5154-H38. Comply with the following aluminum thickness requirements:

| Sign Width | Blank Thickness |
|---|---|
| Less than 48 in. | 0.080 in. |
| 48 or more in. | 0.100 in. |

2 Measure the width of signs along the horizontal edge. Measure the width of diamond shape and pennant shaped signs along the sloped edge of the sign.

### 651.2.2 Mounting Hardware

1 Use 5/16-in. 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 *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 complies with ASTM D4956.

2 In addition to the requirements of ASTM D4956, ensure that reflective sheeting conforms to the following provisions:

- Use reflective sheeting material listed on *Qualified Products List 20*.
- 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 Contractor bears the cost of testing.
- 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.
- Ensure that sheeting maintains the following reflective intensity values for the indicated number of years:
    - Type III – 80% of minimum retroreflective values for Type III sheeting given in ASTM D4956 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 ASTM D4956 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 ASTM D4956 for a service life of 3 years.
    - Type VI – 50% of minimum retroreflective values for Type VI sheeting given in ASTM D4956 for a service life of 3 years.
    - Type IX – 80% of minimum retroreflective values for Type IX sheeting given in ASTM D4956 for a service life of 10 years with the exception of orange sheeting, which shall have a service life of 3 years.
    - Type XI – 80% of minimum retroreflective values for Type XI sheeting given in ASTM D4956 for a service life of 12 years with the exception of orange sheeting, which shall have a service life of 3 years.
- Ensure that sheeting will remain free of cracks, scaling, blisters, or delaminations for the service life of each type specified above.

- Ensure that sheeting will not show any appreciable change in color when compared to unexposed sheeting specimens.
- 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.

3 Replace any traffic control device that fails to perform satisfactorily for either its daytime or nighttime purpose from 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, provide a color match formula from the manufacturer's ink series at no charge to the Department.

2 Ensure that 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 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.

#### 651.2.4.4 Digital Inks

1 Digital printed ink systems may be used when authorized by the Department. The digital print ink systems, products, and processes must comply with the reflective sheeting manufacturer's recommendation. Digital printed ink systems used to print traffic signs must meet daytime and nighttime chromaticity requirements of ASTM D4956. Digital printed ink systems for corresponding sheeting types must be warranted as outlined in **Subsection 651.2.3**. In addition, the digital printed ink systems must meet 70% of the retroreflectivity requirements for each respective film color.

## 651.3 Construction

### 651.3.1 Fabrication

#### 651.3.1.1 Dimensions

1 Use the general design and dimensions as specified in the Plans, the MUTCD, the FHWA *Standard Highway Signs*, and the *Special Highway Signs Drawings*. Make the corner radii and hole placement of each individual sign according to 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.

#### 651.3.1.2 Sign Blanks and Surface Preparation

##### 651.3.1.2.1 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 652.3.1.3**.

##### 651.3.1.2.2 Degreasing

1 Degrease sheeting blanks using the sheeting manufacturer's current processes and specifications or one of the following methods:

- Immerse blanks in a saturated vapor of trichloroethylene or perchloroethylene.
- 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.

##### 651.3.1.2.3 Etching

1 Use one of the following methods to etch the blanks after degreasing:

- 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.
- 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.

#### 651.3.1.2.4 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 B449 or ASTM B921, Class 2, 10 to 33 mg/ft$^2$ with a median of 25 mg/ft$^2$.

### 651.3.2 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 contaminates after cleaning and etching and before the application of the final finish coat.

### 651.3.3 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 (e.g., pressure sensitive, heat activated).

2 Splice the sheeting according to the manufacturer's recommendations for the type of material used with the following additions or exceptions:

- Do not splice flat sheet signs except where the narrowest dimension of the panel is in excess of the sheeting width.
- Do not combine remnant pieces on any sign.
- Do not use clear paint or coatings.

### 651.3.4 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$^2$) | Maximum No. of Patches per Sign | Maximum Patch Size per Patch (in$^2$) |
|---|---|---|
| 0 – 15 | 0 | 0 |
| 15.1 – 50.0 | 1 | 1 |
| 50.1 and over | 2 | 2 |

### 651.3.5 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 according to instructions from the manufacturer of the screening ink.

### 651.3.6 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 according to the sheeting manufacturer.

### 651.3.7 Digital Printing

1 Apply legends and borders on reflective sheeting using digital printing when authorized by the Department. Perform all digital printing as recommended by the manufacturer of the retroreflective sheeting. Ensure that the retroreflective sheeting conforms to **Subsection 651.2.3**.

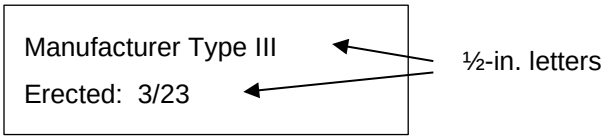
2 Ensure that permanent traffic signs printed with digital ink systems are fabricated with a full sign protective overlay film designed to protect the entire sign from fading and UV degradation. Ensure that the over-lamination complies with the retroreflective sheeting manufacturer's recommendations to ensure proper adhesion and transparency and complies with **Subsection 651.2.3**.

3 Temporary signs printed with black ink only will not require a protective overlay film if the finished sign is warranted as noted in **Subsection 651.2.3**.

4 Use opaque black ink for nonreflectorized message application as manufactured or recommended by the manufacturer of the retroreflective sheeting as noted in **Subsection 651.2.4.2**.

### 651.3.8 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-in. high letters.




### 651.3.9 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 the sheeting manufacturer's special recommendations.

### 651.3.10 Location

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, ensure that 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.

#### 651.3.10.1 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 *Standard Drawings*.

#### 651.3.10.2 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 *Standard Drawings* unless otherwise indicated.

### 651.3.11 Erection

#### 651.3.11.1 General

1 Erect and support all signs, bridge-end markers, and mileposts as specified on the Plans and the *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 the field.

#### 651.3.11.2 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 5/16-in. 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.

#### 651.3.11.3 Flat Sheet Signs Mounted on Other Supports

1 After supports have been erected, attach flat sheet signs to I-beams or circular posts with 5/16-in. 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 manufacturer determines the number, size, and spacing of the channels.

2 Ensure that the sign fabricator attaches the channels 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. Before fabrication, obtain approval from the Director of Traffic Engineering of the brackets used to attach signs to circular posts.

#### 651.3.11.4 Bracing

1 Brace all “D” type flat sheet signs that are 6 ft wide and wider with U-section posts of the size and length indicated in the *Standard Drawings*. Secure the braces tightly to the vertical supports with $^{5}/_{16}$-in. bolts and a lock washer and flat washer between posts and nuts. Attach the signs to the braces as indicated in **Subsection 651.3.11.1** through **Subsection 651.3.11.3**. 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.

### 651.3.11.5 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 right-of-way.

## 651.4 Measurement

1 The quantity for 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.

## 651.5 Payment

1 Payment for the accepted quantity for Flat Sheet Sign (of the type required) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

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 required supports 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 to provide the 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 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 |
| 6510107 | Flat Sheet, Type XI, Fixed Size & Message Sign – Overhead | SF |

(table continued on the next page)

(table continued from the previous page)

| Item No. | Pay Item | Unit |
|---|---|---|
| 6510108 | Flat Sheet, Type XI, Size Determined by Message – Overhead | SF |
| 6510109 | Flat Sheet, Type XI, Fluor Fixed Size & Message Sign | SF |

# Section 652 — Multiple Panel Signs

## 652.1 Description

1 Furnish, fabricate, and install multiple panel signs.

## 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 that complies with ASTM B221, 6063-T6. Configure the signs as shown on the Plans and *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 in., 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 extruded panel corners according to the sheeting manufacturer's recommendations. Also, apply the reflective sheeting to the face according to the sheeting manufacturer's recommendations.

4 Furnish extruded panels in widths of 6 in. and 12 in. 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-in. thick flat sheet aluminum that complies with ASTM B209, 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. Ensure that the sign fabricator installs 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 the extrusion 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 B26, Alloy SG70A-76 or ASTM B108, Alloy 356-T6. Install post clips as indicated on the Plans and *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 either direct applied reflective sheeting or digitally printed as shown in the Plan sign face layout sheets. Shields and arrows may be direct applied or constructed of 0.80-in. flat sheet aluminum with direct applied copy riveted to the background panel.

## 652.3 Construction

### 652.3.1 Fabrication

#### 652.3.1.1 General

1 Fabricate all signs in a uniform, professional manner and with dimensions specified in the MUTCD and on the Plans, *Special Highway Sign Drawings*, and FHWA *Standard Highway Signs Book*. Fabricate route markers and shields used on guide signs with copy sizes and details shown on Standard Drawing 654-110-00.

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, digitally printed or demountable copy, match the prescribed standard colors in the MUTCD and ASTM D4956. Signs with noticeable deviations will be rejected.

#### 652.3.1.2 Extruded Panel Signs

1 Mount all extruded sections horizontally with not more than one 6-in. wide panel per sign. When a 6-in. width is required, place it at the top of the sign. Do not use vertical joints. Use the approved assembly details shown in the *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.

#### 652.3.1.3 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-in. centers across the sign, or use splices as recommended by the extruded channel manufacturer.

#### 652.3.1.4 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.

##### 652.3.1.4.1 Degreasing

1 Degrease the sheeting blanks using the manufacturer's current processes and specifications or by one of the following methods:

- Immerse in a saturated vapor of trichloroethylene or perchloroethylene.
- 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.

##### 652.3.1.4.2 Etching

1 Use one of the following methods to etch the panels after degreasing is completed:

- 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.
- 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.

#### 652.3.1.4.3 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 B449 or ASTM B921, Class 2, 10 to 33 mg/ft$^2$, with a median of 25 mg/ft$^2$.

### 652.3.2 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 contaminates after cleaning and etching and before the application of the final finish coat.

### 652.3.3 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 rivets or screw heads from splicing panels with the same type of sheeting installed on the face.

8 Splice the sheeting as follows:

- Use either vertical splices overlapping not less than 3/16 in. or butt splices.
- Use splices made during fabrication only as necessary to join rolls of sheeting material as provided by the manufacturer.
- Do not use any combination of remnant pieces on any sign.
- Extend sheeting applied to extruded sections over the top edge and down side legs a minimum of 1/16 in.
- Do not exceed a maximum of 4 splices in any 50-yard length of material.
- Seal Class 1 adhesive coated reflective sheeting backgrounds according to the recommendations of the sheeting manufacturer at all splices and sign edges with materials supplied and as specified by the sheeting manufacturer.
- Do not use clear paint to coat the remainder of the sign.
- Ensure that after aging 48 hours at 75ºF, adhesion of reflective sheeting to the sign surface is strong enough to resist stripping from the panel when tested with a stiff putty knife.

### 652.3.4 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.

| Sign Area (sq ft) | Maximum No. of Patches per Sign | Maximum 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 |

### 652.3.5 Legends, Borders, and Accessories

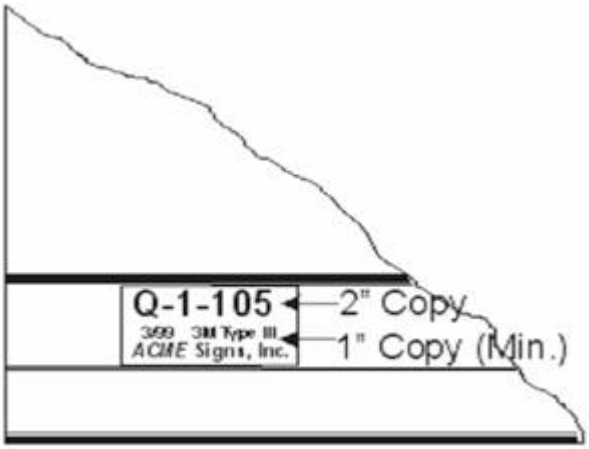
1 Apply legends and borders to extruded panel signs using either direct applied copy or digital printing processes unless otherwise noted. Apply reflective sheeting of the type indicated on the Plans directly to the background sheeting

of the sign according to the manufacturer's recommendations and as shown in the Plan sign face layout sheets. 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**.

### 652.3.6 Identification

1 Attach a permanent decal, produced by the sign fabricator, showing identification numbers in 2-in. high copy on the back of all multiple panel signs. Ensure that the numbers correspond with the sign numbers on the Plans (e.g., Q-1-105). Include in the decal in 1-in. (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 in. from the bottom of the sign and approximately 1 ft from the roadway side of ground-mounted signs or the left-hand side as viewed from the rear of overhead signs.

### 652.3.7 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 that 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.

### 652.3.8 Location

#### 652.3.8.1 General

1 Locate signs approximately as indicated on the Plans. The exact location for each sign is determined by the Contractor and the RCE; however, ensure that major changes in sign location are approved by the Director of Traffic Engineering before erection.

#### 652.3.8.2 Sign Positions

1 Mount signs at the proper elevation, offset, level, and orientation shown on the Plans and *Standard Drawings*. Coordinate this work with the RCE.

#### 652.3.8.3 Orientation of Signs

##### 652.3.8.3.1 Ground Signs

1 Position signs as indicated on the Plans or in the *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 that the sign serves. Locate this observation point at a distance in advance of the sign approximately equal to 60 ft per in. 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 ft measured from the pavement surface at the pavement edge to the bottom of the sign.

##### 652.3.8.3.2 Overhead Signs

1 Position signs as indicated in the *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, the 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 that the sign serves. The observation point is determined as specified for ground signs in **Subsection 652.3.8.3.1**.

### 652.3.9 Erection

#### 652.3.9.1 General

1 Support and erect all signs as previously specified herein and as shown on the Plans and approved Shop Plans. Comply with **Subsection 105.2** and **Section 725**. Ensure that horizontal edges of signs are level and that faces for ground signs are vertical.

2 Do not weld, cut, or fabricate in the field, except for attaching demountable legends and borders that were removed in the shop to facilitate shipping.

#### 652.3.9.2 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 appreciable 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 Standard Drawing 652-105-00.

#### 652.3.9.3 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.

#### 652.3.9.4 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. Inset 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-lb U-section posts, 6-ft 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.

#### 652.3.9.5 Supplemental Panels

1 If shown on the Plans, mount supplemental panels underneath guide signs. Attach the panels to the larger sign using two 3-lb U-section posts, 8-ft 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.

### 652.3.9.6 Glare Screens

1 On overhead sign structures that have 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-in. 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.

### 652.3.10 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.

## 652.4 Measurement

1 The quantity for 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 signs is 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 incidental work for the overhead sign structure to which they are attached.

## 652.5 Payment

1 Payment for the accepted quantity for Extruded Panel Signs – Ground Mounted or Extruded Panel Signs – Mounted Overhead at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Installation of exit panels or supplemental panels including supports, either on top or beneath multiple panel signs, is included in the Contract price for the multiple panel sign to which they are attached.

3 Glare screens attached to overhead sign structures are included in the Contract price for 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 Contract price for the various sign pay items.

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 Furnish, fabricate, and install U-section posts.

## 653.2 Materials

1 Use the specified number of steel U-section posts weighing either 2 lb/ft (2P) or 3 lb/ft (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 (e.g., 2-3P-12′). The sizes indicate the weight of the posts per linear foot (tolerance of ±5%) before galvanizing.

2 Use posts that are made of either re-rolled rail steel or billeted steel conforming to the mechanical and implied chemical requirements of ASTM A499, Grade 60.

3 Use 2P U-section posts, 10 ft long, for bridge end markers and 2P U-section posts, 7.5 ft long, for delineators. For all other posts, use the weight and length indicated on the Plans and the *Standard Drawings*.

4 Use retroreflective sign post panels constructed of a nonmetallic composite or 3mm aluminum composite material covered with a 3-in. wide Type III sheeting. Use sheeting that complies with **Subsection 651.2.3**. Use approved panels included on the *Approved Products List For Traffic Control Devices in Work Zones*.

## 653.3 Construction

### 653.3.1 Fabrication

1 Ensure that U-section posts have a minimum of fifty-eight, ⅜-in. diameter holes punched on 1-in. centers beginning 1 in. 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 in. on centers.

2 After fabrication, hot-dip galvanize the full length and total area of each post according to ASTM A123.

### 653.3.2 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 posts 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. 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 Drive posts at the 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-in. layers of backfill material.

7 Use material removed from the hole for backfilling, except in sandy soil, use backfill comprised of 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, as determined by the RCE, is sufficient to obtain the stability necessary to support the sign(s). Excavate holes to a minimum depth of 18 in. Backfill holes less than 24 in. 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.

11 Remove and replace any post that is bent or otherwise damaged with no adjustment in compensation.

12 When reflective sign post plans are specified, mount the panel for the full length of the post from the sign to within 6 in. above the edge of the roadway. Mount the panel only on posts specified in the Plans or Special Provisions. Secure the panel to the post with a minimum of three 5/16-in. bolts and a lock washer and flat washer between the post and nut or tamper-resistant and rust-resistant screws. Use bolts, washers, and nuts that comply with **Subsection 651.2.2**. Provide the sheeting in the color that matches the background color of the sign, except that the color for the “Yield” and “Do No Enter” signs shall be red. Install panels to both posts if there are two posts supporting the sign.

### 653.3.3 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 5/16-in. 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 galvanized or stainless steel bolts, nuts, and washers.

### 653.3.4 Removing Existing U-Section Posts

1 Remove the entire post and footing or cut off the post at least 1 ft 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 ft with earth material approved by the RCE. Use topsoil in the top 1 ft of backfill.

4 Seed the area according to the requirements of **Section 810**.

## 653.4 Measurement

1 The quantity for U-Section Post for Sign Support – (2P or 3P), U-Section Post for Sign Bracing – 2P is the length of U-section post used for the sign support or bracing and is measured to the nearest 1/100 of a linear foot (LF) of the required post, complete and accepted.

2 The quantity for Retroreflective Sign Post Panel is the length of the panel from the bottom of the sign assembly to the ground (typically the sign mounting height) and is measured to the nearest 1/100 of a linear foot (LF) of the required panel, complete and accepted.

## 653.5 Payment

1 Payment for the accepted quantity for U-Section Post for Sign Support – (2P or 3P), U-Section Post for Sign Bracing – 2P, or Retroreflective Sign Post Panel at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 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 |
| 6531500 | Reflective Sign Post Panels | LF |

# Section 654 — Breakaway Sign Supports

## 654.1 Description

1 Furnish, fabricate, and install breakaway sign supports. Remove existing I-beam breakaway supports, and refurbish and reinstall the existing supports.

## 654.2 Materials

### 654.2.1 General

1 When I-beam is used in these specifications and the Plans relative to breakaway sign supports, I-beam denotes a “W” or “S" section beam as defined in the AISC *Handbook*. Use materials and practices in fabrication according to **Section 709**. Comply with the requirements for the fabrication and use of the I-beam breakaway post found in the *Standard Drawings*.

### 654.2.2 Structural Design

1 Other than those with sizes detailed on the Plans, design breakaway sign supports required by the Plans conforming to the latest AASHTO *Specifications for the Structural Supports for Highway Signs, Luminaires and Traffic Signals*. Use a wind speed of 90 mph for design unless otherwise noted on the Plans or in the Specifications.

### 654.2.3 Perforated Fuse Plates

1 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 *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 an electronic copy of Shop Plans and 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 ASTM A709, Grade 36 or Grade 50 as specified in **Section 709**.

2 Use high strength bolts, nuts, and washers conforming to ASTM F3125, Grade A325 in **Section 709**. Comply with sizes and dimensions of the bolts shown on the Plans and the *Standard Drawings*.

3 Use galvanized malleable iron for beveled washers on S3 × 5.7 or S4 × 7.7 beams.

### 654.2.6 Concrete

1 Use Class 3000 concrete for I-beam breakaway support footings and foundation pads that conform to the applicable requirements of **Section 701**.

### 654.2.7 Temporary Wooden Breakaway Supports

1 Use pressure treated 4-in. × 4-in. or 4-in. × 6-in. Southern Yellow Pine as indicated on the Plans and the *Standard Drawings* that conform to **Sections 706** and **707**.

2 Attach signs to wood supports as detailed on the Plans and *Standard Drawings* using either aluminum angles or U-section posts. Use aluminum angles that conform to ASTM B221, Alloy 6061-T6. Use 3P U-section posts as specified in **Section 653**. Use mechanically galvanized lag bolts, bolts, nuts, and washers as specified in **Section 709**.

## 654.3 Construction

### 654.3.1 General

1 Fabricate I-beam breakaway posts according to the Plans, the *Standard Drawings*, and the approved Shop Plans. Fabricate in a uniform, workmanlike manner.

2 Ensure that I-beam breakaway posts are fabricated in a plant owned and operated by a fabricator experienced in manufacturing quality supports that conform 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.

### 654.3.2 Fabrication

#### 654.3.2.1 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 the fabrication of breakaway posts begins.

2 Replace posts 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 unless authorized.

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 and the holes in the fuse plates. Ensure that the diameter for such holes conform to the *Standard Drawings*. For I-beams supporting flat sheet signs, such as freeway sized speed limit signs, drill holes for sign mounting. For the 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 Ensure that welding required on I-beam breakaway posts conforms to the AASHTO/AWS D1.5, *Bridge Welding Code*.

#### 654.3.2.2 Galvanizing

##### 654.3.2.2.1 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 ASTM A123. Use the galvanized treatment on interior and exterior surfaces of hollow sections. Perform galvanizing after fabrication, including hole punching, welding, or drilling.

##### 654.3.2.2.2 Nuts, Bolts, and Washers

1 Galvanize bolts, nuts, and washers that conforms to ASTM B695, 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.

### 654.3.3 Erection

#### 654.3.3.1 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 *Standard Drawings*.

2 Embed posts directly into soil a depth as shown on the Plans and *Standard Drawings*. Backfill and tamp in 6-in. 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-in. diameter footing to a depth not less than 30 in., and backfill with Class 3000 concrete.

3 Where specified on the Plans, remove wood posts completely including concrete footings. Backfill and compact the resulting holes with earth backfill material approved by the RCE. Use topsoil in the top 1 ft of backfill. Seed the area according to **Section 810**. Remove and dispose of the excavated footing material not used for backfill.

#### 654.3.3.2 Excavation

1 Excavate for post installation to the levels and dimensions shown on the approved Shop Plans, the *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, as determined by 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.

#### 654.3.3.3 Placing Concrete

1 Provide all I-beam post installations with concrete foundations. Use Class 3000 concrete and foundation dimensions shown on the Plans and *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 finished grade matches the surrounding soil elevation. Use 6-in. × 6-in. W2 welded wire fabric as reinforcement that conforms to **Section 703**. Do not pour the concrete pad without forms nor separately from the beam encasement. 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 the neat line as possible and that 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 the foundation area as necessary. If not otherwise included in the Contract, seed the area of disturbed soil according to **Section 810**. Remove and dispose of the excavated footing material not used for backfill.

### 654.3.3.4 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 tops 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 according to the *Standard Drawings*. Unless otherwise specified, install the stub projection at 3 in. 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.

### 654.3.3.5 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 |
|---|---|---|
| ½ in. | 90 ft-lb | 12,000 lb |
| ⅝ in. | 180 ft-lb | 19,000 lb |
| ¾ in. | 320 ft-lb | 28,000 lb |

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 |
|---|---|---|
| ½ in. | 920 – 1380 lb | 95 – 142 in-lb |
| ⅝ in. | 1740 – 2660 lb | 226 – 345 in-lb |
| ¾ in. | 2400 – 3600 lb | 369 – 554 in-lb |

### 654.3.4 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 ft 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 ft below the ground line.

3 Backfill the resulting hole using earth material and compact as directed by the RCE. Fill the top 1 ft of hole with topsoil and level the area as necessary. Remove and dispose of any excavated material not used for backfill. If not otherwise included in the Contract, seed the disturbed area according to **Section 810**.

### 654.3.5 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 according to the requirements 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.

## 654.4 Measurement

1 The quantity for 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 the work is included in the Unit Price for the breakaway sign support item.

2 The quantity for 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 for 4-ft × 4-ft Treated Wood Post or 4-ft × 6-ft Treated Wood Post is the length of treated wood post for the 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, or 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 the work is included in the Contract unit bid price for the treated wood post item post.

4 The quantity for 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 the disturbed area or for the removal of an existing sign, which is incidental work for the post removal and is included in the Contract unit bid price for the post removal item.

## 654.5 Payment

1 Payment for the accepted quantity for Breakaway Sign Supports, Refurbish Breakaway Sign Supports, Treated Wood Post, or Removal of I-Beam or Wood Post at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, and incidentals necessary to complete the work as specified.

2 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″ × 4″ Treated Wood Post | LF |
| 6541310 | 4″ × 6″ Treated Wood Post | LF |
| 6541405 | Removal of I-Beam Post | EA |
| 6541415 | Removal of Wood Post | EA |

# Section 655 — Square Tube Posts

## 655.1 Description

1 Furnish, fabricate, and install square tube posts.

## 655.2 Materials

1 Fabricate posts from cold-rolled steel strip, and apply a commercial quality zinc coating that conforms to ASTM A653 G90 or G140. Use Grade 50 steel. 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 12 gauge (0.105 in.) steel. Ensure that the tubing is high frequency resistance welded in the corner and externally scarfed to agree with a specified corner radii of 5/32 in. ±1/64 in. to ensure proper telescoping action.

2 Use a ⅜-in. galvanized corner bolt of the appropriate length, lock washer, and nut to connect the sign post and the stub assembly.

3 Provide the Mill Test Reports and a Materials Certification for each shipment of square tubing to the RCE. Ensure 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 Construction

### 655.3.1 Fabrication

1 Ensure that the post is straight with a smooth finish to allow a smaller tube to fit freely into the larger tube with minimum play. Punch standard clean-punched open holes 7/16 in. (+1/64 in.) in diameter on 1-in. centers on all four sides beginning 1 in. from the top in each section with the hole spacing being accurate to ⅛ in. in 20 ft of tube length. Ensure that holes are free from plugs and burrs. Holes do not require zinc treatment after fabrication.

### 655.3.2 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 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 an augered or excavated hole, hold the post anchor in the proper position, backfill, and thoroughly tamp the fill in 6-in. layers. Use material removed from the hole for backfilling, except backfill in sandy soil 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, as determined by 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 in. Backfill holes less than 24 in. 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 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.

8 Use a two-part assembly consisting of a main support to which the sign or sign assembly is attached, and use a driven square tube anchor that is one size larger than the main support. The length of the main support will depend on the height of the sign or sign assembly.

9 Use 1¾-in. × 1¾-in. 12-gauge square tube posts for the main supports with a 2-in. × 2-in. anchor for warning and regulatory signs with single or double posts and route marker assemblies.

10 Use 2-in. × 2-in. 12-gauge square tube posts for the main supports with a 2¼-in. × 2¼-in. anchor for sign assemblies consisting of rectangular destination or guide signs supplemented with route markers or other flat sheet signs.

11 Ensure that the anchor is 3 ft in length and is direct driven by mechanical means to a depth of 34 in., thus allowing for a 2-in. portion of the base to remain above ground level for a bolted connection. Ensure that the main support is sleeved into the anchor providing a minimum overlap of 8 in. Attach the main support to the anchor using the appropriate size corner bolt, washer, and nut. The length of the main support will depend on the height of the sign or sign assembly.

12 Standard Drawing 651-110-00 illustrates typical combinations of guide signs and route markers and details on how to calculate H (the height of sign or sign assembly) for various assemblies. The lengths of posts shown on the Drawing are for single-piece, 3-lb U-section posts and may not include provisions for the overlap necessary for the two-piece square tube systems.

## 655.4 Measurement

1 The quantity for Square Tube Post for Sign Supports (for each gauge and size) is the total length, in linear feet, for each square tube post assembly, including the anchor. Obtain the length of the post assembly for each sign installation from the formula given below. For signs having more than one post, multiply the length by the number of posts required for each sign assembly.

2 Calculate the length of posts required for various sizes of standard warning or regulatory sign installations and for sign assemblies consisting of rectangular destination or guide signs supplemented with route markers or other flat sheet signs using the following method:

L = H + MH + A + 1.67 ft, in feet

Where:

H = Height of sign or sign assembly, in feet

MH = Mounting Height (5 ft or 7 ft typical) – 4 ft (minimum for multiple sign assemblies where 3 or more signs are grouped in a vertical orientation), in feet

A = Anchor Length (3 ft)

1.67 ft = Factor for 0.67 ft overlap and shoulder height variations

Round L to the nearest whole foot.

## 655.5 Payment

1 Payment for the accepted quantity for Square Tube Post for Sign Supports (of the gauge, size, and length of post) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals to complete the work as specified.

2 Payment for the accepted quantity for Square Tube Posts for Sign Supports will be based on the main support size for the entire length of the assembly. The Contractor is advised that no additional compensation will be made for the larger size (¼ in.) of the anchor. Include any additional costs associated with the size difference in the bid price for the appropriate size main support.

3 The payment for this 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.

4 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6551110 | Square Tube Post for Sign Supports<br>12 Gauge 1¾″ × 1¾″ × variable | LF |
| 6551115 | Square Tube Post for Sign Supports<br>12 Gauge 2″ × 2″ × variable | LF |

# Section 656 — Delineators

## 656.1 Description

1 Furnish, fabricate, and install delineators.

## 656.2 Materials

### 656.2.1 General

1 Use the following types of delineators as shown on the Plans and *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-in. 5052-0 aluminum or other alloy approved by the Director of Traffic Engineering for housing formed to approximately a 3.25-in. diameter and to a depth that retains the acrylic reflector.

3 Expand a 3/16-in. inside diameter aluminum grommet in the reflector mounting hole.

4 Provide an acrylic plastic reflector consisting of a transparent plastic face with 7 sq in. 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 affects the 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-in. flat sheet aluminum measuring 3½ in. × 3½ in. with white or yellow Type IX reflective sheeting to construct flat sheet aluminum delineators with a 5/16-in. attachment hole in the center of the aluminum.

### 656.2.4 Flexible Post Delineators

#### 656.2.4.1 Prequalification and Certification

1 Use post delineators made by manufacturers listed on *Qualified Products 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 complies with 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 that the post is wide enough to accommodate a minimum of 3-in. wide reflective sheeting on one or both sides without overhanging the edges. Use Type IX or Type XI reflective sheeting in either yellow or white with a minimum reflective surface of 27 sq in.

3 Provide posts lengths as shown on the Plans and *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.

- 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 in. × 4 in. and constructed of Type IX retroreflective sheeting. Bond the delineator to the barrier with an adhesive 3 in. from the top at a 200-ft spacing.

### 656.2.6 Reflective Materials

1 Provide white or yellow Type IX reflective sheeting material to reflectorize the delineators that conforms to **Subsection 651.2.3**.

### 656.2.7 Certification

#### 656.2.7.1 General

1 Ensure that the manufacturer of prismatic plastic delineators conducts quality control tests that meet the requirements of these specifications.

2 Provide the RCE with a certified report from the manufacturer showing the results of their quality control tests and a certification stating that the delineators furnished meet all of 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 | Yellow | Red |
| | | 119 | 71 | 29 |
| 20 | 1/10 | Crystal | Yellow | Red |
| | | 47 | 28 | 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 the test constitutes failure of the lot.

### 656.2.7.4 Optical Testing Procedure

1 Test the reflective surface of the delineators by locating it a distance of 100 ft from a single effective 2-in. diameter light source operated at approximately normal efficiency. Measure the return light from the reflector by use of a photoelectric photometer having a minimum sensitivity of 1 × 107 foot-candles per mm scale division. Use a photometer with a receiver aperture of 0.5-in. diameter shielded to eliminate stray light. Ensure that the distance from the light source center to aperture center is 2.1 in. for 0.1-degree observance angle. Spin the reflectors during testing to average the orientation effect.

2 If a test distance other than 100 ft 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 bath water at room temperature. Subject the submerged samples to a vacuum of a 5-in. 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 Test 3 reflectors for 4 hours in a circulating air oven at 175°F (±5°F). Place specimens in a horizontal position on a grid or perforated shelf permitting free air circulation. Remove the reflectors from the oven, and permit them 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 Construction

### 656.3.1 Mounting Hardware

1 Attach delineators to U-section posts using a 3/16-in. × 3-in. commercial lock bolt fastener and flanged (vandal proof) collar (3/16-in. I.D. × ¾-in. O.D.) as shown in the *Standard Drawings,* or use another vandal-proof hardware approved by the RCE. Use aluminum alloy 6061 (artificially aged) for pin and collar. A 3/16-in. × 3-in. stainless steel pan head machine screw may be used in lieu of the flanged lock fastener.

### 656.3.2 Location

#### 656.3.2.1 General

1 Install delineators at the locations shown on the Plans and *Standard Drawings* and as specified in the MUTCD.

#### 656.3.2.2 Delineator Positions

1 Install delineator positions in a temporary manner until approved by the RCE.

#### 656.3.2.3 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.

#### 656.3.2.4 Clearances

1 Locate delineators so that the top reflective unit is approximately 4 ft above the grade of the pavement edge and 2 ft back of the shoulder edge or the face of an unmountable 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 *Standard Drawings*.

### 656.3.3 Erection

#### 656.3.3.1 General

1 Support and erect all delineators as specified on the Plans and *Standard Drawings*.

#### 656.3.3.2 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 manufacturer's 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 to 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 in. from the top with a 200-ft spacing. Use the details shown on the *Standard Drawings* for the methods of attachment for bridge mounted delineators. Mount all other delineators on driven 2P U-section posts.

### 656.4 Measurement

1 The quantity for Delineator (of the type required) is measured by each (EA) type of delineator installed, complete and accepted.

### 656.5 Payment

1 Payment for the accepted quantity for Delineator (of the type required) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, and incidentals necessary to complete the work as specified.

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 Post with Type IX Reflective Sheeting | EA |
| 6562110 | Delineator, Double, Mono-Directional, Including Supports | EA |

(table continued on the next page)

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| Item No. | Pay Item | Unit |
|---|---|---|
| 6562115 | Delineator, Single, Bi-Directional, Including Supports | 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″ × 4″ Bridge, Wall or Barrier Mounted | EA |

# Section 657 — Overhead Sign Structures

## 657.1 Description

1 Furnish, fabricate, and install new overhead sign structures. Refurbish, modify, or remove exiting overhead sign structures. Furnish, fabricate, and install sign lighting systems.

### 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 ft 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 where the bridge skew is great. A single sign assembly can be made up of two or more individual structures mounted together where there is an extreme skew or length.
- Span-wire 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 that conform to these specifications, the Special Provisions, latest AASHTO

*Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, and the AASHTO *LRFD Bridge Design Specifications*.

2 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 lb — one applied vertically downward, and one applied horizontally at a right angle to the walkway side of the railing. Apply each load separately, and locate 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 latest AASHTO *Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and the following requirements:

- Do not allow the vertical dead load deflection at the end of the cantilever structure arm exceed L/150 due to distortions in arm and vertical supports, where L is the length of arm from the center of vertical support to the outer edge of sign.
- Do not allow the horizontal deflection at the 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 $d^2/400$ ft, where d is the sign depth in feet.
- When required, provide camber to offset the deflection in the structure caused by loads on the horizontal section of the structure. Ensure that Shop Plans 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 at least 6 anchor bolts in cantilever structures.
- Do not allow the cantilever arm to exceed a length of 45 ft.

### 657.1.3 Footings

#### 657.1.3.1 General

1 Design the footings for overhead sign structures in conformity with the Plans, the latest AASHTO *Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and the AASHTO *LRFD Bridge Design Specifications*. The footing type may be a shallow spread type foundation, deep cylindrical type foundation, or pile foundation depending on the soil conditions and structure type.

#### 657.1.3.2 Subsurface Data for Design of Footings

1 See the Geotechnical Subsurface Data report for generalized information on the project site, if available. Obtaining subsurface data, according to the SCDOT *Geotechnical Design Manual*, for the design of foundations 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 according to these specifications, the Special Provisions, and the applicable Supplemental Specifications.

### 657.1.4 Required Drawings

1 Submit Shop Plans with fabrication details for overhead structures, complete with illustrations of any electrical fittings such as luminaires, pipe outlets, etc., and design calculations for the structures and structure foundations according to **Section 725**. Submit drawings and calculations to the Director of Traffic Engineering. Drawings are not considered complete without the electrical accommodations. Partial or incomplete submittals will not be accepted.

2 The 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 the 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 Before preparing the required drawings, verify the position, dimension, size, condition, and any other information pertaining to the design of an overhead sign structure. Check the existing roadway bridges on which overhead signs will be mounted, and determine the necessary dimensions, elevations, or other data needed to prepare the drawings. Include the cost of the investigation in the unit price bid of the overhead sign structure.

## 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 (e.g., pipe, steel angle) throughout the project to provide structures of similar appearance. 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 Provide overhead sign structures with provisions to accommodate sign lighting. If sign lighting is not included as part of the project, plug all wiring outlets not used with galvanized steel plugs.

### 657.2.2 Steel Overhead Structures

1 Provide structural steel that complies with the latest AASHTO *Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals,* the AASHTO *LRFD Bridge Design Specifications,* and the following:

- Steel pipe for overhead sign structures that complies with ASTM A500, Grade B (modified to 52 ksi yield) or API-5L-X52 (52 ksi yield).
- Steel for flanges and plates that complies with ASTM A572, Grade 50.
- Steel angles that comply with ASTM A36.
- Nuts, bolts, washers, and direct tension indicators that comply with **Section 709**. Use ASTM F3125, Grade A325 bolts for structural steel fasteners. Galvanize all hardware.
- Hardware, other than ASTM F3125, Grade A325 bolts, that complies with ASTM A307.
- Welds meeting the requirements of 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 that complies with ASTM A123, including clamps and brackets for mounting the signs. Galvanize all interior and exterior surfaces of hollow sections. Galvanize after fabrication when 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 the bottoms of columns for overhead structures on a solid base plate or provide 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 the latest AASHTO *Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and ASTM F1554,

Grade 55. Provide the anchor bolts with seismic hooks or a seismic plate. Do not use lock washers.

2 Galvanize anchor bolts, nuts, and washers according to ASTM A153. Galvanize anchor bolts the entire length of the bolt.

### 657.2.5 Concrete Foundations

1 Use Class 3000 concrete or greater for foundations and foundation pads that conform to **Section 701**.

## 657.3 Construction

### 657.3.1 Fabrication

#### 657.3.1.1 Overhead Sign Supports

1 Overhead sign structures may be welded, bolted, riveted, or fastened by other means if 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 AISC-certified in both the Simple Bridge and Bridge Component categories. The Department may require inspection by an independent inspector or the OMR inspector during fabrication and both before and after galvanizing. Notify the SME at least 14 days before the beginning of fabrication for each individual project so that in-plant inspection can be coordinated.

3 Ensure that all welding is performed 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 careful 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 Use Direct Tension Indicators conforming to **Section 709** for all bolted connections of chord and structure members. Conduct inspections of tightening of bolts either 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 an electrical control box. Install electrical outlets on the lower front chord member to provide connections to luminaires and to vertical supports. Install outlets for the control box according to Standard Drawing 657-108-00.

6 Provide adjustable brackets for mounting signs to the structures. Hinge the brackets at the bottom to permit the mounting of sign faces at an angle between a truly vertical position and 3 degrees from vertical. Obtain the 3-degree angle by rotating the front upper edge of the sign in front of the bottom edge. Use bracket lengths equal to the heights of the signs being supported. Provide two 13/32-in. × 2-in. slotted holes, centered $1^{1}/_{16}$ in. from the top and bottom of each hanger for two direct connections using ⅜-in. 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.

### 657.3.1.2 Maintenance Walkways

1 Provide maintenance walkways on all overhead structures. 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-ft 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 the walkway adequately at the end.

3 Construct a walkway to provide a 1-ft vertical clearance between the top of the horizontal walkway support members and the bottom of the lowest sign served as shown in the Plans. In addition, locate the bottom sign hanger hinge plate to accommodate the installation of glare screens (1-ft minimum typical at 6-in. increments) between the bottom of the hinge plate and the gusset plates (if applicable) of the bottom walkway support member. Provide the following distances from the sign face to the walkway elements:

- Safety angle ..... 6 in.
- Walkway, near edge ..... 10 in.
- Walkway, far edge ..... 3 ft - 4 in.
- Safety railing, raised ..... 4 ft
- Center of luminaire ..... 4 ft - 9 in.

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 the railing to withstand a loading specified in **Subsection 657.1.2**.

6 Fabricate the safety railing in 10-ft lengths, and locate the two parallel rails at 1 ft - 6 in. and 3 ft 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 in.

7 Ensure that the open ends of the walkway have a 3/16-in. galvanized steel coil safety chain of approximately 12 links per foot attached with ¼-in. 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.

### 657.3.2 Location

#### 657.3.2.1 General

1 Locate and erect overhead sign supports in conformance with the Plans. Obtain approval from the Director of Traffic Engineering for any major change in location before erection.

#### 657.3.2.2 Orientation

1 Orient the faces of overhead signs 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, ensure that the 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.

#### 657.3.2.3 Vertical Clearances

1 Provide a clearance from the lowest member of the overhead structure of not less than 17.5 ft to the highest point of the roadway over the entire width of the pavement and shoulders.

### 657.3.3 Erection

#### 657.3.3.1 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 according to **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 the 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 for the top 4 in. of all concrete work. Provide necessary braces to keep

anchor bolts and encased posts in the proper position and alignment and in conformance to the approved foundation design. Ensure that excavation work conforms to **Section 204**. Pour concrete flush with the ground surface. For a sloping surface, level the top of the footing with the high side of the slope.

3 When forms are used, ensure that they conform to the appropriate portions of the specifications and that chamfer strips are used in all corners. Backfill around the foundations in 6-in. layers and thoroughly tamp each layer.

4 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**.

5 If piles or cofferdams are required for construction of the footings, ensure that all work conforms to **Section 711** and **Section 204**, the Plans, and/or the Special Provisions.

6 Install electrical conduit in the footing of the structure on the side that is closest to the point where electrical service is obtained unless otherwise noted in the Design Plans or Shop Plans. Use 2-in. galvanized steel conduit stubbed up 6 in. above the top of the footing pedestal. Ensure that the conduit enters the footing at a point 2 ft below ground level and is stubbed out 2 ft from the edge of the footing and capped off if unused.

#### 657.3.3.2 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 cantilever structure 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 ⅓ turn-of-the-nut method to tension the anchor bolts as specified in the latest AASHTO *Specifications for the Structural Supports for Highway Signs, Luminaires and Traffic Signals*. The RCE will verify the tightening of all anchor bolts.

#### 657.3.3.3 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 *Standard Drawings* and the following SCDOT Traffic Signals Material Specifications:

- M 688.5 “Furnish Steel Strain Pole and Foundation”
- M 688.6 “Furnish Concrete Strain Pole”
- M 682.3 “Steel Cable”

2 Copies of the Traffic Signals Material Specifications are available from the Director of Traffic Engineering.

3 Provide footings for strain poles of either precast 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.

### 657.3.4 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 **Subsection 657.3.3.2**.
- Remove existing grout pads under the structure base plates.

Perform the aforementioned items as a minimum and any additional items, if required, on the Plans or in the Special Provisions.

### 657.3.5 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 the required structural modification design and drawings according to the requirements for new overhead sign structures. Submit the structural modification design and drawings for review and acceptance by the Director of Traffic Engineering before beginning work.

### 657.3.6 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 ft below the ground line. The removed structure becomes the property of the Contractor. Remove the footing or pedestal and any debris from the removal operation from the site.

### 657.3.7 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. Submit an electronic copy of catalog cuts, photometric layouts, and a schematic for the system to the Director of Traffic Engineering for review and approval before beginning work.

## 657.4 Measurement

1 The quantity for Erect 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 according to **Sections 204** and **711**, respectively.

2 The quantity for Refurbish Overhead Sign Structure No. (XX) is measured by each (EA) existing overhead sign structure refurbished, complete and accepted.

3 The quantity for Modification of Overhead Sign Structure No. (XX) is measured by each (EA) existing overhead structure modified, complete and accepted.

4 The quantity for 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 included in the Contract unit bid price for the removal of each overhead sign structure.

5 The quantity for Sign Lighting System No. (XX) is measured by each (EA) sign lighting system installed, complete and accepted.

6 The quantity for Overhead Span-Wire Sign Structure No. (XX) is measured by each (EA) span wire structure installed, complete, and accepted.

## 657.5 Payment

1 Payment for the accepted quantity for Erect Overhead Sign Structure, Modification of Overhead Sign Structure, Refurbish Overhead Sign Structure, Removal of Overhead Sign Structure, Overhand Span-Wire Structure, or Sign Lighting System is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 If required by the Contract, the cofferdams and piles are paid for according to **Sections 204** and **711**.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6573100 | Erect 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 |
| 6573185 | Overhead Span-Wire Structure No. (XX) | EA |
| 6573200 | Sign Lighting System (XX) | EA |

# Section 658 — Roadway Lighting

## 658.1 Description

### 658.1.1 Scope of Work

1 Design, furnish, and install roadway lighting systems according to all national and state codes and standards to include:

- Complete plans, design basis documentation, and cut sheets for all aspects of the lighting system including photometric study, electrical schematics, foundations, poles, system controllers, controller cabinets, and luminaries.
- Electrical services, complete to the point of connection with the utility company's facilities.
- Service entrance equipment, including system luminaire control panels.
- Complete grounding system for lighting and equipment sufficient for lightning protection, including grounding conductors, ground rods, and grounding connections.
- Complete branch circuit wiring system for lighting and equipment, including conduit, trenching and backfill, jacking and boring, concrete encasement, pull boxes, and wiring.
- Luminaries, poles, and foundations for roadway lighting.

### 658.1.2 Definitions

#### 658.1.2.1 Partial Interchange Lighting

1 Lighting of the exit ramps, beginning at the start of the deceleration lane along a freeway or interstate and extending to the ramp terminal at the crossroad; and the entrance ramps, beginning at the ramp terminals of the crossroad and extending to the end of the acceleration lane along the freeway or interstate.

#### 658.1.2.2 Complete Interchange Lighting

1 Places lights on entrance and exit ramps in the same locations as partial interchange lighting. In addition, lighting is placed along the mainline between the entrance and exit ramps and on the crossroad between the ramp terminals. Additional lighting is placed on the crossroad a minimum of 750 ft measured from the ramp terminal or a minimum of 1000 ft measured from the centerline of the Intestate or freeway, whichever is greater.

#### 658.1.2.3 Continuous Freeway Lighting

1 Includes complete interchange lighting and lighting between interchanges along the mainline. Continuous lighting can include a number of interchanges and is usually provided in urban areas.

#### 658.1.2.4 Luminaire

1 A complete lighting unit consisting of a driver, housing, and lamp or lamps, together with the parts designed to distribute the light (refractors, mirrors, lens, etc.) to position and protect the lamps, and connect the lamps to the power supply, also referred to as the “fixture.”

#### 658.1.2.5 Illuminance Based Design

1 A design approach that calculates the amount of light on the roadway surface. The illuminance method of roadway lighting design determines the amount of light incident on the roadway surface from the roadway lighting system. Illuminance is the density of luminous flux (light) incident on a surface.

#### 658.1.2.6 Standard Roadway Lighting Pole

1 A pole less than 50 ft in height with breakaway foundations with one to two fixtures attached.

#### 658.1.2.7 High Mast Light Pole (HMLP)

1 A pole greater than 75 ft in height with multiple luminaires attached at the top and an integrated lowering system.

### 658.2 Materials

### 658.2.1 General

1 Ensure that all electrical materials conform to the applicable standards — NFPA 70, NEC, ANSI, NEMA, and UL, where a standard has been established. Ensure that the mark of the listing organization appears on the electrical material and equipment.

2 Ensure that the units for any one item (e.g., poles, luminaires, lamps, control devices, enclosures, circuit breakers) are made by the same manufacturer.

3 Before materials are ordered, submit the finished plans, including the photometric study, to the Director of Traffic Engineering’s office for review and acceptance. Submit the documents electronically in Adobe Acrobat (pdf) format.

4 Before any materials or equipment are ordered or delivered to the site, submit the South Carolina Professional Engineer (PE) stamped Shop Plans and

equipment specifications to the Director of Traffic Engineering for acceptance on the following materials:

- Control panels, including all devices and equipment;
- Luminaires, poles, and lowering systems;
- Wire, cable, and electrical disconnects (fuses, etc.);
- Raceways and fittings;
- Pull boxes and junction boxes; and
- Foundations, including breakaway hardware where required.

### 658.2.2 Substitutions

1 Interpret a specific reference in this Section to any article, device, product, material, fixture, form, type of construction, etc., by name, make, or catalog number, with or without the words "or equal," as establishing a standard of quality. Do not construe any reference as limiting competition. The Contractor may, at its option, propose any substitution that is considered equal to the named item.

2 Submit written requests to use substitute materials or equipment for acceptance to the Director of Traffic Engineering. Submit samples, descriptive literature, and engineering information (e.g., 3rd party certified photometric data files in IES format for any alternative luminaire submitted for approval) as necessary to identify and appraise the product.

### 658.2.3 Cable

1 Ensure that underground cable for low voltage parallel circuits conforms to the Underwriter's Laboratories UL-83 for copper conductor with Type RHH-RHW-USE, 600 volt, 75 C, cross linked polyethylene insulation.

2 Ensure that all cable is 7 or 19 strand according to ASTM B8. For power cable, use a conductor size not smaller than No. 8 AWG. Use a control cable conductor size not less than No. 14 AWG. These limits do not apply to leads furnished by manufacturers on fixtures and equipment.

3 Use copper power conductor cable.

4 Design cable type, size, number of conductors, strand, and service voltage according to the NEC and voltage drop requirements.

### 658.2.4 Cable Connections

1 Ensure that in-line connections for roadway lighting circuits that are located in the base of each pole are fused molded rubber connector kits (Elastimold Style 82S or approved equal of Bussman or Gould) or fused ILSCO "Streetwise Streetlight connectors." Use one kit for each conductor.

2 Use dual element fuses, current limiting type rated 600 volt, and conforming to UL 168.

### 658.2.5 Plastic Conduit and Fittings

1 Use plastic conduit that is sunlight resistant polyvinyl chloride (PVC), Schedule 80, that complies with NEMA Specification TC-2 and UL Standard UL-514, and/or ASTM D1784. Use fittings that meet NEMA TC-3 and UL-514. Do not use half or quarter size conduit. Use the following conduit sizes — 1 in., 2 in., 3 in., etc.

### 658.2.6 Galvanized Rigid Conduit and Fittings

1 Use hot-dipped galvanized conduit for all exposed conduit runs. Ensure that galvanized rigid conduit conforms to Federal Specification WW-C-581, American Standards Association Specification USAS C80.1-1996 and Underwriter's Laboratories UL-6 with full weight screwed fittings. Ensure that bushings for conduits 1.5 in. and larger are the grounding type with insulated throat.

2 Provide expansion fittings in conduit systems at all structural expansion joints. Use expansion fittings that are the linear sleeve type, constructed from conduit sleeves and reducing fittings. Use a braided copper grounding jumper with each expansion fitting. Ensure that the expansion fittings provide for an 8-in. maximum movement. Use fittings that are O-Z type EXPB, or approved equal, such as Crouse Hinds, Appleton, Killark or Spring City.

### 658.2.7 HDPE Rolled Conduit

1 Underground conductors may be installed in HDPE rolled conduit, plowed or directional bored in. Ensure that the conduit is a minimum of Schedule 80 or SDR 11 HDPE and red in color. Do not use HDPE where the conduit is exposed. If splicing of the HDPE conduit is required, use comfit fittings.

### 658.2.8 Pull Boxes

1 For pull boxes, use Armorcast A6001640TAPCX28, 17 in. × 30 in. × 28 in., or approved equal. Ensure that all pull boxes have the SCDOT ELECTRIC logo cast on the lid. Install a red passive marking ball, operating at a frequency of 169.8KHZ, in each pull box. Ensure that the red passive marker ball is compatible with a Metro Mark passive marker locater 760 Dx or approved equal.

### 658.2.9 Marking Posts

1 Provide marking posts that are the round dome type, ProMark PM303 or approved equal, red in color with the word "ELECTRIC" plus the following messages and phone numbers:

XXXXX County Roads and Bridges – XXX-XXX-XXXX
After Hours – XXX-XXX-XXXX

### 658.2.10 Concrete and Reinforcement

1 Use concrete for light pole foundations and concrete encasement of conduits that conform to Class 4000 concrete specified in **Section 701**.

2 Use reinforcing steel that is deformed steel reinforcement bars conforming to **Section 703**. Provide anchor bolts as shown on the Shop Plans for the foundation that comply with ASTM F1554, Grade 55 (Bolts), and ASTM A563 (Nuts). Provide the ASTM identification and grade with the pole documentation. Ensure that bolts and nuts are galvanized according to ASTM A123.

### 658.2.11 All Roadway Light Emitting Diode (LED) Luminaire Assemblies

1 If requested, ensure that the luminaire manufacturer provides documentation of no less than 5 years of experience in manufacturing LED-based lighting products. Ensure that the manufacturing facility is ISO 9001 certified. In addition, ensure that the manufacturer provides a minimum 5-year warranty covering the luminaire housing, wiring, and connections, LED light source(s), and LED driver. Negligible light output from more than 10% of the LED packages constitutes luminaire failure.

### 658.2.12 Luminaire

#### 658.2.12.1 General

1 Ensure that the luminaire compliance and performance claims are independently certified by an approved US Department of Energy National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory according to Illuminating Engineering Society of North America (IESNA) LM-79 and LM-80. Provide the certification reports with each luminaire. Document the long term lumen maintenance for each luminaire according to the Illuminating Engineering Society of North America (IESNA) TM-21.

2 Ensure that all assembled luminaires are electrically tested before shipment from the factory to ensure that lighting output matches the values required in the Plans.

3 Ensure that luminaires exceed a rating of 6 per ASTM D1654 after 1000 hours of salt spray fog testing per ASTM B117. Ensure that the housing coating exhibits no greater than a 30% reduction of gloss per ASTM D523 after 500 hours of QUV testing at ASTM G154 Cycle 6.

4 At a minimum, ensure that the fixture has been tested to ANSI 136.31 3.0G vibration requirements or greater.

5 Provide UL labelling that includes:

- Labels indicating that the product is suitable for use in wet locations and listed to UL1598;
- External label per ANSI C136.15; and
- Internal label per ANSI C136.22; ensure that the internal label identifies the manufacturer, year, and month of manufacture and the manufacturer's part number.

### 658.2.12.2 Fixture Construction

1 Provide a housing that is coated cast aluminum and includes an attached level indicator. Ensure that all surfaces are smooth and free of burrs. The exposed luminaire hardware must be stainless steel, with all mating surfaces gasketed.

2 In addition, ensure that:

- The LED driver and light source are replaceable independent of luminaire housing.
- Fixtures use borosilicate glass prismatic optics.
- A barrier-type terminal block secured to housing for power connection to luminaire is provided.
- Lugs with screws for wire sizes up to 6 AWG are provided; identify each terminal position.
- Terminal blocks are easily accessible to installers or repair personnel; wire nuts are prohibited inside the luminaire housing.
- Grommets are installed in cable entry holes; cable entry holes are free from sharp edges that might cut conductors or an ungloved hand.
- All conductors inside the luminaire are neatly secured with tie-wraps as needed to prevent pinch points and assist in trouble shooting.
- All internal components are assembled and prewired using modular electrical connections.

### 658.2.12.3 Thermal Management

1 Ensure that the mechanical design of protruding external surfaces (heat sink fins) on roadway luminaries facilitates hose-down cleaning and discourages debris accumulation. Ensure that the luminaire has a minimum heat sink surface such that the LED manufacturer's maximum junction temperature is not exceeded at the maximum rated ambient temperature specified in **Subsection 658.3.5.1**.

2 In addition, ensure that:

- Thermal management is via natural convection only; do not use any active cooling methods such as fans.
- Mounting to heat sinks internally is via screws; do not use thermal grease.
- All LEDs provide the same optical pattern such that a catastrophic failure of individual LEDs will not constitute a loss in the distribution pattern.

### 658.2.12.4 Surge Protection

1 Ensure that the luminaire is protected by an integral surge protection device tested according to ANSI/IEEE Standard C62.4 for standard and optional waveforms defined in ANSI/IEEE C62.41.2, location category C (High) for 10 KV Basic Impulse Level (BIL). Ensure that:

- Both common and differential mode protection are provided.
- The failure mode of the surge protector is to turn the luminaire off.
- The surge protector is field replaceable in the event of failure and is automatically reset after operation with no manual intervention required.

### 658.2.12.5 LED Driver

1 Ensure that the replaceable LED driver operates at 120V, 240V, or 480V line voltages as shown in the Plans. Ensure that the driver operating frequency is high enough to avoid visible flicker in the light output.

2 Ensure that the driver is UL certified for use in dry or damp locations and reduces output power to the LEDs if the maximum allowable case temperature is exceeded.

3 In addition, ensure that the:

- Driver life expectancy is 50,000 hours at 175°F and 100,000 hours at 160°F.
- Power factor (PF) is at least 0.90 at full input power at the specified voltage.
- Driver complies with UL standard UL 1012 or UL 1310.
- Driver will not be adversely affected by the cycling or failure of one or more LED modules during the life of the driver.
- Driver reliably starts and operates the lamp in ambient temperatures from -5°F to 105°F for the rated life of the lamp.

### 658.2.12.6 LED Lamp

1 Ensure that each LED is rated for a minimum operational life of 50,000 hours at 105°F and complies with IESNA L-85 standards at 68°F ambient temperature. Ensure that the photometry complies with IESNA LM-79 when operating at an ambient temperature of 75°F. Ensure that the LED module loses no more than 10% optical intensity when operating at 105°F when compared to its initial delivered lumens at 75°F. Ensure that:

- All LED modules are constructed so that the failure of one LED will not result in the loss of the entire luminaire and that the modules can be replaced without replacing the entire luminaire.
- Each LED die or the LED module is enclosed in a non-removable transparent lens of borosilicate glass.
- The LED module produces a nominal correlated color temperature of 4000K ± 250K with a color rendering index (CRI) of at least 70 and a minimum output of 80 lumens per watt efficacy.

### 658.2.12.7 LED Underdeck Luminaires

1 For underdeck lighting, only use a wall mounted assembly mounted on the bridge pier or pier cap. Mount the luminaires level and perpendicular to the roadway surface being lighted.

2 For the material component requirements for a LED underdeck luminaire, use the same type as those for a standard LED roadway luminaire. Ensure that the same manufacturer provides the luminaire and accompanying driver. Ensure that the requirements for the LED are the same as for the roadway LED.

3 According to current AASHTO guidelines, the minimum lighting levels under bridge decks are the same level as the adjacent roadway. In addition, space and position the lights to achieve the requirements for uniformity.

### 658.2.12.8 LED High Mast Luminaires

1 Ensure that the luminaires for high mast applications are suitable for mounting on poles 100 ft or taller. Arrange 6 luminaires in a circular, symmetrical configuration, and mount the luminaires on a top latching lowering device (ring) supplied by the luminaire manufacturer. Mount the luminaire to the lowering device using a 4-bolt mounting system.

2 Ensure that the luminaries are available in a variety of symmetrical and asymmetrical light distribution patterns. Equip asymmetrical fixtures with a rotatable optical assembly that can throw light towards the roadway for offset installations.

3 For the material component requirements for a LED high mast luminaire, use the same as those for a standard LED roadway luminaire. Ensure that the same manufacturer provides the luminaire and accompanying driver. Ensure that the requirements for the LED are the same as for the roadway LED.

### 658.2.13 Lighting Control Assembly

1 Install control cabinets at the locations as suggested on the Plans with final locations determined by the Contractor and approved by the Engineer of Record.

2 For foundation sizing for controller cabinets, provide a minimum of 24 in. between the edge of the cabinet and the edge of concrete on all sides. Ensure that the foundation extends above ground elevation a minimum of 6 in.

#### 658.2.13.1 Cabinet

1 Mount the components for control of lighting inside a weatherproof NEMA 3R stainless steel pedestal type enclosure, as manufactured by Milbank, Hoffman Engineering, GE, Square-D, Austin Berryhill, or an approved equal. Ensure that the enclosure includes the meter base within the single enclosed pedestal. Ensure that the utility metering is isolated, lockable, and sealable. Use a meter socket that conforms to the utility requirements and is viewable from the exterior via lockable window panel (unless this conflicts with the utility requirement). Ensure that the pedestal pad anchorage is not visible from outside.

2 Equip the panel with a 3-point latching door with provisions for padlocking.

3 Equip the panel with an approved 650-volt, 3-pole lightning surge protector as manufactured by General Electric, Square D, Deltrol, or an approved equal.

#### 658.2.13.2 Internal Cabinet Components

1 Provide a cabinet that has an auxiliary device circuit at 120 V AC, single phase, to supply a ground fault interrupting, a duplex convenience receptacle, a fluorescent or LED cabinet light, and a photocell for the lighting system. Ensure that the cabinet light is a 17 W (fluorescent rating) minimum surface mounted fixture with protected lamp cover and is directly connected to a door actuated switch. Do not mount the lamp to the door. Use a receptacle that is a 20 A, ground fault interrupting, duplex receptacle in a weatherproof box with appropriate cover (NEMA 5-20R-GFCI).

2 Provide panelboards that are manufactured by Milbank, Siemens, General Electric, Square D, Westinghouse, I-T-E, or an approved equal. The Contractor is responsible for determining the type and rating. Provide busses that are copper for bolt-in type circuit breakers. Ensure that all feeders, branch circuits, and auxiliary and control circuits have overcurrent protection with circuit

breakers. Use circuit breakers that are standard UL-listed, molded case type, thermal magnetic as specified on the drawings.

3 Ensure that lighting contactors are the electrically operated, mechanically held type. Ensure that the contactor control input voltage matches the photocell. Use contactors with an ampere rating not less than that required for the intended use shown on the plans. Provide a hand-off-auto selector switch to override the photocell. Provide contactors that are manufactured by General Electric, Square D, Siemens, Westinghouse, I-T-E, or an approved equal.

4 Ensure that the photocell has an integral, locking type, brass, 3-prong plug according to NEMA Specification SH16-1962. Ensure that the gasket is a moisture proof seal for the luminaire socket. Ensure that the photocell is rated 1000 watts at 120 volts. Mount the photocell exterior to the control cabinet and facing North. Do not mount photocells to individual luminaires. If the photocell fails, ensure that the luminaires remain on, as a notification of needed maintenance. Provide a photocell with a design life of 20 years, and match the manufacturer of the LED luminaires.

5 Ensure that photocell receptacles are rotatable.

6 Size all equipment including panels, boxes, breakers, and contactors to handle the loads required to operate the system.

### 658.2.14 Light Poles (General)

1 Equipment and materials covered by other referenced specifications are subject to acceptance through the manufacturer's certification of compliance with the applicable specifications.

2 Provide poles as specified on the drawings and in the Contract, and ensure that the poles are manufactured according to the latest AASHTO *Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

### 658.2.15 Standard Roadway Lighting Poles

1 Ensure that poles and accessories are spun brushed aluminum. Provide aluminum poles that have a cast aluminum base welded to the lower end. After bonding or welding, ensure that the base develops the full strength of the adjacent shaft to resist bending action. Provide poles that are 35 ft or as specified in the Plans.

2 Provide removable anchor bolt covers with each pole. Secure covers to the base plate with tamperproof, stainless steel screws.

3 Provide anchor bolts and nuts as specified in **Subsection 658.2.10**. Ensure that the anchor bolts are sized as recommended by the pole manufacturer. Provide FHWA approved frangible breakaway couplings.

### 658.2.16 High Mast Lighting Poles

1 Provide poles that are either round or multi-sided tapered galvanized steel designed to support the number and type of luminaires, support ring, and lowering device as specified. Ensure that poles are fabricated from ASTM A595, Grade A high strength steel, hot dipped galvanized according to ASTM A123. Sectional poles may be used.

2 Furnish a shaft with handhole(s) for access to the circuit breaker and with a lowering system winch and mechanism. Secure the handhole(s) to the pole with tamperproof stainless steel screws. Reinforce the handholes to provide the equivalent strength of the pole section lost in the opening. Provide a mounting bracket for attaching the portable lowering device.

3 Ensure that the poles are fabricated and welded according to the AWS D1.1 Specification. Inspect all welds according to the AWS standards using dye penetrant or magnetic particle inspections. Ensure that the first welded joint of each full penetration transverse weld for each order is nondestructively examined to certify that the weld has the required quality. Ensure that longitudinal seam welds have a minimum of 60% penetration and are verified by polishing, etching, and examining a trimming that has been cut-off from selected male tube ends. Weld the female tube ends in the area of telescoping joints on both the inside and outside to ensure the integrity of the weld. Do not use transverse welds to secure telescoping joints.

4 Size anchor bolts as recommended by the manufacturer of ASTM F1554 Grade 55 steel, and provide a bearing plate of ASTM A36 steel. Ensure that the threaded ends of anchor bolts are galvanized according to ASTM A153. Supply each anchor bolt with two anchor nuts and two flat washers.

### 658.2.17 High Mast Lowering System (Top Latching Type)

1 Provide high mast poles and a lowering device of the same manufacturer as the luminaire or approved equal to ensure compatibility.

2 Ensure that the lowering system consists of a head frame, luminaire ring, and circuit breaker assembly. Ensure that the head frame structure is zinc coated steel.

3 Provide a head frame that encompasses cable sheaves that have been zinc-electroplated per ASTM A164 and have been yellow chromate dipped for corrosion resistance. Press oil-impregnated sintered bronze bushings into the steel sheave hub, and ensure that the bushings ride on stainless steel shafts.

4 Provide hoisting cables that are stainless steel 7 × 19 aircraft cable of 3/16-in. diameter manufactured according to MIL Spec W-5424.

5 Provide a power cord roller assembly that consists of rollers mounted between two cold-rolled steel plates that have been zinc-electroplated according to

ASTM A164 and that have been yellow chromate dipped. Provide a power cord that rides on rollers mounted on AISI 304 stainless steel shafts. Place 6 rollers on a radius on either end of the plates to support the power cord in a 7-in. bending radius. At either end of the plates, provide a keeper bar over the power cord between the plates to keep the cord in its track during pole erection and during normal operation. Cover the head frame with an aluminum cover.

6 Ensure that the head frame includes 3 latch barrels that support the luminaire ring assembly. Accomplish latching by the alternating raising and lowering of the luminaire ring assembly by the winch and hoisting assembly. Ensure that there is no moving latch parts or springs attached to the head frame assembly. Signal the latching and locking of each latching mechanism by retroreflecting indicator flags visible from the ground. Ensure that the latching mechanism will not be impaired by the formation of ice and does not require adjustment after the original installation.

7 Ensure that the luminaire ring has been fabricated of steel C-channel, hot dip galvanized according to ASTM A386 Class B with the appropriate number of 2-in. nominal galvanized steel pipe mounting arms. Wire the luminaire ring with a power cord with a suitable number of conductors and current-carrying capacity for the total load with a 2% maximum voltage drop.

8 Attach electrical cords to the weather-tight wiring chamber through weather-tight cable connections. Provide a prewired 600-volt terminal block in the weather-tight chamber. Provide a weather-tight twist lock power inlet on the chamber to allow testing of the luminaires while in the lowered position.

9 Provide roller-contact, spring-loaded centering arms that will center the luminaire ring while ascending and descending the pole. Ensure that the arm system can keep the ring concentric with the pole in winds up to 30 mph. Sacrifice the ultimate support of the luminaire ring by individual or total spring failure.

10 Use a winch that has an ultimate strength of five times the lifted load with the number of layers of cable with which it will be used. Ensure that the winch has a worm gear reduction ratio, and include an integral friction drag brake on the worm shaft to prevent free spooling of the winch.

11 Provide a winch that has been prewound with stainless steel 7 × 19 aircraft cable manufactured according to MIL W-5424 of ¼-in. diameter. Support the drum at both ends, and provide keepers to ensure that uncoiled cable will rewrap onto the drum.

### 658.2.18 Portable Drive Motor for High Mast Lowering Device

1 Provide a portable power unit that contains the drive motor, torque limiter, and cable wound winch and that can be installed, operated, and removed by one person. Provide 2 portable power units to the Department upon completion of the project.

2 Ensure that the drill motor is a heavy-duty reversing type with a stalling torque at least twice that required to operate the device. Use the drill to drive the winch through the torque limiter coupling to limit the lifting force. Ensure that there is a back-up shear pin designed to shear at a torque level between 35% and 70% over the torque limiter setting. Control the drill by a reversing switch connected by a 20-ft remote cord.

## 658.3 Construction

### 658.3.1 General Requirements

1 Ensure that at least one of every three persons in each work crew:

- Is a certified journeyman electrician,
- Is present and is involved with all work required for installation and operation testing of electrical materials and equipment, and
- Possesses at a minimum an IMSA Roadway Lighting Level 1 Certification.

2 Align devices, cabinets, covers, fixtures, exposed raceways, etc., plumb and parallel or perpendicular to the curb lines and/or the structure or ground lines. Neatly loop and lace the wiring in panel boards and cabinets with nylon cable ties, and do not wad the wiring. Identify wires at each terminal or junction with adhesive backed permanent plastic wire markers. The Department reserves the right to require repair or replacement of defective or inferior workmanship and material at no additional cost to the Department.

### 658.3.2 Coordination

1 Coordinate all work under this Section with other trades to ensure the proper location of outlets and equipment connections and to minimize conflicts with structural members, piping, grading, etc. Resolve all conflicts between equipment and/or material locations as directed by the RCE at no additional cost to the Department.

### 658.3.3 Utilities

1 Coordinate the service locations, arrangement, and compatibility for metering of electrical service entrances in detail with the local service utility.

### 658.3.4 Codes and Permits

1 Ensure that the installation and materials comply with NFPA-70 *National Electrical Code*, ANSI C2 *National Electrical Safety Code*, and all local codes.

Apply and pay for all permits, required training, and inspection required by local and state agencies for construction.

### 658.3.5 Design of Lighting Systems

#### 658.3.5.1 Design Standards and Operating Conditions

1 Provide a lighting system that conforms to the design/installation requirements in the table below and operate per the conditions. Additional component manufacturing standards are listed in **Subsection 658.2**.

| System ID | Design Standard |
|---|---|
| Photometric Analysis* | AASHTO *Roadway Lighting Design Guide*, Illuminance Method |
| Poles and Foundations | AASHTO *Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, latest edition, and MASH |
| Electrical | NFPA-70 National Electric Code |
| Lightning | NFPA 780, LPI 175 |

**See Additional Design Considerations in **Subsection 658.3.5.2**.*

2 Ensure that the system starts within 10 minutes and operates in continuous service for the following environmental conditions:

- -4°F to +104°F ambient; and
- Snow and ice with accumulations per latest AASHTO *Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

3 Ensure that the system starts and operates in continuous service for the following electrical service conditions:

- For non-interstate routes, interstate entrance and exit ramps (excluding high mast lighting), and roundabouts — single phase 120/240VAC at 60 Hz.
- For interstate mainline or other high mast lighting — 240V single phase or 480V three phase for multiple pole locations or extended runs.
- Input voltage fluctuations of ±10%.
- System able to restart automatically upon a restoration of power during a “call for lighting.”

4 Design the lighting system to include:

- Voltage drop calculations (see the Design Standards table above),
- Conduit and conductor size requirements,
- Design of lighting controller cabinets including all components, and
- Determination of length of cable runs.

5 Ensure the compatibility of all components of the system, and provide for sufficient lightning protection. Provide a schematic of the system, control cabinets, and circuitry.

#### 658.3.5.2 Additional Design Considerations

1 Evaluate the following additional design considerations:

- Locate high mast light poles (HMLP) to minimize traffic impacts so that no lane closures occur during system maintenance.
- Mount HMLPs a minimum of 4 ft behind guardrail. On highways with no guardrail, set back poles 46 ft from the edge of traveled way. Protect HMLPs located less than 46 ft from the nearest edge of traveled way by guardrail or barrier wall.
- Design HMLPs using a baseplate with a minimum of 8 anchor bolts.
- Design the system to minimize the number of required controller cabinets.
- Power and control the roadway lighting independently of other systems (e.g., sign lighting, ITS).
- Limit the voltage drop to 3% on branch circuits and 2% on feeders for a combined total of 5% from the service entrance.

### 658.3.6 Photometric Analysis

1 Submit photometric layouts including IES files and catalog cuts for the proposed LED roadway luminaire. Ensure that the photometric evaluation shows that the proposed luminaire will meet or exceed the design shown in the plans. Conduct photometric analysis using a 6 ft × 6 ft grid. Limit LED luminaires to 90% of their lumen output during analysis. Consider the potential of “light pollution” in the surrounding area.

### 658.3.7 Supports

1 Ensure that conduits, boxes, cabinets, enclosures, fixtures, etc., mounted above ground are securely attached to structural members or structural walls at intervals required by the NEC or as recommended by the manufacturer.

### 658.3.8 Cutting and Patching

1 Ensure that the electrical contractor performs all boring, drilling, and cutting of sidewalks and roadways as required to install and support raceways and equipment. Provide finished patching to match existing surfaces and conditions.

### 658.3.9 Trenching and Backfill

1 Ensure that the electrical contractor performs all excavation, trenching, and backfilling necessary to install the work. Ensure that trenches are run at a 36-in. minimum depth from finished grades. Contact all underground utilities (electric, telephone, cable TV, gas, water, sewer), and establish locations of underground utilities before digging. Damages to underground utilities will be repaired by the Owner of the line, and the Contractor that is responsible for the damage will pay all repair costs. After completion of backfilling operations, restore the disturbed areas to their original condition by leveling, raking, seeding, and mulching.

2 Excavate all cable trenches to a width not less than 6 in. Deepen or widen the trench where more than two conduits will be installed in the same trench. Unless otherwise specified in the Plans, install all conduits in the same location, and ensure that the conduits are running in the same general direction in the same trench.

3 When rock excavation is encountered, remove the rock to a depth of at least 3 in. below the required trench depth, and replace the rock with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a ¼-in. sieve. Determine the type of soil or rock to be excavated before bidding.

4 After the conduit has been installed, backfill the trench 3 in. deep, loose measurement, with backfill that is either earth or sand containing no mineral aggregate particles that would be retained on a ¼-in. sieve. Do not compact this layer. Provide a second layer that is 5 in. deep, loose measurement and that contains no particles that would be retained on a 1-in. sieve. Ensure that the remainder of the backfill contains no stone or aggregate larger than a 4-in. maximum diameter and is placed in layers an 8-in. maximum depth, loose measurement.

5 Tamp and compact the second and subsequent layers to at least the density of the adjacent undisturbed soil and to the satisfaction of the RCE. If necessary to obtain the desired compaction, moisten or aerate the backfill material as required.

6 Do not excessively wet trenches, and ensure that the trenches do not contain pools of water during backfilling operations. Backfill and tamp the trench level with the adjacent surface, except that, when sod will be placed over the trench, stop the backfilling at a depth equal to the thickness of the sod to be used, with

proper allowance for settlement. Remove and dispose of any excess excavated material according to methods approved by the RCE.

### 658.3.10 Bored and Jacked Conduit (Pushing)

1 Where necessary to cross an existing roadway and where steel galvanized conduit will be used, bore under the roadway and jack the conduit into the bore. Obtain approval for the method of boring and jacking from the RCE before beginning work. Limit the maximum conduit size to 4 in.

### 658.3.11 Bored and Jacked Conduit (Pulled)

1 When HDPE conduit is used under existing roadway, bore under the roadway and pull the conduit through the bore. Obtain approval for the method of boring and jacking from the RCE before beginning work. Limit the maximum conduit size to 4 in.

### 658.3.12 Restoration

1 Where sod has been removed, replace as soon as possible after the backfilling is completed. Restore all areas disturbed by the trenching, storing of dirt, cable laying, pad construction, and other work to its original condition, including any necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Perform this work according to **Section 810**. The Contractor is responsible for maintaining all disturbed surfaces and replacements until final acceptance.

### 658.3.13 Marking Posts

1 Place marking posts at 500-ft intervals along conduit runs and everywhere the conduit makes a turn. Mark all junction boxes and the ends of jacked and bored conduits under the roadway. In addition, place red marking tapes in the trench.

### 658.3.14 Grounding

1 Ground and bond the entire system according to the *National Electrical Code.* In design and installation, consider the additional requirement for added lightning protection according to NFPA 780 and LPI 175.

2 Ground the electrical service to driven ground rods as required by the *National Electrical Code*. Ensure that the grounding point is inside the main service equipment.

3 Bond each raceway to every cabinet, pull box, etc., to which it is connected by grounding bushings and bonding jumpers sized according to NEC Table 250-95, even when separate grounding conductors are specified. Install an insulated

stranded copper wire, No. 8 AWG minimum size, for grounding in all circuit runs. Securely attach the grounding wire to each light base.

### 658.3.15 Conduit

1 Install direct burial conduits as necessary to provide electrical service to the lighting. The RCE will approve specific locations as the work progresses. Size the conduits to accommodate the size and number of conductors.

2 Mandrel each conduit. Push an iron-shod mandrel, not more than ¼ in. smaller than the bore of the conduit, through each conduit with jointed conduit rods. Ensure that the mandrel has a leather or rubber gasket slightly larger than the conduit diameter.

3 Provide all spare conduits with a No. 10 gauge galvanized iron or steel drag wire or equivalent plastic cord with a 200-lb tensile strength for pulling the permanent wiring. Leave sufficient length in manholes or pull boxes to bend the drag wire back to prevent it from slipping back into the conduit. Where spare conduits are installed, plug the open ends with removable tapered plugs, designed by the manufacturers, or with hardwood plugs conforming accurately to the shape of the conduit and with the larger end of the plug at least ¼ in. greater in diameter than the conduit.

4 Securely fasten all conduits in place during construction as work progresses, and plug the conduit to prevent seepage of grout, water, or dirt. Do not install any conduit section with a defective joint.

### 658.3.16 Pull Boxes

1 Place pull boxes at intervals of 250 ft along conduit runs and at turns in the runs, at all junction boxes, and at the ends of jacked or bored conduit. Stake the final locations of the pull boxes. The RCE will approve the locations before construction. Place the pull boxes in excavated holes over pea gravel or crushed stone for drainage. Ensure that the top of the pull box lies flush inside the pull box. Place the top of the pull box 1 in. above the finished grade, then place 4 in. of concrete backfill on all sides of the pull box.

2 Document the locations using the Global Positioning System (GPS) with the coordinates for each pull box on the as-built plans.

### 658.3.17 Wiring

1 Install cable at the approximate locations indicated in the lighting layout plans. The Contractor and RCE will determine specific locations.

2 Cable connections will be permitted only at the light base locations for connecting the underground cable to the leads of the individual luminaires.

Splices will be permitted for cables in pull boxes and manholes where approved by the RCE or shown in the Plans.

3 Make field cable splices and taps with copper sleeve compression type connectors only. Use a compression tool of the type that will release only after full compression to the sleeve is made. After the compression is complete, insulate the splice with two wraps, half lapped, of insulating rubber tape. Apply Scotch No. 33, or approved equal, over the rubber tape to at least 3 in. beyond the sleeve on each conductor entering the splice. Pad all sharp points and edges, and fill all voids with rubber and plastic tape. Do not excessively stretch the tape so as to cause creeping. Where approved by the RCE, a heat shrinkable, self-sealing, splice insulator kit may be used in lieu of the taping above for splices in pole bases and in structure boxes above ground. Ensure that all spliced joints are watertight and in a silicone gel-filled enclosure.

4 Make cable splices in pull boxes with a pressed sleeve connector or equivalent, and install a protective plastic case around the cable. Seal the ends of the cases with plastic tape. Fill the case by pouring a 2-part, field mixed hardening insulation compound according to the manufacturer's instructions. Ensure that splices are watertight and capable of continuous submersion in water.

### 658.3.18 Installation of Wire in Conduit

1 Ensure that the maximum number and voltage ratings of cables installed in each single conduit, and the current-carrying capacity of each cable, comply with the *National Electric Code* and the local agency having jurisdiction. Ensure that conductors for a circuit (i.e., supply and return) are routed together when passing through conductive material (e.g., metal conduit).

2 Do not make any connections or joints in cables installed in conduits.

3 Ensure that the conduit is open, continuous, and clear of debris before installing cable. Install the cable so as to prevent harmful stretching of the conductor, damage to the insulation, or damage to the outer protective covering. Seal the ends of all cables with moisture-seal tape before pulling the cable into the conduit. Leave sealed until the connections are made. Where more than one cable will be installed in a conduit under the same Contract, pull all cable in the conduit at the same time. The pulling of a cable through conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Pulling tensions should be governed by the recommended standard practices for straight pulls or bends. Use a lubricant recommended for the type of cable being installed where pulling lubricant is required. Upon completion of the installation of wiring in conduits, seal the ends of conduit with untreated oakum or another sealer as approved by the RCE. Replace conduit markers temporarily removed for excavations as required.

### 658.3.19 Placing Pole Foundations

1 Install the poles at the approximate locations indicated in the Plans. Stake out the exact locations and obtain approval from the RCE before commencing construction. Do not install high mast foundations within 46 ft of the roadway when there is no shielding available.

### 658.3.20 Pole Foundations

1 Stake each pole location and obtain approval from the RCE before commencing work. Excavate holes for pole foundations in undisturbed earth to the dimensions indicated on the accepted Shop Plans. Submit to the RCE Shop Plans of the foundation and design calculations certified by a Professional Engineer licensed and registered in South Carolina. Perform any subsurface explorations, if required, and all design calculations according to the SCDOT *Geotechnical Design Manual*.

2 Erect foundation reinforcement, anchor bolts, and conduits as indicated on the drawings, and secure in place for the placement of concrete. Ensure that all reinforcement and anchor bolts have a 3-in. minimum clearance from the outside edge of the concrete. Ensure that anchor bolts extend high enough to permit double nuts and a bearing plate according to the manufacturer's recommendations. Place concrete in the excavated hole against undisturbed earth. Vibrate concrete according to ACI recommendations to ensure that there are no voids in the foundation. Allow 28 days for curing before placing poles on foundation.

### 658.3.21 Controller Cabinet Foundations

1 Ensure that the cabinet foundation sizing provides for a minimum of 24 in. between the edge of the cabinet and the edge of concrete on all sides. Ensure that the foundation extends above the ground elevation a minimum of 6 in.

### 658.3.22 Poles

1 Assemble poles, luminaires, wiring, and other components, and allow for observation by the RCE before erecting a pole. Place and adjust leveling nuts and the bearing plate so that the pole will have a level-bearing surface to rest on. Erect the pole according to the manufacturer's recommendations, using lifting equipment that will not damage the finish surfaces of the poles. Use a transit to check and level the pole. Tension nuts according to the manufacturer's instructions and **Section 709**. Install bolt covers with stainless steel security screws over each anchor bolt. Do not place grout under the base plate between the base plate and the top of the footing.

### 658.3.23 Luminaires

1 Ensure that luminaires are installed, leveled, and aimed according to the recommendations of the manufacturer and as indicated on the Plans. Take all necessary measures to prevent spill light and glare. Support the wiring within the poles at the top of the pole with a cable clamp or attachment clip to prevent tension on the cable splices or connections to the luminaires. Ensure that luminaires are connected to balance the loading between all phases on the supply circuit. Clean all luminaires after completion of installation, and securely tighten all aiming devices and clamps.

### 658.3.24 Ground Rod Testing

1 Before connecting ground rods to the grounding conductor, test each ground rod for earth resistance. Use the Fall Of Potential test method according to IEEE Standard 81. Notify the RCE 7 days before performing the testing. Do not perform any tests within 7 days of measurable rainfall greater than 0.01 in. If the resistance of any ground rod exceeds 25 ohms, notify the RCE for further action.

2 Furnish to the RCE a written certification of the testing, listing each ground rod as identified in the Plans, the resulting value of resistance, and any further corrective action taken.

### 658.3.25 Completion of Work

1 Erect and level the poles and connect to the power and control systems. Repair and/or refinish any damaged surfaces. Test lowering the system and latching mechanism at least three times for each pole. Ensure that all equipment and luminaires are operational. Instruct SCDOT maintenance personnel in the operation and maintenance of the system.

2 The Department may perform an as-built photometric analysis to ensure system conformance to the desired lighting.

### 658.3.26 Acceptance Testing

1 Upon completion of work, ensure that the entire system is completely operational and tested to conform to these specifications and Plans and inspected and approved by the RCE. Correct all defects in workmanship and material at no additional cost to the Department.

2 Upon completion of all installations and before final acceptance by the Department, remove all debris from the site. Clean and apply touch up paint on fixture lenses and trims, cabinets, enclosures, cover plates, etc.

### 658.3.27 As-Built Drawings

1 Maintain one set of clean plans for as-built drawings. Daily record all changes, revisions, or modifications to the lighting system on the drawings, and record the final locations of conduits, pull boxes, luminaires, etc., with red-line pencil. Upon completion of the project, submit the red-line drawings to the RCE for the preparation of the final as-built drawings. Ensure that the drawings include:

- Final locations of service panels, meters, etc.;
- Final routing of conduit runs;
- Final locations of light poles;
- Final locations of junction boxes; and
- Final locations and number of jacked and bored conduits.

### 658.3.28 Maintenance and Operating Manual

1 Furnish the Department with two complete maintenance and operating manuals for each piece of equipment and material furnished under the project. Bind the manuals in hard cover binders with tabs for each item or piece of equipment. Furnish the manuals before the final inspection. The Department will not provide final acceptance until the system maintenance personnel are instructed in the maintenance and operation of all systems.

## 658.4 Measurement

1 The quantity for each type of Light Stand, Design and Installation of Roadway Lighting Electrical System, or Potable Drive Motor for High Mast Lowering Device is measured by each (EA) new system installed according to the applicable specifications, complete and accepted.

## 658.5 Payment

1 Payment for the accepted quantity for each type of Light Stand, Design and Installation of Roadway Lighting Electrical System, or Potable Drive Motor for High Mast Lowering Device is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified. All provisions necessary for the services are incidental to the work, unless otherwise indicated.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 6581000 | Design and Installation of Roadway Lighting Electrical System No (XXX) | EA |
| 6581145 | Single Aluminum Light Standard - 35′ - Breakaway – Including Mounting Arm, Luminaire and Foundation | EA |
| 6585015 | High Mast Galvanized Steel Light Standard - 100′ - Top Latch Lowering Device – Including Luminaires, Pole and Foundation | EA |
| 6585020 | High Mast Galvanized Steel Light Standard - 120′ - Top Latch Lowering Device – Including Luminaires, Pole and Foundation | EA |
| 6585050 | Portable Drive Motor for High Mast Lowering Device | EA |

# DIVISION 700
# STRUCTURES

## Section 701 — Portland Cement and Portland Cement Concrete

### 701.1 Description

1 Furnish, store, and handle the materials, and proportion, mix, and deliver the Portland cement concrete.

### 701.2 Materials

#### 701.2.1 Cement

1 Use Portland or blended Portland cement as specified hereafter.

##### 701.2.1.1 Equivalent Alkalis

1 Comply with the requirements for low-alkali cement, defined as an equivalent alkali ($Na_2O + 0.658K_2O$) measurement equal to or less than 0.60%, except as noted in the following paragraph.

2 For precast items included in **Sections 714** and **719**, ensure that cement with alkali contents greater than 0.60% to a maximum of 0.75% are only used with the following conditions. Unless the use of high alkali cement is explicitly allowed, produce high alkali cement concrete using a supplementary cementitious material (SCM) as given herein. Use a replacement of 20% of the cement at a ratio of 1.2:1 with Type F fly ash as designated in **Subsection 701.3.10**, or replace at a ratio of 1:1 by weight with at least 30% but no more than 50% of the cement with granulated blast-furnace slag from a source included on *Qualified Products List 18* as designated in **Subsection 701.3.10**.

##### 701.2.1.2 Allowable Cement Types

1 Use one of the following types of Portland and blended Portland cement as specified hereafter.

2 Use Portland cement meeting the requirements of AASHTO M 85 from sources included on *Qualified Products List 6*.

3 Use Type IS Portland blast-furnace slag cement meeting the requirements of AASHTO M 240 from sources included on *Qualified Products List 18*. Ensure that the slag constituent is 25% or less of the total weight of the Portland blast-furnace slag cement.

4 Use Type IL Portland-limestone cement meeting the requirements of AASHTO M 240 from sources included on *Qualified Products List 86*. Ensure

that the limestone constituent is 15% or less of the total weight of the Portland-limestone cement.

#### 701.2.1.3 Cement Handling and Reporting

1 Do not store incompatible brands of cement or different types of cement in the same cement storage bin or silo, and do not use incompatible brands together in any continuous pour.

2 Ensure that the SME approves the weighing and handling procedures of bulk cement before its use. Protect cement shipments from water or any contamination with foreign substances at all times. Inspect, sample, and test questionable cement before use. Do not use cement that is lumpy or caked or from open or damaged containers.

3 Measure cement by weight.

4 Furnish certified mill test reports that consist of physical and chemical test results obtained by the supplier on samples of cement representative of that being certified. Ensure that the mill test report includes the type of cement, the brand of cement, the silo number or ship name, the date of grind or voyage number, the date of shipment, and a certification statement stating that the cement meets the requirements of AASHTO M 85 or AASHTO M 240 for the type of cement being furnished.

5 If subsequent laboratory testing of mill or job control samples determines that a cement shipment does not comply with these specifications, discontinue the use of the cement from that cement mill until testing demonstrates that the problem has been corrected. Replace or otherwise make 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 AASHTO M 295, except for the supplementary optional physical requirements. Use fly ash from sources listed on *Qualified Products List 3.* Furnish certified mill test reports and shipping tickets from the supplier for each shipment.

### 701.2.3 Granulated Blast-Furnace Slag

1 If slag is used, use granulated, blast-furnace slag Grade 100 or higher conforming to ASTM C989. Use slag from sources listed on *Qualified Products List 6*.

### 701.2.4 Silica Fume

1 Use silica fume meeting the general requirements of ASTM C1240. Ensure that the raw silica fume meets the chemical requirements of Table 1 and Table 2 and the physical requirements of Table 3 in ASTM C1240. 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 C1240 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-lb 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-lb bag and whole bags as small as 40 lb are permitted only if approved by the RCE. Ensure 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 the water as part of the total water in the mix. Ensure that the computed water content corresponds to 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 Use a design mix for air-entrained concrete based on 4.5% (±1.5%) entrained air, except for prestressed concrete. If the concrete is pumped, then the entrained air will be acceptable at 5.5% (±1.5%) measured at the truck.

2 Do not use air entrainment exceeding the maximum limits specified in the paragraph above unless approved by the SME. Air entrainment for Class 10,000 concrete is left to the judgment of the Contractor and with approval of the SME.

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 an 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. Use admixtures from sources on *Qualified Products 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 701.3.8** and **701.3.9**. Do not use a Type B retarding admixture. Use admixtures from sources appearing on *Qualified Products 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 *Qualified Products List 53*. Adhere to the manufacturer's written recommendations regarding the use of the admixture including storage, transportation, method of mixing, and applicable rates. Add the corrosion inhibitor to the mix by a dispenser meeting the requirements of **Subsection 701.3.4.4**.

2 Furnish the RCE with a copy of the manufacturer's certified test report showing the composition of the corrosion inhibitor.

### 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 to the OMR the fine aggregate in the concrete mix design for approval. Use natural sand, manufactured sand, or a combination of natural and manufactured sand meeting **Subsections 701.2.9.2** through **701.2.9.8**. Use marine limestone fine aggregate only if the water-soluble chloride content of the aggregate, when tested according to ASTM C1524, is less than 200 ppm. Marine limestone coarse and fine aggregate can be used together only if their combined water-soluble chloride content, when tested according to ASTM C1524, is less than 200 ppm.

### 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 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 Ensure that the 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 days and 28 days is not less than 95% when tested according to 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-in. 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 Qualified Sources

1 Use sand from sources that appear on *Qualified Products List 1.*

### 701.2.9.8 Gradation of Fine Aggregate

1 Use fine aggregate for all classes of Portland cement concrete conforming to the gradations for FA-10 or FA-10M as indicated in the Gradation of Fine Aggregate table in **Appendix A-3** 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. Ensure that the aggregate 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 determined by AASHTO T 104. Use coarse aggregate for Portland cement concrete conforming to the requirements in **Subsections 701.2.10.1** through **701.2.10.3**.

2 Use marine limestone coarse aggregate in reinforced concrete only if the water soluble chloride content of the aggregate, when tested according to ASTM C1524, is less than 200 ppm. Marine limestone coarse and fine aggregate can be used together only if their combined water-soluble chloride content, when tested according to ASTM C1524, is less than 200 ppm. For non-reinforced concrete applications, 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 a marine limestone aggregate is used, use a sprinkler system to produce a saturated aggregate during concrete batching.

### 701.2.10.2 Qualified Sources

1 Use coarse aggregate from sources listed on *Qualified Products List 2* and approved for use with Portland cement concrete.

### 701.2.10.3 Gradation of Coarse Aggregate

1 Use Aggregate No. 56, No. 57, or No. 67 as coarse aggregate for Portland cement concrete. Aggregate No. 78 or No. 789 may be used in thin sections and in areas of congested reinforcement, 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, No. 78,

and No. 789 as indicated in the table entitled Gradation of Coarse Aggregates in **Appendix A-2**.

### 701.2.11 Water

#### 701.2.11.1 General

1 Ensure 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 making this determination. 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 evaluation process that conforms to AASHTO R 18 or, for chemical testing, has otherwise been approved by the SCDES for the tests being conducted. Supply AASHTO R 18 documentation to the SME for review and acceptance before using a non-SCDES 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, compare the water with distilled or other satisfactory water using the standard cement test for soundness, time of setting, and 1:3 mortar strength with standard sand conforming to ASTM C778 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 according to AASHTO T 26. If an approved water source reservoir is relatively shallow, enclose the intake pipe and elevate the water to exclude silt, mud, grass, or other foreign matter.

4 For use as mix water, ensure that water from washout operations or that is a blend of concrete wash water and other acceptable water sources has been certified by the concrete producer as complying with 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.

**Acceptance Criteria for Questionable Water Supplies**

| Criteria | Limits | Test Method (1) |
|---|---|---|
| Compressive Strength, Minimum Percent Control at 7 days | 90% | AASHTO T 22 (ASTM C39) |
| Time of Set, Deviation from Control | From 1:00 hr. earlier to 1:30 hr. later | AASHTO T 197 (ASTM C403) |

*(1) Base the comparison on fixed proportions and the same volume of test water compared to control mix using public water or distilled water.*

5 Wash water from mixer washout may be used only with RCE approval. When wash water is permitted, provide satisfactory proof or data that there are no detrimental effects if potentially reactive aggregates are used. Discontinue the use of wash water if an 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 specified above. Conduct subsequent tests on the water every month with records of test results provided upon request by the RCE or the SME.

6 Do not allow the specific gravity of the mixing water sampled from the discharge line to exceed 1.03 at any time that 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 the work.

### 701.2.12 Concrete Mix Design

#### 701.2.12.1 General

1 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, 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 specified. Prepare and deliver the mixture according to these specifications.

2 Design the concrete mix and determine the proportions of cementitious material, fine aggregate, coarse aggregate, and admixtures (when used) that produce a workable concrete mix. Meet the criteria for the typical classes of concrete 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 according to the requirements for the specific type of work and with consideration of the specific gravities of the materials to provide the desired workability and consistency.

3 An independent testing laboratory accredited by the AASHTO Accreditation Program may be used, at no cost to the Department, to design the mix for the class of concrete specified, or use a mix design previously reviewed and used by the Department.

4 Submit all mix designs to the SME for review a minimum of 15 days before use in SCDOT projects. Submit the mixes on the appropriate OMR form approved by the SME. After successful review by the SME, provide a copy of the mix design showing the SME's stamp to the RCE before supplying that mix to the project.

5 Once a mix has been reviewed by the SME, the mix is valid for a period of 3 years if the mix ingredients or proportions are not changed. The mix may be supplied to any SCDOT project requiring that class of concrete during that period.

6 For the water-cementitious material ratio, use the ratio of water to cementitious materials by weight. When a mix design is reviewed by the SME using a water-cementitious ratio lower than the maximum allowed in the Structural Concrete table in **Subsection 701.2.12.2**, the lower water-cementitious ratio as reviewed by the SME becomes the maximum allowable for that mix.

7 Design the concrete mix using Department qualified ingredients intended for use in the project and make all trial batches using such materials.

8 Base mix designs on the air entrainment specifications in **Subsection 701.2.5**.

9 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.

10 Base mix designs on specific gravities and the saturated surface dry moisture contents of aggregate obtained from a source on *Qualified Products List 2* and fine aggregate obtained from a source on *Qualified Products List 1*. Include the SCDOT Number as shown on *Qualified Products Lists 1* and *2* for all aggregate sources on the mix design form.

11 Base the percent fine to coarse aggregate ratio on volume. Values of this ratio shown in the Structural Concrete table in **Subsection 701.2.12.2** are general

guidelines for the classes of concrete shown. Vary this ratio to obtain the desired workability.

12 No separate payment is made for the cost of the laboratory engaged by the Contractor, for the materials furnished and used for trial batches, for the preparation and testing of trial batches either by the Contractor or its laboratory, or for furnishing the SME with the mix data, the results of the cylinder tests, and yield to be tested.

13 After successful review of a mix design by the SME, do not change the mix proportions or the sources of the individual mix ingredients with the exception of the fly ash source. Fly ash sources can be changed if needed due to supply issues (except for mass concrete mixes), provided that the alternative source is listed in *Qualified Products List 3*. If modifications are necessary (other than the fly ash source), submit a new mix design for review by the SME.

### 701.2.12.2 Structural Concrete Table

1 Unless otherwise noted or directed, ensure that that the properties of the various classes of concrete incorporated into the work conform to the following Structural Concrete table. The compressive strength is based on ASTM C39.

### Structural Concrete Table

| Aggregate Type | Minimum Cement Content (lb/cu yd) | 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 |
| **Class 3000** | | | | |
| Crushed Stone | 588 | 3000 | 35:65 | 0.46 |
| Gravel | 588 | 3000 | 34:66 | 0.44 |
| **Class 4000** | | | | |
| Crushed Stone | 611 | 4000 | 35:65 | 0.40 |
| Gravel | 611 | 4000 | 34:66 | 0.40 |
| **Class 4000S** *(See Note 1)* | | | | |
| Crushed Stone | 682 | 4000 | 38:62 | 0.45 |
| Gravel | 682 | 4000 | 38:62 | 0.45 |
| **Class 4000DS** *(See Notes 2 & 3)* | | | | |
| Crushed Stone | 625 | 4000 | 40:60 | 0.44 |
| Gravel | 625 | 4000 | 39:61 | 0.43 |
| **Class 4000P** *(See Note 4)* | | | | |
| Crushed Stone | 682 | 4000 | 34:66 | 0.43 |
| Gravel | 682 | 4000 | 33:67 | 0.38 |
| **Class 5000** | | | | |
| Crushed Stone | 705 | 5000 | 35:65 | 0.40 |
| Gravel | 705 | 5000 | 34:55 | 0.40 |

### 701.2.12.3 Structural Concrete Table Notes

**Note 1:**

Use Class 4000S for concrete foundation seals and underwater placement.

**Note 2:**

Use Type G or Type D admixture.

**Note 3:**

Use Class 4000DS concrete for drilled shaft and drilled pile construction.

Design the mix for drilled shaft concrete, and determine the proportions of cement, fine aggregate, coarse aggregate, water, and water reducing/retarding admixture that produce a workable concrete mix meeting the following criteria:

- Minimum cement per cubic yard ..... 625 lb
- Slump..... 7 in. to 9 in.
- Max. water/cementitious ratio..... (see Table)
- 28-day minimum compressive strength..... 4000 psi
- Air entraining admixture..... Not required
- Nominal coarse aggregate size ..... ¾ in.
- No. 67 aggregate gradation..... As required

Design the concrete mix using approved ingredients intended for use on the project. Test trial mix for complete conformance with the Specifications.

Submit the proposed mix with test results showing full compliance with the Specifications to the SME for review.

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.

**Note 4**:

Minimum Class 4000P concrete is the minimum concrete strength required in non-prestressed precast items.

### 701.2.12.4 Non-Conforming, Non-Prestressed Concrete

#### 701.2.12.4.1 Price Reduction

1 This Subsection applies to non-prestressed concrete. For prestressed concrete, see **Subsection 701.2.12.5**. 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.

**Price Reduction for Non-Conforming Cylinders**

| Cylinder Test Results | Price Reduction per Cubic Yard[1,2] (Percent) × (Contract Unit Price) | |
|---|---|---|
| **Percentage of Minimum Strength** | **With Contract Unit Price** | **Without Contract Unit Price[3]** |
| 98.0 – 100.0 | 0% | 0% |
| 95.0 – 97.9 | 5% | 25% |
| 90.0 – 94.9 | 10% | 50% |

1 *The BCE may approve the use of concrete test method ASTM C805 to determine the accepted strength, if the concrete test cylinders have been considered non-conforming.*

2 *The total amount of the price reduction will not be less than $500.00.*

3 *If there is no Contract unit price for concrete, use (percent reduction) × (supplier's invoice unit cost).*

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 to evaluate the strength of the concrete in place. Ensure that test cores are taken, conditioned, and tested according to **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 Determine the limits of questionable concrete using test method ASTM C805 at the direction of and in the presence of the RCE. 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 Use an independent firm, accredited by AASHTO in ASTM C42**,** to 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 the cores (3 in. to 4 in. in diameter), sized to match the testing equipment used, from each area of concrete that produced a set of 28-day cylinders with compressive strength less than 90% of the required strength. Take care to avoid damaging reinforcing steel. Properly label cores before transferring to the testing facility as indicated in **Subsection 701.2.12.4.2.3**. Obtain and test cores at no cost to the Department.

### 701.2.12.4.2.3 Conditioning and Testing Cores

1 Have the cores compression tested according to ASTM C42 by an independent testing firm accredited by AASHTO in ASTM C42. Transfer the cores to the RCE or the independent testing firm for compression testing immediately after they are obtained. Provide an official report from the testing laboratory detailing the core test results to the RCE and 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 if the taking of cores would result in irreversible damage to the structure, the BCE may approve test method ASTM C805 to determine the strength of the concrete. Have the testing performed in the presence of the RCE, by an independent laboratory accredited by AASHTO in ASTM C805.

2 If the ASTM C805 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 Engineer 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[1]** | **Price Reduction per Cubic Yard[2] (Percent) × (Contract Unit Price)** | |
|---|---|---|
| **Percentage of Minimum Strength** | **With Contract Unit Price** | **Without Contract Unit Price[3]** |
| 98.0 – 100.0 | 0% | 0% |
| 95.0 – 97.9 | 5% | 25% |
| 90.0 – 94.9 | 10% | 50% |
| 85.0 – 89.9 | 15%[4] | 80% |

[1] *Or ASTM C805, if approved by the BCE.*

[2] *The total amount of the Price Reduction will not be less than $500.00.*

[3] *If there is no Contract unit price for concrete, use (percent reduction) × (supplier's invoice unit cost).*

[4] *Use 15% of Contract unit price or 80% of supplier's invoice unit cost, whichever is greater.*

#### 701.2.12.5 Non-Conforming, Prestressed Concrete

1 Do not core prestressed concrete elements unless specifically authorized by the BCE. If allowed to remain in-place, non-conforming concrete for prestressed elements will be subject to the same price reductions outlined in **Subsection 701.2.12.4**. Due to the complex nature of prestressed elements, the Engineer of Record will evaluate test cylinders falling below the specified strengths on a case by case basis.

#### 701.2.12.6 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 Construction

### 701.3.1 Equipment

#### 701.3.1.1 Equipment, Inspection, and Approval

1 Ensure that all specified equipment has been inspected and approved before use. Schedule the inspections at least annually and at other times considered necessary by the RCE.

#### 701.3.1.2 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 ±2% of the required weight and that the total weight of aggregate is within ±2% of the total required weight. Use beam, springless-dial, or load cell scales for weighing aggregates and cement. Ensure that the 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 an accidental change of position.

4 Provide a dust tight enclosure for dial scales. Ensure that the chart is made from a durable material and has good readability.

5 Periodically check scales used in batching Portland cement concrete for accuracy by an independent calibration service accredited according to ISO/IEC 17025 or under the supervision of a South Carolina licensed and registered Professional Engineer. Post on the scales or in the batching room a

statement certifying as to the accuracy of the scales with the date of inspection. Provide the documentation of the scale calibration to the OMR or SCDOT representative upon request. 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.

### 701.3.1.3 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 *Qualified Products List 28.*

2 Ensure that there is adequate water storage. Ensure that that the mixer is equipped with a device to accurately weigh or measure and automatically 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 1.0% 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 into the mixer drum. Ensure 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.

3 Maintain mixers in good working condition. Repair mixers when necessary to ensure that the concrete has a uniform quality. Examine mixers for any change in condition due to the 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 in. 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 the 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, ensure that they are capable of measuring and placing exactly and consistently the desired amount of admixtures in each batch.

### 701.3.1.4 Truck Mixers

1 Ensure that all truck mixers are pre-approved by SCDOT or National Ready Mixed Concrete Association (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 the truck mixer does not have a rating plate, provide the OMR with 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 the truck mixer indicated on the capacity plate. Ensure that the NRMCA plate is accessible, clear, and legible at all times. Ensure that 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.

**Truck Mixers**

| 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 |
| 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. Ensure 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. Ensure that the 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 in. 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.

### 701.3.2 Care and Storage of Concrete Aggregates

1 Handle and store concrete aggregates to prevent intermixing, segregation, and contamination by foreign materials. Handle and stockpile each aggregate component from a different source or gradation separately. Clear vegetation and other extraneous matter from stockpile sites, so that the sites have natural ground bottoms, and ensure that the stockpile sites are generally smooth, firm, and well drained. Do not use the bottom 1 ft 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 ft in depth.

### 701.3.3 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.

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 in. high and ¼ in. thick or deep. Ensure that the sign clearly identifies the material that is in the silo.

### 701.3.4 Measuring Materials

#### 701.3.4.1 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 701.3.1.2** and that are not used to weigh other materials.

#### 701.3.4.2 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 that the water weighs 8.33 lb/gal.

#### 701.3.4.3 Fine and Coarse Aggregate

1 Measure fine and coarse aggregates separately by weight on scales meeting the requirements of **Subsection 701.3.1.2**. In measuring aggregates, make allowance for water in the aggregates. For determining the moisture content of aggregates, use automatic sensing devices if available; otherwise, take representative samples and investigate individually or combined in a composite sample.

#### 701.3.4.4 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 ounces or ounces per hundred pounds of cement. Identify graduated strips based on the rate at which the admixture is being measured for the specific diameter of the tube being used.

2 Calibrate meter and timing dispensers by obtaining a metered sample and checking the accuracy of the system. Check the equipment and ensure its approval 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 ±3.0%. Discharge the admixture into the stream of water entering the mixer drum or into the pre-measured or pre-weighed water for each batch. 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 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.

### 701.3.5 Concrete Batching and Mixing

#### 701.3.5.1 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 Ensure that an SCDOT-certified Level 1 Concrete Technician is present at the plant when concrete is being produced for SCDOT work. The SCDOT-certified Level 1 Concrete 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 Level 1 Concrete 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 Level 1 Concrete Technician complete and sign a SCDOT Form 700.04, Ready Mix Concrete Report. Except for Class 2500 concrete, prestressed, precast concrete, and concrete produced by a volumetric mixer, the Department will not accept concrete unless a completed SCDOT Form 700.04, signed and certified by the SCDOT-certified Level 1 Concrete Technician, accompanies the delivery of concrete.

3 Provide sufficient advance notification to the RCE on the name of the plant supplying the concrete to permit time to make the necessary arrangements for inspection of equipment at the plant.

#### 701.3.5.2 Batching and Mixing in Cold Weather

1 When batching and mixing concrete at atmospheric temperatures below 50°F, as determined by the RCE, ensure that measures are implemented to provide batched concrete with a temperature of at least 50°F when placed in the forms. Batch and mix concrete at atmospheric temperatures below 35°F only when permitted by the RCE. Implemented measures may include but are not limited to the following:

A. Replacing a portion of the design mix water with heated water not exceeding 170°F at discharge into the mixer, or

B. Heating aggregates by steam, dry heat, or placing in heated mixing water. Use any aggregate heating method or apparatus that heats the aggregates uniformly without creating hot spots.

2 Do not use aggregates that contain ice, frost, or frozen particles in the concrete mix. When either aggregates or water are heated above 100°F, combine the aggregate and a portion of the water before adding cement to avoid flash set. Cement may be added with water or with a mixture of water and aggregate having a temperature less than 100°F.

3 Do not implement alternative measures to those listed above without prior approval from the RCE.

4 Recommendations provided in ACI 306R *Guide to Cold Weather Concreting* may be used to meet the requirements of this Subsection with RCE approval.

### 701.3.5.3 Batching and Mixing in Hot Weather

1 When batching and mixing concrete in hot weather, ensure that measures are implemented to prevent the concrete mix temperature from exceeding 90°F measured before placement in the forms. For Class 2500, do not allow the concrete mix temperature to exceed 95°F. For mass concrete pours, do not allow the concrete 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 Implemented measures to meet mix temperature requirements may include but are not limited to the following:

A. Using Type II cement,

B. Sprinkling coarse aggregate with water to cool by evaporation,

C. Using chilled mixing water or cubed/crushed ice to replace part of the mixing water. If using ice, ensure that the ice melts before the batch is discharged from the mixing unit, and

D. Scheduling pours during cooler portions of the day.

3 Do not implement alternative measures to those listed above without prior approval by the RCE.

4 Recommendations provided in ACI 305R *Guide to Hot Weather Concreting* may be used to meet the requirements of this Subsection with RCE approval.

### 701.3.5.4 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 as 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.

### 701.3.5.5 Truck Mixing

1 After all materials, including water, have been placed in a truck mixer, rotate the 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 an agitating speed of 2 rpm to 6 rpm or at the speed designated for agitation by the manufacturer.

### 701.3.5.6 Wash Water Stabilizers

1 Ready mix concrete producers may use mixer drum wash water stabilizing agents in truck and central mix drums. Use products that appear on *Qualified Products List 32*. Ensure that that the stabilizing agents are used according to *Qualified Products 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 met or technical problems are encountered because of using a stabilizer.

### 701.3.5.7 Volumetric Concrete Mixing

1 Provide volumetric mixers with rating plates indicating that the performance of the mixer is according to the Volumetric Mixer Manufacturer Bureau (VMMB). Ensure that mixers comply with ASTM C685. Follow the manufacturer's recommended procedures for all mixing operations. Provide the procedures to the RCE for review upon request.

2 Ensure that the concrete mixing truck is an auger-type continuous mixer used in conjunction with volumetric proportioning. Ensure that the mixer produces concrete, uniform in color and appearance, with a homogeneous distribution of the material throughout the mixture. Establish the mixing time necessary to produce uniform concrete. Only acceptable equipment capable of producing uniform results will be permitted.

3 Continuous volumetric concrete mixers may be used, with the approval of the RCE and SME, for non-structural concrete. Ensure that mix designs comply with **Subsection 701.2.12** and that all materials used comply with **Subsection 701.2**. Ensure that continuous volumetric concrete mixers are capable of combining aggregate, cement and/or fly ash, water, and admixtures into a uniform mixture within the specified mixing period.

4 Ensure that continuous volumetric concrete mixers meet the following additional requirements:

- A capacity to carry (in separate compartments for each ingredient) enough of each individual ingredient to produce a minimum of 6 cu yd of concrete;
- A recording meter capable of measuring the cement as it is introduced into the mixture;
- An adjustable flow control valve capable of controlling the flow of water and admixture as the materials are introduced into the mixture;
- A water flow meter capable of indicating to the nearest 0.10 gal the quantity of gallons used;
- The capability of being calibrated to automatically proportion and blend all components of the concrete mixture on a continuous or intermittent basis, as required; and
- Equipped with an onboard ticketing system that will electronically produce a record of all material used and the respective weights and total volume of concrete placed; ensure that tickets also identify the following information at a minimum:
    - Contractor name,
    - SCDOT Project ID,
    - Date,
    - Truck No.,
    - Ticket No.,
    - Time start/end of pour,
    - Mix ID and description, and
    - Aggregate moisture before mixing.

5 Calibrate the continuous volumetric concrete mixer according to the manufacturer's recommendations. Provide the RCE with the means to verify the calibration of the continuous volumetric concrete mixer.

6 The RCE will allow operation of the continuous volumetric concrete mixer if the concrete produced is within the limits of the specifications.

7 Tolerances in proportioning the various ingredients are:

- Cement and fly ash, mass %: 0.0 to +4.0
- Fine aggregate, mass %: ±2.0
- Coarse aggregate, mass %: ±2.0
- Admixtures, mass, or volume %: ±3.0
- Water, mass, or volume %: ±1.0

8 Perform the calibration process of each volumetric mixer at least once every 12 months or at any time the materials change.

9 Upon written request, the use of volumetric mixers may be allowed on small quantities of structural concrete on a case by case basis upon approval by the DOC Office.

### 701.3.6 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.

### 701.3.7 Slump

1 Except for Class 2500 concrete and unless otherwise specified, provide concrete that has a maximum slump of 4 in. when measured according to ASTM C143. Do not exceed the water to cementitious 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 If the additional water is required to obtain the specified slump at the work site, the RCE may approve adding water from an acceptable water supply. Do not exceed the maximum water to cementitious material ratio shown in either the Structural Concrete table in **Subsection 701.2.12.2** or the submitted and reviewed concrete mix design being supplied. When additional water is added, ensure that the truck mixer drum turns a minimum of 25 revolutions at mixing speed before discharging the concrete.

4 For Class 2500 concrete with an initial slump between 4 in. to 6 in., additional cement may be added at the work site at the rate of 20 lb of cement per cubic yard of concrete per inch of slump over 4 in. to attempt to bring the slump down to the maximum of 4 in. Batches of Class 2500 concrete with slumps greater than 4 in. after the allowable addition of cement will not be accepted for Department use.

### 701.3.8 Water Reducers

1 A water reducer may be used to increase the slump of concrete. A water reducing admixture (WRA) may be used to increase the slump to a maximum of 6 in. A high-range water reducer (HRWR) may be used to increase the slump to a maximum of 9 in. Do not allow the slump of concrete used in bridge decks to exceed 6 in.

2 Use WRA or HRWR admixtures listed on *Qualified Products List 5*. Provide to the RCE for prior approval the admixture manufacturer's product data sheet that clearly states that the product is intended for use as a WRA or a HRWR. Use

WRA and HRWR admixtures according to the manufacturer's recommendations and the limitations specified in this Subsection.

3 Type F and Type G admixtures can be added to concrete at the work site just before discharge to increase workability while leaving the water to cementitious material ratio unchanged. If the admixtures are used at the work site, add them just before discharge, and mix the 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 ensure that the slump does not exceed the maximum slump limits indicated in **Subsection 701.3.7**. Discontinue or avoid the use of the 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.

### 701.3.9 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 in concrete that is not likely to reach its final position in the forms before initial set occurs. Ensure that proportioning and dispensing equipment is calibrated once per year.

### 701.3.10 Fly Ash and Granulated, Blast-Furnace Slag

1 The addition of fly ash or granulated, blast-furnace slag is allowed in the concrete mix if the following requirements are met:

A. Fly ash or granulated, blast-furnace slag may replace the allowable percentages of Type I, Type II, or Type III Portland cement or Type IL Portland-limestone cement. Do not use fly ash or slag replacement for mixes using Type I (SM) or Type IP blended cements.

B. When fly ash is used to replace the Portland and Type IL Portland-limestone 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 specified in the mixture. This percentage may be increased to 35% for mass concrete elements.

C. When 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 specified in the mixture.

D. Submit a mix design to the OMR for review a minimum of 7 days in advance of batching. Indicate in the submittal the amount of cement to be removed, the material that will replace it, and the compressive strength results of the mix.

E. After batching begins and as concrete is delivered to the work site, ensure 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.

F. To ensure accurate batching, provide separate storage bins, conveying devices, weighing equipment, and weighing procedures for each material (fly ash or slag) used.

G. When 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.

H. Submit a mix design to the OMR for review a minimum of 7 days in advance of batching. Indicate in the submittal the amount of cement to be removed, the material that will replace it, and the compressive strength results of the mix.

I. After batching begins and as concrete is delivered to the work site, ensure 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.

J. To ensure accurate batching, provide separate storage bins, conveying devices, weighing equipment, and weighing procedures for each material (fly ash or slag) used.

## 701.4 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, 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 ¾ in. 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 cost for concrete used in precast/prestressed members, bridge barrier parapet, 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.

## 701.5 Payment

1 Payment for the accepted quantity for Concrete for Structures – Class at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

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 all related items that do not have a separate pay item in the Contract, including but not limited to the cost of pipe drains, flashing, pipes, anchors, and other similar material.

4 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7011100 | Concrete for Structures – Class 3000 (Roadway) | CY |
| 7011400 | Concrete for Structures – Class 4000 | CY |
| 7011401 | Concrete for Structures – Class 4000 (Retaining Walls) | 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 | CY |
| 7011600 | Concrete for Structures – Class 5000 | CY |

# Section 702 — Concrete Structures

## 702.1 Description

1 Furnish, place, finish, and cure concrete bridges, culverts, and miscellaneous structures, including forms and falsework.

## 702.2 Materials

### 702.2.1 Concrete

1 Provide concrete conforming to **Section 701**. Provide the class of concrete for each type of structure, structural element, or concrete item as specified or as directed by the RCE.

### 702.2.2 Pipes and Conduits

1 If polyvinyl chloride (PVC) pipe schedule 40, 80, or 120 is used for conduit, ensure that the pipe complies with ASTM D1785.

### 702.2.3 Liquid Curing Compounds

1 Use liquid curing compounds conforming to ASTM C309, either Class A all resin or all wax based, or Class B all resin based. Ensure that all products are volatile organic compound compliant (water based or solvent-emulsion). Do not use total solvent-based products. Determine water retention of the compound according to AASHTO T 155.

2 Use materials from sources appearing on *Qualified Products List 33*.

3 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 the material meets ASTM C309 for the type and class furnished,
- Safety Data Sheets (SDS), and
- Application instructions.

4 Only furnish the submittals to the RCE once, unless there are material changes.

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 the label on the project storage tank for identification.

6 The RCE will accept the material if the product is on the QPL, all required documents have been properly submitted, and the product has been delivered in properly labeled containers.

### 702.2.4 Falsework

1 Submit to the BCE the detailed Working Drawings and design calculations for falsework according to **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 decks; or
- Any other items designated on the Plans or in the Special Provisions as requiring falsework.

2 Ensure that the Working Drawings and design calculations are sealed by a South Carolina licensed and registered Professional Engineer and comply with **Subsection 702.3.2**.

3 If a falsework system has been previously used successfully on a SCDOT project, the Working Drawings for that system are not required to be resubmitted to the BCE but, instead submit to the RCE for verification purposes, 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 and the calculations sealed by a South Carolina licensed and registered Professional Engineer.

### 702.2.5 Forms

1 Submit detailed Working Drawings for forms involving items of work listed in **Subsection 702.2.4** according to **Subsection 105.2** and **Section 725**. Ensure that the Working Drawings are sealed by a South Carolina licensed and registered Professional Engineer and comply with **Subsection 702.3.2.3**.

2 If a form system has been previously used successfully on an SCDOT project, Working Drawings for that system are not required to be resubmitted to the BCE. Submit to the RCE, for verification purposes, 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 licensed and 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 incidental to the construction operations. Ensure that the interior dimensions of

the forms conform to the specified shape and dimensions of the finished concrete. Construct and maintain forms to prevent warping and opening of joints due to the expansion or shrinkage of the forms. Ensure that the forms are substantial and unyielding and that the design includes the effect of vibration of concrete and the impact of concrete as placed.

4 Use dressed lumber or plywood for 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 Construction

### 702.3.1 Equipment

#### 702.3.1.1 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 if failure of any of the required vibrators occurs. 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.

#### 702.3.1.2 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 in. Use a tremie constructed in sections having flanged couplings fitted with watertight gaskets.

#### 702.3.1.3 Curing Blankets

1 Use curing blankets of a natural or synthetic fiber-polyethylene mat or other material expressly manufactured for curing concrete. Ensure that the exposed side is a white opaque polyethylene.

### 702.3.2 Falsework/Forming Systems

#### 702.3.2.1 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 702.2.4** and **702.2.5** for submittal requirements.

### 702.3.2.2 Design

1 Design falsework/form systems to accommodate all vertical and horizontal loading that may be placed upon the system 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 lb/cu ft for normal concrete and not less than 120 lb/cu ft 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 lb/sq ft applied over the area supported, plus 75 lb/linear ft 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 lb/sq ft 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 specified alignment and curvature. 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 in. or less.

5 When falsework will 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 will 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.

7 Provide all submittals according to **Section 725**. Only submittals that have the seal and signature of the Contractor's Engineer of Record, who is licensed and registered in South Carolina, are acceptable.

#### 702.3.2.3 Working Drawing Submittals

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 702.2.4** and **702.2.5** for special submittal requirements.

#### 702.3.2.4 Inspection of Falsework Systems

##### 702.3.2.4.1 General

1 Install falsework/form systems according to the submitted, reviewed, and accepted Working Drawings. Do not deviate from these drawings. Properly install clean, lubricated bolts in all bolted connections.

2 The Contractor's designated qualified inspector must inspect the falsework/form systems to ensure that the assembly and installation of the system is according to the accepted falsework/form Working Drawings. Provide the RCE with a written certificate of compliance with the accepted Working Drawings from the designated inspector before loading the system. If the RCE determines that a system has not been assembled or installed according to the accepted Working Drawings, provide an inspection and a written certificate of compliance by a South Carolina licensed and registered Professional Engineer for the system in question. Correct all deficiencies found during the inspection to the satisfaction of the Contractor's qualified inspector and the RCE before loading the falsework system.

##### 702.3.2.4.2 Designated Inspector Qualifications

1 Provide the RCE with the name and qualifications of the Contractor's designated qualified inspector. Ensure 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.

##### 702.3.2.4.3 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.

### 702.3.2.5 Wood Forms

1 Use machined surface chamfer strips to form fillets on concrete members of the specified size and locations. Design and construct forms such that the forms may be removed without damaging 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 in. to the surface of the concrete. Wire form-ties of special design with a weakened section not less than ¾ in. back from the concrete face may be used at places of minor pressure, provided that the ties have ¾-in. deep wooden or plastic cone nuts to ensure the breaking of the tie at least ¾ in. 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 the alternatives without the written approval of the BCE.

3 Roughen cavities left by washers, cone nuts, or falsework/form support systems, and then plug, without any voids, with non-shrink structural grout approved by the RCE. If the grout plug shows a crack after setting, remove the plug 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 the alternatives without the written approval of the BCE.

### 702.3.2.6 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 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 damaging the concrete. Ensure that all embedded elements are galvanized.

2 Do not use metal forms that do not present a smooth surface or do not line up properly. 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.

### 702.3.2.7 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, ensure that the forms comply with the requirements for SIP forms contained in this Subsection.

#### 702.3.2.7.1 Material for SIP Forms

1 Fabricate permanent steel bridge deck forms and supports from steel conforming to ASTM A446/A653, Grades 40 or 50, and having a coating class of G165 according to ASTM A653.

#### 702.3.2.7.2 Design of SIP Forms

##### 702.3.2.7.2.1 Loads for SIP Forms

1 Base the design of SIP steel forms on the dead load of forms, reinforcement, and plastic concrete plus 50 lb/sq ft for construction loads. Limit the allowable unit working stress in the steel sheet to not more than 72.5% of the specified minimum yield strength of the material furnished. Do not exceed 36,000 psi.

##### 702.3.2.7.2.2 Deflection of SIP Forms

1 Calculate deflections using the weight of the forms, the plastic concrete, and reinforcement. Do not use a loading of less than 120 lb/sq ft 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 ft, do not allow deflections to exceed 1/180 of the form span length or ½ in., whichever is less. For form span lengths greater than 10 ft, do not allow deflections to exceed 1/240 of the form span length or ¾ in., 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 specified in this Subsection.

##### 702.3.2.7.2.3 Span Length of SIP Forms

1 Use the clear span distance of the form plus 2 in. measured parallel to form flutes as the design span length for forms.

##### 702.3.2.7.2.4 Design Properties of SIP Forms

1 Compute the physical design properties according to the AISI *Cold-Formed Steel Design Manual*.

#### 702.3.2.7.3 Reinforcing Steel in SIP Forms

1 Ensure that the bottom mat of reinforcing steel in SIP forms has a minimum concrete cover of 1 in. Maintain the plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck.

#### 702.3.2.7.4 Lateral Bracing for SIP Forms

1 Do not consider permanent steel bridge deck forms as lateral bracing for compression flanges of supporting structural members.

#### 702.3.2.7.5 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.

#### 702.3.2.7.6 Welding of SIP Forms

1 Do not weld SIP forms to beam or girder flanges or other structural steel bridge elements.

#### 702.3.2.7.7 Shop Plans for SIP Forms

1 Submit Shop Plans according to **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.

#### 702.3.2.7.8 Construction with SIP Forms

1 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 in. 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.

2 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 according to ASTM A780 with no color added. Minor heat discoloration in areas of welds do not need to be touched up.

3 Locate transverse construction joints at the bottom of a form flute. Field drill ¼-in. weep holes at not less than 12 in. on-center along the line of the joint.

#### 702.3.2.7.9 Placing Concrete in SIP Forms

1 Place concrete according to the manufacturer's recommendations. Vibrate the concrete to avoid honeycombing and voids, especially at construction joints, expansion joints, and valleys and ends of form sheets.

### 702.3.2.7.10 Inspection of SIP Forms

1 Provide reasonable facilities for the RCE to conduct a safe and convenient inspection of the SIP forms.

2 The Contractor's method of construction will be carefully observed during all phases of 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.

3 If the RCE determines that the procedures used during concrete placement warrant inspection of the underside of the deck, form removal may be required at selected locations. Where requested, remove the forms for visual inspection after the concrete has attained adequate strength. Perform the removal of the permanent steel bridge deck forms at no additional cost to the Department.

### 702.3.2.8 Construction of Falsework/Form Systems

1 Set all wood and metal forms as outlined in **Subsections 702.3.2.5** and **702.3.2.6,** 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 according to **Subsection 702.3.2.7**. If before or during the placing of concrete, the forms appear to be unsatisfactory, the RCE will stop all work on the project until the defects have been corrected.

2 Do not place forms in a 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 that 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 and during the placement of concrete. Check all dimensions and ensure 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.

### 702.3.3 Handling and Placing Concrete

#### 702.3.3.1 General

1 Provide adequate lighting system when placing concrete during nighttime.

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 Class 4000DS or Class 4000S concrete is used or the placement is authorized in writing by the BCE. Comply with **Subsection 702.3.3.7**.

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 cu yd/hr, 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 cu yd/hr 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. 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 ensure 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 concrete set.

10 Place concrete while fresh and before initial set has occurred. Do not use or re-temper concrete in which initial set has begun. Never re-temper concrete. Do not use concrete containing lumps or crusts of hardened materials. If any

concrete is found defective, remove or repair the concrete 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 ft 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 alternative 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 ft unless flexible metal or rubber-like pipes are used. Fill each part of the form by depositing the concrete as close to its final position as practical. 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 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 according to **Subsection 702.3.3.5**. If vibration cannot be done effectively because of obstruction by reinforcement or other causes, consolidate concrete by vibrating the form as satisfactory to the RCE.

17 Except in the fabrication of prestressed concrete members, place concrete in horizontal layers not more than 18 in. thick, unless hereinafter specified. When less than a complete layer of concrete is placed in one operation, terminate the concrete pour in a vertical plane. To prevent damage 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.

### 702.3.3.2 Entrained Air and Slump Tests

1 Before discharge into forms, the Department's representative will perform entrained air content (as determined by ASTM C231 or ASTM C173) and slump (as determined by ASTM C143) tests on the first concrete truck to arrive at the point of delivery for every pour to ensure specification compliance. If the first truck arrives with material that is out of tolerance, a retest will be performed after the steps have been taken to correct out of tolerance loads of concrete. Subsequent trucks will be tested, corrected as outlined below, and retested upon arrival until the material meets Department specifications. Once test results demonstrate consistently acceptable results, future entrained air and slump testing will be at the discretion of the Department's representative and when making concrete test specimens for compressive strength testing.

2 Secure the sample for testing after 1 cu yd of concrete has been discharged from the delivery vehicle. The 1 cu yd can be used in the work if the concrete meets Department specifications and is placed into equipment such as a concrete bucket and crane that conveys the concrete without introducing contamination or segregation. The Department will then obtain at least 1 cu ft of concrete from the delivery vehicle in a sampling receptacle that conforms to ASTM C31.

3 If either the entrained air content or slump testing yields a test result that is outside of the allowable range, the Department's representative will perform one retest on a different sample of the load in question. Before the retest, the Contractor and/or ready mixed concrete producer may elect to take steps to bring the mix within specifications, such as adding air entraining admixture, adding water that was held back at the plant, etc. When taking corrective steps, ensure that all other specifications such as allowable time, required number of additional mixing revolutions, and maximum water/cementitious material ratio comply with Department specifications. If the results of the retest are still outside of the allowable range, the load will be rejected and the Contractor will be immediately informed of the test results. Ensure that the producer is immediately notified of the test results through a pre-established means of communication. If the results of the retest indicate passing properties, then the concrete will be permitted to be used in the work.

4 Ensure that no additional cement is added to loads of concrete previously rejected for excessive water content or slump, with the exception of Class 2500 non-structural concrete, as indicated in **Subsection 701.3.7**.

### 702.3.3.3 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 the adjacent forms, and remove all

chalky, loose, or foreign materials. Clean reinforcing steel so that the steel 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; and 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, ensure that the width of the key is approximately one-third of the total width of the section, and ensure that the key occupies approximately the middle third of the section. Ensure that the height/depth of the key is approximately one-third of its width.

### 702.3.3.4 Pumping Concrete

1 Ensure 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.

### 702.3.3.5 Vibration of Concrete

1 Vibrate all classes of concrete except Class 4000DS and Class 4000S. Use vibrators as specified in **Subsection 702.3.1.1** during placement of non-prestressed concrete. For prestressed concrete, use vibrators as specified in **Subsection 704.3.5.1** in addition to the requirements of this Subsection.

2 Apply vibration at the point of deposit and in the area of freshly deposited concrete. Slowly insert and withdraw the vibrators vertically 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.

3 Apply vibrators at uniformly spaced points but not farther apart than twice the radius that the vibrator is visibly effective.

4 Supplement vibration by spading as necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

5 Perform vibration to avoid contact with forms and ties as practical. Do not use vibrators to move the concrete.

### 702.3.3.6 Mass Concrete Placement

1 Requirements for the use of mass concrete procedures are a function of equivalent cement content (ECC) of the concrete mix and the dimensions of the pour. Determine the ECC on a per cubic yard basis with the following formula:

ECC = 1.0(PC) + 0.5(FAF) + 0.8(FAC) + 1.2(SF) + 1.0(SC)

Where:

PC = Portland cement
FAF = Class F fly ash
FAC = Class C fly ash
SF = Silica fume
SC = Slag cement

All units are in pounds per cubic yard.

2 Use the following procedures for mass concrete:

- For concrete mixes with an ECC < 650 lb/cu yd, use procedures for mass concrete placement for a pour that has dimensions of 5 ft or greater in three different directions. For a circular cross section, a mass concrete placement is defined as a pour that has a diameter of 6 ft or greater and a length of 5 ft or greater.
- For concrete mixes with an ECC ≥ 650 lb/cu yd, use procedures for mass concrete placement for a pour that has dimensions of 4 ft or greater in three different directions. For a circular cross section, a mass concrete placement is defined as a pour that has a diameter of 5 ft or greater and a length of 4 ft or greater.
- Mass concrete requirements do not apply to foundation seals (Class 4000S).

3 For all mass concrete pours, do not allow the maximum temperature during curing to exceed the following temperatures:

- For concrete mixes where the total cementitious materials consist of at least 25% Class F fly ash, 35% Class C fly ash, or 35% granulated blast furnace slag by weight, ensure that the maximum temperature during curing does not exceed 180°F.
- For all other concrete mixes, ensure that the maximum temperature during curing does not exceed 160°F.

4 For all mass concrete pours, do not allow the mix temperature to exceed 80ºF measured at discharge into the forms or shaft. With the exception of permanently cased drilled shafts, maintain a temperature differential of 35ºF or less between the interior and exterior of all mass pour elements during curing.

Temperature differential management is not required for drilled shafts that use construction casing according to **Subsection 712.3.7.3**.

5 No later than 30 days before placing mass concrete, submit to the BCE for review and acceptance a Mass Concrete Placement Plan containing, but not limited to, the following:

- Concrete mix design to be used for the mass concrete pour,
- 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 maximum temperature and differential within the limits noted above, and
- Details of the proposed monitoring system.

6 Submit for review by the OMR all special concrete mix designs that are part of the Temperature Control Plan. Do not use high-early-strength (AASHTO M 85 Type III) cement or accelerating admixtures in mass concrete. As an additional measure to aid in temperature control of mass concrete elements, up to 35% of the minimum cement content may be replaced with fly ash.

7 Provide temperature monitoring devices to ensure compliance with the Specifications. Use temperature monitoring devices to collect and record a minimum of one data point per hour. Provide redundancy so that loss of a single monitoring device does not result in the inability to verify the specification requirements. Provide the RCE with a copy of each set of readings and a temperature chart for each mass pour element showing temperature readings vs. time. Provide temperature data to the RCE on a daily basis through the conclusion of monitoring. The RCE may suspend subsequent mass concrete placements for failure to comply with the reporting requirements herein.

8 An exclusion to the temperature monitoring requirements will be permitted for drilled shafts meeting all of the following conditions:

- Shaft diameter less than 10 ft (thickness of casing, if present, may be excluded from measurement);
- Total cementitious materials within concrete mix consisting of at least 25% Class F fly ash by weight;
- ECC of concrete mix is less than or equal to 575 lb/cu yd;
- Placement temperature of 80 ºF or less; and
- Use of construction casing according to **Subsection 712.3.7.3**.

9 For drilled shafts not meeting all of the conditions outlined above, place temperature monitoring devices on 10-ft maximum intervals from the mid-depth to the top of the shaft. Do not place monitors within one shaft diameter from the

top of the shaft. For shafts less than 40 ft in length, monitor a minimum of two elevations. For uncooled shafts, centrally locate the monitoring locations. Minor offsets may be permitted to allow for tremie access if permitted by the BCE. Where cooling tubes are used, place monitoring locations laterally at the estimated center of heat generation. Coordinate the placement of temperature monitoring devices with shaft reinforcing and crosshole sonic logging (CSL) access tubes provided according to **Subsection 712.3.12**. Do not provide additional access tubes around the perimeter of the reinforcing cage that will reduce reinforcing clearances. Do not use monitoring equipment cast into shafts that will interfere with CSL testing. Continue monitoring temperatures in drilled shafts for a minimum of 36 hours after the maximum temperature is measured.

10 For all other mass concrete placements, record temperature development between the location of maximum heat and the exterior of the element at points accepted by the BCE, and monitor the mass pour maximum temperature and temperature differential. Generally, use one monitoring point in the center of the largest mass of concrete and a second point approximately 2 in. inside the face nearest to the first monitoring point. Continue monitoring the temperature until the interior temperature is within 35ºF of the lowest ambient temperature or for a maximum of two weeks.

11 If the monitoring indicates that the proposed measures are not controlling the concrete temperatures as specified, provide to the BCE an engineering assessment of the short- and long-term impacts associated with the non-conformance. Perform the inspection, testing and evaluation of the non-conformance at no additional cost to the Department. Additionally, make the necessary revisions to the Temperature Control Plan and submit the revised plan for review. No additional mass concrete placements will be allowed until the required items have been provided to and accepted by the BCE.

12 The Contractor assumes all risks associated with placing a mass pour of concrete. BCE review of the Contractor's Mass Concrete Placement Plan does not relieve the Contractor of the responsibility for obtaining satisfactory results. If the RCE determines that any mass concrete placed under this specification is unsatisfactory, make the necessary repairs or remove and replace the material at no additional cost to the Department.

13 Provide the control of temperatures in mass concrete pours in addition to any other Contract requirements that apply to this work. All costs associated with temperature controls for mass concrete are incidental to the work.

### 702.3.3.7 Depositing Concrete Underwater

1 When concrete is permitted to be deposited in water by the Contract or with the written approval of the BCE, ensure that the concrete and procedure conform to the following requirements:

- Conform to the requirements of **Subsection 712.3.11** for depositing Class 4000DS concrete in water.
- Ensure that Class 4000S concrete has a slump of approximately 8 in.
- 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.
- To prevent segregation, 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.
- Maintain still water at the point of deposit.

2 Place concrete seals continuously from start to finish and keep the surface of the concrete as nearly horizontal as practical 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 the surface 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 the tremie in the deposited concrete. Ensure 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.

### 702.3.3.8 Concrete Exposed to Tidal Water

1 Except for the initial surface finish, do not disturb the original formed surfaces below the elevation of high tide. To secure a thick and dense surface film, heavily coat the form surface with shellac or acceptable form oil.

2 Notify the BCE of 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 any changes if warranted.

3 Deposit concrete in-the-dry in tidal water within the range of tidal water indicated in this Subsection. Do not allow tidal water directly contact the concrete until the concrete has hardened for at least 3 days.

### 702.3.3.9 Temperature Control

#### 702.3.3.9.1 Concreting in Cold Weather

1 Do not place concrete when the air temperature as measured at the location of the concreting operation is below 35ºF as determined by the RCE unless authorized by the RCE.

2 When concreting in cold weather above 35ºF or with RCE authorization below 35ºF, use suitable equipment and materials as necessary to protect the uncured concrete when air temperatures are anticipated to drop below 50ºF at any time within 96 hours following concrete placement. Ensure that the implemented measures maintain the air temperature surrounding the concrete between 50ºF and 100ºF. Place hi-lo thermometers on the concrete surface at locations directed by the RCE. Monitor concrete temperatures for a period of 4 days after the concrete is placed. Additional monitoring locations may be added by the Contractor if deemed appropriate to ensure concrete protection.

3 Before placing concrete in cold weather, ensure that a contingency plan and provisions are in place to quickly and adequately address sudden temperature changes below those forecasted during the curing period. Check concrete temperatures before leaving for the day to determine if additional protection measures are needed when overnight temperatures are forecasted to drop below 35ºF.

4 Implemented measures to protect concrete placed during cold weather may include but are not limited to the following:

A. Curing blankets conforming to the requirements found in **Subsection 702.3.1.3**. If used, ensure that curing blankets remain in place for a minimum of 4 days;

B. Heating equipment such as stoves, salamanders, or steam equipment deemed necessary to protect the concrete. Dry heat may be used if a system to maintain adequate moisture is used to maintain the concrete in a wet condition during the curing period; and

C. Windbreaks or heated enclosures.

5 Before placing concrete, remove all ice and frost from all materials and surfaces in contact with the concrete.

6 Do not implement alternative measures to those listed above without prior approval by the RCE.

7 Recommendations provided in ACI 306R *Guide to Cold Weather Concreting* may be used to meet the requirements of this Subsection with RCE approval.

8 Maintain the temperature of the air surrounding the curing concrete within the specified limits.

### 702.3.3.9.2 Concrete in Hot Weather

1 When concreting in hot weather, implement measures to prevent a reduction in concrete workability, losses from cement hydration, evaporation, drying, or elevated concrete temperatures. Implement measures to maintain the temperature of concrete below 90°F as measured at the point of discharge from the delivery unit, with the exceptions of Class 2500 concrete and mass concrete pours. Cool the steel forms and reinforcing steel that exceed 120°F before concrete placement.

2 Implemented measures to protect concrete placed during hot weather may include but are not limited to the following:

A. Scheduling work so that the concrete can be placed with the least possible delay;

B. Scheduling work so that the concrete can be placed during a cooler part of the day;

C. Reducing loss of water through absorption by pre-wetting the subgrade or forms just before concrete placement so that the forms will not absorb water from the mix;

D. Spraying forms and reinforcing steel with cool fresh water just before placement of concrete;

E. Erecting windbreakers to prevent wind from drying exposed concrete surfaces while finishing the surfaces;

F. Using water-curing methods to provide evaporative cooling;

G. Screeding and floating concrete as it is placed, and start curing procedures immediately; and

H. Applying liquid curing compound as specified in **Subsection 702.2.3** to all exposed surfaces as finishing is completed.

3 Do not allow the concrete temperature for Class 2500 concrete to exceed 95ºF at discharge. Do not allow the mass concrete mix temperature as measured at discharge into the forms exceed 80°F.

4 Do not implement alternative measures to those listed above without prior approval by the RCE.

5 Recommendations provided in ACI 305R *Guide to Hot Weather Concreting* may be used to meet the requirements of this Subsection with RCE approval.

### 702.3.3.9.3 Responsibility for Satisfactory Results of Temperature Control

1 The Contractor assumes all risks associated with the placing of concrete, and any permission given to place concrete under such conditions will not relieve the

Contractor of 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 in the Contract documents that may apply to the concrete placement. Include all costs associated with temperature controls for concrete placement in the unit cost of the concrete.

### 702.3.4 Setting Finished Grade of Concrete Bridge Deck Slabs

#### 702.3.4.1 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 ½ in.

#### 702.3.4.2 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. Remove all surplus material from the gutters where final hand finishing is permitted. Complete all screeding before the initial set of the concrete has occurred.

3 As screeding is completed at the beginning or end of a pour, especially where fresh concrete adjoins hardened concrete, check the surface of the slab in the longitudinal direction with a 20-ft straightedge or, if approved by the RCE, use a 10-ft straightedge due to the vertical curve ordinate. Correct all abrupt changes that 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 specified grades, and finish the surface to the same surface texture as the wearing surface. Along the edges of the slab where the screed cannot pass, ensure that concrete finishers use a straightedge a minimum 4 ft in length, and ensure that the proper slope of the deck is maintained.

5 For 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. 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 100 ft or less, the Contractor may use a longitudinal screed equal to the length of the span.

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 The RCE will check the slab 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 in., whichever is smaller. Do not allow the maximum deviation from the design cross slope of the deck to exceed ¼ in. measured over any 12 ft of bridge width. Remove excessive heights of ridges formed by the finishing processes.

9 Remove or correct irregularities that exceed the maximum deviations stated in this Subsection to the satisfaction of the RCE and/or BCE at no additional cost to the Department. Do not perform grooving before satisfying the requirements of this Subsection.

### 702.3.5 Concrete Curing

#### 702.3.5.1 Curing of Bridge Decks

1 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, which must be accepted before placing concrete. Do not allow the foggers to spray directly onto the concrete. However, condensation from the foggers that wets 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.

3 The use of a pressure washer with a fine mist nozzle on the wand in lieu of using foggers is acceptable if there is a satisfactory performance in the field as determined by the RCE. Ensure that the system does not drip or pond water on the concrete. Ensure that the system sprays over the concrete (a minimum of

4 ft) and not directly on the concrete and maintains the humidity over the entire surface of the concrete until the curing mats are installed. However, these measures alone may not prevent plastic cracking of the deck. Provide other preventive measures as necessary, including windbreaks, placement of approved Type 2 curing compound or, if necessary, delaying the pour until more suitable conditions are present.

4 Wet-cure the top surface of the bridge deck for a minimum of 7 days.

5 Construction traffic may be placed over the slab if 90% of the 28-day compressive design strength has been reached, even if curing blankets are still in place. Obtain approval from the RCE to place construction traffic on the slab in less than 7 days. Base the strength determination on breaks of cylinders that have been cured similarly to the deck.

6 Provide and maintain a curing box for SCDOT use at the testing site to cure cylinders for 28-day breaks. Ensure that the curing box is capable of holding cylinders at a temperature between 60ºF and 80ºF until the 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.

7 For curing, use curing blankets that conform to **Subsection 702.3.1.3**. Place curing blankets as soon as practical 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.

### 702.3.5.2 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 702.3.5.1**. 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 according to **Subsection 704.3.5.3**.

2 Polyethylene sheeting may be used for curing concrete columns. Ensure that the overlapping edges of the adjacent wraps and the extreme edges of the sheeting are sealed, and maintain a saturated condition 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 702.3.12**.

4 A Type 1, Class B curing compound may be used as soon as practical instead of curing blankets. Ensure that it meets the requirements of **Subsection 702.2.3**.

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 gal per 150 sq ft until the entire surface has a solid and vapor-tight coating of the curing compound. Apply the compound with a spray nozzle that is held 2 ft 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 Provide and maintain a curing box at the testing site for SCDOT use to cure cylinders for 28-day breaks. Ensure that the curing box is capable of holding cylinders at a temperature between 60ºF and 80ºF until the cylinders are shipped within 48 hours 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.

7 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 will be cast, including projecting reinforcing steel, completely remove the compound using steel wire brushes or by other means accepted by the RCE.

8 Protect the sprayed surface film from abrasion or damage for at least 3 days. Do not allow unnecessary walking or the placing of forms, lumber, reinforcing steel, or equipment or allow unnecessary walking on the surface until the film is at least 3 days old.

### 702.3.6 Removal of Falsework and Forms

1 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 for columns and piers in less than 24 hours. Do not remove the forms for all other items in less than 5 hours.

2 Keep forms and falsework under slabs, decks, beams, girders, caps, arches, and structures or parts of structure carrying static dead loads in place until the concrete compressive strength reaches at least 75% of the design strength. Compressive strength verification for the removal of forms and falsework on bent caps and full-depth patches on bridge decks may be performed through the use of a calibrated rebound hammer conforming to ASTM C805. Other nondestructive test methods may be used where rebound hammer is allowed with prior approval by the BCE. For all other elements referenced above, prepare additional test cylinders and cure under similar conditions for use in form and falsework removal strength determinations. Document and report the

results of all strength tests performed by the Contractor to the RCE before removing forms and falsework, regardless of the test method.

3 The allowance for the use of the calibrated rebound hammer described above is strictly for removal of forms and falsework. Verify the strength requirements for the addition of superimposed loads as described in **Subsection 702.3.7** with concrete test cylinders.

4 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.

5 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.

6 Extra test cylinders for early form or falsework removal will be at no additional cost to the Department.

### 702.3.7 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 ft above the top of footing or bottom slab until the concrete develops a minimum of 90% of the 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 the footing or drilled shaft concrete and erecting column forms.
- Wait a minimum of 24 hours between placing the footing and drilled shaft concrete and placing column concrete and until column concrete attains a minimum of 75% of the design compressive strength as verified by testing extra test cylinders.
- Wait a minimum of 72 hours between placing column or pile buildup concrete and beginning erection of cap forms.

- Wait until column or pile buildup concrete attains a minimum of 75% of the design compressive strength as verified by testing extra test cylinders before placing cap concrete.
- 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 an adjacent shaft/drilled pile within a 20-ft 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 construction vehicles or equipment are allowed within the 20-ft radius of the cast concrete item.
- Wait a minimum of 24 hours before driving piles within 100 ft of recently placed concrete.

5 Do not blast within a 50-ft 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 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.

11 If loads or equipment exceeding 80,000 lb gross weight will be placed on the structure, submit the proposed plan with calculations for placing the load(s) on the structure for review, comments, and written acceptance by the BCE. Ensure that the plan and design calculations are prepared by a South Carolina licensed and registered Professional Engineer.

### 702.3.8 Initial Surface Finish

1 Thoroughly vibrate and work the concrete in all structures during the placement operation using 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 702.3.6**, carefully remove the forms. Immediately following form removal, perform the initial surface finishing as described in this Subsection.

3 Individual "bug holes," voids, or similar surface defects larger than ¾ in. wide in any direction or ½ in. deep require repair. Clusters of smaller defects may also warrant repair at the discretion of the RCE.

4 Remove fins and ridges in the concrete surface resulting from misaligned forms by grinding or other methods accepted by the RCE.

5 Use sand and cement mortar to carefully point all depressions resulting from the removal of metal ties and other holes and rough places. Ensure that pointed surfaces are flush with the surrounding structure surface by using a wooden float (or equivalent) before setting of the sand and cement mortar mixture occurs.

### 702.3.9 Repair of Concrete Surface Defects

1 After initial finishing is complete, the RCE will inspect the concrete surfaces. Repair minor surface defects as specified in this Subsection to the satisfaction of the RCE. When it is necessary to add a thin layer of structural grout/concrete to cured concrete, use a suitable type of epoxy bonding compound that produces an adequate bond between the two layers. Ensure that the grout/concrete is suitable for the type of concrete repair for which it will be used and that the epoxy compound meets ASTM C881. Obtain acceptance by the BCE of the grout/concrete and epoxy before its use.

2 Ensure that repaired 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 according to **Subsection 702.3.11**.

### 702.3.10 Repair of Cracks in Top Surface of Bridge Decks

1 Fill cracks on the surface of bridge deck or portions of cracks, including construction joints, with widths of 0.007 in. or greater, which appear before the bridge is opened to the traveling public, at no additional cost to the Department. Fill the cracks using a gravity flow, low viscosity, crack healer/penetrating material capable of filling cracks down to 0.003 in. Use crack sealing material that meets ASTM C881. 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.

2 Make repairs at no additional cost to the Department. The repairs will not justify an extension of the Contract completion date.

3 Decks that have excessive surface cracking or full depth cracking that jeopardizes the structural integrity of the deck or service life of the deck may be deemed unacceptable by the RCE and require more significant repairs, up to and including removal and replacement.

### 702.3.11 Repair of Top Surface of Bridge Decks

1 Repair isolated small holes (approximately 1 in. or less in diameter) with near vertical sides with an epoxy patching material with sand added.

2 For defective areas that are less than 500 sq ft total of the bridge deck, use the following repair procedure:

A. Sawcut and remove defective areas specified by the RCE.

B. Remove all defective and/or delaminated concrete in the outlined areas to sound concrete or a minimum depth of 1 in. below the top mat of the reinforcing steel, whichever is deeper. If jackhammers are used, limit the maximum size to 15 lb. Do not damage the vertical sides of the sawcut during concrete removal.

C. Remove all grease, dirt, oil, or foreign material from the patch areas by blast cleaning.

D. Immediately before placing patching material, remove all dust, sand, and blasting debris with oil-free compressed air.

E. Design a repair concrete mix with approximately 35% aggregate No. 89M or 789 stone by volume. Submit the proposed concrete mix design to the SME for review and furnish a copy to the RCE. Do not use the mix until it has been reviewed by the SME.

F. Immediately after cleaning, while the vertical edge surface is dry and the air temperature and concrete surface temperature are between 50ºF and 80ºF, apply an approved moisture resilient epoxy bonding compound that meets ASTM C881 according to the manufacturer's recommendations to all vertical edges of the repair area.

G. While the epoxy is tacky, pour in the accepted concrete repair mix.

H. Finish off the top on the new patch to the proper grade and cure the patch according to **Subsection 702.3.5.1**, unless otherwise directed by the BCE.

3 For defective areas that are greater than 500 sq ft total for the bridge deck, submit to the BCE a detailed analysis of the defects, a structural analysis of the deck as constructed, and a comprehensive repair proposal signed and sealed by a South Carolina licensed and registered Professional Engineer. The BCE will determine if repairs may be attempted based on the Contractor's proposal; otherwise, the defective deck span will not be accepted.

4 Complete repair work before grooving the bridge deck.

5 Make repairs at no additional cost to the Department. Repairs will not justify an extension of the Contract completion date.

### 702.3.12 Final Finish or Exposed Concrete Surfaces other than Bridge Decks

#### 702.3.12.1 General

1 After providing the initial surface finish according to **Subsection 702.3.8**, provide a final finish to exposed concrete surfaces of structures, except for bridge deck slabs, as specified in the Plans and according to the following requirements for a sprayed or brushed finish. The finish used is at the option of the Contractor. However, use the same finish, either sprayed or brushed, throughout the structure. Notify the RCE of the type of surface finish proposed 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 on *Qualified Products 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 Ensure that the certificate states that the material meets SCDOT Specifications and is essentially the same as that on *Qualified Products 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.

### 702.3.12.2 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. Ensure 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 gal/minute, and a 10 HP or equivalent pump and that is equipped with a working pressure gauge near the nozzle to check the working pressure.

2 If the foreign matter is not removed by the water blast method, use an alternative 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 sufficient time (usually 20 to 45 days) for the membrane to dissipate, and then remove any membrane that remains.

### 702.3.12.3 Application of Final Finish Coating

1 Allow the concrete to cure for 28 days before application of the finial finishing coat. A shorter cure time may be allowed by the RCE if 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. Ensure that the surface is clean and surface dry according to the manufacturer's

recommendations before application of the coating. If the coating is sprayed, use application equipment recommended by the manufacturer of the coating. Ensure that the spray procedure is as approved by the coating manufacturer. Ensure that the coverage per gallon of the coating is according to these specifications and does not exceed 60 sq ft/gal.

### 702.3.12.4 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) sq ft/gal of coating or as recommended by the manufacturer. 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 any 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 recommended by the manufacturer of the material. Apply the sprayed finish strictly according to the written instructions of the product manufacturer. Ensure that the actual application of the material is performed by an operator specially trained for this work and who is skilled in the application of the sprayed finish.

2 Ensure that the spray material is for exterior coating. Use the color Near White (AMS-STD 37778) with smooth texture. The spray coating material may be solvent borne or waterborne. Ensure that the coating meets the following requirements:

A. Durability by accelerated weathering testing is 5000 hours minimum according to ASTM G153.

B. Durability by freeze thaw testing is 50 cycles minimum without detrimental effect. Conduct the test procedure using a test chamber capable of maintaining a -15ºF temperature for 1 hour and a +70ºF temperature for 1 hour, which constitutes one freeze thaw cycle.

C. Durability by salt spray testing is 300 hours minimum according to ASTM B117 without loss of adhesion or deterioration of the coating.

D. Moisture vapor permeability is 0.4 metric perms minimum according to ASTM E96.

3 Ensure that the solvent borne 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. Volatile organic compound is 3.5 lb/gal maximum.

F. The coating total solids is a minimum 68% by weight.

4 Ensure that the 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.

### 702.3.12.5 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 two 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 according to the written recommendations of the product manufacturer. Use workers who have been instructed in its preparation and application to apply the material. Ensure that the final brushing of the material is generally performed 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. Ensure that the final color of the finish is Near White (AMS-STD 37778) with a smooth texture.

3 Use material from a source on *Qualified Products List 7*. Furnish the manufacturer's certification with each shipment stating that it meets the Department's specifications for a brushed-on application.

### 702.3.13 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 General Note Sheet of the Plans or in the Special Provisions. Discontinue the final finish 6 in. 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 extend the finish 18 in. back from the edges of all surfaces to be covered with earth. Continue the final finish at least 24 in. inside the barrel of the culvert at each end.

4 When specified, include the costs of labor, materials, and equipment in the items of work that receive the finishes.

### 702.3.14 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 the 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.

### 702.3.15 Bridge Deck Rideability

1 Provide stakes, lines, and grades according to **Subsection 105.8**. With the RCE present, check the slab for smoothness using a rolling straightedge immediately after the curing operation is complete. Provide a rolling straightedge equipped with devices for marking irregularities in the slab surface of ⅛ in. or more in a length of 10 ft for removal. For temporary detour bridges, ¼ in. or more in a length of 10 ft is acceptable. Details of an acceptable rolling straightedge are available from the BCE office and will be furnished on request. When the bridge length is longer than 100 ft, provide a surface smoothness that conforms to **SC-M-701**.

2 In addition to the longitudinal rolling straightedge check, ensure that the deck surface meets a 0.20 in. in 10 ft straightedge check made transversely across the slab at a spacing determined by the RCE. Perform the longitudinal rolling straightedge tests first.

3 Payment for the above work is according to **Subsection 105.8.2**.

### 702.3.16 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 Ensure that the equipment used for grinding and texturing does not cause damage to other bridge components and does not damage deck concrete that will remain. Do not allow the depth of grinding to exceed ½ in. nor encroach upon the required rebar cover by more than ½ in.

3 Use machines with diamond blades to produce a uniform texture finish. Do not texture the deck surface within 12 in. of the gutter lines or within 2 in. of expansion or deflection joints. The Contractor may elect to produce a textured finish simultaneously with the grinding operation.

4 Contain and remove debris and residue from the grinding and texturing operation by vacuum or other methods approved by the RCE. Ensure that 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.

### 702.3.17 Grooved Surface Finish

1 After the new bridge deck concrete has cured and all applicable rideability specifications have been satisfied, cut grooves into the hardened concrete deck in conformance with this Subsection. Groove the new bridge deck before opening the bridge to traffic. Groove any areas of bridge decks constructed in stages before opening the bridge to temporary or permanent traffic.

2 Cut the grooves into the hardened concrete using a mechanical sawing device that leaves grooves that are 0.125 in. wide and 0.125 in. deep. Provide grooves with a center-to-center spacing that varies randomly from 0.625 in. to 1.125 in. Do not groove across expansion or contraction joints.

3 Skew angles are measured from perpendicular to the centerline of the bridge. Groove the hardened surface of the bridge deck to the extents and in the directions as follows:

A. On bridges with skew angles less than or equal to 20 degrees, cut grooves parallel to the expansion or contraction joints. Extend grooving to within 2 in. to 4 in. from the edge of expansion or contraction joints and to between 6 in. and 18 in. from the gutter line or edge of the raised median. Triangular areas of ungrooved surface concrete are permitted within the 6 in. to 18 in. of transverse offset from the gutter line or edge of raised median.

B. On bridges with skew angles greater than 20 degrees or for irregular bridges with skews that vary, cut grooves perpendicular to the bridge centerline. Extend the grooving to between 2 in. and 18 in. from and perpendicular to the edge of expansion or contraction joints. Do not groove across expansion or contraction joints. Triangular areas of ungrooved surface concrete are permitted within the 2 in. to 18 in. of offset from expansion or contraction joints. Extend grooving to within 11 in. to 13 in. from the gutter line or edge of the raised median.

C. Cut grooves as directed in Item A or B above for bridges constructed in stages when possible. If transverse grooving on a bridge constructed in

stages would result in ungrooved pavements or an otherwise unsatisfactory groove pattern within the travel lanes, the Contractor may cut grooves parallel to the bridge centerline with written BCE approval. When grooving parallel to the bridge centerline, extend the groove pattern as directed in Item B above.

4 Contain and remove residue from the sawing operation from the deck by vacuum or other methods. Ensure that 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.

5 Notify the RCE at least 3 days before performing any deck grooving work. Ensure that the RCE approves in writing any deviation from the above requirements before starting work. Provide a written groove pattern to the RCE for approval using Standard Form 700.21 before the work begins. Perform grooving in the presence of the RCE or a Department representative on site to view the grooving operation.

### 702.3.18 Weep Holes and Drains

1 Locate and construct weep holes and drains as specified or as directed by the RCE. The cost of labor, materials, and equipment is incidental to the structural concrete pay item. No deduction in measurement of concrete is made for these openings.

### 702.3.19 Widening Existing Concrete Structures

1 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-ft intervals and determine elevations to the nearest 0.01 of a foot. Use identical stations for all surveys 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 As necessary, perform grinding and texturing of the deck to meet the longitudinal rolling straightedge, rideability, and transverse straightedge requirements in **Subsection 702.3.15**. 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 above mentioned work, except grinding and texturing, in the unit price 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 in. minimum) to provide a straight line to tie into. Thoroughly roughen to an amplitude of ¼ in. just before casting the new concrete. Just before 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 C881, Type II. Apply bonding epoxy according to the manufacturer's written recommendations.

5 At no additional cost to the Department, repair or replace to the satisfaction of 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 in the Contract, and as determined by the BCE are needed, are paid as extra work.

## 702.4 Measurement

1 Measurement is made according to other applicable sections of the 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.

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 The quantity for the pay item Grooved Surface Finish is the exposed bridge deck surface area inside of the barrier walls and is measured by the square yard (SY), complete and accepted.

4 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 of Concrete Bridge Decks for Widening 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.

## 702.5 Payment

1 All costs of the work described in **Section 702**, except for the pay items listed below, are incidental and included in other items of work. Include all costs 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 Payment for the accepted quantity for Grooved Surface Finish at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

3 Payment for the accepted quantity for Grinding and Texturing Concrete Bridge Deck at the Unit Price is full compensation for furnishing all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

4 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7023200 | Grooved Surface Finish | SY |
| 7028000 | Grinding/Texturing of Concrete Bridge Decks for Widening | SY |

# Section 703 — Reinforcing Steel

## 703.1 Description

1 Furnish, protect, and place reinforcing steel and wire fabric.

## 703.2 Materials

### 703.2.1 Reinforcing Bars

#### 703.2.1.1 General

1 Provide reinforcing bars (rebar) and dowels that meet AASHTO M 31, Type W with a minimum single yield strength level of 60,000 psi, designated as Grade 60 and that are from a source listed on *Qualified Products List 60*.

2 Ensure that each shipment of rebar delivered to the project is accompanied by the manufacturer's mill test report for each heat included in the delivery. Ensure that the mill test report includes the following:

- Producer information;
- Heat number and size of rebar represented by the report;
- The grade for which the steel qualifies;
- Tensile test results including yield strength, tensile strength, and elongation; and
- Statement ensuring that the steel was melted and manufactured in the United States.

#### 703.2.1.2 Quality Assurance (QA) Sample Requirements

1 Acceptance or rejection of all reinforcing steel, with the exception of those described in **Subsection 703.2.1.4**, is based on samples taken in the field by the SCDOT inspector or observed being taken in field by the SCDOT inspector and tested in conformance with AASHTO T 244 by the OMR or an OMR authorized AASHTO accredited testing laboratory. Ensure that each sample includes one complete set of the bar's mill markings and is accompanied by the sample heat's mill test report. Do not tie or fasten reinforcing steel for use in the structure before samples are taken.

2 Once a rebar sample is obtained, the sample must remain in the custody of the SCDOT inspector until delivery to the OMR or OMR authorized AASHTO accredited testing laboratory. Samples delivered to the OMR by the Contractor will not be accepted.

3 Any samples failing to comply with **Subsection 703.2.1** require two check samples of the same heat and rebar size. If either of the check samples fails,

do not use the heat represented in the work, and take a sample from every size of every shipment of rebar produced by the same rebar producer for the remainder of the project for testing.

#### 703.2.1.3 Coiled Rebar

1 With the exception of ultimate butt-welded splices and bars included in **Subsection 703.2.1.4**, ensure that all rebar shipped in a coiled state from the producer listed on *Qualified Products List 60* is sampled after mechanical straightening as used in the project. Ensure that all samples meet all specifications of AASHTO M 31, Type W, as shipped to the project.

#### 703.2.1.4 Reinforcing Bars Exempt from Acceptance Sampling and Testing

1 With the exception of ultimate butt-welded splices, reinforcing bars bent before shipment to the project that have no straight lengths 5 ft or longer will be accepted based upon a manufacturer's certified mill test report from a rebar producer listed on *Qualified Products List 60.*

### 703.2.2 Wire and Wire Fabric

#### 703.2.2.1 General

1 Provide wire and welded wire fabric for concrete reinforcement conforming to AASHTO M 336.

#### 703.2.2.2 Wire (Non-welded) for Concrete Reinforcement

##### 703.2.2.2.1 Quality Assurance (QA) Sample Requirements

1 Acceptance or rejection of wire (non-welded) for concrete reinforcement is based on samples taken in the field by the SCDOT inspector or observed being taken in field by the SCDOT inspector and tested conforming to AASHTO T 244 by the OMR or an OMR authorized AASHTO accredited testing laboratory. Ensure that each sample is accompanied by the manufacturer's material certification and test report.

2 Once a wire sample is obtained, the sample must remain in the custody of the SCDOT inspector until delivery to the OMR or OMR authorized AASHTO accredited testing laboratory. Samples delivered to the OMR by the Contractor will not be accepted.

3 Any samples failing to comply with **Subsection 703.2.1** require two check samples of the same shipment, producer, and size. If either of the check samples fails, that size of wire from that producer from that shipment is rejected. Do not use the rejected wire in the work.

#### 703.2.2.3 Welded Wire Fabric for Concrete Reinforcement

##### 703.2.2.3.1 General

1 Ensure that any welded wire fabric provided for use on SCDOT projects is produced by a manufacturer included on *Qualified Products List 85*.

##### 703.2.2.3.2 Acceptance Requirements

1 Acceptance of welded wire fabric for concrete reinforcement will be based on the manufacturer's material certification and test report. Ensure that the material certification and test report indicate if the wires are deformed and the sizes of the wires in both directions. Ensure that the report contains the manufacturer's test results demonstrating that the welded wire complies with AASHTO M 336 and the strength requirements shown in the Plans. Ensure that the report indicates that the steel has been melted and manufactured in the United States.

### 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 the rebar to the limits shown. Provide zinc-coated reinforcing steel in structures that is produced by one of the following methods:

- Provide hot-dipped galvanized rebar that is galvanized according to ASTM A767, Class I. Galvanize the steel bars after fabrication. Do not use hot-dipped galvanized rebar produced by the water quenching method.
- Provide continuous hot-dip galvanized rebar that is galvanized according to ASTM A1094.

#### 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. Ensure that 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 that warrant repair or replacement. Do not incorporate into the work any reinforcing bar that has 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 this 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, chairs, and reinforcing steel supports according to **Subsection 703.2.6.1**.

### 703.2.4 Mechanical Couplers for Reinforcing Steel

#### 703.2.4.1 General

1 Use mechanical coupler components that are compatible with the reinforcing bars specified in **Subsection 703.2.1**, and manufacture all splices with the mechanical couplers 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. Use mechanical couplers listed on *Qualified Products List 73* for the category of coupler required.

#### 703.2.4.2 Materials

##### 703.2.4.2.1 General

1 A LOT of mechanical couplers is defined as 150, or fraction thereof, of the same type of mechanical coupler used for each bar size and each bar deformation pattern that is used in the work. For ultimate mechanical couplers, ensure that the length of the coupler is less than 10 times the nominal bar diameter. Use service couplers only in locations indicated on the design drawings. Ensure that mechanical couplers meet the following specifications when tested with AASHTO M 31, Type W rebar:

- Cyclic and fatigue tests (current version of California Department of Transportation California Test 670).
- Tensile test (AASHTO T 244) – For ultimate mechanical couplers, a minimum tensile strength of 80 ksi or 125% of the actual yield strength

of the reinforcing bar, whichever is greater; for service couplers, at least 125% of the specified minimum yield strength of the reinforcing bar.

- Slip test – according to the table listed below.

| Reinforcing Bar No. | Total Slip (inch) |
|---|---|
| 4 | 0.020 |
| 5 | 0.020 |
| 6 | 0.020 |
| 7 | 0.028 |
| 8 | 0.028 |
| 9 | 0.028 |
| 10 | 0.036 |
| 11 | 0.036 |
| 14 | 0.048 |
| 18 | 0.060 |

*Note: The total slip must not exceed the values shown in the table when tested under California Test 670.*

#### 703.2.4.2.2 Manufacturer's Certification

1 Provide to the RCE a certified statement from the manufacturer of each type of mechanical coupler used that includes the following information:

- A description of the device, including dimensions, designations, material specifications, and the specific model name;
- A description of the method of packaging and identification;
- A statement that the product complies with **Subsection 106.10** and **Section 703**; and
- Detailed installation instructions.

### 703.2.4.3 Quality Assurance (QA) Sample Requirements

#### 703.2.4.3.1 General

1 Acceptance or rejection of mechanical couplers will be based on random samples assembled by the Contractor using reinforcing bars of the same heat numbers used in the work. The RCE will obtain sample assemblies at the project site before being incorporated into the work and submitted to the OMR or OMR authorized AASHTO accredited testing laboratory for testing. If the sample fails,

two check samples of coupler assemblies using couplers from the same LOT for testing are required.

2 If one or both of the check samples fail, the LOT of couplers is rejected. Do not use in the work.

3 When the LOT of failing couplers is tapered and threaded bar type couplers, both the couplers and corresponding tapered and threaded rebar are rejected. If it is demonstrated to the satisfaction of the RCE that the tapering and threading on the rebar is correct, the rebar may be used with another LOT of couplers, provided that a passing sample coupler assembly is obtained using the new LOT of couplers. Alternatively, if it can be demonstrated to the satisfaction of the RCE that the rebar tapering and threading is incorrect and the couplers themselves are acceptable, the couplers may be used with another shipment of rebar, provided that a passing sample coupler assembly is obtained using the new shipment of tapered and threaded rebar.

4 Once a coupler assembly sample is obtained, the sample must remain in the custody of the SCDOT inspector until delivery to the OMR or OMR authorized AASHTO accredited testing laboratory. Samples delivered to the OMR by the Contractor will not be accepted.

#### 703.2.4.3.2 Test Criteria

1 The OMR will test the tensile strength of sample coupler assemblies conforming to AASHTO T 244 to ensure that the splice achieves an ultimate strength of at least:

- 75,000 psi for service splices, and/or
- 80,000 psi for ultimate splices.

### 703.2.4.4 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 per the manufacturer's instructions. Immediately before installation, check the threads and ease of rotation of any threaded parts of couplers to detect contamination that could cause binding. 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, as determined by 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.

### 703.2.5 Ultimate Butt-Welded Splices (UBWS)

#### 703.2.5.1 Material

1 Use UBWS containing steel that conforms to **Subsection 703.2.1**. Use only UBWS produced using a resistance (flash) welding process by a fabricator listed on *Qualified Products List 103* for the hoop diameter and bar size required.

#### 703.2.5.2 Quality Assurance (QA) Test Requirements

##### 703.2.5.2.1 General

1 A UBWS LOT is defined as a shipment of the same UBWS diameter produced from each bar size and heat number that is used in the work. Acceptance or rejection will be based on sample welded splices used in the work randomly selected by the RCE at the project site and submitted to the OMR or an OMR authorized AASHTO accredited laboratory for testing.

2 Once a UBWS sample is obtained, the sample must remain in the custody of the SCDOT inspector until delivery to the OMR or OMR authorized AASHTO accredited testing laboratory. Samples delivered to the OMR by the Contractor will not be accepted.

3 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, any material not conforming to these specifications will be subject to rejection and replacement of the removed material at no additional time or cost to the Department.

##### 703.2.5.2.2 Test Criteria

1 The OMR will test the tensile strength of the sample splice conforming to AASHTO T 244 to ensure that the UBWS achieves at least 100% of the specified ultimate tensile strength of the reinforcing bar.

2 If a sample fails, two check samples from the same LOT for testing by the OMR are required. Any material not conforming to the requirements in this Subsection will be subject to rejection. If the sample splice fails to conform to these provisions, all splices in the LOT represented by the QA tests will be rejected.

3 Do not mix or combine the LOTS of UBWS being tested before the successful completion of the QA tests.

##### 703.2.5.2.3 Corrective Action

1 When a LOT of UBWS is rejected, fulfill the following requirements before using additional UBWS in the work:

- Perform a complete review of the producer's quality control process for these splices.
- Submit a written report to the RCE describing the cause of failure for the splices in the LOT and provisions for correcting the failure in future LOTS.
- The RCE has 30 days 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 for further testing.

### 703.2.6 Bar Supports

#### 703.2.6.1 General

1 For bar supports that contact forms or floor surfaces, use plastic bar supports. Where removable forms are used, do not use continuous legs or rails that are in contact with the forms. For supports that do not contact forms or the floor surface, use wire bar supports. Where galvanized bars are used, use galvanized wire or plastic supports.

2 Ensure that the wire bar supports comply with the 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.

3 Ensure that plastic bar supports meet the following requirements:

A. Chairs and bolsters are of adequate strength to resist a 300-lb concentrated load without permanent deformation or breakage.

B. The plastic 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.

D. Protect the plastic bar supports from exposure to sunlight until placed in the forms.

4 For flat slabs spans, support the lower layer of slab steel with Slab Bolster (SB) bar supports. Place 1 row near each end of the span with interior rows spaced approximately 24 in. on center.

5 For beam spans where steel stay-in-place forms are used, support the lower layer of slab steel with Slab Bolster Upper (SBU) bar supports spaced approximately 36 in. on center with a minimum of 3 rows between longitudinal

beams and 1 row on each overhang placed not more than 12 in. from the edge of slab. Ensure that the bar supports have Class 1 maximum protection, unless shown otherwise in the Plans.

6 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 at a maximum of 30 in. on center.

#### 703.2.6.2 Concrete Blocks

1 When concrete will 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 in. 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.

### 703.2.7 Tie Wire

1 Provide tie wire galvanized according to AASHTO M 232, Class D for use with galvanized bars. Use black tie wire for non-galvanized bars.

## 703.3 Construction

### 703.3.1 Protection of Materials

1 Store steel reinforcement on platforms, skids, or other supports raised above the ground a minimum of 6 in., and protect the reinforcement from mechanical damage, 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 being used in the work.

### 703.3.2 Bending

1 Bend the reinforcement accurately to the specified shapes. Use proper equipment for cutting and bending reinforcement. Ensure that bar bending is performed according to 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 specified shapes and dimensions. Make any allowances necessary to account for creep in the bars during bending to secure the specified shapes and dimensions.

### 703.3.3 Placing and Fastening

1 Accurately place reinforcement and, during the placing and consolidation of concrete, firmly hold in the specified positions. Maintain distances from the forms and between layers using concrete blocks, hangers, bolsters, or other approved supports complying with **Subsection 703.2.6**.

2 Hold the reinforcement together by tie wire at all intersections except where the spacing is 12 in. 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. Do not tack weld reinforcing bars.

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 703.3.1**. 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.

### 703.3.4 Splicing of Bars

#### 703.3.4.1 General

1 Furnish all reinforcement in the full lengths specified. Except for splices identified on the Plans, do not splice bars without advance written approval from the BCE. Stagger approved splices when possible. Submit the proposed locations of splices for approval from the BCE before installation.

#### 703.3.4.2 Lapped Splices

1 Provide lapped splices of the specified length. In lapped splices, place and wire the bars to maintain the specified minimum distance to the surface of the concrete.

### 703.3.4.3 Ultimate Welded Lap Splices

1 Use welded splices only if detailed on the Plans or with the written approval of the BCE. Ensure that 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 OMR approval 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 OMR approval.

### 703.3.4.4 Ultimate Welded Butt Splices

1 Use ultimate welded butt splices only if detailed on the Plans or with the written approval of the BCE. Ensure that the ultimate welded butt splices comply with **Subsection 703.2.5**.

### 703.3.4.5 Mechanical Couplers

1 Use mechanical couplers only if detailed on the Plans or with written approval of the BCE. Ensure that the mechanical couplers comply with **Subsection 703.2.4**. Do not install any couplers until the passing strength test reports for that LOT have been provided to the RCE.

## 703.4 Measurement

1 The quantity for Reinforcing Steel for Structures is the weight of reinforcing steel placed in a structure according to 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 AASHTO M 31, Type W.

4 The weight of reinforcing wire, welded wire fabric, and plain bar of sizes other than those listed in Table 1 of AASHTO M 31, Type W, is computed from tables of weight published by CRSI or computed using the nominal dimensions and an assumed unit weight of 490 lb/cu ft. 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, and 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 these 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 the items. If rebar is 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 in this Section, is not measured. Mechanical couplers are not measured and are considered incidental to the reinforcing steel item.

8 No allowance is made for the weight of galvanizing in computing the weight of reinforcing steel.

## 703.5 Payment

1 Payment for the accepted quantity for Reinforcing Steel for Structures at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

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 Furnish and place materials for pretensioning or post-tensioning concrete members.

## 704.2 Materials

### 704.2.1 Concrete

1 Provide concrete for prestressed members using the specified concrete strength. If a 28-day compressive strength of 5000 psi is specified, use a mix meeting Class 5000 as specified in **Subsection 701.2.12.2**. Ensure that prestressed concrete conforms to **Section 701**, except for the following modifications:

- Use Aggregate No. 56, No. 57, No. 67, No. 78, or No. 789 as coarse aggregate.
- The coarse/fine aggregate percentage ratio must be between 55%/45% and 65%/35%.
- Use marine limestone coarse aggregate and/or fine aggregate in prestressed concrete only if the total water soluble content of the combined coarse and fine aggregate, when tested according to ASTM C1524, is below 100 ppm.
- Do not use slag material as a coarse aggregate.
- The maximum water-cementitious material ratio for prestressed concrete with 28-day compressive strength greater than 5000 psi is 0.38.
- Submit concrete mix designs to the SME for review. The mix design must designate the design 28-day strength of the mix. Any mix showing a pattern of failure to meet the design 28-day strength will require a re-design of the mix.

### 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 specified. 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 using 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 AASHTO M 204.

#### 704.2.2.2 High-Tensile Strength Seven-Wire Strand

1 Ensure that high-tensile-strength, seven-wire strand conforms to AASHTO M 203. Use only high-tensile-strength, seven-wire strand produced by sources included on *Qualified Products List 106*.

#### 704.2.2.3 High-Tensile Strength Alloy Bars

1 Use high-tensile-strength alloy bars that conform to 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 devices for alloy bar post-tensioning are 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 The Department reserves the right to sample and test prestressing steel, post-tensioning strands, and anchorage assemblies at any time when used on a SCDOT project.

### 704.2.5 Steel Reinforcement

1 Ensure that that deformed steel reinforcement bars conform to **Section 703**.

### 704.2.6 Post-Tensioning Grout

1 Use a commercial premixed grout specifically designed for grouting steel cables, anchorages, and rods meeting ASTM C1107 requirements and accepted by the SME or BCE. Ensure that the commercial premixed grout is non-shrink, non-corrosive, and non-metallic. At the option of the Contractor, a mixture of cement, water, and sand in the proportions of 100 lb of cement to 50 lb of sand (all passing the No. 30 sieve) to approximately 5½ gal of water may be used instead of the commercial premixed grout. Ensure that the sand and cement are from sources listed on *Qualified Products List 1* and *Qualified Products List 6*.

Ensure that water complies with **Subsection 701.2.11**. Use the amount of water necessary to provide a grout of the consistency of thick paint. The sand may be omitted if desired, but obtain the consistency stated above. Mix the grout in a mechanical mixer for at least 2 minutes and keep the mix constantly agitated.

### 704.2.7 Grout for Prestressed Cored Slabs and Box Beams

1 Use a non-shrink, non-corrosive, and non-metallic grout meeting ASTM C1107 requirements, and accepted by the SME or BCE, in the shear keys, dowel holes, and all recesses in the prestressed concrete of cored slabs and box beams that reaches a compressive strength of 5000 psi in 24 hours.

## 704.3 Construction

### 704.3.1 Equipment

1 Provide all equipment necessary for the construction and tensioning process. Calibrate gauges, jacks, and pumps as a system, the same as their use in the tensioning operations. Perform the calibration and provide the accompanying documentation, with an independent calibration service accredited according to ISO/IEC 17025 or under the supervision of a South Carolina licensed and 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, at a minimum, at least once every 12 months.

### 704.3.2 General

1 Ensure that all fabrication of prestressed concrete members in structures is performed by a fabricator certified according to the Prestressed Concrete Institute (PCI) Plant Certification Program for the category of work to be performed. Ensure that a PCI-certified technician at the plant supervises all work performed on prestressed concrete members for SCDOT projects. Have this technician ensure that all prestressing operations are performed properly, and assist the Department's representative in conducting tests and measurements that may be necessary. Ensure that each precast/prestressed concrete fabricator submits 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 the 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 the beam.

Place the information, described above, on piles in an area that will not be covered by the cap.

### 704.3.3 Shop Plans and Working Drawings

1 Before commencing fabrication, submit for review and acceptance by the designer the complete Shop Plans that are signed and sealed by a South Carolina licensed and registered Professional Engineer certifying conformance with the Contract documents. Include details of the plant, forms, equipment, and method of fabrication, including pickup devices and tensioning and de-tensioning procedures in detail for manufacturing the precast prestressed concrete members. Include strand elongation computations, procedure, and sequence of jacking and release of the deflected strands, description of the holdup or hold-down devices for the deflected strands, and other methods or procedures that may be desired by the Department 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 according to **Subsection 105.2** and **Section 725**.

### 704.3.4 Forms

1 Ensure that all forms have smooth joints and produces surfaces of the concrete members free of fins. Use forms that are well braced to maintain true shape and dimension. If form ties are used, use the snap-off or threaded type so that no tie metal remains closer than ¾ in. from the surface of the concrete. Form the bottom corners of the beams with ¾ in. × ¾ in. (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. Ensure that all forms are 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 the form. When forms are continually reused, use steel forms.

2 Recess hold-down devices for deflected strands a distance of 1 in. or more from the exposed face of the concrete, and fill the resulting holes with non-shrink grout. As an alternative, rest the hold-down device on the bottom form and allow the device to remain in place after concrete placement. Mechanically galvanize, according to ASTM B695, the portion of the device in contact with the form for a minimum distance of 1½ in., and fill any voids with non-shrink grout. Ensure that the non-shrink grout has the same design 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 in the Plans.

### 704.3.5 Concrete Work

#### 704.3.5.1 Placing Concrete

1 Do not deposit concrete in the forms until the Department's representative has inspected and approved the placement of the reinforcement, prestressing steel, post-tensioning ducts, anchorages, and other items. Vibrate the concrete internally and/or externally as required for proper consolidation of concrete. Vibrate so as to avoid displacement of reinforcing steel, conduits, or strands.

#### 704.3.5.2 Finishing Concrete

1 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 in. with mortar, and ensure that the surfaces are smooth and free from irregularities. Provide a surface finish as set forth in **Section 702** on the outside faces of exterior beams and piles and the exterior sides of hollow core bridges.

2 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 the aggregate. Intentionally roughen the top surface to full amplitude of approximately ¼ in.

#### 704.3.5.3 Concrete Curing

1 Cure prestressed members using the moist curing method or by using low-pressure steam or radiant heat. Ensure that all wet mats and covers are accepted by the Department's inspector. Side forms may be removed when, as determined by the Department's inspector, the concrete has hardened sufficiently to permit the removal without damage to the concrete member. Additional curing is not required after detensioning.

##### 704.3.5.3.1 Moist Curing Method

1 Under normal curing temperatures, ensure that the moist curing method conforms to the following requirements:

- 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 have been removed, protect the units with wet mats and a vapor proof cover until the units have attained the strength requirements for detensioning.

- If 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.

#### 704.3.5.3.2 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 occur. If the time of initial set is determined by AASHTO T 197, then the time limits described above may be waived. During the waiting period in cold weather, maintain the temperature within the curing chamber between 50ºF and 80ºF 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 using pipes circulating steam, hot oil, or hot water or by using 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 40ºF per hour until the desired curing temperature is reached. Do not allow the average curing temperature within the enclosure to exceed 160ºF. Do not allow the curing temperature at any single point to vary more than 10ºF 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 so as to avoid rapid temperature changes in the concrete.

### 704.3.5.4 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 the 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 the determination of minimum

compressive strength for detensioning with the girder or under matching conditions. Additional curing is not required after detensioning.

#### 704.3.5.5 Inspection and Testing

1 Ensure that the Department's representative has free access to the fabrication plant at all times to inspect 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.

#### 704.3.5.6 Cylinder Molds

1 Furnish an ample supply of 4-in. × 8-in. cylinder molds, acceptable to the OMR, for the casting of test cylinders.

#### 704.3.5.7 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. Ensure that calibration reports are available for review on request by the OMR.

### 704.3.6 Tensioning Procedure

#### 704.3.6.1 General

1 During construction, protect the prestressing wire, strand, or bars from damage due to the 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 deposited on the strands, clean the tendon to the satisfaction of the Department's representative.

#### 704.3.6.2 Pretensioning

1 In the Shop Plans, show the number, size, and location of the strands required to induce the necessary prestress force. Submit a written request for approval of any variances from the design to the BCE before submitting the Shop Plans. Obtain written permission from the BCE before any such changes are made. Give each tendon of all sizes an initial tension as shown on the accepted Shop Plans. Measure the initial tension by a suitable means indicating the stress

directly from the jacking gauge or a dynamometer. Do not measure by elongation of the tendon. Apply the remaining prestressing force to the strands using 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 the strands first in a horizontal position by a partial force in the amount as shown on the accepted 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.

### 704.3.6.3 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. Recheck the calibration every 6 months or furnish a proving ring to check the 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 strands or wires in a tendon simultaneously. Stress strands not on the vertical axis of the beam so 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 so as to cause undesirable bending about the axis. Apply tension in each tendon according to 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 jacking force. Ensure that the elongation of strands is measured and the stresses checked according to the requirements 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 using the end anchorages, grout the ducts containing the strands.

Ensure that the methods and materials for anchoring and grouting post-tensioning strands have been 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 approximately 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.

### 704.3.6.4 Combined Pretensioning and Post-Tensioning

1 When the Plans call for or allow a combination of pretensioning and post-tensioning, adhere to all requirements of both the pretensioning and post-tensioning.

### 704.3.6.5 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. Handle, store, and transport the components to prevent any damage from 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.

2 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 a rigging diagram and 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 executing the work according to the Contract

Documents. 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 the beams and report any discrepancies between the actual and plan camber to the RCE. Allow an additional 30 days for review when the bridge is over a railroad.

### 704.3.7 Prestressed Cored Slabs and Box Beams

#### 704.3.7.1 General

1 Unless otherwise specified below, ensure that prestressed cored slabs and box beams conform to the requirements of this Section.

#### 704.3.7.2 Forms

1 Conform to the requirements of **Subsection 704.3.4**. In addition, for all slab sections and box beam sections:

- Provide a ¾-in. chamfer to the bottom edges on ends and sides, top outside edges, and acute corners.
- Round the top edges on the ends of all sections with a ¼-in. finishing tool.
- Provide square corners on the top edges along shear keys.
- Do not chamfer vertical edges at the ends.

2 Provide holes and recesses at locations indicated in the Shop Plans for insertion of the 1¼-in. diameter transverse tie rods.

#### 704.3.7.3 Finishing

1 For all slab sections and box beam sections:

- Provide a broom finish to the top surface.
- No surface finish is required for the sides and bottom, except the exposed side of the exterior sections.
- Fill all voids with grout on the exposed side of the exterior sections, ensuring that the resulting surface finish is essentially the same color and surface finish as the surrounding concrete.

#### 704.3.7.4 Shop Fitting

1 To ensure a proper field fit, assemble the cored slab and box beam spans in the shop/yard and match mark the pieces. Ensure that the pieces fit together neatly

and in a manner acceptable to the Department's inspector. Provide the correct alignment of the holes for the transverse tie rods.

### 704.3.7.5 Transverse Tie Rods

1 In each span, place 1¼-in. diameter transverse tie rods and tighten to a snug fit. After the 1¼-in. diameter transverse tie rods have been tightened in a span and before any equipment, material, or barrier parapet is placed on the span, fill the shear keys, dowel holes, and tie rod recesses with the non-shrink grout as specified and allow curing for a minimum of 3 days. To prevent leakage of grout, place foam backer rod or other material acceptable to the RCE along the bottom of the joint between adjacent slab and box beam units. 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 portions of transverse tie rods before grouting the recesses.

2 With the approval of the RCE, material and equipment may be placed on the cored slab and box beam spans after the transverse tie rods have been tightened, the grout in shear keys has cured for 3 days minimum, and the grout has reached a compressive strength of 5000 psi.

### 704.3.7.6 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, box beams, and structure to support the equipment and mats without damage. Ensure that a Professional Engineer licensed and 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 and box beams. Ensure that these drawings provide a complete description and location of the equipment that is intended to be placed 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 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.

## 704.4 Measurement

1 The quantity for the pay item Prestressed Concrete Beams (Type specified), Cored Slab (of the size specified), or Box Beam (of the size specified) is the

length of the prestressed concrete beam, cored slab, or Box Beam erected according to 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 measured and paid for as specified in **Subsections 711.4** and **711.5**.

3 Other prestressed members are measured and paid for as specified on the Plans or in the Special Provisions.

## 704.5 Payment

1 Payment for the accepted quantity for Prestressed Concrete Beams (Type specified), Cored Slab (of the size specified), or Box Beam (of the size specified) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Partial payment for prestressed concrete beams may be made according to **Subsections 109.7** and **109.8**.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7041010 | Prestressed Concrete Beam (Type 1 – Mod.) | LF |
| 7042000 | Prestressed Concrete Beam (Type II) | LF |
| 7043000 | Prestressed Concrete Beam (Type III) | LF |
| 7044000 | Prestressed Concrete Beam (Type IV) | LF |
| 70445XX | Prestressed Concrete Bulb Tee Beam (XX″ Mod.) | LF |
| 70454XX | Prestressed Concrete Florida I-Beam (XX″) | LF |
| 7046010 | 3′-0″ × 1′-9″ Cored Slab | LF |
| 7046020 | 3′-0″ × 2′-0″ Cored Slab | LF |
| 7046110 | 3′-0″ × 1′-9″ Slab | LF |
| 7046120 | 3′-0″ × 2′-0″ Slab | LF |
| 7046210 | 3′-0″ × 2′-9″ Box Beam | LF |
| 7046220 | 3′-0″ × 3′-3″ Box Beam | LF |

# Section 705 — Bridge Railing

## 705.1 Description

1 Furnish materials and construct rails on structures, including furnishing and placing mortar or concrete, anchor bolts, reinforcing steel dowels, or other devices used to attach the rails to the structure.

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.

## 705.2 Materials

### 705.2.1 Cast-in-Place Concrete Railing Wall and Barrier Parapet

1 Use Class 4000 concrete or greater. Use concrete and procedures conforming to **Sections 701** and **702**. Provide reinforcing steel conforming to **Section 703**.

### 705.2.2 Precast Bridge Barrier Parapet

1 Use Class 5000 concrete or greater for precast bridge parapet. Use concrete and procedures conforming to **Sections 701** and **702**. Provide reinforcing steel conforming to **Section 703**. Galvanize all installation hardware consisting of bolts, nuts, washers, inserts, and rods according to AASHTO M 111 or AASHTO M 232 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. Submit Shop Plans according to **Subsection 105.2** and **Section 725**, and show complete details of all parts of the post and rail. Ensure that all steel rail and post components conform to AASHTO M 270, Grade 36 or 50. Provide required hardware including bolts, nuts, screws, etc., conforming to **Subsection 705.2.5**.

#### 705.2.3.2 Galvanizing

1 Hot-dip galvanize steel posts and railing according to AASHTO M 111 or AASHTO M 232 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 MIL-DTL-24441 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 ASTM B221, Alloy 6061-T6.

#### 705.2.4.2 Cast Aluminum

1 Ensure cast aluminum railing post and other items for permanent mold castings conform to ASTM B108, Alloy G70B-T61, except that the elongation in 2 in. 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 ASTM F593 Alloy 304, and stainless steel nuts meeting ASTM F594 Alloy 304. Use washers that meet ASTM F844, except that the washers are made from Alloy 304 stainless steel.

## 705.3 Construction

### 705.3.1 General

1 Ensure that shop fabricated railing is of such uniformity 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. 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 specified roadway grade.

### 705.3.2 Fabrication and Erection of Metal Railing

1 Ensure that the fabrication and erection of steel railing conforms to **Section 709** and to this specification. Splice rail members generally near railing posts, and do so only as shown on the Plans. Submit Working Drawings for metal railing according to **Subsection 105.2** and **Section 725**.

2 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 on the Plans or, if not shown on the Plans, provide the separation with a 1/16-in. thick elastomeric sheet, Durometer 60, that meets AASHTO M 251.

3 Weld all steel railing according to the applicable sections of AASHTO/AWS D1.5, *Bridge Welding Code* or AWS D1.1 *Structural Welding Code*. Weld all aluminum railing conforming to Section 10 of the current AWS D1.2, *Structural Welding Code – Aluminum*.

### 705.3.3 Concrete Bridge Railing Wall and Barrier Parapet

1 Construct the concrete railing wall and barrier parapet conforming to **Section 702**. In the construction of railing forms, ensure that the 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 as determined by the RCE. Removal and replacement is at no additional cost to the Department.

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. No additional reinforcing steel is required, and the payment for the concrete in the slab is for the quantity shown on the Plans.

#### 705.3.3.1 Concrete Bridge Rail Surface Finish

1 Provide either a rubbed finish or a final surface finish as specified in **Subsection 702.3.12** and as specified in the Contract.

### 705.4 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 according to **Subsection 703.4**.

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.

## 705.5 Payment

1 Payment for the accepted quantity for Concrete Bridge Parapet, Concrete Bridge Railing, or Precast Bridge Parapet at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Reinforcing steel in cast-in-place concrete parapets and railings is paid for under the provisions of **Subsection 703.5**.

3 Payment for the accepted quantity for Steel Bridge Railing, Steel Handrail, or Metal Bicycle Handrail at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

4 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 |
| 7051040 | 42″ Mash Concrete Barrier Parapet-Hand Formed | LF |
| 7051050 | 42″ Mash Concrete Barrier Parapet/Railing Wall | LF |
| 7051060 | 42″ Concrete Median Barrier (TL-4) – Bridge | LF |
| 7051070 | 56″ Concrete Median Barrier (TL-5) – Bridge | 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 |

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| Item No. | Pay Item | Unit |
|---|---|---|
| 7054010 | Concrete Bridge Railing Wall (2′-6″ Height) | LF |
| 7054012 | Concrete Bridge Railing Wall (2′ Height) | LF |
| 7054030 | Concrete Bridge Railing Wall with Form Liner Finisher | LF |
| 7055010 | Steel Handrails | LF |
| 7055100 | Metal Bicycle Handrail | LF |

# Section 706 — Wood Products for Use in Highway Construction

## 706.1 Description

1 Furnish wood products for falsework, forms, bracing, sheeting, and miscellaneous wood products.

## 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 specified size, grade, and length. Where specified, treat structural lumber according to **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 specified size, grade, and length. For other miscellaneous uses of lumber, not specified on the Plans, use grades and sizes according to the *Southern Pine Inspection Bureau Grading Rules* for the intended use. Where specified, treat lumber according to **Section 707**.

### 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 according to **Section 707**.

### 706.2.4 Wood Fence Posts and Braces

#### 706.2.4.1 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 *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 1½ times the diameter of the elements. 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 in. above the top strand of wire and a minimum embedment in firm ground of 2½ ft for line posts and 3 ft for other posts.

3 Treat Southern Yellow Pine posts and braces according to **Section 707**.

#### 706.2.4.2 Line Posts and Braces

1 Use round posts having a nominal diameter of 4 in. with no diameter less than 3½ in. at any point or square posts sawn nominal 4 in. × 4 in. with no dimension less than 3⅝ in. rough or 3½ in. dressed.

#### 706.2.4.3 End, Corner, Gate, and Pull Posts

1 Use round posts having a nominal diameter of 6 in. with no diameter less than 5½ in. at any point or square posts sawn nominal 6 in. × 6 in. with no dimension less than 5⅝ in. rough or 5½ in. dressed.

### 706.2.5 Timber Piles

1 Furnish and place timber piles according to **SC-M-711-1**.

## 706.3 Construction

1 Not applicable.

## 706.4 Measurement

1 Measurement for wood products is made according to other sections of these specifications that govern the items of work that incorporate the wood products specified.

## 706.5 Payment

1 Payment for wood products is made according to other sections of these specifications that govern the items of work that include the wood products specified.

# Section 707 — Preservation Treatment of Wood Products

## 707.1 Description

1 Provide preservative treatment for timber and lumber for guardrail posts, fence posts, fenders, dolphins and piling.

## 707.2 Materials

### 707.2.1 General

1 Ensure that the supplier of treated wood products uses a third-party treated wood inspection agency accredited by the American Lumber Standard Committee (ALSC) or an independent treated wood inspection company approved by the RCE. Inspect and test the material according to applicable American Wood Protection Association (AWPA) Standards or AASHTO M 133 at no cost to the Department. Provide inspection reports referencing applicable industry standards for each shipment before its use on the project.

2 Ensure that a copy of the inspection agency's report is provided to the RCE for each shipment. In lieu of LOT inspection, the RCE will accept treated wood material (e.g., sawn lumber or timbers including guardrail posts, blockouts and related components, signposts and fence posts) manufactured by a facility that is continually monitored by an ALSC accredited third-party treated wood inspection agency or an RCE approved inspection company and bearing the quality mark of the agency. The RCE will visually inspect and approve all treated wood products before use on the project.

3 Ensure that the treatment plant maintains standard quality control procedures as described in AWPA M3.

### 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 according to AASHTO M 133, which references the requirements of applicable AWPA Standards and International Code Council – Evaluation Service (ICC-ES).

## 707.3 Construction

### 707.3.1 Treating Methods

1 Treat wood products according to AASHTO M 133, which references the requirements of applicable AWPA Standards and ICC-ES.

### 707.3.2 Retention of Preservative

1 For wood products treated with oil-borne preservatives, express the net retention in pounds of preservative per cubic foot of wood. Ensure that all treated lumber products are treated to a minimum ground-contact UC4A retention level. For material treated with water-borne preservatives, express the net retention in pounds of dry preservative per cubic foot of wood.

2 Ensure that the retention and penetration of preservative meets AWPA U1 and T1, or the applicable ICC-ES report, by use category and by product. The determination will be made by assay, by the inspection agency/company accredited by ALSC or approved by the RCE, as provided in **Subsection 707.2**, and according to AWPA M2/M25.

### 707.3.3 Handling and Storage

1 Handle and store treated wood products according to AWPA M4.

### 707.3.4 Fabrication

1 Where practical, perform all required fabrication prior to treatment. If fabrication is required after treatment, perform the fabrication according to AWPA M4.

## 707.4 Measurement

1 No measurement is made for the preservative treatment of wood products.

## 707.5 Payment

1 No direct payment is made for the preservative treatment of wood products. 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 Furnish fastening hardware for timber structures including bolts, lag screws, nuts, nails, washers, rods, eye bars, turnbuckles, shapes, and plates.

## 708.2 Materials

### 708.2.1 General

1 Furnish fastening hardware as specified or as directed by the BCE.

2 Furnish bolts, drift pins, dowels, lag screws, nails, and machine bolts of low carbon steel conforming to **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 **Subsection 709.2.1**.

### 708.2.3 Castings

1 Provide castings of cast steel or gray-iron as specified conforming to **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 ½-in. bolts or smaller that are bearing on wood or metal.

3 For bolts larger than ½-in. 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 Furnish galvanized hardware according to AASHTO M 111, AASHTO M 232, or ASTM B695, Class 55, as applicable.

## 708.3 Construction

1 Any extra length of bolts or extra washers used will be at no additional cost to the Department. The unit weight for galvanized hardware is assumed to be the same as non-galvanized hardware for payment.

## 708.4 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.

## 708.5 Payment

1 Payment for the accepted quantity for Hardware at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 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 Furnish, fabricate, and erect steel structures and structural steel elements for other structures.

### 709.1.1 Design and Details of Design

1 When performed by the Contractor, ensure that the design methods, calculations, and details of the design of structural steel comply with the AASHTO *LRFD Bridge Design Specifications,* applicable SCDOT Structures Manuals, and these specifications. For conflicts between SCDOT specifications and the AASHTO specifications, the requirements of the SCDOT 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 the camber of structural members, tolerances, finishes, type of fasteners, and other information as may be required for the preparation of Shop Plans and Working Drawings.

### 709.1.3 Shop Plans and Working Drawings

1 Furnish Shop Plans showing the complete details and sizes of component parts of the structure and details of all miscellaneous parts such as nuts, bolts, drains, etc. Submit additional stress sheets, Working Drawings, and Erection Plans as required. Ensure that Shop Plan, Working Drawing, and Erection Plan submissions conform to **Subsection 105.2**, **Section 725**, and **Subsection 709.3.5.4**.

## 709.2 Materials

### 709.2.1 Structural Steel

#### 709.2.1.1 General

1 Ensure that all structural steel conforms to AASHTO M 270.

2 Thermo-mechanical control processed (TMCP) HPS 70W steel may be directly substituted for quenched and tempered (Q&T) HPS 70W steel for plate thicknesses up to 2 in.

3 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 AASHTO/AWS D1.5*, Bridge Welding Code*.

#### 709.2.1.3 Charpy V-Notch Testing

1 Perform Charpy V-Notch testing of the following structural steel members. Ensure that the longitudinal Charpy V-Notch results comply with the requirements of AASHTO M 270, Zone 2. Sample according to the requirements of AASHTO M 270. Perform testing according to ASTM E23.

##### 709.2.1.3.1 Simple Span Rolled Beam

1 Perform Charpy V-Notch testing of the beam itself and the 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, 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 and any top or bottom cover plate located in a tension region. 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 all web plates, the top flange plates, and the bottom flange plates located in tension regions as indicated in the Plans. Also, perform testing on all web splice plates and top and bottom flange splice plates, excluding any filler plates.

#### 709.2.1.4 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 according to AASHTO/AWS D1.5, *Bridge Welding Code*.

2 Clean all structural steel to the requirements of Near White Blast Cleaning according to 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 restore the surface finish to the specified Near White Blast Clean condition.

3 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 AASHTO M 169 (ASTM A108) 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 is a low carbon grade suitable for welding and complies with ASTM A109.

2 Provide shear connector studs suitable for welding to steel beams and girders with automatically timed stud-welding equipment.

3 Ensure that studs are of the specified type, size or diameter, and length and are listed on *Qualified Products List 25*.

### 709.2.3 Welding Electrodes

1 Ensure that the electrodes used in welding structural steel conform to the 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 according to the appropriate ASTM materials specifications.

2 Ensure that additional requirements for the field or shop installation of ASTM F3125, Grade A325 high strength bolts are met.

3 Ensure that all bolts, nuts, washers, and Direct Tension Indicators (DTI) are marked according to the appropriate ASTM specifications.

4 Use galvanized bolts, nuts, washers, and DTIs where steel is to be painted. Use non-galvanized bolts, nuts, washers, and DTIs where steel is not to be painted.

#### 709.2.4.2 Bolts

1 Provide bolts meeting ASTM F3125, Grade A325. Mechanically galvanize Type 1 bolts according to ASTM B695, Class 50. Use non-galvanized Type 3 bolts where steel is not to be painted.

#### 709.2.4.3 Nuts

1 Furnish nuts meeting ASTM A563, Grade DH or DH3 as specified. Ensure that Grade DH nuts are mechanically galvanized according to ASTM B695, Class 50. Ensure that plain nuts for Type 3 bolts are Grade DH3.

2 Provide galvanized nuts tapped oversize the minimum amount required for proper assembly. Ensure that the amount of over-tap in the nut allows the nut to assemble freely on the bolt in the coated condition and meets the mechanical requirements of ASTM A563 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 ASTM F436 as revised by these specifications.

2 Mechanically galvanize washers for Type 1 bolts according to ASTM B695, 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 (DTIs)

1 Furnish DTIs complying with ASTM F959.

2 Mechanically galvanize the DTIs for Type 1 bolts according to ASTM B695, Class 50. Use non-galvanized weathering steel DTIs 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 according to ASTM F606, Method 1.

2 Perform wedge tests according to ASTM F606 on full size bolts. Perform tests after galvanizing. Perform testing at the minimum frequency specified in ASTM F3125, Grade A325.

3 Measure the thickness of the zinc coating on the wrench flats or top of the bolt head.

##### 709.2.4.6.2 Nuts

1 Perform proof load tests according to ASTM F606. Perform testing at the minimum frequency specified in ASTM A563. 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 (DTIs)

1 Test the DTIs according to **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 according to **Subsection 709.3.3.10** for long bolts and/or **Subsection 709.3.3.11** for bolts too short to be tested in a tension measuring device (TMD). Perform rotational-capacity tests on all structural fastener assemblies before 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 F3125, Grade 325 Bolts**

| Bolt Diameter (inches) | ½ | ⅝ | ¾ | ⅞ | 1 | 1⅛ | 1¼ | 1⅜ | 1½ |
|---|---|---|---|---|---|---|---|---|---|
| Minimum Installation Tension* | 12 | 19 | 28 | 39 | 51 | 64 | 81 | 97 | 118 |
| Minimum Turn Test Tension** | 14 | 22 | 32 | 45 | 59 | 74 | 94 | 112 | 136 |

* *Installation tension equals 70% × Min. Tensile Strength in kips.*
*** Turn test tension equals 1.15 × 70% × 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 Ensure that the manufacturer or distributor that performs the tests certifies that the results reported are accurate.

#### 709.2.4.6.8 Documentation

##### 709.2.4.6.8.1 Mill Test Report (MTR)

1 Furnish MTRs for all mill steel used in the manufacture of the bolts, nuts, and washers. Ensure that each MTR indicates the place where the material has been melted and manufactured.

##### 709.2.4.6.8.2 Manufacturer Certified Test Report (MCTR)

1 Ensure that the manufacturer of the bolts, nuts, and washers furnishes a MCTR for the items furnished. Ensure that the MCTR shows the relevant information required according to **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**; and
- Results of the test required in **Subsection 709.2.4.6.5**, if performed by the manufacturer.

3 Provide a MCTR that certifies that the furnished DTIs 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 MCTRs conform to this specification and the appropriate ASTM specifications.

### 709.2.4.6.9 Shipping

#### 709.2.4.6.9.1 Marking

1 Permanently mark on the side of 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 ASTM A307, Grade A. Provide bolts with single self-locking nuts or double nuts. 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 in. greater than the nominal diameter specified for the bolts.

2 Furnish ribbed bolts with round heads conforming to ANSI B18.5. Provide nuts that are hexagonal, either recessed or with a washer of suitable thickness. Ensure that 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 AASHTO M 102 (ASTM A668), Class C, D, F, and G.

2 Furnish steel castings meeting AASHTO M 103 (ASTM A27) as designated on the Plans.

3 Provide iron castings meeting AASHTO M 105, Class No. 30B. Ensure that the test bars are Type B and are made and tested according to AASHTO M 105.

4 Furnish malleable castings meeting ASTM A47, Grade 35018.

5 Provide bronze castings meeting ASTM B22, Alloy C91100 or C91300.

6 Furnish other miscellaneous metals conforming to the AASHTO *LRFD Bridge Design Specifications*.

7 Furnish a certification for the above listed metals stating that the materials 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 as specified in **Section 724**.

### 709.2.8 Paint

1 Provide the paint and paint system as specified in **Section 710**.

## 709.3 Construction

### 709.3.1 Shop Fabrication

#### 709.3.1.1 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.

### 709.3.1.2 Notice of Beginning of Work

1 Provide the OMR ample notice (14 days minimum) before beginning work at the fabrication shop and in the rolling mill or foundry when specified so that inspection may be conducted. Do not perform any work before the OMR has been notified and the inspection is completed.

### 709.3.1.3 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 according to the American Institute of Steel Construction (AISC) Quality Certification Program for the category of work required.

### 709.3.1.4 Storage of Materials

1 Store structural materials, both plain and fabricated, at the fabricating shop above the ground and on platforms, skids, or other supports. Keep materials free of dirt, grease, and other foreign matter, and protect as practical from corrosion.

### 709.3.1.5 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.

### 709.3.1.6 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 the 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 at no additional cost to the Department.

### 709.3.1.7 Mill Test Reports and Shipping Statements

1 Furnish the OMR with complete, certified mill test reports showing the chemical analysis and the physical tests for each heat of steel for all members. Furnish the OMR with shipping statements.

### 709.3.1.8 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 if 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.

### 709.3.1.9 Straightening Material

1 If straightening is required, use Department approved methods that do not damage the metal. If heat is applied, do not allow the maximum temperature of the steel to exceed 1100ºF. Sharp kinks and bends are cause for rejection of the material.

### 709.3.1.10 Flame Cutting

1 Ensure that flame cutting of structural steel conforms to the AASHTO/AWS D1.5, *Bridge Welding Code*.

### 709.3.1.11 Edge Planing

1 Plane, mill, grind, or thermal cut to a depth of ¼ in. the sheared edges of plates more than ⅝ in. in thickness and which carry calculated stress.

### 709.3.1.12 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 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.

### 709.3.1.13 Flange Bearing Area

1 Ensure that flange surfaces bearing on sole plates conform to the tolerances specified in the 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 1/16 in. 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 ⅛ in. Correct gaps exceeding ⅛ in. in fit-up by a method approved by the BCE before welding the flange to the sole plate.

### 709.3.1.14 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 ¼ in.

### 709.3.1.15 End Connection Angles

1 Build floor beams, stringers, and girders having end connection angles to the 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 detailed drawings.

### 709.3.1.16 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 ¼ in., +⅛ in., -3/16 in.

### 709.3.1.17 Bent Plates

1 Obtain unwelded, cold-bent, load-carrying, rolled-steel plates from the stock plates.

2 Ensure 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. Satisfy the following requirements (where t is the plate thickness):

- Where the bend lines are oriented perpendicular to the direction of final rolling, use 5.0t.
- Where the bend lines are oriented parallel to the direction of final rolling, use 7.5t.
- For cross frame and diaphragm connection plates up to ¾ in., use 1.5t.

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 1100ºF. Reject plates from all ASTM or AASHTO designations inadvertently heated above 1100ºF, or re-quench and re-temper the plates using the correct ASTM procedures.

5 Before bending, round the corners of the plate to a radius of 1/16 in. throughout the portion of the plate at which the bending will occur.

#### 709.3.1.18 Camber

1 Furnish to the OMR a camber diagram prepared by the fabricator, showing the camber at each panel point for trusses or arch ribs, and at the location of field splices and fractions of span length (¼ points minimum, 1/10 points maximum) for continuous beams 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, ensure that the camber diagram shows the 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 according to 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 the vertical camber. This effect may be more pronounced when the top and bottom flanges are of unequal width on a given transverse cross section.

#### 709.3.1.19 Shop Assembly

##### 709.3.1.19.1 General

1 Clean metal contact surfaces before assembling. Assemble the field connections of main members of 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 ream the sub-size holes to the specified size while the connections are assembled.

2 Ensure that each assembly, including camber, alignment, accuracy of holes, and fit of milled joints, is approved by the Department's inspector before commencing reaming or before a computer numerically controlled (CNC) drilled check assembly is dismantled.

##### 709.3.1.19.2 Progressive Truss or Girder Assembly

1 Unless otherwise specified, use progressive girder assembly. Ensure that the assembly contains at least one "carry over" longitudinal segment of the previous assembly, repositioned for accurate alignment (i.e., providing the advancing assembly the proper relative rotation, horizontal, and vertical position) plus one or more longitudinal segments at the advancing end. For entire structures with lengths up to 150 ft, assemble the entire line. The sequence of assembly may

start from any location in the structure provided that the preceding requirements are satisfied. For structures longer than 150 ft, ensure that each assembly is not less than 150 ft long regardless of the length of individual continuous panels or sections.

#### 709.3.1.19.3 Check Assemblies with Computer Numerically Controlled (CNC) Drilled Field Connections

1 When using CNC drilling with progressive assembly, produce a check assembly for each major structural type of each project, unless otherwise specified.

2 Base check assemblies on the proposed order of erection, joints in bearings, special complex points, and similar considerations.

3 Ensure that each check assembly is the first section of each major structural type to be fabricated, unless otherwise agreed to by the Department's shop inspector.

4 No shop assemblies other than the check assemblies are required.

5 If the check assembly fails to demonstrate that the required accuracy is being obtained, further check of the assemblies may be required by the Department's shop inspector at no additional cost to the Department.

### 709.3.1.20 Match Marking

1 Match-mark connecting parts assembled in the shop for reaming holes in field connections, and furnish a diagram identifying the marks to the Department's shop inspector.

### 709.3.1.21 Finished Members at Fabrication Shop

1 Ensure that finished members are true to line and free from twists, bends, and open joints. For box member dimensional tolerance issues, including twists, contact the BCE for guidance.

### 709.3.1.22 Weighing Members

1 When specified that any part of the material is paid for by actual weight, weigh the finished work in the presence of the Department's inspector. In this case, supply satisfactory scales and perform all work involved in handling and weighing the various parts.

### 709.3.1.23 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 material orders, shipping statements, and erection diagrams as requested by the OMR. Provide the weights of the individual members on the statements. Mark the weight on members weighing more than 3 tons.

3 Load structural members on trucks or cars so that the members 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. Protect all hardware from damage in transit. Post a plainly marked list and description of the contained material on the outside of each shipping container.

### 709.3.2 Structural Welding

#### 709.3.2.1 General

1 Ensure that the welding of steel structures and all subsequent references to welding conform to AASHTO/AWS D1.5*, Bridge Welding Code*, the Plans, and the Special Provisions. In addition, adhere to the provisions of **Subsection 709.3.2.2** through **709.3.2.6**.

#### 709.3.2.2 Preheat and Interpass Temperatures

1 Obtain the pre-heat and interpass temperatures required for welding structural steel as specified in the AASHTO/AWS D1.5, *Bridge Welding Code.*

#### 709.3.2.3 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 according to the AASHTO/AWS D1.5*, Bridge Welding Code*. Do not use electro-slag and electro-gas.

#### 709.3.2.4 Welding Shear Studs

1 Weld shear connector studs conforming to the AASHTO/AWS D1.5, *Bridge Welding Code*.

2 Do not allow longitudinal and lateral spacing of studs with respect to each other and to the edges of beam or girder flanges to vary by more than ½ in. from the dimensions shown on the Plans. Spacing may vary by up to 1 in. 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.

### 709.3.2.5 Field Welding

#### 709.3.2.5.1 General

1 Consider all field welding as structural welding, except for the 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 the 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 according to the qualification procedures of the 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 *Qualified Products List 26*. Prepare the test specimens in the presence of, and test and evaluate the specimens 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 of welding approved and the name of the welder and a statement that the welder is duly qualified as a field welder according to the SCDOT requirements. Ensure that the report shows the name of the independent laboratory technician(s) making the evaluation and that the report 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 valid for 2 years and renewable every 2 years if the welder has been engaged in welding procedures during the preceding 2-year period. The list of certified structural steel field welders are included in *Qualified Products List 41*.

#### 709.3.2.5.2 Submittals and Notifications

1 Notify the RCE and the SME at least 14 days before performing any field welding of any items incorporated into the structure by completing Form 700.16 (*SCDOT Welding Procedure Specification*) and submitting the form to the RCE

and the SME. The Department's review and acceptance are required before any field welding will be permitted. Submit to the RCE and OMR for review and acceptance a Structural Field Welding Quality Control (QC) Plan for all structural field welding a minimum of 30 days before performing any field welding. Ensure that the Plan conforms to the 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.

2 Within 14 days after receipt of the QC Plan, the Contractor will be notified of QC Plan acceptance or any additional information required and/or changes that may be necessary to meet the requirements of the Plans and Specifications. If any parts of the QC Plan are unacceptable and rejected, resubmit the changes for re-evaluation. The Contractor will be notified of their acceptance or rejection within 7 days after receipt of the proposed changes.

3 Coordinate and schedule structural field welding with the Department's inspector or Department authorized inspection agency's inspector a minimum of 14 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.

### 709.3.2.6 Inspection of Welds

#### 709.3.2.6.1 General

1 Ensure that the structural steel fabrication and construction assembly, including all shop and field welding, is performed according to the AASHTO/AWS D1.5*, Bridge Welding Code* except as noted herein. Fabrication and welding quality assurance (QA) inspection in the fabricating shops will be performed by the Department's representative, either an OMR inspector or an inspector from a commercial testing laboratory acting for the Department.

#### 709.3.2.6.2 Nondestructive Testing of Welds and Metals

1 Perform radiographic, ultrasonic, magnetic particle, and dye penetrant testing of welds conforming to the 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:

*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, 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.

### 709.3.2.6.3 Inspection of Welded Studs

1 After welding the first 2 studs on the flange and after 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 SME 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 that 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 a 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 the 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 to 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, for 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 studs in the group as required in the paragraph above and replace.

7 The studs tested that show no sign of failure may remain in the bent position.

8 If during the progress of the work, inspection and testing indicates, as determined by the Department’s representative, that the shear connections being obtained are not satisfactory, make the required changes in the welding

procedure, welding equipment, and type of shear connector as necessary to secure satisfactory results at no additional cost to the Department.

### 709.3.3 Bolted Connections

#### 709.3.3.1 Bolt Holes

##### 709.3.3.1.1 Bolt Holes for High Strength Bolts

1 Punch or drill holes for high strength bolts. Unless sub-punching and reaming are required under **Subsection 709.3.3.7**, material forming parts of a member composed of not more than five pieces of metal may be punched 1/16 in. larger than the nominal diameter of the bolts when the thickness of any of the pieces is not greater than ¾ in. for structural steel, ⅝ in. for high-strength steel, or ½ in. 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 ¾ in. for structural steel, ⅝ in. for high-strength steel, or ½ in. for quenched and tempered alloy steel, either sub-drill or drill full-size holes.

3 When required under **Subsection 709.3.3.7**, sub-punch or sub-drill (sub-drilled if thickness limitation governs) all holes 3/16 in. smaller and, after assembling, reamed 1/16 in. larger or drilled full size to 1/16 in. larger than the nominal diameter of the bolts.

4 When permitted by the BCE**,** enlarged or slotted holes are allowed with high-strength bolts.

##### 709.3.3.1.2 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 3/16 in. 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. Provide a driving fit in the finished holes as specified.

#### 709.3.3.2 Punched Holes

1 Do not use a die with a diameter more than 1/16 in. 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.

#### 709.3.3.3 Reamed or Drilled Holes

1 Ensure that reamed or drilled holes are cylindrical, perpendicular to the member, and comply with **Subsection 709.3.3.1** as to size. Where practical, 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 the connecting parts that require 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.

### 709.3.3.4 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, ⅛ in. 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, 3/16 in. smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

### 709.3.3.5 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 demonstrate no offset greater than 1/32 in. 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.

### 709.3.3.6 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 709.3.3**) in field connections and field splices of main members of continuous beam spans and plate girders, and subsequently ream while assembled onto a steel template, as required by **Subsection 709.3.1.19**. 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.

2 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 accurately as to position and angle and firmly bolted in place. Ensure that the 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 accurately located so that the parts or members are duplicates and require no match-marking.

3 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 be in the completed bridge, and fasten the parts securely in position before and during the reaming or drilling of the holes in the joint.

4 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.

5 Perform additional sub-punching and reaming as specified.

6 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 using suitable CNC drilling or punching equipment, subject to the specific provisions contained in this Subsection. Ensure that full-size punched holes meet **Subsection 709.3.3.1**.

7 Unless otherwise specified in the Special Provisions or on the Plans, when CNC drilling or punching equipment is used, the SME may require that the Contractor, by means of check assemblies, demonstrate that the drilling or punching procedure consistently produces holes and connections meeting **Subsections 709.3.3.5** and **709.3.1.19**.

8 Submit to the SME 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 CNC 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.

9 Drill or punch holes with CNC equipment to the appropriate size through individual pieces or through any combination of pieces held tightly together.

### 709.3.3.7 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.

### 709.3.3.8 Installation of High Strength Bolts

1 The following requirements 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 the fasteners 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 before 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 709.3.3.10** or **709.3.3.11** 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 TMD and a dial type torque wrench of suitable range at each job site during the 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 the 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 the hardware back into 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 DTIs. Perform the installation verification test according to the procedures in this Subsection.

9 During installation, regardless of the tightening method used, ensure 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 retesting as directed by the RCE to confirm that storage has not reduced the effectiveness of the lubricant. Ensure that the retesting is 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. Reject bolts, nuts, or washers that are weathered, rusty, or dirty. Submit for approval a procedure for cleaning and re-lubricating rejected fastener LOTs. Retest recleaned or relubricated bolt, nut, and washer assemblies before installation.

#### 709.3.3.9 Procedures for Verification and Installation of High Strength Bolt DTIs

##### 709.3.3.9.1 Verification of DTI Performance

1 Verify DTI performance according to **SC-T-152** before installation of bolts in the work. In bridge work, 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 specification ASTM F959. The basic principle used in this verification test is to ensure 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.

##### 709.3.3.9.2 Test Equipment

1 Use equipment for DTI verification and testing as outlined in **SC-T-152**.

##### 709.3.3.9.3 Verification Test Procedure

1 Perform the DTI verification test procedure according to **SC-T-152**.

2 The DTI fails the verification test if the 0.005-in. 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 turn 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 according to **SC-T-151** by tightening to the minimum DTI gap measured and check according to paragraph 3 above. Do not use the 95% alternative because short bolts are not tested in the tension-measuring device for rotational capacity. Check the DTI used with the short bolt according to **SC-T-152** using a longer bolt in the tension measuring device.

### 709.3.3.9.4 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 to 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. For uncoated DTIs used under a stationary or turned element and for coated DTIs used under a stationary element, further tension the bolts until the number of refusals of the 0.005-in. feeler gauge is equal to or greater than the number shown in the following table. For coated DTIs used under a turned element, ensure that the 0.005-in. feeler gauge is refused in all spaces. If the bolt is tensioned so that no visible gap in any space remains, remove the bolt and DTI and replace with a new properly tensioned bolt and DTI.

**Inspection Criteria**

| Number of spaces in washers | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|
| Minimum 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.*

### 709.3.3.10 Procedure for Performing Rotational Capacity Test (Long Bolts in TMD)

1 Perform the rotational-capacity (R/C) test on the long bolts meeting ASTM F3125, Grade A325 according to the testing procedure in **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 | 74 | 94 | 112 | 136 |

3 Assemblies that have evidence of stripping fail the test.

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)

Assemblies with torque values exceeding this calculated value fail the test.

### 709.3.3.11 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 TMD according to the testing procedure in **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) | ½ | ⅝ | ¾ | ⅞ | 1 | 1⅛ | 1¼ | 1⅜ | 1½ |
|---|---|---|---|---|---|---|---|---|---|
| Torque (ft-lb) | 150 | 290 | 500 | 820 | 1230 | 1730 | 2450 | 3210 | 4250 |

* *Ensure that the measured torque is as follows:*

$$\textit{Torque} \leq 0.25 \times P \times D$$

*Where:*

*Torque = Measured torque (foot pounds)*
*P = Turn test tension (pounds)*
*D = Bolt diameters (feet)*

3 Assemblies that fail before the required rotation, either by stripping or by fracture, fail the test.

#### 709.3.3.12 Installation of Turned and Ribbed Bolts

##### 709.3.3.12.1 General

1 This Subsection does not pertain to the use of high-strength bolts.

##### 709.3.3.12.2 Turned Bolts

1 Ream holes for turned bolts to provide for a light driving fit. Ensure that threads are entirely outside of the holes. Provide a washer under the nut.

##### 709.3.3.12.3 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, ream the hole and replace with an oversized bolt.

### 709.3.4 Bridge Bearing Assemblies

#### 709.3.4.1 General

1 Use rolled steel conforming to AASHTO M 270 (ASTM A709), Grade 36 or Grade 50, for all steel bearing plates.

#### 709.3.4.2 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 250 |
| Pins and pin holes | ANSI 125 |
| Sliding bearings | ANSI 125 |

#### 709.3.4.3 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 in. from a plane perpendicular to the vertical axis.

#### 709.3.4.4 Rocker and Masonry Plates

1 Machine sliding surfaces of both the rocker and the plate flat to an ANSI 250 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, provide 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 if 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.

#### 709.3.4.5 Elastomeric Bearing Pads

1 Ensure that elastomeric bearing pads meet **Section 724**. Provide elastomeric material and laminate to the specified size and thickness.

### 709.3.5 Field Erection

#### 709.3.5.1 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.

#### 709.3.5.2 Handling and Storing Materials

1 Place material stored on skids above the ground. Keep the 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 close enough together to prevent damage 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 damage discovered. The Contractor is responsible for the loss of any accepted material or for any damage caused after being received.

### 709.3.5.3 Falsework

1 Ensure that the falsework is properly designed, substantially constructed, and properly maintained for the loads the structure is intended to support. If requested by the BCE, submit for review and acceptance the Working Drawings for falsework or for changes in an existing structure necessary for maintaining traffic. The BCE may require that Working Drawings bear the seal and signature of a South Carolina licensed and registered Professional Engineer. 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**.

### 709.3.5.4 Erection Plan

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 a rigging diagram and 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 used or from performing all work according to the Contract Documents. 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 the beams and report any discrepancies between the actual and plan camber to the RCE. Allow an additional 30 days for review when the bridge is over a railroad.

### 709.3.5.5 Bearings and Anchorages

1 Verify that all masonry/concrete buildups are level before placing any bridge bearings or elastomeric bearing pads, and furnish the RCE with written documentation of the verification. Set the bridge bearings level and in the exact position, and ensure that the bearings 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 specified.

4 When setting the location of anchors, rockers, or rollers, consider any variation from mean temperature at the time of setting and any anticipated lengthening of the bottom chord or bottom flange due to dead load after setting. The intention is that, at mean temperature and under dead load, the rockers and rollers are vertical and the anchor bolts at expansion bearings are centered in their slots as near as practical. 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 bolts and nuts.

5 Do not place bridge bearings on masonry/concrete bearing areas that are irregular or improperly formed.

### 709.3.5.6 Erection of Structure

1 Erect the metal work, remove the temporary construction, and perform all work required to complete the bridge or bridges as covered by the Contract, including the removal of the old structure or structures, if specified, all according to the Plans and Contract specifications.

### 709.3.5.7 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 damages or distorts the members. Clean the 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 that cylindrical erection pins are 1/32 in. larger.

### 709.3.5.8 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 to the RCE 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 and including a proposed method of correction. When approved, make the corrections 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 damage. Make the necessary corrections and replacements.

### 709.3.5.9 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 damage. Straighten distorted members by mechanical means or, if approved by the BCE, by carefully planned procedures and the supervised application of a limited amount of localized heat. Do not allow the maximum temperature of ASTM or AASHTO designated metals to exceed 1100ºF, and do not allow the temperature to exceed 950ºF within 6 in. of weld metal. Do not apply heat directly on weld metal. Monitor the metal temperature using temperature indicating crayons, liquids, or bimetal thermometers. Reject all metal inadvertently heated above 1100ºF, or requench and retemper the metal using the 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.

### 709.3.6 Removal of Existing Structure and Falsework

1 Remove existing structures according to **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 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 the 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.

## 709.4 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. The structural

steel weight is the computed weight assuming that the unit weight of steel is 490 lb/cu ft and the unit weight of cast iron is 450 lb/cu ft.

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 because 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. Add an additional 5% for fillets and overruns.

6 The right is expressly reserved to weigh a portion or all 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.

## 709.5 Payment

1 Payment for the accepted quantity of Structural Steel is determined using either the Unit Price per pound or Lump Sum price as stated in the Contract. Payment is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified Partial payments are made as indicated in **Subsections 109.7** and **109.8**.

### 709.5.1 Price per Pound Basis

1 The Department's computed weights are final unless such weights are found in error by more than 1½%.

### 709.5.2 Lump-Sum Basis

1 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.

### 709.5.3 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 Prepare and apply paint to specified surfaces. Provide protective devices to avoid damage to the work, facilities, or traffic. Dispose of waste.

## 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 of 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 the samples are made.

2 Inspection and/or sampling will be performed at the point of manufacture when practical. 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 ingredients and the finished paint. Submit samples to the OMR for testing. The manufacturer may proceed with making the paint before receiving test results on the ingredient

samples; however, if 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, SCDES, and local city or county requirements for volatile organic compounds. Use material from *Qualified Products 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. Provide paint in new, strong containers that are properly sealed. Clearly mark each container 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 on *Qualified Products List 19*. Ensure that the prime coat is produced by the same manufacturer as the intermediate and 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 on *Qualified Products 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 on *Qualified Products List 19*.

### 710.2.5 Paint Systems

#### 710.2.5.1 Paint System PS1

1 When Paint System PS1 is specified for new structural steel, including all grades of weathering steel, apply the following paints as specified:

- 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 (AMS-STD 26622) finish coat unless specified otherwise in the Contact documents.

2 Ensure that the primer coat, intermediate coat, and finish coat of paint are produced by the same manufacturer.

3 When the Plans specify partial painting of any grade of weathering structural steel, furnish a brown color (AMS-STD 30045) finish coat to match the long-term color of the weathering steel.

### 710.2.5.2 Paint System PS2

1 When Paint System PS2 is specified 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 and on new steel piling, sway bracing, and casing left in place, apply the following paints as specified:

- 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 (AMS-STD 26622) finish coat unless specified otherwise in the Contract documents. Tint the intermediate coat of aluminum epoxy mastic paint to be clearly distinguishable from the primer coat of aluminum epoxy mastic paint.

3 Ensure that the primer coat, intermediate coat, and finish coat of paint are produced by the same manufacturer.

### 710.2.5.3 Determination of Paint System

1 Unless specified otherwise in the Contract documents, use the table below to determine the applicable paint system for use.

| Material | Paint System |
|---|---|
| New Structural Steel | PS1 |
| Existing Structural Steel | PS2 |
| Exposed Portions of New Steel Piling, Casing left in place | PS2 |

## 710.3 Construction

### 710.3.1 Painting

#### 710.3.1.1 General

1 Perform surface preparation and paint application according to the following Subsections. Protect all portions of the structure against disfigurement by spatter, splashes, and smirches of paint or of paint material, and ensure the protection of pedestrians, vehicular, or other traffic upon, near, or underneath the bridge structure during painting activities.

2 Ensure that the name, telephone number, and address of the person(s) responsible for processing all claims resulting from the painting work are available at each bridge. Process claims in an expedient manner.

#### 710.3.1.2 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 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 before concrete placement.

#### 710.3.1.3 Slip Critical Surfaces

1 For friction type connections designated on the Plans as Class B slip critical, blast clean as defined in the SSPC-SP 10, and coat the contact surfaces with an inorganic zinc-rich paint.

### 710.3.2 Primer Application

#### 710.3.2.1 Inorganic Zinc Silicate Primer

##### 710.3.2.1.1 Surface Preparation

1 Clean structural steel (including all grades of weathering steel unless noted otherwise in the Plans) according to SSPC-SP 10**,** *Near White Blast Cleaning*. Ensure that 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.

##### 710.3.2.1.2 Application of Paint

1 Shop apply inorganic zinc silicate primer unless otherwise specified in the Contract documents. Mix inorganic zinc silicate primer and apply within 12 hours after cleaning and before rusting occurs. Apply paint according to the manufacturer's written recommendations and by workers 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 40ºF or at the minimum temperature recommended by the paint manufacturer, whichever is higher. Do not apply paint on damp surfaces. Do not apply paint when, as determined by the OMR representative, conditions are otherwise unsatisfactory for the work. Do not apply paint when the steel surface temperature is less than 5ºF above the dew point.

##### 710.3.2.1.3 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 that have a dry film thickness less than 3.5 mils for each component. 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 710.3.2.1.1**, and repaint components with severe deficiencies (e.g., areas with readings less than 2.5 mils dry film thickness, excessive mud-cracking or sagging) that, as determined by the OMR representative, cannot be easily corrected by the touch-up method.

3 Allow the inorganic zinc silicate primer to cure according to the manufacturer's recommendations before the aluminum epoxy mastic touch-up or the next coat is applied.

#### 710.3.2.1.4 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.

#### 710.3.2.1.5 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.

### 710.3.2.2 Aluminum Epoxy Mastic Primer

#### 710.3.2.2.1 Surface Preparation

1 Clean new or existing structural steel to the requirements of SSPC-SP 6, *Commercial Blast Cleaning* unless otherwise specified in the Contract documents. 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 that all steel surfaces are dust free.

3 When aluminum epoxy mastic paint is specified for existing structural steel, clean surfaces that are 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 the 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 the cleaned condition as specified.

4 Immediately before the application of any specified intermediate coat or finish coat of paint, clean steel surfaces of all contaminants present on the coated surface according to the paint manufacturer's written instructions unless accepted otherwise by the BCE.

#### 710.3.2.2.2 Application of Paint

1 Apply aluminum epoxy mastic primer within 8 hours after cleaning and before any rusting occurs. Mix paint and apply according to the paint manufacturer's written recommendations using workers skilled in this type of work.

2 Apply aluminum epoxy mastic primer only when the paint, surrounding air, and steel surface temperatures are above 40ºF. Do not apply paint on damp surfaces. Do not apply paint when, as determined by the Department representative, conditions are otherwise unsatisfactory for the work. Do not apply paint when the surface temperature is less than 5ºF above the dew point.

3 Touch up 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.

#### 710.3.2.2.3 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.

#### 710.3.2.2.4 Methods of Application

##### 710.3.2.2.4.1 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 alternative method is approved by the BCE. However, spray application may be used any time the structure is within a closed containment system.

#### 710.3.2.2.4.2 Brush and/or Roller Application

1 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.

#### 710.3.2.2.4.3 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.

### 710.3.3 Field Painting

#### 710.3.3.1 New Superstructure Steel

#### 710.3.3.1.1 General

1 Immediately before 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 according to the paint manufacturer's written instructions unless otherwise accepted by the BCE. Do not allow the maximum time between application of the intermediate coat of paint and the finish coat of paint to exceed 30 days. Apply field coats of paint only when the surrounding air, the steel surface, and the paint temperatures are above 40ºF. Do not apply paint on damp surfaces. Do not apply paint when the air is misty or, as determined by the RCE, is otherwise unsatisfactory for work. Do not apply paint when the surface temperature is less than 5ºF above the dew point.

#### 710.3.3.1.2 Surface Preparation

1 Clean surface areas and all high strength bolts, washers, and nuts (except galvanized bolts, washers, and nuts) as described in **Subsection 710.3.3.1.1** using wire brushes or other suitable tools to remove all objectionable material as listed above to the satisfaction of the RCE. 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 accepted by the OMR. In addition to the specified cleaning and just before 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.

#### 710.3.3.1.3 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 according to the manufacturer's recommendations 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.

#### 710.3.3.1.4 Field Coats

##### 710.3.3.1.4.1 Paint System PS1

1 Apply field coats of paint to all new structural steel including all grades of weathering steel as specified in **Subsection 710.2.5.1**.

##### 710.3.3.1.4.2 Contractor Proposed Plans

1 The Contractor may elect to apply the specified field coats of paint before casting the concrete bridge deck provided that the following conditions are satisfied:

- 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 days before beginning the painting work.
- 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.
- Any required cleaning and touch-up of the primer coat of paint is performed as noted in **Subsections 710.3.3.1.1** and **710.3.3.1.2** before applying any specified field coat of paint, and the inorganic zinc silicate

primer paint's cure time is a minimum of 60 days before application of any specified field coat of paint.

- Any damage to the painted steelwork is corrected before the final inspection of the project.
- 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.
- 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.
- The specified finish coat of field paint cures a minimum of 14 days before casting the deck concrete.

#### 710.3.3.1.5 Application of Paint

##### 710.3.3.1.5.1 General

1 Allow the inorganic zinc silicate primer paint applied as specified in **Subsection 710.3.2** to cure according to the manufacturer's recommendations before application of either intermediate coat of paint.

##### 710.3.3.1.5.2 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 the 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.

#### 710.3.3.1.6 Thickness Requirements

1 Apply paint coat with a minimum dry film thickness as specified. Apply a smooth, uniform coating without film cracking, sagging, or loss of adhesion.

#### 710.3.3.1.7 Methods of Application

##### 710.3.3.1.7.1 Brush and/or Roller Application

1 Ensure that foreign materials are not deposited in the paint film. For all other applied coatings, apply with brush and/or roller application as specified by the paint manufacturer.

##### 710.3.3.1.7.2 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.

##### 710.3.3.1.7.3 Aluminum Epoxy Mastic Paint

1 The aluminum epoxy mastic paint may be applied by spray, brush, and/or roller application, except if the structure is over existing traffic or in an urban area, in which case, apply paint by brushes and/or rollers unless an alternative method is accepted by the BCE. Spray application may be used any time the structure is within a closed containment system.

##### 710.3.3.1.7.4 High Build Aliphatic Polyurethane Paint

1 Apply high build aliphatic polyurethane paint by spray application unless accepted 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.

#### 710.3.3.2 Existing Structural Steel, New Steel Piling, and Casing Left in Place

##### 710.3.3.2.1 Surface Preparation

1 Before 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 according to the paint manufacturer's written instructions unless accepted otherwise by the BCE.

#### 710.3.3.2.2 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 according to **Subsection 710.3.2.1.3**.

#### 710.3.3.2.3 Field Coats

1 Paint all structural steel as specified in **Subsection 710.2.5**.

#### 710.3.3.2.4 Application of Paint

##### 710.3.3.2.4.1 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 days.

##### 710.3.3.2.4.2 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 days.

#### 710.3.3.2.5 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 710.2.5**. Ensure that a smooth uniform coating is applied without any film cracking, sagging, or loss of adhesion.

#### 710.3.3.2.6 Methods of Application

##### 710.3.3.2.6.1 Aluminum Epoxy Mastic Paint

1 Apply the aluminum epoxy mastic paint either by spray, brush, and/or roller application as specified in **Subsection 710.3.3.1.7.3**.

#### 710.3.3.2.6.2 High Build Aliphatic Polyurethane Paint

1 Apply the high build aliphatic polyurethane paint by spray application as specified in **Subsection 710.3.3.1.5.2**.

### 710.3.4 Measurement of Dry Film Paint Thickness

1 Perform the measurement of dry film paint thickness according to the SSPC-PA 2, *Paint Application Specification No. 2* unless specified otherwise by the BCE.

## 710.4 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.

## 710.5 Payment

1 The work and materials required, described, and specified in the cleaning and painting of new structural steel according to the Contract 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. The cost is included in the Contract bid price for each such item.

2 The lump sum payment for Cleaning and Painting Existing Structural Steel is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

3 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 Furnish and drive foundation piles of the type and dimensions designated, including cutting off or building up foundation piles when required.

## 711.2 Materials

### 711.2.1 Prestressed Concrete Piling

#### 711.2.1.1 Concrete

1 Ensure that the materials, equipment, construction methods, etc., conform to **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 according to **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 accepted 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 according to **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 according to **Section 702** that governs the surface finish of concrete.

### 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 ASTM A6 and AASHTO M 270 (ASTM A709), Grade 50. Provide steel pipe conforming to ASTM A252, Grade 2 either seamless or spiral welded.

#### 711.2.2.2 Reinforcing Steel

1 Use reinforcing steel for pipe pile anchors conforming to **Section 703**.

### 711.2.3 Timber Pile

1 Comply with **SC-M-711-1**.

### 711.2.4 Length of Piling

#### 711.2.4.1 Length of Prestressed Concrete Piling

1 Cast concrete piling to the specified length except 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, as determined by 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 the length of steel piling used as prestressed pile points as shown on the Plans or as directed by the BCE.

### 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 eliminate the danger of cracking. Lift concrete piling by suitable devices attached 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 accepted 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 avoids damage to the piling. Store piling material on skids above the ground. Keep the material clean and properly drained. Support long members on skids spaced near enough together to prevent damage from deflection.

2 For steel H-piling, one handling hole, 1½ in. in diameter, may be placed in the web of the pile at either or both ends. For steel pipe piling, two handling holes, 1½ in. in diameter, may be placed in the wall at one end.

## 711.3 Construction

### 711.3.1 Equipment

#### 711.3.1.1 Pile Hammers for Prestressed Concrete and Steel Piling

1 Drive prestressed concrete and steel piling with a single acting air, steam, or diesel hammer or double acting diesel hammer or hydraulic hammer. 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.

#### 711.3.1.2 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 according to the hammer manufacturer's guidelines. Do not use wood, wire rope, or 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.

#### 711.3.1.3 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 before driving of not less than 4 in. 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 ½ of the original thickness or begins to burn. Ensure that the pile cushion dimensions match the cross-sectional area of the pile head.

#### 711.3.1.4 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 provide 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.

#### 711.3.1.5 Templates

1 Provide a rigid steel template that is capable of maintaining the pile in proper position and alignment during driving with swinging leads or with semi-fixed leads. The template should be configured to provide support to all sides of the pile.

2 For piles on land, locate the template within 5 ft of cut-off or within 5 ft of ground line whichever is lower, except as otherwise indicated in this Subsection or accepted by the BCE. For piles in water, locate the template within 5 ft of cut-off or within 5 ft 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 ft 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 ft of the ground and an upper template a minimum of 8 ft 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 by the RCE and/or BCE, to keep the pile within the plan alignment tolerances. Where the upper template conflicts with driving piles in a continuous operation, the distance between the upper and lower templates may be reduced as necessary to accommodate continuous driving. Where the final top of pile elevations will be less than 5 ft above final grade, a single stage template may be used.

5 If during pile installation, the template does not maintain the pile alignment within the specified alignment tolerances, discontinue driving and make the necessary improvements to the template. Obtain RCE acceptance of the changes to the template before resuming pile driving.

### 711.3.1.6 Followers

1 Unless specifically allowed in the Contract, or accepted in writing by the BCE, do not use followers in the driving of piling, except when pile placement is required through water. If the use of a follower is desired, select the hammer considering 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 required resistance 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 in the pile analysis.

### 711.3.1.7 Water Jets

1 Do not use water jets unless accepted by the BCE or specified elsewhere in the Contract. If accepted, 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 100 psi pressure at 2 jet nozzles of ¾-in. 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 resistance.

### 711.3.2 Pile Installation Plan

1 No later than 30 days before driving the first pile, submit a *Pile Installation Plan* to the BCE and the RCE. Include in the 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 the required resistance. Include in the submittal the necessary charts and recent calibrations for any pressure measuring equipment and the method for monitoring pile advancement.
- Detailed drawings of any proposed followers.
- Sequence of driving footing piles for each different configuration of pile layout.
- Proposed schedule for the index pile program and production pile driving.
- Details of proposed items and procedures used to protect the integrity of existing structures.
- Methods and equipment proposed to prevent displacement of piles during placement and compaction of fill, including MSE wall backfill placement, within 15 ft 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 Special Provisions. Within 21 days after receipt of the plan, the BCE will notify the Contractor of plan acceptance or any additional information required and/or changes that may be necessary to meet the Contract requirements. If any part of the plan is found to be unacceptable, agree upon changes with the BCE and resubmit changes for re-evaluation. The BCE will notify the Contractor within 7 days after receipt of the 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 Submit to SCDOT for review one pile driving system per pile type that is within the energy range indicated in the Plans. Additional review time will be required if more than one pile driving system is submitted per pile type.

4 If the Contractor elects to use pile driving systems outside of the hammer energy range indicated in the Plans, contact the RCE or BCE to inform them of this change. The Contractor may be required to retain the services of a Professional Engineer licensed by the State of South Carolina to evaluate the pile driving system and determine its effect on the project. The Department will require 14 days to review the evaluation and either concur with using the pile driving system or reject the system. No extension of Contract time will be granted for delays due to failure of the Contractor to observe these time requirements.

5 The criteria that 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 pile driving analyzer (PDA) at the required pile resistance must be between 36 and 100 blows 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 pile driving analyzer (PDA) must not exceed the allowable installation stresses as indicated in **Subsection 711.3.7**. When PDA testing is performed, perform the testing according to ASTM D4945.

6 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 determined by the BCE that the accepted driving system fails to perform satisfactorily during actual driving, the Department reserves the right to revise the driving criteria.

### 711.3.3 Allowable Installation Stresses in Piling

#### 711.3.3.1 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:

Tensile Stresses < 3 × SQRT ($f'_c$) + 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:

Compressive Stress < 0.85 ($f'_c$) – prestress

3 If required, determine the stresses by Wave Equation Analysis or Dynamic Pile Analyzer (ASTM D4945), whichever is appropriate.

### 711.3.3.2 Steel Piling

1 Do not allow the compressive stresses in the steel pile due to driving to exceed 90% of the yield stress. If required, determine stresses by Wave Equation Analysis or Dynamic Pile Analyzer (ASTM D4945), whichever is appropriate.

### 711.3.4 Index Piling

1 When index piling is required, drive index piling of the type specified and of the length specified at the location designated in the Plans, subject to the approval of the BCE. Incorporate index piling into the final structure unless otherwise directed by the BCE. Unless otherwise accepted in writing by the BCE, drive index piling with the same equipment used in driving the production piling. Do not use a follower for driving index piles unless accepted in writing by the BCE. Drive index piling as soon as practical to minimize delay in determining the length of production piling. The estimated production pile lengths shown on the Plans are for bid estimation purposes only. Unless accepted in writing by the BCE, do not order production piling until all index piling have been driven, the data evaluated, and the piling length accepted by the BCE. The Contractor will be notified by the BCE of the accepted pile lengths within 10 days after receipt of the Index Pile and/or Load Test data.

2 The Department reserves the right 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.

### 711.3.5 Driving of Piling

### 711.3.5.1 Pile Driving Setup

1 Prepare the site for pile installation. Furnish mats and/or barges as necessary to facilitate access. Remove foreseeable obstructions that will conflict with pile locations or setup of equipment necessary for pile installation. Install the template according to **Subsection 711.3.1.5** and prepare the crane, pile hammer, cushions, leads, and all other materials, labor, equipment, tools, supplies, transportation and incidentals necessary for completion of the work. Furnish and place temporary bracing as 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.

2 Do not drive piling until after the excavation is complete. Ensure that the heads of all piles are in a true plane and perpendicular to the longitudinal axis of the pile before attaching the helmet. Protect the heads of piles with a pile cushion as specified in **Subsection 711.3.1.3**.

### 711.3.5.2 Methods of Driving

1 Drive piling according to an accepted Pile Installation Plan as specified in **Subsection 711.3.2** and with equipment meeting **Subsection 711.3.1**.

2 Do not pre-drill for piling, except where specifically noted in the Plans or accepted by the BCE. When pre-drilled holes are allowed, drive the piling with the hammer to its final position and to the required resistance. 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 according to **Subsection 711.3.9**.

5 Splice steel piling driven below grade according to **Subsection 711.3.10**.

6 Remove any material forced up between the piling to the correct elevation before concrete for the foundation is placed.

### 711.3.5.3 Allowable Variation in Driving

1 Drive piling with a variation of not more than ¼ in. per ft from the vertical and a maximum pile head variation of not more than 3 in. from the position shown on the Plans. Drive piling with the head in the proper location without inducing excessive stresses in the piling.

2 Notify the BCE of any piles that are not within the specified tolerances. Remedial actions, if required, will be at no additional cost to the Department. Correct piles driven out of their proper location or below the designated cutoff elevation, at no cost to the Department, using methods approved by the BCE. Do not re-use pulled out piles unless approved by the BCE.

3 Drive piling such that the cap may be placed in its proper location without inducing objectionable stresses in the piling as determined by the RCE. Do not apply lateral pressure to any pile during installation or to the pile after installation.

### 711.3.6 Minimum Penetration

1 Drive piling to a minimum penetration shown in the Plans, or the depth at which the required resistance has been achieved, whichever is greater unless directed otherwise by the BCE.

2 To avoid cutting off a pile, the Contractor may elect, at its risk, to continue driving the pile until it reaches the required elevation.

3 Immediately stop any extended driving beyond the required driving resistance 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 ½ in. at full stroke or equivalent multiples thereof.

4 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.

5 If practical refusal is due to an obstruction encountered within 5 ft of the ground surface at the time of pile installation, remove the obstruction at no additional cost to the Department. Deeper obstructions will be assessed on a case by case basis. If removal of deeper obstruction is determined necessary, all reasonable costs will be paid by the Department as extra work.

### 711.3.7 Determination of Bearing Values

1 Pile bearing will be determined by the BCE based on the Pile Driving Analyzer Test (ASTM D4945). If a pay item for Pile Driving Analyzer Test Set-up is provided, then use the Pile Driving Analyzer. If conditions warrant, the Department reserves the right to require Pile Driving Analyzer Tests even if not provided for in the Plans.

#### 711.3.7.1 Wave Equation Analysis

1 Drive piling to the required resistance shown in the Plans. The actual pile resistance obtained during driving will be determined by the Department based on a Wave Equation Analysis.

#### 711.3.7.2 Pile Driving Analyzer

1 Drive piling to the required resistance shown in the Plans as determined by the Department using the Pile Driving Analyzer according to ASTM D4945.

2 The Department will use a Pile Driving 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 resistances. 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 ft × 4 ft 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.

### 711.3.8 Restriking Piling

1 The Contractor may be required to restrike a number of index piling or selected production piling after initial driving. If a Pile Driving Analyzer is being used, 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 BCE. The time limit for a requested restrike will not be greater than 14 days, unless specified otherwise in the Contract. 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 in. or a maximum of 50 blows, whichever occurs first. If the pile has not reached the required resistance, continue driving until the required resistance is obtained.

2 Measurement and payment for restriking of piling is as specified in **Subsections 711.4** and **711.5**.

### 711.3.9 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 a minimum of 48 hours or until the concrete has set sufficiently to avoid damage to the concrete during removal of forms. 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.

### 711.3.10 Splices for Steel Piling

#### 711.3.10.1 Steel H-Piling

1 If splices are necessary for steel H-piling, make splices as follows:

A. If bent during the driving process, cut off the piling below the bent portion before splicing.

B. 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° with the horizontal. A surface of ⅛ in. may be left unbeveled. Guide plates may be temporarily attached to the web or flanges to properly align the pile sections before welding.

C. Set the upper pile on the lower pile and temporarily clamp thereto. Separate the beveled edges of the upper pile approximately ⅛ in. from

the unbeveled edges of the lower pile. Make the axes of the two piling coincide by adjusting the clamps.

D. 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 AASHTO/AWS D1.5, *Bridge Welding Code*.

2 Prefabricated splicers may be used at no additional cost to the Department. Install according to 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 that the total amount of weld provided on the web is at least equal to the length of weld if a splicer has not been used. Use prefabricated 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 711.3.12**.

### 711.3.10.2 Steel Pipe Piling

1 If splices are necessary for steel pipe piling, make them as follows:

A. Bevel the surface of one of the piles on the outside edge of the wall at an angle of approximately 45° with the horizontal. A surface of ⅛ in. may be left unbeveled. Guide bars may be temporarily attached to the pipe wall to properly align the pile sections before welding.

B. Butt the beveled pile to other pile and temporarily clamp thereto. Separate the beveled edge of the pile approximately ⅛ in. from the squared edge of the other pile. Make the axes of the two piles coincide by adjusting the clamps.

C. 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 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 711.3.12**.

### 711.3.11 Welding of Steel Piling

1 Weld steel piling, including bracing, caps, splices, etc., according to **Section 709** unless otherwise indicated on the Plans and in the Special Provisions or as directed by the BCE or RCE.

### 711.3.12 Painting of Steel Piling

1 Steel piling that is entirely below ground need not be painted. Paint the exposed portions of steel piling from the bottom of the bent cap down to an elevation of 1 ft below the designated 100-year scour line. When the 100-year scour line is not shown on the Plans, paint the piling to a depth of 5 ft below the ground line or streambed elevation, whichever depth is greater. Paint the 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. Paint steel piling according to **Subsection 710.3.3.2** when indicated on the Plans and in the Special Provisions or as directed by the BCE or RCE.

### 711.3.13 Prestressed Pile Points and Reinforced Pile Tips

#### 711.3.13.1 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 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 before driving. If as determined by the RCE and/or BCE splices are necessary, provide slices as indicated in **Subsection 711.3.10**.

#### 711.3.13.2 Reinforced Pile Tips

1 When specified in the Contract, provide reinforced steel piling with manufactured cast steel pile tips conforming to AASHTO M 103/ASTMA27 or ASTM A148. Install the steel pile tips according to 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 accepted by the RCE before installation and that the welds are visually inspected by the RCE in the field.

## 711.4 Measurement

### 711.4.1 Pile Driving Analyzer Test Set-up and Restrikes

1 The quantity of Pile Driving Analyzer Test Set-Ups shown in the Plans is estimated for bid purposes only. The quantity for the pay item Pile Driving Analyzer Test Set-Ups is measured for payment by each (EA) of index or production pilings to which Pile Driving Analyzer test equipment is attached for testing, complete and accepted.

2 Pile driving analyzer test set-ups required due to Contractor errors or inadequate pile driving procedures or equipment are not measured for payment.

3 If a pay item for Pile Driving Analyzer Test Set-Up is not included in the Contract or if the 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.

### 711.4.2 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 the length of piling cut-off due to damage during driving or due to the unnecessary driving past the designated top of pile elevation.

### 711.4.3 Pile Build-up Preparation

1 The quantity for the pay item 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.

### 711.4.4 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 ft of pile point is made for each steel H-pile splice eligible for payment and installed as per **Subsection 711.3.10.1**. An allowance of 6 ft of pile point is made for each pipe pile splice eligible for payment and installed as

per **Subsection 711.3.10.2**. Pile points not conforming to these specifications or not accepted by the RCE and/or BCE are not included in this measurement.

### 711.4.5 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.

### 711.4.6 Index Piling

1 The quantity for the pay item Index Piling (of each type) is the length of piling, including allowance for splices and driven and removed if specified and is measured for payment by the linear foot (LF), complete and accepted.

### 711.4.7 Steel Piling

1 The quantity for the pay item Steel Piling (of each type) is the length of steel H-pile or 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 if it extends the pile beyond plan length or the length initially established by the BCE. An allowance of 4 ft of steel H-pile is added for each steel H-pile splice eligible for payment and installed as per **Subsection 711.3.10.1**. An allowance of 6 ft of steel pipe pile is added for each pipe pile splice eligible for payment and installed as per **Subsection 711.3.10.2**. These measurements do not include piling that does not conform to these specifications or is not accepted by the RCE and/or BCE.

### 711.4.8 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.

## 711.5 Payment

### 711.5.1 Pile Driving Analyzer Test Set-Up and Restrikes

1 Payment for the accepted quantity for Pile Driving Analyzer Test Set-Ups at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

### 711.5.2 Prestressed Concrete Piling

1 Payment for the accepted quantity for Prestressed Concrete Piling (of each type) at the Unit Price is full compensation for furnishing all materials, labor,

equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified. The fixed pile driving costs are included in the pay item Pile Driving Set-Up.

### 711.5.3 Pile Build-up Preparation

1 Payment for the accepted quantity for Pile Build-Up Preparation (of each type) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work a specified.

### 711.5.4 Prestressed Pile Points

1 Payment for the accepted quantity for Prestressed Pile Points (of each type) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

### 711.5.5 Reinforced Pile Tips

1 Payment for the accepted quantity for Reinforced Pile Tips (of each type) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

### 711.5.6 Index Piling

1 Payment for the accepted quantity for Index Piling (of each type) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified. 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 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.

### 711.5.7 Steel Piling

1 Payment for the accepted quantity for Steel H-Bearing Piling or Steel Pipe Piling (of each type) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified. The fixed pile driving costs are included in the pay item Pile Driving Set-Up.

### 711.5.8 Pile Driving Set-Up

1 Payment for the accepted quantity for Pile Driving Set-Up at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified. 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.

### 711.5.9 Pay Items

1 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7110001 | Pile Driving Analyzer Test Set-Up | EA |
| 7110010 | Pile Driving Set-Up | EA |
| 7110XX0 | Prestressed Concrete Piling – (*(size)*″ Sq.) | LF |
| 7110XX1 | Pile Build-Up Preparation – (*(size)*″ Sq.) | EA |
| 7110XX5 | Prestressed Index Piling – (*(size)*″ *(shape)*) Sq.) | LF |
| 71111XX | Prestressed Pile Point – *(HP size)*″ | LF |
| 71113XX | Prestressed Pile Point – (*(pipe diameter)*″ *(Extra Strong or Double Extra Strong pipe)*) | LF |
| 71115XX | Reinforced Pile Tips – (*(size)*) | EA |
| 71117XX | Reinforced Pile Tips – (*(pipe diameter)*″ *(Extra Strong or Double Extra Strong)*) | EA |
| 7112XXX | Steel H-Bearing Piling – (HP *(size)* × *(weight))* | LF |
| 7112XX2 | Steel H-Bearing Index Piling – (HP *(size)* × *(weight))* | LF |
| 7113XX0 | Steel Pipe Piling (*(diameter)*″ Diameter) | LF |
| 7113XX2 | Steel Pipe Index Piling – (*(diameter)*″ Diameter) | LF |

# Section 712 — Drilled Shaft Foundations

## 712.1 Description

1 Construct drilled shafts of reinforced concrete cast in cylindrically excavated holes that extend into soil or rock to support the structure and applied loads.

2 For the purposes of this specification:

- Drilled shafts are cast-in-place shafts with reinforcing steel and have a diameter 30 in. or greater.
- Construction casing refers to casing that remain in-place. Temporary casings are removed prior to or during the concreting process.

## 712.2 Materials

1 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 **Section 703**.

## 712.3 Construction

### 712.3.1 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 ft 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. Use equipment that is 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 according to 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 the maximum compressive 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 BCE.

### 712.3.2 Qualifications of the Contractor

1 Ensure that the installation of drilled shafts is performed by personnel who specialize in drilled shaft 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 shafts. Provide a drilled shaft supervisor with at least this minimum experience on site during the entire construction process of all drilled foundations (e.g., drilling, coring, placing of reinforcement, concreting) to troubleshoot any problems that may arise during the construction process. Complete and sign the drilled shaft documentation as specified in **Subsection 712.3.3**.

2 Failure to comply with the above requirements will result in the suspension of all work related to the drilled shafts. Do not begin work on the drilled shafts until the required personnel qualifications and experience are accepted by the BCE. The Department is not liable for any damages or costs related to the suspension of this work nor will the project completion date be postponed for delays in furnishing the qualifications.

### 712.3.3 Drilled Shaft Documentation

#### 712.3.3.1 Drilled Shaft Installation Plan

1 Submit a *Drilled Shaft Installation Plan* and transmittal letter to the BCE and RCE for review and acceptance. Submit the *Drilled Shaft Installation Plan* a minimum of 30 days before the proposed date to begin drilled shaft installation.

2 Ensure that the plan addresses and includes, at a minimum, the following information:

- Provide a list and size of proposed equipment to be used on the project such as cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, tremies, concrete pumps, casings, templates, etc. Include resumes of the drilled shaft supervisor and drilled shaft rig operator(s).
- Detail the sequence of construction operations for shaft construction in bents or in groups. If the Contractor anticipates and submits the dry method of construction, also submit the wet method of construction to minimize construction delay if the wet method of construction criteria occurs.
- 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, desand, and dispose of slurry. Provide the type and frequency of tests to be 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.
- Details of the steel reinforcing cage, such as method of placement, spacers, concrete feet, supports, method of centering the cage in the shaft, handling, lateral stability, prevention of buckling, etc. Include the number, type, and location (relative to the cage and excavation) of cranes to be used. Identify the pickup points on the cage and indicate how the cage will be supported during concrete placement.
- 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 on the Drilled Shaft Concrete Volumes Log (SCDOT Construction Form 700.11). Indicate the total length of time (time from when first load of concrete is batched until all concrete is placed) necessary to pour the shaft based on the availability of materials and equipment and the construction techniques being used, concrete trucks available, haul distance, etc. For wet concrete placement, indicate how the tremie will be blocked to prevent slurry from entering the tremie.
- Means of disposing of excavated materials.
- The proposed method to check the dimensions and 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.
- The proposed method to clean the bottom of the excavation and the proposed method to evaluating the cleanliness of the excavation bottom.
- Construction and/or temporary casing details including the dimensions and elevations. Include splice details, painting, and/or casing removal details, if applicable.
- Details of the 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.

- Other information required by the Contract or requested by the Department.

3 The BCE will evaluate the *Drilled Shaft Installation Plan* for conformance to the Contract requirements. 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 so, submit a revised *Drilled Shaft 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.

4 Do not commence installation of drilled shaft foundations until the *Drilled Shaft Installation Plan* is accepted by the BCE.

5 Acceptance of the *Drilled Shaft Installation Plan* does not relieve the Contractor of the responsibility to provide sound and adequate foundations that conform to the Contract. Do not make changes in the methods or equipment after acceptance of the *Drilled Shaft Installation Plan* without the written consent of the BCE.

#### 712.3.3.2 Drilled Shaft Construction Forms

1 With the assistance of the inspector, provide the RCE with the following documentation:

- Drilled Shaft Log (Form 700.14),
- Drilled Shaft Excavation Log (Form 700.12),
- Slurry Inspection Log (Form 700.09),
- Drilled Shaft Inspection Log (Form 700.13),
- Drilled Shaft Concrete Placement Log (Form 700.10), and
- Drilled Shaft Concrete Volumes Log (Form 700.11).

2 Ensure that the documentation indicates the theoretical versus actual concrete volume. 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.

3 Provide the RCE with the completed and signed documentation listed above for each drilled shaft foundation no later than 72 hours after the completion of each drilled shaft foundation. Submit only those forms applicable to a specific shaft (e.g., Slurry Inspection Logs will not be required for shafts using dry concrete placement methods).

#### 712.3.3.3 Shop Drawings

1 Provide Shop Drawings as required by the Plans or the BCE according to **Section 725**.

### 712.3.3.4 Concrete Mix Designs

1 Submit concrete mix designs according to **Section 701**. Provide slump loss tests if concrete batching, mixing, and placement are anticipated to exceed 2 hours. Provide mass concrete placement details if the drilled shaft meets the definition for mass concrete as detailed in **Section 702**.

### 712.3.4 Drilled Shaft Setup

1 Prepare the site for drilled shaft installation. Furnish mats and/or barges as necessary to facilitate access. Remove foreseeable obstructions that will conflict with drilled shaft locations or setup of equipment necessary for drilled shaft installation. Prepare the drill rig, augers, drilling buckets, and all other materials, labor, equipment, tools, supplies, transportation, and incidentals necessary for completion of the work.

### 712.3.5 General Construction Methods

1 Perform the excavations required for the drilled shafts through the 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.

2 If soil conditions warrant, the BCE may direct that the shafts be extended below the estimated bottom elevations shown on the Plans. Any additional compensation will be at the Contract unit price for the respective items as described in **Subsection 712.5**.

3 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 are located 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 concrete from water action during placement and curing of the concrete. Install the construction casing to produce an effective seal at the bottom of the casing. Ensure that casings left in place conform to the requirements for construction casing in **Subsection 712.3.7.3**.

### 712.3.5.1 Dry Construction Methods

1 The dry construction method will be allowed by the RCE only when the excavation demonstrates the following:

A. Less than 12 in. of water accumulates in the bottom of the excavation over a 1-hour period with no pumping permitted. For dry excavations, do not allow the depth of water to exceed 3 in. immediately before concrete placement in the excavated hole. Record on the Drilled Shaft Log the

actual depth of water in the excavated hole just before concrete placement.

B. The sides and bottom of the excavation remain stable without caving, sloughing, or swelling. If immediately following the completion of the excavation, the stability of the hole is questionable, confer with the RCE to either case the hole, backfill the hole, or place the rebar cage and concrete.

C. Loose material and water can be satisfactorily removed before inspection and before concrete placement.

2 If the RCE deems that the excavation meets all 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 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.

3 Begin the setting of the rebar cage and concreting immediately after completion of the excavation, cleaning, inspection, and acceptance of the hole.

#### 712.3.5.2 Wet Construction Method

1 Use the wet construction method at sites where a dry excavation cannot be achieved per **Section 712.3.5.1**. Use water (only with the written permission of the BCE or as indicated in the Contract), 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 foundation. Ensure that the casing conforms to **Subsection 712.3.7** and the slurry conforms to **Subsection 712.3.8**.

2 If constructed in the wet, ensure that a positive head of at least 4 ft relative to the highest groundwater level encountered is maintained at all times. Accommodate any fluctuations in the fluid level during tool or casing withdrawal, and maintain the positive head from initial fluid introduction into the excavation through the initial set of concrete.

### 712.3.6 Excavation

#### 712.3.6.1 General

1 Unless otherwise specified or accepted by the BCE, install casing before beginning the excavation. The Plans will indicate the expected length of shaft, the elevation of the top of the shaft, and the estimated elevation of the bottom of drilled shaft. The BCE reserves the right to alter the elevations of the drilled shaft based on the top of rock and/or the results of a Load Test, if performed. Where drilled shaft lengths are altered, an adjustment in price will be made by

applying the 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.

3 Haul off waste material removed from excavations, concrete spillage, and other debris, and dispose of offsite at location(s) 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 complies with local, state, and federal environmental pollution laws and ordinances.

4 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.

### 712.3.6.2 Obstructions

1 Remove surface and subsurface obstructions within the top 10 ft below the elevation of the original ground at drilled shaft locations at no additional cost to the Department.

2 Notify the RCE of any unforeseen obstruction deeper than 10 ft 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. 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.

3 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.

### 712.3.6.3 Elevation of Rock

1 If rock is encountered more than 2 ft higher or lower than the elevation shown on the Plans, immediately notify the RCE. The RCE will then immediately notify the 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 compressive strength shown in the Contract 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 2-in. diameter rock core specimens using NQ or NX coring equipment, unless otherwise approved by the BCE. Determine the rock compressive strength using ASTM D7012, Method C or D.

### 712.3.7 Steel Casings

#### 712.3.7.1 General

1 Use steel casings that are smooth, clean, and watertight and have ample strength to withstand both handling and installation stresses and the pressure of both the concrete and the surrounding earth materials. Ensure that the outside diameter of casing is not less than the specified size of the drilled shaft foundation. Unless otherwise indicated on the Plans or authorized in writing by the BCE, insert casings near existing foundations or structures to the required full depth before any drilling.

2 Pre-drilling with slurry and/or over-reaming to beyond the outside of the casing may require the installation of casing, but do not use unless accepted in writing by the 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 BCE before use. Such removal and stabilization operations are at the Contractor's expense.

#### 712.3.7.2 Temporary Casing

1 Unless a pay item for construction casing is included in the pay quantities, all subsurface casings 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, request this in the *Drilled Shaft Installation Plan*. Provide details indicating adequate support for the reinforcing cage. The use of telescoping casing will be at the discretion of the 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 ft below the top of ground elevation.

5 Do not use temporary casing where the design requires 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 ft above the hydrostatic water level. As the casing is withdrawn, 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 deeper to compensate for loss of frictional resistance in the cased zone, providing straddle shafts to compensate for capacity loss, or providing a replacement shaft. Complete all corrective measures including removal or re-design of structural members to the satisfaction of the BCE without additional compensation or extension of Contract time. In addition, no additional compensation will be paid for any abandoned casing remaining in place.

### 712.3.7.3 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 BCE. Use casing having a thickness as indicated on the Plans or greater. Unless otherwise directed by the BCE, use new steel casing conforming to ASTM A36 or ASTM A252, Grade 2 or 3 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 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.

4 If the Contractor intends to use telescoping casing, request this in the *Drilled Shaft Installation Plan*. Provide details indicating adequate support for the reinforcing cage. The use of telescoping casing will be allowed at the discretion of the 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 for buckling. Space the reinforcing cage concentrically inside the excavation with adequate support.

5 Paint construction casing before installation from the top of the casing to an elevation 5 ft below the mean low water elevation in lakes and tidal environments. For land installation applications, paint the construction casing before installation from the top of the casing to an elevation of 5 ft below the mud line/ground elevation. Paint the casing in conformance with **Section 710**. Install casing in a continuous unit. Each unit may be fabricated from one or more sections. Use a section as long as feasible and spliced according to **Subsection 712.3.7.4**. Grind exposed edges of construction casing smooth, remove attached steel, and apply touch-up painting. Ensure that the paint on exposed portions of casing is uniform in appearance once the shaft construction has been completed. The RCE will determine the acceptability of the finish.

6 Thoroughly clean wall surfaces of construction casings of any organics and other materials detrimental to the soundness of the shaft concrete and reinforcing steel.

### 712.3.7.4 Welded Splices

1 Do not use splices in construction casing unless authorized in writing by the BCE. If splices in casings are necessary and are authorized, make welds as follows:

- Bevel the surface of only one section of casing on the outside edge of the wall at an angle of approximately 45° with the horizontal. A surface of ⅛ in. may be left unbeveled. Guide bars may be temporarily attached to the casing wall to align the sections before welding.
- Butt the beveled section to the unbeveled section, and temporarily clamp thereto. Separate the beveled edge approximately ⅛ in. from the edge of the other section, and make the axes of the two sections coincide by adjusting the clamps.
- 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 is the butt weld designated as B-U4b in AASHTO/AWS D1.5*, Bridge Welding Code*.

2 Remove all coatings from the metal at the welds before welding is initiated, and remove the slag after all welding is complete.

3 Welded splices in construction or 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 AASHTO/AWS D1.5, *Bridge Welding Code*.

### 712.3.8 Slurry

1 If the wet construction method is used, use either mineral or synthetic polymer 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 natural polymer slurry. Use water as the drilling fluid only when specified in the Contract. Use only potable water when water is allowed for use as the drilling fluid.

2 During construction, maintain the level of slurry in the shaft excavation at a level not less than 5 ft above the observed groundwater level during construction. If a sudden significant loss of slurry to the excavation occurs, stop the construction of the foundation until a method to stop the slurry loss or an alternative construction procedure is accepted by the BCE.

3 Prevent the slurry from “setting up” in the shaft by using methods such as agitation, circulation, adjusting the properties of the slurry, or a combination of these methods as required depending on the type of slurry used (e.g., mineral or polymer).

4 Obtain a test sample of the slurry from the storage tank, and ensure that it meets the requirements shown herein 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.

5 Ensure that a 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 ft up the shaft, until two consecutive samples produce acceptable values for density, viscosity, pH, and sand content. When slurry samples are found to be unacceptable, take the action necessary to bring the slurry within the specification requirements. Do not pour concrete until re-sampling and testing yield acceptable values.

6 Complete all reports of the tests required above, secure the signature of the Drilled Shaft Supervisor, and furnish to the RCE upon completion of each drilled shaft.

7 If, as determined by the RCE, the slurry construction method fails to produce the desired results, discontinue this method and propose an alternative method for acceptance by the BCE.

8 Properly dispose of slurry and any drilling spoils that have been mixed with slurry offsite in suitable areas according to the applicable local, state, and federal laws.

#### 712.3.8.1 Mineral Slurry

1 When mineral slurries are used, ensure that the mineral grain size distribution is sufficient to 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.

2 Thoroughly premix the mineral slurry with potable water. The RCE may allow the use of on-site/off-site fresh water from a creek, river, or lake, if the water is not muddy or 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 before mixing with the mineral slurry or use in the shaft unless otherwise directed by the BCE. Ensure that the pH value of the water meets the values shown in this Subsection. All costs for testing of the water quality are incidental to drilled shaft construction. The BCE is the sole judge of whether the water is acceptable for hydrating the mineral slurry.

3 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 sound wall foundations or during the actual drilling operation in the drilled shaft construction unless specified in the Contract. Sand content requirements of the slurry remain in effect before and after the drilling process for shafts.

4 Implement control tests on the mineral slurry using a 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 |
| Viscosity (seconds/quart) | 28 – 45 | 28 – 45 | Marsh Cone API 13B-1 |
| pH | 8 – 11 | 8 – 11 | pH paper, pH meter API 13B-1 |

** Increase by 2 lb/cu ft in salt water.*

*Notes:*

- *Perform tests when the slurry temperature is above 40°F.*
- *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 RB 13B-1, Section 5).*

5 Perform 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.

### 712.3.8.2 Synthetic Polymer Slurry

1 Submit the proposed synthetic polymer slurry product to the BCE for review. The BCE will be the sole judge of whether the product meets the requirements of this Specification. If accepted, ensure that slurry properties at the time of mixing and

concreting meet the manufacturer's written recommendations. Ensure that the sand content at the base of the drilled shaft excavation does not exceed 1% when measured according to Method API RP 13B, Section 5, at any point.

2 Thoroughly premix the polymer slurry with potable water. The RCE may allow the use of on-site/off-site fresh water from a creek, river, or lake, if the water is not muddy or 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 before mixing with the polymer slurry, or use in the shaft unless otherwise directed by the BCE. Ensure that the pH value of the water meets the values shown in this Subsection. All costs for testing of the water quality are incidental to drilled shaft construction. The BCE is the sole judge of whether water is acceptable for hydrating the polymer slurry.

3 Allow an adequate time (as prescribed by the polymer 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.

4 Adhere to the acceptable range of values for those physical properties shown in the following table.

**Synthetic Polymer Slurry**
**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) | 62.5 – 64.0 | 62.5 – 64.0 | Density Balance API 13B-1 |
| Viscosity (seconds/quart) | 30 – 125 | 55 – 114 | Marsh Cone API 13B-1 |
| pH | 6 – 11.5 | 6 – 11.5 | pH paper, pH meter API 13B-1 |

** Increase by 2 lb/cu ft in salt water.*

*Notes:*

- *Perform tests when the slurry temperature is above 40°F.*
- *Allow approximately 1 hour for flocculants to settle out before bottom cleaning; do not allow sand content to exceed 1% (by volume) at any point in the borehole as determined by the American Petroleum Institute Sand Content Test (API RB 13B-1, Section 5).*

5 Contain polymer slurry and any drilling spoils and keep out of any surface water at all times. Contact the polymer slurry supplier/manufacturer to determine the appropriate method of neutralizing and/or disposing of the specific polymer slurry used. Disposal of polymer slurries and materials mixed with slurry is considered incidental to the installation and construction of the drilled shaft.

6 Ensure that a technical representative of the polymer slurry supplier/ manufacturer is present on-site during construction of the first drilled shaft to provide recommendations on the formulation best suited for the subsurface soil conditions.

### 712.3.9 Inspection of Excavations

#### 712.3.9.1 Dimensions and Alignment

1 Provide equipment for checking the dimensions and alignment of each excavation. Determine the dimensions and alignment of the drilled shaft 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° offsets equal to the shaft diameter for alignment and dimension checks.

B. Other proposed methods provided to and accepted by the 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.

#### 712.3.9.2 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.

#### 712.3.9.3 Excavation Inspection

1 The RCE will verify each excavation for acceptance before placement of the reinforcing cage and concrete. Provide the 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.

### 712.3.9.4 Excavation Cleanliness

1 Provide a cleaning operation so that a minimum of 50% of the base of each excavation has less than ½ in. 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 in. 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 in. immediately before concrete placement. Ensure that the Drilled Shaft Foreman records in the Drilled Shaft Log the actual depth (in inches) of water present in the shaft at the 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.

### 712.3.9.5 Construction Tolerances

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 in. 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 in. to minus 3 in. from the plan elevation.

C. The vertical alignment of a vertical shaft excavation does not vary from the plan alignment by more than ¼ in. per ft of depth.

D. After all concrete has been placed, the top of the reinforcing cage is no more than 6 in. above and no more than 3 in. 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, 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 ±⅜ in. per ft of diameter.

2 Drilled shaft excavations and completed shafts not constructed within the required tolerances are unacceptable. The Contractor is responsible for

correcting all unacceptable shaft excavations and completed shafts 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 excavations, are furnished without additional 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.

### 712.3.10 Reinforcing Cage

#### 712.3.10.1 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. Immediately place the reinforcing cage after the excavation is inspected and accepted.

2 Provide the necessary temporary or permanent stiffening to prevent inelastic deformation of the reinforcing cage 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 according to **Subsection 712.3.12**.

#### 712.3.10.2 Splicing of the Reinforcing Cage

1 If the bottom of the constructed shaft elevation is lower than the bottom of shaft elevation shown on the Plans, extend all longitudinal bars the additional length. Continue hoops for the extra depth and extend the stiffener bars to the final depth. Splice the bars by mechanical couplers, or use unspliced bars of the proper length. Splice the cage due to the 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 specified on the Plans or in the Special Provisions.

#### 712.3.10.3 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 ft vertically) to ensure concentric spacing for the entire cage length. Provide one 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 ensure that 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 oversized 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.

### 712.3.11 Concrete Placement

#### 712.3.11.1 General

1 Do not allow the maximum time between completion of excavation and the initiation of concrete placement to exceed 12 hours unless otherwise approved in writing by the BCE. 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 712.3.11.4**.

2 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 slurry/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.

3 Before concrete placement, provide test results of both a trial mix and a slump loss test conducted by an approved testing laboratory using **SC-T-45** to demonstrate that the concrete will maintain a slump of 4 in. or greater throughout the expected duration of the shaft pour. Conduct the trial mix and slump loss tests using concrete and ambient temperatures appropriate for site conditions. The Department may conduct random slump loss tests on production shafts. Inform the RCE of the expected pour duration. For shaft pour durations less than 2 hours, slump loss testing is not required.

4 Before placement of concrete via tremie or pump line, ensure that sufficient concrete is on site to place the bottom 10 ft of drilled shaft. If at any time during the concrete placement, the tremie or pump line orifice is positioned above the concrete-slurry interface, the shaft is considered defective. In this 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 the replacement of defective shafts.

5 Once the concrete starts to set, wait a minimum of 12 hours as determined by the RCE or BCE before drilling adjacent shafts within a 20-ft radius of the cast concrete. Multiple shafts may be drilled before 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 construction vehicles or equipment are allowed within the 20-ft radius of the concrete item cast.

### 712.3.11.2 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. Ensure 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 in. 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. Ensure that 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. 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 ft in concrete at all times after starting the flow of concrete. Maintain a continuous flow of 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.

### 712.3.11.3 Pumping Concrete

1 Concrete pumps and lines may be used for concrete placement in either wet or dry excavations. Ensure that the pump lines are a minimum of 5 in. 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 Ensure that the discharge orifice remains at least 10 ft 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.

### 712.3.11.4 Free-fall of Concrete

1 With the written acceptance of the BCE, the free fall of concrete may be allowed under the following conditions:

- The excavation is a dry construction method excavation as defined under **Subsection 712.3.5.1**.
- The inspector can see the top of the rising concrete during the pour and can determine if the concrete is striking the reinforcing cage.
- The concrete is placed in a chute with a rigid pipe to direct the concrete straight down.
- The concrete fall is less than 75 ft.
- The maximum size of aggregate is ¾ in.; the slump is in the 7-in. to 9-in. range; and there are no strength problems.
- A tremie or pump is on site and is prepared for use if it becomes necessary.
- 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 and/or BCE determines that the free-fall method is not producing satisfactory results.

### 712.3.11.5 Forms

1 When the top of shaft 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 a form so that the removal will not damage the underlying concrete. Remove the casing according to the following requirements:

- The concrete has attained a compressive strength of 3000 psi as determined from test cylinder breaks.
- After removal of the casing, continue curing the concrete for the full curing period according to **Subsection 702.3.5.2**.
- The concrete is not exposed to moving water or tidal water for at least 7 days after removal of the casing.

### 712.3.12 Crosshole Sonic Logging

#### 712.3.12.1 Materials

1 Provide CSL testing access tubes according to ASTM D6760. Use steel pipe with a minimum interior diameter of 1.5 in.

#### 712.3.12.2 Preparation

1 Perform the CSL preparation according to ASTM D6760.

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 in. A minimum of 4 access tubes per shaft is required. Use the following table to determine the number of tubes.

**CSL Access Tube Layout Scheme**

| Shaft Diameter | Number of Tubes Required | Configuration Around the Inside of a Circular Reinforcement Cage |
|---|---|---|
| 36 in. to 48 in. | 4 | 90° apart |
| Greater than 48 in. | 1 tube per 12 in. of uncased shaft diameter | (360°/No. of tubes) |

4 Inspect the access tubes before 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 before concreting, and inform the RCE in writing of the location of the problem area.

5 Provide an access platform for Department personnel to safely and adequately perform the CSL Testing.

#### 712.3.12.3 Test Procedure

1 Department personnel will perform the CSL logging according to ASTM D6760 between 72 hours and 15 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. Before any scheduling of CSL tests, verify access tube lengths and their condition in the presence of Department

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.

### 712.3.12.4 Evaluation of CSL Test Results

1 Within 14 days of CSL testing, 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, additional evaluation may be required, including additional CSL testing and coring. If coring is directed by the BCE, core the shaft according to **Subsection 712.3.12.5** 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 before coring, subject to the written acceptance of the BCE.

3 If repair is required, 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.

4 If no repair is required, the Department will pay for all costs for core drilling (including mobilization of drilling equipment and grouting the core hole closed with non-shrink grout) and core strength testing, if performed.

### 712.3.12.5 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 BCE will determine the number and location of the cores. 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 in.

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 or box similar to those used in rock coring operations. 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, saw cut 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 and the coring log to the RCE.

#### 712.3.12.6 Repairing and Acceptance of Defective Shafts

1 If the drilled shaft CSL tests and cored samples indicate that the shaft is defective, the Contractor is responsible for improving the defective shaft to the satisfaction of the BCE. The 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.

2 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.

3 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.

### 712.4 Measurement

#### 712.4.1 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 determined by the length of the reinforced concrete drilled shaft as 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 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 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 according to **Subsection 712.3.6.3**.

### 712.4.2 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 according to **Subsection 712.3.6.3** and the elevation of the final bottom of shaft authorized by the RCE 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 and/or BCE. 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.

### 712.4.3 Reinforcing Steel

1 The quantity for the reinforcing steel in drilled shafts is the theoretical number of pounds (LB) of reinforcing steel required to construct the drilled shafts to the dimensions and elevations shown on the Plans, unless revised by the BCE, and is measured according to **Subsection 703.4**.

### 712.4.4 Concrete for Drilled Shafts

1 Concrete for 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.

### 712.4.5 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 of construction casing is the difference between the authorized top of casing elevation and the final authorized bottom of casing elevation. Any unpaid length of construction casing removed become the property of the Contractor for disposal away from the site.

3 An allowance of 5 ft 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. Measurements do not include casing that is not provided or installed according to these specifications or directed and accepted by the BCE.

4 Installation and removal of temporary casing is not measured for payment and is included in the cost of the drilled shaft item.

### 712.4.6 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.

### 712.4.7 Crosshole Sonic Logging (CSL)

1 The quantity for the item Crosshole Sonic Logging Set-Up is measured by each (EA) platform set-up, complete and accepted.

2 There is no separate measurement for providing and installing CSL pipes, filling and removing the potable water from the CSL pipes, 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 the CSL pipes are placed.

## 712.5 Payment

### 712.5.1 Drilled Shafts Excavation

1 Payment for the accepted quantity for Drilled Shafts with Wet and Dry Excavation or Drilled Shafts with Rock Excavation at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified. Fixed drilled shaft costs are included in the pay item Drilled Shaft Set-Up as specified in **Subsection 712.5.5**.

### 712.5.2 Reinforcing Steel

1 The quantity of reinforcing steel measured as specified in **Subsections 712.4.3** and **703.4** is paid for as Reinforcing Steel for Structures (Bridge) according to **Subsection 703.5**. Payment is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

### 712.5.3 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 Drilled Shaft items.

### 712.5.4 Construction Casing

1 Payment for the accepted quantity for Construction Casing at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified. 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.

### 712.5.5 Drilled Shaft Set-up

1 Payment for the accepted quantity for Drilled Shaft Set-Up at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

### 712.5.6 Crosshole Sonic Logging (CSL)

1 Payment for the accepted quantity for Crosshole Sonic Logging Set-Up at the Unit Price is full compensation for furnishing access and all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

### 712.5.7 Pay Items

1 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7120006 | Drilled Shaft Set-Up | EA |
| 7120XX1 | Drilled Shafts with Wet & Dry Excavation – (*diameter*)″ Diameter | LF |
| 7120XX2 | Drilled Shafts with Rock Excavation – (*diameter*)″ Diameter | LF |
| 7120XX5 | Construction Casing – (*diameter*)″ Diameter | LF |
| 7120010 | Crosshole Sonic Logging Set-Up | EA |

# Section 713 — Earth Retaining Structures

1 Ensure that all types and sizes of earth retaining structures conform to the requirements of the Special Provisions and the applicable SCDOT Supplemental Specifications, OMR Standard Method of Tests, and the Supplemental Technical Specifications **SC-M-713-X**.

# Section 714 — Permanent Pipe Culverts

1 Ensure that all types and sizes of permanent and temporary pipe culverts conform to the requirements of the Special Provisions and the applicable SCDOT Supplemental Specifications, OMR Standard Method of Tests, and Supplemental Technical Specifications **SC-M-714-X**.

# Section 715 — Temporary Pipe and Pipe Arch

## 715.1 Description

1 Furnish, install, and remove temporary pipe or pipe arches.

## 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 in **SC-M-714** or the *Standard Drawings*, provide a copy of the pipe manufacturer's fill height tables and installation specifications to the RCE before installing temporary pipe. Note that the fill height tables shown on the *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 **SC-M-714** may be installed for temporary use. Once the pipe has been used in a temporary application, the pipe may not be used in a subsequent permanent installation.

### 715.2.3 Galvanized Corrugated Steel Pipe and Pipe Arch (CSP)

1 Provide corrugated steel pipe (CSP) meeting AASHTO M 36 and corrugated steel pipe arch (CSPA) meeting AASHTO M 36, Type II. Where elliptical pipe is specified, 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.

2 Ensure that the dimensions of the pipe arch are according to AASHTO M 36, Type II as measured from the inside crest of the corrugations.

3 Fabricate end sections from materials conforming to AASHTO M 218.

### 715.2.4 Corrugated High Density Polyethylene Pipe (HDPE) Type C

1 Provide corrugated high density polyethylene pipe conforming to 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 Construction

### 715.3.1 Installation of Temporary Pipes and Pipe Arches

1 Install temporary pipe or pipe arch according to the submitted manufacturer's recommendations for loading conditions and installation procedures for the temporary pipe or pipe arch.

### 715.3.2 Abandoning Pipe

1 At locations on the Plans where drainage pipe will 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 according to **Section 210**.

### 715.3.3 Removal of Temporary Pipes and Pipe Arches

1 Remove temporary pipe or pipe arch installations if required by the RCE or as an alternative 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.

## 715.4 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 and accepted.

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 considered 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 according to the manufacturer's installation requirements for temporary pipe or pipe arch is not measured and are considered incidental materials for the temporary pipe or pipe arch item. Dispose of the unstable material as outlined in **Subsection 203.2.1.5**.

## 715.5 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 for 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) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 71580XX | *xx*″ Corrugated Steel Pipe (CSP) – Temporary | LF |
| 7158005 | Corrugated Steel Pipe Arch – Temporary | LF |
| 71590XX | *xx*″ Corrugated High Density Polyethylene (HDPE) Pipe Type (*C* or *S*) – Temporary | LF |

# Section 716 — Drilled Pile Foundations

1 Ensure that all drilled piles are installed to conform to the requirements of the Special Provisions and the applicable SCDOT Supplemental Specifications, OMR Standard Method of Tests, and Supplemental Technical Specification **SC-M-716-1**.

# Section 717

*This Section has been Reserved for Future Use.*

# Section 718 — Brick, Rubble, and Concrete Block Masonry

## 718.1 Description

1 Provide and install brick, rubble, or concrete block masonry.

## 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 ASTM C32, Grade MM. Ensure that clay or shale brick used in the construction of buildings, retaining walls, steps, and other above ground structures conform to ASTM C62, 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 ASTM C55.

### 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. Ensure that the stone rubble is free from rounded, worn, or weathered surfaces.

2 In general, provide stones with thicknesses of not less than 6 in., 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 in. or less thick, provide stone for headers of sufficient length to extend entirely through the wall.

### 718.2.4 Concrete Block

1 For all construction other than the construction of drainage structures, furnish concrete block that are hollow or solid load-bearing concrete masonry units conforming to ASTM C90.

2 For all construction of drainage structures, furnish concrete block that are solid load-bearing concrete masonry units conforming to ASTM C139.

### 718.2.5 Mortar

#### 718.2.5.1 Portland Cement

1 Provide Portland cement that complies with **Subsection 701.2.1**.

#### 718.2.5.2 Masonry Cement

1 Provide masonry cement conforming to ASTM C91 for the type necessary to make the type of mortar specified in ASTM C270.

#### 718.2.5.3 Hydrated Lime

1 Furnish hydrated lime conforming to ASTM C207, Type S.

#### 718.2.5.4 Aggregate

1 Ensure that aggregate is fine aggregate conforming to **Subsection 701.2.9**.

#### 718.2.5.5 Reinforcing Steel

1 Provide reinforcing steel conforming to AASHTO M 31, Type W, Grade 60, and meeting **Section 703**.

### 718.3 Construction

#### 718.3.1 Proportioning and Mixing Mortar

1 Prepare mortar according to the required proportioning specified in ASTM C270 by blending the required materials to produce Type M, Type S, or Type N mortar. Use proportioning shown in the table below.

| Mortar | Type | Portland Cement or Blended Cement | Masonry Cement | Hydrated Lime or Lime Putty | Aggregate Ratio (Measured in Damp Loose Conditions) |
|---|---|---|---|---|---|
| Cement Lime | M<br>S<br>N | 1<br>1<br>1 | —<br>—<br>— | ¼<br>¼ to ½<br>¼ to 1¼ | Not less than 2¼ and not more than 3 times the sum of the separate volumes of cementitious materials |
| Masonry Cement | M<br>S<br>N | 1<br>½<br>— | 1<br>1<br>1 | —<br>—<br>— | |

2 Ensure that the minimum 28-day strength of the mortar types is 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.

### 718.3.2 Brickwork

1 Lay brick to line in courses of full and closed joints of mortar that are not less than ¼ in. nor more than ½ in. 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 near as practical. 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 where practical in making the 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.

### 718.3.3 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.

### 718.3.4 Stonework

#### 718.3.4.1 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 a 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.

#### 718.3.4.2 Stonework for Walls

1 For the wall foundations and bottom courses, use 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 that extend for a distance of twice their thickness into the backing. For walls up to 18 in. thick, ensure that the headers extend through the wall. Ensure 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 in. on the face of the wall, and ensure that no joints in the face are more than 2 in. 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 specified on the Plans or directed by the RCE.

### 718.3.5 Blockwork

1 Adhere to the provisions of **Subsection 718.3.2** when laying concrete block.

### 718.3.6 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 in. of loose material until firm and solid.

## 718.4 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 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 204.4**.

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).

## 718.5 Payment

1 Payment for the accepted quantity for Brick Masonry, Brick Masonry (Reinforced), Rubble Masonry, Rubble Masonry Tree-Well, or Concrete Block Masonry at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Excavation, measured as provided in **Subsection 718.4**, is paid for as Unclassified Excavation as prescribed in **Subsection 204.5**.

3 Masonry used in constructing catch basins, drop inlets, manholes, spring boxes, junction boxes, and similar items is paid for according to **Section 719**.

4 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, Inlets, and Manholes

## 719.1 Description

1 Provide and install catch basins, drop inlets, manholes, junction boxes, and spring boxes.

## 719.2 Materials

### 719.2.1 Cast-in-Place Concrete

1 Provide Class 4000 for cast-in-place concrete conforming to **Section 701**.

### 719.2.2 Clay or Shale Brick, Concrete Brick, and Concrete Block

1 Provide clay or shale brick, concrete brick, and concrete block conforming to **Subsection 718.2**.

### 719.2.3 Mortar Materials

1 Provide mortar materials conforming to **Subsection 718.2.5**.

### 719.2.4 Castings

1 Provide iron castings for frames, grates, covers, etc., conforming to AASHTO M 105, Class 35B, and the alternative load test conforming to AASHTO M 306.

2 Produce castings in closed molds and boldly filleted at angles. Ensure that the arises are sharp and perfect and ensure 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. Ensure that gratings and covers fit firmly into their respective frames.

3 Steel grates and frames may be used instead of cast iron if the loading and hydraulic requirements are met and they conform to the following:

- Hot dip zinc coat steel grates and frame according to AASHTO M 111.
- Dimension steel grates and frame to be interchangeable with each piece of the cast iron grate and frame shown on the Plans.
- Provide steel grates and frames of sufficient strength to meet or exceed the loading requirements of *Federal Specification RR-F-621*.

4 Ensure that the manufacturer has a testing program to verify that the castings comply with the strength requirements of AASHTO M 105. Ensure that test bars are Type B and are made and tested according to AASHTO M 105.

### 719.2.5 Reinforcing Steel

1 Furnish reinforcing steel that complies with **Section 703** and the *Standard Drawings*.

### 719.2.6 Structural Steel

1 Provide structural steel conforming to AASHTO M 270, Grade 36 or 50.

### 719.2.7 Precast Reinforced Concrete Drainage Structures

#### 719.2.7.1 General

1 Furnish precast drainage structures from a producer included on *Qualified Products List 14*. Use Class 4000P Portland cement concrete conforming to **Section 701**. Use reinforcing steel conforming **Section 703**.

2 If cast-in-place drainage structures are substituted for precast drainage structures, ensure that the structures are produced according to the *Standard Drawings*.

#### 719.2.7.2 Precast Drainage Base

1 Ensure that drainage bases are manufactured to the sizes shown on the Plans and according to AASHTO M 199. Ensure that drainage bases are manufactured with all required openings to accept all prescribed inlet and outlet pipes.

#### 719.2.7.3 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 the transitions are manufactured according to AASHTO M 199.

#### 719.2.7.4 Precast Concrete Risers

1 Ensure that risers are manufactured to the diameters and lengths shown on the Plans and according to AASHTO M 199. Place risers plum and backfill in a manner that preserves their alignment.

#### 719.2.7.5 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-in. 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 ft.

## 719.3 Construction

### 719.3.1 Excavation

1 Excavate to the required depth, and compact the material on which the masonry is constructed to a firm even surface.

### 719.3.2 Brick Masonry

1 Construct brick masonry according to **Section 718**.

### 719.3.3 Reinforced Concrete

1 Construct reinforced concrete according to **Sections 701**, **702**, and **703**. Place reinforcing steel, if required, in position as shown on the Plans and hold securely in place.

### 719.3.4 Placing Pipe

1 Incorporate inlet and outlet pipes into the structure at the elevation, direction, and grade required. Neatly and substantially hold the 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 according to **Section 718**.

### 719.3.5 Placing Castings

1 Set the castings in a full mortar bed composed of one part Portland cement to two parts of fine aggregate, meeting **Subsections 718.2.5** and **718.3.1**.

### 719.3.6 Precast Concrete Drainage Structures

1 Fabricate and install precast concrete drainage structures according to these specifications and applicable AASHTO specifications. Ensure that the manufacturer of precast components provides recommendations for all field connections of precast sections and piping.

2 Use the same foundation and bedding detail established for the pipe culverts. When the plans specify improved foundations for pipe, extend the improved

foundation under the base slab of the drainage structure. Include the cost of bedding in the cost of the respective drainage structure

3 Seal joints with a butyl rubber joint sealant meeting **Section 714** and ASTM C990. Apply the sealant according to the manufacturer's recommendations. Supply a copy of the recommendations to the RCE.

### 719.3.7 Grade Adjustment of Existing Structure

1 When grade adjustment of an existing structure is required, remove the frames, covers, and gratings and reconstruct the walls as required. Perform the work using salvaged materials when practical. 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.

### 719.3.8 Backfilling

1 Use pipe select backfill and compaction methods described in **Section 714** around the entire perimeter of the box within each pipe embedment zone and the trench excavation created to install the box and pipe(s).

## 719.4 Measurement

1 The quantity for new or adjusted cast-in-place, brick, or block masonry drainage structure is measured by each (EA) unit, complete 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 ft, the quantity for the pay item Extra Depth of Box is the depth of the drainage structure in excess of 6 ft 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, for 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 this 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.

## 719.5 Payment

1 Payment for the accepted quantity for new or adjusted drainage structures at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Payment for drainage structures is made according to the following schedule:

**Drainage Structure Pay Schedule**

| Structure | Brickwork Complete | Throat/Pad Complete | Finish Work* |
|---|---|---|---|
| Type 1 | 90% | — | 10% |
| Types 9 | 90% | — | 10% |
| Type 9 Manhole | 90% | — | 10% |
| Manhole | 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% |
| Type 25 | 90% | — | 10% |
| Type 125 | 90% | — | 10% |

* *Includes the completion of lid and grate and the placement of flowline invert, steps, cutting pipes flush with walls, and grouting the lid in place.*

3 Payment for the accepted quantity for Extra Depth of Box at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified. Extra Depth of Box is not applicable to precast 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 is included in the Contract unit bid price for the pay item that requires the work.

5 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7191XXX | Catch Basin (type) | EA |
| 71920XX | Drop Inlet (*size*) | EA |
| 7192105 | Manhole | EA |
| 71922XX | (*size*) Junction Box | EA |
| 7192300 | Spring Box | EA |
| 71930XX | Precast Concrete Riser – (*size*)″ Diameter | LF |
| 71931XX | PC Drainage Base – (*size*)″ Diameter | EA |
| 71931XX | PC Transition Section (Flat Slab) – (*size*)″ to (*size*)″ | EA |
| 719317X | PC Transition Section (Cone) – (*size*)″ to (*size*)″ | 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 Construct 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.

## 720.2 Materials

### 720.2.1 Portland Cement Concrete

1 Provide Class 2500 Portland cement concrete conforming to **Section 701**.

### 720.2.2 Expansion Joint Material

1 Provide expansion joint materials meeting **Section 723**.

### 720.2.3 Reinforcing Steel

1 Provide reinforcing steel conforming to **Section 703**.

## 720.3 Construction

### 720.3.1 Subgrade

1 Thoroughly compact the subgrade and finish to a smooth, firmly compacted surface, which is moist at the time the concrete is placed. 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.

### 720.3.2 Forms

1 Use wood or metal forms of a depth equal to the thickness of the concrete course. Ensure that the forms 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 the forms, clean and oil the forms. Use flexible or curved forms on curves as necessary to prevent a chord effect in the alignment of the finished work.

### 720.3.3 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 in. 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.

### 720.3.4 Mixing and Placing Concrete

1 Batch and mix the concrete according to **Section 701**.

2 Construct concrete curbs, concrete gutters, and concrete curb and gutters in uniform 10-ft sections, except where shorter sections are necessary for closures; however, ensure that no section is less than 4 ft 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 practical after placing the concrete. Leave the forms in place until the concrete has set sufficiently and their removal does not damage the concrete.

### 720.3.5 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, as determined by 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 using form construction. Make weakened joints, spaced at 10-ft 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.

### 720.3.6 Joints

#### 720.3.6.1 Expansion Joints

1 Ensure that preformed expansion joints are ¾ in. thick and extend the full depth of the concrete. Construct joints at the locations indicated on the Plans and at the following locations:

- Where 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 joint 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 the structures with an expansion joint.
- Place transverse expansion joints at intervals of not more than 100 ft in all concrete shapes.

#### 720.3.6.2 Contraction Joints

1 Divide the concrete slabs in sidewalks between expansion joints into blocks 10 ft in length by scoring transversely after floating operations are completed. Where the sidewalk slabs are more than 10 ft in width, score the slabs longitudinally in the center. Extend transverse and longitudinal scoring for a depth of 1 in. and not less than ¼ in. or more than ½ in. 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 ft, and extend not less than a quarter of the median depth.

### 720.3.7 Final Finish

#### 720.3.7.1 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. Ensure that joints are clean and corners well rounded. Edge the corners and conform to the typical cross section. Eliminate all tool marks in final finish.

### 720.3.7.2 Sidewalks, Gutters, Medians, and Driveways

1 Apply the final finish for sidewalks, gutters, medians, and driveways by brooming as specified in **Subsection 720.3.7.1**, unless otherwise directed. As soon as the forms are removed from the concrete median, rub down the sides to a smooth and uniform finish. Remove mortar or aggregate particles that spill onto the pavement.

### 720.3.7.3 Repair of Defects

1 As soon as the forms are removed from all concrete shapes, fill honeycombed areas 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 additional cost to the Department.

### 720.3.8 Protection and Curing

1 Protect the concrete as specified in **Subsection 702.3.7**, and cure with liquid, membrane-forming compounds meeting **Subsection 702.2.3**. Ensure that the methods and rates of application of curing compounds are according to **Subsection 702.3.5.2**.

### 720.3.9 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 the concrete gutter so that the earth materials are a minimum of 1 in. above the concrete. Maintain an earth roll on each side as necessary to prevent undermining of curb and gutter.

## 720.4 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 according to the Plans, Specifications, and *Standard Drawings*.

3 Excavation, when applicable and approved, is measured according to **Subsection 203.4**.

## 720.5 Payment

1 Payment for the accepted quantity of the specified item at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Excavation, when applicable and approved, is paid for according to **Subsection 203.5**.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7201000 | Concrete Curb (9″ × 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 Construct asphalt curb.

## 721.2 Materials

1 Provide materials conforming to **Section 403**. Conform to the manufacture and hauling of the asphalt mixture specified in **Sections 401** and **403**.

## 721.3 Construction

### 721.3.1 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 before use:

- The automatic curb machine is constructed and is operated to consolidate the mixture to produce a dense mass free of voids.
- 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 to the required curb as specified.

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 for both type and condition before the start of work.

### 721.3.2 Weather and Surface Temperature Restrictions

1 Do not construct asphalt curb when the pavement or base is wet or frozen.

### 721.3.3 Preparation of Bed

#### 721.3.3.1 Subgrade

1 When the curb will be placed directly on the subgrade, prepare the subgrade according to **Section 208**.

### 721.3.3.2 Existing Pavement or Base

1 When curb will 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. Ensure that the surface is thoroughly dry and, when directed by the RCE, apply a tack coat of asphalt material as specified in **Subsection 401.3.13**. During application, prevent the spread of the tack coat to areas outside of the area occupied by the curb.

### 721.3.4 Backfilling

1 When required, promptly backfill after the curb has reached ambient temperature to afford support and protection. Accomplish backfilling using the methods, equipment, and compaction to prevent damage to the curb and to obtain satisfactory results.

### 721.3.5 Painting and Sealing

1 When sealing or painting is required, paint and seal curb that is clean and dry and that has reached the ambient temperature.

## 721.4 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 according to **Subsection 203.4**.

## 721.5 Payment

1 Payment for the accepted quantity for Asphalt Curb at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Excavation, when applicable and approved, is paid according to **Subsection 203.5**.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7213000 | Asphalt Curb | LF |

# Section 722 — Precast Concrete Box Culverts

## 722.1 Description

1 Provide and install precast concrete box culverts.

## 722.2 Materials

### 722.2.1 Precast Concrete Sections

1 Ensure that precast concrete box culvert sections conform to either AASHTO M 259 for depths of cover 2 ft and greater or AASHTO M 273 for depths of cover less than 2 ft, with the exception of modifications as stated herein. Ensure that the precast concrete box culverts conform to the manufacturing procedures, tolerance, and designs specified in ASTM C1577.

2 Manufacture the sections according to the applicable 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 additional cost to the Department and with prior written approval of the OMR. Ensure that box culvert is obtained from a source listed on *Qualified Products List 14.*

### 722.2.2 Site Cast Concrete

1 Except for the aggregate gradation, provide concrete for the precast sections comply with **Sections 701** and **714**. Ensure that concrete for components cast at the site (wingwalls, headwalls, aprons, cut-off walls, etc.) comply with **Section 701** for Class 4000 concrete (minimum).

### 722.2.3 Reinforcing Steel

1 Provide reinforcing steel conforming to AASHTO M 259 or **Section 703**, as applicable.

### 722.2.4 Joint Material

1 Use a joint seal material that is a preformed flexible joint sealant conforming to ASTM C990.

### 722.2.5 Liquid Curing Compounds

1 Use liquid curing compounds conforming to **Subsection 702.2.3**.

## 722.3 Construction

### 722.3.1 Fabrication

#### 722.3.1.1 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 ⅛ in. Ensure that forms are clean and have a light coating of a bond-breaking material applied before concrete placement.

3 Provide a maximum of 4 lifting holes, 2 in. in diameter or 2 in. square or lifting lugs, as required, in each section to properly complete fabrication and installation. Form the holes in-place, cut the holes into the fresh concrete, or core them into the hardened concrete.

4 Provide precast sections with a minimum length of 4 ft. 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 *Standard Drawing*s for culvert openings or as directed by the RCE.

#### 722.3.1.2 Finishing and Marking

1 Finish and mark precast sections according to AASHTO M 259, AASHTO M 273, ASTM C1433, or ASTM C1577 with the addition of the SCDOT project number.

#### 722.3.1.3 Fabrication Tolerances

1 Ensure that the precast sections do not exceed the geometric tolerances allowed in AASHTO M 259, AASHTO M 273, ASTM C1433, or ASTM C1577.

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 an 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. Ensure that the diagonal measurements do not vary by more than ½ in.

4 Deviations from the above tolerances are acceptable if the sections can be fitted at the plant and if 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 in.

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 according to **Subsection 722.3.1.5**. When fine cracks 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 that is acceptable to the OMR. Do not apply loading upon sections until the 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.

### 722.3.1.4 Samples and Tests

1 Provide concrete compressive strength test cylinders according to AASHTO M 259, AASHTO M 273, or ASTM C1577, 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 If the initial test fails 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 additional cost to the Department.

### 722.3.1.5 Curing

1 Cure precast concrete box culverts made in a precast plant according to AASHTO M 259, AASHTO M 273, or ASTM C1577.

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 according to **Subsection 702.3.5.2**.

### 722.3.2 Bedding

1 Ensure that excavation for foundations of precast concrete box culverts conform to **Section 204** and the details shown on the Plans. Level the foundation area to ensure uniform support throughout the entire width and length of the structure. Ensure that bedding material is minimum fine aggregate and no larger than coarse aggregate (No. 57 stone) conforming to **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) according to **Section 203** 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 in. of bedding material between the rock surface and the bottom of the bottom slab.

### 722.3.3 Laying Sections

1 Place sections beginning at the outlet end of the conduit with the groove end laid upgrade (and the flat end toward the outlet) unless otherwise approved by the RCE. Install successive tongue ends into each adjoining groove. Provide a positive means to pull or push each section firmly into the previously placed section so that the joints are tightly meshed. Install the final section with the flat end toward the inlet. Repair and fill lift holes with mortar or concrete, and cure as directed after the sections have been installed.

### 722.3.4 Joints

#### 722.3.4.1 General

1 Construct joints between the precast box sections using preformed flexible joint sealant according to ASTM C990. Do not use mortar. Install joint sealant according to the manufacturer's recommendations 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 to provide sufficient 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. Place 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.

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.

### 722.3.5 Backfilling

1 Conform backfilling materials and construction methods to the requirements on the Plans and **Subsection 205.3.2**.

2 When multiple barrel structures are specified, place the barrels a minimum of 3½ in. apart. Place the material between culvert barrels according to the Plans and the *Standard Drawings*. When not specified in the Plans, use flowable fill or continuous concrete for gap material. Provide a minimum 6-in. 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.

### 722.3.6 Connections

1 Make connections with other structures including headwalls, wingwalls, aprons, inlets, structures, or manholes according to 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 **Sections 701** and **702** unless directed otherwise by the RCE. Use reinforcing steel conforming to **Section 703**.

3 Place a minimum of ½ in. grout layer between the culvert top slab and bottom of drainage structure. Do not install risers directly on the top slab of culvert unless directed by the RCE.

4 Ensure that all inlet structures and pipe openings are soil tight. Consult with the Design Engineer and the box culvert manufacturer before field cutting any opening in the culvert.

5 Install resin anchors according to the Plans and *Standard Drawings*.

## 722.4 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 according to **Subsection 204.4** and includes unstable material removed as specified in **Subsection 203.3**.

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) according to **Subsection 701.4**.

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) according to **Subsection 703.4**. 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.

## 722.5 Payment

1 Payment for the accepted quantity for PC Box Culverts (of the size, type, and fill height specified) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Structure excavation is paid for as Structure Excavation for Culverts according to **Subsection 204.5**.

3 Cast-in-place Class 4000 concrete is paid for according to **Subsection 701.5**.

4 Reinforcing steel other than that in precast box sections is paid for as Reinforcing Steel for Structures according to **Subsection 703.5**.

5 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 722XXXX | *(size)* PC Box Culvert *(type)* Fill Height ≤ *(fill height)"* | LF |

# Section 723 — Deck Joints

## 723.1 Description

1 Furnish and install deck joints.

## 723.2 Materials

### 723.2.1 Preformed Joint Filler

1 Use either sponge rubber (Type I) or polyurethane-bonded recycled rubber (Type IV) preformed joint material that meets AASHTO M 153 or semi-rigid, closed-cell polypropylene foam that meets ASTM D8139. Other materials such as polyvinyl chloride (PVC) may be used, if the PVC meets the recovery, compression, and extrusion requirements in either AASHTO M 153 or ASTM D8139. Do not use non-extruding and resilient bituminous (AASHTO M 213) types of preformed joint filler.

2 Use only approved preformed joint material that is listed on *Qualified Products List 81*.

3 Provide a manufacturer's certification to the RCE stating that the material conforms to SCDOT Specifications.

### 723.2.2 Elastomeric Compression Seals for Bridge Decks

1 Use preformed elastomeric compression seals for bridge deck joints consisting of flexible closed cell materials made of olefin polymers or blends of olefin polymers and other polymers meeting the requirements in the Plans. Install compression seals with adhesive meeting the requirements in the Plans. Install the seals according to 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 Provide a manufacturer's certification to the RCE stating that the material conforms to SCDOT Specifications.

### 723.2.3 Armor Plate

1 Provide steel armor plates that comply with AASHTO M 270/ASTM A709, Grade 50W. Ensure that studs used in the anchorage system meet **Subsection 709.2.2**.

### 723.2.4 Roofing Felt

1 Use a standard self-adhesive roofing underlayment with at least a 60 mil. thickness.

### 723.2.5 Polyvinyl Chloride Waterstops

1 Provide flexible polyvinyl chloride waterstops of the specified size and type. Use material conforming to the AASHTO *LRFD Bridge Construction Specifications*.

### 723.2.6 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 ASTM C920 for a multiple component, self-leveling material.

2 When specified or as an alternative to the above mentioned filler, use a self-leveling, cold-applied, rapid cure, two-part, ultra-low modulus, 100% silicone rubber sealant. Provide the material packaged such that no premixing or measuring is required. Use sealant capable of accommodating movements up to ±½ in. for bridge joints 1 in. to 3 in. wide. Check throat depth immediately before and during installation. Provide a manufacturer's representative on site if requested by the RCE.

3 Provide circular cross-section backer rod consisting of closed-cell, polyethylene foam that is ⅛ in. greater in diameter than the maximum joint width.

4 Use material from sources appearing on *Qualified Products List 11.*

### 723.2.7 Deck Joint Strip Seals

1 Use strip seal systems consisting of preformed elastomeric seals meeting the requirements specified in the Plans. Install strip seals with adhesive meeting the requirements specified in the Plans.

## 723.3 Construction

### 723.3.1 General

1 Provide fixed and expansion joints in concrete structures only at the locations shown on the Plans or otherwise specified. Set all steel armor plates, strip seal joint plates, steel finger joint plates, etc., at ¼ in. below the finished roadway elevation.

### 723.3.2 Open Joints

1 Construct open joints using removable bulk-heading forms that are removable without damage to concrete.

### 723.3.3 Sliding Joints

1 When roofing felt is used, ensure that the supporting or first formed concrete surface is true, smooth, and parallel to the direction of movement. Cut, place,

and hold the roofing felt against the surface so that the felt is smooth and snug and does not become displaced or damaged during concrete placement. Hold the roofing felt in place with the forms or 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 no contact between the concrete on each side of the joint, and that the joint is free to move in the proper direction for the required distance.

### 723.3.4 Compression Seal Joints

1 Fabricate filled compression joints from elastomeric compression seals or preformed joint filler or both, as indicated in the Contract documents or as directed by the BCE.

2 Cut the joint filler out of the least number of pieces practical 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 according to the recommendations of the manufacturer or by other suitable means, as approved by the RCE.

### 723.3.5 Deck Joint Strip Seal

#### 723.3.5.1 Shop Plans

1 Before fabricating any joints, provide Shop Plans for review and approval of the joint proposed for use where steel extrusions are part of the strip seal assembly. Ensure that the Shop Plans submittals are according to **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.

#### 723.3.5.2 Installation

1 Install the strip seal assembly according to the manufacturer’s specifications. Ensure that the joint is installed such that it is watertight.

2 Ensure that a factory representative is present for the installation unless the Contractor is proficient in the work. 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 14 days in advance.

## 723.4 Measurement

1 The quantity for the pay item Deck Joint Strip Seal or Compression Seal Joint is the length of compression seal joint in-place and is measured by the linear foot (LF), complete and accepted. The joint length is measured from edge of deck to edge of deck along the centerline of joint.

2 Unless otherwise specified, all other joint types are not measured for separate payment. Include all materials, labor, equipment, tools, supplies, and incidentals necessary to furnish and install expansion joints in the Contract unit bid price for concrete.

## 723.5 Payment

1 Payment for the accepted quantity for Deck Joint Strip Seal or Compression Seal Joint at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Unless otherwise specified, payment for all other joints is included in the payment for Concrete for Structures – Class (as specified) in **Subsection 701.5**.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7232310 | Deck Joint Strip Seal | LF |
| 7232320 | Compression Seal Joint | LF |

# Section 724 — Elastomeric Bearings

## 724.1 Description

1 Furnish and install elastomeric bearings, either plain (consisting of elastomer only) or laminated (consisting of alternating individual layers of elastomer and internal steel laminates).

## 724.2 Materials

1 Provide elastomer materials consisting of low-temperature Grade 2 Polychloroprene (Neoprene) as required by AASHTO M 251. Ensure that all bearings comply with the requirements of AASHTO M 251 as specified by the Plans.

2 Obtain elastomeric bearings that are fabricated by a manufacturer on *Qualified Products List 24*.

## 724.3 Construction

1 Submit Shop Plans for bridge bearing assemblies according to **Section 725**.

### 724.3.1 Fabrication

1 Fabricate the bearing pad in conformance with AASHTO M 251 and in conformance with the details shown in the Plans.

2 Fill pin grooves in laminated bearings with a vulcanized neoprene or silicone material capable of bonding and maintaining integrity with the pad.

### 724.3.2 Reporting

1 Ensure that the manufacturer performs all testing as required by AASHTO M 251.

2 Provide a manufacturer's material certification with each shipped lot of bearings, certifying that the specific lot of bearings meets SCDOT and AASHTO M 251 requirements. Ensure that the certification packet includes the specific lot number and the manufacturer's certified test results for the lot. For laminated elastomeric bearings, include mill test reports for all steel used in the bearings.

### 724.3.3 Installation

1 Plane bearing surfaces under the elastomer to within 0.062 in. and horizontal to within 0.01 radians according to the Contract. Ensure that the elastomeric bearings bear directly on the concrete surface.

2 Tighten nuts for anchor bolts finger tight, then back off 1/16 in., 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 ¼ in.

4 Exercise caution where a field weld or shop weld is made while the elastomeric bearing pad is in contact with the metal. Do not expose the elastomer or elastomer bond to instantaneous temperatures greater than 400ºF. Any damage to elastomeric bearing due to welding is cause for rejection. Monitor the temperature using heat crayons.

## 724.4 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.

## 724.5 Payment

1 Payment for the accepted quantity for Elastomeric Bearing at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Payment for the steel sole plate is included in the Contract Unit Price for structural steel or prestressed concrete beams as applicable.

3 Anchor bolts, washers, and nuts are included in the pay item for reinforcing steel.

4 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7243100 | Elastomeric Bearing | EA |
| 7243150 | Elastomeric Bearing Assembly (Flat Slab) | EA |

# Section 725 — Shop Plans and Working Drawings for Structures

## 725.1 Description

1 Submit Shop Plans and Working Drawings for construction projects as required in the Standard Construction Specifications, Supplemental Specifications, Supplemental Technical Specifications, and Special Provisions.

2 Shop Plans become a permanent part of the project, such as structural steel fabrication drawings, prestressed concrete beam drawings, or any other supplementary plans or similar data that the Contractor is required to submit to the RCE for review before fabrication. Shop Plans, including any red-lined revisions, become part of the as-built drawings for the completed structure.

3 Working Drawings as defined in **Subsection 101.3** may 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 RCE for review before assembly of the subject of the drawings on the project site.

### 725.1.1 Shop Plans

1 Submit Shop Plans and supporting engineering calculations to the RCE no later than 30 days before fabrication. Submit Shop Plans through an approved electronic system in Adobe PDF format. No extension of Contract time is granted for delays due to failure to observe this time requirement. Ensure that the fabricator of the material component of the structure notifies the OMR a minimum of 14 days before the start of fabrication.

2 Clearly identify the SC File Number, Project ID, County Name(s), Route Number(s), and Project Description in the Shop Plan submittal.

3 Ensure that Shop Plans are accurate, complete, neat, and legible. Shop Plans should be scaled such that they are legible on an 11-in. × 17-in. paper size, when printed.

4 Electronically submit Shop Plans for the following items:

- Armor plates;
- Bridge bearings;
- Bearing or sole plates, shims, booster plates, and other structural steel bearing assembly components;
- Anchor bolt assemblies;
- Tie rod assemblies;
- Intermediate steel diaphragms;
- Structural steel members;

- Expansion joint components;
- Miscellaneous steel members except piling and sway bracing;
- Metal bridge railings or metal bridge railing extensions;
- SIP bridge deck forms;
- Prestressed and/or post-tensioned concrete beam or girder;
- Prestressed concrete piling;
- Miscellaneous prestressed and post-tensioned concrete members;
- Precast box culverts;
- Precast floorless culverts;
- Mechanically-stabilized earth (MSE) walls;
- Prefabricated retaining wall components;
- Sound barrier walls;
- Signage; and
- Other items specified in the Contract Documents.

5 Ensure that Shop Plans and supporting engineering calculations bear the seal and signature of a South Carolina licensed and registered Professional Engineer with the exception of the following items fabricated according to the details shown in the Plans:

- Armor plates;
- Bearing or sole plates, shims, and booster plates;
- Anchor bolt assemblies;
- Tie rod assemblies;
- Intermediate steel diaphragms;
- Structural steel girders;
- Prestressed concrete piling;
- Elastomeric bearing pads; and
- Metal bridge railings or metal bridge railing extensions.

6 If the items listed above are modified from the details shown in the plans, ensure that the Shop Plans and supporting engineering calculations bear the seal and signature of a South Carolina licensed and registered Professional Engineer.

### 725.1.2 Working Drawings and Design Calculations

1 Ensure that the Working Drawings are accurate, complete, neat, and legible and that supporting engineering calculations are included. Ensure that Working Drawings and engineering calculations conform to the AASHTO *Guide Specifications for Bridge Temporary Works*. Identify the title and edition of the design specifications used to prepare Working Drawings and engineering calculations. Identify the design methodologies, material properties, design loads, load capacities, and any other parameters necessary to demonstrate that the design meets the necessary requirements.

2 Submit Working Drawings and engineering calculations to the RCE through an approved electronic system in Adobe PDF format.

3 Submit Working Drawings and supporting engineering calculations to the RCE for review and acceptance a minimum of 30 days before erection or installation of the element.

4 Ensure that the Working Drawings and engineering calculations for falsework/form systems over or adjacent to railroad tracks have been reviewed and accepted by the designated railroad representative before SCDOT acceptance.

5 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 Construction

1 Do not begin fabrication of items that require Shop Plans until the reviewed Shop Plans have been accepted, stamped, and distributed by the Department. When Working Drawings are required, do not begin installation of the items until the accepted drawings have been received from the Department or from the Engineer of Record (with Departmental concurrence).

## 725.4 Measurement

1 This work is not measured for payment.

## 725.5 Payment

1 No separate payment is made for compliance with this specification. All costs of this work are incidental to the project and included in other items of work.

# Section 726 — Bridge Deck Patching

## 726.1 Description

1 Install partial and full depth concrete patches on existing bridge decks.

## 726.2 Materials

1 Unless noted otherwise, use Class 4000 concrete that conforms to **Section 701**. Where patching quantities are limited, such that less than 3 cu yd will be placed in a shift, proprietary mixes may be submitted to the BCE for consideration.

2 Use moisture resilient epoxy bonding compound that meets ASTM C881.

## 726.3 Construction

### 726.3.1 Concrete Removal for Full Depth Patching

1 The area of removal of the concrete to full depth is from center of girder to center of girder. If the full depth holes are small (less than 6 sq ft), the RCE will consult with the BCE for the method in which the areas are to be repaired.

2 Outline the defective areas and sawcut the outline to a minimum depth of 1½ in. or as limited by the existing reinforcing steel concrete cover.

3 Remove all defective and/or delaminated concrete in the outlined areas through the full depth of the slab or deck by use of a concrete milling machine and/or pneumatic hammers as necessary. A mechanical scarifier may be used on small areas. If pneumatic hammers are used, limit the maximum size to 40 lb. Do not damage the reinforcing steel or the vertical sawcut sides during concrete removal. Replace reinforcing steel damaged by concrete removal operations at no additional cost to the Department. Ensure that adequate precautions are taken to contain debris.

### 726.3.2 Concrete Removal for Partial-depth Patching

1 Outline the defective areas and sawcut the outline to a minimum depth of 1½ in. or as limited by the existing reinforcing steel concrete cover.

2 Remove all defective and/or delaminated concrete in the outlined areas by use of a concrete milling machine and/or pneumatic hammers to a minimum depth of 1 in. below the top mat of reinforcing steel. A mechanical scarifier may be used on small areas. If pneumatic hammers are used, limit the maximum size to 40 lb. If removal of unsound concrete extends through ½ of the depth of the concrete slab or deck, remove the remaining sound concrete and replace as outlined herein for full-depth patching. Do not damage the reinforcing steel or the vertical sawcut sides during concrete removal. Replace reinforcing steel

damaged by concrete removal operations at no additional cost to the Department.

### 726.3.3 Surface Preparation and Concrete Placement

1 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.

2 Immediately after cleaning, while the vertical edge surface is dry and the air temperature is between 50°F and 80°F, apply an accepted moisture resilient epoxy bonding compound according to the manufacturer's recommendations to all vertical edges of the area to be repaired. While the epoxy is tacky, place the accepted concrete repair mix. Finish off the top on the new concrete patch to the proper grade, and cure the patch according to **Subsection 702.3.5.2**, unless otherwise directed by the BCE.

3 Do not place a concrete overlay or any equipment on the patches until the patches have developed a compressive strength of 3600 psi.

## 726.4 Measurement

### 726.4.1 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.

### 726.4.2 Concrete Class 4000 for Partial Depth Patching

1 The quantity for the pay item Concrete Class 4000 for Partial Depth Deck Patching is the volume of concrete placed to make the patch and is measured by the square yard (SY) 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.

### 726.4.3 Concrete Class 4000 for Full Depth Patching

1 The quantity for the pay item Concrete Class 4000 for Full Depth Deck Patching is the volume of concrete placed 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.

### 726.4.4 Reinforcing Steel

1 The quantity of reinforcing steel required to replace existing deteriorated reinforcing steel is measured according to **Subsection 703.4**.

## 726.5 Payment

### 726.5.1 Concrete Class 4000 for Deck Patching

1 Payment for the accepted quantity for Concrete Class 4000 for Partial Depth Deck Patching or Concrete Class 4000 for Full Depth Deck Patching at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

### 726.5.2 Reinforcing Steel

1 Payment for providing and placing reinforcing steel in patches areas is according to **Subsection 703.5**.

### 726.5.3 Pay Items

1 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7260800 | Concrete Class 4000 for Full Depth Deck Patching | CY |
| 7260850 | Concrete Class 4000 for Partial Depth Deck Patching | SY |

# Section 727

*This Section has been Reserved for Future Use.*

# Section 728 — Waterproofing

## 728.1 Description

1 Waterproof or damp proof Portland cement concrete surfaces. Prepare the surface, and waterproof designated bridge decks and Portland cement concrete structures using the described method.

### 728.1.1 Substructure Waterproofing

1 Waterproofing Portland cement concrete surfaces for substructures is applicable to protecting the inside of spandrel-filled arches, backs of abutments, retaining walls, etc.

### 728.1.2 Bridge Deck Waterproofing

1 Bridge deck waterproofing is performed 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.

## 728.2 Materials

### 728.2.1 Substructure Waterproofing

1 Use the following materials and coats for this method of waterproofing:

- 1 asphalt primer coat conforming to ASTM D41;
- 3 asphalt mop coats conforming to ASTM D449, Type A below ground and Type B above ground; alternate mop coats with fabric applications; and
- 2 applications of waterproofing fabric conforming to ASTM D173.

2 Ensure that the asphalt saturation conforms to ASTM D449,Type A below ground and Type B above ground.

### 728.2.2 Substructure Waterproofing (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 *Qualified Products List 67* that meet the following requirements when tested with the referenced test method.

3 Before installation, provide a manufacturer's certification to the RCE stating that the waterproofing membrane complies with these requirements.

| Physical Property | Required Value | Test Method |
|---|---|---|
| Thickness | 0.060 in. minimum | — |
| Thickness of polyethylene film | 0.004 in. minimum | — |
| Tensile strength | 250 psi | ASTM D412 (Die C) |
| Ultimate elongation | 200% minimum | ASTM D412 (Die C) |
| Permeance | 0.1 perms maximum | ASTM E96, Procedure B |
| Cycling over crack at -15ºF | 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 in. to ¼ in. (6 mm) |
| Puncture resistance | 40 lb minimum | ASTM E154 |
| Pliability (180°bend over a 1-in. mandrel at -25ºF) | No cracks | ASTM D146 |

### 728.2.3 Bridge Deck Waterproofing

1 Apply the waterproofing system 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 *Qualified Products List 10*. For approval, submit test results to verify that the materials meet the requirements of this specification. With each shipment of material, furnish a certification stating that the material complies with these requirements.

#### 728.2.3.1 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 lb per inch of width | ASTM D882, modified for 1-in. opening, or ASTM D1000 modified for 4-in. grip opening |
| Permeance | 0.10 perms | ASTM E96, Method B |
| Puncture Resistance (Min.) | 200 lb | ASTM E154 |
| Pliability | No cracks or splits @ 180° bend. (Select one method) | ½-in. mandrel @ 0ºF, or ½-in. mandrel @ -10ºF, or 1-in. mandrel @ 125ºF |

## 728.3 Construction

### 728.3.1 Substructure Waterproofing

#### 728.3.1.1 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.

#### 728.3.1.2 Storage of Fabric

1 Store the fabric in a dry, protected place. Do not store the rolls on end.

#### 728.3.1.3 Surface Preparation

1 Protect the membrane from punctures by making all concrete surfaces reasonably smooth and free from projections or holes. Ensure 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 35ºF without special authorization from the RCE. If the

surface of the concrete becomes damp, cover it with a 2-in. 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.

#### 728.3.1.4 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 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 300ºF and not more than 350ºF. 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 point so that when the waterproofing application is completed, water will run over and not against or along the laps.

2 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 in. wide. Make all end laps at least 12 in. Beginning at the low point of the surface, mop a section about 20 in. 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.

3 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 in. Continue this process until the entire surface is covered, each strip of fabric lapping at least 2 in. 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 heavily mop the fabric sufficiently to completely conceal the weave. Use at least 12 gal of mopping asphalt for each 100 sq ft of finished work on horizontal surfaces, and use at least 15 gal on vertical surfaces. Regulate the work so that all fabric receives the final mopping of asphalt by the close of a day’s work. Thoroughly seal all laps.

#### 728.3.1.5 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 widths to extend beyond the joint or crack at least 12 in. each way. Lap the fabric at least 12 in. 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.

#### 728.3.1.6 Requirements in any Application

1 Ensure that water does not seep 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 in. 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 so that movement in the joint does not cause rupture of the membrane.

5 At the ends of the structure, carry the waterproofing a substantial distance down on the abutments, and make suitable provisions for all movement.

#### 728.3.1.7 Damage Patching

1 Prevent damage to the finished waterproofing. Patch damage that occurs. Apply a patch that extends at least 12 in. beyond the outermost damaged portion, and then use a second ply extending at least 3 in. beyond the first.

### 728.3.2 Substructure Waterproofing (Alternative)

#### 728.3.2.1 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.

#### 728.3.2.2 Storage of Membrane

1 Store the membrane in a dry, protected place. Do not store the rolls on end.

### 728.3.2.3 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 702.3.8**. 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.

### 728.3.2.4 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.

### 728.3.2.5 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.

### 728.3.2.6 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-in. wide membrane strip before applying the main waterproofing. The surface of this pre-strip does not need to be primed.

### 728.3.2.7 Sealing of Seams

1 Ensure that edge and end seams overlap at least 4 in. on all applications.

### 728.3.2.8 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.

### 728.3.2.9 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 in. in all directions from the slit, and seal the edges of the patch with mastic.

## 728.4 Measurement

1 The quantity for the pay item Waterproofing or Waterproofing (Bridge Deck) is the surface area over which the waterproofing is applied and is measured by the square yard (SY), complete and accepted.

## 728.5 Payment

1 Payment for the accepted quantity for Waterproofing or Waterproofing (Bridge Deck) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 7282000 | Waterproofing | SY |
| 7283000 | Waterproofing (Bridge Deck) | SY |

# DIVISION 800
# INCIDENTAL CONSTRUCTION

## Section 801 — Aggregate Underdrains

### 801.1 Description

1 Construct aggregate underdrains using granular filter materials.

### 801.2 Materials

#### 801.2.1 Coarse Aggregate

1 Use crushed stone, gravel, or slag that meets the gradation requirements of Coarse Aggregate No. 57 as provided in the Appendix. Do not use slag with more than 60% abrasion loss when tested according to AASHTO T 96. Use aggregate obtained from sources listed on *Qualified Products List 2*.

#### 801.2.2 Geotextile

1 Provide an engineered fabric capable of reducing soil erosion. Use fabrics appearing on *Qualified Products List 44*. Submit the manufacturer's literature on the proposed product and proof of satisfactory performance to the RCE before use.

2 Provide geotextiles 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 D4632 | 90 lb | 200 lb |
| Seam Strength** ASTM D4632 | 80 lb | 180 lb |
| Puncture Strength ASTM D4833 | 40 lb | 80 lb |
| CBR Puncture ASTM D6241 | 225 psi | 475 psi |
| Trapezoid Tear Strength ASTM D4533 | 40 lb | 80 lb |
| Elongation at Failure ASTM D4632 | 15% minimum | 15% minimum |
| Ultraviolet Degradation at 500 Hours ASTM D4355 | 50% Strength Retained | 50% Strength Retained |

* *Fabric is protected when cushioned from rock placement by a sufficient layer of sand or gravel at least 6 in. thick or by zero height of placement. All other conditions are unprotected.*

** *Values apply to both field and manufactured seams. Sew seams upwards for inspection*.

| Piping Resistance (Soil Retention) & Permittivity Requirements | | |
|---|---|---|
| **Type** | **AOS (ASTM D4751)** | **Permittivity (ASTM D4491)** |
| Type A | ≥ No. 30 Std Sieve | ≥ 0.7 per sec |
| Type B | ≥ No. 40 Std Sieve | ≥ 0.2 per sec |
| 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 Use Type A fabric for soils with less than 15% particles, by weight, passing the No. 200 sieve.

4 Use Type B fabric for soils with 15% to 50% particles, by weight, passing the No. 200 sieve.

5 Use Type C fabric for soils with more than 50% particles, by weight, passing the No. 200 sieve.

## 801.3 Construction

### 801.3.1 General

1 Excavate a 12-in. 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 ½ in. in 10 ft. If necessary, tamp to ensure that the bottom of the trench is smooth and firm.

### 801.3.2 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 in. unless directed otherwise by the RCE.

### 801.3.3 Longitudinal Drains

1 When aggregate underdrains are used as longitudinal drains or at other locations determined necessary by the RCE, excavate a 12-in. wide trench to a depth directed by the RCE.

### 801.3.4 Backfill

1 Fill the remainder of trenches not filled with aggregate with suitable earth material and thoroughly compact in 4-in. layers. Provide suitable outlets and

protect with small dry stone box openings. Maintain the outlets so that the outlets function properly at all times.

### 801.3.5 Geotextile

1 Wrap geotextile in a protective covering to prevent damage during shipping and handling. Label each roll to provide product identification for inventory and quality control. Store the fabric rolls in a manner to protect the rolls from the elements, including ultraviolet radiation. Limit weather exposure to a maximum of 14 days between lay down and cover.

2 Prepare the surface to receive the geotextile in a smooth condition, free of obstructions and debris that may damage the fabric during installation. Provide sand or granular filler layer if necessary to minimize any potential voids.

3 Construct seams by overlapping or as recommended by the manufacturer. Overlap longitudinal seams in trenches a minimum length equal to the trench width. Make all other overlaps a minimum 18 in. Overlap in the direction of flow. After placing the backfill material in trench installations, fold fabric over the top of the filter material to overlap at least 12 in. or the width of the trench, whichever is less.

4 Remove and replace damaged fabric at no additional cost to the Department. Repair damaged fabric using a patch that extends 3 ft beyond the damage in all directions.

## 801.4 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 that exceeds a 6-in. depth, the quantity is measured by the linear foot (LF) and is directly proportional to a 6-in. deep underdrain. Geotextile used for Aggregate Underdrain is incidental to the construction and is not measured for payment.

2 If necessary to place the bottom of the aggregate underdrain either more than 24 in. below the subgrade or below the cross-section lines to which the roadway is graded or more than 24 in. below the ground surface when the drain is constructed outside of the roadway lines, the excavation that exceeds 24 in. is measured as Unclassified Excavation according to **Subsection 203.4**.

3 The stone box outlets are included in the measurement of the quantity for Aggregate Underdrain.

## 801.5 Payment

1 Payment for the accepted quantity for Aggregate Underdrain (Aggregate No. *XXX*) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 The additional excavation for underdrains beyond 24 in. is paid for as Unclassified Excavation according to **Subsection 203.5**. 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.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 8011300 | Aggregate Underdrain (Aggregate No. 57) | LF |
| 8011400 | Aggregate Underdrain (Aggregate No. 57) | CY |

# Section 802 — Pipe Underdrains

## 802.1 Description

1 Construct underdrains using pipe and granular filter material, and construct underdrain pipe outlets.

## 802.2 Materials

### 802.2.1 Pipe Underdrain

#### 802.2.1.1 Corrugated Polyethylene Pipe Underdrain

1 Provide pipe that meets AASHTO M 252 for corrugated polyethylene pipe.

#### 802.2.1.2 Polyvinyl Chloride (PVC) Pipe Underdrain

1 Provide PVC pipe that meets AASHTO M 278, Class PS 46, cell classification 12454-B as defined in ASTM D1734**,** or pipe that meets ASTM D3034, SDR 35.

#### 802.2.1.3 Polyethylene (PE) Pipe Underdrain

1 In all underdrain applications under this Section, polyethylene pipe may be substituted where PVC PS 46 pipe is specified. Ensure that the polyethylene pipe meets AASHTO M 252 and *Qualified Products List 30*, with the following exceptions:

A. Corrugated polyethylene pipe underdrain, in nominal sizes of 4 in. through 10 in., 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 that meets the minimum pipe stiffness (PS) of AASHTO M 278 at 5% deflection when tested according to ASTM D2412.

C. Acceptance of polyethylene pipe underdrain is based on conformance with the above specifications.

### 802.2.2 Aggregate Fill

1 Use coarse aggregate No. 57 consisting of crushed stone, crushed slag, or gravel conforming to **Subsection 801.2.1**.

### 802.2.3 Material for Underdrain End Protector

1 Use Class 3000 or Class 4000P concrete conforming to the applicable subsections of **Section 701** and reinforcing steel conforming to the applicable subsections of **Section 703**. Comply with Standard Drawing 802-105-00.

### 802.2.4 Geocomposite Wall Drain

1 Provide geocomposite wall drain as specified in **SC-M-802-1**.

### 802.2.5 Geotextile

1 Provide geotextile as specified in **Subsection 801.2.2**.

## 802.3 Construction

### 802.3.1 General

1 Excavate trenches for pipe underdrains to a width equal to the outside diameter of the pipe plus 8 in. 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 the pipe in the center of the trench. 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 in. in width, is of sufficient length to wrap the entire joint, covers at least 3 in. 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 by the RCE, place coarse aggregate No. 57 around the pipe. Place the aggregate to provide a minimum depth of 20 in. 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-in. layers. Construct according to **Subsection 801.3**.

### 802.3.2 Pipe Outlets

1 Construct pipe outlets and protect with underdrain end protectors as directed by the RCE or according to the manufacturer's recommendations for precast units. 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 according to **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 that conforms to **Section 714**. Place and compact the earth material in 4-in. layers. Construct underdrain end protectors for pipe according to Standard Drawing 802-105-00.

### 802.3.3 Geotextile

1 Comply with **Subsection 801.3.5**.

## 802.4 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 The quantity for the pay item Underdrain End Protector is measured by each (EA).

3 If necessary to place the bottom of the pipe underdrain 1) more than 36 in. below the subgrade, or 2) below the cross-section lines to which the roadway is graded, or 3) more than 36 in. below the ground surface when the drain is constructed outside the roadway lines, the quantity of the excavation that exceeds 36 in. is measured as Unclassified Excavation according to **Subsection 203.4**.

## 802.5 Payment

1 Payment for the accepted quantity for Pipe Underdrain (of the type and size required) or Underdrain End Protector at the Unit price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 8021104 | 4″ Pipe Underdrain | LF |
| 8021106 | 6″ Pipe Underdrain | LF |
| 8021110 | 10″ Pipe Underdrain | LF |
| 8021204 | 4″ Perforated Pipe Underdrain w/geotextile | LF |
| 8021206 | 6″ Perforated Pipe Underdrain w/geotextile | LF |
| 8021208 | 8″ Perforated Pipe Underdrain w/geotextile | LF |
| 8021210 | 10″ Perforated Pipe Underdrain w/geotextile | LF |
| 80240XX | Underdrain End Protector | EA |

# Section 803 — Temporary Pipe Slope Drains

## 803.1 Description

1 Construct temporary intake spillway assemblies and pipe slope drains on the shoulders, slopes, and at other designated locations.

## 803.2 Materials

### 803.2.1 Corrugated Steel Pipe (CSP)

1 Use corrugated steel pipe (CSP) meeting AASHTO M 36.

### 803.2.2 Corrugated High Density Polyethylene (HDPE) Pipe

1 Use corrugated high density polyethylene (HDPE) pipe conforming to AASHTO M 294 Type C or Type S. Use HDPE pipe from sources on *Qualified Products List 30*.

## 803.3 Construction

1 Construct temporary pipe slope drains and intake assemblies according to Standard Drawing 803-105-40.

## 803.4 Measurement

1 The quantity for the pay item Temporary 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 No measurement is made for excavation and backfilling necessary for the construction and installation of the above items. The work is considered incidental to the pipe slope drain work, and no separate measurement is made.

## 803.5 Payment

1 Payment for the accepted quantity for Temporary Pipe Slope Drain (of the diameter specified) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 8034120 | 12″ Temporary Pipe Slope Drain | LF |
| 8034150 | 15″ Temporary Pipe Slope Drain | LF |
| 8034180 | 18″ Temporary Pipe Slope Drain | LF |

# Section 804 — Riprap and Slope Protection

## 804.1 Description

1 Construct a protective layer of broken stone, polyvinyl chloride (PVC) coated wire enclosed rock gabions, or concrete slope protection.

## 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 the stone has a sodium sulfate content less than or equal to 15% as tested according to AASHTO T 104. Use stone that is suitable for the purpose intended and obtained from a source on *Qualified Products List 2*.

2 Provide riprap conforming to the gradation classes in the following table.

| Riprap Class | Rock Size (Feet) | Rock Size[(1)] (lb) | Percent of Riprap Smaller Than |
|---|---|---|---|
| A | 0.75 | 37 | 100 |
| | 0.50 | 11 | 50 |
| | 0.20 | 0.7 | 15 |
| B | 1.33 | 200 | 100 |
| | 1.0 | 75 | 85 |
| | 0.75 | 37 | 50 |
| | 0.42 | 5 | 10 |
| C | 1.80 | 500 | 100 |
| | 1.30 | 200 | 50 |
| | 0.40 | 5 | 10 |
| D | 2.25 | 1000 | 100 |
| | 1.80 | 500 | 50 |
| | 0.95 | 75 | 10 |
| E | 2.85 | 2000 | 100 |
| | 2.25 | 1000 | 50 |
| | 1.80 | 500 | 5 |
| F | 3.60 | 4000 | 100 |
| | 2.85 | 2000 | 50 |
| | 2.25 | 1000 | 5 |

*(1) Specific Gravity > 2.6*

### 804.2.2 Polyvinyl Chloride (PVC) Coated Wire-Enclosed Gabions

#### 804.2.2.1 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 **Subsections 804.2.2.2** through **804.2.2.5**.

#### 804.2.2.2 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 in.) |
| Tensile Strength of Wire | 60,000 psi |
| Mesh Openings | 3 in. × 3 in. |
| Galvanizing | According to ASTM A641, Class 3 |
| PVC Coating | Gray color, 0.015 in. thick min. |
| Lacing Wire Diameter (gauge) | 13.5 gauge (0.087 in.) |
| Spiral Binder Diameter (gauge) | 12 gauge (0.105 in.) |

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 the resistant characteristics after a period of not less than 3000 hours under tests according to ASTM G152.

#### 804.2.2.3 Rock

1 Provide rock to fill the PVC coated wire units that meets **Subsection 804.2.1**. Ensure that the rock is well graded and that the minimum rock size is at least 125% larger than the mesh aperture size. Ensure that the maximum rock size, measured normal to the slope, does not exceed the thickness of the gabion.

#### 804.2.2.4 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, that has the same PVC coating as the wire mesh. Provide stiffeners for support by providing diagonal braces with the same PVC coating as on the wire mesh.

#### 804.2.2.5 Geotextile Fabric

1 Provide geotextile fabric in conformance with **Subsection 804.2.5**.

### 804.2.3 Cast-in-Place Concrete Slope Protection

1 Provide cast-in-place concrete for slope protection conforming to Class 2500 concrete specified in the applicable Subsections of **Section 701**.

### 804.2.4 Fiber Reinforced Concrete Slope Protection

1 Provide fiber reinforced concrete for slope protection conforming to ASTM C94, ASTM C1116, and ASTM E119 that has 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 fillibrated twisted-bundle form for reinforcement. Do not use monofilament or untwisted fibers.
- Length. Base the minimum fibrous length on the top-size coarse aggregate – Multi-Design Gradation.

### 804.2.5 Geotextile Fabric

1 Provide Class 2 geotextiles for erosion control under riprap applications that conform to the physical requirements in **Subsection 801.2.2**.

## 804.3 Construction

### 804.3.1 Riprap Placement

1 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 so that the larger and smaller stones are well distributed, and the entire mass of stone conforms to the specified gradation. Place riprap so that the percentage of voids is as small as practical. Place riprap to its full thickness in one operation to avoid displacing the underlying material.

2 Unless the Plans specify a different toe treatment, dig a 2-ft 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.

### 804.3.2 Geotextile Fabric

1 Place the fabric on the required slope according to **Subsection 801.3.5**.

2 For installation on slopes, install geotextiles according to the manufacturer's recommendations. Pull geotextiles taut so that they are in tension and free of kinks, folds, wrinkles, or creases.

3 Install approved fastener pins through both strips of overlapped fabric at no less than 5-ft 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 to prevent damage to the fabric. Begin placement of the material at the toe of the slope and proceed upward.

### 804.3.3 PVC Coated Wire-Enclosed Gabions

1 Ensure that the prepared 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 Class 2 geotextile fabric that meets **Subsection 804.2.5** for all gabions. Place on a prepared subgrade and overlap adjacent strips a minimum of 2 ft. Place and anchor the empty PVC coated wire mesh units to ensure proper alignment and to avoid damage to the geotextile fabric. If the geotextile is damaged, replace or repair 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 in. with lacing or spiral binder wire.

4 Fill the empty units carefully with rock 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. Do not damage the unit when filling with rock. Replace any damaged units, including damage to the PVC coating. 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 as acceptable to the RCE.

### 804.3.4 Concrete Slope Protection

1 Provide cast-in-place concrete slope protection consisting of Class 2500 concrete that meets **Subsection 804.2.3** or fiber-reinforced Class 2500 concrete meeting **Subsection 804.2.4** as indicated in the Contract documents. Construct according to the Plans at the locations indicated or where directed by the RCE. Ensure that the slope on which slope protection is placed conforms to the requirements shown on the Plans unless otherwise directed by the RCE.

2 When specified, provide reinforcement that meets **Section 703**, and place according to the Plans. Finish the slope surface uniformly with floats and texture by dragging with wet burlap. After finishing, cure the slope protection according to **Subsection 501.3.16**.

3 Do not use this type of slope protection near a stream, floodplain, marsh, wetland, or tidal areas.

## 804.4 Measurement

1 The Quantity for the Pay item Riprap (of the type specified) is measured by the ton (TON), complete and accepted. Excavation for riprap is incidental and not measured for payment.

2 The Quantity for the Pay item PVC Coated Wire – Enclosed Rock Gabion is the volume of gabions in place and is measured by the cubic yard (CY), complete and accepted.

3 The Quantity for the Pay item Slope Protection – 4-in. Concrete is measured by 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.

4 The Quantity for the Pay item Geotextile under riprap is measured by the square yard (SY) parallel to the slope, complete and accepted. Sand and granular fill under the fabric is incidental and not measured for payment.

## 804.5 Payment

1 Payment for the accepted quantity for Riprap, PVC Coated Wire Enclosed Rock (Gabion), or Slope Protection at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 8041010 | Riprap (Class A) | TON |
| 8041020 | Riprap (Class B) | TON |
| 8041030 | Riprap (Class C) | TON |
| 8041040 | Riprap (Class D) | TON |
| 8041050 | Riprap (Class E) | TON |
| 8041060 | Riprap (Class F) | TON |
| 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

1 Ensure that all types and sizes of guardrails conform to the Special Provisions, the applicable SCDOT Supplemental Specifications, and the Supplemental Technical Specification **SC-M-805**.

# Section 806 — Fences

## 806.1 Description

### 806.1.1 Permanent Fencing

1 Furnish and install fences and gates for permanent fencing, which includes the following:

- Woven Wire,
- Barbed Wire,
- Chain-Link, and
- Ornamental Steel Picket.

### 806.1.2 Temporary Barrier Fence for Environmental Boundary

1 Furnish, install, maintain, and remove temporary barrier fence for environmental boundary at the limits of permitted construction activities to delineate environmentally, historically, and/or culturally sensitive areas.

## 806.2 Materials

### 806.2.1 Wood and Braces

1 Use wood posts and braces as shown in the Plans or *Standard Drawings*.

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 that comply with ASTM A702 and galvanizing conforming to ASTM A123.

### 806.2.2 Steel Fence Posts

1 Provide steel posts that conform to the Plans or the requirements of AASHTO M 181 as shown on the *Standard Drawings*. Protect cut ends that are not placed underground by applying two coats of 90% minimum zinc-rich, cold-galvanizing compound. Provide tubular section posts with heavy malleable iron caps made to provide a drive-fit over the outside of the section to exclude moisture. Furnish all end, pull, and brace posts for farm-field type fence with braces, fittings, and details required for a complete installation as shown on the Plans or *Standard Drawings*. 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 five 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 aluminum strip, aluminum wire, or galvanized steel wire according to 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 in. or as specified in the Plans.

### 806.2.3 Zinc-Coated Steel Woven Wire Fabric

1 Use zinc-coated steel woven wire fabric conforming to AASHTO M 279, Grade 60, Coating Type Z, and Coating Class 1.

### 806.2.4 Barbed Wire

1 The term "gauge" in this Subsection refers to the measurement of wire as specified in AASHTO M 279 or AASHTO M 280. 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) four-point round barbs placed not more than 5 in. apart in conformance with AASHTO M 280, Coating Type Z, Class 1 (or better) for zinc-coated (galvanized) steel barbed wire or ASTM A121, Coating Type A, for aluminum-coated steel barbed wire.

### 806.2.5 Chain-Link Fence Fabric

1 Use chain-link fence fabric conforming to AASHTO M 181 as specified on the Plans or *Standard Drawings*.

### 806.2.6 Ornamental Steel Picket Fencing

#### 806.2.6.1 Tubing

1 Use cold roll steel sheet that conforms to ASTM A924 for fence elements. Ensure that cold roll sheet metal conforms to ASTM A787, Type 2 AWG, light oil 1008/1010. Coat fence elements according to ASTM A653, LFQ RS Coating G90 C10088/C1010, Grade C.

#### 806.2.6.2 Welds

1 Provide weld elements with ⅛-in. fillet butt weld on two sides with 50,000-psi tensile strength.

#### 806.2.6.3 Pickets

1 Use 1-in. × 1-in. × 16-gauge galvanized cold roll steel for pickets.

#### 806.2.6.4 Rails

1 Use 1-in. × 2-in. × 14-gauge galvanized cold roll steel for rails.

#### 806.2.6.5 Posts

1 Use 2½-in. × 2½-in. × 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 Use Class 2500 concrete for the embedment of steel posts. Ensure that concrete conforms to **Section 701**. If reinforcing steel is required, use reinforcing steel conforming to **Section 703**.

#### 806.2.6.8 Finish Color

1 Furnish fence elements with a black finish.

### 806.2.7 Gates

#### 806.2.7.1 Chain-Link Fence Gates

1 Ensure that chain-link fence gate material conforms to AASHTO M 181 for the metal, coating, sizes of wire, and mesh specified.

### 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 in. in length or 16-gauge stainless steel, pneumatically driven staples, made from 304 stainless steel, coated with adhesive, and not less than 2 in. in length.

### 806.2.9 Temporary Barrier Fence for Environmental Boundary

1 Construct the temporary barrier fence using orange mesh fabric mounted on regularly spaced steel posts. Use orange barrier fence meeting the following requirements:

- Constructed of polyethylene, polypropylene, or a combination of the two;
- Contains an ultraviolet stabilizer or inhibitor;
- Mesh opening – 1½ in. × 1½ in. (minimum), 3 in. × 3 in. (maximum);
- Tensile strength – 180 lb/ft (minimum); and
- 4 ft × 100 ft roll weight – 18 lb (minimum).

2 Use steel posts with a minimum length of 5 ft and a minimum weight of 1.25 lb/ft of length. In poor soil conditions where the fence is not stable, equip steel posts with soil stabilization plates, use longer steel posts, or decrease post spacing.

## 806.3 Construction

### 806.3.1 Permanent Fencing

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 contacting the ground. Prevent excessive openings between the ground and the bottom of the fence before erecting the fabric. Where it is not practical 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 Where breaks in a run of fencing are required or at intersections with existing fences, make the appropriate adjustments in post-spacing to conform to the requirements for the types of closure indicated.

5 Do not install fence elements on posts, strain guys, or bracing set in concrete until 4 days after the placement of 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 the specified conditions.

7 Stretch all wire taut at the required elevations.

8 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 all applicable electric safety codes.

### 806.3.2 Setting Posts for Permanent Fence

1 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 Use the same post spacing as the fence being replaced but with a maximum distance of 12 ft on centers for woven wire and barbed wire fences and a maximum of 10 ft for chain-link fence.

3 Set posts accurately spaced, lined, plumb, and to a uniform height before the fabric is attached and ensure conformance with the *Standard Drawings*. Posts may be driven into place if 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 in. in depth and so that the post is securely held.

4 Securely brace the corner, end, gate, and pull posts at intervals of not more than 500 ft as indicated on the Plans or as directed by the RCE and ensure conformance with the *Standard Drawings*. Brace all corner and pull posts in two directions. Brace end and gate posts in one direction. Ensure that 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 practical for the fencing to follow the contour of the ground closely, furnish extra-length posts at no additional cost to the Department.

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 ft for line posts and 3 ft for pull and corner posts) and when additional lengths are included in the Contract. 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.

### 806.3.3 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 with as many additional staples as required to secure the fabric in a workmanlike installation. 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 the fence between posts unless splicing devices recommended by the fence manufacturer are used and are approved by the RCE.

### 806.3.4 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 required. Fasten the fabric to line posts, top rail, and tension wires with the wires or bands specified and spaced as required.

### 806.3.5 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 using galvanized staples or to metal posts using 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 the fence between posts.

### 806.3.6 Installing Ornamental Steel Picket Fencing

1 Set all posts according to the *Standard Drawings*.

2 Apply black finish as follows:

- Clean, degrease, and prime welded panels and posts.
- Powder coat prime the panel, post, and cap with one coat.
- Touch up field welds with cold galvanized primer and enamel spray paint.

### 806.3.7 Installing Gates

1 Ensure that gates are square and plumb, and swing freely through their entire range of required movement.

### 806.3.8 Temporary Barrier Fence for Environmental Boundary

#### 806.3.8.1 Clearing and Grubbing

1 Install all temporary barrier fences before any clearing and grubbing or other land-disturbing activities. Failure to install the fence as specified herein will result in stoppage of all land-disturbing construction operations until the necessary fence is installed. If written request is made in advance by the Contractor, the RCE may allow limited construction activities in areas that are not adjacent to protected areas before the installation of temporary barrier fence.

2 The horizontal placement of the fence may be reasonably adjusted away from protected areas in the field to avoid obstructions if there is sufficient room to perform the work, including the installation and maintenance of erosion control devices. If vegetation and other obstructions prevent the installation of barrier fence in areas where work is required, clear as needed to install the fence

without the use of mechanized equipment (i.e., hand clear) to avoid damage to protected areas.

#### 806.3.8.2 Installation and Removal

1 Install fence along environmentally, historically, and/or culturally sensitive areas within the project limits as identified on the plans, permit drawings, and/or as directed by the RCE. Set and maintain posts in a vertical position, which may be hand set or set with a post driver at a maximum spacing of 8 ft. Where conditions warrant, reduced post spacing may be required. If hand set, thoroughly tamp all backfill material. Attach the orange fabric to the steel posts with wire or other acceptable means. Install the barrier fence to conform to the general contour of the ground. Terminate temporary barrier fence at stream crossings and ditches.

2 The RCE may allow minor deviations to the post spacing or allow the temporary attachment of the fencing to trees, large shrubs, or other obstructions to minimize hand clearing. Once all required clearing and grubbing is complete in the area, relocate any barrier fence temporarily attached to trees, large shrubs, or other obstructions to steel posts. Closely monitor any active work near any sections of barrier fence that are not attached to steel posts to ensure that protected areas are not disturbed until all barrier fence is permanently attached to steel posts.

3 Maintain the fence in a satisfactory condition for the duration of the project as determined by the RCE. Remove the temporary barrier fence upon completion of the project.

### 806.4 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 the Contract includes a separate pay item for gates, 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 that exceeds the normal post length specified and is measured by the linear foot (LF) of post, complete and accepted.

4 The quantity for Temporary Barrier Fence for Environmental Boundary is measured by the linear feet of fence installed, complete and accepted.

## 806.5 Payment

1 Payment for the accepted quantity for all fence pay items or Additional Length of Post at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 For Temporary Barrier Fence for Environmental Boundary, no direct payment will be made for soil stabilization plates, extra-length posts, posts and post bracing, and adjustment, maintenance or resetting of temporary barrier fence during construction.

3 Payment for the accepted quantity for Gate (of the type and size required) at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

4 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 8061XX0 | Woven Wire Fence *(type)* | LF |
| 8062X00 | Barbed Wire Fence – *(1, 2, 3, 4, 5, or 6)* 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 | *(width)*′ *(type)* Gate *(height)*″ Height | EA |
| 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 |
| 8068301 | Temporary Barrier Fence for Environmental Boundary | LF |

# Section 807 — Reset Fence

## 807.1 Description

1 Remove existing fence within the limits of the improvement and, if necessary, store the fence, and reset or rebuild the fence.

### 807.1.1 Classification of Work

#### 807.1.1.1 Reset Chain-Link Fence

1 The work for the item Reset Chain-link Fence includes 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 includes 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.

## 807.2 Materials

1 Unless otherwise 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 that conform to **Subsection 706.2.4**. Do not use posts of different types in the same fence.

## 807.3 Construction

1 Remove and rebuild the fences at the location designated on the Plans or by the RCE. Ensure that the fence is 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 ft on center, except for chain-link fence where the maximum distance is 12 ft on center. Remove and dispose 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 according to **Subsection 806.3**. 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 the 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.

## 807.4 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.

## 807.5 Payment

1 Payment for the accepted quantity for Reset Fence or Reset Chain-Link Fence at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 No payment is made until the Contractor provides a signed copy of Construction Form 800.01.

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 Remove and relocate structures, buildings, and other scheduled moving items.

## 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 cannot be moved with the structure. Use masonry mortar that conforms to **Subsection 718.2.5**.

3 Construct concrete driveways and walkways to replace existing drives and walks according to **Section 720**. Construct driveways at a uniform thickness of 6 in. and walkways or sidewalks at a uniform thickness of 4 in.

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.

## 808.3 Construction

1 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 its moving is necessary because of the relocation of a building or structure. Each moving item is identified by a unique schedule number.

2 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 ft; raise or lower from the final elevation shown on the Plans a distance of 18 in.; or turn a building or structure through an angle of 15 degrees more or less than indicated on the Plans at no additional cost to the Department.

3 Moving items as parts of power transmission or other public utility lines are approximate for the distance to be moved, materials to be furnished, and appurtenances. Perform the work according to the owner's standard practice

and to its satisfaction. Contact the owner(s) of the moving items and determine the amount of work required before bidding.

4 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 according to SCDES regulations.

5 Prepare structures for removal and then move and place the structures in their new, required locations or as designated by the RCE. Set structures plumb and level. Leave the entire structure including appurtenances in the same or better condition than it was before moving.

6 Do not make any change or alteration in the work specified unless approved in advance by the RCE.

7 Do not place the bottom of the wooden sill of a structure less than 12 in. above ground.

8 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 these elements accordingly. Disconnect and remove the following if not integral to the building:

- Cellars, cellar steps, drains, and walls;
- Concrete or masonry porches and floors;
- Concrete, brick, and masonry foundations and supports; and
- Septic tanks, fireplaces, chimneys, and other appurtenances attached or connected to the building.

9 Construct the 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 considered part of the structure to maintain the same symmetry existing before relocation.

10 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 of this work to the satisfaction of the RCE.

11 When sanitary sewers, water, gas, electric, or telephone service lines are connected to the building being relocated, move and reconnect the service lines without unnecessary inconvenience to the occupants of the building. Plug or otherwise satisfactorily disconnect utilities not reconnected to prevent infiltration of foreign matter. Arrange 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 the utilities in the Contract price for moving the building to which the utilities are attached. Ensure that all connections and installations are according to all codes, ordinances, or

regulations governing the work. Provide notices to public utility companies and pay for any fees charged by the utilities for the moving operation.

12 Conduct moving operations to allow businesses to render service to their customers without undue interruption. After work is started on any building, maintain sufficient labor to ensure satisfactory progress. Weather permitting, do not discontinue work on any building without consent of the RCE.

13 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.

14 Relocate the content of structures at the same time as the structure to its new site. If it is not practical 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.

15 Carry all foundations for pillars, underpinnings, or chimneys a minimum of 12 in. below ground and/or to a solid bearing. Construct footings 6 in. wider than pillars or underpinnings and 12 in. wider than the chimneys proper.

16 Install septic tanks, tile drainage fields, and privy meeting the requirements of SCDES.

17 Ensure that new wells and pumps furnish an adequate supply of potable water and, in all cases, ensure that the wells and pumps 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.

18 When the Plans specify buildings, structures, etc., to be dismantled or salvaged, dismantle the structures with sufficient care to preserve the salvage value of the materials therein. Store all salvage materials at the required locations or designated by the RCE. Dispose of all discarded material, rubbish, or debris as directed by the RCE.

## 808.4 Measurement

1 Moving items are paid on a lump sum (LS) basis and, therefore, there is no specific measurement of quantities for the items. For acceptance for payment, the completed moving item must be accepted by the property owner and the RCE.

## 808.5 Payment

1 The lump sum payment for Moving Item No. (*schedule number*) is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 No payment is made for a moving items until the Contractor provides a signed Construction Form 800.01. In extreme cases when, as determined by the RCE, this requirement is being abused by the property owner, the Department may waive the procurement of the owner's release.

3 Pay item under this Section includes the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 8081000 | Moving Item No. (*Schedule No.*) | LS |

# Section 809 — Right-of-Way Markers and Plat

## 809.1 Description

1 Furnish and install right-of-way markers and provide the right-of-way plat.

## 809.2 Materials

1 Provide materials specified in Standard Drawing 809-105-00.

## 809.3 Construction

### 809.3.1 Reinforced Concrete Markers

1 Provide and install reinforced concrete markers according to Standard Drawing 809-105-00 or as directed by the RCE.

### 809.3.2 Rebar and Cap Markers

1 Provide and install rebar and cap right-of-way markers according to Standard Drawing 809-105-00 or as directed by the RCE.

### 809.3.3 Reset Right-of-Way Markers

1 When the Contract provides for existing right-of-way markers to be reset, remove the existing markers and, if necessary, store, protect, and reset the markers at the original locations described in **Subsection 809.3.1** or **809.3.2** as applicable.

### 809.3.4 Right-of-Way Survey Plat

1 Submit one copy of the right-of-way plat on full sized plan sheets (22 in. × 36 in.) before substantial completion of work. Ensure that the right-of-way plat meets South Carolina Code of Regulations, §49-460-A, and the latest SCDOT *Preconstruction Survey Manual*, Section 4.15.02. Record a copy of the plat in the Register of Deeds (ROD) office of the county or counties in which the project resides.

## 809.4 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. No measurement is made for Right-of-Way Plat and is reimbursed as lump sum (LS).

## 809.5 Payment

1 Payment for the accepted quantity for Right-of-Way Marker (Reinforced Concrete), Right-of-Way Marker (Rebar and Cap), or Reset Right-of-Way Marker at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, and transportation, and incidentals necessary to complete the work as specified.

2 The lump sum payment for Right-of-Way Plat is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 8091000 | Right-of-Way Marker (Reinforced Concrete) | EA |
| 8091010 | Right-of-Way Marker (Rebar and Cap) | EA |
| 8091050 | Right-of-Way Plat | LS |
| 8092000 | Reset Right-of-Way Marker | EA |

# Section 810 — Seeding

1 Ensure that all seeding conforms to the Special Provisions, the applicable SCDOT Supplemental Specifications, the OMR Standard Method of Tests, and the Supplemental Technical Specification **SC-M-810-4**.

# Section 811

*This Section has been Reserved for Future Use.*

# Section 812 — Erosion Control Measures

## 812.1 Description

1 Provide erosion control measures as specified.

## 812.2 Materials

1 None specified.

## 812.3 Construction

1 In addition to the erosion control measures specified in the Plans, *Standard Specifications*, Supplemental Technical Specifications, and Special Provisions, all land disturbing activities (clearing and grubbing, excavation, borrow and fill) are subject to the requirements in the following permits and regulations:

- South Carolina Code of Regulations § 63-380, "Standard Plan for Erosion, Sediment, and Stormwater Runoff Control." The regulation can be found at the South Carolina Legislature website.
- *Erosion and Sediment Reduction Act* of 1983 (Title 48, Chapter 18 of the South Carolina Code of Laws of 1983, as amended). Section 70 authorizes the SCDES to administer the regulation with respect to lands under the jurisdiction of the South Carolina Department of Transportation. The code can be found at the South Carolina Legislature website.
- National Pollutant Discharge Elimination System (NPDES) General Permit Number SCR160000, effective January 1, 2013 (or latest version). The Environmental Protection Agency, in accordance with the *Federal Clean Water Act*, has granted to the SCDES the authority to administer the federal NPDES permit program in the State of South Carolina. The permit may be viewed at the SCDOT website.

2 In accordance with the NPDES General Permit SCR160000 Section 2.1.F, the Prime Contractor hired by SCDOT for a project will become a Secondary Operator with SCDOT upon signing the awarded contract. The Secondary Operator must sign the SCDOT Construction Certification Form (800.06) before any work is performed on the project.

3 By signing the Contract, the Contractor accepts/understands the terms and conditions of the *Storm Water Pollution Prevention Plan* (SWPPP) as required by the NPDES General Permit SCR160000 and may be legally accountable to SCDES for compliance with the terms and conditions of the SWPPP. In addition, the Contractor is responsible for ensuring that all subcontractors comply with the SWPPP and the permit requirements.

4 At the preconstruction conference with the Contractor, the SWPPP will be explained and discussed so that the Contractor understands its responsibilities in the SWPPP.

5 Upon authorization of coverage, fully implement the SWPPP. Coordinate the prompt installation of erosion control devices with construction activities to maintain compliance with the above regulations and NPDES General Permit.

6 Erosion and Sediment Control Inspections will be conducted by a qualified individual (Certified Erosion Prevention and Sediment Control Inspectors (CEPSCI), P.E., or those as stated in the permit) by the Department at least every 7 days. A representative of the Contractor is also encouraged to accompany the inspection. Correct deficiencies noted during these inspections within the assigned priority period. If deficiencies are not corrected within this timeframe, the RCE may stop all work (except erosion and sediment control measures) until the deficiencies have been corrected.

7 Provide special attention to critical areas within the project limits (e.g., running streams, water bodies, wetlands). In these areas, the RCE may direct the Contractor to undertake immediate corrective action but, in no case, will allow the deficiencies to remain unresolved more than 48 hours for a priority 1 deficiency or 7 days for a priority 2 deficiency. This is according to their assigned priority as identified during the Erosion and Sediment Control Inspection.

8 Failure to adequately comply with the provisions as detailed above or any other required erosion control measures can 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 SCDES according to its authority.

9 The Contractor is responsible for any fines assessed on the Department by SCDES as the result of the Contractor's non-compliance or violation of any permit provisions according to **Subsection 107.1**.

## 812.4 Measurement

1 No measurements are made under this Section.

## 812.5 Payment

1 No payment is made under this Section.

# Section 813 — Sodding

## 813.1 Description

1 Furnish and place sod of perennial turf-forming grasses on designated areas.

## 813.2 Materials

### 813.2.1 Sod

1 Provide sod that consists of living, well-established growth. Provide vigorous, well-rooted, healthy turf, free from disease, insect pests, weeds, other grasses, stones, and any other harmful or detrimental materials.

#### 813.2.1.1 Fertilizer

1 Provide fertilizer conforming to the requirements of **Section 810**.

#### 813.2.1.2 Lime

1 Provide lime conforming to the requirements of **Section 810**.

## 813.3 Construction

### 813.3.1 Advance Preparations

1 Perform the advance soil preparations specified in **Section 810**. Provide machine stripped sod with a uniform soil thickness of approximately 1 in. The minimum acceptable soil thickness is ¾ in. The measurement for thickness excludes top growth and thatch. Roll or fold before lifting. Handle sod to prevent tearing, breaking, drying, or any other damage.

### 813.3.2 Lime and Fertilizer

1 Apply lime and fertilizer as specified in **Section 810** or according to soil tests. Do not apply lime and fertilizer until 1 month after installation of sod.

### 813.3.3 Furnishing and Placing Topsoil

1 To ensure a good stand of grass 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.

### 813.3.4 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 the 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.

### 813.3.5 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.

### 813.3.6 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.

## 813.4 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 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 according to **Section 810**.

## 813.5 Payment

1 Payment for the accepted quantity for Sodding at the Unit Price is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified, except for organic top soil, which is paid for according to **Section 810**.

2 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 8131000 | Sodding | MSY |

# Section 814

*This Section has been Reserved for Future Use*

# Section 815 — Erosion Control

1 Provide erosion control according to the Special Provisions, the applicable SCDOT Supplemental Specifications, the OMR Standard Method of Tests, and the Supplemental Technical Specifications **SC-M-815-X**.

# Section 816 — Sediment Control Basins and Stormwater Detention Ponds

## 816.1 Description

1 Construct temporary and permanent sediment control basins and stormwater detention ponds.

### 816.1.1 Basins and Ponds

1 A Sediment Control Basin is a temporary basin that is used during construction to trap sediment in stormwater before exiting the right-of-way.

2 A Stormwater Detention Pond is a permanent “dry pond” structure that is used to detain stormwater for a period of time to reduce the peak flow rate. Detention Ponds consist of a basin storage area, a dam, an outfall structure, an emergency spillway, and a security fence with gate.

3 A Water Quality Pond is a permanent stormwater “wet” or “retention” structure designed to treat stormwater runoff for pollutants of concern. A water quality pond requires a specific design to be included in the Plans. Water Quality Ponds consist of a basin storage area, a dam, an outfall structure, an emergency spillway, and a security fence with gate.

4 If a Detention Pond and Water Quality Pond is used for sediment control during construction, this is considered a “Multi-purpose Basin.” The guidance for adaptation of a detention pond to a multi-purpose pond is contained in the notes section of the *Standard Drawings*.

### 816.1.2 Types of Outlets

1 A temporary outlet control structure is the discharge device for a sediment control basin and a multipurpose basin during construction.

2 A permanent outlet control structure is the discharge device for a detention pond and water quality pond.

## 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 Construction

### 816.3.1 General

1 Construct the required sediment retention structures and devices according to the Specifications, the *Standard Drawings,* and Plans*,* unless otherwise directed by the RCE.

### 816.3.2 Site Work

1 Locate and construct the sediment control structures and basin before performing other earthwork.

2 Clear and grub the entire area of the basin and spillway according to **Section 201**. Turn the entire area to a depth of 6 in. and compact to 95.0% compaction. Fill all holes in the foundation area of the dam with suitable material and compact to 95.0% compaction.

### 816.3.3 Silt Basin

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

according to the Plans and the *Standard Drawings*. Remove sediment as necessary to ensure that the basin functions properly.

### 816.3.4 Cutoff Trench

1 Excavate a cutoff trench to a depth of 4 ft or deeper with 1H:1V 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 in. in depth and compact to 95.0% compaction. Ensure that the moisture content of the fill material is adequate for obtaining the required compaction.

### 816.3.5 Earth Dam

1 Construct the dam core to the required dimensions and to an elevation level with the flowline of the emergency spillway. Construct the core with a top width of 8 ft and 1H:1V side slopes. Place fill adjacent to pipes or other structures in 4-in. layers and compact by hand or by manually directed tampers or plate vibrators. Place the fill over pipes to a minimum of 2 ft 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 according to **Section 810**.

### 816.3.6 Aggregate Diaphragm

1 Construct an aggregate diaphragm parallel to the dam and around the outlet pipe immediately at the outlet side of the cutoff trench. Construct the aggregate diaphragm to a depth of 2 ft extending three times the pipe diameter vertically and horizontally, and a minimum of 18 in. beneath the pipe. Use FA-10 fine aggregate. Place a minimum of 2 ft of fill material over the diaphragm.

### 816.3.7 Aggregate Drain

1 Construct an aggregate drain for the diaphragm, 1.5 times the diameter of the pipe or a minimum of 1 ft around the pipe, to the downstream 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 ft outside the aggregate drain in all directions. Use riprap meeting the requirements for Class B Riprap in **Subsection 804.2**.

### 816.3.8 Emergency Spillway

1 Construct an emergency spillway on original ground at the grades and locations shown on the *Standard Drawings*. Construct a spillway outfall channel to the

main outfall channel as shown on the *Standard Drawings*. Seed the sides and bottom of the emergency spillway and spillway outfall channel as directed by the RCE and according to **Section 810**.

### 816.3.9 Sediment Control Basin

1 Construct sediment control basin according to the *Standard Drawings*. Ensure that the sediment control basin meets the sediment trapping requirements in the latest National Pollutant Discharge Elimination Construction General Permit.

### 816.3.10 Stormwater Detention Pond

1 Construct the stormwater detention pond 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 dewatering pipe at the same flow line as the outlet pipe. 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-ft gate unless otherwise directed by the RCE. In urban areas, erect a standard 72-in. chain-link security fence according to **Section 806** unless otherwise directed by the RCE.

### 816.3.11 Water Quality Pond

1 Construct the water quality pond according to the design plans. 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 dewatering pipe at the same flow line as the outlet pipe. 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-ft gate unless otherwise directed by the RCE. In urban areas, erect a standard 72-in. chain-link security fence according to **Section 806** unless otherwise directed by the RCE.

## 816.4 Measurement

1 The preparation of the area around the basins and ponds is included in the quantity for Clearing and Grubbing and is measured according to **Subsection 201.4**.

2 The quantity for the pay item Silt Basins is the volume of material excavated for the construction and backfilling of silt basins, measured by the cubic yard (CY) of material moved during each operation, complete and accepted. Each operation is measured separately.

3 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 to this item and is not measured for payment.

4 The quantity for the pay item Temporary or Permanent Outlet is measured by each (EA) with the specified size, complete and accepted.

5 Concrete, reinforcing steel, trash rack, anti-vortex plate, hardware fabric, treated wood post, No. 5 aggregate, riser and 4 ft 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.

6 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.

7 The quantity for Woven Wire Fence Type 1 without Barbed Wire or Chain-Link Fence is measured according to **Subsection 806.4**.

8 The quantity for Geotextile for Erosion Control Under Riprap is measured according to **Subsection 804.4**.

9 The quantity for Pipe (of the size and type required), exclusive of the 4 ft of pipe included in the sediment control structure, is measure according to **Section 714**.

10 The quantity for Riprap is measured according to **Subsection 804.4**.

11 The quantity for seeding operations is measured according to **Section 810**.

## 816.5 Payment

1 Payment for the accepted quantity for Temporary or Permanent Sediment Control Outlet, Aggregate Diaphragm, Silt Basin, or Cleaning Silt Basin is full compensation for furnishing all materials, labor, equipment, tools, supplies, transportation, and incidentals necessary to complete the work as specified.

2 The payments for the items in the following table are according to the indicated Section or Subsection.

| Work | Payments according to |
|---|---|
| Clearing and Grubbing | **Subsection 201.5** |
| Unclassified Excavation | **Subsection 203.5** |
| Pipe (not including 4 ft of outlet pipe) | **Section 714** |
| Geotextile for Erosion Control Under Riprap | **Subsection 804.5** |
| Riprap (Class B) | **Subsection 804.5** |
| All Seeding Operations | **Section 810** |

3 Pay items under this Section include the following:

| Item No. | Pay Item | Unit |
|---|---|---|
| 81600X0 | Temporary *(riser dia.)*″ × *(outlet dia.)*″ Sediment Control Outlet | EA |
| 81602X0 | Permanent *(riser dia.)*″ × *(outlet dia.)*″ Outlet | EA |
| 8161100 | Aggregate Diaphragm | CY |
| 8164000 | Silt Basin | CY |
| 8164010 | Cleaning Silt Basin | CY |

# APPENDICES

## Gradation of Coarse Aggregates

| Sieve Designation | Percentage by Weight Passing Sieves Having Square Openings | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Aggregate No. | | | | | | | | | |
| | CR-14 | 5 | 56 | 57 | 67 | 6M | 8M | 78 | 789 | 89M |
| 2 in. | 100 | – | – | – | – | – | – | – | – | – |
| 1½ in. | 95 – 100 | 100 | 100 | 100 | – | – | – | – | – | – |
| 1 in. | 70 – 100 | 90 – 100 | 90 – 100 | 95 – 100 | 100 | 100 | – | – | – | – |
| ¾ in. | – | 20 – 55 | 40 – 85 | – | 90 – 100 | 90 – 100 | 100 | 100 | 100 | – |
| ½ in. | 35 – 65 | 0 – 10 | 10 – 40 | 25 – 60 | – | – | 95 – 100 | 90 – 100 | 95 – 100 | 100 |
| ⅜ in. | – | 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 in. | – | – | – | – |
| ⅜ in. | 100 | 100 | 100 | 100 |
| No. 4 | 96 – 100 | 95 – 100 | 90 – 100 | 90 –100 |
| No. 8 | 75 – 100 | 75 – 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.*

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