2000
Standard Specifications
for Highway Construction

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APPENDIX

DIVISION 100

GENERAL PROVISIONS

SECTION 101

DEFINITIONS AND TERMS

101.01 Terms and Abbreviations. Wherever in these specifications or in other contract documents the following terms or their abbreviations are used, the intent and meaning shall be interpreted as set forth in this section.

Wherever the following abbreviations are used in these specifications or on the plans, they are to be construed the same as the respective expressions represented:

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AED	Associated Equipment Distributors
AGC	Associated General Contractors of America
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ALS	*American Lumber Standards*
ANLA	American Nursery & Landscape Association
ANSI	American National Standards Institute, Inc.
ARA	American Railway Association
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASNS	*American Standard for Nursery Stock*
ASTM	American Society for Testing Materials
AWWA	American Water Works Association

AWPA	American Wood Preserver Association
AWS	American Welding Society
CRSI	Concrete Reinforcing Steel Institute
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards General Services Administration
NCHRP	National Cooperative Highway Research Program
SAE	Society of Automotive Engineers
SCMUTCD	*South Carolina Manual on Uniform Traffic Control Devices for Streets and Highways*
SPIB	Southern Pine Inspection Bureau
SSPC	Steel Structures Painting Council

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

101.03 Advertisement. The official notice publicly published by the Department inviting bids and carrying a description of the work, the proposal guaranty requirement, information concerning the date, place and hour of opening bids and other pertinent information.

101.04 Award. The official letter from the Director notifying the successful bidder that the proposed work has been awarded to it, and authorizing work to begin upon the execution, and approval of a satisfactory contract therefor, and bond to secure the performance thereof, and to such other conditions as may be specified or otherwise required by law.

101.05 Base Course. The layer or layers of specified or selected material of designated thickness or rate of application placed on a **subbase** or **subgrade** to comprise a component of the pavement structure to support the pavement or subsequent layer of the construction.

101.06 Bidder. Any individual, firm, corporation, or combination of same submitting a bid for the work contemplated, acting directly or through a duly authorized representative.

101.07 Bridge. A structure, including supports, erected over a depression or an obstruction, such as water, highway or railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of roadway of more than 20 feet.

The length of a bridge structure 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; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening. The width is the clear width measured at right angles to the longitudinal centerline between the bottom of curbs.

101.08 Calendar Day. Every day shown on the calendar, Sundays and holidays included.

101.09 Change Order. A written order to the Contractor, signed by the Engineer, directing changes in the work within the provisions of the contract.

101.10 Channel. Natural or artificial water course.

101.11 Commission. The Commission of the South Carolina Department of Transportation.

101.12 Construction Estimate. The official written itemization of the value of materials in-place and work performed. Construction Estimate may also be referred to as Progress Estimate.

101.13 Contract. The executed agreement between the Department and the successful bidder, setting forth the obligations of the parties thereunder, including but not limited to,

the performance of the work, the furnishing of labor and materials, and the basis of payment.

The Contract includes the proposal, contract form, **payment bond**, **performance and indemnity bond**, these **specifications**, **supplemental specifications**, **special provisions**, general and detailed plans, and notice to proceed. Also any **change orders**, **supplemental agreements**, and **force account work orders** that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

101.14 Contract Bond. The approved form of security, executed by the Contractor and its Surety or Sureties, guaranteeing complete execution of the contract and all supplemental agreements pertaining thereto, and the payment of all legal debts pertaining to the performance of the work.

101.15 Contract Item (Pay Item). An item of work specifically described and for which a price, either unit or lump sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials described in the text of a specification item included in the contract or described in any subdivision of the text of the supplemental specifications or special provisions of the contract.

In the proposal, contract items are given a unique 7 digit Item Number. Generally, the first 3 digits correspond to a section of the standard specifications. The remaining 4 digits are for individual identification of each contract item.

101.16 Contract Modification Request (CMR). Departmental document that is used to change contract quantities for items with unit prices, provide for incentives, penalties, and adjustments for unit price items as provided in the original contract, delete contract items, and revise **contract time**.

101.17 (the) 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.

101.18 Contract Time. The number of **calendar days** or completion date specified in the proposal, indicating the time allowed for the completion of the work contemplated, including authorized time extensions.

In case a calendar date of completion is specified in the proposal, the work shall be completed by that date.

101.19 County. The County or Counties of South Carolina in which the work herein is to be done.

101.20 Crossover. A travelway connecting the two lanes of a divided highway to provide for the movement of traffic across or between the lanes.

101.21 Culvert. Any structure not classified as a bridge, that provides an opening under any roadway, including pipe culverts and any structure so named on the plans.

101.22 (the) Department. The South Carolina Department of Transportation.

101.23 (the) Director. The Executive Director of the South Carolina Department of Transportation.

101.24 (the) Engineer. State Highway Engineer of the South Carolina Department of Transportation, acting directly or through a duly authorized representative, such representative acting within the scope of particular assigned duties or authority.

101.25 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.

101.26 Extra Work. The performance of work or furnishing of material that is found necessary for proper completion of the improvement and that in principle is an obligation of the Contractor, but that is not covered by any item in the proposal and for which no means of payment, direct or indirect, has been provided in the contract. Such extra work shall be performed at duly negotiated prices by supplemental agreement or by force account.

101.27 Force Account Work Order. A written order of the State Highway Engineer directing the Contractor to perform **extra work** or furnish extra materials.

101.28 Highway. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way. This term will, in general be synonymous with "road" and "street."

101.29 Inspector. The authorized representative of the Engineer assigned to make detailed inspections of materials or contract performance.

101.30 Instructions to Bidders. The Notice to Contractors containing all necessary information as to provisions, requirements, date, place, and time of submitting proposals.

101.31 Laboratory. The official materials and testing laboratory of the Department at Columbia or any other materials and testing laboratory that may be designated by the Department.

101.32 Lump Sum. Costs to complete all work under a contract item (pay item). It includes all labor, equipment and material costs plus all overhead, profit, and any other direct or indirect cost or expense necessary to perform the work.

101.33 Major Item of Work. A contract item for which the original contract amount exceeds 10 percent of the total origi-

nal contract amount.

101.34 Materials. Any substances specified for use in the construction of the project and its appurtenances.

101.35 Median. The portion of a divided highway separating the traveled ways for traffic in opposite directions.

101.36 Optimum Moisture Content for Compaction. The moisture content of a soil calculated based on dry weight of soil at which the soil can be compacted to the approximate maximum density under a specified standard method of compaction.

101.37 Parking Lane. An auxiliary lane adjoining the traveled way for vehicular parking.

101.38 Pavement. The uppermost layer of material placed on the traveled way, shoulders, or both usually placed as the wearing or riding surface. This term is used interchangeably with surface or surfacing.

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

101.40 Payment Bond. The approved form of security furnished by the Contractor to guarantee the payment to all persons supplying labor and materials in the prosecution of the work in accordance with the terms of the contract.

101.41 Performance and Indemnity Bond. The approved form of security furnished by the Contractor to guarantee the completion of the work in accordance with the terms of the contract.

101.42 (the) Plans. The official approved engineering drawings including profiles, cross-sections, and supplemental

drawings, or exact reproductions thereof that show the location, character, dimensions, and details of the work to be done; and that are to be considered as a part of the contract supplementary to these specifications; and that are identified in the proposal form.

101.43 Preconstruction Conference. A conference following award and before the start of construction to be attended by a duly authorized representative of the Engineer and by the responsible officials of the Contractor and other affected parties.

101.44 Prequalification. The procedure established and administered by the Department by virtue of which prospective bidders are required to establish their responsibility and competence in advance of submitting proposals.

101.45 Project or File. The specific section or sections of highway together with all appurtenances and construction to be performed thereon under the contract.

101.46 Proposal. The written offer of the bidder, submitted on the prescribed proposal form, properly signed and guaranteed, to perform the work at the prices quoted by the bidder.

101.47 Proposal Form. The approved form on which the Department requires formal bids to be prepared and submitted for the work.

101.48 Proposal Guaranty. The security furnished by the bidder with the proposal for a project, as guaranty that it will enter into a contract for the work if its proposal is accepted.

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

101.50 Right of Way. The land secured and reserved by the Department for the construction and maintenance of the highway.

101.51 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 will be synonymous with "highway" and "street."

101.52 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 roadway of divided highways will not be considered roadbed.

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

101.54 Roadside Development. Those items necessary to the complete highway that provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the highway.

101.55 Roadway. The entire area between the outside limits of construction, including appertaining structures, all slopes, ramps, intersections, drives and side ditches, channels, waterways, etc. necessary for proper drainage.

101.56 SC-T-(#). The designation of a **South Carolina Department of Transportation Research and Materials Laboratory** Test Method.

101.57 Shop Plans. Drawings that contain manufacturing details of an item that will become a permanent part of the project and its appurtenances, such as bending diagrams for reinforcing steel, structural steel fabrication drawings, prestressing steel strand layout drawings, or any other sup-

plementary plans or similar data that the Contractor is required to submit to the Engineer for approval before fabrication.

101.58 Shoulders. 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.

101.59 Sidewalk. That portion of the roadway primarily constructed for the use of pedestrians.

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

101.61 (the) Special Provisions. Provisions inserted in the proposal form and contract revising or supplementing these specifications to cover conditions peculiar to the individual project.

101.62 (the) Specifications. The general term comprising all the directions, provisions, and requirements contained herein, entitled *South Carolina Department of Transportation Standard Specifications for Highway Construction*, together with any **supplemental specifications** or **special provisions** that may be added, and all documents of any description, including notes on plans, pertaining to the method and manner of performing the work or to the quantities and qualities of materials to be furnished under the contract.

101.63 Specified Completion Date. The date on which the contract work is specified to be completed.

101.64 (the) State. The State of South Carolina.

101.65 (the) State Highway Engineer. The State Highway Engineer of the South Carolina Department of Transportation.

101.66 Street. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way. This term will, in general, be synonymous with "highway" and "road."

101.67 Structures. Bridges, culverts, catch basins, drop inlets, manholes, retaining walls, cribbing, end walls, buildings, sewers, service pipes, underdrains, foundation drains and other miscellaneous items that may be encountered in the work, and that are not otherwise classified herein.

101.68 Subbase. The layer or layers of specified or selected material of designated thickness or rate of application placed on a subgrade to comprise a component of the pavement structure to support the **base course**, pavement, or subsequent layer of the construction.

101.69 Subcontractor. Any individual, firm or corporation to whom the Contractor sublets any part of the Contract.

101.70 Subgrade. The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

101.71 Substructure. All of that part of the structure below the bridge seats or below the spring lines of concrete arches. Backwalls and wingwalls of abutments shall be considered as parts of the substructure.

101.72 Superintendent. The Contractor's authorized representative in responsible charge of the work.

101.73 Superstructure. All of that part of the structure above the bridge seats or above the spring lines of concrete arches.

101.74 Supplemental Agreement (SA). A written agreement made and entered into by and between the Contractor

and the Department, covering alterations and unforeseen work incidental to the proper completion of the project, when such work is to be paid for at an agreed unit or lump sum price.

Such supplemental agreement becomes a part of the contract when approved and properly executed.

101.75 Supplemental Specifications. Specifications adopted after the publication of the standard specifications and that constitute a part thereof and of the contract. Supplemental specifications shall prevail over standard specifications when in conflict therewith.

101.76 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.

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

101.78 Titles (or Headings). The titles or headings of the sections and subsections of these standard specifications are in bold type herein and are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

101.79 Traffic Lane. That portion of a traveled way for the movement of a single line of vehicles.

101.80 Traveled Way or Travelway. The portion of the roadway for the movement of vehicles, exclusive of the shoulders.

101.81 Understood "By the Engineer." In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is, or is to

be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, necessary, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned," it shall be understood as if the expression were followed by the words "by the Engineer" or "to the Engineer."

101.82 Unit Price. Costs for each unit of a **contract item (pay item)**. It includes all labor, equipment and material costs plus all overhead, profit, and any other direct or indirect costs or expenses necessary to perform the work.

101.83 (the) Work. Work shall mean the furnishing of all labor, materials, equipment, transportation and other incidentals necessary to the successful completion of the project or the portion of the project involved and the carrying out of all the duties and obligations imposed by the contract. The scope of the work is defined by the contract as defined in **Subsection 101.13.**

101.84 Working Drawings. 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 Engineer for approval before assembly of the subject of the drawings on the project site.

SECTION 102

BIDDING REQUIREMENTS AND CONDITIONS

102.01 Prequalification. Unless otherwise specified, all bidders on projects let to contract by the Department must be

prequalified in accordance with **R63.300, *Code of Laws of South Carolina (1976) Regulations***, as amended.

A contractor must obtain a General Contractor's License and a Bidder's License from the S.C. Licensing Board for Contractor's before being awarded a contract. Such licenses shall not be a prerequisite to the submission of a proposal.

102.02 Contents of Proposal Forms. The proposal forms will show the location and description of the proposed work, the approximate estimates of the various quantities of work to be performed or materials to be furnished, the amount of the proposal guaranty, the number of **calendar days** or date on which the work is to be completed, and the date, time, and place of opening of proposals. The form will include any **special provisions** or requirements not contained in the plans or these standard specifications. All papers bound with or attached to the proposal form are considered a part thereof and must not be detached or altered. If the bidder produces the *Schedule of Price* sheets using the Electronic Bidding System, these sheets shall be produced and included in the proposal as directed in **Subsection 102.06**.

The plans, specifications, and other documents designated in the proposal form are considered a part of the proposal form whether attached or not attached.

A bidder may purchase a proposal form and plans from the Department for the sum specified.

102.03 Interpretation of Quantities. The quantities listed in the proposal form are approximate only and are prepared for the comparison of bids. Payment to the Contractor will be made only for the actual quantities of work performed and accepted or materials furnished in accordance with the contract. The quantities of work to be done and materials to be furnished may be increased, decreased, or omitted as hereinafter provided, without in any way invalidating the prices bid.

102.04 Examination of Plans, Specifications, Special Provisions, Site of Work, etc. The bidder shall examine carefully the site of the proposed work, the proposal, plans, specifications, supplemental specifications, special provisions, and contract forms before submitting a proposal. The submission of a bid shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the plans, specifications, special provisions, and contract.

102.05 Preparation of Proposal. The bidder shall submit the proposal on the form furnished by the Department. If the bidder produces the *Schedule of Price* sheets using the Electronic Bidding System, these sheets shall be produced and included in the proposal as directed in **Subsection 102.06**. The bidder shall state the prices, in figures, for which it proposes to do each item of work. All handwritten figures shall be in ink. If an entry is made in the proposal and subsequently changed by the bidder, the original figure or figures shall be completely obliterated to eliminate any doubt as to the bid price. All changes in the bid prices shall be initialed by the bidder. The bidder shall show the products of the respective unit prices and quantities written in figures in the column provided for that purpose and the total amount of the proposal obtained by adding the amounts of the several items.

The bidder's proposal shall be signed correctly with ink. If the proposal is made by an individual, his/her name and post office address must be shown; if made by a firm or partnership, the name and post office address of each member of the firm or partnership must be shown; if made by a corporation, the person signing the proposal must show the name of the State under the laws of which the corporation is chartered, the names, titles and business addresses of the president, vice president, secretary, and treasurer.

If two or more Contractors bid as a joint venture, the appropriate information on each Contractor must be shown as referred to in the foregoing paragraph for single Contractors.

102.06 Electronic Bidding System. On most projects, the Department will make available to bidders a 3 1/2-inch computer diskette that is suitable for preparing a bid on a personal computer. The diskette will contain the Electronic Bidding System (EBS) and will produce the *Schedule of Price* sheets containing items identical to those listed in the original proposal. This system may be used by the bidder to prepare the bid and print the *Schedule of Price* sheets for submittal. The bidder may request an Electronic Bidding System diskette when ordering proposal forms.

The only entries permitted to the bidder are the Prequalification Number, the Company Name, the Company Address, and the unit or lump sum prices for each item required to be bid in order to produce an official *Schedule of Price* sheets. The EBS program will compute the extended dollar amounts of each item based upon the unit and lump sum prices entered; and when all entries have been completed, will summarize the total bid and allow the printing of a complete set of the *Schedule of Price* sheets.

When utilized by the bidder, the computer generated *Schedule of Price* sheets, along with the complete proposal package will constitute the official bid. The *Schedule of Price* sheets produced with the EBS is the only alternate form permitted to be substituted in the proposal. If the computer generated *Schedule of Price* sheets are used by the bidder, no entries should be made by the bidder into the original *Schedule of Price* sheets included in the proposal. If both the original and the computer generated *Schedule of Price* sheets are completed, only the computer generated *Schedule of Price* sheets will be recognized for the official bid.

The computer generated *Schedule of Price* sheets shall be stapled to the first page of the original *Schedule of Price*

sheets in the proposal. Paper clips shall not be used on any part of the proposal. The computer generated *Schedule of Price* sheets shall be printed with distinct, legible, and precise characters on one side of 8 1/2 x 11 inch paper with the lines proceeding across the 8 1/2 inch width of the page. Ample space shall be retained in the left margin for attachment to the proposal. If continuous feed paper is used, the perforations shall be removed and the sheets separated before attaching to the proposal. If the bidder makes any handwritten changes to the computer generated *Schedule of Price* sheets after they have been printed, the changes shall be initialed as per requirements in **Subsection 102.05**.

The alterations outlined in the previous paragraph are the only allowable alterations the bidder shall make to the proposal. If there are any other alterations, format changes, or sheets detached from the proposal, the proposal may be rejected.

The computer diskette shall be included in the bidder's proposal package by enclosing in the envelope provided and stapling the envelope to the top sheet of the computer generated *Schedule of Price* sheets. The Department will not be responsible for loss or damage to bid diskette after it has been mailed or delivered to the bidder. If loss or damage occurs, the bidder may order another diskette.

In case of a discrepancy between the unit or lump sum prices submitted on the computer generated *Schedule of Price* sheets and those entered on the diskette returned to the Department, the unit or lump sum prices submitted on the computer generated *Schedule of Price* sheets shall prevail.

102.07 Counterproposals. A bidder will not be permitted to offer any counterproposal linking a bid on one project with a bid on another project or projects unless a counterproposal is authorized in the special provisions in the proposal.

102.08 Qualifying Letters Prohibited. Bidders will not be permitted to file with their bids any letters limiting the number

of projects on which they will accept an award. Bidders will be awarded all projects on which their low bids are satisfactory to the Department, provided they are qualified for such projects.

102.09 Irregular Proposals.

A. A proposal will be considered irregular and may be rejected for any one of the following reasons:

1. If the proposal is on a form other than that furnished by the Department; or if the form is altered or any part detached; unless the proposal is altered as otherwise allowed in **Subsection 102.06.**

2. If the proposal contains obviously unbalanced bid prices.

3. If there is a reason to believe that any bidder has an economic interest in more than one proposal on the same project or that there has been collusion among the bidders.

4. If the bidder fails to provide a description and approximate quantity of work to be performed or materials to be supplied, the unit price or the dollar amount of participation by each Disadvantaged Business Enterprise firm listed on the *Committal Sheet*.

B. A proposal will be considered irregular and shall be rejected for any one of the following reasons:

1. If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which make the proposal indefinite or ambiguous as to its meaning.

2. If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.

3. If the proposal does not contain a unit price for each pay item listed except in the case of authorized alternate pay items.

4. If the proposal form is unsigned.

102.10 Proposal Guaranty. No proposal will be considered unless accompanied by a proposal guaranty in the form of a Bid Bond on ***SCDOT Form 674***, in the amount of 5% of the submitted bid, written by a company licensed for surety authority by the **Chief Insurance Commissioner of the South Carolina Department of Insurance** and assigned a rating of **"B**" or better by A.M. Best Company on its most recent ***Best's Insurance Report***. The proposal guaranty shall be made payable to the South Carolina Department of Transportation.

102.11 Delivery of Proposals. Each proposal should be submitted in a special envelope furnished by the Department. The blank spaces on the envelope shall be filled in correctly to clearly indicate its contents. When an envelope other than the special one furnished by the Department is used, it shall be of the same general size and shape and be properly marked to indicate its contents and shall bear the name and address of the bidder. When sent by mail, the sealed proposal shall be addressed to the S. C. Department of Transportation, PO Drawer 365, Columbia, SC 29202 and to the attention of the Contracts Administrator. In order to be considered, all proposals sent by mail must be received by the Contracts Administrator before the time specified in the ***Notice to Contractors***. All proposals submitted otherwise shall be filed before the time and at the place specified in the *Notice to Contractors*. Proposals received after the time for opening of bids will be returned to the bidder unopened.

102.12 Withdrawal of Proposals. A bidder may, without prejudice, withdraw or revise a proposal after it has been deposited with the Department, provided the request for such withdrawal or revision is in writing or by telegram and is in the hands of the official indicated in the **advertisement** before the time and date set for the opening of bids.

102.13 Public Opening of Proposals. Proposals will be opened and read publicly at the time and place indicated in the proposal form. Bidders or their authorized agents are invited to be present.

102.14 Disqualification of Bidders. More than one proposal from an individual, a firm or partnership, a corporation, or any association, under the same or different names, will not be considered for any single project. Reasonable grounds for believing that any bidder is interested as a principal in more than one proposal for the work contemplated will cause the rejection of all proposals in which such bidder is believed to be interested.

Any or all proposals will be 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 of the Department until the participant has been reinstated as a qualified bidder. Contracts will be awarded only to responsible bidders capable of performing the class of work contemplated, within the time specified, and having sufficient resources and finances to carry on the work properly.

SECTION 103

AWARD AND EXECUTION OF CONTRACT

103.01 Consideration of Proposals. After the proposals are opened and read, they will be compared based on the summation of the products of the approximate quantities shown in the bid schedule by the unit bid prices. The results of such comparisons will be available to the public. In case of a discrepancy between unit bid prices and extensions, the unit bid price shall govern.

The right is reserved to reject any or all proposals, to waive technicalities or to advertise for new proposals, if in the judgment of the Director, the best interest of the Department will be promoted thereby.

103.02 Award of Contract. The award of contract, if it were awarded, will be made to the lowest responsible and qualified bidder whose proposal complies with all the requirements prescribed. The award of the contract will be made within thirty (30) **calendar days** after the opening of proposals unless otherwise specified in the special provisions. The successful bidder will be notified by letter to the address shown on the proposal that its bid has been accepted, and that it has been awarded the contract. An award will not be made in any case until all information required by the Department has been received from the bidder, and the bidder's responsibility established.

103.03 Cancellation of Award. The Department reserves the right to cancel the award of any contract at any time before the execution of said contract by all parties without any liability against the Department.

103.04 Return of Proposal Guaranty. All proposal guaranties will be retained by the Department until the contract is executed by the successful bidder, after which all such proposal guaranties will be destroyed unless the guaranty form contains a note requesting it be returned to the bidder or the Surety.

103.05 Bond Requirements. The successful bidder shall, at the time of the execution of the contract, file with the Department the following bonds:

1. A **Performance and Indemnity Bond**, with a Surety or Sureties satisfactory to the Department, in the full amount of the contract, and in no case less than $10,000.00, for the protection of the Department.

2. A **Payment Bond**, with a Surety or Sureties satisfactory to the Department, in the amount of not less than 50% of the contract, 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.

These bonds shall be in accordance with the requirements of **Sections 57-5-1660, *Code of Laws of South Carolina*,** as amended. Criteria that shall be necessary in order for a Surety or Sureties to be deemed satisfactory by the Department, shall include, but not be limited to the following:

1. Bonds shall be written by a company licensed for surety authority by the Chief Insurance Commissioner of the South Carolina Department of Insurance.

2. The Surety company shall be assigned a rating of **"B"** or better by A.M. Best Company on its most recent ***Best's Insurance Report***.

103.06 Execution and Approval of Contract. The contract shall be signed by the successful bidder and returned, together with satisfactory **contract bonds** to the Contracts Administrator within twenty (20) **calendar days** after the contract is mailed for execution. No contract shall be considered as effective until it has been fully executed by all parties thereto.

103.07 Failure to Execute Contract and File Bond. Failure to execute the contract and file acceptable bonds within twenty (20) calendar days after the contract is mailed for execution shall be just cause for the annulment of the award and the forfeiture of the proposal guaranty. Should the award be annulled, the proposal guaranty shall become the property of the Department, not as a penalty, but as liquidated damages.

103.08 Contractor's Liability Insurance. The Contractor shall purchase and maintain, in a company or companies acceptable to the Department, such insurance as will protect the Contractor from claims set forth below which may arise out of or result from the Contractor's operations under the contract, whether such operations be performed by the Contractor or by Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

1. Claims under workers' or workmen's compensation, disability benefit and other similar employee benefit acts that are applicable to be performed;

2. Claims for damages because of bodily injury, occupational sickness or disease, or death of the Contractor's employees;

3. Claims for damages because of bodily injury, sickness or disease, or death of any person other than the Contractor's employees;

4. Claims for damages insured by usual personal injury liability coverage that are sustained (a) by any person as a result of an offense directly or indirectly related to the employment of such person by the Contractor, or (b) by any other person;

5. Claims for damages, other than to the work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom;

6. Claims for damages because of bodily injury, death of any person, or property damage arising out of the ownership, maintenance, or use of any motor vehicle;

7. Claims involving contractual liability insurance applicable to the Contractor's obligations under the indemnity provisions of this contract.

The insurance required by this subsection shall be written for not less than any limits of liability specified in the following table, or required by law, whichever is greater.

	Limits of Liability (in $1000)
1. Worker's Compensation Insurance:	
State……..	Statutory
Employer's Liability:	
Per Accident……...	100
Disease, Policy Limit…….	500
Disease, Each Employee…….	100

2. Comprehensive General Liability:	Bodily Injury	Property Damage
Premises and Operations……..	500	100
Contractor's Protective Liability…….	500	100
Products Liability, including Completed Operations Coverage….	500	100

3. Comprehensive Automobile Liability:	Bodily Injury	Property Damage
All owned Automobiles……..	250/500	100
Non-owned Automobiles…….	250/500	100
Hired Car Coverage…….	250/500	100

Certificates of Insurance acceptable to the Department shall be filed with the Department before commencement of the work. These certificates shall contain a provision that coverage afforded under the policies will not be canceled until at least thirty (30) days prior written notice has been given to the Department.

103.09 Deferral and Cancellation of Contract. If before the Department's receipt of bids, award of contract, and execution of the contract documents, the low bidder, its officers, directors, employees, subsidiaries, affiliates, or parent corporation is indicted for activities that upon conviction may result in its disqualification as a bidder pursuant to Department Regulations, the Department reserves the right to defer the award and execution of the contract documents until the criminal charges have been resolved, and to cancel the award without forfeiture of the proposal guaranty, and to re-bid the project upon any conviction or plea of guilty or nolo contendre. If the criminal charges have not been resolved within ninety (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.

A low bidder indicted (directly or through its officers, direc-

tors, employees, subsidiaries, affiliates, or parent corporation) after bid, but before either award or execution of contract documents, will be entitled to promptly withdraw its proposal without forfeiture of the proposal guaranty provided that such indicted contractor will not be eligible to re-bid the job before resolution of the criminal indictment if the Department elects to reject all other initial bids and re-advertise the job.

103.10 Mobilization. This work consists of the Contractor's 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. Mobilization will be paid for at the contract lump sum price bid, which price and payment shall be full compensation for organizing and moving all forces, supplies, equipment and incidentals to the project site, regardless of the number of times such moves are made, and all preconstruction costs incurred after award of the contract. This price shall also include costs for demobilization.

The Engineer will include payments for mobilization on the first and second construction estimates. Each payment will be for 1/2 of the contract lump sum price for Mobilization, subject to the limits shown in the following table:

Contract Amount (CA)	Max. Payment First Estimate	Max. Payment Second Estimate
0 - $40,000	CA $\times$ 0.05	CA $\times$ 0.05
$40,000 - $200,000	$2,000	$2,000
$200,000 - $2,000,000	CA $\times$ 0.01	CA $\times$ 0.01
$2,000,000 and above	(CA $\times$ 0.005) +$10,000	(CA $\times$ 0.005) +$10,000

If the contract price for Mobilization results in a remaining amount to be paid for mobilization after payments are made according to the above table, the remaining amount will be paid after all work has been completed and accepted.

Completion of erection of materials processing plants, if any, will not be required as a condition for the release of the second installment.

Partial payment for this item shall in no way act to preclude or limit any of the provisions of partial payments otherwise provided for by the contract or these specifications.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
1031000	Mobilization	Lump Sum

SECTION 104

SCOPE OF WORK

104.01 Intent of Contract. The intent of the contract is to provide for the construction and completion in every detail of the work described and contemplated. The Contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, specifications and terms of the contract.

104.02 Alteration of Plans or Character of Work. The Engineer shall have the right to make, at any time, such increases or decreases in quantities and such alterations in the plans or character of the work, including, but not limited to

alterations in the grade or alignment of the road or structure or both, as may be found necessary or desirable. Such alterations shall not be considered as a waiver of any conditions of the contract nor release the surety. The Contractor shall accept the work as altered, the same as if it had been a part of the original contract.

The right is reserved to increase or decrease any or all of the items in the list of approximate quantities shown in the proposal form. The total amount of such increase or decrease, whether it applies to one or several items, shall not exceed in value 20% of the total contract amount, except that variations in the items of solid rock excavation or bridge foundation work, including piling, shall not be considered in determining increases or decreases under this provision, it being understood that quantities of these items cannot be determined accurately before the work is performed.

In addition to the above limitation to increases or decreases in the contract value, quantity increases or decreases for individual **major items of work**, as defined in **Subsection 101.33**, shall be limited to 25% of the original contract quantity.

Alterations of plans or of the nature of the work will not involve or require work beyond the termini of the original proposed construction except as may be necessary for drainage, transitions in alignment and grade or otherwise necessary to satisfactorily complete the work contemplated, unless the contract has been extended in accordance with the provisions of **Subsection 104.04**.

Increases or decreases in the quantities of work within the limits specified shall in no way invalidate the unit bid or contract prices. No claim shall be made by the Contractor for any loss of anticipated profits because of any such alteration or by reason of any variation between the approximate quantities and the quantities of work as done.

Payment for work occasioned by changes or alterations will be made in accordance with the provisions set forth in **Subsection 109.03**. If the altered or added work is of sufficient magnitude as to require additional time in which to complete the project, such time adjustment will be made in accordance with the provisions of **Subsection 108.06**.

Increases or decreases in excess of the limits stated above for the contract value or for the quantity of a major item shall constitute a significant change, which may warrant consideration by the Department of equitable adjustment in the unit price. Any price adjustment for the increase in quantity of a major item shall apply only to that portion in excess of 125% of original contract item quantity, or in the case of a decrease below 75%, to the actual amount of work performed. The adjustments in contract unit price shall be handled as outlined in **Subsection 101.09**, **Subsection 109.03,** or **Subsection 109.04**.

Should the Contractor encounter or the Department discover during the progress of work, subsurface or latent physical conditions at the site differing substantially from those in the contract, or unknown physical conditions at the site of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the contract, the Engineer shall be promptly notified in writing of such conditions. If the Engineer finds that the conditions do substantially differ and would cause a substantial increase or decrease in the cost of, or the time required for performance of the work, an equitable adjustment will be negotiated and a Supplemental Agreement executed in accordance with **Subsection 109.03**. If the Contractor and the Department are unable to reach an agreement concerning prices, the work shall be performed in accordance with the provisions of **Subsection 109.04**.

The Contractor shall submit notice of differing site condition to the Department before performing additional work resulting from the alleged differing site condition. Notification

shall be submitted to the Department on **SCDOT *Form No. 616, Contractor Notice of Claim***. If the issue cannot be resolved by the methods specified in this Subsection, then the Contractor shall submit to the Department at the appropriate time a fully detailed request ("Claim") for additional time or compensation. The claim shall be submitted in accordance with **Subsection 105.16**.

The Contractor shall not begin work until a Supplemental Agreement has been executed or a Force Account order has been issued for the affected work. Revised contract unit prices will be applicable only to that portion of the work created as a result of the changed condition.

Whenever alterations are made in plans, or within the contract provisions, and such alterations result in leaving the Contractor, either on hand or in transit, with materials that were ordered prior to notice being given the Contractor of the alterations, 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 Department pay the Contractor any allowance for anticipated profits. The Contractor will be responsible for these surplus materials until delivered by him to a point designated by the Engineer. The Department will not take over or be responsible for any materials purchased in advance of the apparent need for them, or assume any responsibility for losses to the Contractor due to his furnishing an excess of materials, except where the excess has been brought about by alterations of the plans that the Contractor could not reasonably foresee.

The above provisions shall not apply to materials left over due to changes in substructures caused by foundation conditions being at variances from those assumed or shown.

104.03 Value Engineering. This specification provides an incentive to the Contractor to initiate, develop, and present to the Department for consideration, any cost reduction proposals conceived by the Contractor involving changes in the

drawings, designs, specifications, or other requirements of the contract. This specification does not apply unless the proposal submitted is specifically identified by the Contractor as being presented for consideration as a Value Engineering Proposal.

Value Engineering Proposals contemplated are those that would result in a net savings to the Department by providing a decrease in the total cost of construction or reduce the construction time without increasing the cost to construct the project. The affects the proposal may have on the following items, but not limited to these items, will be considered by the Department when evaluating the proposal:

1) Service Life
2) Safety
3) Reliability
4) Economy of Operation
5) Ease of Maintenance
6) Desired Aesthetics
7) Design
8) Standardized Features

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.

The Department reserves the right to reject at its discretion any Value Engineering Proposal submitted that would require additional right-of-way. Substitution of another design alternate, which is detailed in the contract plans, for the one on which the Contractor bid, will not be allowed. Plan errors that are identified by the Contractor, and result in a cost reduction, will not qualify for submittal as a Value Engineering Proposal. Pending execution of a formal **supplemental agreement**, implementing an approved Value Engineering Proposal, the Contractor shall remain obligated to perform in accordance with the terms of the existing **contract**. No time extension will be granted due to the time required to review a Value Engineering Proposal.

The Contractor is encouraged to include this specification in contracts with Subcontractors. The Contractor shall 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 shall not reduce the Department's share of the savings resulting from the proposal. Should the Contractor desire a preliminary review of a possible Value Engineering Proposal, before expending considerable time and expense in full development, a copy of the preliminary proposal shall be submitted to the Engineer. The submittal shall be entitled: *Preliminary Value Engineering Proposal Review Request* and must contain sufficient drawings, cost estimates and written information that can be clearly understood and interpreted. Also, include the identity of any private engineering firms proposed by the Contractor to prepare designs or revisions to 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. This review does not obligate the Department to approve the final proposal should a preliminary review indicate the proposal has possible merit. The Department is under no obligation to consider any Value Engineering Proposal, preliminary or final, which is submitted.

A copy of the *Final Value Engineering Proposal* shall be submitted by the Contractor to the Engineer. The proposal shall contain, as a minimum, the following:

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

2. A description of the difference between the existing contract requirements and the proposed modifications, with the comparative advantages and disadvantages of each.

3. If applicable, a complete drawing of the details cover-

ing the proposed modifications and supporting design computations shall be included in the final submittal. The preparation of new designs or revisions or modifications to the designs shown in the contract drawings shall be accomplished and sealed by a Professional Engineer registered in the State of South Carolina. Further, the Department may require a review, and possibly the redesign, be accomplished by the project's original designer, or an approved equal. The Department may contract with private engineering firms, when needed, for reviews requested by the Department. The Contractor shall contract with the original project designer, or an approved equal, when required by the Department, for any design work needed to completely and accurately prepare contract drawings. The Department may waive the requirements to have the preparation of contract drawings 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.

4. An itemized list of the contract requirements that would be modified and a recommendation of how to make each modification.

5. A detailed estimate of the cost of performing work under the proposed modification.

6. 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.

To facilitate the preparation of revisions to contract drawings, the Contractor may purchase reproducible copies of drawings for their use through the Department. The preparation of new design drawings by or for the Contractor shall be coordinated with the appropriate Department Division. The Contractor shall provide, at no charge to the Department, one set of reproducible drawings of the approved design needed to implement the proposal.

The Engineer will be the sole judge of the acceptability of a Value Engineering Proposal requested in accordance with these provisions and of the estimated net savings resulting from the approval of all or any part of the proposal. The Contractor has the right to withdraw, in whole or in part, any proposal not accepted by the Department within the period to be specified in the proposal as indicated in item six (6) above.

If a Value Engineering Proposal is approved, the necessary changes will be effected by supplemental agreement. Included as a part of the supplemental agreement will be provisions for price adjustment giving the Contractor 50% of the net savings to the project resulting from the modifications.

The Department reserves the right to include in the supplemental agreement any conditions it deems appropriate for consideration, approval, and implementation of the proposal. Acceptance of the supplemental agreement by the Contractor shall constitute acceptance of such conditions.

The final net savings to be distributed will be the difference in cost between the existing contract cost for the involved bid items and the actual final cost occurring as a result of the modification. Only those unit price items directly affected by the supplemental agreement will be 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 judgement of the Department, such prices do not represent a fair measure of the value of the work to be performed or to be deleted.

Subsequent change documents affecting the modified unit bid items but not related to the Value Engineering Proposal will be excluded from such determination. The Department's review and administrative costs for Value Engineering Proposals will be borne by the Department. The Contractor's costs for designs and /or revisions to designs and the preparation of design drawings will be borne by the Contractor. 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 shall constitute full compensation to them for effecting all changes pursuant to the agreement. The new savings will be prorated, 50% for the Contractor and 50% for the Department, for all accepted Value Engineering Proposals.

Upon execution of the supplemental agreement, the Department will thereafter have the right to use, duplicate or disclose in whole or in part any data necessary for utilization of the modification on other projects without obligation or compensation of any kind to the Contractor. Restrictions or conditions imposed by the Contractor for use of proposal on other projects shall not be valid.

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

Unless and until a supplemental agreement is executed and issued by the Department, the Contractor shall remain obligated to perform the work in accordance with the terms of the existing contract.

Acceptance of the modification and its implementation will not modify the completion date of the contract unless specifically provided for in the supplemental agreement.

The Contractor shall not be entitled to additional compensation for alterations in the plans or in the details of construction pursuant to the Value Engineering Proposal.

The Department will not be 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.

The Department reserves the right to negotiate desired changes with the Contractor under the provisions of the con-

tract even though the changes are the result of a Value Engineering Proposal submitted on another contract. In this instance, the savings will be prorated in accordance with the terms of the negotiated agreement.

Payment will be made under:

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

104.04 Extension of Contract. Upon written agreement with the Contractor, the Department may extend the work beyond the limits of the contract or add an additional road or roads as agreed. Such extension shall not exceed 50% of the total amount of the original contract being extended or shall not exceed $100,000.00 whichever is the lesser amount, except as approved in advance by the Commission. Should these limitations conflict with State laws, contract extensions shall be governed by the limitations of the State laws existing at the time of the extension. Extended work shall be performed at the same unit price as in the original contract. If there is no unit price for an item in the original contract, the unit price of such item shall be agreed upon, and a supplemental agreement shall be executed before beginning work.

104.05 Extra Work. The Contractor shall perform unforeseen work, for which there is no price included in the contract, whenever the Department deems it necessary or desirable to complete the work as contemplated and such extra work shall be performed in accordance with the specifications and as directed; provided however, that before any extra work is started, a **supplemental agreement** shall be entered into, or a **force account work order** issued.

104.06 Detours and Haul Roads. When the plans indicate that traffic is to use detour roads or structures, the items of work involved will be provided for in the contract, or their con-

struction and maintenance may be performed by the Department. At places on the project where detour roads or structures are not shown on the plans or provided for in the contract, it shall be the Contractor's responsibility to provide adequately for traffic without extra compensation. If the Contractor uses such roads that have been provided by the Department to haul its materials or equipment over, it shall bear a proportionate part of the construction and maintenance costs as determined by the Engineer. The Contractor will be required to bear all costs of constructing and maintaining new roads that are necessary to enable it to haul materials over the shortest practicable route. If the Engineer so directs, the Contractor shall 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.

104.07 Maintenance and Maintaining Traffic. Unless otherwise provided, an existing road while undergoing improvements shall be kept open to all traffic by the Contractor. The Contractor shall be required, without direct compensation, to maintain in a condition satisfactory to the Engineer, the entire section or sections of highway, within the limits of the work being performed by the Contractor under the contract from the time the Contractor first begins work until all work has been completed and accepted, except that the Department may, when requested by the Contractor, assist in removing ice and snow from portions of the project that are open to traffic. Such work by Department forces shall in no way be construed as a waiver of the Contractor's responsibility as set forth herein or in cited specifications. This provision shall not be construed to require the Contractor to maintain portions of the highway or roadway that are not in the limits of the contract. The Contractor shall, where determined necessary by the Engineer, provide and maintain temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages and farms. This work shall also include the satisfactory maintenance of the old roadway wholly or in part, even though a section or sec-

tions of the old roadway may be outside the new right of way, until such time as the new road is sufficiently completed to adequately accommodate traffic; keeping the roadway being constructed in shape so as to be well drained at all times, and when such sections are being used by the traveling public, paying special attention to keeping the subgrade and the newly laid **subbase** or **base course**, or surfacing in a condition that is safe and comfortable for public travel; keeping all water courses free from obstruction; repairing all defects promptly and in a manner that will insure durability; and all work necessary to keep the subgrade, subbase or base course, surface course, shoulders, slopes and ditches to the required cross-section and grade.

The Contractor shall coordinate and perform the various phases or stages of the construction, paying attention to weather conditions, seasons of the year, etc., so as to afford the least inconveniences to the adjacent landowners and the traveling public.

The Contractor will be relieved of maintenance of a section or sections when all work on such section or sections covered by the contract has been satisfactorily completed, the final cleaning-up performed and the final inspection made.

104.08 Removal and Disposal of Structures and Obstructions. Unless otherwise provided, the Contractor shall remove, without extra compensation, any existing structure or portion thereof, fences, or buildings or other encumbrances or obstructions upon or within the limits of the right of way which are not necessary to the improvement or which interfere in any way with the new construction and they shall be removed with sufficient care to preserve the salvage value of the materials therein. Such materials when not designated for use in the new construction will, unless otherwise provided, become the property of the owner or the Department, as the case may be. All such materials belonging to owners of abutting property shall be piled neatly and in an acceptable manner upon their property or otherwise disposed of as required. All such

materials reserved for use by the Department shall be removed without damage in sections that can be readily transported and shall be neatly piled at accessible points. Whenever materials are stored upon the highway, the Contractor will be held responsible for its care and preservation until its authorized removal. The Contractor shall remove all material designated by the Engineer as having no salvage value, all discarded materials, and rubbish or debris from the highway without extra compensation, and shall dispose of it as directed by the Engineer.

Any structure, any part of which conflicts with the installation of a new structure, shall be removed by the Contractor, and all work and costs incidental to this removal shall be included in the contract prices for the new structure.

Whenever it is necessary to remove, reset or rearrange any building or structure outside the limits of the roadway which is not provided for in the contract, the Contractor may be required by the Engineer to perform this work as extra work; or the work may be performed by the Department or by the owners under separate agreement.

The Contractor will be required to use every precaution to prevent interference with utilities. The Department will not be responsible for any damage to or interference with the utilities by the Contractor, or for the cost of protecting the utilities from such interference or damage.

104.09 Rights In and Use of Materials Found on the Work. The Contractor, with the approval of the Engineer, may use on the project such stone, gravel, sand or other material determined suitable by the Engineer, as may be found in the excavation and will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used. The Contractor shall replace, at its own expense and with other acceptable material, all of that portion of the excavation materials so removed and used which was needed for use in

the embankments, backfills, approaches or otherwise. No charge for the materials so used will be made against the Contractor. The Contractor shall not excavate or remove any material from within the highway location that is not within the grading limits, without written authorization from the Engineer.

Unless otherwise provided, the material from any existing old structure may be used temporarily by the Contractor in the erection of the new structure. Such material shall not be cut or otherwise damaged except with the approval of the Engineer, and upon completion of the work shall be placed where it may be readily loaded on trucks. If the Contractor unnecessarily damages or impairs the salvage value of the material removed from an existing structure, it will be charged an amount estimated by the Engineer as sufficient to cover the loss, damage, or impairment in salvage value.

104.10 Final Cleaning Up. Before acceptance and final payment is made, the Contractor shall, without extra compensation, clear the highway structures and site of all obstructions placed by the Contractor, and shall remove from the right of way, borrow pits and adjacent property all surplus or discarded materials, rubbish, temporary buildings, structures and equipment; restore in an acceptable manner all property, both public and private, which has been damaged during the prosecution of the work; and shall 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

105.01 Authority of the Engineer. The Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the rate of progress of the work; all questions regarding the interpretation of the plans and specifications; all questions as to the acceptable fulfillment of the contract on the part of the Contractor; all questions as to disputes and mutual rights between Contractors, and all questions as to compensation; and the Engineer shall determine the amount and quantity of the several kinds of work performed and materials furnished which are to be paid for under the contract; and the Engineer's decisions shall be final.

The Engineer will have the authority to direct where and when work shall be performed on the project so that other work may be expedited to the end that the entire project shall be completed in the most satisfactory manner. The Engineer will have the authority to suspend the work wholly or in part, or to withhold further payments to the Contractor due to failure to correct conditions unsafe for the workmen or the general public; for failure to carry out provisions of the contract; for failure to carry out orders; for such periods as the Engineer may deem necessary due to unsuitable weather; for conditions considered unsuitable for the prosecution of the work; or for any other conditions or reason deemed to be in the public interest. No additional compensation will be paid the Contractor because of such suspension.

The Engineer is not authorized to increase the obligation of the Department under the contract except as herein provided.

105.02 The Plans, Working Drawings, and Shop Plans. The "plans," consisting of general drawings showing such

details as are necessary to give a comprehensive idea of the construction contemplated, will be furnished by the Department. Road plans will normally show the alignment, profile, grades, and typical cross-sections. In general, structure plans will show in detail the dimensions of the work contemplated. In cases where dimensions are not shown, the structure plans will show general features and details necessary to give a comprehensive idea of the structure.

The plans for bridges will show sufficient information to enable the Contractor to determine the work contemplated, but the Engineer reserves the right to supplement these plans with construction plans. The Contractor shall submit all essential or desirable working drawings, shop plans, and erection plans to the Department for review and acceptance, and shall not perform any work on the items involved until said plans have been accepted. Any work done or materials ordered before the acceptance of such working drawings, shop plans, and erection plans shall be at the Contractor's risk.

The information contained upon the plans regarding the results obtained from test piles and borings is a record of the conditions revealed by field work 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 Engineer observing the operations. The Contractor is not bound to accept or rely on these data, but shall interpret them in the light of its own experience, and it should make such additional borings and investigations, including test piles, as desired in order to determine or satisfy itself concerning the conditions affecting lengths of piles or governing or entering into the construction of the foundations.

The plans will show the foundation depths and dimensions on which the estimate of quantities is based. These depths and foundation dimensions, however, are subject to such variation as may be necessary to secure a foundation satisfactory to the Engineer, and the right is expressly reserved to

increase or diminish the dimensions and depths of substructures as the Engineer may determine.

When it is necessary to increase or decrease the height of a substructure or part thereof, the change will generally be made in that portion between the bottom of cap and top of footings.

Working drawings and shop plans shall be furnished by the Contractor and shall be accepted by the Department before work is started on their aspect of the project. For steel structures, shop plans shall include details, dimensions, material specification, and other information necessary for the complete fabrication of the metalwork and any items attached to the metalwork. The working drawings may include details of falsework, temporary bracing, and the erection process for the metalwork. Working drawings and shop plans for concrete structures shall consist of such detailed plans as may reasonably be required for the successful prosecution of the work, and which are not in the plans furnished by the Department. These shall include shop plans and working drawings for bending details and schedules for reinforcing steel, falsework, bracing, cribs, cofferdams, and deck formwork as required by the project. The working drawings and shop drawings for the prestressed members shall show formwork details and dimensions, strand sizes, stand patterns, location of holddown points methods for applying the desired tension in the strands, how detensioning will be affected, and methods of lifting and handling the prestressed members.

In the case of steel superstructures, drawings shall be furnished as provided for in **Section 709**, *Structural Steel*.

In the case of prestressed concrete, drawings shall be furnished as provided for in **Section 704**, *Prestressed Concrete*.

The Contractor shall furnish the Department with such copies of shop plans and working drawings in accordance

with the requirements of **Section 725**, and upon completion of the work, the original or duplicate tracings shall be furnished the Engineer. It is expressly understood that the approval by the Engineer of the Contractor's shop plans and working drawings is general; and such approval will not relieve the Contractor of any responsibility.

The contract price shall include the cost of furnishing all shop drawings and working drawings.

105.03 Conformity with Plans and Specifications. All work performed and all materials furnished shall be 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 Engineer and authorized in writing.

In the event the Engineer finds the materials or the finished product in which the materials are used not within reasonably close conformity with the plans and specifications but that reasonably acceptable work has been produced, the Engineer shall then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials necessary to conform to the determination.

In the event the Engineer finds the materials or the finished product in which the materials are used, or the work performed are not in reasonably close conformity with the plans and specifications and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by the Contractor without additional compensation.

105.04 Coordination of Plans, Specifications, and Special Provisions. These **specifications**, the supplemen-

tal specifications, the plans, **special provisions** and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In the event of any discrepancy; the special provisions shall govern over the plans; calculated dimensions shown on the plans, unless obviously incorrect, shall govern over scaled dimensions; the plans shall govern over standard drawings; standard drawings shall govern over the specifications; and **supplemental specifications** shall govern over these standard specifications. The Contractor shall take no advantage of any error or omission in the plans or of any discrepancy between the plans and specifications. The Engineer shall make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the specifications and plans as construed by him, and his decision shall be final.

105.05 Cooperation by Contractors. The Contractor will be supplied with a minimum of two copies of the plans, specifications, and contract assemblies, including special provisions. The contractor shall keep one set available on the work at all times. The Contractor will notify the District Engineering Administrator in writing as early as possible as to the time and place at which he expects to begin work, but, in all cases, at least seven (7) days before beginning work, in order to provide sufficient time for the staking out of the work.

The Contractor shall give the work the constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer, the Engineer's authorized representatives, and other contractors in every way possible. The Contractor shall at all times have on the work, as its agent, a competent **superintendent** or foreman capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer or the Engineer’s authorized representative, and have full authority to execute such orders or directions without delay.

Such superintendence shall be furnished irrespective of the amount of work sublet.

105.06 Cooperation with Utilities. The Department will notify all utility companies, all pipe line owners, or other parties affected, and endeavor to have all necessary adjustments of the public or private utility fixtures, pipe lines, and other appurtenances within or adjacent to the limits of construction, made as soon as practicable.

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 that are to be relocated or adjusted are to be moved by the owners under separate agreement, except as otherwise provided for in the special provisions or as noted on the plans, or as otherwise provided for in **Subsection 202.02**.

The plans will show all known utilities located within the limits of the contract according to information obtained. The accuracy of the plans in this respect is not guaranteed by the Department. The Contractor shall have considered in his bid all of the permanent and temporary utility appurtenances in their present or relocated position. No additional compensation will be allowed for any delays, inconveniences, or damage sustained by the Contractor due to any interference from the said utility appurtenances, delays in relocation of utilities or the operation of moving them.

Unless otherwise provided, the cost of temporary rearrangement of utilities made only in order to facilitate the construction of the work will be borne by the Contractor.

105.07 Cooperation between Contractors. Where work which is being performed by a Contractor for the Department is continuous to or within the limits covered by another contract, the respective rights of the various interests involved shall be determined by the Engineer to secure the earliest

practicable completion of the work.

When the Department awards separate contracts for work within the limits of one project, each Contractor shall conduct its work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Each Contractor involved shall assume all liability, financial or otherwise in connection with its contract and shall protect and save harmless the Department from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced because of the presence and operations of other Contractors working within the limits of the same project, and the Contractor shall assume all responsibility of all work not completed or accepted because of the presence and operations of the other Contractors.

Whenever road and bridge contracts are let separately and the limits of one contract are included within or adjacent to the limits of the other contract, the bridge Contractor shall have prior rights at the bridge site or sites for a reasonable period of time. Such prior rights will permit the bridge Contractor to store materials and equipment within reasonable spaces, and to do the necessary hauling and other incidental work as the Engineer may determine. This condition of priority shall not serve to release the road Contractor from its obligation to construct or maintain the bridge approaches, unless all other road work is completed before the bridge work has progressed to a stage where the approach work can be performed to the satisfaction of the Engineer. If practicable in the opinion of the Engineer, the bridge Contractor may be required, at its expense, to locate or relocate its materials and equipment in order to permit construction of the approaches.

Wherever the Engineer considers it desirable to clear and grub the right of way at the bridge site, or to construct bridge approaches prior to the construction of the bridge ends, or to complete bridge ends prior to other parts of bridge work, such work shall be done when directed by the Engineer.

105.08 Construction Stakes, Lines, and Grades.

A. Construction Stakes, Lines, and Grades Partially Provided by the Department. Unless otherwise provided, the Engineer will set construction stakes as necessary, establishing lines, slopes, continuous profile-grade, centerline of roadway, centerline of piers and abutments, a bench mark adjacent to the work, and vertical control elevations for flow lines, footings, caps, bridge seats, screed elevations, etc. In addition, the Engineer will furnish the Contractor with all necessary information relating to lines, slopes and grades. Using the control lines and grades established by the Engineer, the Contractor shall be responsible for completing the layout and performing the work.

The Contractor shall be responsible for the accuracy of transfer from the control lines and grades and layout of the work. The Contractor shall also be 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 State of replacing them will be charged against the Contractor and will be deducted from payment for the work.

The Contractor shall furnish, free of charge, all guard stakes, templates, straightedges and other devices necessary for checking, marking and maintaining points, lines, and grades.

The Department will be responsible for the accuracy of control lines and grades established by the Engineer. In case of error in the establishment of the original construction or survey stakes set by the Engineer, and discovered after the work has been fully or partially completed in compliance with the erroneous stakes, the Contractor will be paid for such additional work as may be required because of such error at the contract unit price for the class

of work involved.

On all bridge contracts, the Contractor shall, when requested, furnish assistance to give points and elevations during construction of the project. Such assistance shall be that usually required of a rodman.

B. Construction Stakes, Lines, and Grades Provided by the Contractor. The Contractor will be required to provide all the layouts necessary to construct the elements of this project. The Department will provide adequate reference points to the centerline of survey and bench marks as shown in the plans or as provided by the Engineer. Any additional control points set by the Department shall be identified in the field and documented in writing to the Contractor and the field notes shall be kept in the office of the Engineer.

The Contractor shall provide field personnel and set all additional stakes for this project, which are needed to establish offset stakes, reference points, and any other horizontal or vertical controls, including supplementary bench marks, necessary to secure a correct layout of the work. The Contractor will not be required to determine the property line between properties.

All computations of survey work required in the execution of this project shall be performed by a Registered Land Surveyor or a Registered Professional Engineer in the State of South Carolina. These computations shall be accompanied by the designated RLS's or PE's seal and signature.

The Contractor shall be responsible for having the finished work substantially conform to the lines, grades, elevations and dimensions called for in the plans or as provided by the Engineer. Any inspection or checking of the Contractor's layout by the Engineer and the acceptance of all or any part of it shall not relieve the Contractor of his responsibility to secure the proper dimensions, grades and

elevations of the several parts of the work. The Contractor shall exercise care in the preservation of stakes and bench marks, and shall have them reset at his expense when any are damaged, lost, displaced or removed. The Contractor shall use competent personnel and suitable equipment for the layout work required. The Contractor shall not engage the services of any person or persons in the employ of the SCDOT for the performance of any work covered by this item.

The Engineer will make random checks of the Contractor's staking to determine if the work is in substantial conformance with the plans. Where the Contractor's work will tie into work that is being or will be done by others, checks will be made to determine if the work is in conformance with the proposed overall grade and horizontal alignment. For bridge construction projects, the Contractor shall be required to provide bridge deck grades to the Engineer for review before placing deck forms.

If during the course of staking or construction work, unforeseen utilities and/or field conditions arise which conflict with construction as shown in the plans, the Contractor shall immediately notify the Engineer. The Engineer will review the Contractor’s findings and adjust the lines and grades accordingly or make arrangements for the utility to relocate its facilities. The resulting adjustments will be provided to the Contractor so that his survey crew can perform the adjusted staking. Adjusted staking as described above shall be considered a normal consequence of construction. No additional compensation will be due to the Contractor for this work, or for any delays due to adjustments to staking.

Measurement and Payment. Measurement will be for each Construction Stakes, Lines, and Grades item contained in the contract.

Payment for each portion of this item in the project will be proportional to the amount of the relevant work com-

pleted. In no case shall the sum of all payments for this item be in excess of the total bid amount for Construction Stakes, Lines, and Grades, which price and payment shall be full compensation for a material, equipment, tools, labor, and incidental work, including computations, necessary to complete the work.

Payment includes all direct and indirect costs and expenses required to complete the work.

Payment will be made under:

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

C. Construction Stakes, Lines, and Grades (For Bridge(s) Only) Provided by the Contractor. The Contractor will be required to provide all the layouts necessary to construct the bridge elements of this project. The Department will provide adequate reference points to the centerline of survey and bench marks as shown in the plans or as provided by the Engineer. Any additional control points set by the Department shall be identified in the field and documented in writing to the Contractor and the field notes shall be kept in the office of the Engineer.

The Contractor shall provide field personnel and set all additional stakes for the bridge elements of this project, which are needed to establish offset stakes, reference points, and any other horizontal or vertical controls, including supplementary bench marks, necessary to secure a correct layout of the work. The Contractor will not be required to determine the property line between properties.

Any computations of survey work required in the execution of this project shall be performed by a Registered Land Surveyor or a Registered Professional Engineer in

the State of South Carolina. The computation of survey

work shall be accompanied by the designated RLS's or PE's seal and signature.

The Contractor shall be responsible for having the finished work substantially conform to the lines, grades, elevations and dimensions called for in the plans or as provided by the Engineer. Any inspection or checking of the Contractor's layout by the Engineer and the acceptance of all or any part of it shall not relieve the Contractor of his responsibility to secure the proper dimensions, grades and elevations of the several parts of the work. The Contractor shall exercise care in the preservation of stakes and benchmarks, and shall have them reset at his expense when any are damaged, lost, displaced or removed. The Contractor shall use competent personnel and suitable equipment for the layout work required. The Contractor shall not engage the services of any person or persons in the employ of the SCDOT for the performance of any work covered by this item.

The Engineer will make random checks of the Contractor's staking to determine if the work is in substantial conformance with the plans. Where the Contractor's work will tie into work that is being or will be done by others, checks will be made to determine if the work is in conformance with the proposed overall grade and horizontal alignment. For bridge construction projects, the Contractor shall be required to provide bridge deck grades to the Engineer for review before placing deck forms.

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, the Contractor shall immediately notify the Engineer. The Engineer will review the Contractor's findings and adjust the lines and grades accordingly or arrange for the utility to relocate its facilities. The resulting adjustments will be provided to the Contractor so that his survey crew can perform the adjusted staking. Adjusted staking as described above shall be considered a normal consequence of construction. No

additional compensation will be due to the Contractor for this work, or for any delays due to adjustments to staking.

Measurement and Payment. Measurement will be for each item of Construction Stakes, Lines, and Grades (For Bridge Only) contained in the contract.

Payment for each portion of this item in the project will be proportional to the amount of the relevant work completed. In no case shall the sum of all payments for this item be in excess of the total bid amount for Construction Stakes, Lines, and Grades (For Bridge Only), which price and payment shall be full compensation for a material, equipment, tools, labor, and incidental work, including computations, to complete the work.

Payment includes all direct and indirect costs and expenses required to complete the work.

Payment will be made under:

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

105.09 Authority and Duties of the Engineer's Representative. Authorized representatives of the Engineer may inspect all work done and materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the material to be used. Such inspection, however, shall not relieve the Contractor from any obligation to perform all of the work strictly in accordance with the requirements of the contract. The Engineer's representative shall have the authority to reject defective material and to suspend any work that is being improperly performed, subject to the final decision of the Engineer. The

Engineer’s representative will not be authorized to alter or

waive the provisions of the contract, to approve or accept any portion of the work, or to issue instructions contrary to the plans and specifications. The Engineer's representative shall in no case act as superintendent or perform other duties for the Contractor, nor interfere with the management of the work by the latter. Any advice that the Engineer's representative may give the Contractor shall, in no way, be construed as binding the Engineer or the Department in any way, or as releasing the Contractor from the fulfillment of the terms of the contract.

105.10 Inspection of the Work. The Contractor shall furnish the Engineer with every reasonable facility for ascertaining whether or not the work as performed and materials used are in accordance with the requirements and intent of the contract. The Contractor, at any time before final acceptance of the work, shall remove or uncover such portions of the finished work as may be directed by the Engineer. After examination by the Engineer, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed and examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed, shall be paid for as **extra work**; but should the work so exposed and examined prove unacceptable, the uncovering, or removing, and replacing of the covering or making good the parts removed, shall be at the Contractor's expense. Any work done or materials used without supervision or inspection by the Engineer or the Engineer's representative may be ordered removed and replaced at the Contractor's expense. Failure to reject any defective work or material shall not in any way prevent later rejection when such defect is discovered, or obligate the Department to final acceptance.

When any unit of government or political subdivision, public utility company, or any railroad corporation is to pay a portion of the cost of the work covered by the contract, its respective representatives shall have the right to inspect the work. Such inspection shall not make any unit of government

or political subdivision or any railroad corporation or utility company a part of the contract and shall in no way interfere with the rights of the parties hereunder.

105.11 Removal of Unacceptable and Unauthorized Work. All work that does not conform to the requirements of the contract will be considered unacceptable, unless otherwise determined acceptable under the provisions in **Subsection 105.03**.

Unacceptable work, whether 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, shall be removed immediately and replaced in an acceptable manner.

Where lines and grades are necessary, no work shall be done without lines and grades having been given by the Engineer. Work done contrary to the instructions of the Engineer, work done beyond the lines shown on the plans, or as given, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

Upon failure on the part of the Contractor to comply forthwith with any order of the Engineer made under the provisions of this Subsection, the Engineer will have authority to cause unacceptable work to be corrected, removed and replaced and unauthorized work to be removed and to deduct the costs from any moneys due or to become due the Contractor. In case no such moneys are available, the expense so incurred shall be paid by the Contractor's Surety.

105.12 Load Restriction. The Contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the project. A special permit will not relieve the Contractor of liability for damage which may

result from the moving of materials or equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures or the roadway or to any other type of construction will not be permitted. Hauling of materials over the **base course** or surface course under construction shall be limited as directed by the Engineer to prevent damage to any portion of the pavement structure. No loads will be permitted on a concrete pavement, base course, or structure before the expiration of the curing period. No loads will be permitted on a portland cement stabilized base before the placing of the pavement, unless otherwise directed by the Engineer. In no case shall legal load limits be exceeded unless permitted in writing by the authority having jurisdiction over the road being used.

105.13 Failure to Maintain Roadway or Structure. If the Contractor, at any time, fails to comply with the provisions of **Subsection 104.07**, the Engineer will immediately notify the Contractor of such non-compliance. If the Contractor fails to remedy unsatisfactory maintenance within twenty-four (24) hours after receipt of such notice, the Engineer may immediately proceed to maintain the project, and the entire cost of this maintenance will be deducted from monies due or to become due the Contractor on its contract.

105.14 Termination of Contract. The contract may be terminated by the Department for the following:

a. For Convenience. The Department may by written order terminate the contract or any portion thereof after determining that termination would be in the public interest. Such reasons for termination may include, but need not be necessarily limited to, executive orders of the President of the United States relating to prosecution of war or national defense, national emergency which creates a serious shortage of materials, insufficient funds by the Department due to extenuating circumstances, orders from duly constituted authorities relating to energy conservation, and re-

straining orders or injunctions obtained by third-party citizen action resulting from national or local environmental protection laws or where the issuance of such order or injunction is primarily caused by acts or omissions of persons or agencies other than the Contractor.

b. For Criminal Conviction. The Department may, by written order, terminate the contract after execution of the contract documents upon the Contractor's conviction, or plea of guilty or nolo contendre as to an indictment charging activities that would result in the Contractor's disqualification as a bidder. At the Department's option, termination may be for convenience pursuant to **Subsection 105.14(a)** above or for Default pursuant to **Subsection 108.10**.

When the Department orders termination 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 will be made either at agreed prices or by force account methods described elsewhere in these specifications. Items that are eliminated in their entirety by such termination shall be paid for as provided in **Subsection 109.05**.

Acceptable materials, obtained by the Contractor for the work but which have not been incorporated therein, may, at the option of the Department, be purchased from the Contractor at actual cost delivered to a prescribed location, or otherwise disposed of as mutually agreed.

After receipt of Notice of Termination from the Department, the Contractor shall submit, within sixty (60) days of the effective termination date, its claim for additional damages or costs not covered above or elsewhere in these specifications. Such claim may include such cost items as reasonable idle equipment time, mobilization efforts, bidding and project investigative costs, overhead expenses attributable to the project terminated, actual idle labor cost if work is stopped in

advance of termination date and guaranteed payments for private land usage as part of original contract. The intent of negotiating this claim would be that an equitable settlement figure be reached with the Contractor. In no event, however, will loss of anticipated profits be considered as part of any settlement.

The Contractor agrees to make his cost records available to the extent necessary to determine the validity and amount of each item claimed.

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

105.15 Acceptance and Final Inspection.

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

B. Final Acceptance. When the Engineer deems that the project is substantially complete, the Engineer shall promptly make an inspection. If all construction provided for and contemplated by the contract is found completed to the Engineer's satisfaction, that inspection shall constitute the final inspection and the Engineer will notify the Contractor in writing of final acceptance after the date of the final inspection.

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

105.16 Claims for Adjustment and Disputes. Whenever the Contractor believes that it is or will be entitled to additional compensation, whether due to delay, extra work, breach of contract, or other causes arising out of or related to the contract, the Contractor shall follow the procedures set forth in this subsection.

A. Delay Claims. The term "delay" shall be deemed to mean any event, action, force, or factor that extends the Contractor's time of performance. This subsection is intended to cover all such events, actions, forces, or factors, whether they be styled "delay," "disruption," "interference," "impedance," "hindrance," or otherwise. The Contractor cannot compute delay damages on any basis other than the original contract completion date as properly adjusted for time extensions granted.

Within two weeks after determining that a delay has occurred, the Contractor must give the Department written notice of its intention to file a claim for delay damages. Notification shall be submitted to the Department on **SCDOT Form No. 616, *Contractor Notice of Claim*.**

The Department shall have no liability for any delay damages that accrued more than two weeks before the filing of such notice. Failure of the Contractor to give such written notice in a timely fashion will be grounds for denial of the claim.

The Contractor agrees that the failure to give notice will prejudice the Department and further agrees that the Department's conduct shall not constitute a waiver of this contractual notice requirement.

Compliance with the provisions of this subsection will be a condition precedent to any recovery of delay damages by the Contractor.

After giving the Department notice of intention to file a claim for delay damages, the Contractor must 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.

On a monthly basis after giving notice of intention to file a claim for delay damages, the Contractor shall prepare and submit to the Department's representative, written reports providing the following information:

1. Potential effect to the schedule caused by the delay.

2. Identification of all operations that the Contractor claims have been delayed, or are to be delayed.

3. 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.

4. Itemization of all extra costs being incurred, including:

a. An explanation as to how these extra costs relate to the delay and complete details of the Contractor's method of measurements, calculations, and resultant quantifications.

b. Identification of all project employees for whom the Contractor seeks additional compensation.

c. Identification by make, model and manufacturer's number of all items of equipment for which the Contractor seeks additional compensation.

NOTE: When the status of the information or condition of Items 1, 2, 3, or 4 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.

B. Claims for Acceleration. The Department shall have no liability for any constructive acceleration. If the Department gives express written direction for the Contractor to accelerate its effort, then both parties shall execute a supplemental agreement as defined in **Subsection 101.74**.

C. Other Claims. If the Contractor believes that it should be entitled to additional compensation for reasons other than delay or acceleration, the Contractor shall notify the Engineer in writing of its intent to claim such additional compensation before beginning or proceeding further with the Work out of which such claim arises. Notification shall be submitted to the Department on **SCDOT Form No. 616, *Contractor Notice of Claim***. If such notification is not given, then the Contractor waives its right to any additional compensation.

The liability of the Department for such claims shall be limited to those items of damages which are specifically identified as payable in connection with delay claims as set forth in **Subsection 105.16D**. For such claims, the Department will have no liability for those items of damages identified as not payable in connection with delay claims as set forth in **Subsection 105.16E**.

D. Recoverable Damages. Only the following items may be recovered by the Contractor as with respect to "delay" claims or "other" claims. The Department shall have no li-

ability for damages beyond the following items:

1. Additional job site labor expenses.

2. Documented additional costs for materials.

3. Equipment costs, as determined in accordance with this subsection.

4. Documented costs of extended job site overhead.

5. An additional 10% of the total of items 1, 2, 3, and 4 above, for home office overhead and profit; however, in no case will this amount exceed the anticipated margin for home office overhead and profit provided for in the Contractor's original bid estimate. Additionally home office overhead margins paid to the Contractor, included in supplemental agreements, will be considered as partial or final compensation for these costs.

6. Bond costs.

7. Subcontractor costs, as determined by, and limited to, those items identified as payable under paragraphs 1, 2, 3, 4, 5, and 6 above.

For purposes of computing extra equipment costs, rates used shall be 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. In no case will equipment rates be allowed in excess of those in the ***Rental Rate Blue Book***, with the appropriate adjustments noted in **Subsection 109.04**. Stand-by rate will be 50% of the operating rate.

E. Non-Recoverable Damages. The parties agree that, in any claim for damages, the Department will have no liability for the following items of damages or expense:

1. Profit, in excess of that provided in **Subsection 105.16D.5**.

2. Loss of profit.

3. Labor inefficiencies.

4. Home office overhead in excess of that provided in **Subsection 105.16D.5**.

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

6. Interest and any other indirect costs or expenses of any nature other than those allowable under **Subsection 105.16D.4**.

7. Attorneys fees, claims preparation expenses or costs of litigation.

F. Required Contents of Claims. All claims must be submitted in writing, and must be sufficient in detail to enable the Engineer to ascertain the basis and the amount of each claim. All information submitted to the Department under this subsection will be used solely for analyzing and/or resolving the claim. At a minimum, the following information opposite a checkmark (✓) must be provided.

For Delay Claims	For Other Claims	Required Documentation
✓		1. 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.

✓		2. An as-built chart, CPM scheme or other diagram depicting in graphic form how the operations were adversely affected.
	✓	3. A detailed factual statement of the claim providing all necessary dates, locations and items of work affected by the claim.
✓	✓	4. The date on which actions resulting in the claim occurred or conditions resulting in the claim became evident.
✓	✓	5. A copy of the ***Contractor Notice of Claim*** **(SCDOT Form 616)** filed for the specific claim by the Contractor.
✓	✓	6. The name, function, and activity of each Department official, or employee, involved in, or knowledgeable about facts that give rise to such claim.
✓	✓	7. The name, function, and activity of each Contractor or Subcontractor official, or employee, involved in, or knowledgeable about facts that gave rise to such claim.
	✓	8. The specific provisions of the contract that support the claim and a statement of the reasons why such provisions support the claim.
✓	✓	9. The identification of any pertinent documents, and the substance of any material oral communication relating to such claim.
✓	✓	10. 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.

✓	✓	11. The amount of additional compensation sought and a breakdown of that amount into the categories specified as payable under **Subsection 105.16D** above.
✓	✓	12. If an extension of time is also sought, the specific days for which it is sought and the basis for such claim as determined by an analysis of the construction schedule. If a schedule is not required for the contract, the request for time will be analyzed based on other documentation as required in this subsection.

G. Required Certification of Claims. When submitting the claim, the Contractor must certify in writing, under oath in accordance with the formalities required by South Carolina law, as to the following:

1. That the claim is made in good faith.

2. That supportive data is accurate and complete to the Contractor's best knowledge and belief.

3. That the amount of the claim accurately reflects what the Contractor in good faith believes to be the Department's liability.

The Contractor shall use the ***CERTIFICATE OF CLAIM*** form, which can be obtained from the Department, in complying with these requirements.

H. Auditing of Claims. All claims filed against the Department shall be subject to audit at any time following the filing of such claim, whether or not such claim is part of a suit pending in the courts of this State. The audit may be performed by employees of the Department or by an independent auditor appointed by the Department. The audit

may begin on ten days notice to the Contractor, Subcontractor or Supplier. The Contractor, Subcontractor or Supplier shall make a good faith effort to cooperate with the auditors. Failure of the Contractor, Subcontractor or Supplier to maintain and retain sufficient records to allow the Department's auditor to verify the claim shall constitute a waiver of that portion of such claim that cannot be verified and shall bar recovery thereunder.

Without limiting the generality of the foregoing, and as a minimum, the auditors shall have available to them the following documents:

1. Daily time sheets and foreman's daily reports.

2. Union agreements, if any.

3. Insurance, welfare, and benefits records.

4. Payroll register.

5. Earnings records.

6. Payroll tax returns.

7. Material invoices, purchase orders, and all material and supply acquisition contracts.

8. Material cost distribution worksheet.

9. Equipment records (list of company equipment, rates, etc.).

10. Vendor rental agreements and Subcontractor invoices.

11. Subcontractor payment certificates.

12. Canceled checks (payroll and vendors.)

13. Job cost report.

14. Job payroll ledger.

15. General ledger, general journal (if used), and all subsidiary ledgers and journals together with all supporting documentation pertinent to entries made in these ledgers and journals.

16. Cash Disbursements journal.

17. Financial statements for all years reflecting the operations on this project.

18. Income tax returns for all years reflecting the operations on this project.

19. Depreciation records on all company equipment whether such records are maintained by the company, its accountant, or others.

20. 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 other source documents.

21. All documents which reflect the Contractor's actual profit and overhead during the years this Project was being performed and for each of the five (5) years before the commencement of this project.

22. 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.

23. All documents that relate to each and every claim together with all documents that support the amount of damages as to each claim.

24. Worksheets used to prepare the claim establishing the cost components for items of the claim including, but not limited to, labor, benefits and insurance, materials, equipment, Subcontractors, and all documents which establish the time periods, individuals involved, the hours and the rates for the individuals.

I. Remedies Exclusive. The parties agree that the Department shall have no liability to the Contractor for expenses, costs, or items of damage other than those that are specifically identified as payable under this subsection. In the event any legal action is instituted against the Department by the Contractor on account of any claim for additional compensation, whether on account of delay, acceleration, breach of contract, or otherwise, the Contractor agrees that the Department's liability will be limited to those items which are specifically identified as payable in this subsection.

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

SECTION 106

CONTROL OF MATERIAL

106.01 Source of Supply and Quality of Materials. The source of supply of each of the materials specified may be required to be approved by the Engineer before delivery is started, and representative preliminary samples shall be submitted as directed by the Engineer. Only materials conforming to the requirements of these specifications and approved by the Engineer shall be used in the work. The Engineer may, at his/her discretion, approve material at the source before delivery is started. If it is found that sources of supply previously approved do not furnish a uniform or satisfactory product, or if the product from any source proves unacceptable at any time, the Contractor shall furnish approved materials from other approved sources, and shall immediately remove any and all rejected materials from the job site. No material that has become unfit for use in any way shall be used in the work.

In case materials are specified which are not specifically covered in these specifications, such materials shall meet the requirements of the AASHTO specifications which were current on the date bids were advertised, or, when such materials are not covered in the AASHTO specifications, they shall meet the requirements of the ASTM specifications that were current on the date bids were advertised.

106.02 Local Material Sources. Sources of local materials which the Department will acquire and make available to the Contractor for the right to use the materials may be designated on the plans or by the Engineer. If the Contractor desires to use materials from sources other than those designated, it shall acquire the necessary rights to take materials from those sources and shall pay all costs related thereto, including any that result from an increase in length of haul.

106.03 Samples and Tests. The Contractor shall provide materials for samples to be taken for testing by the Engineer at no cost to the Department.

All materials proposed to be used in the construction of the work shall be properly examined, tested, and approved by the Engineer before being incorporated into the work. Any work in which such materials are used without prior test and approval or written permission of the Engineer shall be performed at the Contractor's risk and may be considered as defective and unauthorized, and may not be accepted for payment. Tests will be made by and at the expense of the Department unless otherwise noted in the specifications or contract documents. Tests shall be made in accordance with the methods prescribed in the **AASHTO *Standard Specifications for Highway Materials and Methods of Sampling and Testing* and *Interims*** that were current on the date that bids were advertised, or in cases where no method is prescribed therein, the tests shall be made in accordance with the methods prescribed by the applicable **ASTM specifications** that were current on the date that bids were advertised. Materials to be used in the work may be inspected or tested at any time during their manufacture, preparation, or use.

106.04 Inspection of Bituminous Materials. ***The Policy for Inspection and Use of Asphalt Cement and All Liquid Asphalt Materials*** adopted by the South Carolina Department of Transportation current on the date when the project is advertised, shall be used. The Contractor shall comply with the provisions of the policy. A copy of this policy may be obtained from the:

Research and Materials Engineer
South Carolina Department of Transportation
PO Box 191
Columbia, SC 29202

106.05 Plant Inspection. The Engineer may undertake the inspection of materials at the sources.

If plant inspection is undertaken, the following conditions shall be met:

a. The Engineer shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has contracted for materials and shall be furnished, free of charge, all reasonable and required facilities to assist in determining whether the materials meet the requirements of the specifications.

b. The Engineer shall have full entry at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished.

c. Adequate safety measures shall be provided and maintained.

d. Materials tested and accepted at the source of supply may be re-tested. If, when re-tested, they do not meet the requirements of these specifications or those established for the specific project, they may be rejected.

106.06 Field Laboratory. At no expense to the Department, the Contractor shall provide an inspector's field laboratory fully equipped in accordance with the provisions of applicable specifications.

106.07 Storage of Materials. Materials shall be so stored as to insure the preservation of their quality and fitness for the work. When considered necessary, materials shall be placed on wooden platforms or other hard, clean surfaces and not on the ground and shall be placed under cover when directed. Stored materials shall be located to facilitate proper inspection. Different kinds and sizes of aggregates shall be kept separate during transportation, handling, and storage until used. If necessary, partitions of suitable height and strength shall be constructed between stockpiles to prevent different

materials from becoming mixed. The inclusion of any foreign material will not be permitted.

Subject to the approval of the Engineer, portions of the right of way may be used for storage purposes and for the placing of the Contractor's plant and equipment, but any additional space required therefor must be provided by the Contractor at its expense. Private property shall not be used for storage purposes without written permission of the owner or lessee, and, if requested, copies of such written permission shall be furnished to the Engineer. All storage sites shall be restored to their original condition by the Contractor at its expense.

106.08 Handling Materials. All materials shall be handled in such manner as to preserve their quality and fitness for the work. Aggregates shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segregation of materials. There will be no inconsistencies in the quantities of materials intended for incorporation in work as loaded and measured, and the quantities as actually received at the place of operations.

106.09 Unacceptable Material. All materials not conforming to the requirements of these specifications shall be considered as defective, and all such materials, whether in place or not, shall be rejected and removed immediately from the site of the work, unless otherwise instructed by the Engineer.

No rejected material, the defects of which have been subsequently corrected, shall be used until approval has been given by the Engineer. Should the Contractor fail or refuse to remove and replace the defective materials, whether in place or not, or to make any necessary corrections in an acceptable manner and in accordance with the requirements of these specifications, within the time indicated, in writing, the Engineer shall have the authority to cause the unacceptable or defective materials or work to be removed and replaced or corrected. Any expense incurred by the Department in mak-

ing these removals, replacements, or corrections, that the Contractor has failed or refused to make, shall be paid for out of any monies due, or that may become due, the Contractor. If no such monies are available, the expense so incurred shall be charged against the Contractor's Surety.

106.10 Material Guaranty. After any contract is awarded, the Contractor may be required to furnish a complete statement of the origin, composition, manufacture, and guaranteed performance of any or all materials to be used in the construction of the work, together with samples. These samples may be subjected to the tests provided for in these specifications to determine their quality and fitness for the work.

106.11 Material Pit Acquisition and Testing. When the Contractor is required to provide material pits, the Department may, at the discretion of the Engineer, exercise its right of Eminent Domain in the acquisition of the land. All related costs shall be borne by the Contractor.

When the Contractor is required to furnish materials from pits, the Contractor shall be responsible for obtaining any samples necessary for evaluating the pit material. The Department may furnish the necessary equipment and operator for drilling test holes at locations and to depths designated by the Contractor. The Contractor shall obtain the aforesaid samples of the drilled material and submit the samples to the Department's Research and Materials Laboratory for appropriate tests. These tests shall be made in accordance with standard testing procedures and the test results will be furnished by the Department to the Contractor for its information in evaluating the proposed pit sites.

The Contractor is to designate the drilling location and obtain the samples. The Department assumes no responsibility in the testing services other than the accuracy of the test of the material furnished by the Contractor for testing.

The Department's furnishing of the above described ser-

vice shall generally be limited to the lesser of 2 test holes and 2 sample tests per acre or 2 tests per 16,000 CY of the planned quantity of material.

SECTION 107

LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.01 Laws To Be Observed. The Contractor shall keep fully informed of, and at all times shall observe and comply with, all Federal, State, and Local Laws, ordinances and 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 which in any way affect the conduct of the work or the execution of any documents in connection therewith. The Contractor shall 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.

The Contractor shall execute and file such documents, statements, and affidavits required under any applicable Federal or State law or regulation affecting the proposal, contract, or the prosecution of the work thereunder. The Contractor shall permit the examination of any records made subject to such examination by any Federal or State law or by regulations promulgated thereunder by any State or Federal agency charged with the enforcement of such law.

107.02 Permits, Licenses, and Taxes. Unless provided for otherwise, the Contractor shall obtain all permits and licenses, pay all charges, fees and taxes, and give all notices

necessary and incident to the due and lawful prosecution of the work.

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

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

The Contractor shall allow parties bearing such permits, and only those parties, to make openings in the highway. When ordered by the Engineer, the Contractor shall make all necessary repairs due to such openings in an acceptable manner. Such necessary work will be paid for as **extra work**, as provided in these specifications, and shall be subject to the same conditions as original work performed.

107.05 Federal Participation. When the United States Government is to pay all or a portion of the cost of a project, the Federal laws authorizing such participation and rules and

regulations made pursuant to such laws must be observed by the Contractor. When any Federal laws, rules, or regulations are in conflict with provisions of a federally assisted contract, the Federal requirements shall prevail. These requirements shall take precedence and be in force over and against any such conflicting provisions. The work shall be under the supervision of the Department, but subject to the inspection of the appropriate Federal agency. Such inspection shall not make the Federal Government a party to the contract, and will not interfere with the rights of either party hereunder.

107.06 Sanitary Health and Safety Provisions. The Contractor shall 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 South Carolina Department of Health and Environmental Control or of other authorities having jurisdiction.

Attention is directed to Federal, State and local laws, rules and regulations concerning safety and health standards. The Contractor shall not require any worker to work in surroundings or under conditions that are unsanitary, hazardous, or dangerous to his health or safety.

The Contractor shall comply with requirements pertaining to noise controls on equipment.

107.07 Air Pollution Control. The Contractor shall 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 South Carolina Department of Health and Environmental Control, Bureau of Air Quality Control, Columbia, South Carolina. The Contractor shall comply with County or other regulations pertaining to air pollution.

107.08 Quarantine Regulations. The Contractor shall comply with the quarantine regulations of the **Clemson University Division of Regulatory and Public Service Pro-**

grams and the **United States Department of Agriculture** for plant and insect pest control as they pertain to Witchweed, Imported Fire Ant, or any other insect pest quarantine. The Contractor shall keep informed as to the counties or areas within the State in which quarantine is imposed.

Soil and soil moving equipment, operating in regulated areas will be subject to plant and insect quarantine regulations. In general, these regulations provide for cleaning soil from equipment before it is moved from regulated areas. Complete information may be secured from the Division of Regulatory and Public Service Programs, Clemson University, Clemson, S. C. and the United States Department of Agriculture. Addresses for the United States Department of Agriculture are as follows:

USDA, APHIS, PPQ
Room 513 Federal Building
334 Meeting Street
Charleston, SC 29403

USDA, APHIS, PPQ
9600 Two Notch Road,
Suite 10
Columbia, SC 29229

USDA, APHIS, PPQ
1030 St. Andrews Road,
Suite A-1
P. O. Box 21792
Columbia, SC 29210

USDA, APHIS, PPQ
1949 Industrial Park Road,
Room 153
P. O. Box 762
Conway, SC 29526

USDA, APHIS, PPQ
2102 Airport Road
Greer, SC 29651

USDA, APHIS, PPQ
P. O. Box 12212
Greenville, SC 29612

USDA, APHIS, PPQ
180 Airport Road, Suite F
Mullins, SC 29574

USDA, APHIS, PPQ
I-95 & Hwy. 68
P. O. Box 707
Yemassee, SC 29945

107.09 Public Convenience and Safety. The Contractor shall at all times conduct the work in such a manner as to reasonably provide for the safety and convenience of the

traveling public and of the residents along and adjacent to the highway, and to offer the least practicable obstruction to the flow of traffic. This provision shall not be construed to require the Contractor to provide for the safety and convenience of the traveling public portions of the highway or roadway which are not within the scope and the work being performed by the Contractor as defined by the contract. The Contractor shall not close any bridge or culvert or any portion of the road to traffic until permission has been granted by the Engineer.

Materials stored upon the highway shall be so placed as to cause the minimum obstruction to the traveling public.

107.10 Construction of Bridges Over or Adjacent to Navigable Waters. All work over, on, or adjacent to navigable waters shall be so conducted that free navigation of the waterways will not be interfered with and that the existing navigable depths will not be impaired except as allowed by permit issued by the **U S Coast Guard** and/or the **U S Army Corps of Engineers**, as applicable.

The Contractor shall also provide and maintain such temporary navigation lights and signals as may be required by Coast Guard regulations for the protection of navigation. When in the judgment of the Engineer, the construction has reached a point where such action should be taken, the channel or channels through the structure shall be promptly cleared of all falsework, piling, or other obstructions placed therein to the satisfaction of the US Coast Guard. In any case, such clearing shall be completed before the acceptance of the project.

107.11 Traffic Control. The Contractor shall execute the item Traffic Control as required by **Section 601**, the plans, the ***SCMUTCD***, latest edition (including Part V dated 1992, Revised 1994), and any **special provisions** included in the contract. The Contractor shall provide, erect and maintain all necessary barricades, warning signs, lights, temporary signals, temporary striping, and other traffic control devices as

required by the manual on ***Uniform Traffic Control Devices for Streets and Highways*** and **Section 601**, Work Zone Traffic Control. This work shall be performed without extra compensation unless bid items are set up in the contract. The Contractor shall not be required to provide traffic control on any portion of the highway outside the scope of its work.

The Department will erect and maintain signs on detours or temporary routes that the Contractor is not required to maintain, but the Contractor shall provide and maintain such signs at and along all detours for which it is responsible. The Contractor shall maintain and relocate, where necessary, all regulatory, warning and guide signs in place of those that may be erected by the Department, within the limits of its contract.

The work as defined in the contract shall be considered to have begun with the placing of permanent construction signs by the Contractor. The work shall be considered to have been completed when the Engineer authorizes the Contractor to remove the permanent construction signs and the Contractor does so. The Engineer may permit the Contractor to omit permanent construction signs on low volume roads or streets where the work will be completed within the daylight hours of a single day. However, if the permanent construction signs are omitted, the Contractor shall install temporary signs when the work is in progress.

All barricades, signs, and traffic control devices shall conform to the requirements of the current ***South Carolina Manual on Uniform Traffic Control Devices for Streets and Highways***, unless otherwise permitted by the Engineer. All signs in this handbook have been given an identification number, and full-scale drawings of each sign are available for sign fabricators. These manuals and drawings may be obtained from:

Director of Traffic Engineering
South Carolina Department of Transportation
P. O. Box 191
Columbia, SC 29202

When the work on a roadway is substantially complete, all permanent construction signs will be removed. If signing is required to finish any remaining work, temporary signs shall be used for this purpose.

107.12 Payment for Traffic Control. The Department will pay for Traffic Control on a percentage completed basis as specified in **Subsection 601.03**. The price and payment for Traffic Control shall be full compensation for fabricating, providing, preparing, installing, removing or relocating, maintaining, and repairing or replacing all traffic control items as necessary to complete the work. The price and payment for traffic control shall include furnishing all materials, labor, hardware, equipment, tools, incidentals, and miscellaneous items necessary to complete the work.

Payment includes all direct and indirect costs and expenses required to complete the work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
1071000	Traffic Control	Lump Sum

107.13 Correcting Low Shoulder Conditions.

A. Identifying Existing Low Shoulders Before Commencement of Work. Before the placement of the permanent construction signs and before the Contractor begins work on a resurfacing project, the Engineer and the Contractor shall inspect the roads within the project together for determining existing low shoulder conditions.
The Contractor shall be responsible for placing low shoul-

der signs at these locations and for correcting the existing low shoulders where possible by bringing in and spreading borrow material before starting the resurfacing work. The Engineer and the Contractor shall agree on the time that the Contractor will be allowed to perform work on correcting the existing low shoulder conditions. Before the Contractor commences work erecting low shoulder signs and correcting the existing low shoulders, the Engineer shall notify the Contractor in writing of the specific areas requiring low shoulder signs and/or additional work to correct low shoulder conditions and will also specify the time that the Contractor will be allowed to complete the work. The Contractor will be paid for this work at the contract unit price for Borrow Excavation and Permanent Construction Signs.

B. Maintenance of Low Shoulder Signs During the Project. The Contractor shall maintain all low shoulder signs within the termini of the project until the low shoulder conditions have been corrected to the satisfaction of the Engineer.

C. Work Related to Existing Low Shoulders. Within three (3) working days of completion of the low shoulder correction work, the Engineer shall inspect the prescribed work and, if necessary, direct in writing, the placement of additional low shoulder signs or borrow material before the Contractor commencing paving operations. Once this phase is completed, no further corrective action shall be required by the Contractor until the road surface is paved unless the Contractor is directed to do so by the Engineer.

D. Correction of Low Shoulders Created by Resurfacing. Upon completion of the final riding surface on each road, the Contractor will be allowed three (3) working days to begin correcting low shoulder conditions greater than 2 inches and shall make reasonable efforts, weather permitting, to continue the work until the low shoulder conditions are eliminated to the satisfaction of the Engineer. When necessary, the Contractor shall correct low

shoulder conditions greater than 2 inches by placing borrow material against the edge of the pavement or by such other method as directed by Engineer.

When the Contractor is within three (3) days of completing shoulder work on a roadway, the Contractor shall notify the Engineer. Within three (3) working days of such notification the Engineer shall inspect the prescribed work and, if necessary, direct in writing, the placement of additional borrow material.

107.14 Railway Highway Provisions. If the plans require that materials be hauled across the tracks of any railway, the Contractor will arrange with the railway for any new crossing required or for the use of any existing crossings not within the system of public roads.

All work to be performed by the Contractor on the railroad right of way shall be performed at such times and in such manner as not to interfere with the movement of trains or traffic upon the track of the railway company. The Contractor shall use all care and precaution in order to avoid accidents, damage or delay or interference with the railway company's trains or other property.

All charges made by the railway company for the construction or use of new or existing private crossing, for their subsequent removal, and all charges for watchmen or flagmen service at such crossings shall be reimbursed by the Contractor directly to the railway company under the terms of their own arrangements. Such payment by the Contractor to the railway company shall be made before the acceptance of the project.

The Contractor shall conduct all operations which occur on or over the right of way of any railway company fully within the rules, regulation and requirements of the railway company and in accordance with any agreement made between the Department and the railway company, which is made a part of the contract.

107.15 Use of Explosives. When the use of explosives is necessary for the prosecution of the work, the Contractor shall exercise the utmost care not to endanger life or property, including the new work. The Contractor shall be responsible for all damage resulting from the use of explosives. All explosives shall be stored in a secure manner in compliance with all laws, ordinances, and regulations.

The Contractor shall comply with all laws and ordinances, as well as with **Title 29 Code of Federal Regulations, Part 1926, *Safety and Health Regulations for Construction* (OSHA)**, whichever is the most restrictive, with respect to the use, handling, loading, transportation, and storage of explosives and blasting agents.

The Contractor shall notify each public utility company having structures in proximity to the site of the work of any intention to use explosives, and such notice shall be given sufficiently in advance to enable the companies to take such steps as they deem necessary to protect their property from injury. Such notice shall not relieve the Contractor of responsibility for any damage resulting from blasting operations.

107.16 Preservation and Restoration of Property, Trees, Monuments, Etc. The Contractor shall not enter upon private property for any purpose without first obtaining permission. The Contractor shall be 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 and shall use every precaution necessary to prevent damage or injury thereto. The Contractor shall use suitable precaution to prevent damage to pipes, conduits, underground structures, poles, wires, cables and other overhead structures, whether shown on the plans or not, and shall protect from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location, and shall not remove them until directed. When or where any direct or indirect

damage or injury is done to public or private property by, or on account of, any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the non-execution thereof on the part of the Contractor, the Contractor shall restore, at its own expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as may be directed, or he shall make good such damage in an acceptable manner. Should the Contractor fail to restore such property, or make good such damage or injury, the Engineer may, upon forty-eight (48) hours notice, proceed to repair, build or otherwise restore such property as may been deemed necessary, and the cost thereof will be deducted from any moneys due, or which may become due, the Contractor under the contract. If no such moneys are available, the expense so incurred shall be charged against the Contractor's Surety.

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

107.17 Forest Protection. In carrying out work within or adjacent to state or national forests, the Contractor shall comply with all the regulations of the State or Federal authority having jurisdiction, governing the protection of forests and the carrying out of work within forests, and shall observe all sanitary laws and regulations with respect to the performance of work in forest areas. The Contractor shall keep the areas in an orderly condition, dispose of all refuse, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, latrines, cesspools, septic tanks, and other structures in accordance with the requirements of

the forest supervisor. The Contractor shall take all reasonable precautions to prevent and suppress forest fires. The Contractor shall abide by such rules and instructions as the forest officers may prescribe as to the time and place for burning and for fire control generally. The Contractor shall not cut any roadside timber outside the roadway nor mar the scenic values of the right of way for any purpose whatsoever, without consent of the Engineer, who must obtain permission from the proper forest authority. The responsibility of the Contractor for damages as provided for in **Subsection 107.16** will apply in case of damages caused by the escape of fire.

107.18 Responsibility for Claims, Etc. The Contractor shall indemnify and save harmless the County, the State, the Department, its officers, agents and employees, as well as the city, town or other municipality in which the work is performed and all of their officers, agents and employees from all suits or claims of any character brought because of any injuries or damage received or sustained by any person, persons, or property, in whole or in part, on account of the operations of the said Contractor or any Subcontractor or sub-Subcontractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials or workmanship in constructing the work; or because of any act or omission, neglect, or misconduct of said Contractor or any Subcontractor or sub-Subcontractor; or because of any claims or amounts recovered from any infringements of patent, trademark or copyright; or for failing to pay, when and as due, all bills and other legitimate charges, including lawful claims for labor performed or materials, equipment and supplies furnished for use in and about the construction of the work under contract; or from any claims or amounts arising or recovered under the **Workmen's Compensation Act**, or any other law, ordinance or decree. So much of the money due the Contractor under and by virtue of his contract as may be considered necessary by the Department may be retained for the use of the Department, or, in case no money is due, the Contractor's Surety shall be held

responsible until such suit or suits, action or actions, claim or claims for injuries or damages as aforesaid shall have been settled and suitable evidence to that effect has been furnished the Department; except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he is adequately protected by public liability and property damage insurance.

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

107.20 Opening of Section of Highway to Traffic. When in the opinion of the Engineer, any bridge, roadway or portion thereof is in acceptable condition for travel, it shall be opened to traffic as directed, and such opening shall not be held to be in any way an acceptance of the bridge, roadway or any part of it, or as a waiver of any of the provisions of the contract. Pending completion and final acceptance thereof, necessary repairs or renewals due to any cause other than ordinary wear and tear shall be performed at the expense of the Contractor. If the construction of the project has not been completed and weather conditions require suspension of the laying of the surface courses or other work, the incomplete portions of the work shall be opened to traffic when directed by the Engineer, and maintenance of such incomplete sections shall be carried on by the Contractor, and any repairs necessary to incomplete sections shall be made by the Contractor without any additional compensation.

107.21 Contractor's Responsibility for the Work. Until final acceptance of the work by the Engineer, as evidenced in writing, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements, or from any

other cause, whether arising from the execution or from the non-execution of the work. Unless otherwise provided in these specifications, the Contractor shall rebuild, restore and make good all injuries or damages to any portion of the work occasioned by any cause before final acceptance and shall bear the expense thereof.

The Contractor shall be responsible to the Department for the acts and omissions of its employees, Subcontractors, and their agents and employees, and all other persons performing work under a contract with the Contractor or any of its Subcontractors.

In case suspension of work from any cause whatever, the Contractor shall be responsible for all materials and shall properly store them, if necessary, and shall provide suitable drainage of the roadway, continue the servicing of barricades, lights, signs and other devices; and erect necessary temporary structures without any additional compensation.

107.22 Contractor's Responsibility for Utility Property and Services. Before commencing work, the Contractor shall arrange to protect the properties of railway, telegraph, telephone, power companies, or other property from damage.

The Contractor shall 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.

If utility services are interrupted as a result of accidental breakage, the Contractor shall promptly notify the proper authority and cooperate with them until service has been restored. Work undertaken around fire hydrants shall not commence until provisions for continued service have been made and approved by the local fire authority.

If a permit is issued to a city or other governmental unit for the installation of conduits, poles or other appurtenances for

artificial lighting of the structure, it may be necessary or desirable to revise the plans or make structural changes as needed to accommodate such installation. If the provisions of **Subsection 104.02** shall apply to any changes in quantities of work.

107.23 Furnishing Right of Way. The Department will be responsible for the securing of all rights of way that it deems necessary in advance of construction. Any exceptions will be indicated in the proposal.

107.24 Personal Liability of Public Officials. In carrying out any of the provisions of these specifications, or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the Director, Engineer or Department employees who are their 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.

107.25 No Waiver of Legal Rights. Upon completion of the work, the Department will expeditiously make final inspection and notify the Contractor of acceptance. Such final acceptance, however, shall not preclude or estop the Department from correcting any measurement, estimate or certificate made before or after completion of the work; nor shall the Department be precluded or estopped from recovering any overpayments that may have been made; nor shall the Department be 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 shall not be held to be a waiver of any other subsequent breach. Neither the inspection or acceptance by the Department, or any representative of the Department, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the Department, shall operate as a waiver of any portion of the contract or of any power herein reserved, or of any right to damages.

107.26 Environmental Protection and Water Pollution Control. The Contractor shall comply with all Federal, State, and local laws and regulations controlling pollution of the environment. The Contractor shall take necessary precautions to prevent pollution of streams, lakes, ponds, and reservoirs with fuel, oils, bitumens, chemicals, soil sedimentation, or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

At the Preconstruction Conference, or before the start of construction, the Contractor shall submit in writing to the Engineer for approval, the schedule for accomplishment of temporary and permanent erosion control work as is applicable for clearing and grubbing, grading, bridges and other structures in watercourses, and paving. The amount of surface area of erodible earth material exposed at one time by clearing and grubbing, excavation, borrow, or fill, shall not exceed 750,000 square feet without prior approval by the Engineer. The location of the project, nature of the soil, topographic features, and proximity to watercourses shall be considered when imposing such limitations.

The Contractor shall conduct its operations in a manner consistent with good erosion control practices to minimize soil erosion, and to the extent practicable, prevent sediment from leaving the site. The Contractor shall take whatever measures necessary throughout the life of the project to control erosion and to minimize the deposition of sediment into adjacent rivers, streams, wetlands, and impoundments. Temporary and permanent erosion control measures that will contribute to the control of erosion and sedimentation shall be carried out in conjunction with clearing and grubbing and earthwork operations.

Temporary erosion and sediment control measures such as berms, dikes, slope drains sedimentation basins and temporary seeding shall be provided until permanent drainage facilities and erosion control features are completed and operative.

Unless provided for in the contract, temporary erosion control devices or measures with the exception of sedimentation basins, fiberglass roving, baled straw erosion checks, silt fence, fabric for slope protection, terraces, sectional drains, and temporary seeding will not be paid for directly, but will be considered as a subsidiary obligation of the Contractor covered under various items of the contract work.

Permanent erosion control devices or measures shall consist of culvert pipe, terraces, gutters, bituminous curb, sectional drains, permanent slope drains, rip rap, and the establishment of permanent vegetation (seeding), and when included in the contract they shall be incorporated in the construction with the least possible delay. Cut and fill slopes shall be seeded as the excavation proceeds to the extent considered by the Engineer as desirable or practicable.

When work is begun on a cut or fill section, it shall be graded to the typical section with the least amount of delay in order that all erosion control measures can be promptly installed.

The Contractor shall also conform to the following practices and controls:

a. When the material is excavated from pits, erosion of the pit site shall be so controlled both during and after completion of the work that erosion will be minimized and sediment will not enter streams, wetlands, or other bodies of water. Waste or disposal areas and haul roads shall be located and constructed in a manner that will keep sediment from entering streams.

b. Frequent fording of live streams will not be permitted; therefore, temporary bridges or other structures shall be used whenever an appreciable number of stream crossings are necessary. Unless otherwise approved in writing, mechanized equipment, except equipment normally used

in the construction of structures or channel changes shall not be operated in live streams.

c. When work areas are located adjacent to live streams, the work shall be performed in such a manner to prevent sediment from entering a flowing stream.

d. All waterways shall be cleared as soon as practicable of falsework, piling, debris, or other obstructions placed during construction operations and not a part of the finished work.

e. Pollutants such as fuels, lubricants, bitumens, raw sewage, and other harmful materials shall not be discharged into or near rivers, streams, impoundments, or natural or man made channels leading thereto. Wash water or waste from concrete mixing operations shall not be allowed to enter live streams.

f. All applicable regulations of agencies and statutes relating to the prevention and abatement of pollution shall be complied with in the performance of the contract.

In additional to the requirements set forth above, specific limitation projects may be included in the proposal.

107.27 Hazardous and/or Toxic Waste. If the Contractor should encounter or expose during construction operation any abnormal condition that may indicate the presence of a hazardous and/or toxic waste, work in this area shall be immediately discontinued, and the Engineer shall be notified.

Abnormal conditions shall include, but shall not be 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 that appears abnormal that could be a possible indication of hazardous and/or toxic waste. The conditions shall be treated with extraordinary caution.

The Contractor's operations shall not resume until so directed by the Engineer.

If a building is razed, the Contractor is advised that it will be its responsibility to secure the necessary permits in accordance with the South Carolina Department of Health and Environmental Control requirements.

Where the Contractor performs necessary work required to dispose of these materials, payment will be made at the contract unit price for items applicable to such work or payment shall be made in accordance with **Subsection 104.05** or **109.04**. Should the disposition of waste material require special procedures by certified personnel, the Department will arrange with qualified persons to dispose of the material. Disposition of the hazardous and/or toxic waste shall be made in accordance with the requirements and regulations of the South Carolina Department of Health and Environmental Control.

SECTION 108

PROSECUTION AND PROGRESS

108.01 Subletting of Contract. The Contractor shall 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 moneys payable under the contract, or the claim thereto, without written consent of the Engineer.

On all projects, the Contractor shall perform with its own organization, and with the assistance of workmen under its

immediate supervision, work amounting to not less than 30 percent of the combined value of all items of work embraced in the contract, exclusive of any items of work under the contract that require highly specialized knowledge, craftsmanship, or equipment not ordinarily available in contracting organizations qualified to bid on the project. Such items may be designated in the contract as "specialty items."

Request for permission to sublet, transfer, assign, or otherwise dispose of any portion of the contract shall be in writing and accompanied by a letter showing that the organization or organizations that will perform the work are particularly experienced and equipped for such work. The request shall state the name and mailing address of each proposed Subcontractor and shall also include the item of work to be subcontracted. On all Federal-aid contracts, the request shall also contain a certification that all requirements for Federal-aid construction contracts included in the proposal are physically included and are a part of the subcontracting agreement (contract) between the principal Contractor and the Subcontractor and lower tier Subcontractors. In case of any conflict, the Required Contract Provisions will prevail. On all Federal-aid and State contracts, the request shall state the amount of work involved for each item expressed both as a monetary value and as a percentage of the value of the entire contract. When an agent performs work under a Subcontractor, all requirements applicable to Subcontractors will apply. All pertinent contract requirements shall apply on all work sublet, assigned or otherwise disposed of in any way. Consent to sublet, assign, or otherwise dispose of any portion of the contract shall not serve to release the Contractor or his Surety of any responsibility for the fulfillment of the contract.

108.02 Preconstruction Conference. After receipt of the notice of award and before the beginning of construction, the Engineer and the Contractor shall establish a mutually agreeable date on which a preconstruction conference will be held. The Contractor shall have present at the preconstruction conference the project superintendent, and other representatives

or responsible officials who will be involved during the construction of the project, including representatives of any Subcontractors. Officials of local county and municipal governments, representatives of affected utility companies and other affected agencies may be requested by the Engineer to attend in order that a working understanding can be established, thus providing for the coordination of the work among the various parties and allowing the work to proceed with minimum delay.

The conference discussion of the project may include such matters as the Contractor's plans and schedules, where the prosecution of the work shall 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 method of construction and the method of measuring and paying for the items of work.

108.03 Prosecution of the Work. The Contractor shall begin the work to be performed under the contract on or before a date that will enable 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 shall be responsible for all claims and liabilities of third parties arising out of or connected with such interim work done prior to the contract. The Department will not be responsible for payment to the Contractor for any work performed, costs, expenses, or damages of any kind or nature relative to or resulting from the Department's decision not to execute the contract. The work shall begin at such points as the Engineer may direct, and shall be prosecuted from as many different points, in such part or parts and at such times as may be directed. The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications

within the time set forth in the proposal. Should the prosecution of the work be discontinued for any reason, the Contractor shall notify the Engineer at least seventy-two (72) hours in advance of resuming operations.

108.04 Limitation of Operation. The Contractor shall conduct the work at all times in such manner and in such sequence to the extent practicable that will assure the least interference with traffic. The Contractor shall have due regard to the location of detours and to the provisions for handling traffic. The use of detours and their location shall be approved by the Engineer. The Contractor shall not open work to the prejudice or detriment of work already started. The Engineer may require the Contractor to finish a section on which work is in progress before work is started on any additional sections if the opening of such section is essential to public convenience.

Except as hereinafter specified, no load of material for any construction, including liquid asphalt for application on the roadway, shall be dispatched from cars or plants so late in the day that it cannot be placed, finished, and protected within the specification limits and provisions in actual daylight of that same day. When it is important that construction be ordered to an early completion, the Contractor may work after daylight hours provided sufficient artificial illumination is available, and the work performed under these conditions complies in every respect with the terms and conditions of the contract.

108.05 Character of Workers, Methods, and Equipment. The Contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by these specifications.

All of the Contractor's personnel shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled work shall

have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

Any person employed by the Contractor or by any Subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed forthwith by the Contractor or Subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the Engineer.

Should the Contractor fail to remove such person or persons as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may suspend the work by written notice until the Contractor remedies the situation. The Contractor shall not be entitled to any additional time or damages caused by the suspension.

All equipment that is proposed for use on the work shall be of sufficient size, and in mechanical condition to meet requirements of the work, and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property, or other highways will result from its use.

Sections of these specifications require that the construction be performed by the use of certain methods or equipment. Such methods and equipment shall be used unless others are authorized by the Engineer. Should the Contractor desire to use a method or type of equipment other than those specified, it may request authority from the Engineer to do so. The request shall be in writing and the Engineer may, before considering or granting a request, require the Contractor to furnish at its expense, evidence satisfactory to the Engineer that the equipment or method proposed for use by the Contractor is capable of producing work equal to, or better than that which can be produced by the methods or equipment

specified. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work conforming to the requirements of the applicable section of these specifications. If after trial use of the substituted methods or equipment, the Engineer determines that the work produced is not equal in all respects to that which can be produced by the methods or equipment specified, the Contractor shall discontinue the use of substitute methods or equipment and shall complete the remaining work with the specified methods or equipment. The Contractor shall remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct at no cost to the Department. No change will be made in basis of payment for the construction items involved nor in the contract because of authorizing a change in methods or equipment as stipulated herein.

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

108.06 Determination and Extension of Contract Time. Unless otherwise specified, the Contractor shall complete the work on or before the completion date stated in the contract.

If satisfactory fulfillment of the contract with extensions and increases, authorized under **Subsections 104.02** and **104.04**, requires the performance of work in larger quantities than those set forth in the proposal, the **contract time** shall be increased on a basis commensurate with the affect on the controlling item of work, as determined by the Engineer.

Should the contract be increased by extension of contract as set forth in **Subsection 104.04**, the contract time shall be agreed upon and shall be included in the agreement for the contract extension.

Should satisfactory fulfillment of the contract with deletions and decreases, authorized under **Subsections 104.02** and **104.04**, require the performance of work in smaller quantities than those set forth in the proposal, the contract time will not be reduced.

Weather and seasonal limitations as set forth in the applicable sections of these specifications or other such limitations provided for in the **special provisions** shall not affect the **specified completion date**.

If the Contractor finds it impossible for reasons beyond its control to complete the work within the contract time as specified or as extended, it may, at any time before the expiration of the contract time as extended, make a written request to the Engineer for an extension of time setting forth therein the reasons that the Contractor believes will justify the granting of his request. The Contractor's plea that insufficient time was specified is not a valid reason for extension of time. If the Engineer finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor, the Engineer may extend the time for completion in such amount as the conditions justify. The extended time for completion shall then be in full force and effect the same as though it was the original time for completion.

108.07 Temporary Suspension of Work. The Engineer shall have the authority to suspend the work, wholly or in part, for such periods as the Engineer may deem necessary, due to unsuitable weather, to conditions considered unfavorable for the suitable prosecution of the work, the convenience of the State, or failure on the part of the Contractor to correct conditions unsafe for workmen or the general public; or failure to carry out orders given or to perform any provisions of the contract. *Such suspensions shall not constitute grounds for claims for damages or extra compensation by the Contractor unless the suspension is for the convenience of the State*.

If it should become necessary to stop work for an indefinite period, the Contractor shall make the necessary provisions to maintain accommodations for and safeguard traffic in as satisfactory a manner as is practicable. Materials shall be stored in such a manner so that they will not obstruct or impede the traveling public or become damaged in any manner. The Contractor shall 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. The Contractor shall not suspend work without written authority of the Engineer.

108.08 Failure of Contractor to Maintain Satisfactory Progress. The Contractor may be declared delinquent in his 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**. ***Once declared delinquent, the Contractor will be disqualified for further bidding and for approval as a Subcontractor***.

A Contractor disqualified under the provisions of this subsection, bidding as an individual, firm partnership or corporation shall not be permitted to bid 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.

A delinquency check will be made when determined necessary by the Engineer. The preliminary notice of delinquency will be sent to the delinquent Contractor by registered mail.

A delinquency check will be made when determined necessary by the Engineer. If the Engineer determines that facts exist to hold a Contractor delinquent, then a ***Notice of Delinquency*** shall be sent to the Contractor via certified mail. The

delinquency shall not be effective until fifteen (15) days after receipt of the *Notice of Delinquency* by the Contractor. During those fifteen (15) days, the Contractor shall be allowed to present information in opposition to the delinquency. After fifteen (15) days, the contractor shall be declared delinquent unless the Engineer decides otherwise, based on information received during the fifteen (15) day period. The Engineer shall notify the Contractor, via certified mail, of the delinquency declaration.

108.09 Failure to Complete the Work on Time. If the Contractor fails to substantially complete the work by the contract **specified completion date**, then it shall be liable for liquidated damages for each calendar date past the contract specified completion date. The daily liquidated damages rate shall be determined from the schedule below. The date of substantial completion shall be determined by the Engineer and his decision shall be final.

Schedule of Liquidated Damages for Each Day Overrun in Contract Time		
Original Contract Amount		Daily Charge
From More Than	To and Including	Calendar Day or Fixed Rate
$ 0	$ 50,000	$ 100.00
50,000	100,000	200.00
100,000	500,000	400.00
500,000	1,000,000	600.00
1,000,000	2,000,000	800.00
2,000,000	5,000,000	1100.00
5,000,000	10,000,000	1400.00
10,000,000	----------	1800.00

108.10 Default and Termination of Contract. The Contractor shall be in default if it:

a. Fails to perform the work with sufficient workers and equipment or with sufficient materials to assure the prompt completion of said work.

b. Fails to perform work in accordance with contract requirements and/or refuses to remove and replace rejected materials or unacceptable work.

c. Discontinues the prosecution of the work.

d. Fails to resume work that has been discontinued within a reasonable time after notice to do so.

e. Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency.

f. Allows any final judgment to remain unsatisfied for a period of fifteen (15) days.

g. Make an assignment for the benefit of creditors.

h. For any other cause whatsoever, fails to carry on the work in an acceptable manner.

If the Contractor or Surety does not cure or make sufficient progress toward curing the default within fifteen (15) days of receipt of ***Notice of Default***, then, at the Engineer's discretion, the Contract may be terminated and the Department shall finish the work by whatever methods it deems reasonable and expedient, or the Engineer, without violating the Contract, may take a portion of the work out of the hands of the Contractor. The Department may appropriate or use any or all materials and equipment on the job site as may be suitable and acceptable for performing the work and methods may be used that the Engineer determines will be required for the completion of the contract in an acceptable manner.

All costs and charges incurred by the Department, including attorney's fees, together with the cost of completing the

work under contract will be 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 the Surety shall be liable and shall pay to the Department the amount of such excess.

In all cases, the Surety company will have the right to complete the contract and shall be given thirty (30) days from receipt of Notice of Default or longer in the discretion of the Engineer, in which to get the work under way. This procedure shall not in any way serve to extend the **contract time**. All charges incident to negotiating with the Surety and arranging for work to be resumed including attorney's fees shall be charged against the Contractor or the Surety as part of the cost of the work.

SECTION 109

MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities. All work completed under the contract will be measured by the Engineer according to **United States Standard Measures**.

A station, when used as a definition or term of measurement, will be one hundred (100) linear feet.

The method of measurement and computations to be used in determination of quantities of materials furnished and of work performed under the contract will be those methods generally recognized as good engineering practice.

Unless otherwise specified, longitudinal measurements for area computations will be made along the actual surface of the roadway. No deductions will be made for individual

fixtures having an area of nine (9) square feet or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or authorized by the Engineer.

Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.

All items which 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 structures are placed, unless otherwise specified.

In computing volumes of excavation, the average end area method or other acceptable methods shall be used. Excavation performed beyond the neat lines or slope stakes, will not be measured for payment, except when the materials may be utilized for borrow.

The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be specified and measured in decimal fractions of inches.

When the term "gage" refers to the measurement of wire, it shall mean the wire gage specified in **AASHTO M 32**, **AASHTO M 279** or **AASHTO M 280**.

The term "ton" shall mean the short ton consisting of two thousand (2000) pounds avoir. All materials that are measured and proportioned by weight shall be weighed on accurate, approved scales by competent, qualified personnel at locations designated by the Engineer. All platform scales shall be of sufficient size to permit the entire vehicle or combination of vehicles to rest on the scale platform while being weighed. The Contractor shall furnish all scales at no cost to the Department. The Contractor shall have scales tested by an approved firm or State agency as often as the Engineer may deem necessary to insure 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 Engineer. Except when the Engineer determines that other methods of determining weights for a material is not feasible, railroad car weights or tank truck weights of material passed through mixing plants will not be acceptable.

The tare weight of vehicles hauling material being paid for by weight shall be the empty weight of the vehicle with the driver aboard and the fuel tanks full. All vehicles shall be weighed once each calendar week to determine their tare weights and, except as provided below, this tare weight shall be used for the calendar week in computing net weights. During the course of the calendar week, vehicles shall be spot checked for tare weight. If the spot check shows the tare weight of any vehicle exceeds by three hundred (300) pounds the tare weight determined at the regular weekly weighing, then the tare weight determined during the spot checking shall 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 shall be used in computing net weights for the calendar week. Each vehicle shall bear a legible identification mark.

Materials to be measured by volume shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be of any size or type acceptable to the Engineer, if the body is of a shape such that the actual contents may be readily and accurately determined. All vehicles shall be loaded to at least their water level capacity, and all loads shall be leveled 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.

When requested by the Contractor and approved by the

Engineer in writing, material specified to be measured by the cubic yard may be weighed and converted to cubic yard for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before such method of payment of quantities is used.

Bituminous material measured by volume shall be measured in gallons in tank cars, distributor tanks, tanks, or drums. The Contractor, when requested, shall furnish the Engineer with certified calibration of tank cars, distributor tanks, tanks, and certified quantities in drums in which bituminous materials are delivered or stored. Volumes will be measured at 60°F or will be corrected to the volume at 60°F using **ASTM D 1250** for asphalt or **ASTM D 633** for tars. Except as hereinafter provided, bituminous material to be paid for directly shall be weighed and paid for by the ton. If the Engineer decides that weighing is not feasible, the Bituminous material may be measured by volume as heretofore stipulated and converted to tons, the conversion to be based on the unit weight as determined by the Research and Materials Laboratory.

Cement will be measured by sack or by the ton. The term "sack" shall mean the traditional ninety-four (94) lb. bag size.

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.

When used as a unit of payment, the term "lump sum" will mean complete payment for the work described in the contract. When a complete structure or structural unit (in effect, being sum work) is specified as the unit of measurement, the unit shall be construed to include all necessary fittings and accessories.

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 has been ordered by the Engineer in connection with force account work, transportation to the project will be in accordance with **Subsection 109.04**.

When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gage, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerance established by the industries involved will be acceptable.

109.02 Scope of Payment. The Contractor shall receive and accept compensation provided for in the contract as full payment for furnishing all materials and for performing all work specified in the contract in a complete and acceptable manner and for all risk, loss, damage, or expense of whatever character arising out of the nature of the work or the prosecution thereof, subject to the provisions of **Subsection 107.25**.

If the "Basis of Payment" clause in the specifications relating to any unit price in the bid schedule requires that the said unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not also be measured and paid for under any other pay item which may appear elsewhere in the specifications.

The term "lump sum" when used as an item of payment will mean complete payment for the items of work described in the contract.

The payment of any current or final estimate or of any

retained percentage shall in no way affect the obligation of the Contractor to repair or renew, without additional compensation any defective parts of the construction, or his responsibility for all damages due to such defects. The responsibility of the Contractor for all damages due to such defects will be determined in accordance with **Subsection 107.21**.

109.03 Compensation for Altered Quantities. When the accepted quantities of work vary from the quantities in the bid schedule or the quantities in a **supplemental agreement**, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices and the supplemental agreement 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 therefor or from any other cause.

109.04 Extra and Force Account Work. Extra work performed in accordance with the requirements and provisions of **Subsection 104.05** will be paid for at the unit prices or lump sum stipulated in a **supplemental agreement** or the Department may require the Contractor to do such work on a force account basis to be compensated in the following manner:

A. Labor. For all labor and personnel in direct charge of the specific operations, the Contractor shall receive the current rate of wage (or scale) being paid by the Contractor for each and every hour that said labor and personnel are actually engaged in such work. Social security taxes may be added to the rate or wage.

An amount equal to 30% will be added to the total

labor cost.

B. Materials. For materials accepted by the Engineer and used, the Contractor shall receive the actual cost of such materials delivered on the work, including transportation charges paid by him (exclusive of machinery rentals as hereinafter set forth), to which cost 15% will be added.

C. Equipment. For all machinery or special equipment (other than small tools) the use of which has been authorized by the Engineer, the Contractor will be allowed an hourly rental price based on published rental rates as shown in the ***Rental Rate Blue Book*** published by DATAQUEST, Inc., which are in effect on the date the force account work is ordered. The hourly rate shall be the stated monthly rate divided by 176, after the monthly rate has been adjusted for (a) replacement cost allowances in machine depreciation and (b) contingency cost allowances. Steps to make these adjustments are shown in the *Blue Book*; however the time of an operator is not included. For any equipment not listed in the *Blue Book*, payment shall be made at the prevailing rental rates being paid for such equipment in the area in which the project is located. In all cases, payment for equipment rental shall include only those hours or portion of hours that the equipment is actually in use in the work. Payment will not be made for time spent in moving equipment to and from job sites, or for idle time. Payment will be made for transportation costs for special equipment not needed in the normal prosecution of the other work, but which is necessary in the performance of work on a force account basis.

D. Miscellaneous. No additional compensation will be allowed for general superintendence, health and welfare benefits, insurance, taxes, bond, the use of small tools, or other costs for which no specific allowance is herein provided. However, the prime contractor may be entitled to a 7.5% markup for the cost of work performed by Sub-

contractors.

E. Compensation. The Contractor's representative and the Engineer shall compare records of the cost of work done as ordered on a force account basis at the end of each day. The records shall be made in duplicate and signed by both. Each shall retain one copy.

F. Statements. No payment will be made for work performed on a force account basis until the Contractor has furnished the Engineer with duplicate itemized statements of the cost of such force account work detailed as follows:

1. Name, classification, date, daily hours, total hours, rate and extension for each laborer and foreman.

2. Designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and equipment.

3. Quantities of materials, prices, and extensions.

4. Transportation of materials. Statements shall be accompanied and supported by receipted invoices for all materials used and transportation charges. However, if materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then instead of the invoices the Contractor shall furnish an affidavit certifying that such materials were taken from his stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

109.05 Eliminated Items. Should any items contained in the proposal be found unnecessary for the proper comple-

tion of the work, the Engineer may eliminate such items from the contract and such action shall in no way invalidate the contract. When a Contractor is notified of the elimination of items, it will be reimbursed for actual work done and all costs incurred, including mobilization of materials before said notification. Any such materials may be purchased by the Department in accordance with the provisions of **Subsection 104.02**.

109.06 Partial Payments. Partial payments will be made at least once each month as the work progresses. Should the Contractor earn more than $150,000 within a monthly pay period, the Contractor may request an intermediate estimate once he has earned more than $150,000 within the month. The intermediate estimate may be paid at the discretion of the Engineer. Said payments will be based upon estimates prepared by the Engineer of the value of the work performed and materials completed in place in accordance with the contract and for materials delivered (stockpiled) in accordance with Subsection 109.07 . Monthly partial payment periods will end at the end of the day on the following dates for the respective Engineering Districts:

District No. 1 -Last day of each current month.
District No. 2 - 4th day of each current month.
District No. 3 -25th day of each current month.
District No. 4 - 8th day of each current month.
District No. 5 -17th day of each current month.
District No. 6 -21st day of each current month.
District No. 7 - 4th day of each current month.

109.07 Payment for Material-on-Hand. Upon delivery of material for the project and satisfactory stockpiling or storing in approved areas, the materials listed below will be entered on the monthly construction estimate in accordance with the tabulations below provided:

1. The material has been tested and meets the requirements of the specifications.

2. The Contractor has furnished the Engineer verification of the quantity delivered.

3. The Contractor has furnished the Engineer paid invoices for the material. Written consent of the Surety will be accepted instead of received invoices. However, if the paid invoices are not received by the Engineer by the end of the next monthly partial payment period, payment for the materials will be removed from the monthly estimate.

4. The Contractor has furnished the Engineer, when material is stored or stockpiled on property other than the right of way, the right of entry onto the property for the Department for removing the material, when requested.

Material Stored or Stockpiled	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
Bituminous Surfacing (All Aggregates)	30
Portland Cement Concrete Pavement (Coarse and Intermediate Aggregate)	17
Portland Cement Concrete Pavement (Coarse, Intermediate, and Fine Aggregates)	20

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 en-

tered on the construction estimate at a unit price equal to 60% of the contract bid price.

When the total thickness has not been placed, the material shall be converted to an equivalent area of total specified thickness and paid for as indicated above. The base paid for in this manner shall not be included in the quantity of materials paid for in stockpiles.

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

Material For Structures Cast or Fabricated and Stored but Not Delivered to Job Site	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

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

109.08 Acceptance and Final Payment. When the final inspection and final acceptance have been duly made by the Engineer as provided in **Subsection 105.15**, the Engineer shall 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 there shall be paid to the Contractor 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 shall be subject to correction in the final estimate and payment.

Before the final payment is made, the Contractor may be called on to furnish a letter from his Surety company giving the Surety's approval to the payment of the amount shown on the final estimate, and may be required to 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.

DIVISION 200

EARTHWORK

SECTION 201

CLEARING AND GRUBBING

201.01 Description. This work shall consist of clearing, grubbing, removing and disposing of all vegetation and debris and obstructions within the limits of the right of way, ditch and channel change areas and other easement areas, except such objects as are designated to remain, or are to be otherwise removed in accordance with the plans or other sections of these specifications. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

CONSTRUCTION REQUIREMENTS

201.02 General. The Engineer will establish right of way lines and construction lines and designate all trees, shrubs, plants and other items to remain. The Contractor shall preserve all such designated items. Any damage to natural terrain or to vegetation or objects designated to remain shall be repaired, replaced or otherwise compensated for, as determined by the Engineer, at the expense of the Contractor.

The right of way or roadway, whichever is indicated on the plans, including bridge sites, cut and fill slopes that extend beyond the right of way and such other areas necessary to complete the work shall be cleared of all vegetation, stumps, rubbish, logs, roots, foundations, framework, utility connections not in service, portions of buildings not otherwise provided for, and other objectionable material hereinafter indicated or considered necessary to satisfactorily complete the work. This work shall also include the removal and disposal (or salvage if so required by the Engineer) of fences, posts,

signs, structures, and other obstructions that interfere with the work and that are not to be adjusted or relocated. Whenever clearing and grubbing within roadway is called for, this item shall include the clearing of additional widths within the right of way when so indicated on the plans. In all cases, the Contractor will be required to clear and grub the entire right of way provided at road intersections for sight areas, the entire right of way involved in traffic interchanges, except for items designated by the Engineer to remain, and the entire right of way at bridge sites as indicated hereinafter. The Clearing and Grubbing within Roadway shall include the clearing and disposing of tree tops, damaged trees and other debris within the right of way.

On contracts for Interstate grading projects, unless otherwise provided, the Contractor shall, in addition to clearing and grubbing within the construction lines, clear and grub a minimum distance of 30 feet each side from the edge of the proposed pavement along both lanes and legs of interchanges where the construction lines do not extend this amount.

The proposal for the construction of roads in the Secondary System may include one or more roads to be constructed as a Federal-Aid Secondary Project and one or more roads to be constructed as a State Secondary Project. In such cases, the plans for each road will indicate Clearing and Grubbing within Right of Way or Clearing and Grubbing within Roadway, as applicable. When applicable, the proposal will include a lump sum amount for Clearing and Grubbing within Roadway for all roads on which clearing and grubbing between the construction lines shall be required.

On all contracts, when Clearing and Grubbing within Right of Way is included in the proposal, the work shall include clearing and grubbing the entire right of way. Clearing and Grubbing within Right of Way shall also include all clearing and grubbing necessary where cut and fill slopes, as shown on the plans, extend beyond the right of way line. Trees, plant specimens or other objects considered valuable by ad-

jacent property owners or aesthetically desirable and which are designated by the Engineer to remain, shall not be removed or damaged. Trees which are considered as being or resulting in merchantable timber and other objects or items herein described shall be removed. The Contractor shall, when Clearing and Grubbing within Roadway is included in the proposal, exercise care to avoid cutting, damaging or destroying any timber outside of the construction lines except as designated by the Engineer. Likewise, when Clearing and Grubbing within Right of Way is included in the proposal, the Contractor shall not cut, damage or destroy timber outside the right of way lines unless the plans or special provisions provide for clearing such other areas necessary to complete the work.

Unless otherwise provided in the proposal or on the plans, clearing and grubbing of the right of way will not be required on bridge widening contracts.

201.03 Clearing and Grubbing. Clearing and grubbing work shall be performed before other construction work in the same general area is started. Trees that overhang the roadway shall be trimmed carefully to give a clear height of 18 feet over the roadway. If required by the Engineer, trees of value to be removed shall be sawed into merchantable lengths not less than 5 feet and piled neatly at points within the right of way or in the vicinity of the project designated by the Engineer, and the Contractor will be held responsible for such timber for a reasonable period of time not to exceed thirty (30) days. Should the property owner not remove the timber from the project, the Contractor may be required to remove the timber prior to acceptance of the project.

Within areas where excavation is to be made and where embankments are to be constructed, the ground shall be cleared of all living or dead trees, brush, roots, weeds, leaves and all other objectionable material.

The area where the embankment is to be constructed to a

depth of less than 5 feet shall, in addition to the work as outlined above be cleared of all stumps.

All areas to be excavated shall be grubbed. Stumps allowed to remain under embankments shall not extend more than 8 inches above the ground line or low water level. Stump holes and other holes from which obstructions are removed, except in areas to be excavated, shall be backfilled with suitable material, and thoroughly compacted.

Unless otherwise provided for in the plans or special provisions for the project, Clearing and Grubbing within Roadway as herein described shall include the clearing of the entire right of way at all bridge sites within the extreme limits of the project. Clearing at bridge sites shall consist of cutting all trees, stumps, etc., to within 8 inches of the ground or to low water, and the removal and disposal of all logs, stumps, brush rubbish, etc., for the full width of the right of way and for a distance of 75 feet beyond the beginning and end of the proposed bridges. Clearing and Grubbing within Roadway shall include the grubbing of each proposed bridge site, such area being bounded by lines 5 feet beyond the outside edges of the proposed bridge and 10 feet beyond the beginning and end of the proposed bridge.

Clearing and Grubbing within Right of Way shall include the clearing and grubbing of the entire right of way at all bridge sites

All materials removed by the clearing and grubbing operation shall be removed from the project, burned or otherwise disposed of as specified or directed. Burning shall be performed under constant care of competent guards and shall be done in accordance with applicable laws and ordinances and as provided in **Subsection 107.07**. Stumps and logs may be disposed of by depositing them off the right of way where they will not be visible from any public road. The disposal site shall be approved by the Engineer. The Contractor shall be responsible for obtaining disposal sites and securing any ap-

plicable State, Federal, County or City permits that may be required. The Contractor shall certify in writing to the Department that all permit requirements have been met before placing any material in a disposal area.

Brush, weeds and other designated vegetation, shall be re-cut immediately before final inspection if considered necessary by the Engineer.

201.04 Method of Measurement. When Clearing and Grubbing within Roadway or Clearing and Grubbing within Right of Way is shown in the proposal form as a lump sum, no measurement of the area of clearing and grubbing will be made.

Clearing and grubbing work performed outside the right of way on channel changes or ditches will be measured by the acre. The removal of weeds, plant stalks regardless of size or density, loose rock and small scattered trees will not be considered as clearing and grubbing, and no measurement or payment will be made for such work.

201.05 Basis of Payment. Clearing and grubbing performed within the roadway or right of way, as the case may be, including ditch areas, ramps, connections, sight areas, traffic interchanges, areas necessary for cut or fill slopes and at bridge sites, unless otherwise indicated, will be paid for at the contract lump sum price for the applicable item, which price and payment shall be full compensation for all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, specifications and terms of the contract.

Whenever the quantity of clearing and grubbing required to be performed within the right of way or roadway is increased or decreased without an increase or decrease in length of the project as a result of changes made in the plans during construction, the Engineer will determine the number of acres of clearing and grubbing involved in such change.

The product of the area thus determined and the contract unit price per acre for Clearing and Grubbing Ditches will be added to or deducted from the contract lump sum price for Clearing and Grubbing within Right of Way, or Roadway, as the case may be.

When the total overall length of the road or roads in a contract is increased or decreased, adjustments will be made in the lump sum contract price of the Clearing and Grubbing within Roadway or the Clearing and Grubbing within Right of Way. The adjusted lump sum contract price shall be determined on a mileage basis. The unit price per mile shall be obtained by dividing the lump sum contract price for the clearing and grubbing item by the length of that part of the original contract in miles on which there was an item for Clearing and Grubbing. This unit price per mile will be multiplied by the length in miles of the increase or decrease in the length of the project. The resulting product shall be added to or subtracted from the lump sum contract price for Clearing and Grubbing within Right of Way, or Roadway, as the case may be.

Clearing and grubbing that is authorized by the Engineer to be performed outside of the right of way shown on the plans, except as otherwise provided for herein, will be paid for at the contract unit price for Clearing and Grubbing Ditches, which payment shall be full compensation for all materials, supplies, labor, equipment, tools, transportation, and incidentals necessary to satisfactorily complete the work.

Payment will not be allowed for clearing and grubbing of pits furnished by the Contractor. The expense of clearing and grubbing pits furnished by the Contractor will be included in the contract unit price of unclassified excavation, borrow excavation, earth type bases, etc.

When there is not an item in the proposal for clearing and grubbing work, all such work shall be done as herein provided and will be considered incidental to the other items of work

and no separate or additional compensation will be made therefor.

When obtaining right of way for certain projects, the Department may acquire ownership of the timber located thereon. In these instances, the Contractor's bid for Clearing and Grubbing within Roadway or Right of Way (as applicable) shall reflect a credit for the value of the merchantable timber. The successful bidder will have title to and be responsible for disposing of all timber that is required to be removed from the right of way.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
2011000	Clearing and Grubbing within Right of Way	Lump Sum
2012000	Clearing and Grubbing within Roadway	Lump Sum
2013050	Clearing and Grubbing Ditches	Acre

SECTION 202

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

202.01 Description. This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings, fences, structures, old pavements, abandoned pipe lines and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the contract. It shall include, unless otherwise provided, the salvaging of all materials and backfilling the trenches, holes and pits. When the proposal

does not include pay items for removal of structures and obstructions as set forth in this Section or the removal is not measured and paid for as other items of work as hereinafter provided, such work shall be in accordance with **Subsection 104.08** and **Section 201**.

CONSTRUCTION REQUIREMENTS

202.02 General. The Contractor shall raze and dispose of all buildings, foundations, structures, fences, and any other obstructions that are on the right of way and are not designated to remain. The work shall also include buildings (structures) to be cut off at the right of way line and buildings and appurtenances located entirely outside the right of way limits when such items are indicated as items to be demolished on the plans.

In accordance with regulations of the **South Carolina Department of Health and Environmental Control (SCDHEC)**, the Contractor must secure a permit anytime a facility is razed, due to the possible health hazards should the building contain asbestos. The Contractor shall inspect the facilities identified in the proposal as Demolition Items for the presence of asbestos before the submission of bids. If asbestos is located, the terms of **Subsection 107.27**, *Hazardous and /or Toxic Waste*, shall apply. Any questions about the permit should be directed to the **South Carolina Department of Health and Environmental Control's Bureau of Air Quality** at (803) 734-4547.

When structures (buildings) or other obstructions are designated on the plans to be cut off at a right of way line, they shall be cut off to produce a completed job of first class workmanship and shall include the removal and disposal of all debris and appurtenances, including utility connections from the portion of the building within the right of way. The portion of the building remaining outside the right of way shall be adequately supported. Re-facing, unless otherwise provided, will not be required.

Utility service connections such as sewers, water lines, electrical connections, gas lines, etc., left in place after the removal of the structure (buildings) and obstructions, shall be removed and capped or sealed at the right of way line, the edge of the existing pavement, or shall be capped at the existing mains as directed by the Engineer. Utility materials shall be carefully stored and protected unless such materials are not desired by the owner in which case they shall become the property of the Contractor.

When structures (buildings) or other obstructions are designated on the plans to be cut off at the right of way or to be removed in their entirety, such work shall include the building and all appurtenances, and the material removed in performing this work shall, unless otherwise provided, become the property of the Contractor, except utility materials shall be as heretofore specified. Proper allowance for the value of the salvageable materials shall be taken into account in the bid price for the item involved.

Unusable perishable material shall be destroyed. Unless otherwise permitted, non-perishable material shall be disposed of outside the limits of view from the traveled roadway with written permission of the property owner on whose property the material is placed. Copies of all agreements with property owners are to be furnished to the Engineer. The Contractor shall be responsible for obtaining disposal sites and securing any applicable State, Federal, County or City permits that may be required. The Contractor shall certify in writing to the Department that all permit requirements have been met before placing any material in a disposal area.

Unsuitable material shall be removed from wells, cisterns, septic tanks, other tanks, basements, and cavities. Foundations left by structure removal shall be removed to a depth not less than one foot below natural ground, except that within construction limits, removal shall be to a depth not less than 2 feet below subgrade elevation. Basement floors shall be

broken up to prevent holding of water. Basements or cavities left by structure removal shall be backfilled as directed with material approved by the Engineer and shall be compacted in accordance with the provisions of **Subsection 205.07**, unless otherwise directed.

Where a structure or obstruction has been previously removed and the existing utility connections have not been terminated and capped, the Contractor shall comply with the above provisions for utility service connections.

202.03 Removal of Bridges, Culverts, and Other Drainage Structures. Bridges, culverts, and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic. Any excavation adjacent to the structure or to its approaches shall be adequately shored to avoid damage to them or to traffic.

Before demolition of any bridge structure, the Contractor shall coordinate with the Engineer to complete and submit the **South Carolina Department of Health and Environmental Control (SCDHEC)** form entitled ***Notification of Demolition and Renovation***. The completed form shall be submitted at least ten (10) working days before demolition begins to the following address:

Manager, Asbestos Section
Department of Health
And Environmental Control
2600 Bull Street
Columbia, SC 29201

Unless otherwise directed, the substructures of existing structures shall be removed down to the natural stream bottom and those parts outside of the stream shall be removed down one foot below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits of a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure.

Unless otherwise specified in the plans and/or proposal, the material in the structure to be removed, except castings for drainage structures, shall become the property of the Contractor. It shall be removed from the site before completion of the work and proper allowance for its value shall be taken into account in the bid price of the item involved. If the plans or special provisions provide for the material in the structure to be removed to remain the property of the State, steel or wood bridges shall be carefully dismantled without unnecessary damage, steel members shall be match marked, and all salvaged material shall be stored as directed by the Engineer.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed before placing the new work. Before blasting in any stream, river or lake the Contractor shall coordinate his plans and operations with the local **South Carolina Department of Natural Resources** District Fisheries Biologist and District Law Enforcement Captain.

Should the structural components designated for removal and disposal contain lead-based paints, the Contractor shall comply with all applicable Federal and State requirements for lead as waste, lead in air, lead in water, lead in soil, and worker health and safety.

Concrete or brick box culverts or arches designated on the plans to be removed and which do not interfere or conflict with the placing of a new structure shall be removed and disposed of to a point one foot below the bottom of the top slab or to a point where the side walls will be a minimum of 3 feet below the subgrade elevation. Culverts or arches that interfere or conflict with the new structures shall be removed in their entirety within the extreme limits of the project.

Unless otherwise provided, all concrete removed shall become the property of the Contractor.

202.04 Removal of Pipe and Tile Drains. All existing pipe and tile drains, located within the extreme limits of the project, including bridge sites, shall be removed when so noted on the plans or required by the Engineer. Pipe and tile shall be removed in a careful manner and neatly stored near the project at locations designated by the Engineer unless it is to be relaid as a part of the contract. The Contractor shall be responsible for any damage to pipe or tile during removal and storing due to his negligence or to improper handling or storing. Pipe removed and designated by the Engineer, as having no value, shall be disposed of by the Contractor.

Any pipe or tile, any part of which conflicts with the installation of a new drainage structure, shall be removed by the Contractor, and all work and costs shall be included in the contract prices for the new structure. Likewise, no direct payment will be made for the removal of pipe or tile that is to be re-laid at the same or other locations on the project.

202.05 Removal and Disposal of Existing Pavements, Sidewalks, and Curbs. Existing portland cement concrete, brick, or stone pavements, with or without asphalt overlays; concrete, brick or stone sidewalks; concrete gutter or integral curb and gutter curb; asphalt concrete pavement; and bituminous curb designated for removal shall be removed and disposed of by the Contractor unless such material is suitable for use in constructing the embankment.

Such sawing as is necessary to produce a uniform line between the pavement to be retained and that to be removed shall be performed as directed.

Whenever the plans indicate that concrete gutter is to be retained as a base and the integral curb removed therefrom, the curb shall be removed to the top elevation of the gutter using such methods, as directed by the Engineer, to prevent damage to or displacement of the gutter to be retained.

202.06 Method of Measurement.

a. When the contract stipulates that payment will be made for removal of structures and obstructions on a lump sum basis, the pay item, Removal of Structures and Obstructions, will include all structures and obstructions within the right of way in accordance with the provisions of this Section. When the proposal stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the contract. Material used to backfill excavated areas, as directed, will be measured in cubic yards.

b. When the contract requires the removal of bridges, a separate item will be included in the proposal. Measurement will be a lump sum basis for the work involved. When the plans include an item for Removal and Disposal of Existing Culverts (*width*) ft. x (*height*) ft., the quantity measured will be for each reinforced concrete box culvert of the size indicated, regardless of length, removed as directed in the plans or by the Engineer. Otherwise, the removal of concrete or brick culverts or arches will not be measured. The cost of this work shall be included in the price for the other items of work.

c. Measurement for the removal of pipe, pipe arches and tile drains will be in cubic yards for the excavation necessary for the removal of these items and shall be the volume actually removed between the elevation of the ground surface and the bottom of the pipe, but shall be limited to the volume enclosed by vertical planes located one foot outside and parallel to the neat lines of the pipe, but in no case shall the distance between the vertical planes be less than 3 feet. The volume of the pipe will not be deducted from the measurement. No measurement will be made for the removal of pipe, which is to be replaced by new pipe or for the removal of pipe to be re-laid at any location.

d. When the item Removal and Disposal of Existing Pavement is included in the proposal, the quantity measured shall be the number of square yards of existing brick pavement, brick pavement with asphalt concrete overlay, brick sidewalk, cobblestone pavement, portland cement concrete pavement, portland cement concrete pavement with asphalt concrete overlay, portland cement concrete gutter, portland cement concrete integral curb and gutter, portland cement stabilized base with asphalt concrete overlay acceptably removed and disposed of in accordance with these specifications. The quantity will be determined by actual horizontal area measurements before removal.

e. When the item Removal and Disposal of Existing Asphalt Pavement is included in the proposal, the quantity measured shall be the number of square yards of the asphalt concrete pavement with a total thickness of 2 inches or greater, or as otherwise indicated on the plans or in the special provisions, acceptably removed and disposed of in accordance with these specifications. The quantity will be determined by actual horizontal area measurements before removal.

Asphalt pavements with a total thickness less than 2 inches or as otherwise indicated on the plans or in the special provisions, aggregate bases, earth type bases, and other flexible pavement structure components shall not be measured as a separate item but will be measured as Unclassified Excavation as provided in **Section 203**.

f. When an item for the removal and disposal of existing curb is included in the proposal, the quantity measured shall be the number of linear feet of stone, bituminous, or concrete curb acceptably removed and disposed of in accordance with these specifications. The quantity will be determined by actual measurements before removal.

g. When the plans indicate that existing pavement or curb is to be removed and an item for the removal and disposal of existing pavement or curb is not included in the proposal, the removal and disposal of existing pavement and curb will be measured and paid for as Unclassified Excavation as provided in **Section 203**.

202.07 Basis of Payment. The accepted quantities of Removal of Structures and Obstructions will be paid for at the contract lump sum price bid, which price shall be full compensation for removal and disposing of the obstructions in accordance with the contract. If no contract price is listed in the proposal for any item set forth in this specification, no direct payment will be made for any work necessary to comply with the provisions of such items, except as set out herein, the cost thereof to be included in the various pay items of the contract.

The excavation necessary for the removal of Pipe, Pipe Arches, and Tile Drains shall be paid for at the contract unit price per cubic yard for Unclassified Excavation.

Any necessary backfill required under this Section will be paid for as Unclassified Excavation or Borrow Excavation as applicable.

The work necessary to remove existing brick pavement, brick pavement with asphalt concrete overlay, brick sidewalk, cobblestone pavement, portland cement concrete pavement, portland cement concrete pavement with asphalt concrete overlay, portland cement concrete gutter, portland cement concrete integral curb and gutter, portland cement stabilized base with asphalt concrete overlay shall be paid for at contract unit price for Removal and Disposal of Existing Pavement, which price and payment shall be full compensation for removal and disposal of such material.

The work necessary to remove existing asphalt pavements measured in **Subsection 202.06** shall be paid for at

the contract unit price for Removal and Disposal of Existing Asphalt Pavement, which price and payment shall be full compensation for removal and disposal of such material.

The work necessary to remove existing concrete, bituminous or stone curb shall be paid for at contract unit price for Removal and Disposal of Existing Curb, which price and payment shall be full compensation for removal and disposal of such material.

Overhaul will be in accordance with the provisions of **Section 207**, except no overhaul will be paid for concerning removal and disposal of existing pavements.

Specific obstruction items, stipulated for removal and disposal under unit price pay items, will be paid for at the contract unit price per unit specified in the proposal, which prices and payments shall be full compensation for removal and disposal of such items. The price shall include salvage of materials removed, their custody, preservation, storage on the right of way or as designated, and disposal as provided herein. Subsequent backfill incidental to removal will be paid for at the contract unit price for Unclassified Excavation or Borrow Excavation as applicable.

If the itemized proposal contains the lump sum item Clearing & Grubbing within Right of Way, it shall, in addition to the requirements of **Section 201**, include the cost of all items in **Section 202**, except for those set out specifically as pay items in the itemized proposal or as otherwise provided herein.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
2021000	Removal of Structures and Obstructions	Lump Sum
20220XX	Removal & Disposal Item No. *(number)*	Lump Sum
2023000	Removal & Disposal of Existing Pavement	Square Yard
2024100	Removal & Disposal of Existing Curb	Linear Foot
2024200	Removal & Disposal of Existing Bituminous Curb	Linear Foot
2025000	Removal & Disposal of Existing Asphalt Pavement	Square Yard
20281XX	Removal & Disposal of Existing Bridge	Lump Sum
20285XX	Removal & Disposal of Existing Culvert *(width)* ft. × *(height)* ft.	Each

SECTION 203

ROADWAY AND DRAINAGE EXCAVATION

203.01 Description. This work shall consist of the removal, placement, and compaction or satisfactory disposal of all materials encountered within the limits of the right of way and borrow pits for the construction of the roadway. The above limits may include intersecting roads, driveways, ditches, channels, parking areas, ramps, and private entrances. This work shall also consist of the removal and replacement of unsuitable material in the subgrade or under structures, the stripping of the roadway and material pits, and the excavation work necessary for the formation, compaction, and shaping of all embankments, subgrade, shoulders, slopes, and intersections. All work performed under this Section shall conform to

the typical cross-sections shown on the plans and to the lines and grades established by the Engineer.

All work under this Section shall be performed in a manner that will insure compliance with **Subsection 107.26**, Environmental Protection and Water Pollution Control. The Contractor shall conduct his operations in a manner consistent with good erosion control practices to minimize soil erosion, and to the extent practicable, prevent sediment from leaving the site. The Contractor shall take whatever measures necessary throughout the life of the project to control erosion and to minimize the deposition of sediment into adjacent rivers, streams, wetlands, and impoundments.

The Engineer may limit the surface area of erodible material exposed. In order to limit the area of erodible material, the Engineer may require that partially completed slopes be brought to the required slope and that the seeding be performed at that time in accordance with **Section 810**.

The Contractor shall comply with the provisions of any required permits for the project that limit the surface area of exposed erodible material.

Unless otherwise provided, this work shall also include the removal and disposal of old pavement, surfacing, curb, gutter, sidewalk, foundations, and structures necessary for the completion of the work.

This work shall also include the resetting of all mail boxes, guide signs, traffic control signs and traffic warning signs located in areas disturbed by the construction operation. All reset mailboxes and signs shall be in equal to or better condition as existed before construction. The Contractor without additional compensation shall repair any damage caused by construction operations.

203.02 Site Excavation. Site Excavation shall consist of all excavation necessary to construct the roadway to the typical

section as shown in the plans. All provisions described hereinafter shall apply unless otherwise provided with the exception that no separate payment will be made for overhaul or for the removal and disposal of any surplus material. It shall be the responsibility of the Contractor to inspect the site and to determine the quantities of material necessary to construct the roadway to the plan typical section.

203.03 Unclassified Excavation. Unclassified excavation shall consist of roadway and drainage excavation performed under this Section regardless of the materials encountered or the manner in which they are removed and shall include the work hereinafter described in Subsection 203.04 through **203.09** unless otherwise provided.

203.04 Muck Excavation. Muck excavation shall consist of the removal and satisfactory disposal of unsuitable material located within the limits of the roadway cross-section shown on the plans or at other locations as directed by the Engineer. The unsuitable material shall be excavated to a depth below subgrade as directed by the Engineer. If there is not a bid item listed in the proposal form for this excavation, the unsuitable material will be measured and paid for as Unclassified Excavation. The material paid for as Muck Excavation will be limited to unstable material that cannot be excavated without using equipment such as backhoes, tracked backhoes and trucks.

203.05 Stripping. Stripping shall consist of excavating, removing and disposing of all unsuitable material from the ground surface of borrow and material pits, or soft, spongy, unstable and other unsuitable material from the ground surface within the roadway. If there is not a bid item listed in the proposal form for this excavation, it shall be measured and paid for as Unclassified Excavation. If the material to be stripped is determined by the Engineer to be beneficial to the establishment of permanent vegetation on the project, it shall be salvaged and stockpiled for later use on the project.

203.06 Surplus Material. Surplus material shall consist of the necessary removal and disposal of all surplus material in order to complete the roadway and not required or desired in the embankment. Surplus material may be designated on the plans or referred to as "waste." The Contractor shall be responsible for obtaining disposal sites and disposing of any surplus material that cannot be accommodated by widening embankments and flattening slopes. The disposal sites must comply with all regulations governing the disposal of waste material. Permits must be secured if such disposal sites are located in wetlands and/or the floodplains of live streams and rivers. These permits will include, but are not limited to the **Federal Water Pollution Control Act (Section 404)**, **Federal Disaster Protection Act (Floodplain Management)** and **Coastal Zone Management Act** permits and any other applicable State, Federal, County or City permits that may be required. The Contractor shall certify in writing to the Department that all of these requirements have been met before placing any material in a disposal area. Disposal areas shall be seeded in accordance with **Section 810** or as required by permit provisions or other pertinent regulations. The contract unit price for Unclassified Excavation shall be full compensation for excavating, hauling, disposing of and seeding any surplus material.

203.07 Water Course and Drainage Ditch Excavation.
Water course and drainage ditch excavation shall consist of removing and disposing of material excavated from ditches or stream channels, inlets and outlets to drainage structures. If there is not a item listed in the proposal form for this excavation, it shall be measured and paid for as Unclassified Excavation.

203.08 Rock Excavation. Rock excavation shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without blasting or the use of rippers, hoe-rams, or pavement breakers and all boulders or other detached stones each having a volume of 1/2 cubic yard or more as determined by physical or visual measurement. If there is not a

bid item listed in the proposal form for this excavation, it shall be measured and paid for as Unclassified Excavation.

203.09 Borrow Excavation. Borrow shall consist of approved material required for the construction of embankments or for other portions of the work. Borrow may be obtained from widening cuts on the project, from other locations within the right of way limits of the project, or from borrow pits approved by the Engineer. When using borrow excavation to construct embankments, a maximum of 25% by weight of recycled glass aggregate may be mixed with these materials to obtain the quantities needed. The recycled glass aggregate shall conform to the requirements of **Subsection 206.02B**. Requirements for incorporating recycled glass aggregate in embankment work are contained in **Subsection 206.03B**. Material from borrow pits furnished by the Department will include necessary rights of way for haul roads along the shortest practicable route without cost to the Contractor. Borrow excavation obtained from pits furnished by the Department from locations within the right of way limits or by widening cuts on the project will be paid for at the contract price for Unclassified Excavation with Overhaul as applicable.

When the Contractor is required to furnish the borrow material, an item of Borrow Excavation will be included in the proposal, and no allowance will be made for haul, clearing and grubbing pits, securing necessary permits, haul roads, or other incidental related cost. The Contractor will also be responsible for the restoration of pits and haul roads to a condition satisfactory to property owners and in compliance with the ***South Carolina Mining Act***.

In order to accurately determine by cross-section the quantity of borrow excavation furnished by the Contractor, the Contractor shall designate to the Department the exact location and bounds of the borrow pit or section of pit if material from pit is being furnished to projects other than those included in this contract. The Contractor shall be responsible for reserving and protecting the designated area(s) against its

use for any purpose other than furnishing the required borrow excavation for completing this project.

The types of materials furnished by the Contractor and used in constructing this project shall be approved by the Engineer before being used. Materials that will be acceptable shall have a Plasticity Index (PI) of 23 or less, except within the top 18 inches of the subgrade, the material shall have Plasticity Index of 13 or less. The Plasticity Index will be determined in accordance with **AASHTO T 89 and T 90**.

If soils meeting the above classifications are not available in the area of this project, the better soils that are available shall be used for this purpose as determined by the Engineer.

203.10 Station Grading. Station grading shall consist of all excavation and embankment required for the construction of the road when the plans indicate that payment for grading work is on a station grading basis and when there is a bid item listed in the proposal for Station Grading. The scope and construction requirements of the work to be performed and paid for under this item shall be in accordance with the provisions set out in this **Section 203**, except as otherwise provided in this Section.

If it is necessary to borrow material to bring embankments up to a required grade, such borrow material will be paid for at the contract bid price for Unclassified Excavation with Overhaul as applicable. When it is necessary to remove unsuitable material in cut sections below the finished subgrade elevation, the material excavated below the finished subgrade will be measured and paid for as Unclassified Excavation with Overhaul as applicable. Likewise, when it is necessary to remove unsuitable material in fill sections, before the embankment can be constructed, the material excavated will be measured and paid for as Unclassified Excavation with Overhaul as applicable. Excavation that is removed from inlet or outfall ditches, stream channels or from inlets and outlets of structures shall be measured and paid for as Unclassified Excavation.

Station Grading shall include material necessary to be excavated at intersections, driveways, private entrances, or other miscellaneous excavation necessary for the road construction.

203.11 Geotextile for Separation of Subgrade and Subbase or Base Course Materials. The item Geotextile for Separation of **Subgrade** and **Subbase** or **Base Course** Materials shall consist of furnishing and placing a geotextile for use as a permeable separator to prevent mixing of subgrade with subbase or base course materials. The geotextile shall be designed to allow passage of water while retaining soil without clogging.

Geotextile fabric shall be approved by the Engineer.

CONSTRUCTION REQUIREMENTS

203.12 General. The excavation and embankments for the roadway, intersections, and entrances shall be finished to reasonably smooth and uniform surfaces. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed. Before beginning grading operations in any area, all necessary clearing and grubbing in that area shall be completed in accordance with **Section 201**.

The Contractor shall notify the Engineer in sufficient time before beginning excavation in order that the necessary cross-sections may be taken. The Contractor shall not excavate beyond the dimensions and elevations established and material shall not be removed before the staking and cross-sectioning of the site.

After sufficient clearing and grubbing has been completed and the work has been cross-sectioned and staked, the Contractor may proceed with the excavation and placement of material at such locations and in such a sequence as the Engineer may approve.

All suitable materials excavated shall be used as far as is practicable in the formation of embankment, subgrade, shoulders, and at such other places as directed. The Contractor shall preserve the best materials for use in constructing the top portion of embankments insofar as practicable. In cases where this is impracticable or the material in the balance is unsuitable, the Contractor may be required to borrow suitable material from other balances.

Excavated rock shall be used in forming embankments wherever the depth of fill is sufficient to properly contain the rocks, and shall be placed in accordance with **Subsection 205.04**. Any material that is excavated beyond the slope stakes set for the construction will not be paid for unless such excavation is required in the formation of the embankment or is specifically ordered by the Engineer. Unless otherwise directed by the Engineer, surplus material or waste shall be disposed of by widening the embankments uniformly and flattening the slopes. If additional areas are necessary to accommodate the surplus or waste material, the Contractor shall dispose of the material in accordance with **Subsection 203.06**. Excavated material shall not be deposited above the grade of the finished road, unless permitted by the Engineer, or disposed of in such a manner as to cause damage to adjacent property or impair the appearance or symmetry of the roadway.

When rock is encountered in the subgrade, the rock shall be excavated to a depth of 6 inches below subgrade for the entire width of the roadbed, except where a cement-modified subgrade is specified. If a cement-modified subgrade is specified, the rock shall be excavated to a depth of one foot below subgrade for a width specified in the plans or as directed by the Engineer. The resulting excavated areas shall be backfilled with suitable material specified by the Engineer. The Contractor will be paid for both the material excavated and the material used for backfill. The excavated material will

be paid for as Unclassified Excavation, unless an item of Rock Excavation is included, in which case, this material will be paid for at the contract unit price for Rock Excavation. The backfill material will be paid for at the contract unit price of Unclassified Excavation, unless an item of Borrow Excavation is included, in which case, the backfill material may be paid for as Borrow Excavation, if determined applicable by the Engineer in accordance with **Subsection 203.09**.

Where unstable or other material, that in the opinion of the Engineer, is unsuitable for foundation, subgrade or other roadway purposes, occurs within the limits of the roadway, the Contractor shall be required to remove and dispose of such material to the cross-section shown on the plans or as directed by the Engineer, and backfill the excavation with suitable material.

Whenever it becomes necessary to obtain additional excavation to form the embankments, the Engineer may direct that cuts be widened, cut slopes be flattened, or grades in cuts be lowered in lieu of obtaining material from borrow pits. The widening of cuts or flattening of cut slopes shall be carried to a uniform width throughout the cut in such a manner as to obtain a uniform and neat appearance. Material shall be obtained from those borrow pits, cuts, backslopes and ditches designated and previously cross-sectioned by the Engineer. Borrow pits shall be trimmed and left in a neat and suitable condition to facilitate the accurate measurement of the material excavated. Where practicable, they shall be so excavated that water will not collect or stand therein and after taking of final cross-sections, the pits shall be terraced if so directed by the Engineer.

Where suitable earth type **base course** material, selected material for shoulders, or materials suitable for stabilizing subgrade is encountered in excavation and on areas where embankment is to be placed, whether shown on the plans or not, it shall be salvaged and used accordingly if so directed by the Engineer. Materials that are stockpiled for later use in

the work shall be measured and paid for as Unclassified Excavation in addition to payment under the appropriate item for which the material is used.

Watercourses shall be constructed where and as shown on the plans, or where and as directed, to the lines, grades and cross-section established by the Engineer. All roots, stumps, rock, and other materials in the sides and bottom of watercourses shall be cut to conform to the slope, grade, and shape of the section given. Where practicable, in the opinion of the Engineer, all suitable material excavated from ditches and channels shall be placed in the embankment or, where impracticable, it may be placed along the banks. Excavation or spoil from a watercourse shall not be deposited within 3 feet of the edge of the watercourse and shall be spread uniformly unless otherwise shown in the plans or directed by the Engineer. Ditches or gutters emptying from cuts to embankment shall be constructed to avoid erosion of the embankment.

203.13 Excavating Rock. If material is encountered during roadway excavation, which appears to belong in the classification of rock excavation as set forth in **Subsection 203.08**. Unless otherwise provided, it shall be measured and paid for as Unclassified Excavation.

Final breakage of rock excavation shall conform with or closely approximate the slopelines shown on the plans unless different slopelines are fixed and the Contractor is so notified. The final slopes shall be left reasonably smooth and uniform and all loose and overhanging rock removed. Unless otherwise permitted, no rock shall finally project more than one foot beyond established slopes.

Rock shall be excavated to the required elevation for the full width of the roadway as shown on the plans or as directed by the Engineer. When rock is excavated below the subgrade elevation, the Contractor shall backfill to the subgrade elevation with material approved by the Engineer. Such ma-

terial shall be properly compacted and shaped to the required elevation and cross-section.

The final surface of rock excavation under the roadbed area shall be left so that all areas shall drain.

The Engineer may require the firing of short test lines and exposure of the pre-split slope at any location or area to be pre-split to see that the hole spacing, charge and resulting blast give the desired results. The Engineer reserves the right to require any changes in methods or procedures that he considers necessary to control the effectiveness of the pre-splitting operation.

The pre-split face shall not deviate more than 6 inches from the front line of the drill holes nor more than 12 inches from the back line except where, in the opinion of the Engineer, the character of the rock being pre-split will unavoidably result in irregularities.

203.14 Maintenance of Excavation. The Contractor shall maintain the highway in accordance with the provisions of **Subsection 104.07**.

203.15 Method of Measurement.

a. The quantity of work done under this item, except for Site Excavation and Station Grading, shall be measured in cubic yards of Unclassified Excavation, unless bid items of Rock Excavation or Borrow Excavation have been included in the contract, and are applicable in accordance with these Specifications. These quantities shall consist of the material acceptably excavated as herein prescribed, measured in its original position, and determined from cross-sections by the method of average end areas. Measurements will include 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 also that necessary to

replace such materials; excavation of selected materials required by the Engineer to be stockpiled and reserved for later use in the work; material obtained from borrow pits; and also authorized excavation under bridges or box culverts (exclusive of material classified as Excavation for Structures) where bottom slabs have been omitted.

The volume measured for the construction of a watercourse (ditch or channel excavation) will include material removed from the end of the structure to the end of the watercourse. It will not include excavation necessary to construct the bridge foundations, but will include excavation under structures where such work is directed by the Engineer in the construction of watercourses.

b. On all projects where the plan quantity of Unclassified Excavation is computed from cross-sections included in the plans, the quantity of Unclassified Excavation to be paid for will be the computed quantity shown in the plans. The Contractor will be paid a revised quantity if a revision on any portion of the contract is necessary during construction of the work. Revisions from the computed plan quantity will be made in accordance with the following provisions:

1. Where rock is removed from the subgrade as outlined in **Subsection 203.12**, the quantity to be paid for will be both the material excavated and the material used for backfill. The backfill material will be paid for only once.

Where rock is removed as outlined in **Subsection 203.13**, it shall, unless otherwise provided, be measured and paid for as Unclassified Excavation. The quantity will be computed from cross-sectional measurements made in the field. Measurements will be made only in areas where rock was authorized to be removed. Measurement of unavoidable over-breakage shall be in accordance with the pro-

visions of this **Subsection 203.12**. Over-breakage that, in the opinion of the Engineer, is avoidable shall not be included in the final measured quantity. No direct measurement or payment will be made for pre-splitting, but the cost thereof shall be included in the pay item of Unclassified Excavation, or Rock Excavation when a separate pay item for Rock Excavation is provided.

2. Where the Engineer requires the removal of unsuitable or unstable material, mucking, or stripping, as set forth in **Subsection 203.12**, the quantity will be computed from cross-sectional measurements made in the field. Measurements will be made only in areas where unstable material was authorized to be removed. Where it is necessary to replace unstable material with borrow, payment will be made for material removed and for borrow material to replace it.

3. Where it is necessary to borrow, the material will be measured from cross-sections 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 Engineer, the quantity of borrow material shall be computed after first deducting from the final cross-sectioned area shown in the plans.

4. Where an estimated quantity is shown in the plans for ditches and channels, the final quantity will be obtained from measurements taken in the field.

5. Computed plan quantities will be used where grade changes do not vary more than 0.3 of a foot from plan grade. Where grade changes are greater than these limits, or at the Engineer's discretion, the revised quantities will be obtained by the

method outlined in paragraph (3) above for variations in cross-sections. Revised quantities will include the actual increase or decrease from plan quantities. Before making final payment of the plan quantity of the Unclassified Excavation, the computed plan quantity may be rechecked when considered desirable by the Engineer. Such rechecking may result in an increase or decrease in the quantity of Unclassified Excavation shown in the plans.

c. The quantity of Mucking or Stripping Excavation shall be the volume, in cubic yards, completed and accepted and determined as follows:

The volume shall be calculated by the average end area method. The length for the computation shall be the actual length of the area along the roadway excavated, and the cross-section areas for the calculation shall be the neat line measurement of the typical cross-section shown on the plans and established by the Engineer. The Contractor will not be paid for any material excavated outside the neat lines shown on the plans or as established by the Engineer. Payment for muck or stripping excavation shall be made only once for a particular volume and no allowance will be made for necessary re-excavation.

d. The quantity of Station Grading will be determined by horizontal measurement along the centerline of the road to the nearest 0.01 station. A station shall be considered as 100 feet. Exceptions to the project, such as bridges, railroads, etc., noted on the plans, shall be deducted from the total length of the road.

e. No separate measurement will be made for Site Excavation.

f. Geotextile for Separation of **Subgrade** and **Subbase** or **Base Course** Materials shall be measured by the number

of square yards covered by the fabric and accepted by the Engineer.

203.16 Basis of Payment. The volume measured as provided for in **Subsection 203.15** above shall be paid for at the contract unit price for Unclassified Excavation, or when so listed in the proposal and applicable, it shall be paid for at the contract unit price for Rock Excavation, Stripping Excavation, Muck Excavation or Borrow Excavation. Such price and payment shall constitute full compensation for excavating the material, the formation and compaction of embankments, disposal of surplus or unsuitable material, stripping, preparation and compaction of subgrade and shoulders, de-watering borrow pits when determined necessary, terracing of borrow pits, removal and resetting of mail boxes, guide signs, etc., and the furnishing of all materials, supplies, labor, equipment, tools, transportation, and incidentals necessary to satisfactorily complete the work. This price and payment shall also include hauling of the material within the free haul limit of 3000 feet. If the material is hauled beyond the free haul limit, Overhaul as defined in **Section 207** shall apply except in the case of Borrow Excavation furnished by the Contractor in accordance with **Subsection 203.09**.

Where the Contractor is required to furnish the borrow pits, the material shall be paid for as Borrow Excavation, which price and payment shall constitute full compensation for the cost of the borrow pit, clearing and grubbing of pits, necessary haul roads, hauling of the borrow material to the designated location on the roadway and for all other pertinent stipulations stated above.

Payment will not be made for any excavated material used for purposes other than those designated except material covered in **Subsection 104.09**.

Rock excavation that may be performed for a greater depth than 6 inches below subgrade will not be paid for unless cement-modified subgrade is specified or such work is

specifically authorized by the Engineer. Rock Excavation that may be performed for a greater width than specified will not be paid for unless specifically authorized by the Engineer.

Payment for Station Grading shall include all excavation and embankment and all other work specified in **Subsection 203.10** as required for the completion of the work, except excavation that is specified in **Subsection 203.10** to be measured and paid for as Unclassified Excavation. No payment will be made for overhaul of material excavated on the road and used on the road.

Payment for Site Excavation will be made on a lump sum basis. It shall be the responsibility of the Contractor to inspect the site and to determine the quantities of material necessary to construct the roadway to the plan typical section. No separate payment will be made for any incidental costs associated with this work.

The quantities of geotextile measured in **Subsection 203.15** shall be paid at the contract unit price for Geotextile for Separation of Subgrade and Subbase or Base Course Material, which price and payment shall be full compensation for furnishing all materials, supplies, labor, equipment, tools, transportation, and incidentals necessary to satisfactorily complete the work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
2031000	Unclassified Excavation	Cubic Yard
2031200	Site Excavation	Lump Sum
2032000	Rock Excavation	Cubic Yard
2033000	Borrow Excavation	Cubic Yard
2034000	Muck Excavation	Cubic Yard
2035000	Station Grading	Station
2036000	Geotextile for Separation of Subgrade and Subbase or Base Course Material	Square Yard

SECTION 204

STRUCTURE EXCAVATION

204.01 Description. This work shall consist of the removal and satisfactory disposal of all materials necessary for the construction of foundations and substructures for bridges, box culverts, and other structures when the plans or proposal indicate an item of structure excavation. Work performed shall conform to the lines, grades, dimensions and sections as shown on the plans or as otherwise directed by the Engineer; and shall be performed in the manner and subject to the conditions and requirements hereinafter provided.

Excavation for structures shall include furnishing materials for construction, shoring, sheeting, cribbing and cofferdams (when not itemized in the proposal), and performing all pumping, bailing, draining, backfilling, removal of all bracing, and the disposal of surplus or unsuitable materials.

204.02 Classification. Excavation for structures, except for

box culverts and foundations for bridges shall be unclassified. Unless otherwise provided for on the plans or in the special provisions, excavation for structures performed in connection with foundations of box culverts and bridges shall be classified as follows:

a. Structure Excavation for Culverts shall include all materials excavated as necessary for the construction of reinforced concrete box culverts, subject to the limits stated herein.

b. Dry Excavation for Bridges shall include all materials excavated above the water elevation shown on the plans, except as modified under Rock Excavation.

c. Wet Excavation for Bridges shall include all materials excavated below the water elevation shown on the plans and above the foundation, except as modified under Rock Excavation.

d. Wet and Dry Excavation for Bridges shall include all materials excavated when the water elevation is not shown on the plans, except as modified under Rock Excavation.

e. Rock Excavation for Bridges shall include all hard rock as specified in **Subsection 203.08**. Should a price for Rock Excavation be included in the proposal, then all material meeting the specifications for Rock Excavation will be classified as such wherever found. All other materials will remain unclassified, except Wet Excavation for Bridges, Dry Excavation for Bridges, and Wet and Dry Excavation for Bridges. In the event that no price is called for in the proposal for Rock Excavation, all materials encountered shall be classified as wet, dry, or wet and dry excavation without other classification.

204.03 General. All materials excavated for structures shall be used insofar as suitable and practicable in backfilling around the structure and in the formation of embankments as specified in these specifications, or shall be otherwise disposed of as directed by the Engineer.

The Contractor shall notify the Engineer a sufficient time in advance of the beginning of structure excavation so that the cross-sectional elevations and measurements may be taken of the existing ground and structure. Any materials removed or excavated before such measurements have been taken may not be paid for.

The placing of concrete or masonry in any foundation excavation shall not be started until the Engineer has examined and approved the depth of the excavation, the suitability of the foundation, and the control of the water and pumping operations.

Changes in elevation of footings or foundations for structures shall be in accordance with the provisions of **Subsection 105.02**.

204.04 Preparation of Foundations. Where practicable, foundations shall be excavated to the outline of the footings shown on the plans and shall be of sufficient size to permit the placing of the full width and length of the footings shown or indicated. Round or undercut corners and edges of footings will not be permitted.

a. Rock. All rock or other hard foundation shall be freed from all loose material, cleaned and cut to a firm surface either level, stepped, or serrated, as may be directed by the Engineer. All seams shall be cleaned out and filled with concrete, cement mortar, or grout.

b. Other Materials. When concrete is to be placed on a foundation surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and the fine grading of the foundation to grade shall be made just prior to placing the reinforcing and concrete.

204.05 Cofferdams.

A. General. When the project plans require the use of cofferdams for construction of bridge substructure or other elements of work the cofferdams shall comply with the following requirements:

1. Cofferdam units shall consist of the complete cofferdam required to construct the desired element and must be constructed of heavy structural timber and/or structural steel as a minimum.

2. Materials used to construct a cofferdam shall remain the property of the Contractor and shall be removed in accordance with **Subsection 204.05C**.

3. The Contractor shall comply with **Subsection 702.10** in the design and inspection of cofferdams.

4. When included as a bid item in the proposal, the unit price bid for each cofferdam shall be full compensation regardless of the actual volume of cofferdam constructed.

5. The type of cofferdam (i.e. Type 1, Type 2, etc.) shown in the proposal is based on the theoretical plan volume of the cofferdam and is used by the Department for estimating purposes.

B. Construction. Cofferdams or cribs for foundation construction shall in general be carried well below the bottom of the footings and shall be well braced and of such

construction as will permit them to be pumped free of water and kept free until all concrete below water has reached its initial set. Except where seals are called for on the plans, the interior dimensions of cofferdams shall be sufficient to give clearance for the construction of forms, the inspection of their exteriors, to permit pumping, and handling of leakage outside of the forms. They shall also be so constructed as to protect green concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. Bracing shall not be left in cofferdams or cribs in such a way as to extend into the substructure, without permission of the Engineer.

Cofferdams or cribs that become tilted or have moved laterally shall be righted or enlarged to provide ample clearance and this shall be performed without extra compensation.

C. Removal. Unless otherwise provided, the Contractor shall remove cofferdams or cribs with all falsework, sheeting, and bracing after completion of the substructure. The removal shall be effected in such a manner as not to disturb or mar the finished structure.

204.06 Foundation Seal. When in the opinion of the Engineer, conditions are encountered that render it impracticable to de-water the foundation before placing the concrete, he may allow the construction of a concrete foundation seal. Before placing the seal, the foundation shall be cleaned of all objectionable material to the satisfaction of the Engineer.

The foundation for a concrete seal with foundation piling shall be excavated sufficiently below grade to take care of any "heave" in groundline due to the driving of foundation piles and also to permit backfill of sand or aggregate to sufficient thickness if considered necessary by the Engineer to avoid contamination of the fresh seal concrete by mud. The elevation of the foundation thus prepared shall be within

6 inches of the grade shown on the plans or as established by the Engineer. Earth material in the arched web of the steel sheet piling shall be completely removed so that the seal concrete will be in contact with the sheeting at all areas.

The foundation for a concrete seal without foundation piling shall be leveled to within a 5% grade in any direction from one edge to the opposite edge by blasting if necessary and permitted. Earth material, loose rock and small boulders shall be removed.

The seal concrete shall be constructed as prescribed in **Subsection 702.17**, and after it has cured sufficiently, the cofferdam shall be de-watered, the seal thoroughly cleaned of all laitance and other objectionable materials and the balance of the concrete placed in the dry. Unless the plans or Special Provisions provide for seals, such concrete shall be placed entirely at the expense of the Contractor, except as provided for below. If a seal is authorized by the Engineer, as provided for in the first paragraph of this Section, the Contractor will be paid at the unit price for Concrete Class 4000S for that portion of pier shaft, not actually cast, but that would have been required had the bottom of the footing been placed at the elevation of the bottom of the approved seal.

When weighted cribs are employed and the weight utilized to partially offset the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage, such as dowels or keys, shall be provided to transfer the entire weight of the crib into the foundation seal. When a foundation seal is placed under water, satisfactory steps shall be taken to keep the water level the same on the outside and inside of the cofferdam, so as to prevent pressure on fresh concrete due to a difference in head.

204.07 Pumping. Pumping from the interior of a foundation enclosure shall be done in such a manner as to preclude the possibility of any portion of the concrete materials being carried away. No pumping will be permitted during the placing of

concrete, nor for a period of at least twenty-four (24) hours thereafter, unless it is done from a suitable sump separated from the concrete work by a reasonably watertight wall.

Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure and in no case, in less than three (3) days or such additional length of time as the Engineer may direct.

204.08 Backfill. Backfill for structures shall conform to the requirements of **Subsection 205.03**.

204.09 Permanent or Temporary Sheet Piling.

A. Description. This work shall consist of designing, furnishing, installing, maintaining, and removing temporary sheet piling wall at the locations shown on the plans. The sheet piling wall may be, but is not limited to one of the following types:

a. Steel sheet pile wall - braced or tieback.

b. Steel soldier piles with lagging - braced or tieback.

B. Design. Sheet pile walls shall be designed in accordance with the latest edition of the **AASHTO Standard Specifications for Highway Bridges with interim specifications**, and the applicable requirements of **Subsection 702.10**.

The Contractor shall submit design calculations, methods of construction, and detailed drawings, all bearing the seal of a South Carolina Professional Engineer for review by the Engineer twenty-one (21) days before construction of the wall.

C. Construction. The sheet piling wall shall be constructed in a manner which protects any existing bridge,

existing roadway or railway, and existing traffic, while allowing construction access for new construction. All bracing or tiebacks used must provide access for new construction, while maintaining the existing traffic flow without interruption.

Any wood lagging used shall be in accordance with **Section 706** of these specifications.

204.10 Method of Measurement.

A. Excavation For Bridges. Excavation for bridges will be measured in cubic yards and shall be the volume actually removed between the original elevation of the ground surface and the bottom of the footings, but will not include material removed outside of an area which is bounded by vertical planes 18 inches outside of and parallel to the neat dimensions of the footings, except where specifically authorized in writing by the Engineer. In the case of permanent structural members such as struts, diaphragms, beams, etc, where it is necessary to excavate in order to place forms, such excavation will be included in the volume of structure excavation to be paid for. However, the limits of the paid excavation will not extend more than 12 inches horizontally beyond the sides of the members, nor more than 12 inches below the bottom of the members. Where the excavation begins below the waterline, it shall be measured from the bottom of the watercourse to the bottom of the foundation, thus excluding any measurement of water.

Where a foundation seal and excavation for bridges are included in the plans, the measurement of excavation shall be the volume in cubic yards of material other than water between the bottom of the watercourse and the actual bottom of seal concrete as poured and within the vertical planes of the neat lines of the seal shown on the plans.

B. Excavation For Reinforced Concrete Box Culverts. Excavation for box culverts will be measured in cubic yards, and shall be the volume actually removed between the original elevation of the ground surface and the bottom of the bottom slab, but shall be limited to the volume that is enclosed by vertical planes located 2 feet outside of and parallel to the outside neat lines of the culvert barrel and extending to 2 feet beyond the ends of the wingwalls. This excludes the measurement of excavated material for the wings that is outside the area described above. Measurement of unstable material removed as directed by the Engineer as provided in **Subsection 203.12** will not be limited to the area described above. Measurement will not be made for water or other liquid removed.

Material for backfilling necessary due to the removal of unstable material below grade that is obtained from the roadway or material pits will not be measured separately, but will be included in the measurement of Unclassified Excavation. Material necessary for backfilling that is obtained from sources other than the roadway and material pits will be considered as being equal to the volume of the unstable material removed and measured as provided in **Subsection 203.15**. No direct allowance will be made for overhaul or shrinkage for material to backfill undercut areas.

C. Excavation For Other Structures. Excavation for other structures to be paid for under this Section when such excavation is indicated on the plans or in the proposal, will be measured in cubic yards and shall be the volume actually removed between the original elevation of the ground surface and the bottom of the footing, but shall be limited to the volume that is enclosed by vertical planes located 12 inches outside of and parallel to the neat lines of the footings. Measurement will not include water or other liquid removed.

D. Cofferdams. When included as a bid item in the pro-

posal, cofferdams shall be measured by each cofferdam constructed and de-watered in accordance with the plans. No adjustment will be made for differences between theoretical and actual volume of the cofferdam constructed.

E. Temporary Sheet Piling. Measurement of Temporary Sheet Piling shall be for the actual horizontal length in linear feet of temporary sheet piling wall in place and accepted by the Engineer.

F. Permanent Sheet Piling. Measurement of Permanent Sheet Piling shall be the actual square yards of permanent sheet piling wall in place and accepted by the Engineer.

204.11 Basis of Payment. The quantities determined and classified as provided above will be paid for at the contract unit price for Dry Excavation, Wet Excavation, Rock Excavation, and/or Wet and Dry Excavation for Bridges, or Structural Excavation for Retaining Walls as the case may be, which price and payment shall be full compensation for all labor, materials, equipment, cofferdams, cribs, caissons, sheeting, pumping, bailing, draining, caulking and other items or incidental work that may be necessary to the successful completion of the excavation to the depth indicated on the plans.

If it is found necessary to carry a footing more than 5 feet, but 10 feet or less, below the plan elevation for any individual footing, payment for excavation work performed below the elevation of waterline within these limits will be made at a unit price equal to 150% of the contract unit price for the applicable classification of excavation.

If it is found necessary to carry a footing more than 10 feet below plan elevation for any individual footing, payment for excavation work performed below the elevation of waterline will be made at a unit price equal to 200% of the contract unit price for the applicable classification of excavation. The price and payment shall include the cost of removing cofferdams, cribs, sheeting, backfill, and disposing of surplus material.

Excavation will be paid for under one classification only and no allowance will be made for necessary re-excavation.

Excavation for box culverts including the removal of unstable material for box culverts will be paid for at the contract unit bid price for Structure Excavation for Culverts. Excavation for the necessary backfill material obtained from sources outside the limits of the roadway and material pits will be paid for at the contract unit price for Structure Excavation for Culverts.

Payment for cofferdams will be at 100% of the contract price for each cofferdam of each type when the cofferdam is de-watered. This price and payment shall be full compensation for all labor, design, equipment, and materials necessary to place, de-water, maintain, and remove the cofferdam.

The accepted length of temporary sheet piling wall shall be paid for at the contract unit price for Temporary Sheet Piling, which price and payment shall be full compensation for all materials, design, installation, maintenance, removal, and other items or incidental work for the temporary sheet pile wall.

Permanent sheet piling wall will be paid for at the contract unit price for Permanent Sheet Piling, which price and payment shall be full compensation for all labor, materials, design, installation, and other items or incidental work that may be necessary to the successful completion of the permanent sheet pile wall.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
2041000	Structure Excavation for Culverts	Cubic Yard
2041005	Structure Excavation for Retaining Walls	Cubic Yard
2042000	Dry Excavation for Bridges	Cubic Yard
2043000	Wet Excavation for Bridges	Cubic Yard
2043500	Wet & Dry Excavation for Bridges	Cubic Yard
2044000	Rock Excavation for Bridges	Cubic Yard
2045000	Cofferdam	Each
2045010	Cofferdam - Type 1 (0 – 10,000 CF)	Each
2045020	Cofferdam - Type 2 (10,001 – 20,000 CF)	Each
2045030	Cofferdam - Type 3 (20,001 – 30,000 CF)	Each
2045040	Cofferdam - Type 4 (30,001 – 40,000 CF)	Each
2045050	Cofferdam - Type 5 (40,001 – 50,000 CF)	Each
2045060	Cofferdam - Type 6 (>50,000 CF)	Each
2047000	Temporary Sheet Piling	Linear Foot
2047200	Permanent Sheet Piling	Square Yard

SECTION 205

EMBANKMENT CONSTRUCTION

205.01 Description. This work shall consist of the formation of embankments in accordance with these specifications and in reasonable conformity with the lines, grades and cross-sections indicated on the plans or established by the Engineer, and shall include preparation of the areas upon which

they are to be placed, the construction of dikes or other necessary embankment formations within or outside the right of way; the placing and compacting of approved material within roadway areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits and other depressions within the roadway area. Embankment construction shall also include restoration, compaction, and stability of the embankment and the disposal of surplus and unsuitable material.

All work under this Section shall be performed in a manner that will insure compliance with **Subsection 107.26**, *Environmental Protection and Water Pollution Control*. The Contractor shall conduct his operations in a manner consistent with good erosion control practices to minimize soil erosion, and to the extent practicable, prevent sediment from leaving the site. The Contractor shall take the measures necessary to control erosion and to minimize the deposition of sediment into adjacent watercourses, wetlands, and impoundments throughout the life of the project.

The Engineer may limit the surface area of erodible material exposed. In order to limit the area of erodible material, the Engineer may require that partially completed slopes be brought to the required slope, and that the seeding be performed at that time in accordance with **Section 810**.

The Contractor shall comply with the provisions of any required permits for the project that limit the surface area of exposed erodible material.

Only approved materials shall be used in the construction of embankments and backfills. Unless otherwise provided, embankments shall be constructed of suitable materials excavated under **Sections 203** and **204**.

CONSTRUCTION REQUIREMENTS

205.02 General. Rocks, broken concrete, or other solid ma-

terials shall not be placed in embankment areas where piling is to be driven. Likewise, the top 6 inches of embankments shall not contain any material larger than can pass a 3 inch sieve.

Grading operations shall be so conducted that all suitable material shall be used where required for the formation of embankments, subgrade, shoulders, approaches, intersections, drives and for backfilling around structures. The work shall be done in such a manner and sequence with selective grading and necessary cross-hauling that the most suitable soil shall be reserved for topping the embankments to the extent practicable.

The embankment shall be maintained as provided in **Subsections 104.07** and **205.08**.

All clearing and grubbing shall have been completed in accordance with **Section 201** of these specifications, and stump holes and depressions filled and compacted before proceeding with the embankment construction.

Embankment shall be formed by placing, spreading and compacting the material in successive, uniform, horizontal layers of not more than 8 inches in depth, loose measurement, for the full width of the cross-section, except as set forth in **Subsection 205.04** where the depth may exceed 8 inches. Compaction shall be in accordance with **Subsection 205.07**. Each layer of the embankment material shall be kept uniform and shaped to drain for the full width of the cross-section by the use of blade graders, bulldozers, or other suitable equipment.

Where the embankment is to be constructed in low, undrained areas or where the earth material on which the embankment is to be constructed has a low support value, the Engineer may, at his discretion, permit the depth of the first layer to exceed 8 inches. Unless otherwise provided, dragline casting will not be allowed in constructing embank-

ments unless the material so handled can be placed in layers and compacted as specified herein.

205.03 Embankment Over and Around Structures. No fill shall be placed against any new masonry abutment, wingwall, retaining wall, or culvert, nor over any box culvert, pipe culvert, bridge, or arch, until permission has been given by the Engineer. Backfill behind new structures that will cause unbalanced earth pressure will not be permitted to full height until the concrete has cured for fourteen (14) days. If not subject to unbalanced earth pressure, backfill around piers or bents may be placed after the concrete has cured for three (3) days. Embankment around and over concrete box culverts or retaining walls will not be permitted until the concrete has cured for fourteen (14) days, unless tests of cylinders indicate that the concrete has obtained the required strength. When backfilling around box culverts, if the embankment is brought higher than 1/2 the height of the box, it shall be continued without delay to provide a cover of not less than 12 inches over the top slab. Embankment over and around pipes, culverts, arches, bridges, or other structures shall be of selected materials and shall be thoroughly tamped.

Fill around culverts, bents and piers, and fill below the natural ground surface at abutments, wings, and retaining walls shall be deposited on both sides to approximately the same elevation at the same time. Piers or bents shall not be displaced and shall be checked for proper location as the work progresses. Corrective measures shall be taken if necessary. Fill at arch structures shall be carried up in horizontal layers, symmetrically from haunch to crown and simultaneously over and against all piers, abutments, and arch rings.

Special precaution shall be taken to prevent wedging action of filling material against structures. If directed, back slopes of excavation shall be destroyed by stepping or serrating.

205.04 Rock Embankment. Where rock is used for em-

bankment, no large stones shall be allowed to nest but shall be distributed over the area to avoid pockets. Voids shall be filled carefully with small stones. The final 2 feet of the embankment just below the subgrade elevation shall be composed of suitable material placed in layers not exceeding 8 inches loose measurement and compacted to the required density.

Where the depth of an embankment exceeds 5 feet and will consist entirely of rock, the rock shall be deposited in lifts not to exceed the top size of the material being placed but in no event exceeding 4 feet. The rock for any particular lift shall be deposited on and pushed over the end of the lift being constructed by means of bulldozers or other approved equipment. Depositing of rock over the end of any lift from hauling equipment will not be permitted. If the voids of the last lift are not sufficiently closed, they shall be choked with small broken stone or other suitable material and compacted as directed.

Where the depth of embankment is 5 feet or less, or where the material being placed does not consist entirely of rock, the material shall be placed in lifts not to exceed the top size of the rock being placed but in no event exceeding 2 feet. Each layer shall be choked thoroughly with broken stone or other suitable material and shall be compacted to the required density or as directed.

When a rock fill is to be placed over a structure, the structure shall first be covered with a minimum of 2 feet of earth or other approved material and properly compacted before the rock is placed. This covering shall be placed in accordance with **Subsection 205.03**.

205.05 Embankment On Hillsides and Slopes. Before the embankment is placed on hillsides or against existing embankments, the existing ground surface should be plowed, deeply scarified, or benched depending upon the slope of the existing ground or embankment. When the existing slope is

steeper than 3:1 when measured at right angles to the roadway, the area shall be benched continuously in not less than 12 inch rises. The benching shall be of sufficient width that the embankment may be brought up in layers. Each horizontal cut shall begin at the intersection of the ground line and the vertical face of the previous bench. All such precautionary work shall be done as directed. No direct payment will be made for plowing, scarifying or benching, the cost thereof to be included in the various pay items of the contract.

205.06 Embankment Over Existing Roadbeds. If embankment for new pavement is to be placed over an area where a rigid pavement or any pavement having a concrete base is in place (or in other cases when required), the upper surface of which is 12 inches or less below the subgrade elevation of the proposed new pavement, the existing old pavement, including any concrete base, shall be removed. The method of removal, disposal, and basis of payment shall be as set forth in **Section 202**.

If embankment for new pavement is to be placed over an area where an existing rigid pavement, such as concrete pavement, concrete base with asphaltic concrete overlay, cement stabilized bases with asphaltic concrete pavement, or brick or cobblestone pavement with or without asphaltic concrete overlay, the upper surface of which is more than one foot but less than 2 feet below the subgrade elevation of the proposed new pavement (or in other cases, when required), the existing pavement shall be broken, plowed and recompacted, when so directed. When directed, the pavement shall be broken so the area of any individual unbroken slab or section does not exceed one square yard. No direct payment will be made for this breaking, plowing and compacting of pavement, the cost thereof to be included in the various pay items of the contract.

If embankment for new pavement is to be placed over an area where a flexible type base and pavement is in place, the upper surface of which is 12 inches or less below the sub-

grade elevation of the proposed new pavement, the existing old pavement shall be removed. The method of removal, disposal, and basis of payment shall be as set forth in **Section 202**.

If embankment is to be placed over an area where a flexible type base and pavement is in place, the top of which is more than one foot, but less than two feet, below the subgrade elevation of the proposed new pavement, the existing pavement, when directed, shall be loosened (scarified) and re-compacted for its full depth to prevent the possible trapping of water above the existing surface and to eliminate cleavage planes. No direct payment will be made for this loosening and compacting, the cost thereof to be included in the various pay items in the contract.

205.07 Embankment Compaction. Each layer of embankment shall be compacted to not less than 95% of maximum density before successive layers are applied unless otherwise provided. The compaction shall be accomplished by using suitable construction procedures and while the material is at a suitable moisture content. Maximum densities will be determined by either **AASHTO T 99** (Method A or C as applicable), or **SC T-29**.

On projects where the base and pavement is to be constructed under a later contract, each layer of embankment shall be compacted as specified above.

205.08 Maintenance and Stability. Embankments shall be maintained to the grade and cross-section shown on the plans, or established by the Engineer, until the completion and acceptance of the project.

The Contractor shall be responsible until final acceptance for the stability of all embankments made under the contract and shall replace any portion which, in the opinion of the Engineer, has become displaced or damaged. If, in the opinion of the Engineer, the displacement or damage is due to negli-

gent work on the part of the Contractor, the replacement shall be done by the Contractor without additional compensation. If the work has been properly constructed, completely drained and properly protected and damage to the embankment occurs due to natural causes, such as storms, cloud bursts, floods, slides, subsidence, etc., the Contractor will be paid at the contract unit price for the items necessary in making the repairs or replacement.

205.09 Measurement and Payment. When specified in the contract, embankments constructed will be measured and paid for in accordance with the terms set forth. Unless otherwise provided, embankments will not be paid for directly, but will be considered a necessary part of the work paid for under the items included in the contract prescribed under **Sections 203** and **204**. This payment shall include and be full compensation for all labor, equipment, tools, and incidentals necessary to satisfactorily complete the work.

SECTION 206

EMBANKMENT IN-PLACE

206.01 Description. This work shall consist of the construction of embankment by dredging and pumping acceptable material from rivers, canals or other areas or by excavating, loading and hauling acceptable material from pits and depositing such material at locations shown on the plans in accordance with these specifications and in conformity with the lines, grades and cross-sections indicated on the plans or as established by the Engineer. Unless otherwise provided, embankment in-place may be hydraulically constructed or hauled in from pits.

The Contractor shall, without additional compensation, furnish the necessary borrow pits and haul roads; restore the

premises over which a haul road has been constructed; procure necessary dredging permits and other necessary permits; comply with the laws and regulations pertaining to dredging and pollution; and remove and dispose of the stripping from pits.

All work under this Section shall be performed in a manner that will insure compliance with **Subsection 107.26**, Environmental Protection and Water Pollution Control. The Contractor shall conduct his operations in a manner consistent with good erosion control practices to minimize soil erosion, and to the extent practicable, prevent sediment from leaving the site. Throughout the life of the project, the Contractor shall take the necessary measures to control erosion and to minimize the deposition of sediment into adjacent watercourses, wetlands, and impoundments.

The Engineer may limit the surface area of erodible material exposed. In order to limit the area of erodible material, the Engineer may require that partially completed slopes be brought to the required slope and that the seeding be performed at that time in accordance with **Section 810**.

The Contractor shall comply with the provisions of any required permits for the project, which limit the surface area of exposed erodible material.

The Department may, at the discretion of the Engineer, exercise its right of Eminent Domain in the acquisition of the land for pits. All related costs shall be borne by the Contractor.

MATERIALS

206.02 Materials.

A. Hydraulic Construction Material. The materials used in the embankment when hydraulically constructed shall be excavated by dredging from nearby areas if so

designated in the plans or special provisions. The embankment shall be formed of a material consisting of sand, marl or clay marl with a maximum of 25% by weight of the materials passing the No. 200 sieve. Muck or other objectionable material more than the maximum allowable percentage stated above shall not be placed in the embankment. The determination of the material passing the No. 200 sieve shall be by the wash method. All unsuitable material shall be disposed of in a manner and at a location satisfactory to all parties concerned.

B. Hauled-In Construction Material. When using hauled-in material to construct the embankment, the material shall be furnished by the Contractor and approved by the Engineer before being used. Except for the top 18 inches of the embankment, materials that will be acceptable are classified according to **AASHTO M 145** as: A-1, A-2, A-3, A-4, A-5 or A-6. A maximum of 25% by weight of recycled glass aggregate may be mixed with these materials in constructing the embankment.

The recycled glass shall be free of organic and toxic materials, hypodermic needles and any hazardous materials, and must meet **South Carolina DHEC regulations** as a non-hazardous material. The maximum particle size for recycled glass aggregate shall be 1/2 inch. The lead content for the glass aggregate shall not exceed 5 ppm, and the silver content shall not exceed 5 ppm. The aggregate shall also meet the limits established by the EPA for the primary and secondary drinking water standards. Before any glass is placed on projects, the glass supplier shall furnish the Department certified test results showing that the glass meets the requirements listed herein. These test results shall be no more that one year old at the time it is furnished to the Department. The glass aggregate shall contain not more that one percent by weight of the non-glassy material and shall not contain any portion from mirror glass.

The top 18 inches of the embankment shall, unless otherwise provided, generally be constructed of material meeting one of the following: A-1, A-2-4, A-2-5, A-3 and the better soil of A-2-6 and A-4 classification according to **AASHTO M 145**.

CONSTRUCTION REQUIREMENTS

206.03 General.

A. Hydraulic Construction. When the embankment is hydraulically constructed, the Engineer may, in order to prevent possible slides and maintain a buffer zone, limit the distance between the pit furnished by the Contractor and the right of way line. The Engineer shall approve the location of the pit. In general, no material shall be excavated or dredged within 300 feet of the toe of the proposed embankment.

Embankment shall be carried ahead in a continuous section insofar as practicable. Every precaution must be used to prevent muck from being trapped within the fill section in order that a compact fill of acceptable material will be obtained throughout the embankment volume.

When it is necessary to remove unstable material before placing the hydraulic embankment, the unstable material shall be removed well in advance of placing the embankment material. It shall be moved a sufficient distance away from the excavation site to permit the taking of final cross-sections outlining the limits of the removed unstable material, and so that the embankment material will not come in contact with the unstable material.

The Contractor may use baffles or any form of construction he may select so long as the slopes of the embankments are not steeper than indicated on the plans. All timber use in such baffles, etc., shall be subsequently removed from the embankment and the holes thus formed

shall be filled and thoroughly compacted.

The Contractor shall also provide earth dams, timber baffles, or other means necessary to prevent damage to property beyond the right of way.

A reasonable amount of the excess material placed outside of the prescribed slopes may be used for raising the fill and dressing slopes. When such excess material is used to raise the embankment 2 feet or more, the raised portion shall be formed and compacted as specified in **Section 205**.

Any material that is allowed to invade openings left in the embankment for bridge sites shall be removed by the Contractor without extra compensation to provide the same depth of channel as existed before the construction of the embankment.

If dredge material is stockpiled and later hauled to the site, the construction of the embankment shall be performed in accordance with **Section 205**.

B. Construction Using Hauled-in Material. Embankment in-place constructed using hauled-in material shall be constructed in accordance with the requirements of **Section 205**. After the embankment is constructed to an elevation not subject to the action of ground water, the hauled-in material shall be compacted in layers to not less than 95% of maximum density determined in accordance with **AASHTO T 99**. When the embankment being constructed is subject to ground water, a material not stable under such conditions shall not be permitted.

When it is necessary to remove unstable material before placing the hauled-in material, the unstable material shall be removed well in advance of placing the embankment material. It shall be moved a sufficient distance away from the excavation site to permit the taking of final

cross-sections outlining the limits of the removed unstable material, and so that the embankment material will not come in contact with the unstable material.

When using glass aggregate in embankment material, the glass aggregate shall be spread uniformly on the uncompacted layer of hauled-in material. The spreading shall be accomplished in such a manner that the finished embankment will conform to the lines, grades, dimensions and typical cross-sections as shown on the plans or as directed by the Engineer. The glass aggregate material shall then be thoroughly mixed with the hauled-in material to a depth specified by the Engineer. During he mixing operation, sufficient water shall be added as necessary to bring the moisture to that required for proper compaction. The mixture of soil and the glass aggregate shall be spread and shaped to a uniform thickness, and while at **optimum moisture content**, shall be consolidated until the glass aggregate is bonded and the embankment thoroughly and satisfactorily compacted. A uniform, dense surface, free from loose material shall be required.

206.04 Maintenance and Stability. The requirements set forth in **Subsection 205.08** shall apply.

206.05 Method of Measurement. Embankment In-Place will be measured in cubic yards of roadway embankment completed and accepted, determined as follows:

The volume will be calculated by the average end area method. The length for computation will be the actual length of the embankment accepted. The cross-section area for the calculation will be the neat area of the cross-section shown on the plans above the original ground line, determined before the placing of any fill material, and below the subgrade elevation and slopes shown on the plans. Should the plans or special provisions require, or the Engineer direct, the removal of unstable or unsuitable material from under-

neath the roadbed, the trapezoidal area below the original ground line as shown by the plans or stated in the special provisions will be included in the cross-section area for the calculation. Embankment material used to replace material excavated beyond the lines and grades shown on the plans or directed by the Engineer will not be measured or considered in the pay quantities, unless the placing of such material shall have been specifically authorized in writing by the Engineer.

The removal of unstable material, when required will be measured and paid for as provided in **Subsections 203.15** and **203.16**.

The Contractor shall make his own estimate of the volume of material actually necessary for constructing the embankment to the cross-section shown or designated and no payment will be made for materials that may be deposited or flow outside the neat lines as described above.

206.06 Basis of Payment. The quantity, determined as provided above, will be paid for at the contract unit price for Embankment In-Place, which price and payment shall constitute full compensation for acquiring borrow pits, obtaining permits, stripping borrow pits, haul roads and for excavating, hauling, dredging, pumping and placing of all material; for constructing the embankment complete, subsidence, and the maintenance thereof; disposal of all unsuitable material and effluent water from the embankment area; and for all labor, equipment, tools and incidentals necessary to satisfactorily complete the work.

Payment for overhaul will not be allowed for material used in the construction of Embankment In-Place.

Unless otherwise indicated on the plans, no payment shall be made for any clearing and grubbing of the pit areas. Where no item of clearing and grubbing within the right of

way or roadway is specified in the plans or included in the proposal, the cost of clearing and grubbing shall be included in the contract unit price for Embankment In-Place.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
2061000	Embankment In-Place	Cubic Yard

SECTION 207

OVERHAUL

207.01 Description. This work shall consist of hauling locally excavated material more than 3000 feet in constructing the improvement in accordance with the plans and special provisions.

207.02 Method of Measurement.

In all cases, the length of overhaul will be the distance between the centers of volumes of the material in its original position, and after placing, less 3000 feet. The overhaul distance will be based on the shortest practicable route and any part of the overhaul distance not regarded by the Engineer, as reasonably necessary will be disregarded in computing the overhaul quantity to be paid.

In determining overhaul, the overhaul distance will be measured in half-mile units from the free haul limit of 3000 feet. The first half-mile unit of overhaul will apply to material hauled more than 3000 feet and not more than 5640 feet. The second half-mile unit of overhaul will apply to

material hauled more than 5640 feet and not more than 8280 feet, etc. The number of cubic yard half-miles (CYHM) of overhaul shall be the product of the volume of the material in cubic yards, by the half-mile units as determined above. The measurement of the volume of material for overhaul shall be by the same method prescribed in these specifications for measuring the volume of earthwork material for payment.

When plan quantities for overhaul have been computed and shown on the plans for roadway excavation, the final pay quantity for the roadway overhaul shall be an adjusted amount based on the original plan quantity. The adjusted quantity shall be computed as follows:

> The adjusted quantity of roadway overhaul will be determined by multiplying the original plan quantity of roadway overhaul by the final roadway excavation and then dividing this resultant by the original roadway excavation. When a contract contains more than one road, each will be considered separately.

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

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 will not be considered in the determination of the adjusted overhaul quantity. If it is determined that the overhaul provisions are applicable to the additional material, measurement of overhaul for the additional material will be made as provided above.

207.03 Basis of Payment. The number of cubic yard half-mile (CYHM) of overhaul, determined as provided above, will be paid for at the contract unit price for Overhaul, which price and payment shall be full compensation for all hauling cost beyond the free haul limit of 3000 feet.

On secondary road projects where plan quantities are paid for Unclassified Excavation, the quantity of roadway overhaul to be paid for will be the quantity shown in the balances in the plans where such quantity was obtained by balancing excavation. Where it is necessary to borrow or to raise or lower the grade more than 0.30 of a foot from plan grade, the adjusted quantity of overhaul shall be computed in accordance with **Subsection 207.02**.

Payment will not be made for haul of material excavated by dredge, for material excavated from pits or fields furnished by the Contractor where the contract requires that the Contractor furnish the material pits, or for material placed in an embankment for which payment is made under the item of Embankment In-Place.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
2071000	Overhaul	Cubic Yard Half-Mile

SECTION 208

SUBGRADE

208.01 Description. This work shall consist of the construc-

tion and preparation of the subgrade on that part of the roadway intended to receive the pavement, sidewalk, curb, curb and gutter, base course, and shoulders.

After all earthwork has been substantially completed and all drains and structures have been completed and backfilled, the subgrade, when compacted to the satisfaction of the Engineer, shall conform to the lines, grades and cross-sections shown on the plans or as established by the Engineer.

CONSTRUCTION REQUIREMENTS

208.02 General. All soft, unstable or unsuitable material that will not compact readily shall be removed and replaced with satisfactory material as directed. All objectionable loose rock or boulders shall be removed or broken off to a depth of not less than 6 inches below the surface of the subgrade or 12 inches below the subgrade if a cement modified subgrade is specified. All holes, ruts, or depressions that develop in the subgrade shall be filled with approved material and the subgrade brought to line and grade and compacted. This work shall be performed by the Contractor without any additional compensation. If the subgrade is too dry to compact properly, it shall be wet by sprinkling, if deemed desirable by the Engineer, to secure proper compaction.

The subgrade between lines 18 inches outside the area to be occupied by the pavement structure shall be compacted to not less than 95% of maximum density. The compaction shall be accomplished by using suitable construction procedures and while the subgrade is at a suitable moisture content. Maximum densities will be determined by either **AASHTO T 99** (Method A or C as applicable), **SC T-25**, (Method A or C as applicable), or **SC T-29**.

On projects where the base and pavement are to be constructed under a later contract, the subgrade shall be compacted as specified above to not less than 95% density.

When any portion of the subgrade is constructed on an old roadbed that conforms to or approximately with the elevation of the subgrade, the existing surface shall be scarified and manipulated as directed by the Engineer in order that the subgrade when compacted will have a uniform density.

208.03 Protection and Maintenance. The subgrade shall be maintained in a smooth and compacted condition, free from ruts and depressions, and shall be adequately drained. In no case shall any base, surface course, or pavement be placed on a frozen, muddy or unstable subgrade. Storing or stockpiling of materials directly on the subgrade will not be permitted except with the approval of the Engineer.

No base or surfacing materials shall be placed before the subgrade is checked and approved by the Engineer.

208.04 Method of Measurement. Subgrade work will not be measured for direct payment.

208.05 Basis of Payment. Subgrade work will not be paid for directly, but shall be considered as included and paid for in the various pay items of the contract.

SECTION 209

SHOULDERS AND SLOPES

209.01 Description. This work shall consist of the excavating, hauling, placing, and maintaining approved materials on shoulders in accordance with these specifications and in conformity with the lines, grades and typical cross-sections shown on the plans or as specified. It shall also include excavating, hauling, placing, and maintaining approved material on cut and fill slopes or other designated areas.

It is the intent of this specification that the best available materials be utilized in the construction of shoulders and slopes in order to enhance the establishment of permanent vegetation and minimize the effects of erosion on the project.

MATERIALS

209.02 Materials. The material used in this construction shall be obtained from the following locations:

1. Stockpiled material stripped from within the right of way in the grading operation.

2. Outside the cut or fill slopes in the right of way.

3. Stockpiled material stripped from borrow pits.

4. Select material pits.

5. Roadway and drainage excavation.

Selected material for shoulders or slopes shall consist of a friable material such as topsoil, etc., containing grass roots and having the properties of being comparatively porous, capable of growing grass and of a stable nature in that when compacted it will resist erosion and be capable of supporting vehicles when relatively wet.

Material from the roadway shall be salvaged to the extent that it is available. The Contractor will not be required to furnish material from outside the right of way for this purpose unless otherwise provided. The provisions of **Subsection 104.09** that require the contractor to replace material removed and used on the project are not applicable for this construction operation.

The amount of material available from cut sections shall be considered before considering material from fill sections. However, material may be removed from fill sections if addi-

tional material is needed. If material is removed from fill sections, the Contractor shall notify the Engineer in sufficient time before beginning excavation in order that the necessary cross-sections may be taken.

When an item of Borrow Excavation is included in the proposal, the borrow pit shall be stripped and the stripped material stockpiled for future use if suitable material is available, provided this would not contradict any agreement between the contractor and property owner, affect the restoration of the pit site, or affect compliance with the **South Carolina Mining Act**.

When required by the contract, the Contractor shall provide the material pits and necessary haul roads, and no payment for haul will be made.

When the quality of material described above is not available, and the ordinary excavation material from roadway and drainage excavation is suitable for shoulders and slopes, this material shall be used; however; no compensation under this item of work will be allowed.

CONSTRUCTION REQUIREMENTS

209.03 General. The shoulders and slopes shall be shaped, trimmed, and compacted in proper sequence for the type of base or surfacing being constructed. The construction shall be so performed that the shoulders, adjacent ditches, and slopes shall be adequately drained at all times.

All shoulders on earth type **base courses**, for a width of 18 inches adjacent to the base or **surface course**, shall be compacted along with the base course.

In the case of concrete base or concrete pavement, the shoulders shall be constructed immediately upon the expiration of the curing period. For other types of base or surface courses, the shoulder work shall be done prior to or during

the construction of these courses or as soon thereafter as directed by the Engineer.

Selected material pits shall be scarified and terraced as directed by the Engineer as soon as practicable after the material is removed. Terracing work shall be accomplished in accordance with the standard practices as recommended by the U. S. Soil Conservation Service.

209.04 Maintenance. The Contractor shall maintain the shoulders, slopes and other designated areas by preserving, protecting, replacing and doing such other work as may be necessary to keep the work in a satisfactory condition until the project is accepted.

209.05 Method of Measurement.

A. Measurement of Selected Material. Selected material for shoulders and slopes obtained from stockpiled material stripped in the grading operation; outside the cut or fill slopes in the right of way; stockpiled material stripped from borrow pits; or selected materials pits, will be measured by the cubic yard in place after being brought to the required cross-section, compacted and maintained until the project has been completed and accepted.

In cases where it is not practicable to measure the compacted in place, it will be 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 deduction of 25% for shrinkage.

When selected material for shoulders and slopes is to be placed on irregular areas where it is not feasible or practicable to determine the volume of the soil compacted in place, instead of scaling and counting the loads, the Engineer may designate pit areas from which to obtain selected material for shoulders and slopes where measure

ment will be made in accordance with **Subsection 203.15**. When measurement is made of the material in its original position, no deduction will be made for shrinkage. This method of measurement shall not be allowed when the depth of the pit excavation is less than 18 inches.

B. Ordinary Excavation Material. Material used in the construction of shoulders, other than that obtained from sources specified in **Subsection 209.05A**, will not be measured, nor paid under the item Selected Material for Shoulders and Slopes. When the material used in the shoulders and slopes consists of ordinary roadway or drainage excavation the measurement and payment for this material will be Unclassified Excavation.

209.06 Basis of Payment. Material in shoulders and slopes will be compensated for under this item only when the selected material used consists of material described and measured as provided in **Subsection 209.05A**.

The accepted volume of selected material measured in **Subsection 209.05A** will be paid for at the contract unit price for Selected Material for Shoulders or Slopes when this item is included in the proposal; otherwise payment will be at the contract unit price for Unclassified Excavation or Borrow Excavation, as the case may be. The above price and payment shall be full compensation for excavating, hauling within free haul limit, placing, spreading, shaping and compacting in its final position; for scarifying and terracing the material pits; and for all labor, equipment, tools, maintenance and incidentals necessary to satisfactorily complete the work. Overhaul will be paid for as specified in **Section 207**.

When the contract requires the Contractor to furnish the shoulder material, the unit price and payment shall be full and complete compensation for the work stated above and, in addition, shall cover the cost of material pits, haul roads and hauling of materials.

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

Payment will be made under:

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

SECTION 210

FLOWABLE FILL

210.01 Description. This work shall consist of the use of Flowable Fill, its application, materials, proportioning, handling, maintenance, and protection. Flowable Fill is a controlled low strength material (CLSM) which can be placed in a self-leveling consistency or in a less flowable state to reduce the fluid pressures exerted by the material. The ultimate unconfined compressive strengths should be less than 200 psi to maintain the ability to re-excavate, and the hardened flowable fill should not exhibit settlement.

210.02 Applications. Flowable Fill is suitable for routine backfilling such as for bridge abutments, utility trenches, cross-line pipes, catch basins, drop inlets, manholes, etc.; filling the voids of abandoned below ground structures including pipelines, culverts, and storage tanks; and for structural backfill beneath foundations. Flowable fill is acceptable for use in original construction or in maintenance situations, and can be placed in all weather conditions, including rain.

The mixes fall into the categories of "less flowable" and "very flowable" that are controlled by the amount of water in the mix. The less flowable mix shall be used when it is desirable to put traffic back on a roadway quickly or when being used to backfill pipes which could "float" out of position due to

the buoyant nature of the very flowable mix. The very flowable mix is self-leveling, and requires minimal effort to place but requires more time to displace the extra water and develop load-bearing capacity.

210.03 Materials and Equipment. The materials and equipment used to produce, transport, and place flowable fill shall be in accordance with **Section 701**. Sampling and testing of flowable fill and the materials used to produce it shall not be required except as provided in this Section.

210.04 Proportioning of Mixture. The selection of flowable fill shall be as specified or otherwise approved by the Engineer. For the mixture specified, the proportions of ingredients shall be determined with respect to the specific gravities of the materials available. The proportions for the mixes listed below are based upon the following specific gravities:

Cement	3.15
Fly Ash	2.25
Sand	2.64
Water	1.00

Mix 1			Mix 2		
Less Flowable			Very Flowable *		
Item	Weights Lbs.	Volume CY	Item	Weights Lbs.	Volume CY
Cement (min)	50	0.009	Cement (min)	50	0.009
Fly Ash (min)	600	0.157	Fly Ash (min)	600	0.157
Sand (SSD)	2500	0.562	Sand (SSD)	2500	0.562
Water	458	0.272	Water	541	0.322
Volume in cubic yards (CY)		1.000	Volume in cubic yards (CY)		*1.050

* Note that one cubic yard of very flowable fill produces slightly more than one cubic yard due to the additional mix water. Pay quantity will be based on one cubic yard.

Anticipated unconfined compressive strength for the above mixtures is 80 psi at twenty-eight (28) days and 150 psi at fifty-six (56) days.

If the situation demands greater flowability than Mix 2, the Engineer may increase the fly ash in increments of 50 pounds while decreasing the sand in increments of 58 pounds. If higher unconfined strengths are needed and the ability to easily re-excavate is not necessary, the Engineer may increase the cement in increments of 10 pounds while decreasing the sand in increments of 8 pounds.

210.05 Low Density Flowable Fill. Using high air generators and minimum cement of 60 pounds per cubic yard is an option. Low-density flowable fill contains about 30% ± 10% air entrained into the plastic material to obtain the flowability characteristics of maximum-density flowable fill. Low-density flowable fill is dependent on the development of cementitious bonds to obtain the load-bearing characteristics associated with the standard maximum-density flowable fill.

Before using low-density flowable fill, the mix design and laboratory test data shall be submitted to the Engineer for approval at least thirty (30) days in advance of starting the work. Test data should show material set times, flowability characteristics, and compressive strength at twenty-eight (28) days of 50 psi to 145 psi.

210.06 Preparations and Placement. Before placing flowable fill, the site shall be prepared, and the pipe joints or other utility placed as normal. There should be at least 6-inch cover of flowable fill above any utility line.

The Engineer will select the appropriate type of mix for the application at the site. Typically, the less flowable mix will be used to cover a utility pipe. Once the pipe is covered, it will be sufficiently anchored and water may be added to the remaining flowable fill to ease placement without danger of floating the pipe. If it is important to quickly return traffic to the roadway, the less flowable mix would be preferred full depth.

The flowable fill shall be discharged directly from the mixer

truck into the space to be filled, or by other methods approved by the Engineer. The mix may be placed part depth or full depth as conditions at the site dictate. Compaction of individual layers of flowable fill will not be necessary. Formed walls or other bulkheads shall be constructed to withstand the hydrostatic pressure exerted by the flowable fill. Trench ends outside the roadway should be blocked with sandbags or mounded soil rather than wood or metal forms. When backfilling utilities such as pipe culverts, flowable fill shall be distributed evenly to prevent any movement of the line.

Due to the self-consolidating nature of the flowable fill material, even the less flowable mix, use of vibrators should not be necessary. Placement of the less flowable fill mix may be allowed under conditions of rain or in standing water. Under these conditions, the flowable fill should still attain a uniform (controlled) density.

Once the flowable fill is in the trench, provision shall be made for bleed water, which is displaced during the consolidation process, to run off and away from the surface of the hardening flowable fill. Use of vapor barriers such as plastic sheets is not desired.

An initial subsidence of approximately 1/8 inch per vertical foot of depth of flowable fill is expected as excess water is displaced. Once the flowable fill hardens, there should be no further settlement, and the flowable fill may be shaped the following day to allow the patch thickness required by the Engineer. The patch may be placed directly on top of the flowable fill.

The material will usually support foot traffic within an hour after displacement of the bleed water. The Engineer will determine when full traffic may be allowed on the flowable fill. Typically, the flowable fill will harden sufficiently to allow full traffic within 8 to 20 hours, depending upon placement conditions. If it is necessary to return traffic in less than 8 hours, or if there is concern that traffic flow will cause damage to the fill or any structure below, steel plates shall be used to bridge

over the hardening flowable fill as directed by the Engineer. If the filled cavity is too wide to bridge, steel plates may be placed on the surface of the hardening flowable fill as soon as it is able to support foot traffic (one hour after bleed water is displaced).

It will be the responsibility of the Contractor to produce a mix design and to use the necessary construction techniques to assure that the finished material will perform as intended.

210.07 Method of Measurement. The quantity of flowable fill measured for payment shall be the number of cubic yards of flowable fill delivered to the job site and incorporated into the work as shown on the plans or otherwise directed by the Engineer. Where additional water is added to improve flowability of the mix, the pay quantity will be based upon the proportions of Mix 1. Additional water added in to the mixture will be deducted from the pay quantity in the manner shown for Mix 2.

210.08 Basis of Payment. The quantity of flowable fill, determined as provided above, will be paid for at the contract unit price for Flowable Fill, which price and payment shall be full compensation for furnishing all materials, equipment, tools, admixtures, shoring, steel plates, labor, and incidentals necessary to place flowable fill and to obtain the results herein specified.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
2103000	Flowable Fill	Cubic Yard

DIVISION 300

BASES AND SUBBASES

SECTION 301

CEMENT MODIFIED SUBBASE

301.01 Description. This work shall consist of modifying the existing **subgrade** by pulverizing the in-place soil, adding portland cement, mixing, wetting, compacting and shaping the mixed material to the required density, in accordance with these specifications and conforming to the lines, grades, thickness and typical cross-sections shown on the plans or established by the Engineer.

MATERIALS

301.02 Portland Cement. Portland cement shall conform to the requirements of **Subsection 701.02** of these specifications except that the allowable maximum alkali content ($Na_2O+0.658K_2O$) is increased to 1.0%.

301.03 Water. Water shall conform to the requirements of **Subsection 701.12**.

301.04 Soil. Soil shall consist of the material in the existing subgrade prepared in accordance with **Section 208** of these specifications.

301.05 Bituminous Material. The material for the bituminous curing coat shall be MC-30, RC-30, RS-2, CRS-2, or EA-P Special and shall meet the requirements set forth for bituminous materials in **Section 406**.

CONSTRUCTION REQUIREMENTS

301.06 General. It is the primary requirement of this specifi-

cation to obtain a completed **subbase** of modified material containing a uniform mixture of portland cement and subgrade material, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent courses. It shall be the responsibility of the Contractor to regulate the sequence of his work, to process a sufficient quantity of material to provide full depth as shown on the plans, to use the proper amount of portland cement, maintain the work and rework the courses as necessary to meet the requirements of this specification.

301.07 Equipment. Equipment necessary for the proper construction of the work shall be on the project, in acceptable working condition, and be approved by the Engineer, as to both type and condition, before the start of construction operations. The Contractor shall provide sufficient equipment to enable continuous prosecution of the work and its completion in the specified time. Mixing may be accomplished by (1) a multiple-pass traveling mixing plant or (2) a single-pass traveling mixing plant. The cement modified subbase may be constructed with any machine or combination of machines and auxiliary equipment that will produce results as outlined in this specification, and shall be operated by experienced and capable workers.

301.08 Preparation of Roadbed. Before other construction operations are begun, the roadbed shall be graded and shaped as required to construct the portland cement modified subbase using material in place in conformance with the lines, grades, thickness and typical cross-sections shown on the plans. Unsuitable soil or material shall be removed and replaced with acceptable soil.

301.09 Pulverization. The soil shall be so pulverized that, at the completion of moist-mixing, 100% by weight passes a 2-inch sieve, and a minimum of 65% passes a No. 4 sieve, exclusive of gravel or stone. Old bituminous wearing surface shall be pulverized so that 100% will pass a 2-inch sieve.

The depth of scarification shall be carefully controlled and blading operations conducted in a manner to insure that the surface of the roadbed below the scarified and pulverized material shall remain undisturbed and shall conform to the required cross-section.

301.10 Application of Cement (Road Mix). Portland cement shall be spread uniformly on the pulverized soil at a rate (in pounds per square yard) established by the **Research and Materials Laboratory**. This rate will be established in the laboratory using samples representative of the soils to be modified. The cement shall be spread with equipment that can be calibrated and adjusted so that the established rate will be attained uniformly throughout the length and width of the roadway. The spreading equipment shall have adjustable openings or gate headers and will not be solely dependent on vehicle speed to obtain the required spread rate. A tolerance of ±5% will be allowed in the spread rate for individual sections of roadway; however, adjustments should be made in order to keep the actual spread rate as close as possible to that established by the Research and Materials Laboratory. Cement shall be applied only to such an area that all the operations can be continuous and completed in daylight, unless adequate artificial light is provided, and within six (6) hours of such application.

The percentage of moisture in the soil, at the time of cement application, shall not exceed the quantity that will permit uniform and intimate mixture of soil and cement during dry mixing operations and it shall not exceed the specified **optimum moisture content** for the soil-cement mixture. No equipment, except that used in spreading and mixing will be allowed to pass over the freshly spread cement until it is mixed with the soil.

No cement shall be applied unless the temperature is above 40°F in the shade and rising. The work shall not be performed on a frozen or excessively wet subgrade.

301.11 Mixing and Processing. Unless otherwise provided in the special provisions or shown on the plans, Method (A) or (B) below may be used at the option of the Contractor.

Method A. Multiple-Pass Traveling Mixing Plant. After the cement has been applied, it shall be dry-mixed with the soil. Mixing shall continue until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied. Any mixture of soil and cement that has not been compacted and finished shall not remain undisturbed for more than thirty (30) minutes. Immediately after the dry mixing of soil and cement is complete, water as necessary shall be uniformly applied and incorporated into the mixture. The equipment and supply of water provided shall be adequate to insure continuous application of the required amount of water to sections being processed within three (3) hours of application of the cement. Proper care shall be exercised to insure proper moisture distribution at all times. After the last increment of water has been added, mixing shall continue until a thorough and uniform mix has been obtained.

B. Single-Pass Traveling Mixing Plant. After cement is spread, mixing operations shall proceed as follows:

The mixer shall, in one continuous operation, mix the air-dry soil and cement full depth; add the required moisture uniformly; thoroughly moist-mix the soil, cement, and water; spread the completed soil and cement mixture evenly over the machine processed width of the subgrade and leave it in a loose condition ready for immediate compaction. The mixing plant shall provide for a sufficient period of dry mixing to prevent the formation of cement balls when water is applied. Unpulverized dry soil lumps in the soil-cement mixture immediately behind the mixer will not be allowed. Should this condition prevail, the Contractor shall "pre-wet" the raw soil as necessary to correct this condition. The mixer shall

be provided with means for visibly and accurately gauging the water application. The water shall be applied uniformly through a pressure spray bar. The soil-cement mixture shall not remain undisturbed, after mixing and before compacting for more than thirty (30) minutes.

301.12 Compacting and Finishing. At the start of compaction, the percentage of moisture in the mixture shall not be below or more than two percentage points above the specified optimum moisture content and shall be less than that quantity that will cause the soil and cement mixture to become unstable during compaction and finishing. Before the beginning of the compaction, the mixture shall be in a loose condition for its full depth and then shall be uniformly compacted. Compaction shall continue until the entire depth of the mixture is uniformly compacted to not less than 95% of the maximum density. The maximum density of the composite mix shall be determined by **AASHTO T 134**, **SC-T-25**, or **SC-T-29**. Should tests show that the 95% requirement is not being met, the Contractor shall adjust his construction operations to obtain the required density. Compaction work shall be completed within a period of two (2) hours from the initial rolling. After the mixture is compacted, the surface of the course shall be reshaped as necessary to conform to the required lines, grades, and cross-section. Light scarifying may be required to obtain a uniform surface and prevent scaling. The surface shall be thoroughly compacted and finished by rolling with an approved smooth wheel tandem roller, pneumatic-tired roller or other means satisfactory to the Engineer. Rolling shall be supplemented by broom dragging when required. The compacting and finishing shall be done in such a manner as to produce a smooth, closely knit surface, free from equipment imprints, cracks, ridges or loose material. The moisture content of the surface material shall be maintained within two percentage points of the specified optimum moisture content during finishing operations.

301.13 Reconstruction. If the construction is proceeding

with the approval of the Engineer and the uncompacted soil and cement mixture is wetted by rain so that the moisture content exceeds the allowable, the Contractor will be paid for additional cement used in reconstructing the section, but no compensation will be made for the reconstruction work. If the reconstruction of any section is made necessary by the negligence or omission of the Contractor or unsatisfactory performances of his equipment, or if any section does not comply with the allowable variation in thickness, the Contractor will be required to reconstruct the section without additional compensation.

301.14 Curing. After the cement modified subbase has been finished as specified herein, the surface shall be protected against rapid drying by applying a bituminous membrane to the modified subbase. This membrane shall be applied immediately after finishing operations are complete and shall remain in place until the surface of subsequent courses are placed. The bituminous membrane material shall consist of MC-30, RC-30, RS-2, CRS-2, or EA-P Special applied at a minimum rate of 0.15 gallons per square yard of residual asphalt and shall completely cover and seal the total surface of the modified subbase and fill all voids. It shall be the Contractor's responsibility to protect the bituminous membrane from being picked up by traffic by either sanding or dusting the surface. The cement modified subbase should be allowed to cure for a period of not less than three (3) days before subsequent **base courses** are applied.

301.15 Construction Joints. At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the total width of completed work to form a true vertical face free of loose and shattered material. Cement modification for large, wide areas shall be built to a series of parallel lanes of convenient length and width meeting the approval of the Engineer.

301.16 Surface Smoothness. The finished surface of the modified subbase shall not vary more than 3/8 inch from a

straight edge 10 feet long when applied parallel to the centerline of the road, nor more than 1/2 inch from the typical cross-section shown on the plans. The finished surface of the modified subbase shall not be disturbed after the final finishing and compaction. The removal of random knots will not be permitted after the modified subbase has hardened. Where low areas or depressions result in the finished surface of the subbase, the same material that the modified subbase is to receive as the next component of the **pavement structure** shall be used to true up the finished surface. In cases where the material selected as the next component in the pavement structure is considered unsatisfactory, the Engineer may specify the material to be used. Such corrective work and material shall be performed by the Contractor without any additional compensation.

301.17 Tolerance in Thickness of Modified Subbase. The thickness of the completed modified subbase shall be measured at staggered intervals not to exceed 500 feet in length for two-lane roads. The depth measurement shall be made by test holes through the subbase course. Where the subbase course is deficient by more than one inch, the Contractor shall correct such areas. Where the measured thickness is more than one inch thicker than shown on the plans, it shall be considered as the specified thickness, plus one inch. The average job thickness shall be the average of the depth measurements determined as specified above. Should this average thickness be more than 1/2 inch below the specified thickness, an adjusted unit price shall be used in calculating payment. This adjusted contract unit price shall bear the same ratio to the contract unit price as the average thickness bears to the specified thickness. When the contract includes more than one road, each road shall be considered separately.

301.18 Traffic. Local traffic may be permitted to use completed portions of the cement-modified subbase provided the subbase has hardened sufficiently to prevent marring or damaging of the surface by such usage. After the curing pe-

riod, the subbase may be opened to such traffic that no damage to the subbase or curing coat results. The subgrade shoulders or completed pavement shall be used when available in transporting materials, workers, and equipment throughout the project. Construction equipment will not be permitted on the subbase without the approval of the Engineer, unless it is being used in the subsequent construction operation.

301.19 Maintenance. The Contractor shall be required within the limits of his contract, to maintain the cement modified subbase in good condition until all work has been completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be done by the Contractor without any additional compensation and repeated as often as may be necessary to keep the area continuously intact. Faulty work shall be replaced for the full depth of subbase. The Contractor shall construct the plan depth of cement modification in one homogenous mass. The addition of thin stabilized layers will not be permitted in order to provide the minimum specified depth.

301.20 Method of Measurement. Cement modification of in-place materials will be measured by the square yard of surface area of completed and accepted cement modified subbase. Portland cement at the percentage established by the Research and Materials Laboratory for incorporation in the cement modification will be measured by the ton. Materials placed outside the designated area will not be measured for payment. Portland cement used in excess of 5% of the amount established by the Research and Materials Laboratory will not be measured for payment. The Contractor shall furnish the Engineer with invoices of all cement received.

301.21 Basis of Payment. The work performed and material furnished as prescribed by this item and measured in accordance with the applicable provisions of Subsection 301.20 above will be paid for at the contract unit price for Cement Modified Subbase and Portland Cement for Cement

Modified Subbase, which price and payment shall each be full compensation for preparing the roadbed; furnishing all material; all freight involved; furnishing scales and labor involved in weighing the material; pulverizing and applying cement, water; all processing, mixing, spreading, sprinkling, compacting, finishing, and curing the cement modified subbase; and all manipulations, tools, equipment, fuels, labor, and incidentals necessary to complete the work.

Base that is deficient in thickness will be paid for at the reduced unit price as provided in **Subsection 301.17**.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
3011XXX	Cement Modified Subbase (*(thickness)*" Uniform)	Square Yard
3013000	Portland Cement for Cement Modified Subbase	Ton

SECTION 302

SOIL-AGGREGATE SUBBASE COURSE

302.01 Description. This work shall consist of increasing the strength of the subgrade by the addition of crushed stone, gravel or slag and shall be constructed on a prepared subgrade or other surface in compliance with these specifications and conforming to the lines, grades, dimensions and typical cross-sections shown on the plans, or as directed by the Engineer.

MATERIALS

302.02 Aggregate.

A. Crushed Stone. Crushed stone shall be produced from tough durable stone and shall be free from soft, thin, elongated or laminated pieces, disintegrated particles, vegetable or other deleterious substances. Shale or shale-like aggregates not approved by the Engineer shall not be used. The crushed stone shall meet the grading requirements of Aggregate No. CR-14. When subjected to the Los Angeles Abrasion Test (**AASHTO T 96**) stone shall have an abrasion loss of not more than 65%. Only crushed stone obtained from Department approved sources shall be used.

B. Gravel. Gravel shall be composed of hard durable particles of clean stone, and shall be free from an excess of thin or elongated pieces and vegetable or other deleterious matter. Gravel shall meet the grading requirements of Aggregate No. CR-14. When subjected to the Los Angeles Abrasion Test (AASHTO T 96), gravel shall have an abrasion loss of not more than 65%. Only gravel obtained from Department-approved sources shall be used.

CONSTRUCTION REQUIREMENTS

302.03 Placing, Mixing, and Compacting. The aggregate shall be placed upon the approved subgrade. The spreading shall be accomplished in such a manner that the finished subbase will conform to the rates, lines, grades, dimensions and the typical cross-sections as shown on the plans or as directed by the Engineer. The aggregate subbase material shall then be thoroughly mixed with the subbase or subgrade to the depth specified by the Engineer. During the mixing operation, sufficient water shall be added as necessary to bring the moisture of the mixture to that required for proper compaction.

The mixture of soil and aggregate shall be spread and shaped to a uniform thickness and while at optimum moisture content, shall be consolidated until the aggregates are bonded, and the subbase compacted to at least 95% of the maximum dry density as determined by **AASHTO T 180**. A uniform, dense surface, free from loose material shall be required. Care shall be taken during the shaping and rolling operations to retain the material within the lines specified on the plans. If during the mixing and shaping operations the material becomes segregated, the material shall be re-mixed until a uniform mix is obtained.

The Department reserves the right to increase or decrease the length of road on which the aggregate is to be used from that shown on the plans or stated in the proposal and also to increase or decrease the quantity of materials to be used per square yard. Material used in excess of the authorized amount will not be measured for payment.

302.04 Weight Tickets. The net weight of each load of aggregate and the accumulated net weight of the loads for the day shall be recorded in duplicate upon forms suitable to the Engineer. The weighing shall be performed in accordance with **Subsection 109.01**. With each load of materials delivered to the work, one copy of the weight ticket shall be presented to the Engineer. The tickets delivered to the Engineer shall be included and submitted along with the final construction plans.

At any time during the delivery of material and for the purpose of checking the weighing equipment, the Engineer may direct the Contractor to weigh on tested and approved platform scales, without additional compensation, any truck load that is to be delivered to the work.

302.05 Maintenance. The Contractor will be required to machine, water, roll and perform other operations necessary to condition and preserve the aggregate subbase course until the base is applied.

302.06 Method of Measurement. The quantity of soil aggregate subbase shall be the number of tons of this material as weighed in trucks on approved platform scales and incorporated into the finished work.

No deduction will be made for normal moisture found in the aggregate.

302.07 Basis of Payment. The soil aggregate subbase will be paid for at the contract unit price for Soil Aggregate Subbase, measured as provided in Subsection 302.06 above, which price and payment shall be full compensation for furnishing all materials, handling, weighing, hauling, placing all materials, preparing the subgrade or subbase, watering, mixing, shaping and compacting, as well as furnishing all, tools, equipment, labor, machinery, maintenance, and incidentals necessary to complete the work.

When aggregate meeting the requirements of **Subsection 302.02** is used alone, it shall be paid for at the contract unit price for Aggregate No. CR-14.

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

Payment will be made under:

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

SECTION 303

SAND-CLAY BASE COURSE

303.01 Description. This work shall consist of a sand-clay **base course** composed of approved materials meeting the requirements as specified herein. The base course shall be constructed on the prepared subgrade in accordance with these specifications and in conformity with the typical cross-section shown on the plans and to the lines and grades furnished by the Engineer.

MATERIALS

303.02 Sand-Clay. The material for sand-clay base course shall consist of naturally or artificially proportioned sand clay conforming to the requirements below. Naturally proportioned sand clay is a naturally proportioned soil composed of sand and clay, suitable for the proposed purpose, usually occurring in a layer of considerable depth. Artificially proportioned sand clay is an artificially proportioned combination of sand and clay soil suitable for the proposed purpose. The Contractor shall excavate pit materials and blend them as directed by the Engineer. Where practicable, material pits shall be excavated so that water will not collect nor stand therein.

Sand-clay shall conform to the following requirements:

	Minimum	MAXIMUM
Passing 1 1/2" sieve % by weight	100	--
Material passing # 10 sieve:		
Passing # 10, retained # 60 sieve % by weight	35	80
Silt % by weight	--	10
Clay % by weight	5	23
Material passing # 40 sieve:		
Liquid Limit		28
Plasticity Index		9

303.03 Source of Supply. All material necessary for constructing the sand-clay base course shall be furnished by the Contractor. The Contractor shall be responsible for locating material pits and securing necessary permits for the material pits and haul roads, including permits from railroads, utilities, property owners, and other interested parties. The Contractor shall also be responsible for restoring material pits and haul roads to a condition satisfactory to the property owners after the pits and haul roads are no longer used by the Contractor. Restoration of the pits shall be in accordance with the ***South Carolina Mining Act***.

Sand-clay base course material borrow pits shall be scarified and terraced if determined necessary by the Engineer as soon as practicable after the material is removed. Terracing work shall be accomplished in accordance with the standard practice as recommended by the **U.S. Soil Conservation Service**.

303.04 Bituminous Materials. The Contractor, with the approval of the Engineer, may use MC-30, RC-30, or EA-P Special for priming the base course. The material used shall meet the requirements as specified in **Section 406**.

303.05 Naturally Proportioned Base Material. When a naturally proportioned material meeting the above material requirements has been obtained by the Contractor and approved for use in the project, the material shall be spread on the subgrade to such a depth that when compacted, it will have the thickness and width shown on the plans. Placing, mixing and shaping shall be performed as hereinafter specified.

303.06 Artificially Proportioned Base Material. If a naturally proportioned base material meeting the above requirements is not available within a reasonable haul distance, the Contractor may propose that two classes of approved pit material be used. Materials selected for use in the project and approved by the Engineer shall be proportioned to meet the requirements shown above. The layers shall be spread evenly and mixed until a homogeneous mixture is obtained. Placing, mixing, and shaping shall be performed as hereinafter specified.

303.07 Placing of Material. Base material shall be spread evenly on the approved subgrade that has been prepared as prescribed. If the subgrade is initially approved, but subsequently becomes unstable or unsatisfactory, the Contractor shall make such corrections as are necessary to obtain a satisfactory subgrade without additional compensation. Wetting may be required to recondition a subgrade that has become too dry.

In removing and hauling material from pits, the Contractor shall use care to insure that objectionable material is not mixed with the approved pit material being placed on the road, and the Contractor shall remove any soil containing an excessive amount of such objectionable material.

The placing of base materials shall start at a point farthest from the material pit unless otherwise permitted by the Engi-

neer. Hauling over material previously placed will not be permitted until it has been mixed and shaped as hereinafter required. Hauling over material previously placed will be allowed if the material is to be placed in successive layers or if other conditions make it advisable.

If the base material is dumped on the subgrade in windrows, it shall be spread uniformly over the subgrade not later than the following day, or as soon, as conditions permit.

In case the base course is to be composed of artificially proportioned materials, the materials shall be placed in proper order so that the mixing operation can be prosecuted as hereinafter provided.

If the base course is to have a compacted thickness in excess of 8 inches, it shall be constructed in approximately equal courses not to exceed 8 inches in compacted thickness and each course shall be spread, mixed, shaped and compacted as hereinafter specified.

303.08 Scarifying, Mixing, Re-mixing, Shaping, and Re-shaping. The base course material shall be mixed as soon as practicable after it has been placed on the subgrade. The mixing shall be accomplished by methods that will provide a homogenous mass throughout the width and depth of the base course. The material shall then be shaped immediately to the cross-section and grade shown on the plans. If the base is to be constructed in more that one course, the top inch of the previous course shall be mixed with the next course to ensure an adequate bond between the courses.

Water shall be applied to the base material or the material shall be aerated to provide a moisture content as near the optimum moisture content during mixing and compaction operations as possible.

The Contractor shall remix and reshape all or any part of the base material as many times as may be necessary to

secure a homogeneous mixture of the component material conforming to the requirements of these specifications. If the base course loses its shape, it shall be reshaped as directed, and whenever unsuitable material appears, it shall be removed and replaced with suitable material.

During the process of mixing and shaping, all stones having a dimension greater than 2 1/2 inches, and all roots, sod, weeds, and other deleterious substances shall be removed from the base course.

303.09 Samples and Tests. The sand-clay base course will be sampled promptly by the Engineer after the base course has been mixed, at intervals not to exceed 1000 feet for two lane roads, with at least one sample per road. The samples shall be sent to the Research and Materials Laboratory for tests to determine compliance with gradation and other requirements.

303.10 Application of Prime Coat. When hot mix asphalt or bituminous surface treatment is specified as the subsequent layer on a sand-clay base course, the base course shall be primed in accordance with **Subsection 401.28**. Before placing the prime coat, all irregularities in the base course shall have been repaired. The base course shall have seasoned sufficiently to permit a uniform penetration, and the density of the base course shall have been approved by the Engineer.

When, in the opinion of the Engineer, the bituminous material used to prime the base course may present a hazard to adjacent properties, the prime coat may be deleted from a section of roadway.

The rate of prime shall be from 0.25 to 0.28 gallons per square yard of residual asphalt. The method of application shall be as prescribed in pertinent sections of **Section 406**.

When it is necessary to maintain traffic on a road or a sec-

tion of road before the prime coat has time to sufficiently dry to prevent pickup, the Contractor shall apply sand or some approved granular material as a cover as directed by the Engineer. The cost of furnishing this material and performing this work shall be included in the price of the base course or other items of work and no direct payment will be made.

303.11 Compaction. After mixing and shaping, the base, while at proper moisture, shall be compacted by using suitable construction procedures. The material shall be bladed and rolled until the base has been thoroughly compacted.

When the total compacted thickness of the base course is greater than 8 inches, it shall be placed, mixed and shaped in approximately equal layers. The maximum compacted thickness of any layer shall not exceed 8 inches. When the base course has a total compacted thickness of 8 inches or more, each layer shall be compacted to not less than 100% of the maximum density. Maximum densities for all base thickness will be determined by **AASHTO Method T 99**, **SC-T-25** or **SC-T-29**. Should these tests show that the 100% requirement is not being met, the Contractor will adjust the moisture or his construction operations to obtain the required density.

303.12 Tolerance in Base Thickness. The thickness of the completed base course shall be measured, before surfacing is applied, at staggered intervals not to exceed 250 feet for two lane roads. The depth measurements shall be made by test holes through the base course. Where the base course is deficient by more than 1/2 inch, the Contractor shall correct such areas by scarifying, adding base material and recompacting as directed by the Engineer.

When the base course is paid for on a square yard basis, any measurement that exceeds the specified thickness by more than 1/2 inch shall be considered as the specified thickness plus 1/2 inch. The average of these depth measurements is the average job thickness. When the average thickness is more than 1/4 inch below the specified thickness

and payment is by the square yard, the unit price will be adjusted. This adjusted unit price shall bear the same ratio to the contract unit price as the average thickness bears to the specified thickness.

When the contract includes more than one road, each road shall be considered separately.

303.13 Maintenance. The base course shall be maintained by repeated machining throughout its entire length for such length of time as necessary to provide an adequate base course conforming to the required cross-section, grade, thickness, and proper compaction. Maintenance shall also include the correction of any defects which may develop due to traffic, erosion or other cause; and shall also include watering, machining, rolling and other operations necessary to condition and preserve the base course. Any lack of uniformity in the base course mixture, unevenness in the surface or other irregularities shall be corrected by adding or replacing base materials and re-mixing, reshaping and re-compacting as necessary and required. The base shall be properly drained at all times.

303.14 Method of Measurement. Sand-Clay Base Course will be measured in place and shall be the number of square yards completed and accepted. Material placed outside the area designated shall be disregarded in computing the number of square yards.

Base of variable thickness or bases of thickness for which there is no unit price shall be converted to square yards of equivalent areas of base for which there is a unit price. The conversion shall be based on the base course item that has a thickness nearest the base thickness in question.

Measurement of Prime Coat shall be the number of gallons of residual asphalt applied to the completed and accepted base course.

303.15 Basis of Payment. The quantity of base course, determined as provided above, will be paid for at the contract unit price for Sand-Clay Base Course of the uniform thickness specified. The quantity of bituminous prime material, determined as provided above, will be paid for at the contract unit price for Prime Coat. These prices and payments shall be full compensation for cost of pits and necessary haul roads, clearing and grubbing of pits, excavation, loading, hauling of base course, placing, wetting and compacting the base materials, scarifying, mixing, re-mixing, shaping and reshaping the base course material, priming as directed, and furnishing all tools, equipment, labor, and incidentals necessary to complete the work.

Sand-Clay Base Course that is deficient in thickness will be paid for at the reduced unit price as provided in **Subsection 303.12**.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
30310XX	Sand-Clay Base Course (*(thickness)*" Uniform)	Square Yard
4010005	Prime Coat	Gallon

SECTION 304

COQUINA SHELL BASE COURSE

304.01 Description. This work shall consist of a **base course** composed of coquina shell material constructed on a prepared subgrade in compliance with these specifications and conforming to the lines, grades, dimensions, and cross-

sections shown on the plans or as directed by the Engineer.

MATERIALS

304.02 General Requirements. Coquina shell base course shall be composed of a mixture of aggregated shells, shell fragments and varying amounts of sand and clay obtained from naturally existing deposits.

304.03 Source of Supply. Unless otherwise specified, coquina shell material shall be furnished by the Contractor from pits approved by the Engineer. Samples from each source shall be submitted to the Research and Materials Laboratory for testing thirty (30) days prior to the beginning of any coquina shell base work.

304.04 Coquina Shell Base. Coquina shell base course material shall have a California Bearing Ratio (CBR) of not less than 55 when tested in accordance with **AASHTO T 193** at 100% of **AASHTO T 180** (Method D) density. The material shall have a calcium carbonate equivalent of not less than 45%; however, this requirement may be waived by the Engineer provided the material is determined to be equally suitable for its intended use and complies with the CBR requirement. The coquina shell base course shall also meet the following:

	Min.	**Max**.
Passing 3 1/2 inch sieve, % by weight	100	--
Passing No. 200, sieve % by weight	5	30
Liquid Limit	--	30
Plasticity Index	--	6

The amount passing the No. 200 sieve shall be determined in accordance with **AASHTO T 11**.

304.05 Bituminous Materials. The material for bituminous prime coat shall be MC-30, RC-30, or EA-P Special and shall

meet the requirements as specified in **Section 406** of these specifications.

CONSTRUCTION REQUIREMENTS

304.06 Placing of Material. Coquina shell base course shall be placed on the approved subgrade and uniformly spread in layers not exceeding 8 inches in compacted thickness. The spreading shall be accomplished in such manner that the finished base will conform to the lines, grades, dimensions, and the typical cross-sections as shown on the plans or as directed by the Engineer. Care shall be taken to prevent segregation of the fine from the coarse particles during placing and spreading. All areas of segregation shall be corrected by the Contractor. The Contractor shall insure that objectionable material and debris is removed and not mixed with the coquina shell base course material.

Should the subgrade become unstable after the base course has been placed, the affected section shall be repaired by removing the base course material and the unsatisfactory subgrade material. The unsatisfactory material shall be replaced with suitable material that shall be re-compacted and re-shaped. The base course shall be replaced to the required cross-section, grade, and required compaction.

304.07 Mixing and Shaping. After the base material has been placed and spread, it shall be mixed, while at proper moisture content, with proper equipment to provide a homogeneous mass throughout the width and depth of the base course. The coquina shell base course shall then be shaped to the specified grade and cross-section. All particles of material having a dimension greater than 3 1/2 inches shall be removed during mixing and shaping operations.

304.08 Compaction. After mixing and shaping, the base course shall be compacted by suitable construction procedures. Each layer of material shall be rolled while as near **optimum moisture content** as possible until the base has

been thoroughly compacted. Rolling shall continue until the base is thoroughly bonded. The final rolling shall be performed with pneumatic-tired rollers and shall continue until the entire base course is compacted to not less than 100% of maximum laboratory density as determined by **AASHTO T 180** (Method D).

304.09 Tolerance in Base Course Thickness. The thickness of the completed base course shall be measured at staggered intervals not exceeding 250 feet for two lane roads. The measured thickness shall not be less than 1/2 inch from the specified thickness. Deficient areas shall be corrected by the Contractor by scarifying, adding base material and recompacting as directed by the Engineer. Measured thickness in excess of 1/2 inch greater than specified thickness shall be considered as specified thickness plus 1/2 inch. The average thickness shall be the average of the depth measurements determined as specified above. When the average thickness is more than 1/4 inch below the specified thickness, the unit price will be adjusted. This adjusted unit price shall bear the same ratio to the contract unit price as the average thickness bears to the specified thickness. When the contract includes more than one road, each road shall be considered separately.

304.10 Samples and Test. Each layer of the base course shall be sampled and tested by the Engineer at intervals not to exceed 1000 feet for two lane roads, with at least one sample per road. The base course shall be promptly sampled after it has been mixed and laid down but before initial compaction, operations have begun. The material shall be sampled by taking three portions for the full depth of the layer, one on the center and one approximately 2 feet from each edge of the base course.

Samples will be sent to the Research and Materials Laboratory.

304.11 Application of Prime Coat. When hot mix asphalt or a bituminous surface treatment is specified as the subsequent layer on a Coquina Base Course, the base course shall be primed in accordance with **Subsection 401.28**. Before placing the prime coat, all irregularities in the base course shall have been repaired, the base course shall have seasoned sufficiently to permit a uniform penetration, and the density of the base course shall have been approved by the Engineer.

When, in the opinion of the Engineer, the bituminous material used to prime the base course may present a hazard to adjacent properties, the prime coat may be deleted from a section of roadway.

Prime shall be applied as prescribed in pertinent sections of **Section 406** with residual asphalt at a rate of 0.25 to 0.28 gallons per square yard.

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

304.12 Maintenance. The Contractor shall be responsible for maintaining the coquina shell base course. Maintenance shall include correction of any defects that may develop due to traffic, erosion or other causes, providing proper drainage and any other operations necessary to preserve the base course.

304.13 Method of Measurement. Coquina shell base course will be measured in place and shall be the number of square yards completed and accepted. Material placed outside the area designated shall be disregarded in computing

the number of square yards.

Measurement of Prime Coat shall be the number of gallons of residual asphalt applied to the completed and accepted base course.

304.14 Basis of Payment. The quantity of base course, determined as provided in **Subsection 304.13**, will be paid for at the contract unit price for Coquina Shell Base Course. The quantity of bituminous prime material, determined as provided **Subsection 304.13**, will be paid for at the contract unit price for Prime Coat. These prices and payments shall be full compensation for furnishing, hauling, placing, mixing, compacting, and priming as directed and shall include all materials, as specified, tools, equipment, labor, maintenance, and incidentals necessary to complete the work.

Base course that is deficient in thickness will be paid for at the reduced unit price as provided in **Subsection 304.09**.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
30411XX	Coquina Shell Base Course ((*thickness*)" Uniform)	Square Yard
4010005	Prime Coat	Gallon

SECTION 305

GRADED AGGREGATE BASE COURSE

305.01 Description. This work shall consist of a graded aggregate base course composed of materials as described below, placed on a prepared foundation, mixed, shaped,

compacted, and primed (when directed), all in accordance with these specifications. The **base course** shall conform to the lines, grades, dimensions and cross-sections shown on the plans or as directed by the Engineer.

When the contract specifies a graded aggregate base course, the Contractor, at his/her option, may bid on one of the following alternates listed below. The Contractor must state which alternate is being selected in the bid documents.

1 - Macadam Base Course
2 - Marine Limestone Base Course
3 - Recycled Portland Cement Concrete Base Course

Marine limestone aggregate is generally found in the coastal plains of the state and is defined as any limestone aggregate not meeting the classification of dolomitic limestone. Fossiliferous limestone aggregate and recrystallized limestone aggregate are considered marine limestone aggregate.

MATERIALS

305.02 General Requirements.

A. Macadam Base Course. The **base course** materials shall be composed of crushed stone filled and bound with screenings. The aggregate shall be free from vegetable matter, sand, lumps or balls of clay, or other deleterious matter.

B. Marine Limestone Base Course. The limestone **base course** materials shall be produced from a single source or deposit that will yield a satisfactory mixture conforming to all requirements of these specifications. Limestone base course shall not contain clay, sand, organics, or other materials in sufficient quantity as to be considered detrimental to the proper bonding, finishing, or strength of the base course.

C. Recycled Portland Cement Concrete Base Course. The aggregate in the **base course** shall consist of coarse aggregate of crushed, graded, recycled portland cement concrete mixed together with sand, sand-gravel, soil or other approved materials having similar characteristics, combined as necessary to give a mixture conforming to the requirements hereinafter prescribed.

The aggregate shall be free from lumps or balls of clay or other objectionable matter and shall not contain metals, wood, brick, plastics, or other unacceptable debris.

When Recycled Portland Cement Concrete Base Course is selected by the contractor, the source shall be inspected, sampled and tested, and approved by the Engineer before any material is used in the work. A minimum of four weeks should be allowed for this sampling, testing, and approval.

305.03 Coarse Aggregate. The material retained on the No. 4 sieve shall be known as coarse aggregate and shall consist of hard durable particles of aggregate and shall be reasonably free from thin or elongated pieces, disintegrated particles, vegetable matter, or other deleterious substances. The coarse aggregate shall have an abrasion loss of not more than 65% when subjected to the Los Angeles Abrasion Test (**AASHTO T 96**).

a. Coarse aggregate for Macadam Base Course shall consist of hard, durable particles of crushed slag or stone, excluding marine limestone. The aggregate shall be free from vegetable matter, sand, lumps or balls of clay, or other deleterious matter.

Crushed slag used in Macadam Base Course, when dry and rodded, shall not weigh less than 70 pounds per cubic foot and shall consist of angular fragments, reasonably uniform in density and quality, and reasonably free from glassy, thin, elongated pieces, dirt, or other objectionable material.

b. Coarse aggregate for Marine Limestone Base Course shall consist of sound, durable particles of marine limestone aggregate.

c. Coarse aggregate for Recycled Portland Cement Concrete Base Course shall consist of sound, durable particles of recycled portland cement concrete aggregate, excluding crushed concrete block or pipe.

305.04 Fine Aggregate. The material passing the No. 4 sieve shall be known as fine aggregate or binder material subject to the following requirements:

1. Fine Aggregate for Macadam Base Course shall consist of material produced by crushing operations excluding marine limestone.

2. Fine Aggregate for Marine Limestone Base Course shall consist of marine limestone produced by the mining or crushing operation. No sand will be permitted as fine aggregate.

3. Fine Aggregate for Recycled Portland Cement Concrete Base Course shall consist of material produced by the crushing operation, sand, soil, or other acceptable material, and shall be obtained from sources approved by the Engineer.

305.05 Composite Mixture. After the base course materials have been spread on the subgrade, mixed, and shaped, but prior to the beginning of compaction operations, the composite mixture shall meet the following requirements:

A. Macadam Base Course:

Sieve Designation	Percentage by Weight Passing
2"	100
1 1/2"	95 – 100
1"	70 – 100
1/2"	48 – 75
No. 4	30 – 50
No. 30	11 – 30
No. 200*	0 – 12
Liquid Limit	25 Max.
Plasticity Index	6 Max.

*The amount passing the No. 200 sieve shall be determined by **AASHTO T 11**.

B. Marine Limestone Base Course:

Sieve Designation	Percentage by Weight Passing
2"	100
1 1/2"	95 – 100
1"	70 – 100
1/2"	50 – 85
No. 4	30 – 60
No. 30	17 – 38
No. 200*	0 – 20
Liquid Limit	25 Max.
Plasticity Index	6 Max.

*The amount passing the No. 200 sieve shall be determined by **AASHTO T 11**.

C. Recycled Portland Cement Concrete Base Course:

Sieve Designation	Percentage by Weight Passing
2"	100
1 1/2"	95 - 100
1"	70 - 100
1/2"	48 - 75
No. 4	30 - 50
No. 30	11 - 30
No. 200*	0 - 12
Liquid Limit	25 Max.
Plasticity Index	6 Max.

*The amount passing the No. 200 sieve shall be determined by **AASHTO T 11**.

305.06 Bituminous Materials. The Contractor, with the approval of the Engineer, may use MC-30, RC-30, or EA-P Special for priming the **base course**. The material used shall meet the requirements as specified in **Section 406**.

CONSTRUCTION REQUIREMENTS

305.07 Equipment. A steel wheel roller capable of developing a pressure of 250 to 350 pounds per inch of roller width in the compression wheel shall be required. Other rollers may consist of self-propelled or tractor drawn pneumatic tired rollers, or vibratory rollers. A combination of the above rollers may be necessary to produce a finished product that complies with these specifications.

305.08 Preparation of Subgrade. The **subgrade** for the graded aggregate base course shall be constructed in accordance with the requirements as specified in **Section 208**. The subgrade shall be rolled and compacted for at least 500 feet ahead of the placing of base course materials where practicable.

The shoulders shall be constructed in accordance with the requirements of **Section 209** and accurately trimmed to the alignment and grade of the base course so as to form a trench or channeled section as prescribed on the plans.

305.09 Placing of Base Course Material. The base course material may be delivered to the project with the necessary fines already included. Fines may be added if necessary to obtain the desired density and stability; however, the final gradation shall meet the requirements shown in **Subsection 305.04**.

The base course aggregate shall be placed on the prepared roadbed. The spreading shall be accomplished in such a manner that the finished base course will conform to the lines grades, dimensions, and the typical cross-sections as shown on the plans or as directed by the Engineer.

When the required compacted thickness is 8 inches or less, the base course may be constructed in one layer. Where the required thickness is more than 8 inches, the base course shall be constructed in two or more layers of approximately equal thickness, the maximum compacted thickness of any one layer not to exceed 8 inches. Each layer shall be constructed and compacted as specified herein before the succeeding layer is placed.

Care shall be taken to prevent segregation of the fine from the coarse aggregates during the handling, spreading or shaping of the materials. All areas of segregated coarse or fine material shall be corrected.

Should the subgrade become unstable after the base course has been placed, the affected section shall be repaired. The base course material and unsatisfactory subgrade material shall be removed and replaced with approved subgrade material. The subgrade shall be re-constructed to the required compaction and shape and then the base course replaced at the required cross-section, grade, and compaction.

305.10 Compaction, Rolling, and Finishing. After the base course material is spread, it shall be continually machined with motor graders or other suitable equipment, main-

taining the required section until the base course is thoroughly compacted. Each layer shall be compacted by the use of equipment as specified in **Subsection 305.07**. Should the subgrade become unstable after the base course has been placed, the affected section shall be repaired. After removing the base course material and the unsatisfactory subgrade material, suitable subgrade material shall be placed at the required compaction and shape, and then the base course material replaced to the required cross-section, grade and compaction.

Rolling of the base course shall start at the edge and proceed toward the center except on superelevated curves where rolling shall proceed from the lower to the upper side. On areas not accessible for the operation of standard rollers, compaction shall be performed by approved rollers. Rolling shall continue until the layer is satisfactorily compacted for the full width and depth. Wetting of the base course will be required when necessary. Rolling shall extend over the edges of each layer of base course materials for a distance of 2 feet on the shoulders. Blading and rolling shall continue until a dense, smooth, unyielding and well-bonded base course is obtained.

If initial compaction has been performed and the voids have not been filled, fine aggregate shall be placed upon the base course in an amount only sufficient to fill the voids. The base course shall be broomed, wetted and rolled until the coarse aggregate is firmly set, bonded, and the base course thoroughly compacted for the full width and depth. When the total compacted thickness of the graded aggregate base course is 8 inches or more, the material shall be placed in layers as specified in **Subsection 305.09**. Each layer of the macadam base course while near optimum moisture shall be compacted with equipment capable of obtaining the required density to the full depth. The rolling shall continue until the entire base course is compacted to not less than 100% of maximum laboratory density as determined by **AASHTO T 180** (Method D).

The in-place density and moisture content of the graded aggregate base course shall be determined with a nuclear moisture-density gauge or by other approved means.

On shoulder work or other applicable construction, steel wheel rollers will not be permitted upon the finished pavement except at locations necessary for turning around. During all phases of the work, extreme care shall be taken to protect structures.

305.11 Smoothness Test. The finished surface of the base course shall not vary more than 3/8 inch from a straightedge 10 feet long when applied parallel to the centerline of the roadway nor more than 1/2 inch from the typical cross-section shown on the plans. Any surface irregularities that exceed the above limitations shall be corrected.

305.12 Tolerance in Thickness. The thickness of the completed base course shall be measured at staggered intervals not to exceed 250 feet for two-lane roads. The depth measurements shall be made by test holes through the base course. Where the base course is deficient by more than 1/2 inch, the Contractor shall correct such areas by scarifying, adding base course material and re-compacting as directed by the Engineer.

When the base course is paid for on a square yard basis, any measurement that exceeds the specified thickness by more than 1/2 inch shall be considered as the specified thickness plus 1/2 inch. The average of these depth measurements is the Average Job Thickness. When the average thickness is more than 1/4 inch below the specified thickness and payment is by the square yard, the unit price will be adjusted. This adjusted unit price shall bear the same ratio to the contract unit price as the average thickness bears to the specified thickness. When the contract includes more than one road, each road shall be considered separately.

305.13 Samples and Tests. Each layer of graded aggregate base course shall be sampled and tested by the Engineer at intervals not to exceed 1000 feet for two lane roads,

with at least one test per road. The base course shall be sampled promptly after it has been mixed and laid down but before initial compaction operations have begun. The material shall be sampled by taking three portions for the full depth of the layer, one on the center and one approximately 2 feet from each edge of the base course. Samples will be sent to the Research and Materials Laboratory for tests to determine compliance with gradation and other specified requirements.

305.14 Application of Prime Coat. When a hot mix asphalt or a bituminous surface treatment is specified as the subsequent layer on a Graded Aggregate Base Course, the base course shall be primed in accordance with **Subsection 401.28**. Before placing the prime coat, all irregularities in the base course shall have been repaired, the base course shall have seasoned sufficiently to permit a uniform penetration, and the density of the base course shall have been approved by the Engineer. The base course shall be cleaned of all mud, dirt, dust, and caked or loose material of any description by brooming, blowing, or other methods so as to expose the coarse aggregate in the base course.

When, in the opinion of the Engineer, the bituminous material used to prime the base course may present a hazard to adjacent properties the prime coat may be deleted from a section of roadway.

The rate of application of the prime coat material shall be as follows:

Base Course Material	Application Rate in Gallons per Square Yard of residual asphalt (gal/yd^2)
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

The method of application shall be as prescribed in perti-

nent portions of **Section 406**.

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

305.15 Weight Tickets. When the base course is measured by the ton, the requirements set forth in **Subsection 302.04** regarding weight tickets shall apply in all respects.

305.16 Maintenance. The Contractor will be required to machine the base course as often as is necessary to maintain it smooth and true to grade and cross-section, and to prevent raveling by the application of water as may be required to keep the base course tightly bound until the prime is applied. Any defects that develop shall be repaired.

305.17 Method of Measurement. Graded Aggregate Base Course will be measured as the pay unit called for in the contract.

When paid for by the square yard, the quantity of Graded Aggregate Base Course shall be the number of square yards of base course completed, accepted, and measured in place. Material placed outside the area designated shall be disregarded in computing the number of square yards.

Variable thickness base courses of or base courses of thickness for which there is no contract unit price shall be converted to square yards of equivalent areas of base course for which there is a contract unit price. The conversion shall be based on the base course whose thickness is nearest that of the base course in question.

When paid for by the ton, the quantity for Graded Aggre-

gate Base Course shall be the number of tons, including water contained in the delivered base course material, weighed on approved scales and actually incorporated in the completed and accepted work.

Deductions shall be made for the base course wasted or lost due to the negligence of the Contractor; base course applied in excess of the rate specified or directed in writing; and for any material applied beyond the limits of the work. Should the visual inspection indicate excessive moisture in the base course, a deduction shall be made for the weight of water applied in excess of 2% above optimum moisture as determined by the Engineer.

Measurement for Prime Coat of shall be the number of gallons of residual asphalt applied to the completed and accepted base course.

305.18 Basis of Payment. The quantity of graded aggregate base course, determined as provided above, will be paid for at the contract unit price for Graded Aggregate Base Course. The quantity of prime coat, determined as provided above, will be paid for at the contract unit price for Prime Coat. The above prices and payments shall be full compensation for furnishing, mixing, addition of water, hauling, placing and compacting of all materials, priming as directed, and includes all labor, equipment, tools, maintenance, and incidentals necessary to complete the work.

Base course paid for on a square yard basis and is deficient in thickness will be paid for at the reduced unit price as provided in **Subsection 305.12**.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
30501XX	Graded Aggregate Base Course (*(thickness)*" Uniform)	Square Yard
3050199	Graded Aggregate Base Course	Ton
4010005	Prime Coat	Gallon

SECTION 306

(RESERVED)

SECTION 307

CEMENT STABILIZED EARTH BASE COURSE

307.01 Description. This work shall consist of the construction of a **base course** composed of a combination of local soil and portland cement uniformly mixed, moistened, compacted and shaped, and the applying of a curing coat in accordance with these specifications. The completed base course shall conform to the typical cross-section shown on the plans and to the lines and grades furnished by the Engineer.

MATERIALS

307.02 Portland Cement. Portland cement shall conform to the requirements of **Subsection 701.02** of these specifications except that the allowable maximum alkali content ($Na_2O+0.658K_2O$) is increased to 1.0%.

307.03 Water. Water shall meet the requirements as specified in **Subsection 701.12**.

307.04 Soil. The soil for the cement stabilized earth base course shall consist of natural material in the roadbed, hauled in material or a combination of these materials proportioned as directed. Hauled-in material shall meet the requirements for Sand-Clay in **Section 303**, unless otherwise provided. Unless otherwise specified in the proposal, the Contractor shall furnish all soil and no payment for overhaul or for purchase of the soil will be made. The soil shall be free of roots, sod, weeds, or other deleterious materials. Samples shall be submitted to the Research and Materials Laboratory for approval of materials and for determining the correct cement content at least thirty (30) days prior to beginning construction of the cement stabilized earth base course.

307.05 Bituminous Material. The material for the bituminous curing coat shall be MC-30, RC-30 RS-2, CRS-2, or EA-P Special and shall meet the requirements as set forth for bituminous materials in **Section 406**.

CONSTRUCTION REQUIREMENTS

307.06 Weather Limitations. No cement shall be applied unless the temperature is above 40°F in the shade and rising. The work shall not be performed on a frozen or excessively wet subgrade.

307.07 Preparation of the Existing Roadbed. Before any stabilizing operations are started, the existing roadway shall be graded and shaped to conform to the lines, grades and

cross-sections required. Additional soil needed shall be placed as the Engineer may direct and any unsuitable material shall be removed and replaced with suitable material.

The subgrade shall be firm and shall support the construction equipment without displacement. The subgrade must be compacted as specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

When the stationary plant method of mixing is specified, the subgrade shall be constructed in accordance with the requirements of **Section 208**.

307.08 Conditioning of Base Course Materials. The base course materials shall be pulverized so that at the completion of the moist mixing, 100%, by dry weight, passes the 1 1/2 inch sieve, and a minimum of 80% passes the No. 4 sieve exclusive of gravel and stone retained on the sieve.

During mixing operations, the moisture content of the soil shall not exceed the amount that will permit a uniform and intimate mixture of the soil and cement. It shall not exceed the optimum moisture content of the mixture by more than two percentage points.

307.09 Mixing and Placing Materials. Unless otherwise provided, the base course shall be mixed by the stationary plant method. The road mix method may be used when so specified in the proposal form. The quantity of portland cement to be added to the soil will be a percentage by weight of the dry soil and shall be at the rate directed by the Engineer with the tolerance hereinafter specified.

A. Stationary Plant Method. The soil, cement, and water shall be mixed in a pugmill, either of the batch or continuous-flow type. The plant shall be equipped with feeding and metering devices that will add soil, cement, and water into the mixer in the specified quantities. In all plants, the weight or rate of feed of the cement shall be

within 5% of the amount designated by the Engineer. Mixing shall continue until a uniform, homogeneous mixture is obtained. The Engineer may increase the mixing time when necessary to secure a proper blend of the different materials.

The mixture shall be hauled to the roadway in trucks with protective covers. The mixture shall be placed on a moist subgrade in a uniform layer by an approved spreader. The layers shall be of such contour and thickness that the completed base course will conform to the required grade and cross-section. Dumping of the mixture in piles or windrows will not be permitted.

Not more than thirty (30) minutes shall elapse between the placement of the base course mixture in adjacent lanes except at longitudinal construction joints. Not more than sixty (60) minutes shall elapse between the start of moist mixing and the start of compaction.

B. Road Mix Method. Before the application of portland cement, the roadway to be stabilized shall be loosened and pulverized to the required base course width and to sufficient depth to give the compacted thickness shown on the plans. The loosened soil then shall be shaped to the approximate line and grade shown on the plans.

Portland cement shall be spread over the loosened roadway at the rate established by the Research and Materials Laboratory. This rate will be established in the laboratory using samples representative of the material to be stabilized.

The cement shall be spread with equipment that can be calibrated and adjusted so that the established rate will be attained uniformly throughout the length and width of the roadway.

The spreading equipment shall have adjustable open-

ings or gate headers and will not be solely dependent on vehicle speed to obtain the required spread rate. A tolerance of ±5% will be allowed in the spread rate for individual sections of roadway; however, adjustments should be made in order to keep the actual spread rate as close as possible to that established by the Research and Materials Laboratory. Equipment other than that used in the spreading and mixing will not be allowed to pass over the freshly spread cement.

Immediately after the cement is spread, it shall be mixed with the loosened soil for the full depth of the stabilization. Care must be exercised to avoid mixing below the desired depth. Mixing shall be accomplished by the use of an approved road mixing machine. Disc harrows, road graders, and other equipment may only be used to supplement the mixing done by the approved road mixer. Sufficient passes of the mixing equipment shall be made to insure a homogeneous mixture that is uniform in appearance.

The moisture content of the soil and cement mixture shall be determined upon completion of the mixing operation and, if required, water shall be added as directed. Water supply and distribution equipment shall be available that will permit the continuous application within three (3) hours of all the water required on the section of base course being processed. The water shall be added into the mix in such a manner as to avoid a concentration of water near the surface.

After all necessary water has been added, mixing shall be continued until the water is uniformly distributed throughout the base course. Particular care shall be exercised to insure satisfactory moisture distribution along the edges of the section. When the moist mixing is complete, the percentage of moisture in the mixture shall not be below or more than two percentage points above the specified optimum moisture. In no case shall the moist mixture

be allowed to remain undisturbed for more than thirty (30) minutes before compaction is started.

307.10 Compaction. Before the beginning of the compaction, the mixture shall be in a loose condition for its full depth and then shall be uniformly compacted. Compaction shall continue until the entire depth of the base course mixture is uniformly compacted to not less than 95% of the maximum density. The maximum density of the composite mix shall be determined by **AASHTO T 134**, **SC-T-25** or **SC-T-29**. Should tests show that the 95% requirement is not being met, the Contractor shall adjust his construction operations to obtain the required density. Compaction work shall be completed within a period of two (2) hours from the initial rolling.

After the mixture is compacted, the surface of the base course shall be reshaped as necessary to conform to the required lines, grades, and cross-section. Light scarifying may be required to obtain a uniform surface and prevent scaling.

The surface shall be thoroughly compacted and finished by rolling with an approved smooth wheel tandem roller, pneumatic-tired roller or other means satisfactory to the Engineer. Rolling shall be supplemented by broom dragging when required. The compacting and finishing shall be done in such a manner as to produce a smooth, closely knit surface, free from equipment imprints, cracks, ridges or loose material. The moisture content of the surface material shall be maintained within two percentage points of the specified optimum moisture content during finishing operations.

307.11 Construction Joints. At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face. The base course for large wide areas shall be built in a series of parallel lanes of convenient length and width meeting the approval of the Engineer. Straight longitudinal joints shall be formed at the edge of each day's construction by cutting back into the completed work to form a

true vertical face free of loose or shattered materials.

307.12 Construction Limitations. The area over which the cement or soil and cement mixture is spread shall be limited in order that all operations specified in **Subsections 307.09 and 307.10** can be continuous and all work completed within daylight hours, unless adequate artificial light is provided and within six (6) hours after the application of water to the soil and cement mixture when scarifying is required, otherwise all work shall be completed within three (3) hours.

If operations are interrupted for a continuous period of greater than two (2) hours after the cement has been mixed with the soil, the entire section thus affected shall be reconstructed in accordance with these specifications. When the uncompacted mixture of soil and cement is wetted so that the moisture content exceeds that specified, it may be manipulated and aerated to reduce the moisture to the specified content, provided the base course can be completed within the time limits of these specifications.

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

307.14 Surface Smoothness. The finished surface of the base course shall not vary more than 3/8 inch from a straight edge 10 feet long when applied parallel to the centerline of the road, nor more than 1/2 inch from the typical cross-section shown on the plans.

The finished surface of the base course shall not be disturbed after the final finishing and compaction. The removal of random knots will not be permitted after the base course has hardened. Where low areas or depressions result in the finished surface of the base course, the same material that the base course is to receive as the next component of the pavement structure shall be used in truing-up the finished surface, except in cases when the same material is considered unsatisfactory, the Engineer may specify the material to be used. Such corrective work and materials shall be performed by the Contractor without any additional compensation.

307.15 Tolerance in Base Course Thickness. The thickness of the completed base course shall be measured at staggered intervals not to exceed 250 feet in length for two-lane roads. The depth measurements shall be made by test holes through the base course. Where the base course is deficient by more than 1/2 inch, the Contractor shall correct such areas. Where the measured thickness is more than 1/2 inch thicker than shown on the plans, it shall be considered as the specified thickness, plus 1/2 inch. The average job thickness shall be the average of the depth measurements determined as specified above. Should this average thickness be more than 1/4 inch below the specified thickness, an adjusted unit price shall be used in payment. This adjusted unit price shall bear the same ratio to the contract unit price as the average thickness bears to the specified thickness.

When the contract includes more than one road, each road shall be considered separately.

307.16 Curing Coat. After the base course has hardened, but not later than twelve (12) hours after the completion of finishing operations, a bituminous curing coat, as specified in **Subsection 307.05**, shall be applied at a rate of 0.15 to 0.20

gallons per square yard of residual asphalt. The finished soil-

cement shall be kept continuously moist until the curing coat is applied. At the time the bituminous material is applied, the base course surface shall be dense, free of all loose and extraneous material and shall contain sufficient moisture to prevent penetration by the bituminous material.

The Engineer may, at his discretion, depending upon temperature and weather conditions, permit the application of the curing coat, on base course that is placed and completed during the latter portion of a day, to be deferred until the early part of the following day.

307.17 Opening to Traffic. Unless otherwise directed by the Engineer, the Contractor shall furnish such personnel and barricades along with other devices necessary to prevent construction equipment or other traffic, regardless of the type vehicle or its reason for being on the project, from using the finished base course. The subgrade shoulders or completed pavement, when available, shall be used in transporting materials, men and equipment throughout the length of the project. The finished base course may be crossed at locations designated by the Engineer after the seven (7) day curing period. Such designated crossing shall be covered with at least 8 inches of earth as protection of the completed base course. When the paving operation is commenced, the completed section of the base course may be opened to light construction equipment for a distance not to exceed 1000 feet in advance of the paving work after the seven day curing period has elapsed. When necessary to provide for normal traffic, the Engineer may permit use of the base course for such purposes. Should the bituminous material for the curing coat not be sufficiently dry to prevent pickup when the base course is opened to traffic as outlined above, a granular cover shall be applied before opening.

307.18 Maintenance. The Contractor shall maintain the entire base course, during and after the curing period, within the limits of his contract, in a good and satisfactory condition from the time he first starts work until the work is completed and

accepted. Maintenance shall include the immediate repairs of any defects that may develop. Should any repairs or patching be necessary, they shall extend to the full depth of the base course and shall be made in a manner that will insure the restoration to a uniform and durable base course.

307.19 Method of Measurement.

A. Cement Stabilized Earth Base Course. Cement Stabilized Earth Base Course, complete in place with curing coat and accepted, will be measured by the square yard along the surface of the base course. Materials placed outside the designated area will not be measured for payment.

When the contract does not contain a unit price for a thickness of base course, the base course for which there is no unit price shall be converted to equivalent square yards of base course for which there is a contract unit price. The conversion shall be based on the base course whose thickness is nearest that of the base course in question.

B. Portland Cement for Cement Stabilized Earth Base Course. The quantity of portland cement shall be the number of tons of portland cement accepted and used in the work. Portland cement used in excess of 5% of the amount specified will not be measured for payment.

The quantity of portland cement will be determined by scale weights or by delivered weights. The Contractor shall furnish the Engineer invoices of all cement received.

When the stationary plant method of mixing is used, the quantity of portland cement may be determined by calculating the weight of the composite mix using the actual dry density of the mix for a given area, the depth of the base course specified in the plans, constructed within the tolerance specified in **Subsection 307.15** and the per-

cent cement placed in the mix not in excess of 5% of the amount specified.

C. Unstable Material. Any unsuitable soil removed and replaced and any additional soil required for the base course in accordance with **Subsection 307.07** shall be measured in accordance with **Section 203**.

307.20 Basis of Payment.

A. Cement Stabilized Earth Base Course. The base course measured as provided in **Subsection 307.19A** will be paid for at the contract unit price for Cement Stabilized Earth Base Course with curing, which price and payment shall be full compensation for furnishing all materials (except portland cement), tools, equipment, labor, maintenance, and incidentals necessary to complete the work described.

Base course that is deficient in thickness will be paid for at the reduced unit price as provided in **Subsection 307.15**.

B. Portland Cement for Cement Stabilized Earth Base Course. Portland cement measured as provided in **Subsection 307.19B** will be paid for at the contract unit price for Portland Cement for Cement Stabilized Earth Base Course, which price and payment shall be full compensation for the material accepted and used in the work as described in this Section.

C. Unclassified Excavation. Any unsuitable soil removed and replaced and any additional soil required and measured in accordance with **Subsection 307.19C** will be paid for at the contract unit price for Unclassified Excavation.

Payment for each item includes all direct and indirect

costs or expenses required to complete the work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
30710XX	Cement Stabilized Earth Base Course (*(thickness)*" Uniform)	Square Yard
3072000	Portland Cement for Cement Stabilized Earth Base Course	Ton

SECTION 308

CEMENT STABILIZED AGGREGATE BASE COURSE

308.01 Description. This work shall consist of the construction of a **base course** composed of aggregates and portland cement uniformly mixed, moistened, shaped, and compacted, and application of a curing coat in accordance with these specifications. The completed base shall conform to the typical cross-section shown on the plans and to the lines and grades furnished by the Engineer.

MATERIALS

308.02 Portland Cement. Portland cement shall meet the requirements as specified in **Subsection 701.02** of these specifications except that the allowable maximum alkali content ($Na_2O+0.658K_2O$) is increased to 1.0%.

308.03 Water. Water shall meet the requirements as specified in **Section 701.12**.

308.04 Aggregate. The aggregate shall meet the requirements of macadam base course or marine limestone as specified in **Section 305**. Samples shall be submitted to the Research and Materials Laboratory for approval of materials and for determining the correct cement content at least thirty

(30) days before beginning the operations.

308.05 Bituminous Material. The material for the bituminous curing coat shall be MC-30, RC-30, RS-2, CRS-2, or EA-P Special and shall meet the requirements as set forth for bituminous materials in **Section 406**.

CONSTRUCTION REQUIREMENTS

308.06 Weather Limitations. No cement shall be applied unless the temperature is above 40°F in the shade and rising. The work shall not be performed on a frozen or excessively wet subgrade.

308.07 Preparation of Subgrade. The subgrade for the cement stabilized aggregate base course shall be constructed in accordance with the requirements set forth in **Section 208**. The subgrade shall be completed at least 500 feet ahead of the placing of base course materials where practicable. The shoulders, when included on the plans, shall be constructed in accordance with the requirements of **Section 209**, and accurately trimmed to the alignment and grade of the base course so as to form a trench or channeled section as prescribed on the plans.

308.08 Mixing and Placing Materials. Unless otherwise provided, the base course shall be mixed by the stationary plant method. The quantity of portland cement to be added to the aggregate will be between 2.5% and 5.0% by weight of the surface dry aggregate and shall be at the rate as directed by the Engineer with the tolerance hereinafter specified.

The aggregate, portland cement, and water shall be mixed in a pugmill, either of the batch or continuous-flow type. The plant shall be equipped with feeding and metering devices that will add aggregate, cement, and water into the mixer in the specified quantities. In all plants, the weight or rate of feed of the cement shall be within 5% of the amount designated by the Engineer. Mixing shall continue until a uniform

homogeneous mixture is obtained. The mixing time may be increased by the Engineer when necessary to secure a proper blend of the materials.

The mixture shall be hauled to the roadway in trucks with protective covers. The mixture shall be placed on a moist subgrade in a uniform layer by an approved spreader. The layers shall be of such contour and thickness that the completed base course will conform to the required grade and cross-section. Dumping of the mixture in piles or windrows will not be permitted.

Not more than thirty (30) minutes shall elapse between the placement of the base course mixture in adjacent lanes except at longitudinal construction joints. Not more than sixty (60) minutes shall elapse between the start of moist mixing and the start of compaction.

308.09 Compaction. Before beginning compaction, the mixture shall be in a loose condition for its full depth and then shall be uniformly compacted to not less than 98% of the maximum laboratory density obtained according to **AASHTO T 180** (Method D). The in-place density and moisture content may be determined with a nuclear moisture-density gauge. If necessary, the gauge will be calibrated for moisture content at the beginning of the work and at any time during the work.

The Contractor shall have sufficient vibratory rollers, smooth wheel tandem rollers, three-wheel rollers, pneumatic tired rollers, or other means of obtaining compaction that is satisfactory to the Engineer. The equipment shall be in good working order and the rate of operation shall be sufficient to compact uniformly the specified width and depth of the base course being processed within a period of two hours. The compacting and finishing shall be done in such a manner as to produce a uniform dense mass, free from cracks, ridges or loose material. The moisture content of the surface material shall be maintained within two percentage points of the speci-

fied optimum moisture content during finishing operations.

308.10 Construction Joints. At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face. The base course for large wide areas shall be built in a series of parallel lanes of convenient length and width meeting the approval of the Engineer. Straight longitudinal joints shall be formed 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.

308.11 Construction Limitations. The area over which the cement aggregate mixture is spread shall be limited in order that all operations specified in **Subsections 308.08 and 308.09** can be continuous and all work completed within daylight hours, unless adequate artificial light is provided. All work shall be completed within three (3) hours after the application of water to the aggregate and cement mixture, unless a longer period is approved by the Engineer.

If operations are interrupted for a continuous period of greater than two (2) hours after the cement has been mixed with the aggregate, the entire section thus affected shall be reconstructed in accordance with these specifications. When the uncompacted mixture of aggregate and cement is wetted so that the moisture content exceeds that specified, it may be manipulated and aerated to reduce the moisture to the specified content, provided the base course can be completed within the time limits of these specifications.

308.12 Reconstruction. If the construction of the base course is proceeding with the approval of the Engineer and the uncompacted aggregate and cement mixture is wetted by rain so that the moisture exceeds the allowable, the Contractor will be paid for the additional cement used in reconstructing the section and no additional payment will be made for aggregate, mixing, shaping, and compacting. If the reconstruction of any section is made necessary by the negligence

or omission of the Contractor or unsatisfactory performance of his equipment, or, if any section does not comply with the allowable variation in thickness, the Contractor will be required to reconstruct the section without additional compensation.

308.13 Surface Smoothness. The finished surface of the base course shall not vary more than 3/8 inch from a straight edge 10 feet long when applied parallel to the centerline of the road, nor more than 1/2 inch from the typical cross-section shown on the plans.

The finished surface of the base course shall not be disturbed after the final finishing and compaction. The removal of random knots will not be permitted after the base course has hardened. Where low areas or depressions result in the finished surface of the base course, the same material which the base course is to receive as the next component of the pavement structure shall be used in truing up the finished surface. The Contractor shall furnish the materials and perform this corrective work without additional compensation.

308.14 Tolerance in Base Course Thickness. The thickness of the completed base course shall be measured at staggered intervals not to exceed 250 feet in length for two-lane roads. The depth measurements shall be made by test holes through the base course. Where the base course is deficient by more than 1/2 inch, the Contractor shall correct such areas. Where the measured thickness is more than 1/2 inch thicker than shown on the plans, it shall be considered as the specified thickness, plus 1/2 inch. The average job thickness shall be the average of the depth measurements determined as specified above. Should this average thickness be more than 1/4 inch below the specified thickness, an adjusted unit price shall be used in payment. This adjusted unit price shall bear the same ratio to the contract unit price as the average thickness bears to the specified thickness.

When the contract includes more than one road, each

road shall be considered separately.

308.15 Curing Coat. After the base course has hardened, but not later than twelve (12) hours after the completion of finishing operations, a bituminous curing coat of 0.20 to 0.25 gallons per square yard of residual asphalt shall be applied as specified in **Section 406**. The finished base course shall be kept continuously moist until the curing coat is applied. At the time the bituminous material is applied, the base course surface shall be dense, free of all loose and extraneous material and shall contain sufficient moisture to prevent penetration of the bituminous material.

Depending upon temperature and weather conditions and at his discretion, the Engineer may permit the application of the curing coat for a base course placed and completed during the latter portion of a day to be deferred until the early part of the following day.

308.16 Opening to Traffic. Unless otherwise directed by the Engineer, the Contractor shall furnish such guards, flagmen, barricades along with other devices necessary to prevent construction equipment or other traffic, regardless of the type vehicle or its reason for being on the project, from using the finished base course. The subgrade shoulders, or completed pavement when available, shall be used in transporting materials, men and equipment throughout the length of the project. The finished base course may be crossed at locations designated by the Engineer after the seven (7) day curing period. Such designated crossing shall be covered with at least 3 inches of screenings or sand as protection of the completed base course. When the paving operation is commenced, the completed section of the base course may be opened to light construction equipment for a distance not to exceed 1000 feet in advance of the paving work after the seven (7) day curing period has elapsed. When necessary to

provide for normal traffic, the Engineer may permit use of the base course for such purposes. If the bituminous curing coat

has not sufficiently dried to prevent pickup when the base course is opened to traffic as outlined above, a granular cover shall be applied before opening.

308.17 Maintenance. The Contractor shall be required within the limits of his contract to maintain the cement stabilized aggregate base course in good condition until all work has been completed and accepted. Maintenance shall include the immediate repairs of any defects that may develop. Should any repairs or patching be necessary, they shall extend to the full depth of the base course and shall be made in a manner that will insure the restoration to a uniform and durable base course.

308.18 Method of Measurement.

A. Cement Stabilized Aggregate Base Course. Cement Stabilized Aggregate Base Course, complete in place with curing coat and accepted, will be measured by the square yard along the surface of the road. Materials placed outside the designated area will not be measured for payment.

When the contract does not contain a unit price for a thickness of base course, the base course for which there is no contract unit price shall be converted to equivalent square yards of base course for which there is a contract unit price. The conversion shall be based on the base course that has a thickness nearest to that of the base course thickness in question.

B. Portland Cement for Cement Stabilized Aggregate Base Course. The quantity for Portland Cement for Cement Stabilized Aggregate Base Course shall be the number of tons of portland cement accepted and used in the work. Portland cement used in excess of 5% of the amount specified will not be measured for payment.

The measurement of portland cement will be by scale

weights or by delivered weights. The Contractor shall furnish the Engineer invoices of all cement received.

C. Aggregate. The Contractor shall furnish all aggregate and no payment for the aggregate or haul will be made.

308.19 Basis of Payment.

A. Cement Stabilized Aggregate Base Course. The base course measured as provided in **Subsection 308.18A** above will be paid for at the contract unit price for Cement Stabilized Aggregate Base Course with curing coat, which price and payment shall be full compensation for furnishing all materials (except portland cement), tools, equipment, labor, maintenance, and incidentals necessary to complete the work.

Base course that is deficient in thickness will be paid for at the reduced unit price as provided in **Subsection 308.14**.

B. Portland Cement for Cement Stabilized Aggregate Base Course. Portland cement, measured as provided in **Subsection 308.18B**, will be paid for at the contract unit price for Portland Cement for Cement Stabilized Aggregate Base Course, which price and payment shall be full compensation for the material accepted and used in the work as described in this Section.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
30810XX	Cement Stabilized Aggregate Base Course (*(thickness)*" Uniform)	Square Yard
3082000	Portland Cement for Cement Stabilized Aggregate Base Course	Ton

SECTION 309

HOT MIX SAND ASPHALT BASE COURSE

309.01 Description. This work shall consist of the construction of a Hot Mix Sand Asphalt Base Course composed of fine aggregate and asphalt binder, properly mixed in a hot mix asphalt approved plant and constructed on a prepared **subgrade**, **base course** or other surface, and applying a tack coat when specified, all in accordance with these specifications and conforming to the lines, grades, dimensions, compacted thickness and typical cross-sections shown on the plans or as otherwise specified.

MATERIALS

309.02 Asphalt Binder. The asphalt binder shall meet the requirements of **Subsection 401.02**. The performance grade shall be PG64-22 unless otherwise specified.

309.03 Aggregate. The aggregate material shall be composed of local sand or local sand containing crushed shell, blends of sand and stone, slag or limestone screenings or other approved materials.

A. Sand. Sand shall consist of hard, sharp, angular grains of quartz or other durable rock, free from excessive quantities of clay or other deleterious substances and shall contain not more than 10% total material passing the No. 200 sieve with a maximum of 6% clay, except as provided below. Material passing the No. 200 sieve will be determined by **SC-T-5**. The percent clay will be determined by **SC-T-34**. Clay contained in the sand must be uniformly dispersed throughout the sand and the sand must be free of clay balls. Sand shall be so excavated, blended and stockpiled that a uniform product will be obtained. When sands are blended, one of the sands may contain minus No. 200 material slightly in excess of 10%; however, the composite blend shall not exceed 10% total material passing the No. 200 sieve as stated above.

B. Screenings. Screening shall consist of hard, sharp, angular grains of durable materials produced from stone, slag or gravel meeting the quality requirements of coarse aggregate as specified in **Subsection 401.03D**. When 15% or less screenings are used in a mix, the screenings shall not contain more than 35% passing the No. 200 sieve as determined by SC-T-5. When more than 15% screenings are used in a mix, the screenings shall contain not more than 15% passing the No. 200 sieve as determined by SC-T-5. Screenings containing an excessive amount of flaky, micaceous or other injurious particles shall not be used. Regular screenings shall not have a sand equivalent less than 40. Limestone screenings and fines contained in a crusher-run material produced from limestone material shall have a sand equivalent not less than 28.

In order to determine compliance with the material requirements, the Engineer may sample the aggregate at any point before its introduction into the dryer. The aggregate shall be obtained from pits or sources furnished by the Contractor and the aggregate shall all pass a 1/2 inch sieve with a minimum of 90% of the material passing the No. 4 sieve.

At least thirty (30) days before the beginning of any base course work, the Contractor shall obtain samples (using good sampling methods) of the aggregate to be used in the construction of the base course. The local material will be submitted to the Research and Materials Laboratory at Columbia. Laboratory analysis and tests will be made to determine the suitability of the aggregate and the percentage of asphalt binder to be used.

Excavation from pits shall be so conducted that a homogeneous material of uniform appearance will be produced. When more than one material is used, the materials shall be kept separate until blended from gates at the cold elevator feeders.

309.04 Composition of Mixture. The constituents of the base course shall be combined in such proportions that, after mixing, the resultant mixture will be homogeneous and all particles coated with asphalt binder. Hydrated lime shall be required in all base courses as an anti-stripping additive.

The Contractor shall apply the quantity of asphalt binder to the dry aggregate necessary to provide a completed mixture, compacted in place, meeting the requirements specified below:

	Type 1	**Type 2**
Asphalt Binder, % of Total Mixture	3.8-5.2	3.8-5.2
Minimum Marshall Stability, lbs.	300	500

The exact percentage of asphalt binder to be contained in the mixture will be set between the above limits after labora-

tory tests have been made. The above composition limits are not master ranges of tolerance for asphalt binder content. Permitted tolerances for asphalt binder content are outlined in the document entitled ***Control and Acceptance of Hot Mix Asphalt Mixtures***. This document may be obtained from the Engineer.

The Engineer may direct that the quantity of asphalt material be increased or decreased from the limits specified above in order to secure a more stable mixture.

EQUIPMENT

309.05 Equipment. The requirements provided in **Section 401** shall apply to Hot Mix Sand Asphalt Base Course.

CONSTRUCTION REQUIREMENTS

309.06 General. The requirements provided in **Section 401** shall apply to Hot Mix Sand Asphalt Base Course except as modified herein.

The material shall be permitted to be placed in one hot bin.

The compaction of the Hot Mix Sand Asphalt Base Course shall be accomplished by any combination of approved rollers while the mixture is still at a temperature that will result in maximum density. Under normal conditions, the initial rolling shall be done with the tandem roller or a vibratory roller, provided the vibratory mechanism is disengaged.

309.07 Preparation of Subgrade. Before the placing of the Hot Mix Sand Asphalt Base Course, the subgrade shall be prepared in accordance with the requirements as specified in **Section 208**.

309.08 Tolerance in Base Course Thickness. Where the plans require a uniform thickness of the Hot Mix Sand Asphalt

Base Course and the contract provides for payment on a square yard basis, the thickness of the base course will be determined from measurements taken of the completed base course at intervals not exceeding 500 feet for two lane roads. Where the base course is deficient by more than 1/2 inch, the Contractor shall correct such areas. Where the measured thickness exceeds the specified thickness by more than 1/2 inch, this thickness shall be considered as the specified thickness plus 1/2 inch. The average thickness shall be the average of the depth measurements determined as specified above. When the average thickness is more than 1/4 inch below plan thickness, an adjusted unit price shall be used in payment, which price shall bear the same ratio to the contract unit price as the average thickness of the base course bears to the thickness specified. When the contract includes more than one road, each road shall be considered separately.

No additional payment over the contract unit price will be made for any base course where the average thickness, determined as herein provided, exceeds the specified thickness.

309.09 Application of Tack Coat. When multiple lifts of Sand Asphalt Base Course are required, a tack coat shall be applied conforming to the requirements of **Subsection 401.28**. No direct payment will be made for the necessary tack coat.

309.10 Method of Measurement.

A. Hot Mix Sand Asphalt Base Course. Hot Mix Sand Asphalt Base Course will be measured by the pay unit called for in the contract.

When paid for by the square yard, the quantity of Hot Mix Sand Asphalt Base Course shall be the number of square yards of base course completed, accepted, and measured in place. Material placed outside the area designated shall be disregarded in computing the number of square yards.

Base course of variable thickness used to make proper connections with existing pavements or thickness of mixture for which there is no unit price shall be converted to square yards of equivalent areas of mixtures for which there is a contract unit price. The conversion shall be based on the base course that has a thickness nearest to that of the base course in question.

When paid for by the ton, Hot Mix Sand Asphalt Base Course shall be measured in accordance with **Subsection 401.38**.

B. Liquid Asphalt Binder. When the base course is measured and paid for by the ton, Liquid Asphalt Binder shall be measured by the ton in accordance with **Subsection 401.38**.

No measurement for payment will be made of the Liquid Asphalt Binder when the base course is paid for on a square yard basis except when the quantity of asphalt binder is increased or decreased from the limits as specified in **Subsection 309.04**. The increase or decrease in asphalt binder used shall be the difference in tons between the quantity specified in **Subsection 309.04** and the quantity actually in place in the compacted base course in accordance with written instructions of the Engineer.

309.11 Basis of Payment.

A. Hot Mix Sand Asphalt Base Course. Base course measured as provided in **Subsection 309.10A**, will be paid for at the contract unit price for Hot Mix Sand Asphalt Base Course of the type specified, which price and payment shall be full compensation for furnishing the material pits, clearing and grubbing material pits, excavating, hauling and furnishing all material excluding the asphalt cement in paving mixture and for all, labor, equipment, tools,

maintenance, and incidentals necessary to complete the work as specified.

Base course that is deficient in thickness will be paid for at the reduced unit price as provided in **Subsection 309.08**.

B. Liquid Asphalt Binder. Asphalt binder of the grade specified in the contract, measured as provided in **Subsection 309.10B**, will be paid for at the contract unit price for Liquid Asphalt Binder PG 64-22, which price shall be full compensation for furnishing, hauling, storing, heating, transporting, and placing in the mixture; and including all, tools, equipment, labor, and incidentals necessary to complete the work as specified.

Payment for the increase or deduction for the decrease in the asphalt binder authorized in writing by the Engineer and determined as provided in **Subsection 309.10B**, will be made at the delivered cash price to the Contractor. Payment will not be allowed for asphalt binder used in excess of that authorized in writing by the Engineer.

C. Excavation. All work and costs incidental to the preparation of the subgrade shall be included in the contract unit price for Hot Mix Sand Asphalt Base Course, except that where shown on the plans, such work shall be paid for as Unclassified Excavation.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
30910XX	Hot Mix Sand Asphalt Base Course Type 1 (*(thickness)*" Uniform)	Square Yard
3091100	Hot Mix Sand Asphalt Base Course Type 1	Ton
30920XX	Hot Mix Sand Asphalt Base Course Type 2 (*(thickness)*" Uniform)	Square Yard
3092100	Hot Mix Sand Asphalt Base Course Type 2	Ton
4011004	Liquid Asphalt Binder PG 64-22	Ton

SECTION 310

HOT MIX ASPHALT AGGREGATE BASE COURSE

310.01 Description. This work shall consist of the construction of a Hot Mix Asphalt Aggregate Base Course composed of crushed stone, crushed slag or gravel and asphalt binder mixed in an approved plant and constructed on a prepared **subgrade**, **base course**, or other surfaces and applying a tack coat when specified, all in accordance with these specifications and conforming to the lines, grades, dimensions, thickness, and typical cross-sections shown on the plans or as otherwise specified.

MATERIALS

310.02 Asphalt Binder. Asphalt binder shall meet the requirements of **Subsection 401.02**. The performance grade shall be PG64-22 unless otherwise specified.

310.03 Aggregates. The aggregate material shall conform

to the requirements of **Subsection 401.03**. When Hot Mix Asphalt Aggregate Base Course Type 1 is specified, coarse aggregate shall consist of crushed stone and fine aggregate shall consist of screenings. Hydrated lime shall be required in all base courses as an anti-stripping additive.

310.04 Composition of Mixture. The coarse and fine aggregate shall be combined with asphalt binder in such proportions that the composition by weight of the aggregate shall be within the limits specified below:

Sieve Designation	Percentage by Weight Passing
1 1/2 Inch	100
1 Inch	85-100
1/2 Inch	60-80
No. 4	40-55
No. 8	30-45

The percent of asphalt binder in the total mixture will usually be from 3.5% to 5.5%. The coarse and fine aggregates shall be submitted to the Research and Materials Laboratory in Columbia to determine the exact asphalt binder content to be used in the Hot Mix Asphalt Aggregate Base Course.

The asphalt binder content shall be maintained between ±0.6% of the determined amount.

EQUIPMENT

310.05 Equipment. The equipment requirements specified in **Section 401,** Equipment shall apply to Hot Mix Asphalt Aggregate Base Course.

CONSTRUCTION REQUIREMENTS

310.06 Construction Requirements. The requirements specified in **Subsections 401.15 through 401.37** shall apply to Hot Mix Asphalt Aggregate Base Course.

310.07 Method of Measurements and Basis of Payment. This work will be measured and paid for as specified in **Sub-sections 401.38** and **401.39**.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
310XXXX	Hot Mix Asphalt Aggregate Base Course Type (*1 or 2*)	Ton
4011004	Liquid Asphalt Binder PG64-22	Ton

DIVISION 400

BITUMINOUS PAVEMENTS

SECTION 401

HOT MIXED ASPHALT PAVEMENT

401.01 Description. This work covers the general requirements that are applicable to all types of hot mixed asphalt for base courses, intermediate courses, and surface courses, irrespective of gradation of mineral aggregates or the kind, type, and amount of asphalt binder and additives.

The base, intermediate or surface course shall consist of one or more courses of asphalt coated mineral aggregates constructed on the prepared surface in accordance with these specifications and the specific requirements of the type under contract. The courses shall conform to the required lines, dimensions, thickness and typical cross-section or specified rate of application.

MATERIALS

401.02 Asphalt Binder and Additives. Asphalt binder (asphalt cement) shall conform to all the requirements of **AASHTO MP 1** and shall be PG64-22 unless otherwise specified.

A. Liquid Anti-Stripping Agent. Any liquid anti-stripping agents or other additives that are required shall be approved by the Engineer before their use.

Liquid anti-stripping additive shall be thoroughly blended in line between the asphalt binder storage tank and the point of discharge from the asphalt binder supply line. Blending shall be accomplished by means of a static

spiral pipe line mixer or by other approved devices. The anti-stripping additive delivery system shall be approved by the Engineer.

The liquid anti-stripping additive shall be controlled by a proportioning device that shall be accurate to within ±15% of the amount required. The proportioning device shall have a convenient and accurate means of calibration. The proportioning device shall be interlocked with the asphalt binder feed system so as to maintain the correct proportions for all rates of production and batch sizes and to insure that all mixtures produced are properly treated with anti-stripping additive. Flow indicators or sensing devices for the anti-stripping additive shall be provided and interlocked with the plant controls so that mixture production will be interrupted if introduction of the anti-stripping additive fails. A meter displaying the accumulative number of gallons of anti-stripping additive used in the asphalt mixture shall be located between the anti-stripping additive storage tank and the point the anti-stripping additive is blended in-line with the liquid asphalt. The meter shall be easily accessible to the Engineer.

B. Hydrated Lime. When hydrated lime is used as an asphalt anti-stripping additive, it shall conform to the requirements of **AASHTO M 303**, Type 1.

401.03 Aggregates.

A. Mineral Aggregate. The mineral aggregate shall be composed of fine aggregate or a combination of coarse and fine aggregate. The gradation requirements for coarse and fine aggregates are specified in the tables entitled **Gradation of Coarse Aggregates** and **Gradation of Fine Aggregates** located in the Appendix of these specifications. The blending shall be done through separate bins at the cold elevator feeders and not in the stockpile. Coarse aggregate shall be that portion of the total aggregate retained on a No. 4 sieve and fine aggregate shall be considered that portion passing a No. 4 sieve.

When crusher-run material is used, it will not be necessary that it be screened before entering the cold feed bin. The fine aggregate, coarse aggregate, and any additives in combination with the specified percentage of asphalt binder shall meet the requirements of tests specified before approval may be given for their individual use. The combined effective specific gravity of aggregates in any mix shall not be greater than 2.90. The use of marine (fossiliferous) limestone shall be restricted for surface courses as outlined in **Section 403**. Fine and coarse chrome slag aggregate shall not be used in Surface Types 1C, 1B, and 1.

B. Mineral Filler. Mineral filler shall conform to the requirements of **AASHTO M 17**.

C. Fine Aggregate. The fine aggregate shall consist of sand, stone, slag, gravel, screenings, or a combination of sand and screenings. Fine aggregate shall be uniformly graded from coarse to fine, shall be free of lumps of clay, loam or other foreign matter, and shall not have a coating of injurious material. The Engineer will sample the stockpiled materials at the plant site in order to insure compliance with the requirements.

1. Sand. Sand shall consist of hard, sharp, angular grains of quartz or other durable rock, free from excessive quantities of clay or other deleterious substances and shall contain not more than 10% total material passing the No. 200 sieve with a maximum of 6% clay, except as provided below. Material passing the No. 200 sieve will be determined by **SC-T-5**. The percent clay will be determined by **SC-T-34**. Clay contained in the sand must be uniformly dispersed throughout the sand and the sand must be free of clay balls. Sand shall be so excavated, blended, and stockpiled that a uniform product will be obtained. When sands are blended, one of the sands may contain not greater than 12% minus No. 200 material; however, the composite blend shall not exceed 10%

total material passing the No. 200 sieve as stated above.

2. Screenings. Screening shall consist of hard, sharp, angular grains of durable materials produced from stone, slag or gravel meeting the quality requirements of coarse aggregate as specified in **Subsection 401.03D**. When 15% or less screenings are used in a mix, the screenings shall not contain more than 35% passing the No. 200 sieve as determined by **SC-T-5**. When more than 15% screenings are used in a mix, the screenings shall contain not more than 15% passing the No. 200 sieve as determined by SC-T-5. Screenings containing an excessive amount of flaky, micaceous or other injurious particles shall not be used. Regular screenings shall not have a sand equivalent less than 40 in accordance to **AASHTO T 176**. Marine limestone screenings and fines contained in a crusher-run material produced from marine limestone material shall have a sand equivalent not less than 28.

D. Coarse Aggregate. Coarse aggregate shall consist of clean, washed, tough, durable particles of crushed stone, gravel or approved crushed slag and shall be free from an excess of soft or laminated pieces, disintegrated particles and vegetable or other deleterious substances and free from aggregate coated with soil or other objectionable matter. Dry slag shall have a weight of not less than 75 pounds per cubic foot.

Crushed stone or gravel shall have an abrasion loss of not more than 60% when subjected to the Los Angeles Abrasion Test (AASHTO T 96). Slag shall have an abrasion loss of not more than 45% when subjected to AASHTO T 96.

Crushed coarse aggregate shall have 2 or more freshly mechanically induced fractured faces on at least 70%, based on count, of the material retained of the No. 4

sieve, and not more that 10% flat and elongated particles based on a 5:1 ratio.

Crushed aggregate used in Surface Types 1C and 1B on interstate projects will have an abrasion loss of not more that 55% when subjected to the Los Angeles Abrasion Test (AASHTO T 96).

When coarse aggregates used in Surface Types 1C, 1B, 1, and 3 are subjected to 5 alternations of the Sodium Sulfate Soundness Test (**AASHTO T 104**), the weight loss shall not exceed 15%.

When used in Hot Mix Asphalt (HMA) Courses, steel slag shall be crushed to the desired gradation and kept in a controlled, continuously saturated stockpile for a minimum of six (6) months prior to use. No additional material shall be added to this stockpile during this time.

Before use in an HMA mixture, the stockpiled material shall be tested for expansion following the **SC-T-89** procedure titled *Evaluation of Potential Expansion of Steel Slag.* At the completion of the curing period, the material tested shall have an average total volumetric expansion of less than 0.05% when subjected to the SC-T-89 procedure. Stockpiles not meeting the expansion criterion shall be allowed to cure for an additional two (2) months minimum before re-testing.

When the stockpiled material has been aged, and is to be included in an HMA mix design, the Contractor shall present a certification to the Engineer, along with the mix design for verification, stating that the material has been cured according to specification. A stockpile number will be assigned to the stockpile after receiving certification from the Contractor. Steel slag used by the Contractor for mix designs shall be aged in accordance with this specification.

E. Crusher-Run Material. Crusher-run material to be used in asphalt mixtures shall be produced from areas in

the quarry that will not allow the possibility of intrusion of overburden, dirt, sap rock, or any other deleterious material.

The process for manufacturing the crusher-run material and the quality control program for controlling production shall be approved by the Engineer. The manufacturing process shall be such that a consistent gradation is maintained and this consistent gradation must be verified by quality control test performed by the producer on a daily basis. All test results will be made available to the Engineer upon request.

The coarse aggregate in the crusher-run material shall be free of clay coatings or other harmful films. The fines in the crusher-run shall meet the quality requirements specified for screenings including the sand equivalent requirement. Crusher-run material will not be required to be screened before entering the cold feed bin(s) provided a uniform mixture is being produced. If segregation of the finished mixture is evident, the crusher-run material may be required to be screened into a coarse and a fine size before entering the cold feed bin(s).

Hot Mix Asphalt Aggregate Base Types 1 and 2, Binder Types 1 and 2, and Surface Type 3 shall not contain more than 50% crusher-run material. Crusher-run material will not be permitted in Hot Mix Asphalt Surface Course Types 1C, 1B, and 1.

F. Recycled Asphalt Pavement (RAP). When so stated, reclaimed asphalt pavement will be allowed for use in hot mix asphalt pavements.

The RAP will be milled material from Department projects. Stockpiles of RAP material shall be separated by project and a sign satisfactory to the Engineer shall be erected and maintained by the Contractor on each stockpile to identify the source(s).

The Contractor shall maintain at the plant site a record system for all RAP stockpiles. These records shall contain, but not be limited to, the following:

1. Stockpile identification.

2. Sketch of all stockpile areas at the plant site.

3. RAP source (project, state route, road, or street name.)

4. Dates milled and approximate number of tons in the stockpile.

5. All extraction test results.

The RAP stockpile records shall be available to the Engineer at the plant site. The Department reserves the right to reject, by visual inspection, any stockpiles that are not kept clean and free of foreign materials.

Extraction tests shall be performed at a rate of one per 1000 tons of RAP, with a minimum of 3 per stockpile.

The RAP shall be processed in such a manner that all particles will pass a 2 inch screen before entering the plant and shall be free of foreign matter or other contamination and shall be uniformly graded. RAP particles retained on the 2 inch screen may be re-crushed in such a manner that will not result in further degradation of the aggregates.

The range of RAP in recycled hot mix asphalt mixtures is as follows:

Type Mix	% RAP*
Asphalt Aggregate Base Types 1 & 2	10 - 30
Binder Types 1 & 2 and Surface Types 3 & 4	10 - 25
Surface Type 1	10 - 20

* RAP is limited to 15% maximum when introduced in the hot elevator.

Reclaimed asphalt material will not be allowed in Superpave mixes or Surface Types 1B and 1C.

G. Crushed Glass. Crushed glass is permitted for use as an aggregate in Asphalt Aggregate Base Types 1 and 2 and Binder Types 1 and 2. When used in these mixes, crushed glass shall be limited to a maximum of 15% by weight of total aggregate. The crushed glass shall be processed to meet the following limits:

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

The recycled glass shall be free of organic and toxic materials, hypodermic needles and any hazardous materials, and must meet **South Carolina DHEC** regulations as a non-hazardous material. The lead content for the glass aggregate shall not exceed 5 ppm and the silver content shall not exceed 5 ppm. The aggregate shall also meet the limits established by the EPA for the primary and secondary drinking water standards. The glass aggregate shall contain not more that 1% by weight of the non-glassy materials and shall not contain any portion from mirror glass.

When the stockpiled material is to be included in an HMA mix design, the Contractor shall present a certification to the Engineer, along with the mix design for verification, stating that the material meets specification. A stockpile number will be assigned to the stockpile after receiving certification

from the Contractor.

401.04 Composition of Mixture.

A. Submission of Materials and Job Mix Formula. All Marshall and Superpave asphalt mix designs shall be designed by the Contractor and approved by the Department's **Research and Materials Laboratory** in Columbia, South Carolina. The mix designs shall be prepared in a laboratory approved by the Engineer. Technicians designing Marshall mixes shall be certified as a Level 2, Marshall Method of Mix Design technician. A Level 2S, Superpave Mix Design technician shall design Superpave mixes. The Contractor is responsible for providing a mix with the appropriate materials that will comply with all specifications.

The job mix formula shall indicate a single definite percentage of aggregate passing each required sieve and a single definite percentage of asphalt binder to be contained in the mixture. This percentage of asphalt binder shall be the percentage recovered by **SC-T-64**, *Field Method of Determining Binder Content and Sieve Analysis of Asphalt Hot Mixtures*, or **SC-T-75**, *Determination of Asphalt Binder Content for Asphalt Paving Mixtures by the Ignition Oven,* and will not include any asphalt binder that may be absorbed in the aggregates. If an anti-stripping agent or other additives are required, the percent of each to be incorporated in the mixture shall also be indicated in the job mix formula.

The Engineer may make adjustments in the job mix formula submitted by the Contractor and, if so, will advise the Contractor of the job mix formula to be used.

No work shall be started nor any mixture accepted until the Contractor has submitted in writing and received the Engineer's approval of his intended source of materials and his job mix formulas for the mixture(s) he proposes to furnish.

A job mix formula will not be required for Sand Asphalt Base Courses or for Asphalt Aggregate Base Courses. However, the asphalt content for each mixture will be verified by the Engineer.

B. Gradation Test Methods. The gradation of Asphalt Aggregate Base Courses, Type 1 and 2, and the No. 8 sieve and above for Hot Mix Asphalt Binder Courses, Type 1 and 2, will be determined by **SC-T-63**, *Basket Method of Determining Gradation of Coarse Asphaltic Mix*. The gradation for sieves below the No. 8 will be determined by **SC-T-64**, *Field Method of Determining Binder Content and Sieve Analysis of Asphalt Hot Mixtures*. The gradation of Surface Course Types 1C, 1B, 1, and 3 shall be determined using SC-T-64.

If **SC-T-75**, *Determination of Asphalt Binder Content for Asphalt Paving Mixtures by the Ignition Oven*, is used to determine the asphalt binder content, **SC-T-76**, *Determination of Washed Aggregate Gradation of Hot Mix Asphalt Extracted Aggregates*, will be used to determine the aggregate gradation for all sieves.

C. Tolerances. The tolerances for mixtures are contained in the document entitled **Control and Acceptance of Hot Mix Asphalt Mixtures.** This document may be obtained from the Engineer.

D. Moisture Susceptibility. Hot Mix Asphalt Binder Types 1 and 2 and Surface Types 1C, 1B, 1, and 3 shall be subjected to the indirect tensile strength test during the mix design and during actual production of the mix. The test shall be conducted in accordance with **SC-T-70** entitled *Laboratory Determination of Moisture Susceptibility Based on Retained Strength of Asphalt Concrete Mixtures*. A copy of SC-T-70 is available from the Engineer upon request.

Hot Mix Asphalt Binder Types 1 and 2 and Surface

Types 1C, 1B, 1, and 3 shall have a minimum wet conditioned strength of 65 psi and a minimum tensile strength ratio of 85% during mix design.

Contractors shall resubmit asphalt job mix request for mixtures that do not meet minimum wet conditioned strength and/or minimum tensile strength ratio requirements.

Cores may be molded in the field anytime during construction to determine the moisture susceptibility of an asphalt mix. Hot mix asphalt produced through a plant shall have a minimum wet conditioned strength of 60 psi and a minimum tensile strength ratio of 80%.

E. Dust to Asphalt Ratio. The dust to asphalt ratio for Binder Types 1 and 2 and Surface Types 1C, 1B, 1, 3, and 4 shall be in the limits of 0.60 to 1.20. The dust to asphalt ratio is defined as the percentage of material passing the No. 200 sieve divided by the percentage of asphalt binder. The total amount passing the No. 200 sieve on mix designs will be determined by **AASHTO T 11** and **AASHTO T 27**. The amount passing the No. 200 sieve in the field will be determined by **SC-T-64** or **SC-T-76**.

F. Wash Gradations. During mix designs, wash gradations on coarse and fine aggregates will be used to determine the combined blend of aggregates in the total mixture. Aggregate washed gradations will be determined by **AASHTO T 11** and **AASHTO T 27**. Contractors shall submit washed gradations on **Lab Form 269** when requesting a job mix formula.

G. Aggregate Selection. The Contractor shall use a combination of aggregates so that mix adjustments can be readily performed to correct mix design and field problems related to air voids, dust to asphalt ratio, and gradation. It is recommended that at least 3 uniformly graded aggregated types be used to compose an asphalt mix design: fine, intermediate, and coarse aggregates.

401.05 Mix and Pavement Samples. Samples of the mixture in use will be taken and tested as many times daily as deemed necessary by the Engineer and the mixture must be maintained uniform throughout the project within the applicable tolerances.

The Contractor shall furnish samples of asphalt paving mixtures for testing from trucks at the asphalt plant site, trucks at the roadway site, or samples may be cut from the completed pavement structure. The areas of pavement so removed shall be replaced with new mixture and refinished. No additional compensation will be allowed for furnishing test samples and replacing the areas with new mixtures.

EQUIPMENT

401.06 General. The method employed in performing the work and all equipment, plants, machinery, tools, etc., used in handling the materials and performing any part of the work shall be subject to the approval of the Engineer before work is started, and, when found unsatisfactory, shall be changed and/or improved as required. All equipment, tools, machinery and plants used must be maintained in a satisfactory working condition.

401.07 Mixing Plants. Plants shall be either the batch mixing type or the drum mixing type and shall be so designed, equipped and operated that the weighing, proportioning and mixing of the materials will result in a uniform and satisfactory asphalt mixture meeting the requirements of these specifications. The plant site shall have sufficient storage space for separate stockpiles, bins, or stalls for each size of aggregate. The different sizes shall be kept separated until they have been delivered, without segregation, by the feeder or feeders to the boot of the cold elevator or elevators in their proper proportions. The storage yard shall be maintained neat and orderly and separate stockpiles shall be readily accessible for sampling. Separate dry storage of adequate capacity shall be provided for mineral filler when used.

Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed construction. All mixing plants shall comply with the requirements contained in **AASHTO M 156** with the following modifications:

1. Section 4.1 of AASHTO M 156 shall be deleted and the following substituted:

Plant screens capable of screening all aggregates to the specified sizes and proportions and having normal capacities slightly more than the full capacity of the mixer shall be provided. The screen over the fine bin shall be a No. 6 square or a No. 6 slotted screen. The selection of the other screen sizes shall meet the approval of the Engineer and shall be made so that in screening the remainder of the aggregate, approximate equal proportions will be delivered to each bin insofar as is practicable. A scalping screen will be required to remove oversize aggregates, sticks, roots, or lumps.

2. Batching Plants. Section 6.7, *Automation of Batching*, and Section 6.8, *Recording of Batching*, shall apply.

3. Drum Mixing Plants. The drum mixing plant shall be equipped so that asphalt binder, aggregate, and a total of asphalt binder and aggregate in tons per hour will be printed on a ticket at a time interval prescribed by the Engineer.

401.08 Hydrated Lime Systems. Hydrated lime systems shall be controlled by a proportioning device, which shall be accurate to within plus or minus 10% of the amount required. The lime proportioning system shall consist of a continuous feeder system, which will proportion the flow rate of lime by actual weight. The lime weighing and feeding system shall be controlled by a positive weighing system. The system shall have the ability to continuously monitor the flow rate of dry aggregate in tons per hour. The system shall automati-

cally adjust the flow of lime for any change in dry aggregate flow rate. Volumetrically controlled lime feeder systems will not be allowed.

The moisture content of the damp aggregate shall be entered into the control and the system shall provide a dry aggregate tons per hour signal to control the lime feed.

The control system shall display the following:

1. Percent moisture in the total aggregate.

2. Tons per hour of dry aggregate.

3. Tons per hour or pounds per minute of lime.

The display output shall be from actual continuous scale readings.

The system shall have high and low out of tolerance sensing ability by weight. The system shall sound a horn if the lime is not feeding or if the flow rate of lime is out of tolerance. The horn shall be audible in the plant control room, field lab and at any location at the plant site. There shall be a simple and convenient means of stopping the flow of lime near the silo, so that the monitoring system can be checked when the Engineer deems necessary.

The Contractor shall provide a convenient means to divert the flow of lime from the feeder to an outside sample container to check the lime calibration. Instead of diverting lime from the feeders, the weighing system may be verified in accordance with **SC-T-78**. All the necessary equipment for checking the lime calibration shall be provided by the Contractor and shall remain at the plant site.

A water spray delivery system shall be available to dampen the aggregates. This system shall consist of a spray bar mounted over the cold feed gathering conveyor before adding the hydrated lime. The water spray delivery system

shall not be mounted over the aggregate belt conveyor equipment with the weigh monitoring system. All virgin aggregates being fed to the plant shall pass under the spray bar. The spray bar shall have a minimum of 3 spray nozzles equally spaced across the width of the conveyor belt.

Blending of the lime with the aggregates shall be accomplished by a continuous single shaft or a twin shaft motorized continuous premixing pugmill before entering the dryer of the plant. The continuous premixing pugmill shall be designed such that the aggregate and lime, upon entering the pugmill, is moved in a near horizontal direction by the mixing paddles, without the aid of a conveyor belt, for a distance of at least 3 1/2 feet. The pugmill shall have adequate capacity to uniformly mix and coat the aggregate with the lime without interfering with the normal production rate of the asphalt plant. There shall not be any traces of unmixed lime after the aggregate and lime exit the pugmill.

The lime feeder system and continuous premixing pugmill shall be adequately enclosed to prevent lime from becoming airborne.

The inverted twin-shaft-belt box mixer or any other type of belt mixing device will not be allowed. Mixing devices, which permit the aggregate to fall through the mixing paddles, are not acceptable.

A lime slurry system may be used instead of the damp aggregate system.

All lime systems, including the continuous premixing pugmill, shall be approved by the Engineer before any mix is produced for use in the project.

401.09 Hauling Equipment. Trucks used for hauling asphalt mixture shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin, lime water solution, soap or detergent solution or other approved material, to prevent the mixture from adhering

to the beds. Under no circumstances will any petroleum-based product be permitted for use to prevent asphalt mixtures from adhering to the beds. In all cases, after spraying with solution, truck bodies must be raised so that excess material is drained before placing mixture in the truck. A hole shall be placed in the truck bed at a suitable location for checking the temperature of the mixture. The Contractor shall provide and have installed on vehicles covers made of canvas or other suitable material that will provide a weather-tight enclosure to completely cover and protect the mixture from inclement weather, or where there is evidence of a crust forming.

401.10 Batch and Truck Scales. The Contractor shall provide satisfactory platform truck scales at the plant site for use in obtaining the net weight of each load of finished mixture. All platform scales shall be of sufficient size to permit the entire vehicle or combination of vehicles to rest on the scale platform while being weighed. Combination vehicles may be weighed as separate units provided they are disconnected while being weighed. The scales shall be tested and sealed by an authorized public official or scale serviceperson without any additional compensation at least each six (6) months and as often as the Engineer may deem necessary to insure their accuracy. When an asphalt plant is relocated, the scales shall be tested and sealed by an authorized public official or scale serviceperson.

A digital recorder shall be installed as a part of the platform truck scales. The recorder shall produce a printed digital record on a ticket of the gross and tare weights of the delivery trucks along with a time and date print for each ticket. Provisions shall be made so that scales may not be manually manipulated during the printing process. In addition, the system shall be so interlocked as to allow printing only when the scale has come to rest. The scales and recorder shall be of sufficient capacity and size to accurately weigh the heaviest loaded trucks or tractor trailers that are used for the delivery of the asphalt concrete from that plant.

For batch plants, the Contractor shall provide an approved automatic printer system as specified by **AASHTO M 156**, which will print the weights of the material delivered. The system shall be used in conjunction with an approved automatic batching and mixing control system. The system shall record the total net weight of each load and a total net weight of asphalt binder for each load. Such weights shall be evidenced by a weight ticket (in sufficient copies) for each load. Where tickets are printed in such manner, only the applicable portions of **Subsection 401.37** shall apply.

401.11 Paver. Unless otherwise permitted or directed by the Engineer, the asphalt mixture shall be spread by means of a mechanical self-powered paver capable of spreading and finishing the asphalt mixture without segregation to the depth and width required, true to line, grade, and crown set by the Engineer. The paver shall be equipped with hoppers and distributing screws or satisfactory devices for placing the mixture uniformly in front of the screed. When extendable screeds are used, the distributing screws or augers shall be extended sufficiently to provide uniform distribution of the mixture for the full width of the screed. The screed or strike-off assembly shall operate by cutting, crowding or other practical action that is effective on the mixture at workable temperatures without tearing, shoving, or gouging and that will produce a finished surface of the smoothness and texture required. The screed shall be adjustable as to level and shall have an indicating level attached.

Pavers shall be capable of operating at variable speeds consistent with uniform and continuous laying of the mixture. Stop and go operations of the paver should be avoided.

On projects of sufficient length, in addition to the above requirements, the paver shall be equipped with a system for automatically controlling the pavement cross-slope and for automatically controlling the longitudinal profile. As the paver moves forward, the system shall be such that the paver will automatically anticipate and make adjustments for undulations encountered on the existing surface. A 40 foot mobile

stringline, a 40 foot long ski, or an approved electronic leveling device shall be attached to the paver with the mobile stringline or ski reference being used to establish the longitudinal profile. The grade-following sensor shall be capable of following the taut string, wire, or other reasonable rigid grade reference produced by the leveling device. The automatic cross-slope device shall be adjustable and be able to obtain the proper super-elevation going into curves and maintain the maximum super-elevation within curves once the maximum super-elevation has been reached. For tying into an existing layer of material, the existing material will be used as the grade reference for the grade following sensor.

Manual operation will be permitted for constructing irregularly shaped and minor areas. If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained. If the Contractor fails to obtain and maintain the specified surface tolerance, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made.

401.12 Rollers. The Contractor shall present to the Engineer at the job site the manufacturer's literature for the rollers being used, in order that the Engineer can determine that the rollers conform to the specifications. Means shall be provided so that the tire pressure in the pneumatic-tired roller can be checked. Upon request and without additional compensation, the Contractor shall check the weight of any rollers in use in the presence of the Engineer.

Roller speeds shall be that which gives maximum compaction and a smooth pavement.

A. Steel-Wheel Rollers. Three-wheel steel rollers shall be 10 to 12 tons in weight and two-axle tandem rollers of 8 to 12 tons in weight. These rollers, under working conditions, shall develop a pressure of 250 to 350 pounds per inch of roller width in the compression wheel. Rollers shall be in good working condition and shall be capable of re-

versing without backlash. Rollers shall be equipped 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.

The surface of the rollers shall be free of flat areas, openings or projections that will mar the surface of the pavement.

B. Pneumatic-Tire Rollers. Pneumatic-tire rollers shall be self-propelled, having an effective rolling width of not less than 60 inches. The rollers shall be equipped with pneumatic tires of equal size and diameter which are capable of exerting average contact pressures varying from 40 psi to 90 psi by adjusting the ballast or tire inflation pressures. The wheels of the rollers shall be placed so that one pass will accomplish one complete coverage equal to the rolling width of the machine. There shall be a minimum of 1/4 inch overlap of the tracking wheels. The wheels shall not wobble. The roller shall be constructed so that the contact pressure shall be uniform for all wheels, and the tire pressure of the several tires shall not vary more than 5 pounds per square inch. Pneumatic-tire rollers shall be constructed with enough ballast space to provide uniform wheel loading as may be required. The total operating weight and tire pressure of the roller shall be varied as directed by the Engineer to obtain contact pressures that will result in adequate compaction.

C. Vibratory Rollers. Vibratory rollers shall weigh at least 8 tons and may have either one or two vibrating wheels. The roller shall be operated at a speed, frequency, and amplitude that will yield maximum compaction and a smooth pavement.

401.13 Field Laboratory. The Contractor shall provide and maintain a fully equipped field laboratory and furnish all supplies necessary for performing the quality control inspection and testing at the asphalt plant. The building shall be used exclusively by the Engineer or his representative while mate-

rial is being produced for the Department. It shall have satisfactory electric lighting and electric outlets. The building shall have a minimum floor space of 250 square feet, minimum height of 7 feet, minimum width of 10 feet, have suitable work benches and sufficient water available for tests, be provided with a suitable table or desk with drawers for office work, be supplied with two chairs, and shall also be equipped with a heating oven of satisfactory size with adequate controls for adjusting and maintaining different temperatures. Locks shall be provided for the windows and doors. The building will be so located that the Contractor's plant is in close proximity and full view from the vicinity. The Contractor shall also provide a substantial platform, constructed to the proper height, for use by the Engineer in obtaining asphalt mix samples and inspecting mixtures in truck beds.

The field laboratory shall be so equipped that, with the windows and doors closed and the ventilation system functioning in the prescribed manner, the ambient air temperature shall be maintained between 65°F and 80°F. Enclosures shall be provided for the rotarex, ash determination, and any other procedures where the vapor of the extracting solvent is emitted. Drying the sample after extracting the asphalt binder shall be done under an enclosure or inside an oven vented outside the laboratory. Each enclosure shall be equipped with a hood and glass or other doors capable of enclosing the above processes from the ambient air in the laboratory. An exhaust fan shall be located in the rear or top of the hood for each work compartment with replacement air provided through an open window or other opening as necessary to achieve the specified exchange of air.

The ventilation system shall be capable of exchanging air at the rate of 100 ft^3/ft^2/minute over the entire open door area of each enclosure. The enclosure for ash determination shall be equipped with a damper that can be regulated or some other suitable means to prevent any loss of ash during the ash determination. The ventilation system and the heating and cooling systems for the laboratory shall be so located that the exhausted extracting solvent vapors will not reenter

the laboratory through either the heating or cooling systems. The extracting solvent shall be supplied for use in the laboratory through a closed system opening only under the enclosures. The storage containers for the extracting solvent shall be mounted outside the laboratory and a feed line run from the container to a cut-off valve located in the enclosures. All parts of enclosures, hoods, and other related equipment shall be completely functional whenever testing is being performed. The Contractor shall furnish all electricity, fuel and gas including the furnishing and maintaining of all necessary piping and valves. A cut-off valve for the gas shall be located inside the enclosures for ash determination and copper tubing shall be used from the cut-off valve to the burners.

The Contractor shall furnish, and maintain in good condition, all required testing equipment and supplies at the field laboratory. A list of the required testing equipment and supplies can be obtained from the Research and Materials Laboratory. All testing equipment and supplies shall be subject to approval by a representative from the Research and Materials Laboratory. It shall be the Contractor's responsibility to properly hold and dispose of all used extracting solvent.

When **SC-T-75**, *Determination of Asphalt Binder Content for Asphalt Paving Mixtures by the Ignition Oven*, is used to determine the asphalt binder content, the Contractor shall vent, maintain and operate the ignition oven as per the manufacturers literature and SC-T-75. All records shall be immediately available to the Engineer at the asphalt plant upon request.

401.14 Rumble Strips. A rotary type cutting head will be required for Milled-In Rumble Strips. The head shall have a maximum outside diameter of 24 inches and will be a minimum of 16 inches long. The cutting head shall have the cutting tips arranged in such a pattern as to provide a relatively smooth cut. The cutting head(s) shall be on its own independent suspension from that of the power unit to allow the tool to self-align with the slope of the shoulder and/or any irregularities in the shoulder surface. The cutting tool shall be

equipped with guides to provide consistent alignment of each cut in relation to the roadway and provide uniformity and consistency throughout the project.

CONSTRUCTION REQUIREMENTS

401.15 Plant Inspection. The preparation of all asphalt mixtures shall be subject to inspection at the plant. For checking the adequacy of the equipment in use, inspecting the condition and operation of the plant for the verification of weights or proportions and character of materials, and for the determination and checking of temperatures being maintained in the preparation of the mixtures, the Engineer, or his authorized representative, shall have access at any time to all parts of the paving plant.

When it is anticipated that less than 500 tons of asphalt hot plant mix will be produced in a day, the Engineer may elect not to send as asphalt plant inspector to the plant site to sample and test the mix. Instead, a sample (or samples) will be taken at the project site and will be tested later at the asphalt plant laboratory or may be tested at the Department's District or Columbia Laboratory. The percentage of asphalt binder as determined will be used to determine the quantity of asphalt binder in paving mixture provided the asphalt content is within the job mix formula tolerances. If the sample (or samples) has not been tested by the time the monthly estimate is prepared, then the percent asphalt binder set up in the job mix formula will be paid. This percent will be adjusted if necessary when the sample is tested for asphalt binder content.

Should low volumes be produced for more than 5 successive production days, then the Engineer will place a plant inspector at the plant for a day to sample and test the asphalt mixture.

The Contractor shall notify the Engineer at least 5 days before beginning paving operations in order that inspection of the plant and materials can be performed.

401.16 Paving from Multiple Plants. Paving on the same road using mix from more than one plant will not be permitted during a day's production; however, multiple plants may be permitted by the Engineer when paving work is being performed at different locations with work being performed by separate paving operations.

401.17 Weather and Surface Temperature Restrictions. Asphalt mixture shall not be applied when the existing surface is wet or frozen. The placing of Asphalt Concrete Surface Courses (including Sand Asphalt Surface Courses) will not be permitted during the months of December, January and February except with written permission of the Engineer. For all other mixtures, the existing surface temperature for the placement of asphalt mixtures shall be in accordance with the following table:

Lift Thickness (inches)	Minimum Surface Temperature (degrees F)*
1.0 or less	55
1.1 to 2.0	45
2.1 to 3.0	40
3.1 to 4.5	35

* Surface temperature to be measured with handheld infrared non-contact thermometer away from artificial heat.

401.18 Plant Calibration and Operations. The Contractor shall calibrate his asphalt plant before production so that the mix will conform to the job mix formula and Marshall field criteria. Stockpile aggregate gradation test results and calibration charts or graphs will be kept at the plant and will be immediately available to the Engineer upon request.

A. Batch Plant. When batch plants are used, the Contractor shall calibrate the cold feed bins to the correct proportions on the job mix information sheet. Calibration charts or graphs shall be developed for each individual cold feed bin. The Contractor shall sample each hot bin and perform gradation tests on each hot bin sample. The

Contractor shall be responsible for determining the percentage of material weighed from each hot bin. The Contractor shall immediately correct the automatic proportioning system when it does not consistently deliver materials within the full range of batch sizes within the tolerances stated in **AASHTO M 156**, Subsection 6.7.3 entitled *Accuracy*. The automatic proportioning system shall also be corrected when the liquid asphalt content does not reasonably compare with the extraction test results.

B. Drum Mixer Plants. When drum mixer plants are used, the Contractor shall calibrate the cold feed bins to the correct proportions on the job mix information sheet. Calibration charts or graphs shall be developed for each individual cold feed bin. Liquid asphalt systems shall be recalibrated when there is variance in the asphalt content or when the Engineer deems necessary. The Contractor shall determine the moisture content of the aggregates before entering the drum at least twice a day or when the Engineer deems necessary. Aggregate moisture content test results will be kept in the field lab and will be immediately available to the Engineer upon request.

C. Contractors Monitoring Operations. The Contractor shall be responsible for monitoring the gradation and quality of materials that are delivered to the asphalt plant. When one or more aggregate gradations do not reasonably conform to the gradation on the job mix information sheet, the Contractor shall resubmit another job mix design request. The Contractor's monitoring operation shall not interfere with the Department's routine testing.

D. Failing Samples and Plant Operations. When two consecutive samples fail on gradation, asphalt content, dust to asphalt ratio and/or field criteria, the Contractor shall stop production and make the necessary adjustments. The Contractor shall produce three truck loads of mix and hold plant production until the test results are obtained from the third truck load. This procedure will be followed until the mix produced meets the job mix formula

and/or Marshall field criteria. If after a day's production, the mix fails to meet specifications, the Contractor shall check his plant calibration, perform gradation tests on all stockpiled aggregates, perform a detailed plant inspection, and make necessary adjustments or changes before starting the next day's production. This procedure may be altered when the Engineer deems necessary.

Asphalt plant inspectors will immediately advise the Contractor when air voids are out of specification and the inspector will make another set of Marshall specimens after 3 loads of mix to check air voids.

Marshall specimens will be compacted at a temperature not greater than 300°F, and not less than 290°F or as recommended by the supplier.

401.19 Silos and Surge Bins. Silos shall be approved by the Engineer before being used for overnight storage. Overnight storage approval is based on the recovered viscosity of stored asphalt samples. The recovered viscosity shall not be greater than 13,200 poises.

Silo overnight storage approval is valid for one (1) year and the Contractor must provide to the Engineer a written request for silo approval each year. During the course of the year, if a silo is found not to comply with the specifications then the approval process must be repeated.

The Department is not obligated to purchase any mix stored in a silo or surge bin that does not comply with the job mix formula and/or Marshall field criteria.

401.20 Preparation of Asphalt Binder. The asphalt binder shall be heated to a temperature between 250°F and 325°F, or as recommended by the supplier, in tanks designed to secure uniform heating of the entire content and to provide a continuous supply of the asphalt binder to the mixer at a uniform temperature. At no time before or after shipment to the plant site, shall the asphalt be heated more than 325°F or as recommended by the supplier.

401.21 Preparation of Aggregate. The aggregate for the mixture shall be dried and heated at the plant. The aggregate shall be heated to a temperature between 250°F and 325°F or as recommended by the supplier.

401.22 Preparation of Mixture. The ingredients shall be heated and completed in such manner as to produce a mixture which, when discharged, shall be at a temperature of not less than 250°F nor more than 325°F, or as recommended by the supplier, and, except for sand asphalt mixture for base course construction, shall be within 20°F of the temperature specified by the Engineer. The sand asphalt mixture for base course construction shall be mixed at a temperature (between 250°F and 325°F) to provide complete coating of all particles.

Unless otherwise permitted by the Engineer, the Contractor shall devote the full production of the plant to the project in order that the work will be performed as continuously as possible.

401.23 Mixing: Batch, Drum, and Continuous Mix Plants. The production of HMA at all asphalt plants must follow the asphalt mix design job mix formula, in order to give the correct individual proportions. The aggregates must be dried to a consistent mixing temperature before introducing the asphalt binder into the HMA. The correct proportions of aggregate, mineral filler, lime, and asphalt binder content must be mixed to produce a homogenous asphalt mix in which all particles are thoroughly coated. The asphalt plants must meet **AASHTO M 156**, and all lime systems are to be checked initially by the Engineer. The plants must be able to produce a consistent asphalt mix, without problems with segregation, mix temperature, and varying asphalt binder content to meet Departmental specifications.

401.24 Blending of Hydrated Lime. Hydrated lime shall be uniformly blended with the damp aggregated at a rate 1% by weight of dry aggregate. The damp aggregate shall contain a

minimum of 3% moisture. The water spray delivery system shall be used if aggregate moisture is less than 3% or when the Engineer deems it necessary to prevent lime from becoming airborne. The production rate shall be adjusted so there will not be any retained moisture in the finished mix.

The Contractor shall perform aggregate moisture tests at least twice a day or when deemed necessary by the Engineer. The aggregate moisture samples shall be obtained at a location between the water spray delivery system and the lime feed system.

The percentage of hydrated lime being introduced into the asphaltic mixture will be determined in accordance with **SC-T-71**, *Field Determination of Percent of Lime in Asphalt Mixture* or **SC-T-78**, *Method of Verification of Hydrated Lime Weighing Systems for Hot Mix Asphalt*. If SC-T-71 is used, the Contractor shall check the percentage of hydrated lime at least twice a day or when the Engineer deems necessary. When verifying the lime rate, the Department shall have a representative present to verify all measurements necessary to determine the percentage of hydrated lime being introduced into the asphalt mixture. The Contractor shall verify the weighing system once a week or as the Engineer deems necessary, when SC-T-78 is used. The Department inspector will check the lime rate from the digital display in the control room daily.

The Contractor shall keep a daily record of aggregate moisture tests and lime percentage determinations on **Lab Form No. 283**. The percent of hydrated lime by dry aggregate weight shall be in the range of 0.90 to 1.10. All records shall be immediately available to the Engineer at the asphalt plant upon request.

401.25 Conditioning of Existing Surface. Base courses shall be prepared as set forth in the various sections covering such base course.

Where the surface of the existing pavement or old base is

irregular (including widened shoulders where settled), it shall be brought to uniform contour by leveling with an asphalt mixture and thoroughly compacted until it conforms to the surrounding surface. Where necessary, the leveling shall be performed with a motor grader or paver.

The base course, old pavement, or existing surface shall be thoroughly swept and scraped clean and free from dust and foreign material and maintained until the asphalt mixture is superimposed.

401.26 Conditioning of Subgrade. Before placing any asphalt base course mixture, the subgrade shall be prepared in accordance with the requirements specified in **Section 208**.

401.27 Transportation and Delivery of Mixes. The mixture shall be transported from the plant to the point of use in vehicles meeting the requirements of **Subsection 401.09**. No load of mixture shall leave the plant so late in the day that it cannot be spread, finished, and compacted during daylight of that same day unless an approved artificial lighting system is provided.

The mixture shall be delivered to the spreader at a temperature between 250°F and 325°F, or as recommended by the Engineer, and, except for sand asphalt mixture for base course construction, within 20°F of the temperature set at the plant.

401.28 Application of Prime or Tack Coat.

a. Where the plans call for an asphalt mixture to be placed directly on a sand clay base course, coquina shell base, macadam base course or stabilized aggregate base course, the priming of which is not otherwise provided, a prime coat meeting the requirements of **Section 303**, **304**, **305**, or **306** as applicable shall be applied. A prime coat will not be required when an asphalt mixture is placed directly on the subgrade.

b. Before laying any bituminous mixture on existing

pavements or on unsealed bituminous surface course, a tack coat shall be uniformly applied by use of the distributor spray bars at the rate of 0.05 to 0.15 gallons per square yard of residual asphalt. Lesser amounts will be placed on new pavements while a larger amount will be placed on dry pavements to ensure a bond between the surface being paved and the overlying course. In areas where it is impractical to use distributor spray bars, such as crossovers, small areas, etc., the material may be applied by the use of the handheld nozzle. In both cases, the actual rate of application shall be applied as directed by the Engineer. The tack coat shall consist of asphalt binder or emulsified asphalt. The acceptable grades of emulsified asphalt are RS-1, MS-1, MS-2, HFMS-1, HFMS-2, SS-1, CRS-1, CRS-2, CMS-2, and CSS-1. The emulsified asphalt, with the exception of grades RS-1 and CRS-1, may be diluted with up to 50% water provided the dilution is performed at the manufacturing plant by the manufacturer using acceptable procedures. In no case may any of the emulsions be diluted at the point of use by the user.

In all cases, regardless of the type tack material used, the existing pavement or unsealed bituminous surface course shall be dry and thoroughly cleaned before applying the tack material.

c. When Hot Mix Sand Asphalt Base Course is constructed in layers, the compacted layer upon which another layer is to be placed shall be cleaned and scarified as directed by the Engineer before placing the next successive layer. When considered necessary, as determined by the Engineer, a tack coat shall be applied between layers as stipulated above.

d. Contact surfaces of headers, curbings, gutters, edges of existing pavement, manholes, catch basins, etc. shall be painted with a thin, uniform coating of asphalt material just before the asphalt mixture is placed against them.

e. The tack coat as outlined above shall be applied a sufficient length of time in advance of the laying of the asphalt mixture to permit drying but shall not be applied so far in advance or over such an area as to cause it to lose its adhesiveness.

f. No additional compensation will be allowed for the furnishing and application of the prime and tack coats specified in **Subsection 401.28 (b), (c), and (d)**.

401.29 Spreading and Finishing. Upon arrival at the point of use, the mixture shall be dumped into the mechanical spreader and immediately spread and struck off true to the line, grade, and cross-section stipulated and to such appropriate loose depth for each successive course that when the work is completed, the specified thickness or weight per square yard will be secured. All mixtures shall be delivered and spread while in a thoroughly workable condition and free from lumps. Material should be handled in such a manner to reduce segregation. The mixture shall be dumped in the center of the hoppers and care taken to avoid overloading and spillage on the base. Pavers shall operate, when laying asphalt mixtures, at such speed as may be approved by the Engineer.

If during construction it is found that the spreading and finishing equipment leaves tracks or indented areas in the new course that are not satisfactorily corrected by the scheduled operations, or which produces other permanent blemishes, the use of such equipment shall be discontinued and other satisfactory spreading and finishing equipment shall be provided by the Contractor.

The Contractor shall provide competent personnel who are capable of performing the work incidental to the correction of all pavement irregularities. Irregularities in all hot mix asphalt courses shall be corrected while the mixture is still hot. The Contractor shall give special attention to the straight

edging of construction joints immediately following the final

rolling. The Contractor shall select a competent employee of his organization to perform the straight edging.

Immediately after any course is screeded and before roller compaction is started, the surface shall be checked by the Contractor, any inequalities adjusted and all fat spots and irregular areas removed and replaced with satisfactory material. Irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the edge is rolled.

Unless directed otherwise by the Engineer, compacted thickness of any single constructed course shall not exceed a maximum of 6 inches for Hot Mix Asphalt Aggregate Base Course, 4 inches for Hot Mix Sand Asphalt Base Course and Binder courses, and 3 inches for Hot Mix Surface Course. Each layer shall be placed to such thickness as instructed by the Engineer. Joints in the layers shall overlap a minimum of 6 inches where practicable.

In ditch paving, narrow widening, deep or irregular sections, intersections, turnouts, driveways, or at other locations where it is impracticable to spread and finish the mixture by standard methods, the Contractor may use approved spreading equipment, or acceptable hand methods. When it is considered necessary to improve the profile and cross-section of an existing pavement before placing the additional normal layer of a mixture, the Engineer may require that the material be spread with a blade grader or other type of construction equipment that will give the desired results. Loads shall not be dumped faster than the material can be properly handled. The raking shall be carefully and skillfully done to avoid segregation, and so that after the first passage of the roller over the raked mixture, a minimum amount of back-patching may be required.

The Contractor shall provide approved means for keeping all small tools clean and free from accumulations of asphalt material.

The finished surface of surface courses placed adjacent to

curbs, gutter, manholes, etc. shall be approximately 1/4 inch above the edges of these structures.

401.30 Compaction (Standard). The following compaction requirements prevail where there are no specific density stipulations established in the special provisions of the contract.

The Contractor may select the equipment for spreading and compacting the mixture. Roller patterns and target densities will be established by the Contractor in accordance with **SC-T-65**, *Field Determination of Target Density for Asphaltic Concrete Materials by Use of the Control Strip Technique*. All random sample locations will be determined by **SC-T-100**, *Random Method of Sampling Highway Construction Materials*. These test procedures can be obtained from the Engineer. The cost of all the work determining compaction shall be included in the contract unit price for Hot Mix Asphalt.

To prevent adhesion of mixtures to the steel-wheel roller, the wheels shall be kept moistened, but excess water will not be permitted. The use of oil will not be permitted.

In areas such as ditches or along forms, curbs, headers, and walls not accessible for the operation of rollers as specified herein, compaction shall be performed with hand or mechanical tampers, hand-drawn steel wheel rollers, or self-propelled tandem steel wheel rollers as directed by the Engineer.

The surface of the mixture after compaction shall be smooth and true to the established crown and grade. Any mixture that becomes loose and broken, mixed with dirt, or in any way defective shall be removed and replaced with fresh mix that shall be immediately compacted to conform to the surrounding area.

A. Hot Mix Asphalt Aggregate Bases and Thin Lift Surface Courses. For Hot Mix Asphalt Aggregate Base and thin lift surface courses placed at a rate less than

140 pounds per square yard, the percent compaction will be determined at least every 500 feet per paving lane width. In-place density will be determined with the nuclear gauge at randomly selected locations, and at least one foot from any unsupported edge. In-place density shall be between 98% and 102% of the target density established in accordance with SC-T-65.

B. Sand Asphalt Base, Binders and Surface Courses Placed at a Rate of 140 Pounds per Square Yard or Greater. For Hot Mix Sand Asphalt Base, Binders and Surface Courses placed at a rate of 140 pounds per square yard or greater, 10 cores shall be taken at the same locations within the control strip that nuclear gauge tests were performed in order to establish target density. The average density of the cores shall be determined and this average core density for Binder and Surface courses shall be at least 96% of the average daily field laboratory density as determined by the Marshall Method of test. The average core density for Hot Mix Asphalt Sand Base shall be at least 92% of the average daily field laboratory density determined by the Marshall method of test.

C. Compaction Monitoring. The Contractor shall be responsible for monitoring the compaction process and will be responsible for making adjustments in equipment and/or roller patterns so that the finished asphalt pavement will meet the specified in-place density requirement. In-place density tests shall be conducted by the Contractor at least every 500 feet per paving lane width by conducting nuclear gauge tests at randomly selected locations approved by the Engineer and at least one foot from any unsupported edge. Randomly selected locations will be determined by **SC-T-100** entitled *Random Method of Sampling Highway Construction Materials*.

The average nuclear gauge density for a lot, a day's production of asphalt mixture, should be at least 100% of the target density obtained by **SC-T-65**. Individual nuclear density tests should not be less than 98% of the target

density.

D. Quality Acceptance. The quality acceptance of the in-place density of each lot of Sand Asphalt Bases, Binder Courses, and Surface Courses placed at a rate of 140 pounds per square yard or greater will be based on the average of five, 6 inch diameter cores randomly obtained from the compacted roadway. A lot is defined as a day's production of asphalt mix. The Contractor shall obtain the required cores from the compacted layer at a time and location randomly selected by the Engineer. Random location will be determined by SC-T-100.

The average daily field laboratory density shall be the average bulk density of up to 4 sets of Marshall specimens molded in the field laboratory. One set of Marshall specimens will be molded in the morning and another set in the afternoon to represent a day's production. Each set will be comprised of 2 Marshall specimens. Marshall specimens used for compaction control will meet required air void criteria.

The Contractor shall not start production in a lot until he has obtained the roadway cores from the previous day's production, unless permission is given by the Engineer. The average roadway core density for a day's production shall be a least 96% of the average daily field laboratory density as determined by the Marshall method of test. Individual roadway core densities shall not be less than 95% of the field lab Marshall density.

All nuclear gauge tests and cores required for compaction control shall be obtained by the Contractor using equipment and procedures approved by the Engineer. Dry ice may be used to cool the mat. Any patching and traffic control required during compaction control shall be furnished by the Contractor. These requirements do not apply to patching and leveling courses.

E. Documentation. The Contractor shall submit all nuclear gauge compaction tests on Laboratory Form 266, which can be obtained from the Engineer upon request. The Contractor shall submit his compaction test results to the Engineer at least once a week. The Engineer will report all cored roadway compaction test results on Laboratory Form 266 at least once a week.

F. Weak Base or Poor Surface Conditions. If in the judgement of the Engineer, a weak base or poor surface condition results in a density lower than the minimum specified, a "maximum practical density" lower than that specified may be established by the Engineer.

G. Basis of Payment. The cost of all work determining compaction shall be included in the contract unit price for asphalt mixes.

401.31 Compaction (End Result). The following compaction requirements prevail when end result compaction specifications are stipulated in the contract.

The Contractor may select the equipment for spreading and compacting the mixture, except that intermediate rolling shall be accomplished with a pneumatic roller. When roadway cores are required, it is recommended that the Contractor establish roller patterns and target densities in accordance with **SC-T-65**, *Field Determination of Target Density for Asphaltic Concrete Materials by Use of the Control Strip Technique*. The Contractor shall be responsible for monitoring the compaction process and will be responsible for making adjustments in equipment and/or roller patterns so that the finished asphalt pavement will meet the specified in-place density requirement.

All nuclear gauge tests and cores required for compaction monitoring and acceptance procedures shall be obtained by the Contractor using equipment and procedures approved by the Engineer. Any patching and traffic control required during compaction monitoring and acceptance procedures shall be

furnished by the Contractor. These compaction requirements do not apply to patching and leveling courses.

A. Hot Mix Asphalt Aggregate Bases and Thin Lift Surface Courses. The in-place density of Hot Mix Asphalt Aggregate Base and thin lift surface courses placed at a rate less than 140 pounds per square yard will be based on densities determined by the use of the nuclear density gauge using the backscatter method of testing. The gauge shall be furnished and operated by the Contractor. The nuclear density gauge shall be of the Troxler Model 3400 series, 4600 series or equivalent.

The Contractor shall construct control strips and determine target densities according to SC-T-65. One control strip shall be constructed at the beginning of work on each roadway, shoulder course and on each lift of each course. An additional control strip shall be constructed when a change is made in the type or source of materials or compaction equipment, or whenever a significant change occurs in the composition of the underlying pavement structure or the composition of the material being placed from the same source. The Engineer or the Contractor may initiate an additional control strip at anytime.

Quality Acceptance of Hot Mix Asphalt Aggregate Bases and Thin Lift Surface Courses.

For the purpose of acceptance, each day's production is considered a lot. Acceptance will be based on the average of 10 random nuclear density gauge tests per lot. Randomly selected density locations will be determined by the Engineer using the procedure stated in **SC-T-100** entitled *Random Method of Sampling Highway Construction Materials*, except that 10 successions will be used. The Engineer will observe the Contractor performing density testing for acceptance and record all nuclear density tests on **Lab Form 266**. The Engineer will report nuclear density compaction acceptance results at least once a week.

There will be a reduction in payment for asphalt mix-

ture when the required nuclear density of the compacted course is not at least 98.0% of the established target density and when it is more than 102.0% of the established target density. The payment schedule for lot densities is listed below.

Average Percent of Target Nuclear Control Strip Density	Percent of Unit Price of Mix
Greater than 102.0	97
98.0 - 102.0	100
97.0 - 97.9	95
96.0 - 96.9	90
Less than 96.0	80

Any reduction in payment that is necessary will be determined based on the adjusted unit price per ton of asphalt concrete mixture. The total amount of any reduction in payment will be deducted as a lump sum from monies due the Contractor.

B. Hot Mix Sand Asphalt Base, Binder and Surface Courses Placed at a Rate of 140 Pounds per Square Yard or Greater. For Hot Mix Sand Asphalt Base, Binders and Surface Courses placed at a rate of 140 pounds per square yard or greater, 10 cores shall be taken at the same locations within the control strip that nuclear gauge test were performed in order to establish target density. The in-place density of Sand Asphalt Base, Binder and Surface courses will be determined from the bulk density of cores taken from the roadway. Bulk density of roadway cores will be determined by **SC-T-68** entitled *Determination of Percent Air Voids in Compacted Marshall Specimen*.

The average roadway core density for Binder and Surface courses will be at least 96.5% of the average daily field laboratory density as determined by the Marshall Method of test. The average core density for Sand Asphalt Base will be at least 92% of the average daily field laboratory density as determined by the Marshall Method of test.

Quality Acceptance of Hot Mix Sand Asphalt Base, Binder and Surface Courses Placed at a Rate of 140 Pounds per Square Yard or Greater.

The quality acceptance of the in-place density of each lot, a days production, of Sand Asphalt Base, Binder and Surface placed at a rate of 140 pounds per square yard or greater will be based on the average of 5 cores randomly obtained from the compacted roadway. Cores from the roadway shall be 6 inches in diameter. The Contractor shall obtain the required cores from the compacted layer at a time and random location determined by the Engineer. Random locations will be determined by **SC-T-100**. The Engineer will report cored roadway compaction results at least once a week on **Lab Form 266**.

The average daily field laboratory density shall be the average bulk density of up to 4 sets of Marshall specimens molded in the field laboratory. One set of Marshall specimens will be molded in the morning and another set in the afternoon to represent a day's production. Each set will be comprised of 2 Marshall specimens. Marshall specimens used for compaction control will meet required air void criteria.

There will be a reduction in payment for asphalt mixture when the required average core density is less than the specified percentage of average daily field laboratory density as determined by the Marshall Method of test. Contractors will receive an incentive payment when the average core density of a lot is in the range of 97.1% to 98.5% of the average daily field laboratory density. The payment schedule for lot densities of Binder and Surface is listed as follows:

Average Percent of Daily Field Lab Marshall Density	Percent of Unit Price of Mix
Greater than 98.5	98
97.1 - 98.5	103
96.5 - 97.0	100
96.0 - 96.4	95
95.0 - 95.9	90
94.0 - 94.9	70
Less than 94.0	Reject and Replace

The pavement shall be rejected and replaced at the Contractor's expense when the average lot density for Binder and Surface is less than 94.0% of the average daily field lab density.

The Contractor will not have the option of accepting a price reduction instead of production specification material. The intent of this specification is for the Contractor to achieve an average in-place mat compacted density of at least 96.5% of the average daily field lab Marshall density. The Contractor will not be permitted to continuously produce mix when this compaction requirement is not being met. Material which does not substantially comply with the compaction requirement, even though it may be restricted to isolated areas may be rejected without regard to sampling locations within a lot.

The payment schedule for lot density of Sand Asphalt Base is listed below:

Average Percent of Daily Field Lab Marshall Density	Percent of Unit Price of Mix
Greater than 92.0	100
91.5 - 91.9	97
90.5 - 91.4	95
89.5 - 90.4	90
Less than 89.5	80

Any reduction or incentive payment will be determined on the adjusted unit price per ton of asphalt concrete mixture. The total amount of any reductions in payment will be deducted as a lump sum from monies due the Contractor.

401.32 Joints. Placing of the mixture shall be as continuous as practicable and the roller shall pass over the unprotected end of the fresh laid mixture only when the laying of the course is to be discontinued, or in the case of hot laid mixtures, discontinued long enough to permit the mixture to become chilled.

Longitudinal joints shall be rolled directly behind the paver. The paver shall be so positioned that in spreading, the material overlaps the edge of the lane previously placed by 1 to 2 inches. The loose material shall be left high enough to allow for compaction to the depth of the previously rolled lane. The overlapped material shall be pushed back by means of lutes or other suitable tools to the edge of the “cold” joint. This work shall be performed in such manner to provide a uniform joint when rolled.

Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straight edged or stringlined to assure true alignments.

Longitudinal and transverse joints shall be made in a careful manner and shall present the same texture, density, and smoothness as other sections of the course.

Joints between old and new pavements, or between successive strips, shall be made in such manner as to insure proper bond between the old and new surface for the full depth of the course. The joints, transverse and longitudinal, are to be thoroughly coated with an approved asphalt material before placement of adjacent material. If necessary, joints shall be formed by cutting back on the course. The cost of cutting back and painting of joints shall be included in the contract price for the mixture.

On contracts containing multiple courses, the width of the lanes shall be arranged so that the longitudinal joints of each successive course are offset from the joints of the previous course at least 6 inches where practicable. The width of each lane in the top layer shall be the width of the design travel lanes, unless directed otherwise by the Engineer.

401.33 Rumble Strips and Pavement Markers. If rumble strips are called for in the plans, they shall be placed in the mainline paved shoulder only. No rumble strips will be placed on ramp shoulders.

Milled-in rumble strips (MIRS) shall have finished dimensions of 7 inches ± 1/2 inch wide in the direction of travel and shall be a minimum of 16 inches long measured perpendicular to the direction of travel. The depressions shall have a concave circular shape with a minimum 1/2 inch depth at center. The MIRS shall be placed perpendicular to the roadway on 12 inch centers. The edge of the milled area nearest the road centerline shall be 10 inches from the right edge of the **travelway** of the shoulder.

Milled-in rumble strips will not be constructed on the median paved shoulder unless specified in the plans. If the median shoulder is specified, the milled area shall be 4 inches from the left edge of the travelway on the shoulder. Two 4 inch x 4 inch raised yellow pavement markers shall be placed together at 40 foot intervals along the travelway. The markers are to be placed between the pavement edge line and the

MIRS. The markers shall be placed directly adjacent to each other perpendicular to the travelway.

Removed pavement material suitable for recycling may be used by the Contractor on the project or for use in his other operations at the Contractor's option and expense.

Excess waste material resulting from the operation shall be broomed daily from the road and paved shoulder in a manner approved by the Engineer.

At the end of each working day, all equipment shall be removed to a location where it does not present a hazard to traffic. The pavement shall be cleaned by sweeping or flushing; and the work area shall be reopened to traffic each day.

401.34 Protection of Surface. The newly constructed surface shall be protected from traffic until the mixture has hardened sufficiently to prevent distortion. The surface shall be kept clean and free from foreign material when the shoulders are being constructed.

401.35 Finished Surface Requirements. After compaction, the finished surface of the binder or surface courses shall be smooth, of uniform texture, and true to the specified crown and grade. When checked with a 10 foot straightedge applied parallel to the centerline of the pavement, the finished surface of the binder course shall not vary more than 1/4 inch and the finished surface course shall not vary more than 1/8 inch as measured from the bottom of the straightedge to the top of the finished mixture. Binder or surface courses not meeting these finished surface requirements shall be corrected by repairing, or if necessary, by removing and replacing subject to the approval of the Engineer.

In addition to meeting any specified requirements for surface tolerances, binder and surface courses shall meet the satisfactory riding qualities for the mixture being placed as determined by the Engineer.

401.36 Rideability Requirements. Asphalt concrete surfaces of will be evaluated for a satisfactory ride as determined by the Engineer. If conditions permit and unless otherwise specified in the special provisions, the Department will test the asphalt surface with a Mays Ride Meter in accordance with the **Test Method for Determining Pavement Roughness with the Mays Ride Meter**.

For the Mays Ride Meter to be used, the following conditions must be met:

1. A constant speed of 50 miles per hour must be maintainable throughout each section[1] for which measurements are made.

2. The segment of roadway is a minimum continuous length of 0.5 mile (bridges are considered areas of discontinuity.)

[1]Normally a section will be considered as 1.0 mile in length. However, no measurement will be made on any section less than 0.5 mile in length. Sections that are less than 1.0 mile, but are 0.5 mile or greater, normally occur at the end of a project.

A. New Construction. On new roadway projects, the Mays Ride Meter measurement shall not exceed 40 inches for each mile of each vehicle lane when tested. When initial measurements are 40 inches per mile or less, payment will be based on the original contract unit price per ton of asphalt concrete mixture tested according to the following Schedule for Adjusted Payment:

Schedule For Adjusted Payment	
Roughness (inches/mile)	Price Adjustment
Less than 24	105%
25 – 29	103%
30 – 34	101%
35 – 40	100%
41 – 45	95%
46 – 50	90%
51 – 55	80%
56 and above	See Note 1

Note 1:
For each additional increment of 5 inches per mile of roughness above 55 inches per mile, an additional 10% reduction will be made based on the contract unit price of the asphalt surface mixture.

When the measurement exceeds 40 and the Engineer determines that the pavement does not have an acceptably smooth ride, the Contractor shall correct such deficient sections without additional compensation. The Engineer may withhold payment for the asphalt concrete mixture (or a portion thereof) until the deficiencies have been corrected, and the surface is re-tested and provides an acceptably smooth ride. The method of correcting the surface deficiencies shall be subject to approval by the Engineer. No more than 100% of the contract unit price will be paid for sections where corrective work results in measurements less than 35 inches per mile. If corrections are not made, then the price adjustment based on the original contract unit price per ton of the asphalt concrete mixture according to the Schedule for Adjusted Payment. The total amount of any reduction in payment will be deducted as a lump sum from monies due the Contractor.

Sections of roadway for which the roughness measurement is 56 inches per mile or above will be reviewed on an individual basis. If the Engineer determines that the section is unacceptable, the material shall be removed and replaced or overlaid subject to the approval of the Engineer. Should the Engineer determine that the material may remain in place and does not require an overlay or other corrective action, a price adjustment will be assessed based on the Schedule for Adjusted Payment.

B. Resurfacing Projects. On resurfacing projects, the existing pavement will be tested with the Mays Ride Meter or other method specified in the special provisions before any work is performed by the Contractor and again on the finished surface. To ensure attainment of as smooth a ride as possible, the original roughness value measured on the existing surface for each mile of each vehicle lane shall be improved as shown in the Acceptable Roughness Specification Table (see Appendix.) Where measurements on the finished surface exceed the acceptable limit, the Contractor shall correct such sections without additional compensation. The method of correcting the surface deficiencies shall be approved by the Engineer.

In the event the corrections are not made, then a penalty will be assessed based on the original contract unit price for the asphalt concrete mixture tested as follows:

Roughness over Acceptable Limit (Inches/Mile)	Price Adjustment
1 – 5	95%
6 – 10	90%
11 – 15	85%
16 – 20	80%
21 – 25	75%
26 and above	Replace

The tonnage subject to price adjustment will be based on the original plan quantity for the asphalt concrete mixture as shown on the typical section. When an acceptably smooth ride is not obtained as outlined above, the Engineer may withhold payment for the asphalt concrete mixture (or a portion thereof) until the corrections have been made and the pavement provides an acceptably smooth ride. The total amount of any reduction in payment will be deducted as a lump sum from monies due the Contractor.

401.37 Plant Tickets. The net weight of each load of mixture and the accumulated net weight of the loads for the day shall be recorded in triplicate upon forms furnished by the Contractor and approved by the Engineer. At his discretion, the Engineer may furnish forms for recording the net weight of the loads. The recording of the weights shall be performed by an authorized representative of the Department.

When each load of mixture is delivered to the work, the original copy of the plant ticket for the load shall be presented to the Engineer. The plant inspector shall keep the stub copy until the completion of the work. The tickets delivered to the Engineer on the work shall be included and made a part of and submitted along with the final plans package to the Engineer.

Any changes in the amounts designated on the tickets necessitated by the rejection of any material shall be noted on all copies by the Engineer or Inspector, and the reason stated for such rejection.

At any time during the delivery of material and for the purpose of checking the weighing equipment at the plant, the Engineer may direct the Contractor to weigh or cause to be weighed on tested and approved platform scales, without compensation, any truck load that is to be delivered to the work.

401.38 Method of Measurement. Asphalt plant base, binder, and surface course mixes will be measured by the

ton. The quantity shall be the weight, using approved scales, used in the accepted work and no deduction will be made for the weight of asphalt materials in the mixture.

The quantity of liquid asphalt binder in the paving mixture shall be the number of tons contained in the accepted work. The amount of asphalt binder in the mix shall be determined by either the centrifuge method of extraction, ignition oven, or at the option of the Engineer may be the amounts as printed on the load tickets by use of an approved ticket printer. In order to check scale accuracy when using a ticket printer for payment for asphalt binder, periodic extraction tests will be made (not for pay purposes) on mixes other than those that contain marine limestone or slag.

The quantity of asphalt binder will not include any asphalt that may be absorbed by the aggregate; therefore, if an absorbent type aggregate (such as marine (fossiliferous) limestone or slag) is used in the composition of mixture and a discrepancy is determined between the centrifuge method of extraction or ignition oven and the ticket printer, the centrifuge method of extraction shall be used for payment of the asphalt binder.

Samples from which extraction tests are to be made in order to determine the asphalt content may be taken from mixtures before or after incorporating the mix in the pavement structure. The Engineer may determine the amount of asphalt binder in the mix at such time and frequencies as he may elect.

When the asphalt binder is not being measured by ticket printout, the percentage of asphalt binder as determined by the Engineer at the field laboratory shall be used to determine the quantity of asphalt binder in the paving mixture, unless otherwise directed by the Engineer.

Deductions will be made for all asphalt mixture wasted or lost due to the negligence of the Contractor; asphalt mixture or asphalt binder applied in excess of the rate specified or

directed in writing; and any asphalt mixture applied beyond the limits of the work.

The quantity of Milled-In Rumble Strips will be taken as the sum of the lengths in miles of the individual segments where the MIRS have been satisfactorily installed as indicated on the plans or as directed by the Engineer. Lengths will be measured along the inside edge of the shoulder from the center of the first MIRS in a segment to the center of the last MIRS in that segment. Where MIRS are provided on more than one shoulder, lengths will be measured separately for each segment and added to the sum.

Raised yellow pavement markers will be measured separately for each unit placed.

401.39 Basis of Payment. When the standard method of controlling, accepting, and paying for hot mix asphalt concrete mixtures is used, this work, as measured in **Subsection 401.38**, will be paid for at the contract unit price for Hot Mix Asphalt Course of the type specified. Specific requirements and listing of pay items for the Hot Mix Asphalt Binder Courses and Hot Mix Surface Courses, can be are found in **Subsections 402** and **403**, respectively.

When a method of control and acceptance other than the standard method contained herein is specified, the contract unit price for hot mix asphalt courses will be adjusted in accordance with that method. The details of that method of control and acceptance will be found in the special provisions of the contract.

The above mentioned contract unit prices and payments shall be full compensation for furnishing, mixing, hauling, placing, and compacting all materials, including furnishing and application of tack and prime coats, and for all tools, equipment, labor, and incidentals necessary to complete the work.

The Department reserves the right to base payment on

samples cored from the roadway should the Engineer determine that the asphalt mixture is not adequately represented by the field laboratory results. If payment is based on core samples, the standard method of acceptance will apply regardless of the acceptance method prescribed in the contract.

Unless otherwise specified elsewhere in the contract, hydrated lime will not be paid for separately, and all costs for furnishing and incorporating the lime into the mixture shall be included in the contract unit price for asphalt mixes.

The liquid asphalt binder contained in paving mixtures will be paid for as Liquid Asphalt Binder of the grade specified.

The contract unit price and payment for Milled-In Rumble Strips shall be full compensation for furnishing all tools, equipment, labor, and incidentals to satisfactory complete the work.

Raised yellow pavement markers will be paid for at the contract unit price for Permanent Yellow Pavement Markers Mono-Directional, Retroreflective, 4" X 4", which price and payment shall be full compensation for all materials, tools, equipment, labor, and incidentals required to satisfactorily complete the work.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
401100X	Liquid Asphalt Binder (*grade*)	Ton
4019000	Milled-In Rumble Strip	Mile
6050005	Permanent Yellow Pavement Markers Mono-Directional Retroreflective 4" X 4"	Each

SECTION 402

HOT MIX ASPHALT BINDER COURSE

402.01 Description. This work shall consist of a binder or intermediate course composed of mineral aggregate and asphalt binder, mixed in an approved plant and constructed on a prepared surface in accordance with these specifications and conforming to the lines, grades, dimensions, thickness and typical cross-section shown on the plans or as otherwise specified.

MATERIALS

402.02 General. The materials shall meet the applicable requirements of **Subsections 401.02** through **401.03**. Hydrated lime will be required in all binder courses as an anti-stripping additive.

402.03 Composition of Mixture. The mineral aggregates and asphalt binder shall be combined in such proportions that the composition by weight of the finished mixture shall be within the following composition limits shown in the following tables. When the mix is controlled, accepted, and paid for in accordance with the Volumetric, Low Tonnage, or other control and acceptance methods, specific requirements will be given in the special provisions.

Composition Limits for Hot Mix Asphalt Binder Courses

Required Gradation	
Sieve Designation	**Percentage by Weight Passing**
1 inch	100
3/4 inch	90 - 100
1/2 inch	72 - 90
No. 4	42 - 60
No. 8	30 - 48
No. 30	12 - 29
No. 100	6 - 16
No. 200	2 - 8
Note: The amount between any two consecutive sieves smaller than 1/2 inch shall not be less than 3%.	

Percent of Total Mixture	
Asphalt binder	3.5 - 6.2

Required Job Mix Marshall Design Criteria	
Minimum Stability, lbs.	1200
Air Voids, %	3.5 - 6.0
Flow, 0.01 inch	8 - 16
Dust/Asphalt Ratio	0.6 - 1.2

Voids In Mineral Aggregates (VMA)	
Nominal Maximum Aggregate Size	**Minimum VMA**
3/4 inch	14.0%
1/2 inch	15.0%

Required Field Marshall Criteria	
Minimum Stability, lbs.	1000
Air Voids, %	3.0 - 6.0
Dust/Asphalt Ratio	0.6 - 1.2

The composition limits are master ranges of tolerances. A closer control meeting the requirements as specified in **Sub-section 401.04** will be required. However, the Contractor

shall furnish aggregate of such gradation that an asphalt binder content exceeding 5.7% will not be required.

Listed below are other requirements for each type of binder course.

Binder Course Type 1:

1. Fine aggregate shall be screenings.
2. Coarse aggregate shall be crushed aggregate.
3. Mix design using 75 blow Marshall design procedure.

Binder Course Type 2:

1. Mix design using 50 blow Marshall design procedure.

EQUIPMENT

402.04 Equipment Requirements. Equipment shall meet the applicable requirements of **Subsections 401.06** through **401.14**.

CONSTRUCTION REQUIREMENTS

402.05 Construction Requirements. Construction requirements specified in **Subsections 401.15** through **401.37** shall apply to Hot Mix Asphalt Binder Courses work.

402.06 Method of Measurement and Basis of Payment. This work will be measured and paid for in a similar manner as specified in **Subsections 401.38** and **401.39**.

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

Payment will be made under:

Item No	Pay Item	Pay Unit
402XXXX	Hot Mix Asphalt Binder Course (Type *(1 or 2)*)	Ton

SECTION 403

HOT MIX ASPHALT SURFACE COURSE

403.01 Description. This work shall consist of a surface course composed of mineral aggregate and asphalt binder, mixed in an approved plant and constructed on a prepared surface in accordance with these specifications and conforming to the lines, grades, dimensions, thickness, and typical cross-section shown on the plans or as otherwise specified.

MATERIALS

403.02 General. The materials shall meet the applicable requirements of **Subsections 401.02** through **401.03**. Marine (fossiliferous) limestone shall not be used in any surface course except Type 4. Hydrated lime will be required in all surface courses as an anti-stripping additive.

403.03 Composition of Mixture. The mineral aggregates and asphalt binder shall be combined in such proportions that the composition by weight of the finished mixture shall be within the limits as set forth in **Control and Acceptance of Hot Laid Asphalt Mixtures**. This document can be obtained from the Engineer.

The following composition limits are master ranges of tolerance. Except for the sand-asphalt surface course, a closer control meeting the requirements as specified in **Subsection 401.04**, will be required. A job mix formula is not required for the sand-asphalt surface; however, the asphalt binder content shall be within plus or minus 0.4% of the content specified by the Engineer.

If included in the proposal, Hot Mix Asphalt Surface Course Type 1, 3, or 4 may be used for Ditch Paving.

Composition Limits for Hot Mix Asphalt Surface Courses

Gradation Requirements					
Sieve Designation	**Percentage by Weight Passing**				
	Type 1B	**Type 1C**	**Type 1**	**Type 3**	**Type 4**
1 inch	100		-	-	
3/4 inch	90 – 100	100	100	100	100
1/2 inch	72 – 90	90 – 100	97 – 100	97 – 100	97 – 100
3/8 inch	-	70 – 92	80 – 100	80 – 100	90 – 100
No. 4	42 – 60	42 – 60	58 – 75	58 – 78	75 – 95
No. 8	30 – 48	22 – 42	42 – 60	42 – 64	58 – 82
No. 30	12 – 29	10 – 25	19 – 40	18 – 40	20 – 50
No. 100	6 – 16	4 – 14	8 – 20	5 – 20	6 – 20
No. 200	2 – 8	2 – 8	3 – 8	2 – 8	2 – 10
Note: The amount between any two consecutive sieves smaller than 3/8 inch, shall not be less than 3% for Types 1C, 1B, 1, 3, and 4.					

Percent of Total Mixture					
Asphalt Binder	4.0 - 6.0	4.0 – 6.0	5.0 - 6.5	5.0 – 6.5	5.0 – 6.8

Required Job Mix Marshall Design Criteria					
No. Blows per Face	75	75	50	50	50
Min. Stability, lbs.	1500	1800	1400	600	500
Air Voids, %	4.0 – 4.5	4.0 – 4.5	4.0 – 4.5	4.0 – 6.0	5.0 – 9.0
Flow, 0.01 in.	8 – 16	8 – 16	8 - 16	8 – 16	8 – 16
Dust/Asphalt Ratio	0.60 - 1.20	0.60 -1.20	0.60-1.20	0.60 -1.20	0.60-1.20
% Voids Filled	68 – 76	70 – 77	70 - 77	68 - 77	65 – 78

Nominal Maximum Aggregate Size	**Minimum VMA, %**				
3/4 inch	14.0				
1/2 inch	15.0	15.0	15.0	15.0	
3/8 inch		16.0	16.0	16.0	16.0
No. 4		18.0	18.0	18.0	18.0

Required Field Marshall Criteria					
No. Blows per Face	75	75	50	50	50
Min. Stability, lbs	1250	1500	1250	600	500
Air Voids %	3.0 – 6.0	3.0 - 5.0	3.0 - 5.0	3.0 – 7.0	4.0 – 10.0
Dust/Asphalt Ratio	0.60-1.20	0.60-1.20	0.60-1.20	0.60–1.20	0.60-1.20
Max. % Voids Filled	78	78	78	78	80

Listed below are other specific requirements for surface mixtures.

Surface Types 1B and 1C:

1. Fine aggregate shall be screenings.
2. Coarse aggregate shall be crushed aggregate.

Surface Type 1:

1. Coarse aggregate shall be crushed aggregate.

EQUIPMENT

403.04 Equipment Requirements. Equipment shall meet the applicable requirements of **Subsections 401.06** through **401.14**.

CONSTRUCTION REQUIREMENTS

403.05 Construction Requirements. Construction requirements specified in **Subsections 401.15** through **401.37** shall apply to Hot Mix Asphalt Surface Courses work.

403.06 Method of Measurement and Basis of Payment. This work will be measured and paid for in a similar manner as specified for in **Subsections 401.38** and **401.39** with the following addition:

When the item of Hot Mix Asphalt Surface Course for Ditch Paving is included in the contract, the contract unit price shall include the necessary asphalt binder in the mixture.

Liquid Asphalt Binder will not be measured and paid for separately for mixture used in ditch paving.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
403XXXX	Hot Mix Asphalt Surface Course (Type *(1, 1B, 1C, 3, or 4)*)	Ton
4037000	Hot Mix Asphalt Surface Course for Ditch Paving	Ton

SECTION 404

COLD MIX ASPHALT BINDER COURSE

404.01 Description. This work shall consist of a binder or intermediate course composed of mineral aggregate and asphalt material, mixed in an approved plant and constructed on a prepared surface in accordance with these specifications and conforming to lines, grades, dimensions, thickness, and typical cross-section shown on the plans or as otherwise specified.

MATERIALS

404.02 Asphalt Material. The asphalt material shall conform to the requirements specified in **Subsection 405.02**.

404.03 Mineral Aggregate. The mineral aggregate shall meet the requirements specified in **Subsection 401.03**.

404.04 Composition of Asphalt Binder Course. The mineral aggregate and asphalt material shall be combined in such proportions that the composition by weight of the fin-

ished mixture shall be within the following composition limits.

Composition Limits for Asphalt Binder Courses

Gradation Requirements	
Sieve Designation	**Percentage by Weight Passing**
3/4 inch	100
1/2 inch	95 – 100
3/8 inch	60 – 98
No. 4	30 – 65
No. 8	17 – 36
Note: The amount between any two consecutive sieves smaller than the 1/2 inch sieve shall be not less than 5%.	

Percent of Total Mixture	
Bitumen	4.0 – 7.0

Marshall Stability, lbs.	
Minimum	800

The above composition limits are master ranges of tolerance. A closer control meeting the requirements of **Subsection 401.04** will be required.

Asphalt binder (PG64-22) will be used in design of mixture to check Marshall Stability on the approved job mix.

CONSTRUCTION REQUIREMENTS

404.05 Construction Requirements. Construction requirements specified in **Subsections 405.06** through **405.18** shall apply to Cold Mix Asphalt Binder Course work.

404.06 Method of Measurement and Basis of Payment. This item will be measured and paid for as specified in **Subsections 405.19** and **405.20**.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
4041000	Cold Mix Asphalt Binder Course	Ton

SECTION 405

COLD MIX ASPHALT SURFACE COURSE

405.01 Description. This work shall consist of a surface course composed of mineral aggregate and asphalt material, mixed in an approved plant and constructed on a prepared surface in accordance with these specifications and conforming to the lines, grades, dimensions, thickness, and typical cross-section shown on the plans or as otherwise specified.

MATERIALS

405.02 Asphalt Material. The asphalt material to be used in the mix shall conform to the following cited specifications:

RC 250, RC 800, or RC 3000 - - - - - - - - - **AASHTO M 81**
MC 250, MC 800, or MC 3000 - - - - - - - - - **AASHTO M 82**

Asphalt binder (PG64-22) may be blended with a cut-back asphalt or a liquefier provided a quality mix is produced. Also, a cut-back asphalt emulsion may be used provided an excellent mix results.

405.03 Mineral Aggregate. The mineral aggregate shall meet the requirements as specified in **Subsection 401.03**.

405.04 Composition of Asphalt Surface Course. The mineral aggregate and the asphalt material shall be combined in such proportions that the composition by weight of the finished mixture shall be within the range limits shown in the following tables except as noted:

Composition Limits of Cold Mix Asphalt Surface Courses

Gradation Requirements			
Sieve Designation	**Percentage by Weight Passing**		
	Type 1	**Type 2**	**Type 3**
3/4 inch	100	100	--
1/2 inch	97 - 100	97 - 100	--
3/8 inch	75 - 95	80 - 100	100
No 4	60 - 80	50 - 75	90 - 100
No. 8	43 - 63	40 - 63	70 - 100
No. 30	23 - 39	14 - 39	28 - 60
No. 100	8 - 17	2 - 22	4 - 26
No. 200	2 - 8	0 - 12	2 - 10
Note: For Type 3, the amount between any two consecutive sieves smaller than 3/8 inch shall be not less than 3%.			

Percent of Total Mixture			
	Type 1	**Type 2**	**Type 3**
Bitumen	4.2-6.8	4.2-6.8	5.0-8.0

Marshall Stability, lbs.			
	Type 1	**Type 2**	**Type 3**
Minimum	600	600	--

Asphalt binder (PG64-22) will be used in design of mix to check Marshall Stability on the approved job mix.

The above composition limits are master ranges of tolerance. Except for Type 3, a closer control meeting the requirements as specified in **Subsection 401.04** will be required. An asphalt content will be set for Type 3 and a plus or minus variation of 0.4% will be permitted from the set value.

EQUIPMENT

405.05 Equipment. The plant used in the manufacture of the bituminous mixture and all equipment shall conform to the applicable requirements specified in **Subsections 401.06** through **401.14**. Plants different from the types specified in **Section 401** may be approved for use provided a uniform and satisfactory mixture is produced.

CONSTRUCTION REQUIREMENTS

405.06 Plant Inspection. Plant inspections shall meet the requirements of **Subsection 401.15**.

405.07 Weather Restrictions. The provision for weather restrictions shall be as specified in **Subsection 401.17**.

405.08 Preparation of Aggregate. The aggregate, if wet, shall be surface dried in the drier specified herein before mixing.

405.09 Preparation of Bituminous Mixture. The dried aggregate shall be combined in the mixer in the proportionate quantities of each fraction of aggregate required and thoroughly mixed dry. The bituminous materials may be introduced into the mixture in several component parts provided that the finished mixture and the resulting asphalt binder shall meet the requirements of these specifications. A small percentage of liquefier may be added when necessary to keep the mixture soft and workable until it is spread on the roadway.

The bituminous mixture must have uniform softness and be in such condition at the time of delivery at destination that it can be handled satisfactorily without heating when the temperature is 40°F and above and will not harden when stored outside in a stockpile. It must be capable of withstanding traffic without displacement or raveling immediately after being spread on the roadway and rolled.

405.10 Transportation and Delivery of Mixture. The bituminous mixture shall be transported from the plant to the point of use in tight vehicles that have been previously cleaned of all foreign materials.

405.11 Conditioning of Existing Surface. Conditioning of the existing surface shall be performed as specified in **Subsection 401.25**.

405.12 Application of Prime or Tack Coat. Application of Prime Coat or Tack Coat shall be as specified in **Subsection 401.28**.

405.13 Spreading and Finishing. Spreading and finishing operations shall be as specified in **Subsection 401.29**.

405.14 Compaction. After spreading to the required cross-section, each lift shall be thoroughly and uniformly compacted.

Each roller shall be operated by a competent experienced roller operator and, while the work is underway, must be kept in continuous operation as nearly as practicable.

The initial rolling shall start soon after the mixture has been spread and shall progress at a rate that will furnish compaction to the satisfaction of the Engineer.

Straightedging and backpatching shall be done at any time after initial compaction has been accomplished.

Rolling shall start longitudinally at the sides and proceed gradually to the center of the pavement, overlapping on successive trips approximately one-half the width of the rear wheel. On superelevated sections, rolling shall progress from the lower to the upper edge of the pavement. Rolling shall continue until the entire surface has been rolled and roller marks eliminated. If the surface checks or cracks while being rolled, it may be necessary to postpone rolling to a later time

when cracking will not occur.

The Engineer may require the surface course to be re-rolled at any time within two (2) weeks after it is laid.

The motion of the roller at all times shall be slow enough to avoid displacement of the mixture. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once by the use of rakes and the addition of fresh mixture if necessary.

To prevent adhesion of the mixture to the roller wheels, the wheels shall be kept properly moistened, but excess water will not be permitted. The use of oil will not be permitted.

Along forms, curbs, headers, walls and at other places not accessible to the roller, the mixture shall be thoroughly compacted with hand tamps or mechanical tampers that furnish equivalent compaction.

Under favorable conditions, when the Engineer deems advisable, public traffic shall be placed on the newly laid course.

The surface of the mixture after compaction shall be smooth and true to the established crown and grade. Any mixture that becomes loose and broken, mixed with dirt or in any way defective, shall be removed and replaced with fresh mixture, which shall be immediately compacted to conform to the surrounding area.

405.15 Joints. Joints shall meet the requirements and specifications of **Subsection 401.32**.

405.16 Protection of Surface. The newly constructed surface shall be protected from traffic until the mixture has hardened sufficiently not to be distorted.

Parking shall not be permitted on the surface until it hardens so that the weight of the vehicles will not cause dis-

placement. The surface course shall be kept clean and free from foreign material when the shoulders are being constructed.

405.17 Surface Requirements. Finished surfaces shall meet the requirements and specification in **Subsection 401.35**.

405.18 Plant Tickets. Plant tickets shall meet the requirements specified in **Subsection 401.37**.

405.19 Method of Measurement. The quantity of Cold Mix Asphalt Surface of the type specified shall be the number of tons weighed on approved scales and actually incorporated in the completed and accepted work.

Deductions will be made for all bituminous mixture wasted or lost due to the negligence of the Contractor, bituminous mixture applied in excess of the rate specified or directed in writing, and bituminous mixture applied beyond the limits of the work.

405.20 Basis of Payment. Cold Mix Asphalt Surface Course of the type specified measured as provided in Subsection 405.19 will be paid for at the contract unit price, which price and payment shall be full compensation for furnishing, mixing, hauling, placing, and compacting all materials including furnishing and application of tack and prime coats, and for all tools, equipment, labor, and incidentals necessary to complete the work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
405XXXX	Cold Mix Asphalt Surface Course (Type *(1, 2, or 3)*)	Ton

SECTION 406

BITUMINOUS SURFACING (DOUBLE TREATMENT), TYPES 1, 2, AND 3 AND CLASS A SPECIAL

406.01 Description. This work shall consist of a wearing surface composed of a bituminous prime coat (when specified herein), an application of bituminous material and aggregate, covered with one or more applications of bituminous material and seal aggregate, constructed on a prepared base, all in accordance with the typical cross-section shown on the plans and to the lines and grades set by the Engineer.

Bituminous surfacing, double treatment, will consist of Types 1, 2, and 3 and Class A Special. The composition, preparation, and methods of construction of each type shall be as provided hereinafter.

MATERIALS

406.02 Cut-back Asphalt (Rapid Curing Type). This material shall conform to the requirements of Grade RC-30 as follows:

	Min.	Max.
Water, percent	--	0.2
Viscosity, Saybolt-Furol @77°F, seconds	75	150

Distillation Test:		
Distillate as percent by volume of total distillate to 680°F	Min.	Max.
to 374°F	15	--
to 437°F	55	--
to 500°F	75	--
to 600°F	90	--

Residue from Distillation to 680°F:	Min.	Max.
Volume percentage of sample by difference	50	--

Tests on Residue from Distillation:	Min.	Max.
Penetration, 100 g, 5 sec, @77°F	60	120
Ductility, 5 cm/min @77°F, cm	100	--
Percent Solubility in Trichloroethylene	99	--

The Saybolt-Furol viscosity shall apply.

406.03 Cut-Back Asphalt (Medium Curing Type). This material shall be Grade MC-30 and shall conform to the requirements of **AASHTO M 82**, except that the penetration of the residue shall be 80 to 250. Saybolt-Furol viscosity shall apply.

406.04 Asphalt Binder. Asphalt binder shall conform to the requirements of **AASHTO MP 1** and shall be PG 58-22 unless otherwise specified.

406.05 Emulsified Asphalt (Anionic). Anionic emulsified asphalt of the grade designated as EA-P Special shall conform to the following requirements:

EA-P Special		
Test:	Min.	Max.
Viscosity, Saybolt-Furol @77°F, sec	15	75
Sieve test @140°F, %	--	0.10
Oil Distillate, % by volume of emulsion	--	8
Asphalt as percentage by weight	40	--

406.06 Cationic Emulsified Asphalt. Cationic emulsified asphalt of the grade designated shall conform to the requirements of **AASHTO M 208**.

406.07 Spraying Temperatures for Asphalt Binder. Asphalt binder shall be sprayed at a temperature between 300°F and 350°F, and MC-30 shall be sprayed at a temperature between 50°F and 120°F. All emulsions shall be sprayed at a temperature between 50°F and 160°F. The exact temperature to satisfy conditions will be set by the Engineer at the time of application.

406.08 Aggregates. The aggregates shall consist of clean, tough, durable particles of crushed stone, crushed or uncrushed gravel, or crushed slag and shall be reasonably free from soft, thin, elongated or laminated pieces, disintegrated particles, vegetable, or other deleterious substances. The use of marine (fossiliferous) limestone will not be allowed.

Crushed stone or gravel shall have an abrasion loss of not more than 60% when subjected to the Los Angeles Abrasion Test (**AASHTO T 96**). Slag shall have an abrasion loss of not more than 45% when subjected to the Los Angeles Abrasion Test.

Dry slag shall have a weight of not less than 75 pounds per cubic foot.

Aggregates No. 5 and No. 789 shall be graded within the required gradation limits.

406.09 Variation in Materials. The pounds of aggregate specified in **Subsection 406.15** are based upon an apparent specific gravity of 2.65. If the apparent specific gravity of the aggregate used by the Contractor is found to be other than 2.65, appropriate adjustments will be made in the number of pounds required per square yard to insure a constant volume of coarse and fine aggregate per square yard of bituminous surfacing.

When slag is used as the aggregate, the amount of bituminous material used in the mat and seal applications shall be increased 15% over that herein specified without additional compensation to the Contractor.

When other aggregates with high absorption characteristics are used, the Engineer may increase the quantity of bituminous material specified for each application to compensate for the absorbed material without additional compensation to the Contractor.

No tolerance below the specified minimum quantity per square yard of bituminous material or aggregate will be allowed, except when the Contractor actually obtains a satisfactory uniform cover with material applied at a rate less than that required by these specifications. If for any reason the Engineer should decide to raise the minimum limit, appropriate notice will be given the Contractor in writing. Any increase in the minimum limit will carry a corresponding increase in the maximum limit. The upper limit specified is intended to give the Contractor some leeway in carrying on the work.

EQUIPMENT

406.10 Distributors. All distributors shall be mounted on pneumatic tires of sufficient width to prevent cutting or breaking the surface bond when the tank is fully loaded. The distributor shall be so designed, equipped, maintained and operated that bituminous material at the required constant tem-

perature and pressure may be uniformly applied (without streaking) at the specified rate. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or calibrated tank, and a thermometer for determining the temperature of the contents. If the yield on the asphalt material should appear to be in error after beginning work, the distributor shall be calibrated in a manner satisfactory to the Engineer before proceeding further with the work. The distributor shall be equipped with a hose and nozzle attachment to be used for spotting areas inaccessible to the distributor spray bars. Distributor spray bars shall be adjustable both laterally and vertically. In order to prevent lapping at the junction of two applications, the distributor shall be equipped with a positive shut-off control.

406.11 Aggregate Spreaders. Aggregate spreaders may be approved self-propelled aggregate spreaders, mechanical type spreaders that are hooked onto the supply truck, or tailgate spreaders. The spreaders shall be so constructed that they may be accurately controlled to distribute the aggregate uniformly and at the required rate.

406.12 Rollers. Tandem rollers specified for use under this Section shall be self-propelled steel-wheel tandem rollers exerting a pressure of from 150 to 225 pounds per inch of roller width in the compression wheel.

Pneumatic-tired rollers of approved design shall be capable of being loaded to a gross weight of at least 8 tons. The pneumatic roller shall be loaded as directed by the Engineer.

CONSTRUCTION REQUIREMENTS

406.13 Weather and Seasonal Limitations. No bituminous surfacing work shall be performed between October 15 and March 15 inclusive except with the written permission of the Engineer.

Bituminous material shall not be applied on a wet surface or when the temperature is below 60°F in the shade and falling, or below 55°F in the shade and rising, or when weather

conditions are otherwise unfavorable.

406.14 Cleaning of Surface. The surface of the roadbed to be treated shall be reasonably dry and shall be clean of all dust, dirt, clay, and all deleterious matter at the time the bituminous material is applied. In performing this work, the Contractor shall use rotary sweepers, hand brooms, mechanical brooms, or other equipment acceptable to the Engineer.

406.15 Sequence of Operations. Bituminous surface treatment shall be applied using quantities and sequence of operations as outlined in the table entitled ***Sequence of Operations and Quantities per Square Yard for Bituminous Surfacing (Double Treatment)*** located in the Appendix of these specifications.

406.16 Application of Bituminous Materials.

A. General. Bituminous material shall not be applied until the base or surface on which the material is to be placed is properly cured, firm, intact, clean, dry, and compacted to the satisfaction of the Engineer and conforms to the typical cross-section shown on the plans and to the lines and grades established by the Engineer.

Bituminous materials shall be applied uniformly by means of a distributor at the rate specified, and within the temperature limits stated herein for the particular material being used. Bituminous material shall be applied for the full width to be treated in one application unless the Engineer directs or permits otherwise. If the material is applied to a partial width at a time, suitable and adequate joints shall be provided between adjacent treatments to insure complete and uniform coverage. At the beginning and end of the distribution of each load, care shall be exercised to insure a neat junction. At all starting and stopping places, building paper or other suitable paper, when directed by the Engineer, shall be spread to permit the operation of the distributor nozzles at full force when the bituminous application begins or ends. This paper shall be

removed immediately after the application and destroyed. Special precaution shall be observed to have the distributing machine so adjusted and operated that an even and uniform distribution of the bituminous material will be obtained. If streaking develops, the distributor shall be stopped immediately and the problem corrected before proceeding. Excessive deposits of bituminous materials upon the road surface shall be immediately removed and corrected in a satisfactory manner. The Contractor, in applying bituminous material, shall use effective means of protecting adjacent structures from discoloration.

B. Prime Coat. The Contractor shall not permit any traffic on the primed base until, in the opinion of the Engineer, the bituminous material has penetrated and dried sufficiently that it does not pick-up under traffic. On sections where it is impracticable to detour traffic, the Engineer may direct the Contractor to furnish and spread, without additional compensation, a minimum quantity of sandy material to avoid pick-up, and traffic shall be allowed on these sections.

The Contractor shall maintain the prime coat and surface of the base course intact until it has been covered by superimposed construction. The bituminous surfacing shall be placed within seven (7) days after the base course has been primed.

When the Engineer so directs, the Contractor shall roll the primed base until the loose material is bonded.

406.17 Determination of Truck Weights. If the truckloads of aggregates are not delivered to the work with weight tickets for each load, in order to determine the application rate, the Engineer may require the Contractor to weigh one round of trucks on approved scales. The trucks shall be weighed both loaded and empty. After the work begins, the trucks shall be loaded in the amount as near as possible as when weighed. The Engineer may require the Contractor at any time to level the aggregates in the truck-bed in order that the volume of

the aggregate may be determined. When the unit weight of the aggregates is known, the Engineer may use this method for determining truck weights instead of weighing if he so elects. The cost of this work shall be considered as being included in the contract unit price for bituminous surfacing.

406.18 Spreading of Aggregate. When asphalt binder is used as the bituminous material, sufficient aggregate to cover the application of asphalt shall be available before the application of asphalt binder. The aggregate shall be available at the site of the work loaded in trucks or shall be delivered in such manner that the asphalt binder will be immediately covered in a continuous operation. The required amount of aggregate shall be uniformly spread with approved spreaders. Trucks or spreaders shall be so operated that the bituminous material will be covered with aggregate before the wheels pass over it. The Engineer may delay the application of mat stone when emulsion is used as the bituminous material. The delay after application of the emulsion shall be only the time necessary for the emulsion to set sufficiently to prevent the aggregate from turning over under the wheels of the vehicles. After the aggregate has been spread, it shall be uniformed by light brooming with drag or rotary brooms along with the rolling operations. Hand brooms shall be used as necessary.

The quantity of mat aggregate in place, after the completion of brooming and rolling, shall be no more and no less than that needed to give a complete cover.

406.19 Rolling. The aggregate applications shall be rolled for their entire width as specified in **Subsection 406.15**. Rolling and light brooming shall be repeated as often as, in the opinion of the Engineer, is necessary to obtain smooth, even surface and to insure thorough keying of the aggregate into the asphalt. The rolling shall be done in a longitudinal direction, beginning at the outer edges of the treatment and working toward the center. Each trip of the roller shall overlap the prior one by one-half the width of the roller. Traffic shall be permitted to use the road as soon as the mat aggregate is spread.

When, in the judgment of the Engineer, the aggregate is sufficiently imbedded in the bituminous material, the Contractor shall remove from the surface all loose excess cover material that may be injurious to the finished road.

406.20 Opening to Traffic. After the seal has been rolled and the bituminous material has cured sufficiently to hold the seal aggregate, the surface shall be opened to traffic. On sections where it is impracticable to close to traffic, the Engineer may direct the Contractor to split the seal stone in two applications and traffic shall be allowed to use these sections.

Where the Engineer directs the seal to be split, the seal aggregate specified herein for bituminous surfacing Types 1 and 2 shall be applied as follows:

1. Immediately after the first application of bituminous material for the seal coat, spread 13 to 18 pounds of No. 789 aggregate per square yard uniformly.

2. Apply second application of bituminous material.

3. Spread 6 to 9 pounds of No. 789 aggregate per square yard.

4. Roll as soon as possible with both the steel wheel and pneumatic roller.

The total weight of both seal aggregate applications shall be not less than 22 pounds per square yard. The additional work involved in placing the split seal shall be performed without additional compensation.

406.21 Maintenance. In addition to the maintenance required as specified in **Subsection 104.07**, the Contractor will be required to repair all spotty or bleeding places or any defects that may occur during or after the bituminous surfacing operations. Necessary repairs shall be made in a manner that will restore a uniform surface and insure durability of the portion repaired.

406.22 Method of Measurement. The quantity measured for payment shall be the number of square yards of bituminous surfacing of the type specified in the contract completed, accepted, and measured in-place along the surface of the road. Material placed outside of the area designated to be treated shall be disregarded in computing the number of square yard.

For the purpose of verifying rates of application and measuring materials authorized to be applied at a rate greater or lesser than that required by these specifications, the following rules shall apply:

1. Measurement in all cases shall be based on material actually and properly incorporated into the bituminous surfacing and shall exclude losses due to the negligence of the Contractor or other circumstances as determined by the Engineer.

2. The quantities of bituminous materials used will be based on the volume of the material at the temperature of 60°F. Volumes measured at higher or lower temperatures will be corrected to the volume of the material at 60°F.

3. The weights of mat and seal aggregates when shipped by railroad will be based on proven railroad weights of this material, with appropriate deductions to cover losses in shipment because of damaged cars, negligence of the Contractor in handling the material, or other circumstances, as determined by the Engineer. Weights of aggregates not shipped by railroad will be based on the truck weight tickets or will be based on proven weight per unit of volume as delivered and properly incorporated into the bituminous surfacing.

406.23 Basis of Payment. The accepted quantity, measured as provided in **Subsection 406.22** will be paid for at the contract unit price per square yard for Bituminous Surfacing-Double Treatment, including prime coat when specified, which price and payment shall be full compensation for furnishing, hauling, applying, spreading and rolling all materials and for all labor, equipment, tools, maintenance and incidentals necessary to complete the work.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
406XXXX	Bituminous Surfacing (Double Treatment) Type *(1, 2, 3, or Class A Special)*	Square Yard

406.24 Substitution of Asphalt Concrete Surface Courses for Bituminous Surfacing (Double Treatment). When requested in writing, the Engineer may, at his discretion, allow the Contractor to substitute 150 pounds (average) per square yard of Asphalt Concrete Surface Course, Type 1, 3, or 4 conforming to the requirements set forth in **Section 403** instead of the bituminous surfacing at the same unit price for bituminous surfacing. This substitution will not be allowed when bituminous surfacing is used on paved shoulders as a safety measure.

In computing the average pounds per square yard, the total weight placed on each road will be used to compute the average pounds per square yard for the road. A tolerance of minus 3% from the specified average pounds per square yard will be permitted. However, the depth of the Asphalt Concrete Surface Course shall be at least 0.8 inch at any point in the roadway. The Contractor shall correct any deficiencies without any additional compensation. The amount of asphalt binder to be placed in the mix shall be set by the Engineer, and no separate or additional payment will be made for this

material.

Should the average rate per square yard of surface course be less than the 3% tolerance as allowed above, the amount paid the Contractor shall be reduced. The quantity of square yards shall be reduced by the percentage that the actual average rate varies from 150 pounds per square yard. The actual rate per square yard shall be determined from field measurements and approved weight tickets. Priming shall be performed as required in **Subsection 401.28**.

SECTION 407

BITUMINOUS SURFACING (SINGLE TREATMENT) TYPES 1, 2, AND 3

407.01 Description. This work shall consist of a wearing surface composed of a single application of bituminous material covered with aggregate, constructed upon a prepared base course, existing base or surface course, or the old road surface, all in accordance with these specifications and in conformity with the typical cross-section shown on the plans and to the lines and grades set by the Engineer.

MATERIALS

407.02 Bituminous Materials.

A. Asphalt Binder. Liquid asphalt binder shall conform to the requirements of **AASHTO MP 1** and shall be PG58-22 unless otherwise specified.

B. Emulsified Asphalt. Emulsified asphalt shall be grade CRS-2 and shall conform to the requirements specified in **Subsection 406.06**.

407.03 Aggregate. Aggregate No. 6M shall consist of either crushed stone, crushed slag or gravel and shall meet the quality requirements in **Subsection 406.08** except that crushed stone or crushed slag shall be used on projects where the bituminous surfacing will not be covered by a subsequent layer. Aggregate No. 89M shall be crushed stone and shall meet the quality requirements of **Subsection 406.08**. Gravel will be allowed where subsequent layers are specified, provided the subsequent layer is placed immediately following the placement of the bituminous surfacing. The use of marine (fossiliferous) limestone will not be allowed. Aggregates No. 6M and No. 89M shall be graded within the required gradation limits.

407.04 Variations in Materials. Variations in materials shall conform to the requirements specified in **Subsection 406.09**.

EQUIPMENT

407.05 Equipment Requirements. Equipment shall conform to the requirements specified in **Subsections 406.10 through 406.12**.

CONSTRUCTION REQUIREMENTS

407.06 Weather and Seasonal Limitations. Weather and seasonal limitations shall be as specified in **Subsection 406.13**.

407.07 Preparation of Base. The base or existing surface shall be cleaned for its full width of all dust, clay, or other deleterious matter before bituminous materials are applied.

407.08 Sequence of Operations. Bituminous surface treatment shall be applied using quantities and sequence of operations as outlined in the table entitled ***Sequence of Operations and Quantities per Square Yard for Bituminous Surfacing (Single Treatment)*** located in the Appendix of these specifications.

407.09 Application of Bituminous Materials. Application of bituminous materials shall conform to the requirements specified in **Subsection 406.16**. The temperature at which the bituminous materials are sprayed shall be within the limits specified in **Subsection 406.07**.

407.10 Determination of Truck Weights. Truck weights shall be determined as specified in **Subsection 406.17**.

407.11 Spreading of Aggregate. The Aggregate shall be spread as specified in **Subsection 406.18**. The Contractor shall exercise care not to spread an excessive amount of aggregate that may become a hazard.

407.12 Rolling. The aggregate shall be rolled as specified in **Subsection 406.19** with the following additions: The rolling with the steel wheel roller shall consist of a minimum of two complete passes over the entire treatment area. Rolling with a pneumatic roller shall consist of a minimum of two complete passes over the entire treatment area. Additional passes of the pneumatic roller may be directed by the Engineer. Rolling with the steel wheel roller shall be halted if excessive crushing of aggregate is occurring.

407.13 Maintenance. Maintenance shall conform to the requirements specified in **Subsection 406.21**.

407.14 Method of Measurement. The quantity measured for payment shall be the number of square yards of Bituminous Surfacing (Single Treatment) of the specified type, completed, accepted, and measured in-place along the surface of the road. Material placed outside of the area designated to be treated shall be disregarded in computing the number of square yards.

In order to verify rates of application, the quantities of materials used will be measured as provided in **Subsection 406.22**.

407.15 Basis of Payment. The accepted quantity will be paid for at the contract unit price for Bituminous Surfacing (Single Treatment) of the specified type, which price and payment shall be full compensation for furnishing, hauling, applying, and rolling all materials and including all, tools, equipment, labor, maintenance, and incidentals necessary to complete the work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
407XXXX	Bituminous Surfacing (Single Treatment) Type *(1, 2, or 3)*	Square Yard

SECTION 408

BITUMINOUS SURFACING (TRIPLE TREATMENT) TYPES 1 AND 2

408.01 Description. This work shall consist of a wearing surface composed of a bituminous prime coat when specified and applications of bituminous material and spreading of aggregate, constructed on a prepared base, all in accordance with these specifications and in conformity with the typical cross-section shown on the plans and to the lines and grades set by the Engineer.

MATERIALS

408.02 Bituminous Materials.

A. Emulsified Asphalt. Emulsified asphalt shall be grade CRS-2 and shall conform to the requirements specified in **Subsection 406.06**.

B. Prime. Materials for priming shall be RC-30, MC-30, or EA-P Special and shall meet the requirements specified in **Subsections 406.02**, **406.03**, and **406.05**.

408.03 Aggregate. Aggregates No. 5, No. 6M, No. 89M, and No. 789 shall conform to the requirements specified in **Subsection 406.08**, including the provision concerning marine (fossiliferous) limestone.

Aggregate No. FA-13 shall consist of crushed stone, crushed or uncrushed gravel or sand. The aggregate shall be free from clay balls and adherent films of clay.

Washed screenings may be used in lieu of Aggregate FA-13 in Bituminous Surfacing (Triple Treatment) Type 2, and shall meet the following gradation:

Washed Screenings

Sieve Designation	Percentage by Weight Passing
3/8"	100
No. 4	90-100
No. 8	80-100
No. 30	25-55
No. 100	0-10
No. 200	0-4

408.04 Variation in Materials. Variation in materials shall conform to the requirements specified in **Subsection 406.09**.

CONSTRUCTION REQUIREMENTS

408.05 Equipment. Equipment shall conform to the requirements specified under **Subsection 406.10** through **406.12**, and in addition shall conform to the following: When Aggregate No. FA-13 or washed screenings are used, a spreader equipped with a mechanical device that will spread the Aggregate No. FA-13 or washed screenings at a uniform rate.

408.06 Weather and Seasonal Limitations. Weather and

seasonal limitations shall be as specified in **Subsection 406.13**.

408.07 Cleaning of Base. Cleaning of base course shall conform to the requirements specified in **Subsection 406.14**.

408.08 Sequence of Operations. Bituminous surface treatment shall be applied using quantities and sequence of operations as outlined in the table entitled ***Sequence of Operations and Quantities per Square Yard for Bituminous Surfacing (Triple Treatment) Types 1 and 2*** located in the Appendix of these specifications.

408.09 Applications of Bituminous Materials. The bituminous material shall be applied as specified in **Subsection 406.16**. The temperature at which the bituminous materials are sprayed shall be within the limits specified in **Subsection 406.07**.

408.10 Determination of Truck Weights. Truck weights shall be determined as provided in **Subsection 406.17**.

408.11 Spreading of Aggregate. Spreading of aggregate shall conform to the requirements specified in Subsection **406.18**. The Aggregate No. FA-13 shall be spread using equipment specified in **Subsection 408.05**.

408.12 Brooming and Rolling. Except for the spreading of aggregates No. 789 and No. 89M applied for second layer, each layer of aggregate shall be rolled following spreading as directed by the Engineer. Rolling shall be performed with a steel wheel tandem and pneumatic roller. Rolling and light brooming with drag or rotary brooms shall be repeated as often as, in the opinion of the Engineer, is necessary to obtain a smooth, even surface and to insure thorough keying of the aggregate into the asphalt. Broom operations should be delayed until the asphalt has set sufficiently to hold the stone and prevent the broom from turning the stone over. Traffic shall be permitted to use the road as soon as the mat aggregate is spread. When, in the judgment of the Engineer, the

aggregate is sufficiently embedded in the bitumen, the Contractor shall remove from the surface all loose excess material.

The rolling of the final layer shall be started as soon as sufficient aggregate is spread to prevent pickup and continued until the aggregate is worked into the surface. The initial rolling of the final layer shall be performed with the steel wheel roller. Light brooming with drag or rotary brooms shall begin as soon as possible after the rolling has started and the surface set sufficiently to prevent excessive marking of the seal surface. Further light brooming shall be done as often as necessary to keep the cover aggregate uniformly distributed over the surface. Brooming, rolling and back-spotting shall be continued until the top surface is compacted, bonded and cured to the satisfaction of the Engineer. All surplus aggregate shall be swept off the surface before final acceptance.

408.13 Maintenance. Maintenance shall conform to the requirements specified in **Subsection 406.21**.

408.14 Method of Measurement. The quantity measured for payment shall be the number of square yards of bituminous surfacing, completed, accepted, and measured in-place along the surface of the road. Material placed outside of the area designated to be treated shall be disregarded in computing the number of square yards.

In order to verify rates of application, the quantities of materials used will be measured as provided in **Subsection 406.22**.

408.15 Basis of Payment. The accepted quantity, measured as provided in Subsection 408.14 , will be paid for at the contract unit price for Bituminous Surfacing-Triple Treatment of the specified type, including prime coat when specified, which price and payment shall be full compensation for furnishing, hauling, applying, spreading, and rolling all materials, and including all, tools, equipment, labor, maintenance, and incidentals necessary to complete the work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
408XXXX	Bituminous Surfacing (Triple Treatment) Type *(1 or 2)*	Square Yard

408.16 Substitution of Asphalt Concrete Surface Courses for Bituminous Surfacing (Triple Treatment). Substitution shall be in accordance with the requirements of **Subsection 406.24**.

DIVISION 500

RIGID PAVEMENT

SECTION 501

PORTLAND CEMENT CONCRETE PAVEMENT

501.01 Description. This work shall consist of constructing a pavement composed of portland cement concrete, constructed on a prepared **subbase** or **base course** in a monolithic course in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross-sections shown on the plans or established by the Engineer. Concrete pavement shall normally be constructed using a slip-form paver and stationary side forms shall be used where necessary.

MATERIALS

501.02 Portland Cement, Fly Ash, and Water-Granulated Blast-Furnace Slag. Portland cement, fly ash and water-granulated blast-furnace slag shall meet the requirements of **Subsections 701.02**, **701.03**, and **701.04,** respectively.

When fly ash or water-granulated blast-furnace slag is used, it shall be used in accordance with the requirements contained in **Subsection 701.25**.

501.03 Air-Entraining Admixtures. Unless otherwise specified, all concrete shall be air-entrained. Air-entraining admixtures shall comply with the requirements of **Subsection 701.06**.

501.04 Fine Aggregate. Fine aggregate shall meet the requirements as specified in **Subsection 701.10**.

501.05 Coarse Aggregate. Coarse aggregate shall be Aggregate No. 56 or Aggregate No. 57, meeting gradation and quality requirements as specified in **Subsection 701.11**.

After designated sources are approved by **Research and Materials Laboratory** tests, no change in the sources or character of the material shall be made without due notice to the Engineer and further approval by the Research and Materials Laboratory.

501.06 Water. Water shall meet the requirements of **Subsection 701.12**.

501.07 Joint Fillers. Filler for preformed or sawed joints shall be the type specified and shall be placed in accordance with joint details as shown in the plans. All materials shall be used in accordance with the manufacturer's recommendations regarding preparation of joint walls, application temperatures and necessary equipment to assure proper material placement.

A. Preformed Joint Filler. Preformed joint filler shall conform to the requirement of **AASHTO M 213**. All preformed joint fillers shall have a thickness equal to the width of the joint required and shall be furnished in lengths equal to the width of the slabs in which they are to be installed. The preformed joint filler shall be so shaped that, after installation, the upper and lower surfaces will conform to the shape of the slab and subbase surfaces. The lower surface of the preformed joint filler shall be on or below the surface of the subbase and the upper surface, unless otherwise specified, shall be 1/2 inch below the surface of the slab.

A preformed material composed of 100% scrap tire rubber, shredded and fused into cohesion with a non-toxic, odorless, and tasteless formulated polyurethane binder will be allowed. The shreds shall be treated to resist most types of microbes, oils, fungi, and biological growth. It shall comply with physical properties of

AASHTO M 153, (ASTM D 1752, Type I.)

B. Silicone Sealant. Silicone sealant shall be low modulus and furnished in a one-part silicone formulation. The sealant shall be compatible with the surface to which it is applied. The silicone sealant shall not require heat or primers in order to attain a bond to the joint walls. Acid cure silicone sealants are not acceptable for use on portland cement concrete. Silicone sealant shall be from a approved source on the Department's **Approval List** entitled *Silicone Sealants for Portland Cement Concrete Pavements*. Sawed joints (transverse and longitudinal), unless otherwise specified, shall be filler will a silicone sealant

After source approval, the manufacturer shall furnish with each shipment of materials a certification showing brand name, South Carolina File Number for the project, the shipping date, to whom it is shipped, and the quantity represented in the shipment. The certificate shall contain a statement that the material meets the Department's specifications and is essentially the same as that approved by the Department. The shipped containers shall be plainly marked with the manufacturer's name, lot number, trademark, type of silicone, and end of shelf life date. A materials safety data sheet and installation instruction shall be furnished with each shipment.

C. Bond Breaker. Silicone sealant must be installed over a bond breaker to prevent the sealant form bonding to the bottom of the joint. Bond breaker shall be chemically inert and resistant to oils, gasoline, and solvents. The bond breaker must not stain or adhere to the sealant. Bond breaker shall be a backer rod or tape identified and used in accordance with the plans.

The backer rod shall be of circular cross-section and consist of closed cell polyethylene foam. Generally, it will be 25% greater diameter than the saw cut width.

Bond breaker tape shall be 0.005 inch minimum thick-

ness made from extruded polyethylene and shall have a pressure sensitive adhesive on one side.

A certification shall be furnished by the manufacturer of the backer rod stating that it complies with the Department specification for closed cell polyethylene foam and that the tape is the polyethylene type.

D. Hot Poured Joint Sealant. Hot poured joint sealant shall conform to the requirements of **AASHTO M 301** (**ASTM D 3405**).

501.08 Reinforcing Steel. Reinforcing steel bars for use in concrete pavement shall be of the type, length, size, spacing and quantity shown on the plans and shall meet the requirements specified in **Section 703** and hereinafter specified.

501.09 Tie Bars, Dowel Bars, and Reinforcements. Tie bars and reinforcing steel shall be deformed steel bars conforming to AASHTO M 31, (ASTM A 615), Grade 60. Dowel bars shall be plain, round bars conforming to the requirements of **AASHTO M 31** or **M 42** (**ASTM A 615 or A 616**), Grade 60. They shall be free from burring or other deformation restricting slippage in concrete. Dowel bars shall be coated with an approved material to break the bond between the steel and concrete. Sleeves for dowel bars at expansion joints shall be metal of an approved design to cover 2 inches (±1/4 inch) of the dowel, have a closed end, and have a suitable stop to hold the end of the sleeve at least one inch from the end of the dowel bar.

Wire and wire mesh shall conform to the requirements specified in **Section 703**.

501.10 Curing Materials. Curing materials shall conform to the following requirements:

A. Burlap Cloth Made from Jute or Kenaf. This mate-

rial shall conform to **AASHTO M 182**, Class 3 (10 ounces/yard) or Class 4 (12 ounces/yard).

B. Sheet Materials for Curing Concrete. Waterproof paper, polyethylene film, and white burlap-polyethylene sheet shall conform to the requirements of **AASHTO M 171**.

C. Liquid Membrane-Forming Compounds. Liquid curing compounds shall meet the requirements of **Subsection 702.04**.

501.11 Paving Concrete. Paving concrete shall conform to the following requirements:

A. Proportions. Concrete shall be composed of portland cement, fine aggregate, coarse aggregate, fly ash, water-granulated blast-furnace slag, water and chemical admixtures and shall meet the requirements of **Subsection 701.20** to produce concrete of the specified strength and workability.

B. Concrete Strength. The mix will be designed to produce concrete with a minimum job average flexural strength of 550 psi at the age of 14 days. The concrete shall contain the amount of cement as directed by the Engineer but in no case shall the concrete contain less than 5.5 bags of cement or allowable equivalent when using fly ash or slag per cubic yard of concrete. The water cement ratio, including moisture on the aggregates, shall not be more than 0.53 (6 gal. / bag). This shall be maintained by use of chemical admixtures and/or additional cement if necessary.

C. Trial Batches. At least forty-five (45) days before the beginning of concrete placement, a proposed mix design with data shall be furnished by the Contractor to the Research and Materials Laboratory for mix design approval. Trial batch tests shall be performed using proposed materials furnished by the Contractor. These tests shall be

conducted at the Research and Materials Laboratory in Columbia or at the Contractor's facilities under the supervision of the Research and Materials Laboratory personnel. Selection of the location shall be at the sole discretion of the Research and Materials Engineer.

The concrete mix will first be batched with the proportioning as proposed by the Contractor. Should the proposed design not give adequate strength and workability and meet all the physical requirements, it will be redesigned to the satisfaction of the Contractor and the Engineer.

Concrete from the trial batches will be molded, cured and tested in accordance with **AASHTO T 97** to determine the flexural strength of the concrete at the age of fourteen (14) days. From the trial batch tests, an approved mix design will be established and furnished to the Contractor. A furnished mix design will not relieve the Contractor from producing quality concrete and will not limit further negotiating of changes in the mix design if necessary.

D. Workability of Concrete. Concrete shall be uniformly plastic and workable. The consistency of the concrete shall be determined by the slump test in accordance with **SC-T-42**. The slump shall be in the range of 1 to 2 1/2 inches for slip-form paving and 4 inches maximum for hand or other means of paving. Additional slump shall be obtained by the addition of chemical admixtures while maintaining the job approved water cement ratio. The Contractor shall strive to provide a uniform slump of approximately 2 inches for slip-form paving equipment. The percentage of entrained air voids in the mix shall be from 3% to 6%. When the concrete fails to meet the requirements for workability, the mix design will be adjusted to correct the condition.

Batches produced which have slumps and air void contents outside the above stated ranges shall not be used in the work.

E. Field Sampling and Curing. After the mix proportions and water cement ratio required to produce concrete of the specified strength have been determined, placing of the concrete may be started. The strength of the concrete in the completed pavement will be determined by flexural strength test specimens made in 6 inches x 6 inches x 20 inches steel molds. Test beams will be made in accordance with **SC-T-46**.

A minimum of four beam specimens shall be made to represent each day's run or each 1500 cubic yards of concrete, whichever is smaller.

F. Testing. The beams made and cured as specified above will be tested as follows to determine the flexural strength at 14 days. One beam of the set may be tested at 3 to 7 days or as directed by the Engineer in order to anticipate the 14-day strength. If based on previous experience, the 3 to 7 day projections indicate that the 14-day strength will be below that specified, appropriate mix adjustments will be made. One beam of each set will be tested at 14 days in the field laboratory or in the Research and Materials Laboratory. Two beams of each set will be tested at 14 days in the Research and Materials Laboratory. The 14-day average strength shall be computed by averaging the results of the above 3 beams.

Individual beam strength values that are more than 10% above or below the strength for the set of 3 beams may be rejected as non-representative.

When the concrete fails to meet the requirements for workability or strength, the Contractor will correct the condition by changing the mix design. When testing indicates that a concrete batch has a 14-day flexural strength of 500 psi or less, the Engineer will investigate the causes of the low test results. The Engineer, at his discretion, may require the material to be replaced or accepted at a reduced pay factor if it is determined that the low test results

are due to nonconforming concrete rather than normal test variation.

G. Re-tempering and Admixtures. Re-tempering concrete by adding water or by other means will not be permitted. Concrete that is not within the specified slump limits at the time of placement shall not be used. Admixtures for changing the workability for accelerating the set will be permitted only when there has been an acceptable mix design authorized by the Engineer.

501.12 Field Materials Tests. The Contractor shall furnish the concrete necessary for making concrete job control test specimens. He shall also furnish necessary labor to obtain samples, make specimens, and testing of materials as required in the quality control process.

EQUIPMENT

501.13 Equipment. All equipment and tools necessary for handling materials and performing all parts of the work shall be on the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved by the Engineer. The equipment shall be maintained in a satisfactory working condition at all times until completion of the work.

A. Subbase Planer. The subbase planer shall have a cutting edge or edges, set to conform accurately to the specified subbase elevations. The planer shall be fully energized, self-propelled, and designed for the specific purpose of planing the subbase to the true grade and cross-section. Scratch planers with spikes or teeth will not be permitted.

B. Batching Plant and Equipment.

1. General. The batching plant shall include bins, meters, weighing hoppers and scales for weighing and measuring the fine aggregate, the coarse aggregate,

cement, fly ash, slag, water and admixtures. The cement weighing hoppers shall be properly sealed and vented to preclude dusting during operations. The batch plant shall be equipped with a suitable batch counter which will correctly indicate the number of batches proportioned. The batching plant may be manually controlled or automatically controlled.

All batching equipment in automatic plants shall be 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 included in the system are closed. The automatic batching equipment shall be capable of conversion to manual operation if necessary.

The designated batch weights for bulk cement and each separate aggregate component shall be verified as directed by the Engineer before the batch cycle starts. The Contractor shall make satisfactory provisions for batching other components of the mix at the batching plant or at the roadside paver as may be necessary.

2. Bins and Hoppers. Bins with adequate separate compartments for fine aggregate and coarse aggregate shall be provided at the batching plant. Each compartment shall discharge efficiently and freely into the weighing hopper or hoppers and shall be equipped to control the discharge at variable speeds and to shut off cleanly for proper proportioning. Means shall be provided to enable the removal of overloads of the aggregates before their being charged into the mixer. Weighing hoppers shall be constructed to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Partitions between compartments, both in bins and in hoppers shall be ample to prevent spilling under any working conditions.

3. Scales, Meters, and Dispensers. The scales for

weighing aggregates, water, and cement shall be of beam type, springless dial type, or load cell type. They shall be accurate within 0.5%, when used for cement and within 1.0% when used for aggregate and water under operation conditions throughout the range of use. When beam-type scales are used, provisions, such as a “tell-tale” dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached. A device on the weighing beams shall indicate the critical position clearly. Poises shall be designed to be locked in any position to prevent accidental change of position. The weigh beam and “tell-tale” device shall be in full view of the operator while charging the hopper and the operator shall have convenient access to all controls. Clearance between scale parts, hoppers and bin structure shall be such as to avoid displacement of, or friction between, parts due to accumulations, vibration, or other causes. Pivot mountings shall be designed so that none of the parts will jar loose and to assure unchanged spacing of knife-edges. Scales shall be so designed that all exposed fulcrums, clevises, and similar working parts may readily be kept clean. Weigh beams shall have leveling lugs, and weighing parts of other type scales shall be provided with means for precision adjustment. Scales shall be inspected and sealed at the expense of the Contractor as often as may be deemed necessary by the Engineer to assure their continued accuracy.

Cement shall be measured by weight on a separate scale and hopper. A boot or other approved means to transfer the cement from the weighing hopper shall be provided. Satisfactory methods of handling shall be employed.

Weighing of each material shall be such that the batch weights required will be within a tolerance of one percent for cement and water and two percent for aggregates. Meters for measuring water shall operate

within a tolerance of one percent.

Separate devices, accurate within 3%, easily adjustable and satisfactory to the Engineer, shall be provided in the system for measuring the amounts of chemical admixtures to be added to each batch.

C. Mixers.

1. General. Concrete shall be mixed in central mix plants, except that truck mixers and roadside pavers may be used when authorized by the Engineer. Each mixer shall have attached to it, in a prominent place, a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the recommended speed of rotation of the mixing drum or blades.

Mixers shall be examined daily for accumulation of hard concrete or mortar and wear of blades. The Contractor shall have available at the job site, a copy of the manufacturer's design showing dimensions and arrangement of blades in reference to original height and depth. The blades shall be repaired or replaced when they are worn down one inch or more.

2. Central Mixing Plant. Central mixing plants shall meet the requirements set forth in **Subsection 701.15**.

3. Truck Mixers. Truck mixers shall meet the requirements set forth in **Subsection 701.16**.

4. Roadside Paver Mixers. Roadside mixers, where allowed by the Engineer, shall be original in design and in good working condition. Each mixer shall be inspected and approved by the Engineer before starting work.

D. Transporting Vehicles.

1. Non-Agitator Trucks. Bodies of non-agitating hauling equipment for centrally mixed concrete shall be metal with rounded internal corners. They shall be equipped with vibrators and shall be capable of discharging the concrete at a satisfactorily controlled rate without segregation.

2. Truck Mixers and Truck Agitators. Truck mixers used for mixing and hauling concrete shall meet the requirements set forth in **Subsection 701.16**.

3. Dry Batch Trucks. Vehicles for transporting batched unmixed materials from the batching plant to the roadside paver mixer shall be equipped with batch boxes, containers or bodies of adequate capacity and construction to properly carry the dry volumes required. Partitions separating batches shall be constructed to prevent spilling of the weighed batches from one compartment to another while in transit or when being dumped.

All transporting equipment and accessories used in the proportioning and transportation of concrete materials to the roadside paver mixer shall be so designed and operated as to insure the charging of the mixer with the previously weighed amounts of each material required for each batch without over-spilling or intermixing of batches or wastage.

E. Slip-Form Paver. The slip-form paving machine shall be fully energized, self-propelled and designed for the specific purpose of placing concrete in one pass without the use of fixed side forms. It shall be capable of consolidating and finishing the concrete pavement true to grade and cross-section. No external tractive force shall be applied to the machine. The paver shall be 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 will occur. The paver shall vibrate the concrete for the full width and depth of the layer being placed and shall install a continuous strip of plastic for forming longitudinal weakened plane joints when this method of forming longitudinal joints is being used. The slip-form paver shall be equipped with necessary electronic or hydraulic devices to control the finish elevation of the pavement from a cord. The Engineer may require the use of these controls on a part or all of the paving work in the contract.

F. Concrete Spreaders. The spreader shall be a self-propelled machine, equipped with a power-driven device for spreading the concrete uniformly between the forms without segregation, and provided with an adjustable blade or other approved means for striking off the concrete to the required height and crown. The spreader shall be equipped with effective cleaning devices to insure proper contact at all times between the wheels and the contact surface. Wheels that are supported by an adjacent slab shall have no flanges in contact with the slab.

G. Forms. Straight side forms shall be of sufficient thickness to maintain the true cross-section of the forms and shall be furnished in sections no less than 10 feet in length. Forms shall have a depth equal to at least the prescribed edge thickness of the concrete pavement without horizontal joint and a base width no less than 8 inches. Flexible or curved forms of proper radius shall be used for curves of 150 foot radius or less. Flexible or curved forms shall be of an acceptable design. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base no less than 2/3 the height of the form. Forms with battered top surfaces and bent, twisted or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. Built-up forms shall not be used except where the total area of

pavement of any specified thickness on the project is less than 3000 square yards. Built-up forms will be allowed to extend the form depth 25%. The build-up shall be securely attached to the bottom of the form. The width of the build-up shall be equal to the bottom of the form. The top face of the form shall not vary from a true plane by more than 1/8 inch in 10 feet and the upstanding leg shall not vary by more than 1/4 inch. The forms shall be equipped for locking the ends of abutting form-sections together tightly for secure setting.

H. Finishing Equipment.

1. Finishing Machine. The finishing machine shall be equipped with at least two oscillating type transverse screeds.

2. Vibrators. Vibrators for full width vibration of concrete paving slabs may be either the surface pan type or the internal type with either immersed tube or multiple spuds. They may be attached to the spreader or the finishing machine or mounted on a separate carriage. They shall not come in contact with the joint, load transfer devices, **subgrade** or side forms. The frequency of the surface vibrators shall be no less than 3500 impulses per minute and the frequency of the internal type shall be not less than 5000 for tube vibrators and 7000 for spud vibrators, unless modified by the Engineer. When spud type internal vibrators, either hand operated or attached to spreaders or finishing machines are used adjacent to forms, they shall have a frequency of not less than 3500 impulses per minute. Vibrators attached to a separate carriage, spreader or finishing machine shall be equipped with a control to shut off the operation automatically when forward motion stops. The Contractor shall have and maintain necessary tachometers to verify the frequency of the vibrators.

3. Tube Finisher. The tube finisher shall be a self-

propelled machine of the type and design that will produce a satisfactory finish to the concrete as determined by the Engineer.

4. Hand Tools. The Contractor will have available appropriate straight edge tools to complete the finishing of the slab.

I. Transverse Groover. A mechanical device that is essentially a metal comb capable of spanning the width of the pavement shall be available to produce the transverse grooves. The metal comb shall consist of a single line of tempered spring rectangular steel tines or other approved material uniformly spaced at 1/2 inch centers and securely mounted in a suitable head. The metal comb shall be attached to a mechanical device capable of traversing the entire pavement width in a single pass at a uniform speed. The device shall be an independent separate unit complete in itself and shall not be attached to equipment performing other functions except that it may be part of the curing membrane spray unit. Small or irregular areas may be grooved by hand methods.

J. Curing Membrane Spray Equipment. A mechanical device capable of spanning the width of the pavement shall be provided to uniformly apply the white pigmented curing compound. It shall be self-propelled and equipped with proper pumps and nozzles to spray the slab while traveling at a uniform speed. Small or irregular areas may be sprayed by hand methods.

K. Rain Protection. A mechanical device with an appropriate supply of rolled polyethylene capable of spanning the pavement shall be available at all times along with the other paving equipment. This device shall be such that the polyethylene can be mechanically unrolled on the portion of the slab that has not set enough to resist rain in case of a rain shower.

L. Concrete Saws. The Contractor shall provide sawing

equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate. The saws shall be equipped with water-cooled diamond edge saw blades or abrasive wheels. The Contractor shall provide at least one standby saw that is in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.

M. Miscellaneous Equipment. The Contractor shall provide other tools and equipment, of approved design, necessary for the satisfactory completion of the work.

N. Equipment to Heat and Apply Elastic Joint Filler. The melter/applicator shall be a conventional double boiler type melter with a bottom-sweeping agitator. It shall be equipped with at least a 16 horse-power engine, an agitator in first class working condition, a reliable rotary pump with a 2-inch minimum port size without an internal pressure relief valve, a full 2-inch manual bypass that will allow circulation of the sealant from the pump back into the vat at the farthest possible point away from the pump intake and a 15 foot high-pressure sealing hose with a one inch inside diameter coupled to a sealing wand with a 3/4 inch to 1 inch inside diameter with appropriate insulation to maintain the sealant temperature. Temperature controls and indicators on the melter/applicator unit shall be maintained to a degree of accuracy that can be totally relied upon. A partition shall be provided in the vat to hold the fresh unheated sealant at the farthest possible point away from the pump intake until the sealant is liquefied. A recording thermometer shall be provided for recording the temperature of the liquefied sealant in relation to time, while the melter is being operated.

O. Equipment to Place Silicone Sealant. Equipment to place silicone sealant shall be manually or power oper-

ated. An air compressor and air powered extrusion pump shall be used for the transfer of the sealant from either drums or pails through high-pressure hoses to the joint. Seals, hoses, and hose connections shall be such as to prevent moisture permeation to prevent the sealant from curing prematurely before being installed in the joint. The seals and packing shall be made of TEFLON or equivalent and the hoses shall be lined with TEFLON or equivalent.

The wand for installing the joint sealant shall be made to install the sealant from the bottom up in the joint and shall stay below the top surface of the joint at all times. The proper tooling device shall be available to shape the top surface of the sealant to the proper configuration at the proper time.

All equipment capacities, hose diameter, pump pressures, etc. shall be according to the sealant manufacturer's recommendations.

P. Field Office and Laboratory. The Contractor shall provide and maintain a fully equipped field office and laboratory for performing the quality control inspection and testing at the concrete plant. The buildings shall be used exclusively by the Engineer or his representative. They shall have satisfactory electric lighting and electrical outlets. The building shall have appropriate floor space and inside height along with workbenches, chairs, and sufficient water supply for tests and cleaning testing equipment. The field office building shall be so equipped that with the windows and doors closed the inside temperature can be maintained between 65°F and 80°F. The buildings shall be located in close proximity to and have a full view of the Contractor's plant.

The Contractor shall furnish and maintain in good condition at the field laboratory building all required equipment. Required equipment shall consist of tanks for holding the beam specimens under water controlled at 60°F to 78°F and verified by recording thermometer, equipment to

test fine and coarse aggregate and necessary tools and vibrators for molding specimens. The equipment to test coarse aggregate shall consist of a Gilson shaker with appropriate sieves, a sample splitter with openings approximately 50% greater than the largest particle size, and appropriate scale apparatus for weighing materials. The equipment to test fine aggregate shall consist of a mechanical sieve shaker, appropriate sieves, and an appropriate balance for weighing. The Department will furnish molds and the test machine to perform flexural testing of the concrete beam specimens. The Contractor shall furnish a calibrated compression-testing machine for necessary field testing of cylinders if required.

The Contractor shall furnish the necessary labor to assist the Engineer in obtaining samples of concrete and aggregate, testing, making, handling, and curing the specimens.

CONSTRUCTION REQUIREMENTS

501.14 Preparation of Subbase. The **subbase** shall be brought to reasonably close conformity to the lines, grades, and typical sections shown on the Plans or as designated by the Engineer.

All soft and yielding materials and other portions of the subbase which will not compact readily when rolled or tamped shall be removed and all loose rock or boulders found in the earth excavation shall be removed or broken off to a depth of not less than 6 inches below the surface of the subgrade. All holes or depressions made by the removal of material as described above shall be filled with approved material and the whole subbase compacted and brought to line and grade.

The subbase for concrete base courses or pavements shall include an area 3 feet in width extending beyond the edges of the base course or pavement unless shown otherwise on the plans. When curb and gutter is constructed contiguous with the pavement the subbase shall include an area

2 feet in width extending beyond the back of the curb and gutter. The subbase shall be completed for at least 2500 feet in advance of concrete placing operations when this distance is available.

501.15 Conditioning of Subbase or Base Course.

A. Compaction. The entire subbase or base shall be thoroughly compacted. Any portion of the subbase that is not accessible to a roller shall be compacted with hand tampers to obtain the density requirements for the material.

B. Protection. Before placing any surfacing material on any section, ditches and drains along that section shall be completed to drain the subgrade effectively. In handling materials, tools, equipment, etc., the Contractor shall protect the subbase or base from damage. If ruts are formed, the subbase or base shall be reshaped and re-rolled. At all times, the subbase or base surface shall be kept in such condition that it will drain readily. Until the subbase or base has been checked and approved, no material shall be deposited thereon.

C. Finish for Subbase. Before paving begins, the subbase shall be brought to proper cross-section. High areas shall be trimmed to proper elevation. Low areas may be filled and compacted to a condition similar to that of surrounding grade, or filled with concrete integral with the pavement. No additional compensation will be made for concrete used to correct low subbase. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed. An approved type of subbase or base grader that follows a chord line for grade or rides on the forms shall be used in forming the crown and shaping the subbase to insure that the specified thickness of the finished pavement is secured. The grader shall have the capacity of cutting the surface without reducing compaction. After grading, rubber tired rollers may be required to recondition the surface a sufficient distance

ahead of the placement of concrete to allow necessary inspection and testing of the subgrade.

501.16 Slip-Form Concrete Paving.

A. Slip-Form Method. Where practicable, the slip-form paving machine shall be used. The Contractor shall adopt procedures that shall result in a satisfactory product. No wheeled equipment that disturbs the track lane for other equipment or does not perform satisfactorily will be allowed in the paving train.

No vehicular traffic or mixing equipment will be allowed on the completed grade without the permission of the Engineer.

B. Placing Concrete. The concrete shall be placed with an approved slip-form paving train designed to spread, consolidate, screed, float-finish, texture and place cure material in one complete operation. Slumping of the concrete will not exceed 3/8 inch from a typical cross-section. However, slump at longitudinal construction joints shall not exceed 1/4 inch from a typical cross-section.

The slip-form paving machine shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the machine held to a minimum. If for any reason it is necessary to stop the forward movement of the machine, the vibratory and tamping elements shall also be stopped immediately. Except in an emergency, no tractive force shall be applied to the machinery except that which is controlled from the machine.

The Contractor shall employ such devices and procedures that will insure proper consolidation of the concrete and proper positioning of reinforcement, tie bars, and dowels for joints to produce a monolithic slab.

Areas inaccessible to slip-form paving equipment shall be paved in accordance with the provisions for stationary side forms.

501.17 Fixed Form Concrete Paving.

A. Base Support. The subbase under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any subbase that at the form line is found below established grade shall be filled to grade with granular material in lifts of 1/2 inch or less for a distance of 18 inches on each side of the base of the form, and thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting; except in the case of cement stabilized bases, the removal of random knots or high areas will not be permitted. Imperfections in cement stabilized bases shall be treated as required in **Sections 307** and **308**.

B. Form Setting. After the forms have been set to correct grade, the subbase shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. No settlement or springing of forms under the finishing machine will be permitted.

Forms shall be staked into place with not less than 3 pins for each 10-foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not deviate from true line by more than 1/4 inch at any point. Forms shall be cleaned and oiled before the placing of concrete.

The Contractor shall set and maintain sufficient forms and shall conduct his operations so that the final minor corrections, compaction of subbase and checking and approval of forms shall be complete at least 800 feet in advance of the point of depositing concrete when this distance is available.

C. Removing Forms. Except for auxiliary forms used temporarily in widened areas, forms shall not be removed from freshly placed concrete until it has set at least 8 hours. Forms at the end of contraction joints to be sawed may be removed as soon as joints can be sawed without raveling. Form pullers that depend on the new pavement for support shall not be used at any time. As soon as the side forms have been removed, any minor honeycombed areas shall be filled with mortar, composed of one part of portland cement to two parts of fine aggregate by weight. Major honeycombed areas will be considered as defective work and shall be removed and replaced. After the forms have been removed, the sides of the slab shall be sprayed with curing compound.

501.18 Handling, Measuring, and Batching Materials for Concrete. In stockpiling aggregates, the location and preparation of the sites, the minimum size of pile, and the method adopted to prevent coning or other segregation of component sizes shall be subject to the approval of the Engineer. Stockpiles shall be built up in layers of not more than 3 feet in thickness. Each layer shall be completely in place before beginning the next. Each subsequent layer shall not be allowed to cone down over the previous layer. Under no circumstances will coning of stockpiles be permitted. Aggregates from different sources shall not be stockpiled together unless approved by the Engineer. The area on which materials are to be stockpiled shall be cleared of vegetation and other extraneous materials and shall be smooth, firm, and well drained.

Aggregates shall be handled from stockpiles or other sources to the batching plant in a manner to secure a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used.

All aggregates produced or handled by hydraulic methods

and all washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipments requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregate contains a high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Engineer.

The fine aggregate and coarse aggregate shall be separately weighed into the hopper in the respective amounts set by the Engineer in the job mix approval. Cement, fly ash, and slag shall be measured by weight in scales and hoppers separate from the aggregate scales and hoppers. This equipment shall be equipped with devices to positively indicate the complete discharge of each batch of material into the mixer.

When mixing is to be done at the job site, materials shall be transported from the batching plant to the mixer in vehicles conforming to the requirements specified in **Subsection 501.13D.3**. The Contractor shall use a suitable method of handling the cement from the weighing hopper to the transporting container or into the batch itself for transportation to the mixer (with chute, boot, or other approved device) to prevent the loss of cement and arrange to provide positive assurance of the actual presence in each batch of the entire cement content specified.

In the dry batch process, bulk cement shall be transported to the roadside paver in watertight compartments carrying the full amount of cement required for the batch, or, if permitted, between the fine and coarse aggregate. Batches where cement is placed in contact with the aggregates may be rejected unless mixed within 1 1/2 hours of such contact.

Dry batches shall be delivered to the mixer separately and intact. Each batch shall be dumped into the mixer without the loss of cement and when more than one batch is carried on the truck, without spilling of material from one batch compartment into another.

Water may be measured either by volume or by weight. The accuracy of the water-measuring equipment shall be within a range of error of one percent or less and shall be arranged so that the measurement will not be affected by variations of pressure in the water supply line and will be accurate under all construction conditions encountered. Unless the water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

Methods and equipment for adding the air-entraining agent or other admixtures into the batch shall meet the requirements of **Subsection 701.19D**. Equipment that will not accurately and continuously dispense the correct amount of admixture will not be permitted.

501.19 Weather and Lighting Conditions. Weather restrictions described in **Subsection 702.19** shall govern the concrete operations except that concrete operations shall not be undertaken or continued when the air temperature in the shade and away from artificial heat is 40°F or lower. When the temperature is expected to fall below 32°F, paving will not be permitted in order to prevent damage to the pavement by frost action during the early curing stages. The Contractor will be responsible for the quality and strength of the concrete placed during cold weather and any concrete injured by frost action shall be removed and replaced without additional compensation.

The concrete shall be mixed only in such quantities as are required for immediate use. Any concrete that has stood, after mixing and before placing, until its consistency is below the limits specified, or is not plastic and workable, shall not be used in the work.

Concrete shall not be mixed when either the coarse or the fine aggregate contains frozen particles.

No more concrete shall be mixed than can be placed, finished, and covered during daylight, unless an adequate artificial lighting system is approved and operating.

501.20 Mixing Concrete. The concrete may be mixed at the work site, in a central-mix plant, in truck mixers when allowed, or in a roadside paver.

A. Central Plant Mixing. The plant operations shall meet the requirements specified in **Subsection 701.22D** and the additional requirements or changes as set forth below.

1. Mixing Time. Mixing time for mixers having a rated capacity greater than 2 cubic yards shall not be less than 90 seconds. Any charging time in excess of 20 seconds shall be added to the required 90 second mixing time. Mixing time may be increased by the Engineer if necessary to produce a homogeneous mass.

2. Overload. An overload up to 10% above the mixers nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency is satisfactory and no spillage of concrete occurs.

3. Elapsed Time. Mixed concrete from the central-mixing plant shall be transported in truck mixers, truck agitators or non-agitating trucks. The time elapsing from the time water is added to the mix until the concrete is deposited in place shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, or 60 minutes when hauled in truck mixers or truck agitators. Under unusual conditions and depending upon ambient temperature, the Engineer may allow a slight increase in the elapsed times specified above provided the slump of the concrete, without retempering, is no

less than the average slump for the concrete previously placed, and the concrete is, from visual inspection, otherwise satisfactory.

B. Truck Mixing. The truck mixers shall meet the requirements specified in **Subsection 701.22E**.

C. Roadside Paver Mixer. For concrete mixed at the work site in roadside pavers, mixing time shall be measured from the time all materials, except water, are in the drum and shall not be less than 60 seconds. Four seconds shall be added to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is considered part of the mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein. Unless otherwise permitted, the mixer shall be operated outside the lane of pavement being placed.

The site mixer shall be operated at a drum speed as shown on the manufacturer's nameplate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet, as shown on the manufacturer's AGC standard rating plate on the mixer; except that an overload up to 10% above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation and uniform consistency are satisfactory and provided no spillage of concrete takes place.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

501.21 Placing Reinforcing Steel. Load transfers, as shown on the plans, shall be provided at bridge ends; for the

two approach slabs at each bridge end; and shall be provided for successive slabs adjacent to the approach slabs at each bridge end and at other locations indicated on the plans. The spacing of the joints on the successive slabs adjacent to the reinforced approach slabs may be varied to compensate for any added distances to accommodate the reinforced approach slabs. The minimum width of any slab shall be 16 feet, and the maximum length shall be 25 feet. All other steel shall be placed in accordance with the plans.

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.

Reinforcing steel shall be free from dirt, harmful rust, scale, paint, grease, oil, or any other harmful material that could impair bond of the steel with the concrete.

Dowel bars and tie bars shall be placed as shown on the plans.

501.22 Placing Concrete. When the placing of concrete is started, the amount of equipment and supply of materials shall be sufficient to insure that placing will be continuous for any given working period.

The pavement shall be constructed to its full width in a single operation unless it is otherwise required that it be by other transverse sections, the longitudinal joint line between these sections shall not deviate from the true line shown on the plans by more than 1/4 inch.

The batches shall be deposited to require as little re-handling as possible. Any necessary re-handling shall be with rakes. Workers shall not walk on the fresh concrete with footwear coated with earth or other foreign matter.

The Contractor shall take necessary precautions to prevent segregation of the concrete ingredients while being placed. The discharge end of depositing equipment shall be provided with baffles or other satisfactory devices if considered necessary. All conveying equipment shall be kept clean.

Concrete shall be placed over and against the joints in such a manner as will insure that joints, dowel bars and load transfer assemblies are retained in correct position.

Unless unavoidable, placing shall be continuous between transverse joints without the use of intermediate bulkheads, except as hereinafter provided for construction joints.

Concrete shall be thoroughly consolidated against the faces of all forms and joints, including concrete in a previously constructed lane of pavement, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade or a side form. The vibrator shall not operate more than 15 seconds in any one location. In no case, shall it be operated in a way that brings excess mortar to the surface or causes segregation in the mix. Vibrators shall meet the requirements specified in **Subsection 501.13H.2**.

No concrete shall be placed around a manhole or similar structure until it has been adjusted to proper grade and alignment and the casting completely surrounded by preformed joint material required in **Subsection 501.07A**.

Where concrete is placed adjacent to a previously constructed lane of concrete pavement, the previously constructed concrete shall be at least 10 days old or shall have obtained a modulus of rupture of at least 500 psi as shown by tests of standard specimens. On areas where hand methods of placing and finishing are allowed as specified in **Subsection 501.23**, the fresh concrete may be placed when the previously constructed concrete is 5 days old. The Contractor shall be responsible for any damage caused by the operation of mechanical equipment on any existing pavement lanes. If

any concrete materials fall on or are worked into the surface of a completed slab, they shall be removed immediately by approved methods.

In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently set, the Contractor will be required to have available, at all times, necessary material for the protection of the edges and surface of the fresh concrete. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing materials to protect the surface and edges of the fresh concrete. Immediately after the rain ceases, the Contractor shall make all repairs necessitated by damage from the rain to the pavement, as directed by the Engineer.

501.23 Final Strike-Off, Consolidation, and Finishing.

A. Consolidation and Strike-Off. The Contractor will be required to construct main line pavement and interchange ramp pavement using one or more finishing machines meeting the requirements of **Subsection 501.13H.1**. The machine equipment shall be of an approved type designed to strike-off, consolidate, and finish the concrete pavement. As soon as it is placed and vibrated, the concrete shall be struck-off accurately and screeded with approved equipment, so when it is consolidated and finished, the surface of the pavement will have the required elevation and cross-section.

A sufficient and uniform amount of concrete to insure filling all voids and depressions shall be carried in front of screed at all times. The rate of placement shall not exceed the finishing capacity of the single or multiple finishing machines being used.

The operations shall be controlled so an excess of mortar and water will not be worked to the top. Segregated particles of coarse aggregate that may have collected in front of the screed shall be thoroughly mixed by hand with the unfinished concrete already on the sub-

grade. Under no circumstances, shall aggregate particles be carried forward by the finishing machine and pushed onto the subgrade in front of the mass. The finishing machine shall be operated to prevent damage to joint installations or an existing adjacent slab.

Hand methods of placing, compacting and finishing shall not be used except as follows:

1. When a breakdown of the finishing machine or other emergency occurs and then only for the concrete already mixed or in the process of mixing.

2. On widened portions at bridges, intersections and portions widened beyond traffic lanes.

3. Where the dimensions of the work make the use of power-operated machinery impracticable.

4. At other places permitted by the Engineer or these specifications.

Where hand methods are used, the concrete shall be tamped to insure maximum compaction and a minimum of voids. It shall be leveled slightly above the required finished surface. Then it shall be struck-off to the true surface with a strikeboard with a mechanical vibrator capable of imparting impulses at a rate of no less than 3500 per minute rigidly attached. The strikeboard shall be moved forward with a combined longitudinal and transverse motion and with both ends resting on the forms. The entire area shall be gone over a sufficient number of times, but not less than two, and at intervals that will produce the desired results. A slight excess of concrete shall be carried ahead of the cutting edge.

B. Floating. After the concrete has been struck-off and consolidated, it shall be further smoothed and trued by means of an approved longitudinal float or an approved transverse smoothing float.

1. Hand Methods. Hand methods may be used only if specifically permitted. The hand-float shall be no less than 14 feet long and 6 inches wide, properly stiffened to prevent warping and flexibility and reasonably light to prevent its working into the surface. The use of a distorted float will not be permitted.

Floating shall be in an approximately longitudinal direction from one edge to the other. The float shall be worked along the surface with a sawing motion to each edge and with the forward operator slightly ahead. After each complete transverse operation, there shall be a 1/2 lap longitudinally. The operators handling the float shall be supported by bridges that entirely clear the surface of the pavement.

2. Transverse Smoothing Float. The transverse smoothing float shall be a machine with a smoothing float suspended from and guided by a rigid frame. The frame shall be carried by the forms and have a minimum effective wheelbase of 14 feet. The length of the float shall be approximately 2 inches less than the normal width of the pavement and be adjusted to the required crown. The weight of the float shall be adjusted and coordinated with the finishing screed ahead so a small amount of mortar is carried ahead of the float at all times.

The forward speed of the float shall be adjusted to keep starting and stopping to a minimum.

If necessary, following one of the preceding methods of floating, long-handled floats having blades no less than 5 feet long and 6 inches wide may be used to smooth and fill in open textured areas in the pavement. Long-handled floats shall not be used to float the entire surface of the mainline pavement instead of or supplementing one of the preceding methods of floating. On any pavement other than mainline pavement, floating may be done with a long-handled 10 foot long by

4 inch to 6 inch wide float.

C. Checking and Surface Corrections. As soon as the longitudinal or final floating is complete, all laitance, surplus water, and inert material shall be worked off the surface. The surface shall be made smooth by a scraping or dragging motion with the long-handled 10-foot straightedge. This straightedge shall be placed at the center of the pavement with the blade parallel to the centerline and then pulled slowly and uniformly to the edge. The blade shall then be moved forward one-half its length and the operations repeated until the surface is free from irregularities and makes contact with the blades at all points.

During this checking operation, any remaining depressions shall be filled with fresh concrete and struck off. Projections shall be removed and the checking and correcting continued until the surface has the required smoothness and contour. Care shall be taken to preserve the required crown.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved equipment.

D. Final Finishing. After the surface has been prepared as described above and the water sheen has practically disappeared, the pavement shall, unless otherwise specified or directed, be textured with a drag strip. The drag strip shall consist of a seamless strip of damp burlap, cotton fabric, or artificial turf that shall produce a uniform surface of gritty texture after dragging it longitudinally with a slight back and forth transverse motion along the full width of the pavement.

For pavement 16 feet or more in width, the drag shall be an integral part of the paving train or in the case of stationary side forms shall be mounted on a bridge that

travels on the forms. The dimension of the bottom edge of the drag strip shall be at least 3 feet. The bottom edge of the drag strip shall be in full contact with the pavement surface for the full width of the pavement. The drag shall consist of not less than two layers where burlap fabric is used, with the bottom layer approximately 6 inches wider than the upper layer. The drag shall be maintained in a condition that produces a concrete surface of uniform appearance and reasonably free from grooves over 1/16 inch in depth. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted.

In order to obtain the desired surface qualities or texture, the Engineer may require the use of an approved belt and belting procedure or an approved brooming operation. A belting or brooming operation may be required separately, jointly, or along with the fabric or turf drag. When all finishing is complete, the texturing shall be performed by mechanical equipment for grooving plastic concrete that utilized rectangular shaped spring steel tines. The tines shall be evenly spaced at intervals of approximately 1/2 inch on center. The tines shall produce transverse grooves in the hardened surface of the concrete that are approximately 0.08 inch to 0.12 inch in width and approximately 0.10 inch to 0.15 inch in depth. The finished surface shall meet all straight edge tolerances and rideability and smoothness requirements.

E. Edging at Forms and Joints. Before the concrete has taken its initial set, the edge of the pavement along each side of each slab and on each side of formed joints shall be worked with an approved tool and rounded to the radius required by the plans. A well-defined and continuous radius shall be produced and a smooth dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.

At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. In doing so, the rounding of the corner of the slab

shall not be disturbed. All concrete on top of the joint filler shall be completely removed.

All joints shall be tested with a straightedge before the concrete has set and correction made if one side of the joint is higher than the other or if they are higher or lower than the adjacent slabs.

501.24 Curing. Immediately after the finishing operations have been completed and immediately after the surface water has disappeared, the entire surface of the concrete pavement shall be cured by mechanically applying a uniform coating of the white pigmented curing compound.

If the compound is not applied immediately, the surface shall be kept thoroughly wetted with a fine spray of water until the application of the compound is started. Joints shall be so protected by an approved method that the compound will not enter the joint. The white pigmented compound shall be applied in one or two applications as required by the manufacture's recommendations or as directed by the Engineer. When applied in two applications, the second shall follow the first within 30 minutes.

The compound shall be applied in a continuous uniform film by means of a power-operated pressure spraying or distributing equipment at the approved rate, but not less than 0.06 gallon per square yard of surface. The equipment for applying the compound shall provide for adequate agitation of the compound during application and shall be approved before work is started. If the compound is too thick for satisfactory application during cold weather, the material may be warmed in a water bath with a temperature not exceeding 100°F. Thinning with solvents will not be permitted. Should the method of applying the compound produce a non-uniform film, corrections shall be made immediately.

If rain should fall on the newly coated pavement before the film has dried sufficiently to resist damage or if the film is damaged in any other way, the Contractor shall apply a new

coat of material to the affected areas equal in curing value to

that specified for the original coat. The treated surface shall be protected from damage until the expiration of the curing period. All vehicles and pedestrian traffic will be considered injurious to the film of the applied compound and will be prohibited from using the pavement. However, a minimum of walking may be permitted on the dried film as necessary to carry on the work properly, provided any damage to the film is immediately repaired by the application of a second coat of the compound. If there should be a breakdown of the spraying equipment, protection of the uncoated pavement shall be provided.

501.25 Protection of Pavement. All vehicle traffic shall be excluded from the newly constructed pavement for a period of not less than 14 days, unless the Engineer directs that sections be opened to traffic at an earlier date. Time during the curing period, when the atmospheric temperature is below 40°F shall not be considered or counted. Time when the temperature is in the range of 40°F to 50°F shall be considered at only one-half of the actual time.

Concrete with Type III cement shall be cured for a period of 48 hours in the manner specified herein, or until test specimens indicate a modulus of rupture of 550 psi, whichever is greater. The facility may then be opened to traffic unless weather or other conditions make it advisable to extend this time.

When required by the Engineer, the Contractor shall erect and maintain suitable barricades and shall furnish satisfactory and competent personnel to exclude traffic from the newly constructed pavement for the period herein prescribed. The barriers shall be arranged to not interfere with or impede public traffic on any lane intended to be kept open. The signs, barricades, and lights necessary to clearly indicate the lanes open to traffic shall be maintained by the Contractor. Should it become necessary to move traffic across a lane of pavement from which traffic must be temporarily prohibited, the

Contractor shall, without additional compensation, construct suitable and substantial crossings to bridge over the concrete. These crossings shall be adequate for traffic and satisfactory to the Engineer. Any part of the pavement damaged by traffic or other causes occurring before its final acceptance shall be repaired or replaced by the Contractor in a satisfactory manner. The crossing and pavement repair or replacement shall be done without cost to the Department.

All ditches and drains shall be maintained to provide effective drainage.

A berm of earth adjacent to the pavement edges shall be placed and maintained to prevent underwash of the pavement slab if directed by the Engineer.

501.26 Joints.

A. General Requirements. Longitudinal and transverse joints shall be constructed at the locations and in accordance with the dimensions and other requirements shown on the plans or in the special provisions.

Longitudinal joints shall be constructed parallel to the pavement centerline unless otherwise required. Transverse joints shall be at right angles to the pavement centerline or at the **skew angle** shown on the plans and shall extend the full width of the pavement. All joints shall be constructed true to line with their faces perpendicular to the pavement surface.

The surface of the pavement adjacent to all joints shall be finished to a true plane and unless otherwise specified, the edges of the pavement at all joints shall be rounded to a radius of 1/8 inch or beveled on a 45° angle at the top 1/16 inch to 1/8 inch on each side with an approved mechanically powered rock or disc as shown on the plans or hereinafter specified. The surface across the joints shall be tested with an approved straightedge as the joints are finished and irregularities shall be corrected before the

concrete has hardened.

When the pavement is placed in lanes or partial width slabs, or when existing pavement is widened, transverse joints shall be placed in line with like joints in the adjacent pavement unless otherwise shown on the plans.

When keyed construction joints are required, the key shall be constructed by fastening a wooden strip or a deformed metal plate to the form to produce a continuous keyway conforming to the dimensions shown on the plans. When the adjacent slab of concrete is placed, it shall be carefully consolidated by vibrating or spading along the edge to insure the forming of the key portion of the joint without pockets or honeycomb.

When deformed steel bars are used in keyed joints or in plain butt-type construction joints, they may be bent at right angles against the form of the first lane or portion constructed and straightened into final position before the concrete of the adjacent lane or section is placed.

Dowel bars shall be placed across transverse joints at locations and in accordance with details shown on the plans. Dowels shall be held in position, parallel to the surface and centerline of the pavement, by an approved metal dowel support that will remain in the pavement. The dowels shall be treated as required in **Subsection 501.09** to permit free horizontal movement.

When used in expansion joints, one end of each dowel shall be treated and capped with a close fitting, closed end, metal sleeve as required in Subsection 501.09.

Preformed expansion material used in joints shall be prepared in accordance with **Subsection 501.07A** and shall be placed perpendicular to the pavement surface.

B. Longitudinal Joint. Longitudinal joints shall be constructed in all concrete pavement 16 feet or more in width.

If a particular type is not specified, the joint shall be sawed when two adjacent lanes are placed monolithic.

Tie bars of the specified length, size, spacing, and material shall be placed in all longitudinal contraction and longitudinal construction joints. The bars shall be placed perpendicular to the longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement.

1. Longitudinal Sawed Joints. Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width, and line shown on the plans. Suitable guides or devices shall be used to assure cutting the longitudinal joint on the true line as shown on the plans. The longitudinal joint shall be sawed before the end of the curing period or immediately thereafter and before any equipment or vehicles are allowed on the pavement. Joint sealing shall be as required in **Subsection 501.27**. Beveling of longitudinal sawed joint will not be required.

When adjacent lanes are constructed separately and where required by the plans, a trapezoidal keyway of the dimensions shown on the plans shall be secured to the side forms along the longitudinal joint. Tie bars may be two-piece bolt assemblies as shown on the plans or deformed bars bent at right angles against the form at the first lane constructed and bent back without breaking into final position before the concrete is placed in the adjacent lane. Longitudinal joints so constructed shall be free of surface fins extending beyond the vertical face of the joint and shall be sawed and sealed as specified above.

2. Longitudinal Weakened Plane Joints. The Contractor may form longitudinal weakened plane joints by placing an approved continuous strip of plastic instead of sawing the joint. The plastic shall not react ad-

versely with the chemical constituents of the concrete or bond with the concrete. The plastic strip shall have a minimum thickness of not less than 0.020 inch and a depth not less than 1/4 of the thickness of the slab plus 1/2 inch. The final vertical position of the insert shall be within 10 degrees of a plane normal to the surface of the concrete. The top edge of the strip shall be flush with the finished concrete. The final alignment of the inserted strip shall be uniformly parallel with the centerline of the pavement and shall be free from local irregularities in alignment that exceed 1/2 inch in 10 feet.

In the event the Contractor demonstrates that he is not able to consistently form a satisfactory weakened plane joint, he shall, upon being notified by the Engineer, discontinue the forming of such joints and saw the longitudinal contraction joints as specified in **Subsection 501.26B.1** above.

C. Expansion Joints. Expansion joints of the types specified shall be constructed at the locations shown on the plans or as directed. Dowel bars, if required, shall be furnished and placed in accordance with the requirements specified in **Subsection 501.26A** above. Premolded joint filler shall be appropriately punched to admit the dowels.

The expansion joint filler shall be continuous from form to form and shaped to the subgrade and to the keyway along the form. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved.

The expansion joint filler shall be held in a position normal to the surface. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall deviate no more than 1/4 inch in the horizontal alignment from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent

units. No plugs of concrete will be permitted anywhere within the expansion space.

Transverse expansion joints will not be required, except at bridge ends, unless otherwise specified on the plans. Transverse expansion joints shall have a thickness of one inch, unless otherwise specified.

D. Transverse Contraction Joints. Transverse contraction joints shall be constructed to the dimensions, lines and spacing shown on the plans. They shall be skewed and the spacing shall be randomized when so indicated on the plans. Transverse contraction joints shall be of the sawed type. The forming of joints by using preformed parting strips of any kind is prohibited. Sawed joints shall be constructed as follows:

> Sawed contraction joints shall be joints established by sawing grooves in the surface of the pavement with an approved concrete saw. After each joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly cleaned.
>
> Sawing of the joints shall commence 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 must be expected in order for the sawing process to prevent uncontrolled shrinkage cracking. If sharp edged joints are being obtained, the sawing process shall be speeded up to the point where some raveling is observed. This process shall continue during the day and night regardless of the weather conditions until the day's paving has been sawed. In case of emergency and the sawing procedure gets behind, every third transverse joint shall be sawed as a control system to prevent cracking until raveling is again observed.

E. Transverse Construction Joints. Transverse con-

struction joints shall be made whenever placing of concrete is suspended longer than 30 minutes. Sections of pavement less than 10 feet in length between joints will not be permitted unless directed by the Engineer. To form the joint, a suitable and satisfactory header board, cut to the required cross-section and drilled to receive the dowel bars, shall be accurately set and securely held in a plane perpendicular to the surface. Dowel bars as specified shall be installed in the drilled holes and the concrete thoroughly vibrated.

When the placing of concrete is resumed, the header board shall be carefully removed and any surplus concrete on the subgrade shall be removed. The fresh concrete shall be deposited against the previously placed concrete, and the surface across the joint shall be finished true to grade and cross-section to avoid detriment to the riding qualities of the pavement. The joint will not require a joint sealant.

501.27 Sealing Joints. After curing is completed, both longitudinal and transverse joints shall be filled with the specified sealant. The required joint configuration to receive the seal shall be formed by sawing as outlined in **Subsection 501.26**. Immediately following the sawing operation, the joints shall be flushed with a high-pressure water jet to remove the slurry and any loose material from the joint faces. Joint washing shall be performed in one direction to prevent re-contamination.

Once the joint is dry and before final cleaning begins, it shall be sandblasted to remove contaminants, including membrane curing compound. Sandblasting shall be done in two passes, one for each face, with the nozzle held at an angle to the joint face and within 1 to 2 inches of the pavement. Sandblasting shall be done the same day as the sealing operation and repeated if rain showers occur between initial sandblasting and sealing.

The blast material as well as dust and dirt deposited by

wind and traffic shall be blown out of the joint and away from the area around it using a high-pressure air blast. The air compressor shall produce at least 90 psi and shall be equipped with traps capable of removing moisture and oil from the compressed air. As with the water, the air blast shall move in only one direction to prevent re-contamination of the joint.

Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the Engineer before installation of sealant. All joints to be sealed must be sound, clean, dry, and frost free. Just before placing of the backer rod, the cleanliness of the joint walls shall be judged by rubbing a finger across the dry joint face to assure that residual cement and/or dust has been removed. Joints that still contain dust or have become dirty or contaminated shall be re-cleaned.

After cleaning has been completed, the backer rod shall be placed at the proper depth to form the bottom of the seal. The bond breaker shall be compatible with the sealant. Installation methods and equipment shall be in accordance with the manufacturer's recommendations. Backer rods shall then be made leak proof where required by caulking with a silicone product compatible with the sealant to be used. This may be applied from tubes with a caulking gun device.

The sealant shall then be placed in the joint in accordance with the plan configuration by means of an appropriate pump equipped with a nozzle that is narrow enough to place the material from the bottom up in the joint. The material shall be placed to establish a surface profile the desired depth below the surface of the pavement. All equipment for placing the seal and methods of placement shall be in accordance with the sealant manufacturer's recommendations.

Final cleaning, placing of the bond breaker, and placing of the sealant shall be performed in a continuous operation. Once the final cleaning and sealing operation has begun on a section of pavement, no traffic, construction vehicles, or other equipment shall be allowed on the section of pavement for a

minimum of two hours or until the seal material has cured.

Joints not properly sealed shall have the sealant removed for the full sealant depth, be thoroughly cleaned and resealed in accordance with this specification at no expense to the Department where directed by the Engineer.

Any material spilled on the pavement shall be immediately removed. Solvents shall not be used to remove spills, because they generally carry the materials further into the porous concrete or spread them on the surface.

The silicone sealant shall conform to the requirements of **Subsection 501.07B** and shall be handled and applied as follows:

1. The power extrusion pump shall be connected to either the drum or pail of sealant.

2. All seals on the drum, pail, hoses, and hose connections shall be properly connected to prevent moisture permeation.

3. All hoses and connections shall be cleaned to be assured that blockage from prematurely cured sealant has not occurred. All hoses and connections shall have been previously cleaned.

4. After the final cleaning of the joints, the backer rod shall be installed to the proper depth. The depth is measured from the pavement slab surface to the top of the backer rod.

5. The sealant shall be installed in a single continuous pass from the bottom to the top of the joint.

6. The sealant shall then be tooled to the desired depth and joint configuration and allowed to cure to a tack free condition before allowing traffic on it.

501.28 Requirements for Smoothness and Rideability.
The surface of the concrete pavement shall be true to the specified crown and grade. When an unsatisfactory riding surface is detected, the Engineer shall notify the Contractor that this condition exists. Any defective areas including any unsatisfactory riding surfaces shall be corrected without additional compensation. As soon as the concrete has cured sufficiently to permit walking on it, but not later than 9:00 AM the day following its placement, the surface shall be checked with a 10 foot straightedge or other approved device to check the surface contour. Any curing agent removed during straightedging shall be replaced immediately. All variations of 1/8 inch or more, exclusive of texturing corrugations, shall be plainly marked on the surface. The Contractor shall immediately correct them by rubbing with a carborundum brick and water. In no case shall rubbing be done so that contact with the coarse aggregate is made and the enveloping mortar is broken. If any variations of 1/8 inch or more remain after compliance with the above provisions, they shall be removed by the Contractor, at his expense, with a power-driven grinding machine after the concrete has reached its approximate full strength, but not before it is 30 days old.

Unless otherwise specified in the special provisions, the Department will test the rideability of ground and textured pavement with a Mays Ride Meter. The pavement will be considered acceptable provided the relative roughness does not exceed 55 inches for each mile of each vehicle lane when tested in accordance with the requirements of ***Test Method for Determining Pavement Roughness with the Mays Ride Meter***, or if it satisfies requirements in accordance with test methods specified in the special provisions. If the pavement is not acceptable, the Contractor shall correct the deficiencies to the satisfaction of the Engineer and at not cost to the Department.

Any random cracking determined by the Engineer to be detrimental to the concrete pavement shall be removed and replaced without additional compensation.

When removal is required, the minimum length of slab removed shall be 10 feet in length and shall be the full width of the lane involved. If a remaining length of slab adjacent to a joint is less than 10 feet in length, that portion of slab shall also be removed and replaced. Additional requirements for smoothness in the area of replaced slabs may be required in the special provisions.

501.29 Slabs Adjacent to Bridge Ends and Bar Mat Reinforcement. The length of the first and second slab section from bridge ends shall be the length indicated on the plans and shall contain bar mat reinforcement as shown on the plans. The length of the slab adjacent to skewed bridge ends shall be measured along the centerline of the slab. The left side or right side of this slab shall be increased or decreased as necessary to conform to the bridge **skew**.

The thickness of the two approach slabs at each bridge end may exceed the slab thickness of the remainder of the road. The thickness shall be in accordance with the plans. For measurement purposes, the additional thickness shall be converted to equivalent square yards of slab of the nominal plan thickness. No direct payment will be made for furnishing and placing reinforcing steel mat reinforcement in approach slabs.

501.30 Tapers at Acceleration and Deceleration Lanes. The method of widening for tapers shall be as shown on the plans or as approved by the Engineer.

501.31 Adjacent Lane Construction. Unless otherwise shown on the plans or in the special provisions, the pavement shall be constructed in double lanes; that is, two adjacent lanes paved in a single operation. Whenever possible, the concrete transport vehicles or roadside pavers shall be operated 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, the equipment may be operated upon a newly paved strip with approval of the Engineer. The Contractor shall make a written request and secure written ap-

proval for such operation. The request shall set forth the kind, size and type of equipment; the proposed size of batch; and the safeguards to be installed to prevent damage to the existing pavement.

501.32 Pavement Thickness Tolerance. The thickness of the pavement shall be determined by caliper measurement of a core or the average of caliper measurements of cores cut from the pavement by the Contractor at locations selected by the Engineer. If the measurement or average of measurements is less than the thickness specified in the plans, the area of pavement represented by the deficient cores will either be accepted, replaced or subject to a reduced payment depending on the severity of the deficiency.

A. Averaging of Core Measurements. In calculating the average measurement of the cores, individual measurements that are more than the specified thickness by more than 0.2 inch shall be limited to the maximum of the specified thickness plus 0.2 inch. Measurements that are less than the specified thickness by more than 0.5 inch shall not be included in the average.

B. Representative Areas and Core Measurements.

1. Normal Width Through Lanes. For pavements with uniform cross-sections, each 1000 linear feet, or fraction thereof, of each traffic lane will be considered one area unit. The Engineer will select one or more cores as he sees fit in each area unit.

If the core measurement or the average of the core measurements is deficient by 0.2 inch or less from the plan thickness, full payment will be made.

If the core measurement or the average of the core measurements is deficient by more than 0.2 inch, but less than 0.5 inch from the plan thickness, an adjusted unit price as specified in **Subsection 501.32C,** will be paid for that area of pavement.

2. Varying Width Pavement. For intersections, entrances, crossovers, ramps, and other pavements with varying cross-sections, each 1000 square yards of pavement, or fraction thereof, will be considered as one area unit. The Engineer will select one core location in each area unit.

If the core measurement is deficient by 0.2 inch or less from the plan thickness, full payment will be made.

If the core measurement is deficient by more than 0.2 inch, but less than 0.5 inch from the plan thickness, two additional cores will be taken from the area represented, and the average of the three cores determined. If the average measurement of the three cores is deficient by 0.2 inch or less from the plan thickness, full payment will be made. If the average measurement of the three cores is deficient by more than 0.2 inch, but less than 0.5 inch from the plan thickness, an adjusted unit price as provided in Subsection 501.32C , will be paid for that area of pavement.

C. Concrete Pavement Requiring Price Adjustment. When an area of pavement reveals a deficiency in slab thickness or average slab thickness, sufficient to warrant a reduction in the unit price as provided in **Subsections 501.32B.1** or 501.32B.2, the adjusted unit price shall bear the same ratio to the contract unit price as the square of the thickness or the average thickness of the slab bears to the square of the thickness specified on the plans.

D. Core Measurements Deficient By More Than 0.5 Inch. Where any core measurement indicates a thickness is deficient by more than 0.5 inch, the extent of the deficient thickness shall be determined by taking additional cores at 25 foot intervals in both directions parallel to the centerline until, in each direction, a core is found that is deficient by less than 0.5 inch. The area of pavement subject to this determination shall be the product of

the full width of the slab, or of a traffic lane if only one lane is affected, multiplied by the sum of the distance in each direction from the deficient core along the centerline of the road to the transverse section found not to be deficient by more than 0.5 inch. No payment will be made for the area of pavement determined as outlined above.

With respect to areas of pavements where the thickness is deficient by more than 0.5 inch and payment is withheld, the Engineer shall have the following options:

If in the Engineer's opinion, deficiency is such as to seriously impair the traffic service expected from the pavement, the Engineer may direct that deficient areas be removed and replaced with slabs of satisfactory quality and thickness, which, when accepted, will be duly included in the pay quantity; or

If in the opinion of the Engineer, there is no probability of failure, the Department may allow the Contractor the choice of leaving the defective slab or slabs in place and receiving no compensation or payment for the same, or of removing and replacing the pavement as provided above.

No additional payment over the contract unit price will be made for any pavement, the thickness, or average thickness of which, exceeds the thickness shown on the plans.

501.33 Method of Measurement. The quantity measured for payment under this section shall be the number of square yards of Portland Cement Concrete Pavement completed and accepted, and measured in place along the surface of normal width of through-lane pavement. Pavement constructed outside the area designated to be paved shall be disregarded in computing the number of square yards.

Measurement of Portland Cement Concrete Pavement For Ramps will include ramps acceleration and deceleration lanes, tapers, widened areas and other configurations, other than the normal width of the through lanes, necessary for the interchange of traffic.

Adjacent to bridge ends, over trenches and at other places where the Engineer authorizes the thickness to be other than that shown on the typical cross-section, the volume of concrete pavement authorized by the Engineer and actually placed and accepted shall be converted into equivalent square yards of the typical pavement as shown on the plans.

Wire mesh, bar mat reinforcement, tie bars, dowels, load transfer devices, joint sealant, other materials, and labor necessary to complete the pavement in accordance with the plans will not be measured separately. No direct payment will be made for those items.

501.34 Basis of Payment. The quantity, measured as provided above, will be paid for at the contract unit price for Portland Cement Concrete Pavement, or Portland Cement Concrete Pavement for Ramps, of the thickness specified, which price and payment shall be full compensation for furnishing all materials, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

The bid price shall include joint construction and sealing and the furnishing and placing of wire mesh, bar mat reinforcement, tie bars, load transfer devices, dowels and all materials, labor and equipment necessary to complete the work.

Pavement that is deficient in thickness, but is permitted to be left in place, will be paid for at the reduced unit price or deducted as provided in **Subsection 501.32**. Reductions for deficient thickness may be entered on any estimate after the information becomes available.

No compensation will be allowed for the materials or labor involved in the removal of the defective slabs.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
5011XXX	Portland Cement Concrete Pavement - *(thickness)*" Uniform	Square Yard
5012XXX	Portland Cement Concrete Pavement for Ramps - *(thickness)*" Uniform	Square Yard

SECTION 502

CONCRETE PAVEMENT PATCHING

502.01 Description. This work shall consist of replacing full depth pavement slabs on a prepared **subgrade** or **base course** in accordance with the plans and in accordance with the applicable requirements of the special provisions and **Sections 501**, **701**, and **702**. The pavement replacement slabs will be placed where the distressed concrete has been removed and shall range in size from 12 feet wide by a minimum of 6 feet long up to the full slab length for jointed concrete pavements, while patches of continuously reinforced concrete pavements shall have a minimum dimension of 6 feet in length and width. The depth shall be the depth of the existing pavement. See the plans for details.

The Engineer 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 assure that all of the distressed concrete is removed. Transverse boundaries do not have to be perpendicular to the shoulder in all cases, but shall be at least 18 inches away from transverse cracks in the good concrete.

502.02 Materials.

A. General. The materials shall meet the requirements of **Sections 302**, **501**, **701**, and **703**.

B. Portland Cement Concrete. Portland cement shall be Type I or Type III from an approved source and shall be used at a rate of 800 lbs. per cubic yard. The mix shall have a water cement ratio not exceeding 0.38. Water cement ratio shall be maintained by using normal or high range water reducing materials Type F or G. Non-chloride accelerators shall be used to achieve the specified compressive strength and time of set. Coarse aggregates shall be No. 56, 57, or 67. Provide an air content of 4 1/2% ±1 1/2%.

At least forty-five (45) days before the beginning of placement of concrete in the roadway, the contractor shall submit a proposed mix design to the Department's Research and Materials Laboratory. The Research and Materials Laboratory may either require materials to be provided to the Department's Central Laboratory or to the ready mix plant in order to prepare trial batches. The Contractor may propose to use a previously approved mix design. A previously approved mix design shall not relieve the Contractor of the forty-five (45) day notification requirement and the department may require re-testing of the mix design at its option. Mix designs are project specific, and approval is non-transferable without written approval from the Research and Materials Engineer.

The mix design shall produce a minimum compressive strength of 2000 psi within 6 hours after addition of accelerating admixtures. The Contractor shall provide a representative to be present at the Research and Materials Laboratory or ready mix plant while the proposed mix design is produced. He shall be authorized to make any changes

to the Contractor's proposed mix design in the event that the mix does not meet time and strength requirements. An approved mix design will be furnished to the Contractor.

C Reinforcing Steel. Bar mat reinforcing steel, wire mesh, and dowel bars size and placement shall be as specified in the patching detail included in the plans, special provisions, and **Section 703**.

D. Epoxy System. Epoxy system used to anchor dowel bars, tie bars shall be moisture insensitive, and the manufacturer shall furnish a certification indicating the material meets **ASTM C 881**, Type 4, Grade 3, Class B and/or Class C. A certification by the manufacturer shall be furnished for each lot number received at the job site. If requested by the Engineer, the proposed epoxy system shall be re-verified by using the epoxy with a No. 4 tie bar system in a scrap section of pavement slab. Equipment to test the pullout strength shall be provided by the Contractor and shall bear labels indicating up-to-date calibration by an independent calibration service. The proposed epoxy system shall demonstrate that the pullout strength is approximately 12,000 pounds.

E. Maintenance Stone. Where maintenance stone is required, aggregate shall meet the requirements of Aggregate No. CR-14 as specified in **Subsection 302.02**. All aggregates shall be obtained from SCDOT approved sources.

CONSTRUCTION REQUIREMENTS

502.03 General. The full depth concrete pavement patching work shall be conducted in one lane at a time and in a manner that offers minimum inconvenience to the traveling public. A written Traffic Control Plan prepared by the Contractor shall be approved by the Engineer in advance of starting any work that will interrupt the normal flow of traffic. The inside (passing) lane shall be completed before the outside (travel) lane work begins. No concrete shall be placed when the air temperature is 40^{o}F or below.

502.04 Removal of Existing Pavement. The Engineer 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. Existing pavement slab shall be removed by sawing the pavement full depth with a diamond tipped blade and leaving vertical concrete edges. A carbide tipped wheel saw will be permitted to with in 3 inches of the transverse limits of the patch. The deteriorated pavement slab shall be prepared for removal by either of the following procedures:

1. Make a 1/4 inch wide sawcut the full depth of the pavement in the shoulder-pavement longitudinal joint. The shoulder must not be damaged when removing the adjacent pavement slab.

2. Make sawcut in the shoulder at a distance of 12 inches parallel to the pavement/shoulder longitudinal joint. The length of the sawcut shall be the length of the required pavement patch plus enough distance to accommodate formwork.

Procedure 1 will only be allowed on patches 6 feet to 12 feet in length where the shoulder is not damaged. If the vertical edge of the shoulder is undamaged, the new concrete for the pavement slab may be placed against the undisturbed shoulder.

After Procedure 2, the shoulder material shall be removed and a form set for a new shoulder pavement joint. When the form is removed and longitudinal drains are to be placed at a later date, the shoulder area will be repaired with temporary material that shall consist of thoroughly compacted Aggregate No. CR-14, conforming to the requirements of **Subsection 302.02,** and topped with an asphalt surface course selected by the Engineer. If no drains are required, the shoulder area shall be repaired as specified in **Subsection 502.11**.

Care shall be taken during the removal of the deteriorated pavement and the placement of new concrete to prevent dam-

age to the vertical sawcut in the existing pavement or to the base material.

The Contractor shall be responsible for the proper disposal of the concrete pavement that has been removed.

502.05 Base Preparation. After the deteriorated pavement has been removed, the base shall be prepared and compacted to the depth of the existing pavement. This may require removing some of the existing base material. In the event that poor materials are encountered, additional material shall be removed and a new grade depth established as directed by the Engineer. Aggregate No. CR-14 or portland cement concrete of the same composition used for the pavement patching, as directed by the Engineer, will be used to backfill to the bottom of the existing pavement. All materials on which the concrete pavement is to be placed shall be thoroughly compacted using vibratory compactors. The saw-water from the pavement removal operations may deteriorate compacted base material in the replacement area. The deterioration of the base shall be corrected before placing the new concrete.

When it is necessary to repair continuously reinforced concrete (CRC) pavement in the areas at or near terminal ends, it will not be necessary to remove the terminal end to its full depth. The pavement may be removed to the normal depth of the pavement, taking care to leave the shear steel. If the shear steel is inadvertently removed or damaged, it shall be re-established by means of drilling into the terminal end, and grouting or epoxying new shear steel equivalent in area to the old shear steel.

502.06 Faces of Existing Pavement. Before placing concrete, the faces of the existing pavement shall be thoroughly cleaned and prepared to receive the concrete. Featheredge spalls shall be removed by sawing a new face on the existing pavement.

502.07 Placing of Reinforcement. After removing the deteriorated concrete, new dowels and tie bars shall be estab-

lished in the vertical faces of the remaining pavement slab by drilling and grouting with quick setting, non-shrink mortar or epoxy. Dowel and tie bars shall be established in pavement at a spacing of 12 inches on center or in between the longitudinal reinforcement (where present) in accordance with the details shown in the plans.

Bar mat reinforcing steel or wire mesh shall be installed as specified on the plans or in the special provisions. Reinforcement shall be securely anchored and held in place to avoid movement during concrete placement.

The smooth dowel bars extending into the patch opening shall be thoroughly and uniformly greased to allow the patch concrete to expand and contract. Care shall be taken to ensure that the top and bottom surfaces of the bars are coated with grease.

502.08 Concrete Finishing. The replacement concrete surface shall be given a fine broom texture finish to establish a surface similar to the existing pavement (no tine marks required) and sprayed with curing compound as specified in **Subsection 702.04**.

502.09 Curing. Freshly poured surfaces shall be covered with insulated curing blankets during the curing period, regardless of ambient air temperature. The curing time shall be provided as part of the approved mix design. The curing system shall be approved by the Engineer before commencement of work.

502.10 Joints. Joints shall be sealed in accordance with the plans and the requirements of **Section 504**.

502.11 Shoulders. Where it is necessary to place side forms adjacent to the shoulder, the damaged shoulder shall be repaired using the following based on type of shoulder in place.

A. Asphalt Shoulder. Repair damaged shoulder with Aggregate No. CR-14 and Hot Mix Asphalt Surface Course - (Type 1) overlay as directed by the Engineer.

B. Portland Cement Concrete Shoulder. Repair PCC shoulder with same mix as used in the mainline patching. Coat the surface of the set concrete with a moisture insensitive high modulus epoxy recommended by the manufacturer for the purpose of bonding fresh concrete to old concrete certified to meet **ASTM C 881**, Type V, Grade 1 or 2, Class B or Class C. Deposit concrete in the shoulder area to be patched after the epoxy coating becomes tacky and before it dries.

502.12 Opening Pavement to Traffic. The patched pavement shall not be opened to traffic (public or otherwise) until the strength of 2000 psi has been verified by early break cylinders unless otherwise instructed by the Engineer. The Contractor shall furnish a calibrated compressive test machine in a well-protected area for testing the concrete cylinders at the job site.

After the first patches are made and opened to traffic, they shall be evaluated by traveling over them in normal traffic flow pattern at the allowable speed limit. In the event the patches exhibit noticeable impact or steering indication to the vehicle, the finishing techniques on remaining patches shall be adjusted to provide patch surfaces that do not affect the vehicle as it passes over the patch.

502.13 Method of Measurement. The quantity measured for payment under this section shall be the number of square yards of full depth concrete pavement patching, completed and accepted, and measured in place along the surface of the pavement and ramps. Patches constructed outside the area designated to be patched shall be disregarded in computing the number of square yards.

Adjacent to bridge ends, over trenches, and at other places where the Engineer authorizes the thickness to be other than that specified in the plans, the volume of concrete pavement authorized by the Engineer and actually placed and accepted shall be converted into equivalent square yards of depth of patching as shown on the plans.

The lean concrete used for replacing base course, cement stabilized subbase, and/or subgrade removed as outlined above, shall be measured to the nearest 0.1 cubic yard for Portland Cement Concrete (Special Use) placed and accepted. If Aggregate No. CR-14 is used for this purpose, it will be measured by the ton of Aggregate No. CR-14 placed and accepted.

Unless a separate bid item is included in the contract for temporary or permanent repairs in bituminous shoulders, work and materials for temporary or permanent repairs in bituminous shoulders shall not be measured for payment, but will be considered as an incidental part of the work for this item.

Wire mesh, bar mat reinforcement, dowels, tie bars, load transfer devices, and other materials necessary to complete the patching in accordance with the plans will not be measured separately. Work or material used to anchor reinforcement and ties will not be measured for payment. No direct payment will be made for these items, and they will be considered as part of the pavement patching work.

502.14 Basis of Payment. Payment for the concrete pavement patch area measured in **Subsection 503.13** will be made at the contract unit price for Full Depth Concrete Pavement Patching, which price and payment shall be full compensation for furnishing all materials, equipment, tools, labor, supplies, and incidentals necessary to complete the work. It shall include sawing, removal, and disposal of the existing deteriorated pavement, work and materials used for temporary and permanent repairs to shoulders, joint construction and sealing, wire mesh, bar mat reinforcement, dowels, tie bars, load transfer devices, restoration of terminal ends in continuously reinforced pavement, drilling and grouting reinforcement, epoxy system for reinforcement anchorage and concrete bonding, preparation of subbase, furnishing, placing, finishing, curing, and testing concrete necessary to satisfactorily complete the work.

Payment for Aggregate No. CR-14 or Portland Cement Concrete (Special) used to repair the base under the removed slab as required in these specifications or as directed by the Engineer will be paid at the contract unit price for the respective item.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
3022000	Aggregate No. CR-14	Ton
50210XX	Full Depth Concrete Pavement Patch - *(thickness)*"	Square Yard
5029000	Portland Cement Concrete (Special Use)	Cubic Yard

SECTION 503

GRINDING AND TEXTURING EXISTING CONCRETE PAVEMENT

503.01 Description. This work shall consist of grinding and texturing the existing portland cement concrete pavement longitudinally as shown on the plans or as specified herein.

503.02 Grinding and Texturing. Grinding and texturing shall be performed on the entire surface area of the lanes specified in the plans or as directed by the Engineer. The surface on each side of the transverse joint shall be uniformly ground and textured until the surface on both sides of the transverse joints and all cracks are in the same plane and meet the smoothness required in the contract. This may require additional passes of the equipment to texture both sides of a faulted joint.

The finished surface shall have a parallel corduroy type texture consisting of grooves between 0.090 and 0.150 inch wide. The land area between the grooves shall be between 0.060 inch and 0.125 inch wide. The peaks of the ridges shall be 1/16 inch higher than the bottom of the grooves. The surface shall have a high skid number and shall not produce an excessive noise level under traffic.

The grinding and texturing machine shall be self-propelled with diamond blades, mounted on a multi-blade arbor with a minimum cutting-head width of 36 inches. The equipment shall not cause strain or damage to the underlying surface of the pavement. Equipment that causes excessive ravels, aggregate fractures, spalls, or disturbance of the transverse or longitudinal joints shall be repaired or replaced.

Upon beginning of the grinding and texturing, the Contractor shall perform a demonstration section for inspection and approval by the Engineer. Upon approval of the demonstrated texture by the Engineer, the remaining work shall be performed as approved.

The finished work shall provide satisfactory riding qualities, as determined by the Engineer. Residue from the grinding and texturing operation shall be removed from the roadway and shall not be permitted to flow across shoulders or lanes occupied by traffic or flow into gutters or other drainage structures. Solid residue shall be removed from the pavement surface before such material is blown by the action of traffic or wind. The pavement shall receive a final sweeping with power equipment before opening to traffic.

After completion of grinding and texturing, the pavement surface will be tested by the Department for smoothness and rideability. The pavement shall meet the requirements for smoothness and rideability of new pavement specified in **Subsection 501.28**.

503.03 Method of Measurement. The quantity measured for payment under this Section shall be the number of square yards of grinding and texturing completed and accepted, and measured in place along the surface of the road and ramps. Grinding and texturing performed outside the areas designated shall be disregarded in computing the number of square yards.

503.04 Basis of Payment. The area measured as provided in Subsection 503.03 will be paid for at the contract unit price for Grinding and Texturing Existing Concrete Pavement, which price and payment shall be full compensation for furnishing all materials, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work including satisfactory disposal of waste materials.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
5031000	Grinding and Texturing Existing Concrete Pavement	Square Yard

SECTION 504

CLEANING AND RESEALING OF JOINTS IN PORTLAND CEMENT CONCRETE PAVEMENT

504.01 Description. This work shall consist of the rehabilitation of joints and cracks in portland cement concrete pavements by cleaning, preparing for and placing the specified sealant.

MATERIALS

504.02 Materials. Materials used in this work shall meet the requirements of **Section 501**. Selection of the sealant material shall be in accordance with the following table:

APPLICATION:	ASTM D 3405 Sealant	Silicone Sealants	
		Non-Sag	Self-Level
Old Concrete Pavement w/ transverse and lane longitudinal joints[1], uniform joint widths - no overlay		§	§
Old Concrete Pavement w/ transverse and lane longitudinal joints[1], non-uniform joint widths - no overlay		§	
Old Concrete Pavement w/ transverse and lane longitudinal joints[1], to be overlaid with hot mix asphalt	§		
Concrete Shoulders (with Concrete Pavement) w/ transverse and longitudinal joints, uniform joint widths - no overlay		§	§
Concrete Shoulders (with Concrete Pavement) w/ transverse and longitudinal joints, non-uniform joint widths - 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

Notes:

1 Not constructed with the plastic strip.

2 A bond breaker is not required.

504.03 Preparation of Joints. Joints shall be prepared by removing all joint material to include sealants, inserts, and any material that may have infiltrated the joint. The existing sealant shall be removed from the joint using a vertical edge-cutting tool. A power driven concrete saw with diamond or abrasive blades may be used to remove all old sealant from the joint faces and to expose clean concrete. If required, the faces of the joint shall be cut using a concrete saw with diamond or abrasive blades. The joints shall be cut to the depth and width necessary to provide for the specified dimensions of new joint sealant.

Immediately following the sawing operations, the joints shall be thoroughly flushed with a high-pressure water jet to remove the slurry and any loose material from the joint faces. Joint washing shall be performed in one direction to prevent recontamination of the joint.

Once the joint is dry and before final cleaning begins, the joint shall be sandblasted to remove contaminants. Sandblasting shall be performed in two passes, one for each face, with the nozzle held at an angle to the joint face and within 1 to 2 inches of the pavement. Additional sandblasting passes may be required if necessary to remove all traces of old sealant or other irregularities that may interfere with the bonding of the new sealant. Sandblasting shall be performed the same day as the sealing operation and shall be repeated if rain showers occur between initial sandblasting and sealing.

The blast material as well as dust and dirt deposited by wind and traffic shall be blown out of the joint and away from the surrounding area using a high-pressure air blast. The air compressor shall produce at least 90 psi and shall be equipped with traps capable of removing moisture and oil from the compressed air. As with the water jet, the air blast shall proceed in one direction to prevent recontamination of the joint.

Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the Engineer before installation of sealant. All joints to be sealed must be sound, clean, dry, and frost free. Joints found to contain dust or that have become dirty or contaminated shall be re-cleaned.

504.04 Installation of Sealant. After cleaning has been completed, the bond breaker (bond breaker tape or backer rod) shall be placed at the proper depth to form the bottom of the seal. The bond breaker shall be compatible with the sealant. Installation methods and equipment shall be in accordance with the manufacturer's recommendations. Backer rods shall then be made leak proof where required by caulking with a silicone product compatible with the sealant to be used. This may be applied from tubes with a caulking gun device.

The sealant shall then be placed in the joint in accordance with the plan configuration by means of an appropriate pump equipped with a nozzle that is narrow enough to place the material from the bottom up in the joint. The material shall be placed to establish a surface profile in the desired depth below the surface of the pavement. All equipment for placing the seal and methods of placement shall be in accordance with the sealant manufacturer's recommendations.

Final cleaning, placing of the bond breaker, and placing of the sealant shall be performed in a continuous operation. Once the final cleaning and sealing operation has begun on a section of pavement, no traffic, construction vehicles, or other equipment will be allowed on the section of pavement for a minimum of 2 hours or until the seal material has cured.

As determined by the Engineer, joints not properly sealed shall have the sealant removed for the full sealant depth, be thoroughly cleaned, resealed in accordance with this specification, and all at no expense to the Department.

Any material spilled on the pavement shall be immediately removed. Solvents shall not be used to remove spills, because they generally carry the materials further into the porous concrete or spread them on the surface.

504.05 Hot Poured Sealants. When hot poured sealant, as specified in **Subsection 501.07D** is used, it shall be handled and applied as follows:

A. Heating. During the sealing operation, the melter shall be operated as follows:

1. The initial charging of the melter shall be 1/2 the vat capacity with the other 1/2 being charged after the initial 1/2 charge has liquefied.

2. Continuous agitation shall be maintained once the sealant is liquefied.

3. Circulation pumping shall begin after the sealant has been initially liquefied.

4. Fresh unheated sealant shall be added in a way 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.

5. The melter system shall be thoroughly clean at the start of work and the pump and sealing hose shall be flushed out at the end of each day or work period. Material may be left in the vat overnight and used the next day provided it has not exceeded the maximum heating time during the previous heating period.

6. Sealing will not begin 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 side of the working temperature range for 1/2 hour or more.

7. The recorder shall be operated at all times when the melter is being used. The permanent record chart shall be dated and given to the Engineer each day or chart timing period as proper. The Engineer may waive the requirement for continuous temperature recording on new technology pump systems that reasonably assure low temperature material cannot be applied.

B. Application. During the sealing operation, the hot poured sealant material shall be handled and used as follows:

1. The ambient temperature and groove wall surface temperature shall be 45^{o}F and rising before application begins.

2. The material shall not be heated beyond its safe heating temperature as recommended by the sealant manufacturer.

3. The sealant material shall not be applied when cooler or hotter than the recommended application temperature range.

4. The plastic wrap on the material, as shipped, may be dumped into the vat with the material.

5. The sealant material shall be continuously agitated and circulated once it is liquefied in the melter.

6. The sealant material shall not be stored in direct sunlight or in an ambient temperature over 100°F, such as under a tarp. It should be stored under cover or roof with adequate ventilation.

7. The wand tip shall be such that it will fit into the groove and the material will be placed from the bottom to the top of the groove. The tip shall be equipped with a depth gage to prevent the wand from traveling in the bottom of the groove.

8. The first gallon of material to flow out of the applicator wand at the beginning of the day shall be considered spoil, discharged into a container, and discarded.

9. 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, sealing shall stop, and the remaining material shall be rapidly pumped from the kettle and discarded from the work.

10. The applicator wand shall be returned to the machine, and the material re-circulated immediately upon the completion of each joint sealing.

11. The joints shall not be overfilled. Overfilled joints shall be cleaned and resealed as directed by the Engineer. The correct level for the top of the seal is 1/4 inch below the lower top of joint surface.

504.06 Silicone Sealant. When silicone sealant is used, it shall conform to the requirements of Subsection 501.07B and shall be handled and applied in accordance with **Subsection 501.27**.

504.07 Method of Measurement. The quantity measured for payment under this Section shall be to the nearest 0.1 linear foot of joint cleaning and resealing, complete and measured in place along the surface of the roadway, and accepted by the Engineer.

504.08 Basis of Payment. The length, measured as provided in Subsection 504.07 , will be paid for the contract unit price for the items as listed below, which price and payment shall be full compensation for cleaning and resealing of joints, satisfactory disposal of waste materials, and including all materials, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
5041100	Clean and Seal Longitudinal Joints	Linear Foot
5041200	Clean and Seal Longitudinal Shoulder Joints	Linear Foot
5041300	Clean and Seal Transverse Joints	Linear Foot
5041400	Clean and Seal Transverse Joints at Bridge	Linear Foot

SECTION 505

ROUTING, CLEANING, AND SEALING OF RANDOM CRACKS IN PORTLAND CEMENT CONCRETE PAVEMENTS

505.01 Description. This work shall consist of routing, cleaning, and sealing cracks with silicone sealant in existing portland cement concrete pavement. These cracks are random cracks other than the standard crack patterns in continuously reinforced concrete pavement or transverse cracks in jointed concrete pavement. In general, these cracks are usually open 1/8 inch or more and are greater than 10 feet in length. Cracks to be rehabilitated shall be identified and marked by the Engineer.

MATERIALS

505.02 Materials. Materials used in this work shall meet the requirements of **Section 501**.

CONSTRUCTION REQUIREMENTS

505.03 Construction Requirements.

A. General. Cracks shall be prepared by removing any existing sealant, re-facing and cleaning the crack, installing blocking medium as needed, and sealing the crack.

B. Equipment. Sealing equipment shall be in accordance with the requirements of **Section 501**. A concrete saw with a pivotal small diameter blade that follows the crack shall be used to provide a joint reservoir.

C. Preparation of Cracks. Removal of old sealant, refacing, and cleaning of the cracks shall be in accordance with the applicable requirements in **Subsection 504.03**. The cracks shall be widened to the widths and depths shown in the plans or as directed by the Engineer.

D. Blocking Medium. For cracks 3/8 inch or greater in width, a backer rod meeting the requirements of **Subsection 501.07C** shall be installed in the crack at a uniform depth to prevent entrance of the sealant below the depth specified. The rod shall be compatible with the sealant, installed using the sealant manufacturer's recommendation and not be stretched during installation.

For cracks less than 3/8 inch wide, the use of a blocking medium shall be optional as long as the seals produced are satisfactory. Should the seals prove to be unsatisfactory, the Engineer may require subsequent crack rehabilitation to include installation of blocking media.

E. Installation of Sealant. Sealant shall be installed in accordance with **Subsection 504.04**.

505.04 Method of Measurement. Routing, cleaning, and sealing of random cracks will be measured to the nearest 0.1 linear foot of rehabilitated cracks, complete, measured in place along the surface of the roadway, and accepted by the Engineer.

505.05 Basis of Payment. The length, measured as provide above, will be paid for at the contract unit price for Rout, Clean, and Seal Cracks, which price and payment shall be full compensation for routing, cleaning, and sealing of cracks, satisfactory disposal of waste materials, and includes all materials, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
5051000	Rout, Clean, and Seal Cracks	Linear Foot

DIVISION 600

TRAFFIC CONTROL

SECTION 601

WORK ZONE TRAFFIC CONTROL

601.01 Description. The Contractor, Subcontractor, or anyone working within the highway right of way shall provide a Traffic Control Plan for the maintenance and control of traffic during work within the highway right of way. The Traffic Control Plan shall set forth procedures and guidelines for providing for the safe passage of traffic through and around the project area with a minimum of inconvenience. The Traffic Control Plan shall conform to the requirements of these **standard specifications**, the **plans**, the ***Standard Drawings For Road Construction***, the **special provisions**, all **supplemental specifications**, the manufacturer's requirements and specifications, the ***South Carolina Manual on Uniform Traffic Control Devices for Streets and Highways***, hereinafter referred to as *SCMUTCD*, and the Engineer.

The current *SCMUTCD*, in effect at the time of the contract award, shall provide the minimum requirements for installation, operation, and maintenance of all traffic control devices.

These sections shall specify fabrication, provision, installation, maintenance, performance, relocation, and removal requirements of all traffic control devices, methods, and procedures as required by the plans, the *Standard Drawings For Road Construction*, the special provisions, all supplemental specifications, the manufacturer's requirements and specifications, the *SCMUTCD*, and the Engineer.

Traffic control shall include provision, installation, maintenance, repair, replacement, relocation, and removal of all traf-

fic control devices used for regulating, warning, or directing traffic. All items shall remain the property of the Contractor unless otherwise specified in these standard specifications, the plans, or the special provisions.

601.02 General. These standard specifications set forth specific procedures and requirements and do not relieve the Contractor of any responsibilities incurred by the plans, the *Standard Drawings For Road Construction*, the special provisions, the supplemental specifications, the manufacturer's specifications, the *SCMUTCD*, and the Engineer.

The Contractor shall acquire approval for all revisions, through modifications of the plans, the plans, quantities, and the special provisions, to the project staging as presented in the Traffic Control Plan. Final approval of such revisions will be pending upon review by the Engineer.

When these standard specifications, the plans, or the special provisions do not cover a specific traffic control condition, the Contractor and the Engineer shall agree to a plan of traffic control before beginning the work causing the condition.

The Department reserves the right to restrict construction operations when the continuance of the work would seriously hinder normal traffic flow during holidays, extended holiday periods, weekends, special events or any time traffic is unusually heavy. The Department's right to restrict construction operations shall include lane closures, road closures, or any operation determined necessary by the Engineer. Also, do not close lanes or streets with high volume commuter traffic in cities and urban areas during peak traffic periods unless otherwise specified.

The Department prohibits most lane closures during holidays, holiday weekends, or special events. A holiday occurring on a weekday may require an extension of the holiday restrictions due to the proximity of the weekend as determined by the Engineer. The Department defines most holiday weekends as from 12:00 Noon of the Friday before the week-

end or of the day before the holiday until 6:00 AM of the Monday after the weekend or the day after the holiday. Thanksgiving Holidays are defined as from 12:00 noon of the Wednesday before Thanksgiving Day until 6:00 AM of the Monday after Thanksgiving Day. Christmas holidays are defined as from 12:00 Noon of December 23rd through 6:00 AM of December 27th. The Engineer may extend Christmas holiday restrictions due to the proximity of the weekend. Easter holidays are defined as from 12:00 Noon of the Thursday before Easter until 6:00 AM of the Tuesday after Easter. Special events are events generating excessive traffic as determined by the Department.

The Contractor shall observe all time restrictions regarding lane closures or road closures and the Engineer may extend these time restrictions as traffic conditions warrant. The Department reserves the right to suspend a lane closure or road closure if the Engineer determines the resulting traffic backups to be excessive. Observe and maintain all job specific time restrictions as specified by the plans, the special provisions, and the Engineer. Install and remove lane closures, including all relative traffic control devices and signs, within all time restrictions. Coordinate all work activities requiring lane closures and road closures in accordance with all restrictions.

The Department defines the conditions of day and night in accordance with the level of natural light provided by the sun as measured by a light meter. The terms “Daytime,” “Hours of Daylight.” or any similar term shall refer 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 shall refer to a level of illumination less than 54 Lx or 5 fc.

In all areas where work is being performed during the hours of darkness, the Contractor shall furnish, place, and maintain lighting facilities capable of providing light of sufficient intensity to facilitate good workmanship and proper inspection at all times. The lighting shall be arranged so as not to produce glare or diminish the motorist’s visibility.

The Contractor may illuminate the work area by any com-

bination of portable lights, standard electric lights, existing street lights, etc., that will provide the necessary illumination as follows:

Area Of Illumination	Work Activity	Minimum Illumination Level Lx (fc)
General	Cleaning, Sweeping, Tacking, Painting, etc.	54 (5)
Tasks Around Equipment (50 foot Ahead/Behind)	Milling, Paving, Rolling, Etc.	108 (10)

The Contractor shall provide advance warning arrow panels during the closure of a travel lane of a multilane roadway. The taper section of a lane closure shall require no less than two arrow panels. If the plans do not provide locations for the arrow panels during a lane closure, place one arrow panel at the beginning of the taper and the another arrow panel at the end of the taper. These locations are for normal conditions.

These locations may require adjustments due to horizontal and vertical alignments, various sight distance restrictions, or due to some other type of physical obstruction.

Install changeable message signs as specified hereto when required in lane closure set-ups. Install and use these signs within all lane closure set-ups as directed by the *Standard Drawings For Road Construction*. When lane closures are not present for any time to exceed 24 hours, remove the changeable message signs from the roadway. Place the sign in a predetermined area on the project site, as approved by the Engineer, where the sign is not visible to passing motorists. The preprogrammed messages shall be in accordance with the *Standard Drawings For Road Construction* when used as part of the traffic control set-up for lane closures. The messages displayed on these signs shall be pertinent to the requirements of the traffic control situation and the traffic conditions at all times. At no time will the messages dis-

played on these signs duplicate the legends on the permanent construction signs.

The Department prohibits drop-offs greater than 2 inches next to traffic. However, the Department will permit a drop-off more than 2 inches if the Contractor is actively working in the immediate vicinity of the drop-off. The Contractor shall eliminate these drop-offs at the end of each day's work and at the completion of the construction activities. During the rough grading operations, the Contractor shall provide for the safe movement of traffic by excavating the earth next to the travel lane open to traffic to a 6:1 slope until the fine grading begins. During the fine grading operations, the Contractor shall provide for the safe movement of traffic by placing a material approved by the Engineer next to the travel lane open to traffic at a 6:1 slope. The Contractor shall prepare the 6:1 slope at the end of each workday as necessary. The Engineer will determine which excavations are susceptible to encroachment by errant vehicles and in need of protective cover. The Contractor shall cover these excavations (i.e., catch basins) located next to a travel way with metal plates capable of sustaining vehicular traffic as directed by the Engineer. Supplement these excavations with two or more 4 Foot Type II barricades until completed. Disregard the requirement for metal plates if guardrail or temporary concrete barrier protects the excavation.

The Department prohibits drop-offs greater than 2 inches between adjacent travel lanes open to traffic during paving operations. Also, the Department prohibits drop-offs greater than 1inches between adjacent travel lanes open to traffic during milling operations. The Department shall restrict acceptable drop-offs on multi-lane facilities to no more than one drop-off between adjacent travel lanes carrying traffic in the same direction. Observe all restrictions regarding grade elevation differences and lane closures by maintaining an approved construction schedule. The Contractor shall have the Engineer's approval of the schedule for all milling, paving, or any similar operations before beginning the work.

Properly delineate all travel lanes through construction

zones to provide motorists with a clear and positive travel path. Reflectorize all traffic control devices in place on a project site during the hours of darkness. Supplement lane closures and the designated traffic control devices in and adjacent to the roadway with amber warning lights as directed by the plans, the *Standard Drawings For Road Construction*, the special provisions, and the *SCMUTCD*. Reflectorize cones may be used at night as directed by the *SCMUTCD*, however, plastic drums shall be the preferred traffic control device for use at night.

Whenever two-lane two-way traffic is separated by relocation of one direction of the traffic, install portable plastic drums within the vacated travel lane immediately upon the traffic relocation. At no time is it permissible to allow multiple lanes of uni-directional traffic onto adjacent travel lanes separated by yellow centerline pavement markings. Install these portable plastic drums in the same manner as a lane closure as directed by the *Standard Drawings For Road Construction* and the Engineer.

The Contractor shall provide individuals properly trained in traffic control practices. These individuals shall provide quality assurance of the installation and maintenance of the traffic control. The Contractor shall have a person in charge of the traffic control on the job site at all times when construction activities are in progress. Also, a person shall be available 24 hours a day in case of an emergency or failure of traffic control devices.

When working within the rights-of-way of access controlled roadways such as interstate highways, the Contractor's vehicles shall change direction of travel at interchanges only. The Department prohibits these vehicles from crossing the entire roadway from right side to the **median** or vice versa. When the Contractor's vehicles enter the roadway from a closed lane or the median area, a flagger shall control the Contractor's vehicles. The flagger will not stop traffic, cause traffic to

change lanes, or affect traffic in any manner. The Contractor's vehicles shall not disrupt the normal flow of traffic or enter the travel lanes of the roadway until a sufficient gap is present.

601.03 Contractor's Responsibility. The Contractor is responsible for maintaining the Traffic Control Plan as required by these standard specifications, the plans, the special provisions, all supplemental specifications, the *SCMUTCD*, and the Engineer. The Contractor shall observe all requirements of the Traffic Control Plan. Also, the Contractor is responsible for ensuring all Subcontractors working on the project site observe all requirements of the Traffic Control Plan. Before beginning any work, the Contractor shall submit his plan for constructing the project and maintaining traffic to the Engineer.

The Contractor shall 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 these standard specifications, each Contractor, Subcontractor, sub-Subcontractor, or anyone working on contiguous and overlapping projects shall coordinate work activities as determined by the Department.

The Contractor shall designate a responsible member of the Contractor's organization with sufficient qualifications whose duty shall be to administer the Traffic Control Plan as specified by these standard specifications, the plans, the *Standard Drawings For Road Construction*, the special provisions, all supplemental specifications, the *SCMUTCD*, and the Engineer. This person shall be responsible for assuring that precautions are taken for the protection of the public and all the workers. The Contractor shall advise the Engineer of the designated person's name, telephone numbers, company title, and office location.

The Traffic Control Plan may require installation and maintenance of detour signs outside the immediate project limits.

In such cases, the Contractor is responsible for installing and maintaining these detour signs as required by the plans, the special provisions, and the Engineer.

The Contractor shall conduct frequent inspections of the project to determine the adequacy, effectiveness, and maintenance requirements of the Traffic Control Plan. Due to conditions uncharacteristic to a roadway without construction, prudent revisions may be necessary to provide for the protection of the traveling public and the safety of all personnel employed on the project site. The Contractor shall be responsible for maintenance of the traffic from the time the Contractor installs the permanent or temporary construction signs until the Department accepts the project.

The Contractor is responsible for the installation, maintenance, and performance of all traffic control devices. Install, maintain, and ensure the performance of these traffic control devices as required by these standard specifications, the plans, the special provisions, all supplemental specifications, and the manufacturer's specifications.

The Contractor shall conduct frequent inspections of the project 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 duplicate devices in the proper operational condition. Maintain the required level of reflectivity and color by keeping all signs, barricades, drums, and cones clean.

On roadways open to public travel, the Contractor's trucks and all other construction related vehicles will travel in the direction of normal roadway traffic. However, when these vehicles are operating within a closed travel lane, they may travel in either direction as necessary. The Department PROHIBITS the Contractor or any Subcontractor from storing material and equipment within 30 feet of a travel lane unless there is guardrail or temporary concrete barrier to protect the

area. Also, the Department PROHIBITS the employees of the Contractor or a Subcontractor from parking personal vehicles within 30 feet of a travel lane unless there is guardrail or temporary concrete barrier to protect the area. The Contractor shall remove portable sign supports and all other traffic control devices from within 30 feet of a travel lane when not in use. Also, all portable sign supports shall lie flat with the legs in the retracted position when not in use.

When working adjacent to or over travel lanes, the Contractor shall ensure that dust, debris, tools, or equipment from the operation do not endanger motorists. When working over traffic, the Contractor shall provide suitable safety platforms to catch falling materials or objects. The Contractor shall arrange these safety platforms so as not to encroach on the vertical clearance necessary in the area as determined by the Department.

601.04 Responsible Person. The Engineer is the representative of the Department. The Engineer is responsible for assuring effective administration of the requirements of the Traffic Control Plan as specified by these standard specifications, the plans, the *Standard Drawings For Road Construction*, the special provisions, all supplemental specifications, and the *SCMUTCD* to the best of his/her ability. The is responsible for providing notice to the Contractor, the Subcontractor, the sub-Subcontractor, including utility companies and government entities, or any individual working within the highway rights-of-way for failing to comply with the requirements of the Traffic Control Plan and these standard specifications.

The Engineer is responsible for requesting the assistance of the Highway Patrol or local law enforcement when necessary.

601.05 Method of Measurement. Measurement of payment for Traffic Control shall include all traffic control items necessary for construction. The bid item, Traffic Control, shall include all traffic control items except where the contract includes other bid items for specific traffic control items. The

Department will make payment for Traffic Control as specified by the following schedule:

Percent Contract Complete	Percent Traffic Control To Be Paid For
1 - 5	20
6 - 15	40
16 - 29	60
30 - 49	70
50 - 69	80
70 - 89	90
90 - 100	100

The Department will follow the above schedule as long as the adequacy of the traffic control measures are satisfactory to within the guidelines set forth by these standard specifications, the plans, the S*tandard Drawings For Road Construction*, the special provisions, all supplemental specifications, and the *SCMUTCD* as determined by the Engineer. The Engineer may assess appropriate reductions in monthly payments when the Contractor does not use or maintain traffic control devices as specified by these standard specifications contained herein.

The Engineer will notify the Contractor in the event the Engineer finds that traffic control is not being provided as outlined. When the Contractor fails to provide the appropriate traffic control, the Engineer will immediately suspend all work activities until the Contractor corrects such conditions. During such suspension, the charging of work time shall continue. The Engineer shall have the authority to withhold partial payment for any work on the contract if the traffic control is not being provided as required.

When a contract requires payment for Traffic Control on more than one project, the Department will consider each project separately.

The price and payment for Traffic Control shall be full compensation for fabricating, providing, preparing, installing,

removing or relocating, maintaining, and repairing or replacing all traffic control items as necessary to complete the work. The price and payment for traffic control shall include furnishing all materials, labor, hardware, equipment, tools, incidentals, and miscellaneous items necessary to complete the work.

Payment for Traffic Control shall exclude payment for permanent construction signs, temporary concrete barrier, portable terminal impact attenuators, changeable message signs, pavement markings, temporary pavement markers, or any item specified by a contract unit price bid in the plans, the special provisions, and the contract.

Consider payment for traffic control needed during application of temporary or permanent pavement markings incidental to the item and include payment for this traffic control in the bid item for Traffic Control.

601.06 Basis of Payment. The Department will pay for Traffic Control on a percentage completed basis as specified in **Subsection 601.03**. The price and payment for this work shall be full compensation for furnishing the necessary traffic control.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
1071000	Traffic Control	Lump Sum

SECTION 602

TRAFFIC CONTROL DEVICES IN THE WORK ZONE

602.01 General. Traffic Control Devices are devices, includ-

ing signs, that delineate travel lanes, warn of obstructions and hazards, and provide safe maintenance of traffic during work within or adjacent to the highway rights-of-way. The Contractor shall provide, install, use, and maintain all traffic control devices as specified by the **plans**, the ***Standard Drawings for Road Construction***, the **special provisions**, all **supplemental specifications**, the manufacturer's specifications, the ***SCMUTCD***, and the Engineer. Also, the Contractor shall provide traffic control devices manufactured in compliance with all requirements as specified by the plans, the *Standard Drawings For Road Construction*, the special provisions, all supplemental specifications, the manufacturer's specifications, the *SCMUTCD*, and the Engineer.

The Contractor performing the work shall provide, install, remove, relocate as necessary, and maintain all traffic control devices throughout the duration of the project. When not in use, remove unnecessary traffic control devices in conflict with the roadway conditions to prevent confusion of the traveling public.

All traffic control devices shall comply with the requirements of the **National Cooperative Highway Research Program**, *Report 350, Requirements For Work Zone Traffic Control Devices*. Each traffic control device shall meet these requirements as specified by the supplemental specifications, National Cooperative Highway Research Program, *Report 350*, in effect at the time of the contract award.

Repair or replace damaged or failed traffic control devices as specified by these standard specifications, the special provisions, all supplemental specifications, and as directed by the Engineer. The Contractor shall notify the Engineer prior to repairing or replacing substandard traffic control devices. The Contractor shall provide the Engineer with indisputable evidence that all repairs or replacements were in strict accordance with all manufacturer's and departmental specifications. If the Contractor fails to provide the Engineer with proper notification and evidence of conformity with all manu-

facturer's, SCDOT specifications, and the Engineer will immediately suspend all work. The suspension of work shall continue until all questions regarding the repairs or replacements are resolved. Without proper notification and evidence of conformity with the manufacturer's and departmental specifications, the Contractor shall forfeit payment for those repair or replacement items in question.

Mount all signs and barricades on supports constructed to yield upon impact to minimize hazards to motorists as indicated in Section 5-2.04 of the *SCMUTCD* and as required by the **Federal Highway Administration**.

The Contractor shall only use reflectorizing materials approved by the Department on all traffic control devices. Only those reflectorizing materials listed on the **Approval Sheet**, *South Carolina Department of Transportation Approved Suppliers Of Reflective Sheeting For Signs*, in effect at the time of the contract award are permitted on a project. Obtain copies of the approval sheet from the Engineer. Reflectorize all signs, drums, barricades and other traffic control devices requiring reflectorization with Type III Reflective Sheeting unless otherwise specified in the plans and the special provisions.

Mark all signs on the back with a label made of a durable material capable of retaining its legibility for the life of the sign. Imprint the manufacturer of the sign sheeting and the date of fabrication imprinted on the label.

The Contractor shall provide certification from the sign manufacturer verifying that the reflective sheeting and aluminum sign blanks employed on the project comply with these standard specifications.

The Contractor shall replace any reflectorized traffic control device or sign that fails to perform satisfactorily, day or night, due to deterioration or damage to the reflective material.

When reflectorizing traffic control devices and signs, al-

ways apply the sheeting material evenly to surfaces so the sheeting will be smooth and adhere firmly.

All signs in the *SCMUTCD* and on the traffic control drawings in the *Standard Drawings For Road Construction* have an identification number. Detailed drawings of each sign are available. The Contractor may obtain these sign drawings from the Director of Traffic Engineering.

Splices in reflective sheeting are unacceptable, except for signs to large to be covered with a single piece of the widest material available from the sheeting manufacturer. The Department will permit only one splice per sign and it shall be on a centerline of the sign or barricade. Splices shall overlap not less than 3/16 inch except butt splices that may be used on signs processed with transparent colors, with a gap not greater than 1/32 inch allowed. In horizontal overlapped splices, the top portion shall overlap the bottom portion, as viewed when the sign is in an upright position. Screening paints are prohibited between the sheeting of overlapped splices. When splicing, match the reflective sheeting for color to provide uniform appearance both day and night.

Signs are to have background material constructed of aluminum unless otherwise specified by the plans or the special provisions. Aluminum sign blanks shall meet the requirements of **Section 608** of these specifications.

Before beginning work, the Contractor and the Engineer shall jointly inspect the project limits to determine the necessity for sign removal or relocation and the number of these signs and their locations. Remove, relocate, or cover any existing permanent signs in conflict with changes in the traffic patterns or speed limits because of the installation of the Traffic Control Plan. The Contractor shall install the appropriate temporary signing to the satisfaction of the Engineer. The Contractor shall immediately remove the temporary signing and restore the permanent signing when the conflict is removed. Any necessary removal, relocation, storage, protection, and re-erection of signs located within the scope of the

project is the responsibility of the Contractor. Conduct the re-erection of these signs as directed by the Engineer. The Contractor shall be responsible for the storage of all signs removed from the project site and for the prevention of any corrosion, bending, or defacing of signs in any manner during storage. The Contractor shall replace any sign damaged due to improper protection during removal, storage, or reinstallation with one in such condition equal to that of the sign immediately before the sign's removal. Consider removal, storage,

and re-erection of the signs incidental to the item, Traffic Control. The Department will make no separate payment.

Install all work zone traffic control signing as specified. The Department will prohibit omission or substitution of these signs unless otherwise specified by the special provisions or directed by the Engineer.

Mount all flat sheet signs straight and level and with the face of the signs perpendicular to the surface of the roadway. This requirement applies to all flat sheet signs whether they are portable or have the supports embedded in earth. Mount all advance construction signs 2 feet from the edge of a paved **shoulder** or the face of a curb or 6 feet to 12 feet from the edge of an adjacent travel lane where no paved shoulder exists to the nearest edge of the signs. Also, mount all permanent advance construction signs 7 feet from the ground to the bottom edge of the sign and any secondary advisory signs no less than 6 feet from the bottom edge of a sign to the ground. Mount all temporary advance construction signs no less than 5 feet from the ground to the bottom edge of the sign. The Contractor shall provide special sign mounting assemblies, when necessary, in areas of double-faced guardrail, concrete median barrier, or bridge parapet walls.

The Contractor shall either cover signs in their entirety with an opaque material or remove them from the job site when not in use. The Department prohibits redirecting a sign instead of covering or removing the sign. The Contractor shall cover signs in a manner to prevent any 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.

The Contractor shall have the option to use an electrical power source for various traffic control devices on long term projects due to the extensive maintenance associated with diesel generators and batteries. However, the Department recommends a solar assisted power source for use as an alternative power source when practicable. The Contractor shall install and maintain alternative power sources as specified by these standard specifications and as directed by the Engineer. When using an electrical power source, the Contractor is responsible for all arrangements and costs 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 installed within 30 feet of a travel lane for the purpose of providing electric current to traffic control devices with guardrail or temporary concrete barrier. Equip electrical lines carrying a direct feed from high voltage power lines to traffic control devices with ground fault interruptering circuit breakers.

When an advance warning arrow panel, a changeable message sign, a temporary traffic signal, a truck mounted attenuator, or a portable terminal impact attenuator suffers a strike by an errant vehicle or a mechanical or electronic failure, eliminate the resulting hazardous conditions promptly. The Contractor shall initiate replacement or repair operations of the defective or damaged equipment within the first two hours after discovery or notification of a failure.

The Contractor shall install and conduct flagging operations as specified by these standard specifications and the *SCMUTCD* unless otherwise directed by the plans or the special provisions. Install all essential signs, including the “Advance Flagger” signs (WC20-7-48), in advance of the flagger stations as directed by the *SCMUTCD*. The flaggers shall conduct themselves and the operation within all requirements as set forth by the *SCMUTCD*. Erect all signs relative to the operation before initiation of the operation and immediately remove or cover upon termination of the operation. Station

each flagger no further than 300 feet from the end of a lane closure that requires a flagging operation. Equip each flagger with a Stop/Slow paddle. The Department prohibits the use of flags except during emergency situations. The Engineer will deal with failure by the flaggers to conduct the operation properly within all requirements as set forth by these standard specifications and the *SCMUTCD* or without the necessary signs as failure to provide the traffic control as outlined.

ADVANCE WARNING ARROW PANELS

602.02 Description. This item consists of advance warning arrow panels that are supplementary to other traffic control devices. The advance warning arrow panel provides additional advance warning and directional information to assist motorists through construction and maintenance activities on or adjacent to the **traveled way**. Provide, install, maintain, and operate each arrow panel as specified hereto.

602.03 Requirements. (a) Panel face. The panel shall be rectangular in shape, not less than 48 inches high by 96 inches wide, and finished with a black non-reflectorized surface. Also, the panel shall be equipped with 5 inches minimum yellow or amber lamps (15 or 25 lamps) and each lamp shall be provided with a visor encompassing not less than 180 degrees of the lamp circumference. These lamps shall provide legible message modes at a minimum distance of one mile. Wire the lamps to produce the following message mode indications when operating:

1. 15-Lamp Arrow Panels.

(A) Left arrow mode. 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.

(B) Right arrow mode. 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.

(C) Double arrow mode. 5 lamps in each arrowhead and

3 lamps in a shaft flashing simultaneously.

(D) Caution mode. 4 outermost corner lamps flashing simultaneously.

2. 25-Lamp Arrow Panels.

(A) Left arrow mode. 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.

(B) Right arrow mode. 5 lamps in arrowhead and 5 lamps in a shaft flashing simultaneously.

(C) Double arrow mode. 5 lamps in each arrowhead and 3 lamps in a shaft flashing simultaneously.

(D) Caution mode. 4 outermost corner lamps flashing simultaneously.

(E) Left sequencing arrow mode. 5 lamps in arrowhead and 5 lamps in a shaft, a 3 step sequential action of 2 lamps, 5 lamps, and 10 lamps sequencing from right to left to form a flashing arrow.

(F) Right sequencing arrow mode. 5 lamps in arrowhead and 5 lamps in a shaft, 3 step sequential action of 2 lamps, 5 lamps, and 10 lamps sequencing from left to right to form a flashing arrow.

(G) 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.

(H) 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.

(b) Rear of panel. Equip each panel with 3 lamps located on the rear of the panel that will indicate message mode be-

ing displayed.

(c) Unit operations. A 12 volt electrical system powered from a 12 volt DC power source or an adaptable 110 or 120 volt AC power source shall operate the unit panel. The system shall provide between 25 and 40 complete operating cycles, or flashes, per minute in each of the operational modes specified. The lamp illumination or “ON” time shall be not less than 50% during flashing modes and not less than 25% during sequential modes. The system shall have the capability to track ambient light 24 hours a day and make required adjustments to lamp intensity. The system shall adjust for nighttime lamp intensity through a voltage reduction of no greater than 50%. Also, it shall maintain lamp intensity at a constant and even intensity level throughout all lamps operating in unison.

(d) Power sources. 1. Diesel powered. An air-cooled variable speed diesel engine shall power the unit. The manufacturer shall equip the engine with a minimum 25 gallon capacity fuel tank with a fuel cut-off valve at the tank, a muffled exhaust system, and a steel fabricated security cage that encloses both the engine and the alternator.

2. Solar assisted. A battery bank charged by photovoltaic solar panels and supplemented with a built-in 110 volt 20 amp battery charger shall power the unit. The manufacturer shall equip the unit with an automatic lamp intensity regulator which keeps the lamp output constant with 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 conspicuous spot for easy reading during drive-by inspections. Also, equip the unit with a charge indicator that gives readings on the amount of charge the battery bank is carrying.

3. A/C powered. Power the unit by an adaptable 110 or 120 volt AC power source and equip the unit with ground fault interruptering circuit breakers. The power attachments shall be in accordance with all OSHA regulations and the "**National**

Electrical Code", in effect at the time of the contract award.

(e) Caution mode. A combination pattern of 4 lamps with one in each corner flashing simultaneously shall be the only pattern permitted during the caution mode. The “4 Corners” pattern shall not indicate direction or resemble any other mode. The Department prohibits the use of advance warning arrow panels incapable of producing the “4 Corners” pattern.

(f) Truck mounted units. A unit panel mounted on a truck shall be capable of operating while the vehicle is moving and shall be capable of producing all message modes as listed above.

A unit panel mounted on a truck shall be no less than 7 feet above the surface of the roadway and sufficient to afford visibility to traffic from a maximum distance practical. The Contractor shall mount the unit panel as a permanent fixture on the truck. The Department prohibits attaching a trailer mounted unit panel to a truck.

A vehicle mounted unit shall obtain operating power from the vehicle, a vehicle mounted generating plant, solar assisted facilities, or an adaptable 110 or 120 volt AC power source. Regardless of the source, the supply of electrical energy shall be capable of operating the unit panel as required by these standard specifications, the plans, the special provisions, and the *SCMUTCD*.

(g) Trailer mounted units. Mount these unit panels to provide a minimum height of 7 feet from the bottom of the sign to the surface of the roadway.

A trailer mounted unit shall obtain operating power from a trailer mounted power source mounted on the same trailer as the unit panel or an adaptable 110 or 120 volt AC power source. Regardless of the source, the supply of electrical energy shall be capable of operating the unit panel as required by these standard specifications, the plans, the special provisions, and the *SCMUTCD*.

Equip each diesel powered trailer mounted unit with a fuel tank capacity to operate not less than 24 hours without refueling. Design the fuel tank to minimize the danger of rupture or explosion in case of collision. Do not store additional fuel on or near the trailer.

(h) Trailers. Equip each trailer mounted unit to be in total compliance with **South Carolina Law** governing motor vehicles. The minimum requirement for lights and reflectors shall include turn signals, dual tail lights, 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 No. 12246.

Design and equip each trailer mounted unit with leveling jacks to minimize overturning from wind when in the operating position.

(i) Maintenance. Provide daily maintenance of each unit. All power source generators, including the photovoltaic solar panels on solar assisted units, shall undergo daily maintenance inspections. The Contractor shall replace an inoperative unit within two hours of discovery of the unit failure. If the Contractor fails to replace the inoperative unit within the allotted two hours, the Engineer will impose an immediate cessation of all work activities and removal of all equipment from the roadway. Also, the Contractor shall replace defective or burned out lamps within two hours of discovery of the deficient lamps or the Engineer will impose an immediate cessation of all work activities as well. The Department prohibits defective, deficient, or damaged units on the roadways of this state.

602.04 Operational Requirements. (a) Lane closures. Use the advance warning arrow panel for day or night closures, slow moving maintenance or construction activities, or maintenance or construction activities on extremely hazardous high density and high speed **traveled ways**.

Install arrow panels during stationary lane closures. When traffic control plans are unavailable, place one arrow panel on the roadway **shoulder** at the beginning of the taper and a second within the closure at the end of the taper. However, where the shoulders are narrow or site conditions restrict the use of the shoulder areas, place the first arrow panel in the closed lane behind the channelizing devices. Placement of the first arrow panel at the start of the taper is desirable.

(b) Restrictions. The advance warning arrow panel shall be supplemental to a traffic control plan. The Department prohibits use of an arrow panel separately as a singular entity. Always use an arrow panel along with other various traffic control devices as specified by these standard specifications, the plans, the special provisions, the *SCMUTCD*, and the Engineer.

The Department restricts the sequencing arrow modes to daytime use. Use only the flashing arrow modes, the sequencing chevron modes, or the caution mode at night.

The Department prohibits the use of arrow panels as a part of a flagging operation to direct passing moves into lanes used by opposing traffic.

602.05 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include the advance warning arrow panels. The Department will make no separate payment unless the contract includes specific bid items for advance warning arrow panels.

602.06 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, operating, and maintaining the arrow panels. Payment shall include providing the unit's primary power source and furnishing all labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary for installing, operating, and maintaining the arrow panels until completion of the project. Also, payment shall include beginning repair or replacement operations of damaged units within the first two

hours after notification of a damage causing incident or an electrical failure. Payment shall include any installation, or removal and reinstallation, of a lane closure or any other traffic control set-up necessary during repair or replacement operations.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
1071000	Traffic Control	Lump Sum

BARRICADES (TYPES I AND II)

602.07 Description. This item consists of Types I and II barricades. The Contractor shall use these devices to develop taper sections and channelize traffic into lane closures, delineate travel lanes, and to mark specific hazards. Always reflectorize these barricades with Type III reflective sheeting unless otherwise specified by the plans and the special provisions. The reflective sheeting shall have alternate orange and white stripes sloping downward at a 45 degree angle in the direction traffic is to pass. Provide, install, and maintain each Type I and Type II barricade as specified hereto.

Type II barricades, no less than 4 feet wide, shall be the traffic control device used for the taper sections of lane closures. Consider these applications of the traffic control devices within lane closures standard unless otherwise directed by the plans, the special provisions, or the Engineer.

602.08 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include Type I and Type II barricades. The Department will make no separate payment unless the contract includes specific bid items for Type I and Type II barricades.

However, the Department will pay for the barricades separately when the contract includes a separate pay item. To determine the quantity of installed barricades, measure the width of the barricade on a linear foot basis unless the contract specifies otherwise.

602.09 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining the barricades. Payment shall include fabrication of the barricades with proper reflective sheeting and use of proper supports. Payment shall include furnishing all labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary for installing and maintaining the barricades until completion of the project.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
1071000	Traffic Control	Lump Sum

BARRICADES (TYPE III)

602.10 Description. This item consists of Type III barricades. The Contractor shall erect these devices on the roadway to close the roadway to traffic and to prevent traffic from entering a construction area. Always reflectorize these barricades with Type III reflective sheeting unless otherwise specified by the plans and the special provisions. The reflective sheeting shall have alternate orange and white stripes sloping downward at 45 degree angles. The plans will illustrate the direction of the sloping orange and white stripes or the *SCMUTCD* will specify direction of the stripes when plans are unavailable. Provide, install, and maintain each Type III barricade as specified hereto.

602.11 Method of Measurement. The contract lump sum

price bid item for Traffic Control shall include Type III barricades. The Department will make no separate payment unless the contract includes specific bid items for Type III barricades.

However, the Department will pay for the barricades separately when the contract includes a separate pay item. To determine the quantity of installed barricades, measure the width of the barricade on a linear foot basis unless the contract specifies otherwise.

602.12 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining the barricades. Payment shall include fabrication of the barricades with proper reflective sheeting and use of proper supports. Also, payment shall include furnishing all labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary for installing and maintaining the barricades until completion of the project.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
1071000	Traffic Control	Lump Sum

CHANGEABLE MESSAGE SIGNS

602.13 Description. This item consists of changeable message signs that are supplementary to other traffic control devices. The changeable message sign provides additional advance warning and directional information to assist motorists through construction and maintenance work zones on or adjacent to the **traveled way**. Provide, install, maintain, and operate each changeable message sign as specified in the supplemental specification, “Changeable Message Signs," in effect at the time of the contract award.

602.14 Requirements. (a) Sign Panel. The size of the sign panel shall be no less than 76 inches vertical by 113 inches horizontal. The display shall be comprised of three message lines and each message line shall be comprised of no less than eight matrices per line with each matrix measuring no less than 18 inches high x 12 inches wide. Each matrix shall be 7 rows high x 5 columns wide of message components. The message components of each matrix shall be interchangeable and message updates shall be accomplished in less than 400 milliseconds. The message shall be clearly visible and legible from a distance of 900 feet.

Each sign panel will have a minimum number of 280 message components per line with a total of 840 message components in all. These message components shall be evenly spaced at 40 columns per line and proportionally spaced and centered.

The types of sign panels utilized in accordance with these standard specifications shall be as follows:

1. FLIP DISK: This sign utilizes flip disk elements as message components. These flip disk elements shall have a face area of no less than 3.75 square inches and shall be colored saturn yellow on the face and flat black on the back side. Each matrix shall contain 35 flip disk elements.

2. LED: This sign utilizes LED elements as message components. Each matrix shall contain 35 LED lamp pixels.

3. LED/ FLIP DISK (Hybrid): This sign utilizes a combination of LED and flip disk elements as message components. The flip disk elements shall have a face area of no less than 3.75 square inches and shall be colored saturn yellow on the face and flat black on the back side. Each matrix shall contain 35 flip disk elements and 35 LED lamp pixels.

Sign panels that utilize flip disk elements for message components shall have internal illumination during the hours of darkness and during cloudy weather and/or severe

weather. This internal illumination shall be provided by fluorescent lamps. These lamps shall be wired parallel to prevent a burned out lamp from affecting the remaining lamps. Placement of these lamps shall be such that the illumination is distributed evenly without the presence of "dim spots" or "hot spots". Activation of these lamps shall be controlled by a photo cell.

(b) Controller. The controller shall be an electronic unit housed in a weatherproof, rust resistant box, with a keyed lock and a light for night operation. The unit shall be provided with a jack that will allow direct communications between the on-board controller and an IBM compatible personal computer. This unit shall also have an LCD display screen that will allow the operator to review all messages prior to display of the messages on the sign.

The controller shall be capable of storing 199 factory preprogrammed messages and up to 199 additional messages being created, edited, stored, displayed, and/or deleted by the user. Messages shall be stored in memory in a manner to prevent the necessity of a battery to recall these messages from memory. The computer shall allow the operator to program the controller to display multiple messages in sequence. A "default message" shall be programmed for constant display in "Flip Disk" and "Flip Disk/LED (Hybrid)" signs in the event of a malfunction such as a power loss and total shut down of the sign.

The controller shall be equipped with a selector switch that will allow the operator to control the light source intensity. The selector shall be capable of "bright", "dim", and "automatic" modes. When the selector switch is in the "automatic" mode, control of the light source intensity from day to night and back to day shall be controlled by the controller as determined by a photo cell.

(c) Power Source. The electrical power for operation of the sign shall be supplied by a 12 VDC power source or a 110 VAC or a 120 VAC power source. Operating power shall be obtained from a power source mounted on the trailer on which

the unit is mounted unless an adaptable 110 VAC or 120 VAC power source is available. Regardless of the source, the supply of electrical energy shall be capable of operating the sign panel as required by these standard specifications, the special provisions, the *SCMUTCD,* and the Plans.

1. Diesel Powered. The unit shall be powered by an air-cooled variable speed diesel engine. The engine shall be capable of operating not less than 24 hours without refueling and shall have a minimum 25 gallon capacity fuel tank with a fuel cut-off valve at the tank, a muffled exhaust system, and a steel fabricated security cage that encloses both the engine and a 24 volt alternator.

2. Solar Assisted. The unit shall be powered by a battery bank charged by photovoltaic solar panels and/or a built-in 110 volt 20 amp battery charger. The battery bank shall be housed in a lockable heavy duty steel weatherproof box. The unit shall be equipped with an automatic lamp intensity regulator which keeps the lamp output constant with varying battery voltage. The power control unit shall contain two current meters, one to indicate amperage generated by the battery

charger and the other for amperage generated by the solar panels.

3. A/C Powered. The unit shall be powered by a 110 or 120 volt A/C power source. The unit shall be equipped with ground fault interruptering circuit breakers. All A/C power adaptations shall be accomplished with UL approved equipment and methods.

(d) Trailer and Accessories. The unit shall be mounted on a trailer rated for no less than a 2000 pound capacity. The trailer shall be fabricated and equipped with a single axle, springs, sign support assembly, and four (4) leveling or stabilizer jacks. The sign shall be capable of rotating 360 degrees on a vertical axis to permit positioning for transport or for operation. The sign shall have the capability of being raised into its operating position by one person using a manual crank or a hydraulic system.

Sign panels shall be mounted to provide a minimum height of 7 feet from the bottom of the sign to the surface of the roadway when raised into its operating position.

Units powered by diesel engines shall be equipped with fuel tanks designed to minimize danger of rupture or explosion in case of collision. Additional fuel shall not be stored on or near the trailer.

These trailers shall be properly equipped in compliance with **South Carolina Law** governing motor vehicles. The minimum requirement for lights and reflectors shall include turn signals, dual tail lights, and brake lights. The trailer shall be equipped with Safety chains meeting **SAE J-697 standards** and shall be painted **Federal Standard No. 595**, Orange No. 12246.

Trailer mounted unit panels shall be mounted on trailers equipped to minimize overturning from winds up to 80 miles per hour when in the operating position. The trailer shall be equipped with leveling jacks.

602.15 Method of Measurement. The Department will pay for the changeable message signs at the contract unit price bid. The Contractor shall require the Engineer's approval for any revisions to the quantities and locations of the changeable message signs as required by the plans, the plans quantities, the *Standard Drawings For Road Construction*, and the special provisions prior to installation. The Engineer will only accept measurement of the changeable message signs actually installed and operational on the project. The Department will make no separate payment for sign relocations or operational equipment unless the contract includes specific bid items for these items.

602.16 Basis of Payment. Payment shall be full compensation for providing, installing, removing, and relocating as necessary, operating, and maintaining the changeable message signs. Payment shall include providing the unit's primary

power source as necessary. Payment shall include furnishing all labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary for installing, operating, and maintaining the message signs until completion of the project. Also, payment shall include beginning repair or replacement operations of damaged units within the first two hours after notification of a damage causing incident or electrical failure. Payment shall include any installation, or removal and reinstallation, of a lane closure or any other traffic control set-up during repair or replacement operations.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
6020105	Construction Zone Electric Changeable Message Sign	Each

TRAFFIC CONES

602.17 Description. This item consists of plastic traffic cones. The Contractor shall use these devices 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. These cones shall be a minimum height of 28 inches and orange in color. The Contractor shall always reflectorize cones for use during the hours of darkness. However, the Contractor shall replace cones with plastic drums when traffic control devices are necessary on or adjacent to a **traveled way** during the hours of darkness when required by the typical traffic control standard drawings. The Department will permit the use of cones during the hours of darkness during emergency situations only. Provide, install, and maintain each cone as specified hereto.

602.18 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include cones. The De-

partment will make no separate payment unless the contract includes specific bid items for cones.

602.19 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining the cones. Payment shall include application of properly reflectorized materials, use of an approved ballast, and maintaining a clean and proper construction zone orange color. Also, payment shall include furnishing all labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary for installing and maintaining the cones until completion of the project.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
1071000	Traffic Control	Lump Sum

OVERSIZED TRAFFIC CONES

602.20 Description. This item consists of plastic traffic cones taller than 36 inches. The Contractor shall use these devices 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. These cones shall be a minimum height of 42 inches and orange in color. Provide, install, and maintain each oversized cone as specified hereto.

602.21 Application. The Department may permit the use of oversized cones in place of portable plastic drums during milling and paving operations on multilane roadways.

The Department may consider substitution of oversized cones for portable plastic drums during milling and paving operations when the unavoidable encroachment of equipment

onto an adjacent travel lane will reduce its width to less than 10 feet.

Substitution of oversized cones for portable plastic drums is permitted only within lane closures. Oversized cones are prohibited for any purpose other than as the traffic control devices within lane closures.

602.22 Requirements. All regulations and requirements of the typical traffic control standard drawings that apply to portable plastic drums shall also apply to the oversized cones. Installation and maintenance of these cones in place of portable plastic drums or standard size cones shall ONLY be permitted as required by these standard specifications and as illustrated on the following typical traffic control standard drawings of the ***Standard Drawings For Road Construction***:

a. Non - Interstate Standards.

1. TYPICAL IV TRAFFIC CONTROL	Drawing No. 605-4	Daytime Lane Closure.
2. TYPICAL V TRAFFIC CONTROL	Drawing No. 605-5	Nighttime Lane Closure.
3. TYPICAL VI TRAFFIC CONTROL	Drawing No. 605-6	Dual Lane Closure.
4. TYPICAL VII TRAFFIC CONTROL	Drawing No. 605-7	Center Lane Closure.

b. Interstate Standards.

1. TYPICAL IX TRAFFIC CONTROL	Drawing No. 605-9	Daytime Lane Closure
2. TYPICAL X TRAFFIC CONTROL	Drawing No. 605-10	Nighttime Lane Closure
3. TYPICAL XI TRAFFIC CONTROL	Drawing No. 605-11	Dual Lane Closure
4. TYPICAL XII TRAFFIC CONTROL	Drawing No. 605-12	Center Lane Closure

The Department prohibits use of the oversized cones in any manner or method other than as directed by these specifications.

Oversized cones and standard cones that are 36 inches tall or less are not interchangeable. The Contractor may substitute oversized cones for the smaller cones but the smaller cones are unacceptable as substitutes for the oversized cones or for portable plastic drums.

All oversized cone sizes on a project shall be uniform. The sizes, including the height and width, of all oversized cones used on a project shall be the same throughout the project.

Each oversized cone shall be a two-piece traffic control device with a breakaway design. Each device shall consist of a cone and a rubber base.

Each oversized cone shall be a low density polyethylene plastic device and shall be a standard highway orange color. The minimum height of an oversized cone is 42 inches. Also, the maximum height of an oversized cone is 50 inches. The minimum diameter of the cone cylinder shall be 4inches at the

top of the cone and no less than 7 1/2 inches at the bottom of the cone. The bottom of each cone shall flare outward to form a flange for the rubber base to rest upon and provide stability. The flange should be no less than 10 1/2 inches in diameter to prevent the bottom of the cone from easily passing through the rubber base.

The base, molded from recycled rubber, shall weigh no less than 15 pounds. The base should be no greater than 18 inches wide. The diameter of the hole in the center of the base shall be 1/2 inch larger than the diameter of the cone cylinder at the bottom of the cone and no less than 2 1/2 inches smaller than the cone flange.

Reflectorize each oversized cone with no less than four reflectorized bands, two orange and two white reflectorized bands. Also, the orange and white reflectorized bands shall alternate. Each reflectorized band shall be no less than 6 inches wide and shall be a Type III reflectorized sheeting. Separate each reflectorized band with no more than a 2 inches non-reflectorized area. Splicing of reflectorized sheeting to create the 6 inch reflectorized bands is prohibited.

The construction of the oversized cone shall facilitate storage. The manufacturer should provide a handle type structure on top of the cone to facilitate relocation, installation, and removal operations.

602.23 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include oversized traffic

cones. The Department will make no separate payment unless the contract includes specific bid items for oversized traffic cones.

602.24 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining the oversized cones. Payment shall include application of properly reflectorized materials, use of an approved ballast, and maintaining clean and proper con-

struction zone orange and white colors. Payment shall include furnishing all labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary for installing and maintaining the oversized cones until completion of the project.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
1071000	Traffic Control	Lump Sum

PLASTIC DRUMS

602.25 Description. This item consists of portable plastic drums. The Contractor shall use these devices 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. Always reflectorize these drums with Type III reflective sheeting unless otherwise specified by the plans and the special provisions. Drums are the preferred traffic control device for use adjacent to a **traveled way** during the hours of darkness. Provide, install, and maintain each drum as specified hereto.

The Contractor shall provide drums constructed of a plastic material. The Department prohibits metal drums for traffic control purposes. All drums shall have drain holes in the bottom to prevent accumulation of water and the creation of hazardous masses of ice due to freezing temperatures. Do not weight drums with loose sand, water, or any material to the extent that would make them hazardous to motorists. The Department prohibits placement of ballast on top of a drum. Use 1 - 2 sand bags for ballast. The Contractor shall require the Engineer's approval for the use of any other devices as ballast.

602.26 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include portable plastic drums. The Department will make no separate payment unless the contract includes specific bid items for portable plastic drums.

602.27 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining the drums. Payment shall include fabrication of the drums with a proper reflective sheeting, use of an approved ballast, and maintaining clean and proper construction zone orange and white colors. Payment shall include furnishing all labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary for installing and maintaining the drums until completion of the project.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
1071000	Traffic Control	Lump Sum

TEMPORARY PAVEMENT MARKINGS

602.28 Description. This item consists of pavement markings (Paint, Tape, Thermoplastic, etc.) applied within the limits of a construction or maintenance project. The pavement markings provide delineation for travel lanes and channelize traffic. The Department defines these pavement markings as follows:

(a) Temporary Pavement Markings (Non-Removable Paint). Apply temporary pavement markings (non-removable paint) in areas where the Contractor must maintain the current traffic patterns or cover these markings with a subsequent pavement course or with permanent pavement markings. Consider these markings non-removable due to scar-

ring that results from the removal processes necessary for these markings.

(b) Temporary Pavement Markings (Removable Paint). Apply temporary pavement markings (removable paint) in areas where the Contractor will modify the traffic patterns but must maintain the existing surface course. These markings shall be a type of paint specifically engineered and manufactured for removal by specific chemicals as directed by the manufacturer. Also, these markings shall require removal without any residual effects or scarring of the pavement surface when removal is necessary to modify the traffic patterns.

(c) Temporary Pavement Markings (Tape). Apply temporary pavement markings (tape) in areas where the Contractor will modify the traffic patterns but must maintain the existing surface course. These markings shall be Type 2 Temporary - Removable Preformed Flexible Retroreflective Pavement Markings. Also, these markings shall require removal without any residual effects or scarring of the pavement surface when removal is necessary to modify the traffic patterns.

602.29 Requirements. The Contractor shall apply and maintain these pavement markings within all requirements as specified by these standard specifications.

The pavement markings will include lane lines, no passing zone markings, edge lines, transverse lines, arrows, word, and railroad crossing symbols. Whenever existing pavement markings are removed or covered by an asphalt mixture, the Contractor shall apply new markings before the end of each day's work.

The Contractor shall reflectorize all pavement markings to conform with standard highway colors. Apply the painted lines at a wet film thickness of no less than 15 mils $\pm$ 1 mils and instantly apply the glass beads at a rate of 6 lbs. per gallon of binder.

All lines shall be of the width and length prescribed by the

plans, the *SCMUTCD*, and the Engineer. Normal width lines shall be no less than 4 inches wide. The temporary edgelines are solid and 4 inches wide and the temporary broken white lane lines are 4 inches wide by 10 feet long with a 30 foot gap unless the plans and the special provisions specify otherwise.

Apply no passing zone markings as specified by the plans and the *SCMUTCD*.

Apply all pavement markings as specified. The Contractor shall follow standard practices in applying paint to ensure a straight line with true edges and a clean cut.

Prior to application of pavement markings, clean the roadway surface by sweeping or another approved method to ensure a clean surface for proper adhesion of the markings.

Furnish all temporary and permanent pavement markings as provided for in the plan quantities. The Contractor is responsible for provision, installation, maintenance, relocation, and removal of all pavement markings. A project may require temporary markings due to (a) asphalt mixtures covering existing pavement markings, (b) changes in traffic patterns, (c) changes in alignment due to relocations, etc., and (d) maintenance and replacement of pavement markings which have lost their reflectivity or have become damaged during construction.

Before beginning work, the Contractor and the Engineer shall jointly inspect the project limits to determine the condition of the existing pavement markings. The Contractor shall apply temporary pavement markings (traffic paint or an approved equal) to roadways where the existing pavement markings are deficient as determined by the Engineer. Apply 4 inch double yellow lines to the center lines and 4 inch white solid lines to the edge lines of two-lane two-way roadways within construction zones unless the plans, the special provisions, and the Engineer specify otherwise.

Apply pavement markings to the travel lanes of a resurfaced multilane facility or any roadway with obliterated pavement markings before reopening a closed travel lane to traffic.

The Department prohibits allowing traffic onto travel lanes without pavement markings where pavement markings existed before construction or where the width of the pavement is 24 feet or greater.

The Department prohibits application of temporary pavement markings (traffic paint or an approved equal) that will require modifications to a bridge deck or a final surface course unless otherwise directed by the traffic control plans. For temporary pavement markings on bridge decks and final surface courses, use Type 2 Temporary - Removable Preformed Flexible Retroreflective Pavement Markings or Removable Paint. As the traffic control stages progress, tie each new pavement marking scheme to the existing pavement markings.

The Department prohibits conflicting pavement marking schemes on any roadway opened to traffic.

The Contractor shall be responsible for removal of all conflicting temporary and permanent pavement markings, as necessary. The Contractor shall remove those pavement markings designated for removal by the plans and the Engineer. The Contractor shall complete the removal process prior to revision of the traffic patterns. Remove the designated pavement markings by either (a) sand blasting using air or water, (b) high pressure water, (c) steam or superheated water, (d) grinders, sanders, scrapers, scarifiers, and wire brushes, or (e) solvents and chemicals.

The Department prohibits removal of pavement markings by painting over the obsolete markings. Therefore, the Department prohibits the use of a black paint or any other color of paint or type of paint for painting over markings designated for removal.

When the removal operation consists of a blast cleaning

method within 10 feet of a travel lane open to traffic, remove the residue, including dust particles, immediately after contact between the sand and the treated surface. The removal process shall require a vacuum attachment operating concurrently with the blast cleaning operation or by a method as approved by the Engineer. The Contractor shall be responsible for maintaining safety as required by these standard specifications and all federal, state, and local laws.

During removal of temporary pavement markings, the Contractor shall remove the obsolete pavement markings and any residue resembling the previous pavement marking scheme. If the pavement marking removal process damages the roadway, the Contractor shall repair or resurface the roadway as directed by the Engineer at no additional expense to the Department.

Consider the cost of removing pavement marking as incidental to the pavement marking items unless the contract includes a specific bid item for removal of pavement markings.

Apply the permanent pavement markings to the final surface course when the traffic pattern will no longer change. When resurfacing a road, apply the pavement markings after each application of asphalt mix and bituminous surface treatment, including the final course at the end of each day's work.

602.30 Method of Measurement. The Department will pay for the pavement markings at the contract unit price bid. Measurement, except for arrows, words, and railroad crossing symbols, shall be on a linear foot basis for each width of marking in place, measured along the center of the lines. The measurement shall include the length of the marking only, and shall exclude spaces between broken lines.

Measurement of payment for arrows, words, and railroad crossing symbols shall be for each arrow, word, or railroad crossing symbol. A railroad crossing symbol consists of one "X" and two "R" 's.

The Department will make no separate payment unless

the contract includes a specific bid item for the removal of pavement markings. Consider pavement marking removal incidental to the use of the item.

The Department will make no separate payment for traffic control during application and removal of pavement markings unless the contract includes specific bid items. Consider traffic control for application and removal of pavement markings incidental to the use of the item. Include any additional costs for traffic control in the contract lump sum price bid item for Traffic Control.

602.31 Basis of Payment. Payment shall be full compensation for providing all materials necessary to complete the job properly. Payment shall include preparation of the surface, placement of the material, installation, and maintenance of the pavement markings until the Department accepts the project or the relative warranties expire. Also, payment shall include the removal of any temporary and existing pavement markings, application at correct thickness, and application of glass beads as necessary. Payment shall include all labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary to complete the item of work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
6021X0X	Pavement Markings (Temporary - Removal) *(width)*" *(color)* Broken Lines	Linear Foot
6021XXX	Pavement Markings (Temporary - Removal) *(width)*" *(color)* Solid Lines	Linear Foot
6021030	Pavement Markings (Temporary - Removal) White Single Arrow	Each
6021035	Pavement Markings (Temporary - Removal) White Word Message "Only"	Each
6021040	Pavement Markings (Temporary - Removal) White Combination Arrow	Each
6021045	Pavement Markings (Temporary - Removal) Railroad Crossing Symbols	Each

PORTABLE TERMINAL IMPACT ATTENUATORS FOR WORK ZONES

602.32 Description. This item consists of a portable terminal impact attenuator system used on or adjacent to roadways to protect the ends of concrete barrier walls and other similar hazards in work zones.

The Contractor shall use attenuating devices 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, the unit shall bring the errant vehicle to a safe and controlled stop. When impacted from the side, the unit shall redirect the errant vehicle. Each attenuator shall function within the requirements as detailed by the Department's standard specifications and the manufacturer's specifications.

The Contractor shall provide, install, and maintain all portable terminal impact attenuators as specified hereto.

602.33 Requirements. (a) The Contractor shall assemble, install, maintain, repair or replace as necessary, and relocate each attenuator as detailed by these specifications, the manufacturer's specifications, the special provisions, the plans, and/or the Engineer.

(b) Each attenuator shall be either a QuadGuard System manufactured by Energy Absorption Systems, Incorporated, of Chicago, Illinois, or an approved equal.

Alternative attenuating devices shall meet all standards and requirements as specified under **Subsection 611.01** Description and **Subsection 611.03** Performance, of this specification to be considered an approved equal. Failure to meet these standards and requirements in their entirety shall disqualify an alternative attenuating device as an approved equal.

© Each attenuator shall be either 24 inches, 30 inches, or 36 inches wide as specified and shall contain the number of bays as specified by the special provisions and the plans.

(d) The Contractor shall identify each attenuator with a numbered identification code, unique to each unit. Attach the identification code to the top portion of the back-up. The code shall include the name of the owner and the number of the unit as follows:

Code Example: "NAME OF OWNER - 01"

The number will be 2 to 3 digits. The Contractor may choose the identification numbers.

The Contractor shall print the code legibly with uniform letter heights. The letter heights shall be from 0.5 inch to 1.0 inch tall. All documents, records, and correspondences regarding a specific attenuator shall include that unit's identification code. The Engineer will prohibit the Contractor from bringing any attenuator without a correctly installed and main-

tained identification code onto the project site.

(e) The Contractor shall make all corresponding shop drawings and detailed specifications from the manufacturer available for the Engineer's inspection prior to installation of the attenuator. The shop drawings and specifications shall include performance criteria, installation drawings, and instructions that completely describe the attenuator system. Stamp all shop drawings with the identification code of the corresponding attenuator.

(f) Crushable cartridges shall be Type I and Type II as necessary.

Each cartridge shall be new or in like-new condition. Cartridges exhibiting pulled staples, wrinkles in the plastic container package, exposed internal material, or attempts to repair the cartridge with rivets, screws, etc., are defective and shall be prohibited on the project site. Replace all defective cartridges prior to installation of the unit.

(g) All nose assemblies shall be yellow. Supplement the nose assembly of each attenuator with road signs, either W18-2-24, W18-2R-24, or W18-2L-24, for delineation of the approach end of the unit. The Contractor should request the necessary sign drawings from the Director of Traffic Engineering.

602.34 Performance. (a) The attenuator shall function within all criteria as reported in industry publications.

1. Each attenuator shall meet the test requirements for the **National Cooperative Highway Research Program (NCHRP)**, *Report 350*, 1993, Test Level 3 for re-directive, non-gating terminals and crash cushions as directed by the FHWA. Also, each attenuator shall have approval for use from the FHWA.

2. Design, Selection, and placement of Terminal Impact

Attenuators shall conform to and utilize devices described in:

(A) The **American Association of State Highway and Transportation Officials (AASHTO)** publication, *Roadside Design Guide*, latest edition.

(B) **U.S. Department of Transportation**, **Federal Highway Administration (FHWA)** *Report N5040.16*, *Crash Cushions, Selection Criteria, and Design*.

(b) Each attenuator shall function as described below:

1. Each attenuator shall function in accordance with the following design requirements:

(A) The attenuator shall decelerate and stop vehicles weighing 1800 to 4400 pounds during head-on impacts. The attenuator shall meet the occupant risk and vehicle trajectory criteria required by the NCHRP, *Report 350* Tests 30, 31, 32, and 33. Test 31 shall also evaluate the capacity of the attenuator to absorb the energy of the 4400 pounds standard 3/4 ton pickup truck.

(B) The attenuator shall redirect vehicles weighing 1800 to 4400 pounds that impact the unit along the side at speeds up to 62 mile per hour at angles of 20 degrees or less for both right-way and wrong-way impacts. Measure all angles from the longitudinal centerline of the unit. The attenuator shall meet the requirements of the NCHRP, *Report 350* Tests 36, 37, 38, and 39. These tests shall evaluate the occupant risk and vehicle trajectory criteria, re-directional capability, the structural adequacy of the attenuator, the potential for snagging, and performance during a reverse hit.

(C) All test result data for 4400 pound vehicles shall include the standard 3/4 ton pickup truck.

(D) The attenuator shall remain intact without debris during all impacts within design parameters. After side impacts within design parameters, the unit must remain capable of

sustaining an additional side impact or a head-on impact at full design velocity.

(E) The “coffin corner” is the last 4 feet of the attenuator in front of the hazard. The attenuator shall prevent lateral penetration at or near the “coffin corner” with a subsequent impact against the stationary hazard. The attenuator shall prevent penetration of the “coffin corner” in all impacts from 0 miles per hour up to the maximum design speeds of the unit for vehicles in the weight range of 1800 to 4400 pounds.

602.35 Field Installations. Install each attenuator as detailed by these specifications, the manufacturer’s specifications, the special provisions, the plans, and the Engineer.

The Engineer will inspect each attenuator, including all parts and materials, before and immediately after installation to ensure conformance with all specifications.

(a) An ideal site location places the attenuator farther than 2 feet from the edge of an adjacent travel lane and preferably not closer than 6 feet. Always install the attenuator parallel to the adjacent traffic flow, unless otherwise specified by the special provisions and/or the plans. When placed in a gore area, install the unit parallel to the mainline traffic flow.

Clear all obstructions from the immediate site location. Determine the length of the immediate site location by the length of the attenuator. Prepare the immediate site location to be either 16 feet, 25 feet, or 35 feet long (parallel to the roadway) by 8 feet wide (perpendicular to the roadway). Dress and clear the immediate surrounding area and the approach area 50 feet long in advance of the system of curbs, islands, elevated objects, and depressions where possible. The immediate site location shall place the attenuator at the same grade elevation, including adjustments necessary for superelevation, as the adjacent travel lane or paved shoulder. Make all approach areas in advance of the site location reasonably smooth and flat for no less than 100 feet. Grade unpaved approach areas where necessary to provide for smooth and flat surfaces.

Each site location may require preparations such as grading, slope flattening, paving, provision of a concrete leveling pad, and excavation. Any location that exceeds a cross slope of 8% or has a variance in excess of 2% shall require one or more of the above site preparations. Pave each site location as required by these specifications and the manufacturer's specifications.

A site location within a two-way traffic situation shall require utilization of an approved transition panel. Place the attenuator on the site location to minimize exposure of the rear of the unit to opposing traffic and the possibility of a vehicle snagging the rear of the unit. Drill each transition panel to permit attachment to the hazard or existing guardrail and to the attenuator. Attach the panel to the unit beneath the adjacent fender panel to permit the adjacent forward set of fender panels the ability to move over the transition panel during an impact from the front. Install the panel flat and securely against the side of the hazard to prevent snagging of vehicles as required by these specifications and as directed by the manufacturer's specifications.

Each site location selected for placement of an attenuator shall meet all requirements of these specifications, the special provisions, and/or the plans.

(b) Anchor each attenuator onto a foundation constructed in accordance with these specifications and the manufacturer's specifications. The top of each foundation shall be at the same grade elevation as the adjacent travel lane and/or paved shoulder. Five types of foundations are acceptable. Soil is unacceptable as a foundation. Construct each foundation with the properly matched anchors as follows:

1. FOUNDATION 1: Reinforced portland cement concrete (P.C.C.).

This foundation shall have a minimum thickness of 6 inches.

Classify concrete roadways under this foundation.

The anchors shall be 6 1/2 inch studs @ 5 1/2 inches embedment.

2. FOUNDATION 2: Asphalt concrete (A.C.) over a reinforced portland cement concrete (P.C.C.).

The minimum thickness for this foundation shall be 3 inches A.C. & 3 inches P.C.C.

Asphalt concrete surface courses used for this foundation shall be Types 1, 3, 4, 1B, 1C, or a superpave surface course.

Asphalt concrete binder courses used for this foundation shall be Hot Mix Asphalt Binder, Hot Mix Asphalt Binder Type II, or Superpave Intermediate Course.

The anchors shall be 18 inch threaded rods @ 16 1/2 inches embedment.

3. FOUNDATION 3: Asphalt concrete (A.C.) over a compacted subbase.

This foundation thickness shall be a combination of A.C. with a minimum depth of 6 inches over a compacted subbase with a minimum depth of 6 inches.

Asphalt concrete surface courses used for this foundation shall be Types 1, 3, 4, 1B, 1C, or a superpave surface course.

Asphalt concrete binder courses used for this foundation shall be Hot Mix Asphalt Binder, Hot Mix Asphalt Binder Type II, or Superpave Intermediate Course.

The anchors shall be 18 inch threaded rods @ 16 1/2 inches embedment.

4. FOUNDATION 4: Asphalt concrete (A.C.).

This foundation thickness shall be asphalt concrete (A.C.) with a minimum depth of 8 inches.

Asphalt concrete surface courses used for this foundation shall be Types 1, 3, 4, 1B, 1C, or a superpave surface course.

Asphalt concrete binder courses used for this foundation shall be Hot Mix Asphalt Binder, Hot Mix Asphalt Binder Type II, or Superpave Intermediate Course.

The anchors shall be 18 inch threaded rods @ 16 1/2 inches embedment.

5. FOUNDATION 5: Portable reinforced portland cement concrete (P.C.C.).

This foundation (Reinforced Portable Concrete Pad) shall have a minimum thickness of 8 inches.

The anchors shall be 6 1/2 inch studs @ 5 1/2 inches embedment.

Provide the concrete mix and steel reinforcement as required by these specifications and the manufacturer's specifications. The construction of this pad shall require 4000 psi stone aggregate concrete and #5 rebar spaced on no greater than a 12 inch x 24 inch grid.

The concrete pad dimensions and amount of concrete and length of rebar required shall correspond with the size of the attenuator system with a tension strut backup as follows:

No. of Bays	**Length of Pad**	**Cubic Yards of Concrete Required**	**Length of Rebar Required**
3	15 ft.	1.47 yd^3	104 ft.
6	24 ft.	2.37 yd^3	140 ft.
9	33 ft.	3.25 yd^3	176 ft.

Excavate the site location prior to installation of the at-

tenuator. Install the top of the pad at the same grade elevation as the adjacent travel lane or paved shoulder. Backfill and dress the areas adjacent to the edges of the pad.

Anchor each attenuator as required by these specifications and the manufacturer's specifications. Only 2 types of anchoring systems are acceptable. Use these systems as follows:

Anchor Systems	**Foundation Type**
6 1/2 inch Studs (3/4 inch x 6 1/2 inch) with Grout	1 & 5
18 inch Threaded Rods (3/4 inch x 18 inch) with Grout	2, 3, & 4

The grout used for attenuator anchor systems shall be a two-part polyester epoxy. The grout shall be either the MP-3 Polyester Anchoring System manufactured by Energy Absorption Systems, Inc. or an approved equal.

All components of the anchoring system, including the anchors, shall be new or like-new for each installation or relocation in "Foundations 1, 2, 3, and 4". The Engineer shall approve all components of the anchoring system before installation. Also, the Engineer shall inspect and approve all like-new components before installation.

Correctly match the grout and anchors to the intended foundation as required by these specifications and the manufacturer's specifications for each installation or reinstallation. Reinstallation is the relocation of an attenuator from one location to another on the same project.

Provide the correct number anchors for each installation of a terminal impact attenuator as shown by the following:

NUMBER OF ANCHORS REQUIRED PER ATTENUATOR			
No. of Bays	**24 inch Wide Unit**	**30 inch Wide Unit**	**36 inch Wide Unit**
3	32	32	32
6	52	52	52
9	72	72	72

ANCHOR SYSTEM OPTIONS			
No. of Bays	**6 1/2 inch Studs and 18 inch Threaded Rods with Grout**	**6 1/2 inch Studs with Grout**	**18 inch Threaded Rods with Grout**
3	32 - 6 1/2 inch Studs 32 - 18 inch Threaded Rods 8 Quarts - Grout	32 - 6 1/2 inch Studs 5 Pints - Grout	32 - 18 inch Threaded Rods 8 Quarts - Grout
6	52 - 6 1/2 inch Studs 52 - 18 inch Threaded Rods 13 Quarts - Grout	52 - 6 1/2 inch Studs 5 Quarts - Grout	52 - 18 inch Threaded Rods 13 Quarts - Grout
9	72 - 6 1/2 inch Studs 72 - 18-inch Threaded Rods 18 Quarts - Grout	72 - 6 1/2 inch Studs 7 Quarts - Grout	72 - 18 inch Threaded Rods 18 Quarts - Grout

Notes: 6 1/2 inch Studs require 3 oz. of grout per anchor.
18 inch Threaded Rods require 8 oz. of grout per anchor

602.36 Maintenance. Maintain all attenuators in a good, functional condition at all times and conduct a thorough inspection after any type of impact. Repair or replace any unit that has sustained damage and is unable to function within the requirements of these specifications and the manufacturer's specifications. Initiate refurbishment or total replacement of a damaged unit within the first 2 hours after discovery or notification of an impact. Refurbish or replace any damaged unit within the first 24 hours after discovery or notification of an impact.

The Contractor shall provide the replacement unit when an impact is severe enough to require complete replacement of an attenuator.

Closely examine all parts of an attenuator, including cartridges, anchors, monorail assembly, backup assembly, diaphragms, fender panels, and mushroom washer assemblies, for damages after any incident.

Replace the cartridges, as necessary, after an impact by an errant vehicle. Replace each and every one of the cartridges if an impact on the unit was severe enough to cause compression of all the bays. However, if only a portion of the bays are compressed during an impact, only those cartridges contained within the compressed bays shall require automatic replacement. Closely examine the remaining cartridges in the uncompressed bays for pulled rivets, wrinkles in the plastic container package; or any exposed internal material. Replace any cartridge exhibiting one or more of these defects.

Closely examine all anchors after an impact. Replace 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.

Replace the plastic nose assembly after a head-on impact or any impact that damages the nose assembly.

The Contractor shall have a spare parts package available on the project site at all times when an attenuator is in place. The Contractor shall provide a minimum of one complete spare parts package for 1 to 6 units installed on a project site. The Contractor shall provide a minimum of two complete spare parts packages for 7 to 12 units installed on a project site. Replace the spare parts package or any individual components of the package used. Place the order for replacement parts, necessary to reconstitute the spare parts package, with the vendor within 48 hours. Each spare parts package shall include parts as follows:

Product Description	Quantity
Cartridges - Type I	4
Cartridges - Type II	6
Nose Assembly - QuadGuard System, Yellow	1
Fender Panel Assy - QuadGuard System	2
*****Diaphragm Assy - QuadGuard System	2
******Anchor - 3/4 inch x 6 1/2 inches	6
*******Grout - 1 Pint	1
Mushroom Washer	4
Flathead Allen Screw - 5/8 inch x 3 inches	4
Nut, Hex - 5/8 inch	4

Product Description (continued)	Quantity
Bolt, Hex - 3/4 inch x 2 inches	5
Washer, Flat - 3/4 inch x 2 inches	5
Nut, Hex - 3/4 inch	5

***** Item Size Must Be Specified:
Diaphragm Assy, QuadGuard (24 inch, 30inch, or 36inch)

****** Item May Be Substituted with:
Anchor - 3/4 inch x 18 inches (Required for Foundations 2, 3, & 4)

*** Item May Be Substituted with Grout:
1 Quart (Required for 3/4 inch x 18 inch Anchors)

602.37 Method of Measurement. The Department will pay

for each portable terminal impact attenuator at the contract unit price bid. The Contractor shall require the Engineer's approval prior to installation for any revisions to the quantities and locations of the attenuators as required by the plans, the plans quantities, and the special provisions. The Engineer will measure the number of attenuators actually installed on the project during the stage of work that requires the greatest number of units. If the Contractor limits the work and reduces the number of attenuators used, the Contractor will only receive payment for the number of units actually used.

The Department will make no separate payment for the initial, whole and complete, spare parts package(s). However, the Department will pay for each piece used for repair. The Department will pay for the reconstitution of a spare parts package on a piece by piece as needed basis at the invoice purchase price plus shipping and handling (Not To Exceed 15% of the Invoice Price). The Department will pay for the reconstruction of a spare parts package by Supplemental Agreement as necessary.

The Department will make no separate payment for an anchor kit used for the initial installation of an attenuator. However, the Department will pay for each anchor kit used for reinstallation of an attenuator after relocation from one location to another on the same project site. The Department will pay for each anchor kit at the contract unit price bid. Anchor kits used to anchor attenuators to portable concrete pads (Foundation 5) shall be ineligible for separate payment.

602.38 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating and reinstalling as necessary, and maintaining the attenuator(s). Payment shall include initiating repair or replacement of damaged units within the first two hours after discovery or notification of a damage causing incident and completing the repair or replacement operations within twenty-four hours. Also, payment shall include providing a concrete leveling pad as necessary, concrete and asphalt paving, and preparation and excavation of a site location as necessary. Payment shall include furnishing each initial anchor kit, labor, equipment,

tools and incidentals necessary to complete the work. Consider portable concrete pads (Foundation 5), delineation treatments, and rear transition panels incidental to the use of the item.

Payment for reconstitution of a spare parts package shall be full compensation for reconstituting the initial spare parts package in whole or by individual piece. Payment shall include placing an order for the replacement parts necessary to reconstitute the spare parts package with the vendor within 48 hours after use to repair a damaged units. Also, payment shall include furnishing all labor, equipment, tools and incidentals necessary to complete the work. This payment shall be void if the spare parts are utilized to repair a unit damaged by the Contractor's personnel in the course of performing construction activities.

Payment for anchor kits used for attenuator reinstallation after relocation on the same project site shall be full compensation for providing the anchor kits. Payment shall include providing the correct anchor kits for the corresponding foundations as required by these standard specifications and as provided for by the plans quantities. Also, payment shall include furnishing all labor, equipment, tools and incidentals necessary to complete the work, and for each anchor kit as specified.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
60240X0	Portable Terminal Impact Attenuator - *(3 or 6)* Bay	Each
60240X5	Portable Terminal Impact Attenuator - *(3 or 6)* Bay - 2.0' Wide	Each
60240X6	Portable Terminal Impact Attenuator - *(3 or 6)* Bay - 2.5' Wide	Each
60241X1	Anchor Kit - Portable Attenuator *(3 or 6)* Bay - 6.5" Studs	Each
60241X5	Anchor Kit - Portable Attenuator *(3 or 6)* Bay - 18" Threaded Rods	Each

PERMANENT CONSTRUCTION SIGNS

602.39 Description. This item consists of the signs erected at the termini of a project before work begins and remains in place until the project is complete. However, the Contractor may remove these signs when the project appears complete or omit selected signs in a case of contiguous projects as directed by the Engineer. Consider all other signs temporary. Provide, install, and maintain these signs as specified hereto.

602.40 Requirements. The reflective sheeting for permanent construction signs shall be Type III reflective sheeting unless otherwise specified.

Due to the presence of bridges or permanent concrete barrier wall, the Contractor shall provide customized mounting hardware for these signs where necessary. The Contractor shall provide these signs as required by the plans.

Due to conditions unique to lane closures, temporarily covering some or all permanent construction signs may be required when work activities are being conducted near or at

the project termini. Payment for these signs shall be unaffected.

Erect all permanent construction signs on galvanized 3 pounds U-Section posts per departmental specifications.

The Contractor shall remove the permanent construction signs when the project is complete. The Contractor shall 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 when the Contractor returns to the project to work. Also, the Contractor shall have the option to replace the removed sign assemblies with proper temporary signing as directed by the Engineer.

The Department prohibits overlapping permanent construction signs on contiguous projects. A contiguous project initiated prior to completion of an existing project shall require installation of new permanent construction signs and maintenance of the existing permanent construction signs at the remote termini of each project. The Contractor shall 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 as the Contractor installs the signs at the contiguous terminus of the subsequent project.

Due to conditions unique to contiguous projects, the Contractor may remove or delay installation of certain permanent construction signs as directed by the Engineer. Payment for these signs shall be unaffected.

The Contractor shall be responsible for installation, relocation, and removal of permanent construction signs. Coordinate installation, relocate, and remove the signs at the adjoining termini of contiguous projects as directed by the Engineer.

602.41 Method of Measurement. The Department will pay for the permanent construction signs at the contract unit price

bid. Measurement of the signs will be for the actual square feet of panel installed. The Department will make no deduction for corner radii.

602.42 Basis of Payment. Payment for signs measured per square foot shall be full compensation for providing, installing, relocating as necessary, removing, and maintaining the signs. Payment shall include providing the sign panel with the proper sheeting and legend and erecting the sign on galvanized 3 pounds U-Section posts or customized mounting hardware. Payment shall include providing any necessary customized mounting hardware and installing and removing the signs on contiguous projects as directed by the Engineer. Also, payment shall include providing all labor, hardware, equipment, tools, handling, incidentals, and any miscellaneous items necessary for maintaining the signs until completion of the project.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
6020005	Permanent Construction Signs	Square Feet

TEMPORARY CONSTRUCTION SIGNS

602.43 Description. This item consists of construction, regulatory, warning, and guide signs erected on the roadway for construction and maintenance projects. These signs shall advise motorists of potential hazards and provide construction, regulatory, warning, and guide information as necessary. Provide, install, and maintain these signs as specified hereto.

602.44 Requirements. The reflective sheeting for construction, regulatory, and warning signs installed in conjunction with lane closures and lane shifts shall be Type III reflective sheeting unless otherwise specified.

Due to the presence of bridges or permanent concrete barrier wall, the Contractor shall provide customized mounting hardware for these signs where necessary. The Contractor shall provide these signs as required by the plans.

602.45 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include temporary construction signs. The Department will make no separate payment unless the contract includes specific bid items temporary construction signs.

602.46 Basis of Payment. Payment shall be full compensation for providing, installing, relocating as necessary, removing, and maintaining the signs. Payment shall include providing the sign panel with the proper sheeting and legend and erecting the sign on approved temporary sign supports. Payment shall include providing any necessary customized mounting hardware. Also, payment shall include providing all labor, hardware, equipment, tools, handling, incidentals, and any miscellaneous items necessary for maintaining the signs until completion of the project.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
1071000	Traffic Control	Lump Sum

TEMPORARY CONCRETE BARRIER

602.47 Description. This item consists of portable temporary concrete barrier wall installed on the roadway to prevent traffic from entering the construction area or to separate two-way traffic. Provide, install, and maintain the barrier wall as specified hereto.

Upon completion of the project, the concrete barrier wall shall remain the property of the Contractor unless otherwise specified.

602.48 Requirements. Design and shape of the concrete barrier wall shall meet all requirements as specified by the standard drawings: “Standard For Temporary Concrete Barrier--Drawing No. 805-14” or “Standard For Temporary Concrete Barrier (Alternate)--Drawing No. 805-14A” of the ***Standard Drawings For Road Construction***.

The Contractor shall color the barrier wall “bright white” as directed by the plans, the plans, quantities, and the special provisions. Obtain the coloration by coating or painting. The finish on each section of barrier wall shall be new with no chips, peel areas, or discoloration. The finish shall be smooth to prevent adhesion of roadway particles. If the finish chips, peels or becomes discolored, the Contractor shall remove and replace the defective sections of barrier wall at the Contractor’s expense. The Engineer will inspect previously used barrier walls to ensure its good condition before coating or painting. The Contractor shall re-coat or repaint previously coated or painted barrier walls prior to placement on the job site. The Contractor shall maintain the location and length of the barrier wall as directed by the plans, the plans, quantities, the special provisions, and the Engineer.

602.49 Method of Measurement. The Department will pay for the temporary concrete barrier wall at the contract unit price bid. Measure the barrier wall by the linear foot along the centerline of each section of barrier wall placed end to end as directed in the plans, the *Standard Drawings For Road Construction*, the **special provisions**, and the Engineer. The Contractor shall require the Engineer’s approval prior to installation for any revisions to the quantities and locations of the barrier wall as required by the plans, the plans quantities, and the special provisions. The Engineer will only accept measurement of the barrier wall actually installed on the project during the stage of work that requires the greatest length

barrier wall. If the Contractor limits the work and reduces the length of barrier wall used, the Contractor will only receive payment for the length of barrier wall actually used. The Department will make no separate payment for moving equipment or miscellaneous hardware. Consider such items incidental to the use of the item.

602.50 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining the temporary concrete barrier wall. Payment shall include applying paint or coating, re-coating or re-painting previously used or discolored barrier wall, and removal and replacement of discolored barrier wall. Payment shall include relocation and reinstallation throughout all stages of construction, repair or replacement of damaged barrier walls, and anchoring barrier walls where necessary. Payment shall also include furnishing materials, labor, hardware, equipment, tools, incidentals, anchors, anchor installations and miscellaneous items necessary to complete the work as directed by the Engineer.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
6025001	Temporary Concrete Barrier	Linear Foot

TEMPORARY PAVEMENT MARKERS

602.51 Description. This item consists of temporary pavement markers installed during stage construction as a supplement to the pavement markings. Reapply the pavement markers for each traffic control scheme or traffic relocation or each asphalt concrete course application as directed. However, do not install temporary pavement markers on a new asphalt concrete surface course or any other final surface course unless otherwise directed by the plans, the special

provisions, or the Engineer. Provide, install, and maintain the temporary pavement markers as required by **Subsection 605.03** of these standard specifications, the plans, the special provisions, the *SCMUTCD*, and the Engineer. However, these temporary pavement markers will not require an abrasion-resistant face.

On two-lane two-way roadways, supplement the yellow centerline markings by installing the temporary pavement markers at 80-foot intervals. On primary and secondary multilane roadways, supplement the yellow centerline markings by installing the temporary pavement markers at 40 foot intervals. Also, on all multilane roadways including interstate routes, supplement the broken white lane line markings by installing the temporary pavement markers at 80' intervals. On roadways where turn lanes, accel lanes, and decel lanes are present, supplement the broken white auxiliary lane lines by installing the temporary pavement markers at 40-foot intervals.

At the beginning of a project, install temporary pavement markers on the existing pavement if the existing pavement markers are deficient or no pavement markers are present. Install temporary pavement markers upon the application of an asphalt concrete binder course or an intermediate course to any two adjacent travel lanes. Also, reapply the temporary pavement markers each time the traffic control scheme or the traffic patterns change.

During interstate rehabilitation projects, omit installation of temporary pavement markers on an asphalt concrete binder course or an intermediate course if a final asphalt concrete surface course is applied to all adjacent travel lanes within 60 calendar days of beginning the application of the asphalt concrete binder course or the intermediate course.

On jobs with permanent pavement markers, the Department prohibits the time between completion of the asphalt concrete surface course application to all travel lanes and beginning the application of the permanent pavement mark-

ings to exceed 60 calendar days. The Contractor shall apply the permanent pavement markers to the roadway as directed by the pavement marking plans.

602.52 Method of Measurement. The Department will pay for the temporary pavement markers at the contract unit price bid. The Engineer will only accept measurement of the quantity of temporary pavement markers completely installed during the stage construction.

602.53 Basis of Payment. Payment shall be full compensation for providing, installing, and maintaining the temporary pavement markers. Payment shall include furnishing all materials, preparation of the pavement, labor, hardware, equipment, tools, incidentals, and miscellaneous items necessary to complete the work. Payment shall include removal of any pavement markers, including existing pavement markers installed prior to beginning the construction project, due to traffic pattern changes or failure of the pavement markers. Payment shall also include removal of any temporary pavement markers applied to a final surface course or an open graded friction course prior to application of the permanent pavement markers.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
6023015	Temporary Clear Pavement Markers Mono-Directional, 4"X4"	Each
6023025	Temporary Yellow Pavement Markers Mono-Directional, 4"X4"	Each
6023055	Temporary Yellow Pavement Markers Bi-Directional, 4"X4"	Each

TEMPORARY SHEET PILING FOR TRAFFIC CONTROL

602.54 Description. This item consists of temporary sheet piling walls erected within the highway rights-of-way as support for fill areas to assist stage construction. Design, fabricate, provide, install, maintain, and remove these sheet piling walls as specified hereto. A temporary sheet piling wall may be, but is not limited to either (1) steel sheet pile wall - braced or tieback or (2) steel soldier piles with lagging - braced or tieback.

602.55 Requirements. Design the temporary sheet pile walls as required by the **AASHTO Standard Specifications for Highway Bridges** in effect at the time of the contract award. Also, provide the interim specifications and the applicable requirements of the **special provisions** entitled *Falsework Design and Inspection.*

A Professional Engineer, registered to practice in the state of South Carolina, shall design, sign, and seal the plans and specifications of the temporary sheet piling walls.

The Contractor shall submit the design calculations, methods of construction, and detailed drawings, all signed and sealed by the Design Engineer, to the Engineer twenty-one days prior to construction of the walls.

Construct the temporary sheet piling wall in a manner which provides the necessary protection while allowing construction access for staged construction. All bracing or tiebacks must provide access for the necessary construction while maintaining the traffic flow without interruption.

602.56 Method of Measurement. The Department will pay for the temporary sheet piling walls at the contract unit price bid. Measure the temporary sheet piling walls by the linear foot along the centerline of the walls. The Engineer will only accept measurement of the temporary sheet piling walls in-

stalled as directed by the design plans and specifications.

602.57 Basis of Payment. Payment shall be full compensation for providing, installing, removing, and maintaining the temporary sheet piling walls. Payment shall include furnishing all materials, labor, hardware, equipment, tools, incidentals, and miscellaneous items necessary to complete the work as directed by the Engineer.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
6028020	Temporary Sheet Piling for Traffic Control	Linear Foot

TRUCK MOUNTED ATTENUATORS

602.58 Description. This item consists of truck mounted attenuators used and placed into operation on or adjacent to roadways to aid in providing protection for work zones.

All truck mounted attenuators shall control the deceleration of an impacting vehicle and dissipation of the vehicle's kinetic energy. When struck on the front of the unit, each unit shall bring the errant vehicle to a safe and controlled stop. Provide, install, and maintain each attenuator as specified hereto.

602.59 Performance. Each TMA shall meet the test requirements for the **National Cooperative Highway Program (NCHRP)**, *Report 350*, 1993, Test Level 2 or Test Level 3. Each attenuator shall have approval for use from the FHWA.

When impacted by an errant vehicle when mounted on a truck weighing 15,000 pounds or more the TMA shall perform as follows:

(a) Test Level 2:

1. The TMA shall decelerate and stop vehicles weighing 1800 pounds during head-on impacts at 43 MPH. The attenuator shall meet the occupant risk criteria during the impact of a small car into a TMA as required by the NCHRP, *Report 350,* Test 50.

2. The TMA shall decelerate and stop vehicles weighing 4400 pounds during head-on impacts at 43 MPH. The attenuator shall 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 a TMA as required by the NCHRP, *Report 350,* Test 51.

(b) Test Level 3:

1. The TMA shall decelerate and stop vehicles weighing 1800 pounds during head-on impacts at 62 MPH. The attenuator shall meet the occupant risk criteria during the impact of a small car into a TMA as required by the NCHRP, *Report 350,* Test 50.

2. The TMA shall decelerate and stop vehicles weighing 4400 pounds during head-on impacts at 62 MPH. The attenuator shall 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 a TMA as required by the NCHRP, *Report 350,* Test 51.

3. NCHRP *Report 350* Test 52 and Test 53 results are desirable.

Certified test data showing conformance to the requirements of Test Numbers 50 and 51 of **National Cooperative Highway Research Program (NCHRP), *Report 350*** shall be available to the Department upon request. In the event of such a request, the Contractor shall submit a detailed report of the test data.

602.60 Requirements. The Contractor shall provide, install, maintain, and ensure the proper operation of each TMA as directed by these specifications, the manufacturer's specifications, the special provisions, the *Standard Drawings For Road Construction*, the plans, and the Engineer.

The Contractor shall provide TMA's designed to meet the NCHRP*, Report 350,* Test Level 2 and Test Level 3 requirements as required by these specifications, the special provisions, the *Standard Drawings For Road Construction*, and the Engineer.

(a) Operational Regulations.

Use of a NCHRP, *Report 350,* Test Level 2 or Test Level 3 TMA shall be dependent upon the legal posted regulatory speed limit of the roadway prior to the presence of construction zones, temporary speed limits, or unforeseen roadway hazards.

This specification shall restrict a Test Level 2 TMA, rated for 43 MPH, to use on roadways with legal posted speed limits of 45 MPH or less. These TMA's are prohibited on interstate highways or roadways with posted speed limits of 50 MPH or greater.

A Test Level 3 TMA, rated for 62 MPH, may be used on all roadways. Only Test Level 3 TMA's are permitted on Interstate highways or roadways with posted speed limits of 50 MPH or greater.

(b) System Description.

Attach each TMA to the rear of a truck with a minimum Gross Vehicular Weight of 15,000 pounds (Actual Weight). If the addition of supplemental weight to the vehicle as ballast is necessary, use only dry loose sand for ballast.

The TMA will provide a safety barrier between approach-

ing vehicular traffic and the work zone when properly attached to a truck.

Each TMA shall be like new. Furnish each unit with all equipment, options, and features as required by these specifications.

(c) Lights.

Equip each TMA with lights and reflectors in compliance with applicable South Carolina motor vehicle laws, including turn signals, dual tail lights, and brake lights. Lights shall be visible in both the raised and lowered positions.

(d) Color.

Paint each unit safety yellow. The rear facing of the cartridge in the operating position shall be striped with alternating 4 inch black and 4 inch safety yellow 45 degree striping. The striping will form an inverted "V" at the center of the unit and will slope down and toward the outside of the unit, in both directions from the center. The black paint will be an industrial grade enamel.

602.61 Cartridge and Mechanical Attenuators.

(a) Cartridge Type. This type of TMA shall be constructed of an energy absorbing material surrounded with an aluminum shell. Each TMA shall consist of an expendable (crushable) cartridge, a backup structure, and a mounting assembly.

(b) Mechanical Type. This type of TMA shall be constructed of a steel frame structure with a bracket assembly attached to a bumper assembly. The steel frame will have sufficient structural strength to compress evenly.

602.62 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include truck mounted attenuators. The Department will make no separate payment unless the contract includes specific bid items for truck mounted attenuators.

602.63 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining the attenuators. Payment shall include furnishing all labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary for installing and maintaining the attenuator. Also, payment shall include initiating repair or replacement of damaged units within the first two hours after notification of a damage causing incident and completing the repair or replacement operations within twenty-four hours. Payment shall include any installation, or removal and reinstallation, of a lane closure or any other traffic control set-up during repair or replacement operations.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
1071000	Traffic Control	Lump Sum

WARNING LIGHTS

602.64 Description. This item consists of Types “A”, “B”, and “C” warning lights used as supplemental traffic control devices for signs and barricades. These lights shall be yellow or amber, portable, lens directed, and enclosed. Types “A” and “B” lights shall operate in the flashing mode and Type “C” lights shall operate in the steady burn mode. These lights shall meet all requirements of the *SCMUTCD*. Provide, install, and maintain each warning light as specified hereto.

602.65 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include warning lights.

The Department will make no separate payment unless the contract includes specific bid items for warning lights.

602.66 Basis of Payment. Payment shall be full compensation for providing, installing, relocating as necessary, operating, and maintaining the warning lights. Payment shall include furnishing all materials, labor, equipment, tools, hardware, mounting hardware, incidentals, and any miscellaneous items necessary for operating and maintaining the lights until completion of the project.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
1071000	Traffic Control	Lump Sum

SECTION 603

WORK ZONE
TRAFFIC CONTROL PROCEDURES

603.01 General. The traffic control procedures shall provide for the maintenance of traffic with minimum inconvenience practical for efficient construction of the project and for the safety of the motorists and the workers on the project site. All traffic control procedures shall consist of provision, installation, maintenance, relocation, and removal of the traffic control devices used for regulating, warning, and directing traffic. These procedures shall provide for delineation of travel lanes, warning of obstructions and hazards, and safe maintenance and control of traffic during the work. Conduct all procedures within the requirements as specified hereto.

FLAGGING OPERATIONS

603.02 Description. This item consists of an operation that uses flaggers to control the flow of traffic. The need for a flagging operation may occur 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 the Contractor's equipment on the roadway. Also, a flagging operation may be necessary during a need to direct traffic around construction activities or when it is necessary to maintain continuous traffic at reduced speeds.

603.03 Requirements. All flagging operations shall have the appropriate signing, equipment, and trained personnel. Install all essential signs, including the "Advance Flagger" signs (WC20-7-48), in advance of each flagger station. Flaggers shall conduct themselves and the operation as directed by these **standard specifications**, the **special provisions**, the ***SCMUTCD***, and the Engineer. The Engineer will deal with failure by the flaggers to conduct the operation properly or without the advance flagger signs as failure to provide traffic control as outlined.

603.04 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include flagging operations. The Department will make no separate payment unless the contract includes specific bid items for flagging operations.

603.05 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining the operation. Payment shall include installing and removing all signs as necessary, providing the Stop/Slow paddles and the proper safety attire, personnel, and any miscellaneous equipment necessary to conduct the operation.

LANE CLOSURES

603.06 Description. This item consists of an array of traffic control devices, including signs; installed to channelize traffic and delineate the travel lanes during disruptions of normal travel patterns. The Department will determine specific lane closure requirements according to traffic volumes, physical characteristics and conditions unique to the roadway, and the construction activities.

603.07 Requirements. Lane closures will be either daytime or nighttime. Supplement only the first and last traffic control devices in the taper of a daytime lane closure with warning lights. The Department prohibits daytime lane closures during the hours of darkness or for the duration of weekends and holidays. Supplement all traffic control devices in the taper of a nighttime lane closure with warning lights. Install nighttime lane closures when lane closures are required during the hours of darkness or for the duration of weekends and holidays. The Contractor shall maintain all time restrictions for lane closures as required by the contract.

The Contractor shall use Type II barricades, no less than 4 feet wide, for the taper sections and drums or cones for the tangent sections of lane closures.

The Contractor shall supplement the Type II barricades in a lane closure with warning lights as specified hereto. Supplement the first and last Type II barricades in a taper with Type “B” High Intensity Flashing warning lights at all times and supplement all subsequent Type II barricades in the taper with Type “C” Steady Burning warning lights during the hours of darkness.

Convert a daytime lane closure to a nighttime lane closure whenever circumstances prohibit removal of a daytime lane closure prior to entering nighttime conditions. Add Type “C” Steady Burning warning lights to the Type II barricades without warning lights and replace the cones with portable plastic drums.

Always supplement lane closures on multilane facilities with advance warning arrow panels. Install, maintain, and operate the arrow panels as specified in **Section 602**. The Contractor shall display the "Caution Mode" on arrow panels operating beyond 250 feet from the end of the taper within the tangent section of a closed lane. Also, always display the "Caution Mode" on arrow panels operating within shoulder closures.

The Contractor shall provide a truck mounted "Prepare To Stop" sign or a "Be Prepared To Stop" sign when reducing the number of travel lanes during each lane closure on interstate routes and primary multilane facilities with paved shoulders. The sign shall be supplemented with two yellow 8 inches hazard identification beacons and the sign legend shall use black 8 inches Series "C" letters. In the event traffic backs up, place the truck, manned with an operator, on the **shoulder**, and remain no less than 2000 feet in advance of the traffic queue. However, when the development of traffic queues is not evident or the traffic queues have dissipated, locate the truck in a predetermined area on the project site approved by the Engineer, where the truck is not visible to passing motorists. At no time shall the Contractor place the truck on the shoulder of the roadway without an operator. The Engineer will deal with failure by the Contractor to provide the traffic control for lane closures as failure to provide traffic control as outlined.

When conducting work simultaneously at different locations, always conduct the work in the same travel lane when the installation of lane closures is necessary. The Department prohibits the installation of simultaneous lane closures in different travel lanes unless otherwise directed by the special provisions, the plans, or the Engineer.

Intervals between lane closures shall be no less than 2 miles. These interval restrictions shall apply to lane closures on the same project, contiguous projects, and projects that overlap in any manner. The Engineer will deal with failure to observe these interval restrictions as failure to provide proper

traffic control as outlined.

Contractors shall coordinate lane closure installations on contiguous projects or projects that overlap in any manner as directed by the Engineer unless otherwise directed by the plans and the special provisions.

The Department will restrict the length of lane closures to a maximum distance of 2 miles unless otherwise directed by the plans, the special provisions, and the Engineer.

The Department prohibits lane closures on high volume roadways during peak traffic periods unless otherwise directed. The Department requires the Contractor to acquire approval of the proposed hours for lane closures from the Engineer prior to installing any lane closures on roadways with high volume commuter traffic.

603.08 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include lane closures. The Department will make no separate payment unless the contract includes specific bid items for lane closures.

603.09 Basis of Payment. Payment shall be full compensation for providing, installing, and maintaining the lane closures. Payment shall include removing and relocating all signs and other traffic control devices as necessary. Payment shall include providing all traffic control devices, vehicles, vehicles equipped with advance warning arrow panels and truck mounted attenuators. Payment shall also include proper safety attire, personnel, equipment, tools, hardware, incidentals, and any miscellaneous items necessary to maintain the operation as directed by the plans, the special provisions, and the Engineer.

REMOVAL AND PLACEMENT OF GROUND MOUNTED SIGNS AND SUPPORTS

603.10 Description. This item consists of an array of traffic

control devices, including signs; installed to channelize traffic and delineate the travel lanes the installation and removal operations of ground mounted signs and supports. The Department will determine specific channelization and lane closure requirements according to traffic volumes, physical characteristics and conditions unique to the roadway, and the construction activities.

603.11 Requirements. The Contractor shall provide and maintain the necessary traffic control. When the work may be accomplished on the shoulder of the roadway without placing any equipment, traffic control devices, or materials within 1 foot of the nearest edge of the adjacent travel lane, the Contractor may perform the work with the utilization of shoulder closures.

If the Contractor is unable to perform the work without encroaching upon the adjacent travel lane or within 1 foot of the nearest edge of the adjacent travel, the Contractor shall install a lane closure as necessary.

The Contractor shall install all lane closures and shoulder closures as required by these standard specifications, the “Standard Drawings For Road Construction," the *SCMUTCD*, and the Engineer.

603.12 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include shoulder closures and lane closures for removal and placement of ground mounted signs and supports. The Department will make no separate payment unless the contract includes specific bid items for shoulder closures and lane closures.

603.13 Basis of Payment. Payment shall be full compensation for providing, installing, and maintaining these shoulder closures and lane closures. Payment shall include providing all traffic control devices and removing and relocating all signs and other traffic control devices as necessary. Payment shall include providing proper safety attire, personnel, vehicles, equipment, tools, hardware, incidentals and any miscellane-

ous items necessary to maintain the operation as directed by the plans, the special provisions, and the Engineer.

REMOVAL AND PLACEMENT OF OVERHEAD SIGNS AND STRUCTURES

603.14 Description. This item consists of an array of traffic control devices, including signs; installed to channelize traffic and delineate the travel lanes the installation and removal operations of overhead signs and structures. The Department will determine specific channelization and lane closure requirements according to traffic volumes, physical characteristics and conditions unique to the roadway, and the construction activities.

603.15 Requirements. The Contractor shall provide and maintain the traffic control necessary to close those travel lanes that pass under the sign or the structure to be installed or removed. However, if the sign or structure to be installed or removed is over all the travel lanes, the Contractor shall close the roadway within all requirements of and as directed by **Subsection 603.18** through **Subsection 603.21** of these standard specifications. The Contractor shall maintain access to ramps at all times where feasible.

The Contractor shall install all lane closures as required by these standard specifications, the ***Standard Drawings For Road Construction***, the ***SCMUTCD***, and the Engineer.

603.16 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include lane closures for removal and placement of overhead signs and structures. The Department will make no separate payment unless the contract includes specific bid items for lane closures.

603.17 Basis of Payment. Payment shall be full compensation for providing, installing, and maintaining these lane closures. Payment shall include providing all traffic control devices and removing and relocating all signs and other traffic

control devices as necessary. Payment shall include providing proper safety attire, personnel, vehicles, equipment, tools, hardware, incidentals and any miscellaneous items necessary to maintain the operation as directed by the plans, the special provisions, and the Engineer.

ROAD CLOSURE FOR INSTALLATION AND REMOVAL OF BRIDGE BEAMS OR OVERHEAD SIGN STRUCTURES

603.18 Description. This item consists of an array of traffic control devices, including signs; installed to close the roadway during installation and removal operations of bridge beams and overhead sign structures. When installing or removing bridge beams or overhead sign structures, stop traffic completely during short periods of time necessary to hoist and set into place or remove each bridge beam or sign structure. However, the Contractor may opt to use pacing operations pending approval of the proposed plan by the Engineer. Whenever road closures are necessary for installation or removal of overhead signs, all the requirements specified hereto will apply.

603.19 Requirements. The Contractor shall arrange all equipment and crews to keep each road closure limited to no longer than 20 minutes and preferably shorter. The Contractor shall allow stopped traffic to proceed and clear the area after each installation or removal operation before stopping traffic again to hoist the next bridge beam or sign structure as specified heretofore. Keep all interference with traffic to a minimum.

The Engineer shall coordinate traffic control with the Engineering and the Highway Patrol as necessary. The Engineer should request the assistance of the Highway Patrol when necessary to stop traffic.

The Contractor shall conduct these temporary road closures as directed by these standard specifications, the special

provisions, and the Engineer. The Department will permit these operations at times of the lowest traffic volumes as determined by the special provisions and the Engineer. In most instances, Sunday mornings, from one hour after sunrise until 12:00 Noon, are considered the best times for these operations. The Department prohibits these road closures during holidays, holiday weekends, or special events unless otherwise specified.

The Contractor shall provide a truck mounted “Prepare To Stop” sign or a “Be Prepared To Stop” sign for each approach when closing the roadway on an interstate route and a primary multilane facility with paved shoulders. The sign shall be supplemented with two yellow 8 inch hazard identification beacons and the sign legend shall use black 8 inch Series “C” letters. In the event traffic backs up, place the truck, manned with an operator, on the **shoulder** and remain no less than 2000 feet in advance of the traffic queue. However, when the development of traffic queues is not evident or the traffic queues have dissipated, locate the truck in a predetermined area on the project site approved by the Engineer, where the truck is not visible to passing motorists. At no time shall the Contractor place the truck on the shoulder of the roadway without an operator. The Engineer will deal with failure by the Contractor to provide the traffic control for lane closures as failure to provide traffic control as outlined.

The Contractor shall provide no less than two weeks notice before any road closure.

603.20 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include road closures for removal or installation of bridge beams or overhead sign structures. The Department will make no separate payment unless the contract includes specific bid items for road closures.

603.21 Basis of Payment. Payment shall be full compensation for providing, installing, and maintaining the road closure.

Payment shall include providing all traffic control devices and removing and relocating all signs and other traffic control devices as necessary. Payment shall include providing proper safety attire, personnel, vehicles, equipment, tools, hardware, incidentals and any miscellaneous items necessary to maintain the operation as directed by the plans, the special provisions, and the Engineer.

APPLICATION OF PAVEMENT MARKINGS

603.22 Description. This item consists of all traffic control devices, including signs, the traffic control setup(s), and vehicles provided during the pavement marking application operations on roadways opened to traffic. This item shall also include all traffic control items necessary for the application of raised pavement markers. The Contractor shall maintain the minimum requirements for traffic control devices and equipment on Two-Lane Two-Way Routes, Multilane Non-Interstate Routes, and Interstate Routes as specified hereto.

603.23 Two-Lane, Two-Way Routes. (a) The lead vehicle shall maintain a distance of 500 feet ahead of the vehicle applying the pavement markings. Also, the lead vehicle shall have a 48 inch X 48inch “One Lane Road Ahead” sign (WC20-4-48-A) mounted on top of the vehicle.

(b) The vehicle applying the pavement markings shall have an approved advance warning arrow panel operating in the “Caution Mode”.

(c) A shadow vehicle shall maintain a distance of 500 feet behind the vehicle applying the pavement markings and shall have an approved advance warning arrow panel operating in the “Caution Mode” and a truck mounted attenuator. The vehicle shall have a 48 inch X 48 inch “One Lane Road Ahead” sign (WC20-4-48-A) mounted below the arrow panel.

603.24 Multilane Non-Interstate Routes. (a) The vehicle applying the pavement markings shall have an approved ad-

vance warning arrow panel displaying a flashing arrow.

(b) The first shadow vehicle shall maintain a distance of 500 feet behind the vehicle applying the pavement markings and shall have an approved advance warning arrow panel displaying a flashing arrow and a truck mounted attenuator.

(c) Another shadow vehicle shall maintain a distance of 1000 feet behind the vehicle applying the pavement markings and shall have an approved advance warning arrow panel displaying a flashing arrow and a truck mounted attenuator. Also, the second shadow vehicle shall remain on the shoulder where a paved shoulder exists and shall have a 48 inch X 48 inch “Right (Left) Lane Closed Ahead” sign mounted below the advance warning arrow panel.

603.25 Interstate Routes. (a) The vehicle applying the pavement markings shall have an approved advance warning arrow panel displaying a flashing arrow.

(b) The first shadow vehicle shall maintain a maximum distance of 500 feet behind the vehicle applying the pavement markings and shall have an approved advance warning arrow panel displaying a flashing arrow and a truck mounted attenuator.

(c) Another shadow vehicle shall maintain a maximum distance of 1500 feet behind the vehicle applying the pavement markings and shall have an approved advance warning arrow panel displaying a flashing arrow and a truck mounted attenuator. Also, the second shadow vehicle shall remain on the paved shoulder of the roadway and shall have a 48 inch X 48 inch “Right (Left) Lane Closed Ahead” sign mounted below the advance warning arrow panel.

603.26 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include traffic control for the application of pavement markings. The Department will make no separate payment unless the contract includes specific bid items for traffic control for the application of pavement markings.

603.27 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining all traffic control devices and equipment. Payment shall include providing all vehicles and vehicles equipped with advance warning arrow panels and truck mounted attenuators. Also, payment shall include providing proper safety attire, personnel, labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary to conduct the operation as specified by these standard specifications, the special provisions, and the Engineer.

MILLING OPERATIONS

603.28 Description. This item consists of all traffic control devices, including signs, and the traffic control setup(s) provided during milling operations. The traffic control shall include lane closures installed and maintained to safely channelize traffic and delineate the travel lanes. These lane closures shall also be subject to all restrictions as determined by these standard specifications, the plans, the special provisions, and the Engineer. Provide, install, and maintain the traffic control as specified hereto.

603.29 Requirements. Close the travel lane being milled during milling operations. The Contractor shall provide flagging operations on two-lane facilities and complete lane closures on multilane facilities. Provide, install, and maintain all flagging operations as specified by these standard specifications and the *SCMUTCD*. Provide, install, and maintain all lane closures as specified by these standard specifications and the *Standard Drawings For Road Construction* unless otherwise specified by the plans, the special provisions, or the Engineer. The Contractor shall relocate the lane closure apparatus upon completion of each section as directed by the plans, the special provisions, and the Engineer.

Grade elevation differences shall not exceed one inch between adjacent travel lanes opened to traffic in milled areas. The one inch grade elevation difference restriction shall apply

to any milled travel lane opened to traffic regardless of the condition of the adjacent travel lane.

Maintain all lane closure restrictions regarding drop-offs greater than one inch and any other travel restrictions on milled surfaces, and time restrictions as specified by these standard specifications, the plans, the special provisions, the Engineer.

Maintain all time and travel restrictions in areas where the Contractor may mill only the amount of roadway that can be replaced with an asphalt concrete course prior to removal of the lane closure.

Sweep milled lanes clean of debris and mark with temporary pavement markings before reopening the travel lanes to traffic.

Whenever travel lanes with acceptable grade elevation differences are open to traffic, the Contractor shall provide "Uneven Pavement" signs (W8-11a-48). Reflectorize these signs with Type III reflective sheeting unless otherwise specified. Install these signs adjacent to the uneven travel lanes at intervals no greater than 2600 feet.

603.30 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include traffic control for milling operations. The Department will make no separate payment unless the contract includes specific bid items for traffic control for milling operations.

603.31 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining all traffic control devices. Payment shall include providing vehicles, vehicles equipped with advance warning arrow panels and truck mounted attenuators. Also, payment shall include providing proper safety attire, personnel, labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary to conduct the operation as specified by these standard specifications, the plans, the

special provisions, and the Engineer.

RESURFACING OPERATIONS

603.32 Description. This item consists of all traffic control devices, including signs, and the traffic control setup(s) provided during resurfacing operations. The traffic control shall include lane closures installed and maintained to safely channelize traffic and delineate the travel lanes. These lane closures shall also be subject to all restrictions as determined by these standard specifications, the plans, the special provisions, and the Engineer. Provide, install, and maintain the traffic control as specified hereto.

603.33 Requirements. Close the travel lane being resurfaced during resurfacing operations. Use flagging operations on two-lane facilities and complete lane closures on multilane facilities. Provide, install, and maintain all flagging operations as specified by these standard specifications and the *SCMUTCD*. Provide, install, and maintain all lane closures as specified by these standard specifications and the *Standard Drawings For Road Construction* unless otherwise specified by the plans, the special provisions, or the Engineer. The Contractor shall relocate the lane closure apparatus upon completion of each section as directed by the plans, the special provisions, and the Engineer.

Maintain all lane closure restrictions regarding drop-offs greater than 2 inches and time restrictions as specified by these standard specifications, the plans, the special provisions, and the Engineer. The Contractor shall maintain a construction schedule approved by the Engineer.

Grade elevation differences shall not exceed 2 inches between adjacent travel lanes opened to traffic during resurfacing operations. The Department restricts acceptable drop-offs less than or equal to 2 inches, on multi-lane facilities with three or more travel lanes, to no more than one drop-off between adjacent travel lanes carrying traffic in the same direc-

tion. The Contractor shall observe all restrictions during resurfacing or any similar operations.

The Department prohibits allowing traffic onto travel lanes without pavement markings where pavement markings existed before beginning the resurfacing operation. Apply pavement markings to the travel lanes of a resurfaced roadway before reopening the closed travel lanes to traffic due to the obliteration of the previous pavement markings.

Whenever travel lanes with acceptable grade elevation differences are open to traffic, the Contractor shall provide "Uneven Pavement" signs (W8-11a-48). Reflectorize these signs with Type III Reflective Sheeting unless otherwise specified. Install these signs adjacent to the uneven travel lanes at intervals no greater than 2600 feet.

603.34 Method of Measurement. The contract lump sum price bid item for Traffic Control shall include traffic control resurfacing operations. The Department will make no separate payment unless the contract includes specific bid items for traffic control for resurfacing operations.

603.35 Basis of Payment. Payment shall be full compensation for providing, installing, removing, relocating as necessary, and maintaining all traffic control devices. Payment shall include providing vehicles, vehicles equipped with advance warning arrow panels and truck mounted attenuators. Also, payment shall include providing proper safety attire, personnel, labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary to conduct the operation as specified by these standard specifications, the plans, the special provisions, and the Engineer.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
1071000	Traffic Control	Lump Sum

SECTION 604

PERMANENT PAVEMENT MARKINGS

FAST DRY WATERBORNE PAINT

604.01 Description. This work shall consist of furnishing and applying reflectorized, heavy metals free, fast drying, waterborne, paint for pavement markings. The markings shall be of the color (white or yellow) and pattern as indicated in the Pavement Marking Plans, Pavement Marking Typicals, or the ***South Carolina Manual of Uniform Traffic Control Devices (SCMUTCD)***, latest edition, as applicable. The Contractor shall supply all necessary equipment and materials for the correct application of the marking material to the pavement surface.

This work shall include protection of pavement markings during construction, protection of traffic during installation of pavement markings, determination of no passing zones for two-lane facilities in accordance with the *SCMUTCD*, and providing the Department data used in establishing no passing zones on two-lane facilities.

MATERIAL

604.02 General. The pavement marking shall consist of traffic paint, meeting the requirements given herein, upon which spherical glass beads are applied by dropping immediately following paint application. If required, the pavement surface shall be cleaned in an appropriate manner as described herein immediately prior to application.

A. Paint. Only paint conforming to the requirements of this specification shall be used for this work. Paint more than 12 months old shall not be used. All paint utilized shall have been tested and shown to be in conformance with all applicable specifications by the SCDOT Research and Materials Laboratory before commencement of work. SCDOT Laboratory approval shall be indicated by the Laboratory Test Number stenciled on the side of each paint container. Each paint batch shall be assigned a unique Laboratory Number by the SCDOT Laboratory upon satisfactory completion of testing. For each shipment, the Contractor shall present the Engineer with documentation containing the information specified in **Subsection 604.02A.7.a**. The Engineer shall forward a copy of this information to the SCDOT Research and Materials Laboratory in order to track usage of each paint batch tested.

1. General Requirements. The white and yellow paint shall meet the following general requirements:

a. Paint shall be formulated and manufactured from first grade materials and shall be free from defects and imperfections that might adversely affect the serviceability of the finished product.

b. Paint shall be formulated and processed specifically for service as a suitable binder for glass beads for use on traffic-carrying pavements, including portland cement concrete, bituminous concrete, and brick.

c. Paint shall dry to an elastic adherent finish that will not darken after exposure to sunlight, not show appreciable discoloration with age, or darken under service such that the color or visibility of the reflectorized marking is impaired. They shall further permit ease and uniformity of application and covering properties.

d. Paint shall be heavy metals free as defined in **Subsection 604.02A.4.k**.

e. Paint shall provide the proper anchorage and refraction for glass beads when both binder and spheres are applied in the stipulated quantities with specialized equipment using pressurized bead guns.

f. Paint shall be manufactured and sealed in containers in such manner that during normal shelf life they do not show evidence of settling or livering that would cause the paint to be unusable or detrimental to the specialized equipment used in application.

g. Paint shall show no evidence of skinning when received in sealed containers.

2. Vehicle. The vehicle portion shall be a combination of 100 percent acrylic emulsion resins and sufficient surfactants, dispersants, defoamers, water, and coalescing agents to produce a pigmented binder that meets the requirements of these specifications.

3. Testing and Production Variation. When minimum or maximum values are given in these specifications, they represent values that are to be reliably obtained from testing. They do not represent acceptable mean production values. It shall be the responsibility of the manufacturer to consider variations in production and between testing laboratories when setting manufacturing tolerances.

4. Detailed Requirements.

a. Viscosity. The viscosity shall be 80 to 95 K.U. when tested at 77^{o}F in accordance with **ASTM D 562**.

b. Drying Time. Drying time shall be determined by two methods; Laboratory and Field Application. The paint shall comply with both requirements.

(1) Laboratory Drying Time. The binder shall be tested in accordance with **ASTM D 711** at a wet film thickness of 15 mils ± 1 mil to determine time to no-pickup. The test will be conducted in a standard laboratory atmosphere during which the relative humidity shall be maintained at 50% ± 5%, and the temperature shall be maintained at 73.5°F ± 3.6°F and air flow shall be maintained at a rate of 2.2 mph ± 0.45 mph. The paint described herein shall dry to "no-pickup" in 8 minutes or less.

(2) Field Drying Time. When applied at a wet film thickness of 15 mils and a bead application rate of 6 pounds/gallon, the paint shall dry to a "no-track" condition in the following times under the stipulated conditions:

The paint will be considered to have reached a "no-track" condition when the marking can be traversed by a standard automobile simulating a passing maneuver at a speed of approximately 40 mph without visible tracking of the reflectorized line. Tracking is defined to be visible if it is discernable when viewed at a distance of 50 feet.

c. Flexibility. A 5 mil wet film of the paint shall be cast on a clean, 30-gage tin panel approximately 3 inches by 6 inches. The panel shall be air-dried at room temperature for 18 ± 2 hours and then baked at 122°F ± 4°F for 2 ± 0.25 hours. The panel shall then be allowed to cool at room temperature for 30 ± 10 minutes and then bent around a 0.5 inch metal rod. The paint film shall withstand this test with no sign of film failure or loss of adhesion when viewed

without the use of magnification.

d. Dry Opacity. The white and yellow paint shall have a minimum contrast ratio of 0.965 when tested at a wet film thickness of 10 mils and tested in accordance with **ASTM D 2805**.

e. Directional Reflectance. The daylight reflectance of the paint, without drop-on glass spheres, shall be not less than 86% for white paint, and not less than 50% for yellow paint relative to magnesium oxide when tested in accordance with **ASTM E 1347**.

f. Abrasion Resistance. The paint shall pass the following abrasion resistance test:

> Four plate samples for each lot shall be prepared for testing on the Taber Abrader. The paint shall be applied by a drawdown blade having a clearance of 26 mils. The paint abrasion samples shall then be dried at room temperature for approximately 30 minutes and then dried at 105^{o}C for 18 ± 0.2 hours. After this time, the plates shall be cleaned, dressed, weighed, and abraded for 1000 cycles. After abrading, the samples shall be cleaned with a soft brush and weighed again. The corresponding loss for the four plates shall not exceed 50 mg per plate. The Taber Abrader shall be operated with a weight of 500 g and CS-10 wheels.

g. Glass Bead Adhesion. Both white and yellow paints shall be formulated and processed 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 thickness.

h. Bleeding. The paint shall have a minimum bleeding ratio of 0.98 when tested in accordance with the method given in **Federal Specification** TT-P-1952B, paragraph 4.5.13.

i. Total Non-Volatile, Vehicle Solids, Flash Point. Volatile organic compounds (VOC) for the paint shall not exceed 100 grams/liter. The non-volatile vehicle shall be greater than or equal to 42% when the whole paint is ashed for one hour at 877 F ± 45°F. The white and yellow paints shall have a 75% to 80% total non-volatiles when tested in accordance with **ASTM D 3723**. Closed cup flash point shall be greater than or equal to 140°F.

j. Composition. White paint shall contain a minimum of 1.0 pound/gallon of titanium dioxide in the white pigment. For all colors, the titanium dioxide shall conform to **ASTM D 476**, Types II, III, or IV.

k. Lead Content. For heavy metals free yellow paint, the lead content of the finished binder shall not exceed the legal limit of 0.06 percent maximum when tested for lead content. The yellow pigments shall be organic yellows containing no lead, chromium, or other heavy metal containing pigments. The color shall be established 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. Small quantities of tinting aids may be used as needed to establish an acceptable color.

l. Color. The paint shall be capable of maintaining its original color throughout the life of the line (approximately 2 years). The color of the white paint shall be a clean, bright, untinted white that provides maximum opacity and visibility under daylight and artificial light. The color of the yellow paint shall match color 33538, **Federal Standard No. 595B**.

The following CIE chromaticity coordinates describe the instrumental boundaries of the required yellow color match:

X	Y
.475	.455
.506	.452
.484	.455
.460	.438

m. Distinguishable Color. The yellow color shall be very distinguishable from white markings under day or night conditions when applied on the roadway and be capable of remaining distinguishable during the life of the marking.

n. Grind and Freedom from Lumps. The pigmented binder shall have a grind of not less than 3 on the Hegman-Grind Gauge and shall pass a No. 50 mesh sieve at the time of packaging.

o. Settling. The pigmented binder shall be tested for settling in full pint, triple-sealed friction top paint cans. The cans used for testing shall be lined with an appropriate material designed to be non-reactive with waterborne paints. When these cans are stored free of vibration at an air temperature of 122 F ± 2 F for a period of five days, the paint shall exhibit no dense or hard settling. The degree of settling shall have a rating of 6 or better when evaluated in accordance with **ASTM D 869**. In making the tests, the cans shall be filled to the bottom of the friction seal lip and placed in an inverted position for one hour to insure a complete seal between the cover and the body of the can. At the end of one hour, the filled can shall be placed in an upright position for at least one hour before being placed in an air temperature of 122 F ± 2 F. The can or cans shall be placed in a single tier. After a heating period of 5 days, the cans shall be cooled at room

temperature for four to five hours and the degree of settling evaluated.

p. pH Factor. The pH factor of the pigmented binder as packaged without thinning or diluting shall be 9.5 minimum. This specification is intended to require the use of Rohm and Haas E-2706 Resin, Dow DT211, or an approved equal, for enhancing the time to "no-track." Any substitute resin other than the two expressly mentioned here must be approved by the Engineer before its use. The manufacturer must inform the Department which resin it intends to use when supplying bid award samples. The supplier may not change resins during the life of the contract without prior approval by the Engineer. In the event that low pH water is used to manufacture the finished binder, pH buffers may be used to obtain the minimum pH factor.

q. Solvents. The manufacturer shall use only potable water from a public water supply as the solvent for the binder manufactured by these specifications.

r. Maximum Temperature and Heat Exchanger Dwell Time. Temperatures at the heat exchanger of the paint truck shall not exceed 150^{o}F. Paint shall not dwell in the exchanger for more than 2 hours.

(Note: It is strongly recommended that the exchanger temperature be reduced to 120^{o}F or that the heat to the exchanger and lines be turned off if the material is not to be applied within one hour.)

5. Control Tolerances. Binder materials shipped under these specifications shall conform to the samples submitted for tests and performance in accordance with the following tolerances:

a. Percent Pigment. Total pigment solids shall be

58% to 63% by weight when tested in accordance with **ASTM D 3723**.

b. Volumetric Weight. The density of the pigmented binders shall be 14.0 ± 0.3 pounds/gallon for white and 13.7 ± 0.3 pounds/gallon for yellow. Weight per gallon shall be determined in accordance with **ASTM D 1475**.

c. Vehicle Solids and Total Non-Volatile. All paint submitted for approval must meet the requirements given in **Subsection 604.02A.4.i** of these specifications

(*Note: As noted in* **Subsection 604.02A.3**, *it is the manufacturer's responsibility to consider testing and production variation when selecting mean production values. It is* ***strongly*** *recommended that the vehicle solids be one to two percent higher than the specified minimum values.)*

d. Viscosity. All paint submitted for approval must meet the requirements given in **Subsection 604.02A.4.a** of these specifications.

e. Drying Time. All paint submitted for approval must meet the requirements for Laboratory Drying time given in **Subsection 604.02A.4.b.(1)** of these specifications

6. Samples Required.

a. Qualification Samples. Before shipment, manufacturers supplying paint under these specifications, shall submit the following items for each type and color of paint supplied:

(1) A sample consisting of two 1-quart cans of

paint which the manufacturer proposes to furnish.

(2) Manufacturer's testing results for the samples. These testing results shall minimally

include the items given in **Subsection 604.02A.5** of these specifications and the brand and type of resin used.

(3) Manufacturer's statement of compliance with all requirements of these specifications. This statement must explicitly state that the paint provided is essentially free of lead, cadmium, and other heavy metals.

(4) ***Material Safety Data Sheets***, essentially similar to **Form OSHA-20**, for the material provided.

The items listed above shall be furnished to the following address:

Dr. Andrew M. Johnson, PE
State Materials Engineer
SCDOT Research
and Materials Laboratory
1406 Shop Road
Columbia, SC 29201

The shipping of paint shall not be made until testing indicates that the material proposed is in conformance with these specifications.

b. Production Control Tests. The manufacturer shall perform laboratory tests on each batch of paint produced under these specifications to ensure compliance with these specifications. Results of these tests shall be included with departmental samples as given in **Subsection 604.02A.6.c**.

c. Departmental Samples. After shipping, 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 by the contractor. During packaging operations for each batch and at the time the manufacturer obtains retain samples for each batch, 2 one-quart samples shall be obtained, sealed properly, and forwarded along with the results of the manufacturer's production control tests and a certification of compliance with these specifications to the SCDOT Research and Materials Laboratory at the address shown in **Subsection 604.02A.6.a** of these specifications. The samples will be tested by the Department in whatever manner is deemed necessary. Performance of all sampling shall be observed by Department inspectors or their designated agents. Samples taken by the manufacturer without supervision are not acceptable without permission of the Engineer. The inspectors shall designate at random two containers from each batch to be sampled for testing and enclose a copy of the sampling inspection with the samples.

7. Material Acceptance Criteria.

a. Shipping Records. Once a batch of paint has been approved for shipment, a form to include the following information shall be sent to the Engineer for each shipment:

(1) Date

(2) Consignee

(3) Shipped To

(4) Purchase Order Number

(5) Type of Paint

(6) No. of Gallons Shipped

(7) Batch Number

(8) Laboratory Number furnished by SCDOT-Research & Materials Lab for approved batch(es)

8. Packing and Marking.

a. New Containers. All paint shall be shipped only in new containers that can be properly sealed.

b. Five (5) Gallon Containers: When 5 gallon containers are used, the bucket shall be an ICC approved container for shipping liquids conforming to and this specification. It shall be made of not less than 26-gage steel or may be a plastic bucket with 90 mils minimum wall thickness, a 26-gage metal lid, and shall be of open-head design with lug cover and flowed-in gasket. Metal pails shall have at least one reinforcing bead at the upper end.

If a tapered design is used, two beads shall be provided, one above and one below the point at which the handle is attached to the side of the metal buckets. A suitable wire bail-type handle shall be provided.

c. Fifty-Five (55) Gallon Containers. When 55 gallon drums are used, the drum shall be an open-head type conforming with ICC regulation 17 H as amended by this specification. It shall be constructed of not less than 18 gage steel and with a removable head that is solid and contains no bungs. The bolt used on the ring clamp for securing the removable head bolt shall be 5/8 inches minimum diameter. The ring clamp shall be tightened to prevent spillage when

the drum is tilted during unloading.

d. Fill Level. Each 55 gallon drum shall be filled with 52 gallons of paint to provide an air space at the top. This space is to reduce spillage when stirring is required. One to two quarts of water shall be added to the top of the paint in each filled drum to retard evaporation.

e. Container Marking. All containers shall be plainly marked or labeled to show the following information as appropriate: "Waterborne Lead Free - White", or "Waterborne Lead Free - Yellow". Other information which shall be shown is net gallons and/or liters, name of manufacturer, batch number, date of manufacture (month and year), purchaser's order number, and the type of resin used. For large containers, this legend shall be stenciled on the head and at one point on the side of the container. For smaller pails, the information shall be stenciled at one point on the side of the containers. The printed legend shall be the color of the contents.

f. Container Color. Containers provided under these specifications shall be painted or otherwise colored blue. Other colors may be used with prior approval of the Engineer. Yellow, white, and black are not acceptable container colors.

g. Container Lining. Each drum or metal pail shall have a baked-on epoxy lining on the inside of the container. The coating shall be phenolic epoxy or equal coating.

B. Glass Beads. Only glass beads meeting the requirements of this specification shall be used in the performance of this work. The beads shall be manufactured from 100% recycled cullet glass. This may include window pane glass, architectural glass, automotive glass, or other glass sources.

The beads shall meet all requirements of **AASHTO M 247-81**, Type 1 with moisture resistant coating, with the following exceptions:

Packaging: Section 5.1 of AASHTO M 247-81 shall be replaced by the following:

> The beads shall be packed in 50 or 55 pound waterproof multiple-layer type treated paper bags with a sheet of plastic moisture barrier between paper layers. Including the plastic moisture barrier, the bags shall be of not less than five-ply construction. All pallets must be furnished with the same quantity of bags and each pallet must be secured with shrink-wrap.
>
> Each package shall be marked with the following information: name and address of manufacturer, shipping point, trademark or name, the wording "glass beads", number of pounds, the lot or batch number, and the month and year of manufacture.

Other larger containers may be used subject to approval by the Engineer.

The Department reserves the right to perform sampling of the packaged or unpackaged material at the point of manufacture, the Contractor's facilities, or at the job site. These samples will be tested in the manner deemed appropriate by the Engineer. Before commencement of the work, the Contractor shall provide to the Engineer a Certification of Compliance for the glass beads as specified herein. At least one, 50 or 55 pound bag of beads shall be sampled by the Engineer at random for each 44,000 pounds of beads used. The bead samples and a copy of the certification information shall be forwarded to the SCDOT Research and Materials Laboratory in Columbia for testing.

EQUIPMENT

604.03 Application Equipment.

A. Traveling Applicator. The traveling traffic marking applicator shall be adaptable to traveling at a uniform, predetermined rate of speed both uphill and downhill in order to produce a uniform application of paint. The paint machine shall be of the spray type, capable of satisfactorily applying the paint under pressure with a uniformity of feed through nozzles spraying directly upon the pavement. Each machine shall be capable of applying at least two separate stripes, either solid or skip, in any specified pattern by using at least two adjacent spray nozzles simultaneously. Each paint tank shall be equipped with satisfactory cutoff valves, which will apply broken, or skip lines automatically. The controls shall allow the operator to override set automatic cycles to extend a line or to begin a new cycle at any selected point. Each nozzle shall have a mechanical bead dispenser that will operate simultaneously and in coordination with the spray nozzle and distribute the beads in a uniform pattern at the rate specified. Each nozzle shall be equipped with suitable line guides. The traveling applicator shall also be equipped with paint meters that will indicate the amount of paint dispensed from each tank.

B. Cleaning Equipment. Cleaning equipment shall consist 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. Cleaning shall be conducted in such a manner that the underlying pavement is not damaged.

C. Hand Painting. Hand painting equipment shall consist of suitable applicators, templates, and guides necessary to produce satisfactory results. This equipment will be limited to smaller areas such as traverse lines and stenciled symbols.

604.04 Application of Markings.

A. Cleaning of Surface. All surfaces to be painted shall be thoroughly cleaned of all dust, dirt, grease, oil, and all other foreign matter before application of the marking paint.

B. Maximum Temperature and Heat Exchanger Dwell Time (Waterborne Paint). When waterborne paint is utilized, temperatures at the heat exchanger of the paint truck shall not exceed 150^{o}F. Paint shall not dwell in the exchanger for more than two hours.

(Note: It is strongly recommended that the exchanger temperature be reduced to 120^{o}F or that heat to the exchanger and lines be turned off if the material is not to be applied within one hour.)

C. Alignment of Markings. The markings shall be straight or of uniform curvature and shall conform uniformly to tangents, curves, and transitions. Symbols shall be of dimensions shown in the *SCMUTCD*. Markings shall be of the dimensions as shown on the Pavement Marking Plans or as directed by the Engineer. The Contractor shall provide, at his own expense, sufficient control points to serve as guides for the application of markings.

The finished line markings shall be free from waviness and the lateral deviations shall not exceed 2 inches in 15 feet. Any greater deviation shall be sufficient cause for requiring the Contractor to remove and correct such markings at his own expense. The Contractor shall also be required to remove and correct, at his expense, any symbol markings not meeting the dimensional requirements shown in the *SCMUTCD*.

D. Applicator Type. All longitudinal markings (see page 3-103, *1994 SCMUTCD*) shall be placed with a truck-

mounted applicator except when approved by the Engineer. Such a case 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 (see page 3-106, *1994 SCMUTCD*) may be applied with a portable unit.

E. Application Restrictions. Unless otherwise permitted by the Engineer, no markings shall be applied to areas of pavement when any of the following conditions are present:

1. Any moisture or foreign matter is present on the surface.

2. The air temperature is below 50^{o}F.

3. The relative humidity is above 85%.

The Engineer may waive the temperature and humidity requirements on newly placed pavement when markings are immediately required for safe conduct of traffic.

F. Hours of Operation. Marking operations shall be conducted only during daylight hours, unless nighttime operations are required by the contract. All markings shall be sufficiently dry before opening to traffic.

G. Rate of Application. The wet film thickness for all markings shall be 15 mils. Place glass beads at a minimum rate of 6 pounds per gallon of paint.

H. Protective Measures. When marking operations are conducted under traffic, the Contractor shall take protective measures as outlined in the Traffic Control Plan. At the discretion of the Engineer, markings damaged by traffic, or markings tracked by crossing traffic, shall be repaired and corrected as specified in **Subsection 622.04J** and at the Contractor's expense.

I. Tolerance and Appearance. Markings shall be of the dimensions shown on the Pavement Marking Plans. No marking shall be less than the specified width. The length of the 10 foot painted segment of skip lines shall be a minimum of 10 foot, and the gaps between the painted segments shall vary no more than ±6 inches from the specified dimensions. All markings shall present a clean-cut, uniform, and workmanlike appearance. The Contractor at his expense shall correct all markings that fail to have a uniform, satisfactory appearance, either 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 604.04J .

J. Corrective Measures. All work shall be subject to checks of dimensions and application rates for beads and paint. All traffic markings that fail to meet the requirements given herein shall be corrected at the Contractor's expense. All areas of misted, dripped, and/or splattered paint shall be removed to the satisfaction of the Engineer. In all instances, when it is necessary to remove paint, it shall be done by means satisfactory to the Engineer and which do not damage the underlying pavement.

604.05 Method of Measurement. Pavement markings, except arrows, words, and railroad crossing symbols shall be measured on a linear foot basis for each width and color of fast dry painted pavement marking in place and accepted, measured along the center of the lines. The measurement shall include the length of the painted marking only and conversely shall exclude spaces between broken lines.

Measurement for payment of arrows, words, and railroad crossing symbols shall be for each arrow, word, or railroad crossing. A railroad crossing shall consist of one "X" and two "R"s as shown on the plans.

604.06 Basis of Payment. Accepted lengths of pavement markings will be paid for at the contract unit price for fast dry painted pavement markings of each width, color, and type,

which price and payment shall be full compensation for all materials, labor, equipment, and all incidentals necessary to satisfactorily complete the work.

Traffic control for application and/or removal of pavement markings shall be included in the bid item, Traffic Control, unless separate bid items for traffic control devises are included in the proposal.

The cost of determining the no passing zones for two-lane facilities and providing the Department will the data used in establishing the zones shall be consider incidental to the other items of work, and no separate payment will be made for this work.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
6040X0X	*(width)*" *(color)* Broken Lines (Gaps Excluded) - Fast Dry Paint	Linear Foot
6040X1X	*(width)*" *(color)* Solid Lines (Pavement Edge Lines) - Fast Dry Paint	Linear Foot
6040015	8" White Solid (Crosswalk & Channelization) - Fast Dry Paint	Linear Foot
6040020	12" White Solid Lines (Stop Lines) - Fast Dry Paint	Linear Foot
6040025	24" White Solid Lines (Stop Lines / Diagonal Lines) - Fast Dry Paint	Linear Foot
6040030	White Single Arrow (Left, Straight, or Right) - Fast Dry Paint	Each

6040031	White Single Bike Lane Arrow (Left, Straight, or Right) - Fast Dry Paint	Each
6040035	White Word Message ("Only") - Fast Dry Paint	Each
6040043	White Lane Drop Arrow (Right or Left) - Fast Dry Paint	Each
6040045	Railroad Crossing Symbol - Fast Dry Paint	Each
6040050	Handicap Symbol - Fast Dry Paint	Each
6040055	Bike Lane Symbol - Fast Dry Paint	Linear Foot
6040112	6" Yellow Solid Lines on Curb / Median - Fast Dry Paint	Linear Foot
6040113	6" Yellow Solid Lines on 6" Concrete Curb (Top & Side) - Fast Dry Paint	Linear Foot
6040115	24" Yellow Diagonal Lines - Fast Dry Paint	Linear Foot

THERMOPLASTIC PAVEMENT MARKINGS

604.07 Description. This work shall consist of furnishing and application of permanent thermoplastic pavement markings within the limits of the project to delineate the travel lanes and channelize traffic.

This work shall include protection of pavement markings during construction, protection of traffic during installation of pavement markings, determination of no passing zones for two-lane facilities in accordance with the *South Carolina Manual of Uniform Traffic Control Devices (SCMUTCD*), and providing the Department data used in establishing no passing zones on two-lane facilities.

604.08 Thermoplastic Pavement Marking Material. The thermoplastic pavement marking material shall be a reflectorized mixture of thermoplastic binder and spherical glass beads upon which additional glass beads are applied by dropping immediately following application. If recommended by the thermoplastic manufacturer, the pavement surface shall be coated with a primer-sealer material before application of the thermoplastic binder material.

A. Thermoplastic Compound. The thermoplastic binder compound shall meet all requirements of **AASHTO M 249** with the following adjustments:

1. The material may be shipped in the granulated form or the block form.

2. For longitudinal long line and channelization markings, including gore markings on interstate routes, the material may be either hydrocarbon or Alkyd based.

3. All handwork consisting of stop-bars, crosswalks, legends, and symbols shall be Alkyd Based material only.

B. Glass Beads. The drop-on glass beads shall meet the requirements of **AASHTO M 247**, Type 1.

C. Primer-Sealer. A primer-sealer as recommended by the manufacturer of the thermoplastic pavement marking material shall be used on all portland cement pavement surfaces and all bridge surfaces that have not been overlaid with asphalt. The primer-sealer also shall be used on any type of pavement before the placing of any pavement symbols. Primer-sealer shall be used on asphaltic concrete pavement surfaces if recommended by the manufacturer of the thermoplastic pavement marking material. The primer-sealer shall form a continuous film that will mechanically adhere to the pavement and shall neither

discolor nor cause any noticeable change in the pavement outside of the finished pavement markings. The primer-sealer shall be applied in accordance with the manufacturer's recommendations.

D. Certification. The Contractor shall obtain from the manufacturer of the thermoplastic binder test results of all requirements of AASHTO M 249 for each batch of material furnished along with a final certification that the material furnished meets the requirements of the Department's specifications. The Contractor shall also obtain from the manufacturer of the drop-on glass beads a certification stating that the material furnished meets all the requirements of the contract specifications. Copies of the above-described affidavits shall be furnished to the Engineer.

EQUIPMENT

604.09 Equipment for Thermoplastic Pavement Markings. The application properties of AASHTO M 249 are expanded as follows:

1. Material shall be prepared only by means of an insulated batching machine recommended or furnished by the manufacturer of the compound and shall consist of a special kettle for melting and heating the composition. Applicators may be either a truck-mounted liner or a portable unit. “Truck-mounted” shall be defined as a self-propelled vehicle with six or more wheels and an enclosed cab for housing a driver.

2. If the contract requires extruded application, the material shall be applied to the pavement by an extrusion method herein 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 the material.

3. The batching machine shall be constructed to provide continuous mixing and agitation of the material. All parts of the equipment which come in contract with the material shall be easily accessed and exposed for cleaning and maintenance and designed to prevent accumulation and clogging.

4. The equipment shall be constructed to ensure that all mixing and conveying parts up the final dispensing nozzle/shaping die maintain the material at the appropriate temperature.

5. The controls shall be such that the operator can override set automatic cycles in order to extend a line or to begin a new cycle at any selected point.

6. The applicators shall provide a means for cleanly cutting off square ends. The truck mounted liner shall provide 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 latest edition of the *SCMUTCD*. The marking machine shall travel only in the direction of normal traffic flow during marking operations. The use of pans, aprons, or similar appliances with the nozzle/die overruns will not be permitted.

7. Glass beads applied to the surface of the completed marking shall be applied by an automatic bead dispenser attached to the applicator in such a manner

that the beads are dispensed almost instantly following application of the marking material.

8. The applicators shall be constructed to produce varying width of traffic markings as indicated in the in the latest edition of the *SCMUTCD* and/or in the plans.

9. Kettles and melters must be such that heating is done by controlled heat transfer systems that are oil

jacketed or indirect flame air jacketed. Direct flame equipment will not be allowed. All kettles and melters must be 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.

10. The applicator and kettle must be equipped and arranged as to satisfy the requirements of the National Fire Underwriters, and all state and local requirements.

11. The applicators shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

APPLICATION

604.10 Application of Thermoplastic Pavement Makings.

A. Preparation of Surface. The pavement shall be dry and free of glaze, oil, dirt, grease, or other foreign contaminants. Where directed by the Engineer, the Contractor shall remove any existing markings that conflict with the Pavement Marking Plans by an approved method before the application of thermoplastic material.

On portland cement concrete surfaces including bridge decks, the Contractor shall be required to remove at least 80% of any existing markings by an approved method to provide for adequate bonding of the thermoplastic material. The width of the removal should be 2 inches wider than the line to be applied. A primer sealer recommended by the thermoplastic manufacturer shall be applied to the prepared surface before the application of the thermoplastic material.

When it is necessary to remove old makings from the pavement surface, it shall be the Contractor's responsibility to capture the removed material utilizing a vacuum or

other approved system to prevent its dispersal and to properly dispose of this material. The Contractor shall also be responsible for clean-up, removal, and proper disposal of excess or waste thermoplastic materials from the project site.

B. Application of the Primer-Sealer. Where used, the primer-sealer shall be sprayed on the pavement surface where the lines are to be applied. The application thickness and curing time on the pavement before thermoplastic application shall be governed by the recommendations of the manufacturer of the primer sealer.

C. Application of the Pavement Marking Material. All longitudinal markings shall be placed with a truck-mounted applicator except when approved by the Engineer. Such a case may occur where the length of a particular marking is too short, or the curvature too great, to permit efficient use of the liner. Transverse markings may be applied with a portable unit.

The markings shall be straight or of uniform curvature and shall conform uniformly with tangents, curves and transitions. Symbols shall be of dimensions shown in the *SCMUTCD*. Markings must be of the dimensions and placed as shown on the Pavement Marking Plans or as directed by the Engineer. The Contractor shall provide, at his own expense, sufficient control points to serve as guides for the application of markings.

The finished line pavement markings shall be free from waviness and the lateral deviations shall not exceed two inches in fifteen feet. Any greater deviation shall be sufficient cause for requiring the Contractor to remove and correct such markings at his own expense. The Contractor shall also be required to remove and correct, at his expense, any symbol pavement markings not meeting the dimensional requirements shown in the *SCMUTCD.*

The Contractor shall protect the pavement markings

until dry by placing guarding or warning devices as necessary. In the event, any vehicle should cross the wet marking, such a pavement marking shall be re-applied and any tracking lines made by the moving vehicle shall be removed by the Contractor at no additional expense to the Department.

To avoid poor quality, pavement markings shall be placed only when the surface of the pavement is surface dry as determined by visual inspection and the pavement temperature is minimum 55°F and the air temperature is minimum 50°F. No work will be allowed when any moisture is visible on the pavement surface. The Contractor shall provide each work crew with a hand-held infrared non-contact thermometer with a temperature range of 0°F to 1000°F (Baxter Scientific Products Model No. T 2940-2 or equivalent) to verify the minimum surface temperature and a pocket thermometer capable of accurately measuring air temperature (ERTCO 532PS or equivalent). Air temperature shall be measured away from heat generating equipment.

No thermoplastic pavement markings shall be applied between December 15 and March 15, inclusive. Additionally, the Engineer may disallow application on any days when the weather is cold and/or rainy, and there is some question as to whether the surface temperature will be above 55°F for a period of time adequate to obtain quality pavement markings. The Engineer may also disallow application on any day when, in the Engineer's opinion, moisture conditions are not satisfactory for obtaining quality pavement markings.

New asphalt concrete surfaces shall be in place a minimum of twenty (20) days before marking application. On new portland cement concrete surfaces, the curing compound shall be removed before application.

An adequate number of personnel experienced in the handling and application of this type of material shall be

provided by the Contractor to assure the work is done properly.

Work shall be done only during daylight hours unless specified otherwise, and all markings shall be sufficiently dry, before sunset, to permit crossing by traffic. All protective devices shall be removed before sunset to allow free movement of traffic at night.

The pavement marking material shall be applied at a temperature that will provide best adhesion to the pavement and shall be between 390°F and 420°F as recommended by the manufacturer. The material shall be heated uniformly throughout and shall have a uniform

disbursement of binder, pigment, and glass beads when applied to the surface of the pavement.

All extruded lines 12 inches or less in width, shall be applied with a die that equals the width of the line. All extruded lines greater than 12 inches may be applied with two dies whose combined widths equal the width of the line.

D. Rates of Application.

1. Thermoplastic Material. The thermoplastic material shall be applied at the specified widths and at a rate to result in a new material thickness as specified below:

90 mils for Edge Lines and Median Lines including:
- 4 inch solid white lines,
- 4 inch solid yellow lines,
- 4 inch broken yellow lines,
- 6 inch solid white lines, and
- 6 inch solid yellow lines.

90 mils for Lane Lines including:

4 inch broken white lines and
6 inch broken white lines.

90 mils for Center Lines on Two Lane Roads including:
4 inch broken yellow lines, and
4 inch solid yellow lines.

125 mils for all other lines not listed above.

2. Glass Beads. Drop-on glass beads shall be mechanically applied to the surface of the pavement marking material immediately after the material is applied to the pavement surface, and while the pavement marking material is still molten to ensure that the beads will be held by and mechanically embedded in the surface of the material. The beads shall be uniformly distributed over the entire surface of the marking and shall be applied at a minimum rate of 12 pounds per 100 square feet of stripe.

E. Warranty. The Contractor shall transfer to the Department the warranty on thermoplastic materials issued by the manufacturer. The Contractor shall also furnish the Department the normal warranty for material for a stated period beginning with the last date of marking application on the project. Work will not be allowed to commence until the warranties have been received by the Department.

F. Departmental Sampling. In addition to the initial acceptance of the thermoplastic material, a representative of the Department will sample each batch or lot scheduled for shipment for SCDOT projects for testing. Additional sampling and testing at the job site may occur at the discretion of the Department. A certification from the manufacturer must be submitted for each shipment for each project, certifying that the thermoplastic meets the requirements of **AASHTO 249** as amended herein for each type of thermoplastic material. No thermoplastic material

shall be used nor will payment be made for thermoplastic until the thermoplastic certification is received and accepted by the Engineer. The Department reserves the right to sample and test any thermoplastic material supplied for any SCDOT use at any time.

G. Inspection and Acceptance of Work. All thermoplastic pavement markings shall be inspected for proper line thickness and width, proper adhesion, and proper cycle length. The markings shall also be observed both day and night to determine whether all requirements of the Contract have been met. Any markings failing to have satisfactory appearance, either day or night shall be reapplied by the Contractor at his expense.

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 shall be required to replace any markings or markers that, in the opinion of the Engineer, have not performed satisfactorily during this 180-day period due to defective materials and/or workmanship.

604.11 Method of Measurement. Measurement, except for arrows, words, and railroad crossing symbols, shall be on a linear foot basis for each width and color of thermoplastic pavement marking in place and accepted by the Engineer. The measurement shall be along the center of the lines and shall include the length of the marking only, excluding spaces between broken lines.

Measurement of arrows, words, and railroad crossing symbols shall be for each arrow, word, or railroad-crossing symbol. A railroad-crossing symbol consists of one “X” and two “R”s.

604.12 Basis of Payment. Thermoplastic pavement markings will be paid for at the contract unit price for Thermoplastic Pavement Marking of each width, color, and type, which price and payment shall be full compensation for all materials,

labor, equipment, and all incidentals necessary to satisfactorily complete the work.

The cost of removing pavement markings shall be considered incidental to the other items of work and no separate payment will be made therefor, unless separate bid items have been included in the proposal.

Traffic control for application and/or removal of pavement markings shall be included in the bid item, Traffic Control, unless separate bid items are included in the plans and special provisions.

The cost of determining the no passing zones for two-lane facilities and providing the Department will the data used in establishing the zones shall be consider incidental to the other items of work, and no separate payment will be made for this work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
6041X0X	*(width)*" *(color)* Broken Lines (Gaps Excluded) - Thermoplastic - 90 mil.	Linear Foot
6041X1X	*(width)*" *(color)* Solid Lines (Pavement Edge Lines) - Thermoplastic - 90 mil.	Linear Foot
6041X15	*(width)*" *(color)* Solid Lines - Thermoplastic - 125 mil	Linear Foot
6041020	12" White Solid Lines (Stop Lines) - Thermoplastic - 125 mil.	Linear Foot
6041025	24" White Solid Lines (Stop Lines / Diag. Lines) - Thermoplastic - 125 mil.	Linear Foot

Item No.	Pay Item	Pay Unit
6041035	White Word Message "Only" - Thermoplastic - 125 mil.	Each
6041040	White Combination Arrows (Straight & Right or Straight & Left) - Thermoplastic - 125 mil.	Each
6041045	Railroad Crossing Symbols - Thermoplastic - 125 mil.	Each
6041050	Handicap Symbol - Thermoplastic - 125 mil.	Each

EPOXY PAVEMENT MARKINGS

604.13 Description. This item of work consists of the furnishing and application of permanent epoxy pavement markings within the limits of the project to delineate the travel lanes and channelize traffic.

This work shall include protection of pavement markings during construction, protection of traffic during installation of pavement markings, determination of no passing zones for two-lane facilities in accordance with the *South Carolina Manual on Uniform Traffic Control Devices (SCMUTCD)*, and providing the Department data used in establishing no passing zones on two-lane facilities.

MATERIAL

604.14 Epoxy Pavement Marking Material. Epoxy pavement markings are permanent retro-reflective (white or yellow) and non-retro-reflective (black) pavement marking materials of the color and pattern indicated on the plans or special provisions. The Contractor shall supply all the necessary equipment and materials for proper surface preparation and correct application of the pavement marking material.

The markings applied shall consist of a two component, 100% solids epoxy coating material capable of being applied by truck-mounted spray equipment. The material shall be capable of being applied at a minimum ambient air temperature of 40°F. The material shall be capable of retaining glass spheres and shall be suitable for application to all types of bituminous and concrete pavement surfaces.

A. Epoxy Coating Material. Epoxy marking materials shall comply with the following requirements:

1. Formulation. The epoxy material shall consist 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 shall be common to all colors.

2. Composition. Component A shall be within the following limits:

Pigments:	White	Yellow
Titanium Dioxide[1]	18-25%	-----
Chrome Yellow[2]	-----	23-30%
Organic Yellow	-----	-----
Black	-----	-----
Binder:		
Epoxy Resin	75-82%	70-77%

Pigments:	Non Lead Yellow	Black
Titanium Dioxide[1]	14-17%	-----
Chrome Yellow[2]	-----	-----
Organic Yellow	7-8%	-----
Black	-----	18-25%
Binder:		
Epoxy Resin	75-79%	75-82%

Notes:
1. **ASTM D 476**, Type II & III
2. **ASTM D 211**, Type III

3. Color. The epoxy marking materials, without drop-on beads, shall visually match the color chips that visu-

ally correspond to the **Federal Standard No. 595B** for the following colors:

White
Yellow
Black

The mixed epoxy compound, white, yellow and black, must be applied to 2 sets of 3 inch x 6 inch steel plates at 20 ± 1 mil in thickness, one set with glass beads and one set with no glass beads as specified. Expose the prepared samples as per **ASTM G 53**. The test shall be conducted for 75 hours at 122°F, four hours of humidity, and four hours of UV in alternating cycles. The color of the epoxy materials shall be within 5 units of the Federal Standards shown above.

4. Yellowness Index (ASTM D 1925).

Cure 72 hours after sample preparation.
Take yellow index reading, XYZ C/2°, following the 72-hour cure and preceding QUV (**ASTM G 53**).
Maximum before QUV 10.0
Place sample in QUV for 72 hours.
Maximum after QUV 15.0

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	

5. Directional Reflectance (ASTM E 97). The Directional Reflectance after QUV using XYZ Scale D65/10° is as follows:

White	75 Minimum
Yellow	38 Minimum

6. Epoxide Number. The WPE of the epoxy resin shall be 250 ± 50 as determined by **ASTM D 1652** for white, yellow, and black Component A on a pigment free basis.

7. Amine Number. The amine number of the curing agent (Component B) shall be 450 ± 50 as per **ASTM D 2074**.

8. Toxicity. Upon heating to application temperature, the material shall not exude fumes that are toxic or injurious to persons or property.

9. Viscosity. Formulations of each component shall be such that the viscosity of both components shall coincide (within 10%) at the spray temperature recommended by the manufacturer. Component B shall be formulated to have a steady and constant viscosity at temperatures recommended for spray application.

10. Drying Time. 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, shall exhibit no tracking time when tested according to **ASTM D 711** in less than 15 minutes.

11. Curing. The epoxy materials shall be capable of fully curing under a constant pavement surface temperature of 32°F or above.

12. Adhesion to Concrete. The catalyzed epoxy pavement marking materials, when tested according to ACI Method 503, shall have such a higher degree of adhesion to the specified concrete (4000 psi minimum) surface that there shall be a 100% concrete failure in the performance of this test. The prepared specimens shall be conditioned at room temperature for a minimum of 24 hours and a maximum of 72 hours before

the performance of the tests indicated.

13. Hardness. The epoxy pavement marking materials, when tested according to **ASTM D 2240**, shall have a Shore D Hardness greater than 80. Samples shall be allowed to cure at room temperature for a minimum of 24 hours and a maximum of 72 hours before performing the tests indicated.

14. Abrasion Resistance. The abrasion resistance shall be evaluated on a Taber Abrader with a 1000-gram load and CS-17 wheels. The duration of the test shall be 1000 cycles. The wear index shall be calculated based on **ASTM C 501** and the wear index for the catalyzed material shall not be more than 80. The tests shall be run on cured samples of material which have been applied at a film thickness of 15 $\pm$ 0.5 mil to code S-16 stainless steel plates (to be run without glass spheres). Samples shall be allowed to cure at room temperature for a minimum of 24 hours and a maximum of 72 hours before performing the tests indicated.

15. Tensile Strength. When tested according to **ASTM D 638**, the epoxy pavement marking materials shall have an average tensile strength of not less than 6000 psi. The Type IV specimens shall be cast in a suitable mold and pulled at rate of 0.25 inch per minute by a suitable dynamic testing machine. Samples shall be allowed to cure at room temperature for a minimum of 24 hours and a maximum of 72 hours before performing the tests indicated.

16. Compressive Strength. When tested according to **ASTM D 695**, the catalyzed epoxy marking materials shall have a compressive strength of not less than 12,000 psi. The cast sample shall be conditioned at room temperature for a minimum of 72 hours before performing the indicated tests. The rate of compression of these samples should be no more than 0.25 inch per minute.

B. Glass Beads. Glass beads having a spherical geometry shall be injected or dropped on the white or yellow lines immediately after application to give retroreflectivity to the newly applied lines. A mixture or large beads and small beads shall be used.

1. Composition. The silica content of the beads should be no less than 60%.

2. Physical Characteristics. The glass spheres shall be colorless, clean, transparent, and free from milkiness or excessive air bubbles. The glass beads shall have a minimum refractive index of 1.5 when tested by the liquid immersion method at 77°F. The beads shall be essentially free of sharp angular particles and particles showing surface scarring or scratching.

3. Gradation. The glass spheres shall have the following gradation when tested in accordance with **ASTM D 1214**:

Large Beads

Sieve Number	% Retained
10	0
12	0 - 5
14	5 - 20
16	40 - 80
18	10 - 400
20	0 - 5
Pan	0 - 2

Small Beads

Sieve Number	% Retained
20	0 - 5
30	5 - 20
50	30 - 75
80	9 - 32
100	0 - 5
Pan	0 - 5

4. Roundness. The large beads shall have a minimum of 80% rounds per screen on the two highest sieve quantities. The remaining sieve fractions shall

have no less than 75% rounds. The small beads shall be 70% rounds overall when tested in accordance with **ASTM D 1155**, Procedure A.

5. Angularity. Angular beads (beads with an aspect ratio of greater than 1.2:1, twins, satellites, agglomerates, angular or fire polished particles) shall not exceed 5% overall when examined visually for the small beads. For the large beads, the angulars shall not exceed 3% per screen when tested by the following method:

a. Scope:

A specimen of the material is visually examined using a Bell and Howell Microfiche Reader (with a 20 mm lens) and a number, or count percentage, of angular spheres is obtained for each of the two largest (quantity) sieve fractions.

b. Equipment and Chemicals:

(1) Bell and Howell Microfiche reader, Model ABR VIII, or equivalent with a 20 mm lens.

(2) Transparencies for +14, +16, +18, and +20 mesh spheres defining 1.2:1 aspect ratio.

(3) Mini-splitter.

(4) Clear, transparent tape.

(5) Syringe (3cc) with a 23 gage needle.

(6) Microscope slide.

(7) Cooking oil, Wesson Oil or equivalent, with an approximate 1.5 refractive index. A standard 1.5 refractive index liquid can also be used.

c. Safety Concerns:

(1) It is recommended that safety glasses be worn whenever testing is performed using chemicals, solvents, or glass spheres.

(2) Be sure to immediately sweep up any beads dropped on the floor to avoid slipping.

d. Procedure:

(1) All testing is to be performed on properly split or riffled specimens.

(2) During the gradation of normal testing, retain separately those fractions that contain the two largest quantities of particles. This will usually be at least 75%-80% of the material.

(3) Using the mini-splitter, reduce each fraction to just enough beads to cover a microscope slide when they are adhered to the clear tape. Retain each reduced specimen separately.

(4) Place a piece of clear transparent tape, adhesive side up, over the open side of the mini-splitter pan (lengthwise).

(5) Carefully pour one of the specimens over the tape to adhere the beads to the tape. Any particles that fall into the pan should be recovered

and again poured onto the tape until all particles have adhered to the tape.

(6) A microscope slide is then placed on top of

the beads and the tape secured to the slide by bringing the ends of the tape over the top of the slide. This is repeated for the other mesh size retained.

(7) The beads are next slightly wet with Wesson Oil by injecting a few drops onto the beads (under the tape) using the syringe and needle. Use only a few drops to avoid excess from running off the slide.

(8) Place the slide (beads up) between the two glass plates on the sample tray of the microfiche reader.

(9) Turn on the light and move the sample tray so that the beads are visible on the screen. Focus in on the beads and count the number of non-round beads in the field. Keep track of the number of angular particles in order to determine their concentration.

(10) In order to assist in determining whether a sphere has an aspect ratio greater than 1.2:1, transparencies shall be provided by the manufacturer being examined, select the proper transparency and determine which of the inner circles best matches the width of the sphere in question. Then slide the overlay so that the end of the bead lines up with the outer circle. If the other end of the bead protrudes beyond the opposite edge of the outer circle, the particle aspect ratio is greater than 1.2:1 and the particle is counted as non-round.

(11) If the edge of the particle does not protrude beyond the opposite edge of the outer circle, its shape is either spherical or slightly oval, it will be counted as a round particle.

(12) As was mentioned earlier, excluded from

the category of round particles, regardless of aspect ratio, are twins, satellites, angulars, and fire polished particles.

(13) At least 200 beads shall be counted on each slide. More than one field should be used on a slide to make up the 200 count in order to ensure that the count is representative of the entire specimen.

(14) Calculate the percentage of angular particles at each sieve fraction as follows:

$$\% \text{ Angulars} = \frac{\text{(Total No. of angular particles) x 100\%}}{\text{(Total No. of particles counted)}}$$

(15) If the angular content is greater than 3% for any screen fraction, a second bag from the same lot is to be analyzed. If any of the fractions again fall outside the specification limits for angular content, the lot is rejected. If the second bag is found to be within the specification limits, the lot is accepted.

6. Bead Coatings. All beads shall be embedded and moisture proof coated with Potters Industries AC-100 series or an equivalent performance insuring coating. The embedment coating shall be tested by the Dansyl Chloride Method. The moisture proof coating shall be tested by the following method:

a. Equipment:

(1) Teaspoon

(2) 500 ml Beaker

b. Procedure:

(1) Put about 400 ml of cold water in the beaker.

(2) Fill a spoon with the coated beads and gently immerse them into the water.

(3) Tap the spoon to force the mass of beads to fall to the bottom to the beaker. The material should maintain its initial shape for at least one hour. Some beads may fall from the agglomerated mass, however, there should not be considerable dropping of beads before one hour.

C. Certification. The Contractor shall obtain from the manufacturer of the epoxy material, final certification that each batch of material furnished meets the requirements of the special provisions. The Contractor shall also obtain from the manufacturer of the glass beads certifications that each batch of material furnished meets special provisions. The certifications provided by the Contractor for the marking material or glass beads shall indicate the batch numbers utilized and include the manufacturer's production control tests for each batch. Certifications shall also include the manufacturer's material safety data sheets. Copies of the above affidavits shall be furnished to the Engineer.

D. Department Samples. 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 of glass beads after they are received by the Contractor. The samples may be tested by the Department in whatever manner is deemed necessary. Performance of all sampling shall be observed by Department inspectors or their designated agents. The inspectors shall designate at random two containers from each batch to be sampled for testing and enclose a copy of the sampling inspection with the samples.

E. Marking and Packaging. All materials utilized in the performance of this work shall be provided in the manufac-

turer's original, undamaged packaging. This packaging shall clearly indicate the name of the manufacturer, the type of material packaged, the weight or volume of the material enclosed and the batch or lot numbers. All packaging shall also indicate the date of manufacture and, if applicable, color.

EQUIPMENT

604.15 Equipment for Epoxy Pavement Markings. Equipment for applying the epoxy material shall be truck mounted and capable of mixing the two material components in the proportions recommended by the manufacturer. The equipment shall also be capable of applying the material at the manufacturer's recommended application temperature. The equipment shall be capable of automatically dispensing beads immediately following application of the epoxy material using a double drop system.

The marking equipment shall be capable of applying the epoxy material at a uniform thickness up to 25 mils. In addition, the equipment shall be capable of dispensing beads at a constant rate of 25 pounds per gallon of marking material.

The application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. The equipment shall be constructed to assure continuous uniformity in the dimensions of the applied markings.

The equipment shall be capable of cleanly cutting off square stripe ends. The equipment shall also 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 latest edition of the *SCMUTCD*. In addition, the controls shall be such that the operator can override set automatic cycles in order to extend a line or to begin a new cycle at any selected point.

The equipment shall also be capable of producing mark-

ings of varying widths as indicated in the Pavement Marking Plans, the *SCMUTCD*, or the contract specifications.

The equipment shall travel only in the direction of normal traffic flow during marking operations.

The equipment shall have such a design that the pressure gauges for each type of proportioning pump are constantly visible to the operator at all times so that any fluctuation or pressure difference can be detected immediately.

Electrical foot counters shall be installed on the marking equipment. The counters shall individually tabulate the amount of footage applied by each striping gun. The counters shall have 6 digits with a reset feature.

The marking equipment shall be equipped with a pressure regulated air jet that will spray all debris from the pavement in advance of the applicator guns. The air jet shall operate when marking material is being applied and shall be synchronized with marking material application or remain "on" at all times.

APPLICATION

604.16 Application of Epoxy Pavement Markings.

A. General Requirements. All longitudinal markings shall be placed with a truck-mounted applicator except where approved by the Engineer. Such a case may occur where the length of a particular marking is too short, or the curvature too great, to permit efficient use of the liner. Such markings, as well as transverse markings may be applied with a portable unit.

Markings shall be sharp, well defined, and uniformly retroreflective (except black markings). Pavement markings shall be free of uneven edges, overspray or other readily visible defects which, in the opinion of the Engineer, detract from the appearance or function of the

pavement markings. Non-retroreflective lines are unacceptable with the exception of black pavement markings. Pavement markings which are improperly applied, improperly located or are not of uniform retroreflectivity shall be reapplied. Improperly located markings shall be removed at the contractor's expense and reapplied in the correct location at the contractor's expense, including furnishing of materials.

The markings shall be straight or of uniform curvature and shall conform uniformly with tangents, curves and transitions. Symbols shall be of dimensions shown in the *SCMUTCD*. Markings shall be of the dimensions shown on the pavement marking plans or as directed by the Engineer. The contractor shall provide, at his own expense, sufficient control points to serve as guides for the application of markings.

The finished line markings shall be free from waviness and lateral deviations shall not exceed 2 inches in 100 feet. Any deviation greater than 3 inches will not be acceptable. Any greater deviation shall be sufficient cause for requiring the Contractor to remove and correct such markings at his own expense. The Contractor shall also be required to remove and correct, at his expense, any symbol markings not meeting the dimensional requirements of the *SCMUTCD*.

The Contractor shall protect the markings until dry by placing guarding or warning devices as necessary. In the event any vehicle should cross the wet marking, such a marking shall be re-applied and any tracking lines made by the moving vehicle removed by the Contractor.

In the event that the contract includes sections of roadway where raised pavement markers are installed on the surface, marking material shall not be applied onto the reflective surface of the raised markers. If marking material is applied to the reflective marker surface, the Engineer shall suspend the work and the Contractor shall, at his expense, either remove all marking material from the

reflector unit; or he shall remove and replace in kind the raised marker.

B. Surface Preparation. The Contractor shall clean all visible loose or foreign material from the surface to be marked. The Contractor shall power broom clean all surfaces where gore markings or edge-lines are to be marked before marking application. In addition, all surfaces shall be cleaned by a jet of compressed air immediately before material application. At the time of marking application, the pavement surface shall be free of dirt, dust, oil, grease, and other contaminants.

C. Rate of Application. The epoxy marking materials shall be applied at the rate specified in Table 1 below to produce a uniform wet film thickness of 20 mils, calculated without drop-on beads.

Table 1

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	88	---

Application rates for solid lines in gore areas shall not be less than one gallon per 80 square foot of marking surface (20 mil thickness). Table 2 gives the application rate on a linear foot basis for shorter lengths of markings (gore markings and stop bars.)

Table 2 Linear Foot of Line Per Gallon of Material	
Line Width (inches)	Solid Line Length (feet)
8	120
12	80
24	40

The epoxy shall be heated to the manufacturer's recommended temperature before application to the pavement surface.

Epoxy pavement markings shall be applied only when the surface of the pavement is dry as determined by visual inspection. The minimum required pavement surface temperature for application shall be 45°F. The ambient air temperature shall be at least 40°F during marking operations.

The Contractor shall provide each work crew with a hand held infrared non-contact thermometer with a temperature range of 0°F to 1000°F (Baxter Scientific Products Model No. T 2940-2 or equivalent) to verify the minimum surface temperature and a pocket thermometer capable of accurately measuring the air temperature (ERTCO 532PS or equivalent). Air temperature shall be measured away from heat generating equipment.

No application of markings will be permitted between January 1 and March 1 inclusive.

The Engineer may disallow application of markings on any day when, in the Engineer's opinion, moisture or temperature conditions are not satisfactory.

An adequate number of personnel experienced in the handling and application of this type of material shall be provided by the Contractor to assure that the work is done

properly.

D. Glass Beads. Two sizes of glass beads shall by applied 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. Each type of bead shall be applied simultaneously at a minimum rate of 12 pounds per gallon of marking material (24 pounds per gallon total). The large beads shall be applied first immediately followed by the application of the small beads. The beads shall adhere to the cured epoxy or all marking operation shall cease until corrections are made.

New asphalt concrete surfaces shall be in place a minimum of two weeks before marking application. On new portland cement concrete surfaces, the curing compound shall be removed before application.

E. Warranty. The Contractor shall furnish to the Department the warranty of the epoxy materials issued by the manufacturer. Work will not be allowed to commence until the warranty has been received by the Department.

F. Inspection and Acceptance of Work. All epoxy markings shall be inspected for proper line thickness and width, proper adhesion and proper cycle length. The markings shall also be observed both day and night to determine whether all the requirements of the contract have been met. Any markings failing to have satisfactory appearance, either day or night, shall be reapplied by the Contractor at his own expense.

The final acceptance of the epoxy material shall be delayed for a period of 180 days after the last day markings are applied on the project to permit observation of performance. The Contractor shall be required to replace any markings that, in the opinion of the Engineer, have not performed satisfactorily during this 180-day period due to defective materials and workmanship in manufacture or application.

604.17 Method of Measurement. Measurement, except for arrows, words, and railroad crossing symbols, shall be on a linear foot basis for each width and color of epoxy pavement marking in place and accepted by the Engineer. The measurement shall be along the center of the lines and shall include the length of the marking only, excluding spaces between broken lines.

Measurement of arrows, words, and railroad crossing symbols shall be for each arrow, word, or railroad-crossing symbol. A railroad crossing symbol consists of one “X” and two “R”s.

604.18 Basis of Payment. Epoxy pavement markings will be paid for at the contract unit price for Epoxy Pavement Marking of each width, color, and type, which price and payment shall be full compensation for all materials, labor, equipment, and all incidentals necessary to satisfactorily complete the work.

The cost of removing pavement markings shall be considered incidental to the other items of work and no separate payment will be made therefor, unless separate bid items have been included in the proposal.

Traffic control for application and/or removal of pavement markings shall be included in the bid item, Traffic Control, unless separate bid items are included in the plans and special provisions.

The cost of determining the no passing zones for two-lane facilities and providing the Department will the data used in establishing the zones shall be consider incidental to the other items of work, and no separate payment will be made therefor.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
6042X0X	*(width)*" *(color)* Broken Lines (Gaps Excluded) - Epoxy Paint	Linear Foot
6042X1X	*(width)*" *(color)* Solid Lines (Pavement Edge Lines) - Epoxy Paint	Linear Foot
6042021	12" White Solid Lines (Diagonal Lines) - Epoxy Paint	Linear Foot
6042015	8" White Solid (Crosswalk & Channelization) - Epoxy Paint	Linear Foot
6042020	12" White Solid Lines (Gore Markings) - Epoxy Paint	Linear Foot
6042021	12" White Solid Lines (Diagonal Lines) - Epoxy Paint	Linear Foot
6042025	24" White Solid Lines (Stop Lines / Diagonal Lines) - Epoxy Paint	Linear Foot
6042030	White Single Arrows (Left, Straight, or Right) - Epoxy Paint	Each

Item No.	Pay Item	Pay Unit
6042035	White Word Message ("Only") - Epoxy Paint	Each
6042040	White Combination Arrows (Straight & Right or Straight & Left) - Epoxy Paint	Each

6042043	White Lane Drop Arrow (Right or Left) - Epoxy Paint	Each
6042045	Railroad Crossing Symbol - Epoxy Paint	Each
6042114	12" Yellow Solid Lines (Diagonal Line) - Epoxy Paint	Linear Foot
6042115	24" Yellow Diagonal Line - Epoxy Paint	Linear Foot

SECTION 605

PERMANENT RAISED PAVEMENT MARKERS

605.01 Description. This work shall consist of furnishing and installing durable, abrasion-resistant retroreflective pavement markers at locations designated on the plans and as directed by the Engineer. The pavement markers shall be as specified herein and shall be installed as shown in the plans.

MATERIAL

605.02 Pavement Markers.

A. Shape and Color. The base of the marker shall be approximately 4 inch x 4 inch with 30 degree sloping sides approximately 5/8 inches in height (nominal dimensions). The outer surface of the marker shall be smooth and all corners and edges exposed to traffic must be rounded. Pavement markers may be of various colors or combination of colors and have one or two reflective faces as shown on the Plans. When illuminated by automobile headlights, the reflective faces shall redirect light of the color indicated and as specified in these specifications. The color of the reflectors when illuminated and when not illuminated shall be subject to the approval of the Department. The color of samples will be evaluated, and off-

colors will constitute grounds for rejection.

Drawings of markers shown in the plans are for illustrative purposes only and are not intended to specify any particular product.

B. Physical Requirements. Reflective pavement markers shall be of the prismatic reflector type, consisting of a methyl methacrylate or acrylonitrile butadiene styrene shell filled with a mixture of an inert thermosetting compound and filler material or a polycarbonite body. The exterior surface of the shell shall be smooth and contain one (mono-directional) or two (bi-directional) prismatic reflector faces as shown on the plans, molded to reflect incident light and having a minimum surface area of 2.50 square inches.

A hard, durable, abrasion resistant surface (untempered glass or a special abrasion resistant coating) shall be bonded to the reflective face surface of the marker. The red lens on two color units shall be exempt from this requirement.

The base of the marker shall be free from gloss or substances that may reduce its bond to the adhesive. The presence of a soft or resin rich film on the surface of the base shall be cause for rejection.

C. Strength Requirements. The markers shall be capable of supporting a minimum load of 2,000 pounds. Strength shall be tested by the procedures specified in **Subsection 605.02E.2.d.**

The abrasion resistant surface of the reflector lens shall withstand radial cracking and show only concentric cracks when damaged by impact of hard objects embedded in vehicle tires.

D. Optical Requirements.

1. Optical Performance. The specific intensity of each reflective surface, when tested at a 0.2 degree angle of divergence[1], shall not be less than the following specified values:

	Specific Intensity (SI)		
	Clear	Yellow	Red
0° Incidence Angle[2]	3.0	1.5	0.75
20° Incidence Angle[2]	1.2	0.60	0.30

Notes:

[1] Angle of Divergence - The angle formed by a ray from the light source to the marker, and the returned ray from the marker to the measuring receptor.

[2] Angle of Incidence - The angle formed by a ray from the light source to the marker, and the normal to the leading edge of the marker face.

2. Specific Intensity. The mean candlepower of the reflected light at a given incidence and divergence angle for each foot-candle at the reflector on a plane perpendicular to the incident light.

$$SI = \frac{R_L \times D2}{I_L}$$

Where:

SI = Specific Intensity
R_L = Reflected Light
D = Test Distance
I_L = Incident Light (Light Source)

Optical performance shall be tested as specified under **Subsections 605.02E.2.a** and **605.02E.2.b**.

E. Samples and Tests.

1. Samples. Twenty (20) markers of each type selected at random from each shipment or lot will constitute a representative sample. Markers undamaged from testing by the Department's Research and Materials Laboratory will be available for the Contractor to reclaim.

2. Tests.

a. Optical Test. Ten (10) of the markers will be tested, and if all pass the optical test, the lot will be accepted. If any fail, the remaining 10 will be tested.

The marker being tested shall be located base down with the center of the reflective face 50 feet from the calibrated light source with a blue/red ratio of 2856°Kelvin. The reflected light and the incident light shall be measured by means of a retrophotometer. The "SI" formula shall be used to determine the specific intensity values for the reflective surface.

b. Abrasion Test. Three (3) markers will be picked at random and tested as prescribed below:

Form a 1-inch diameter flat pad using #3 coarse steel wool. Place the steel wool pad on the reflector, apply a load of 50 ± 0.5 pounds and rub the entire reflective surface at least 50 times. A new #3 steel wool pad should be used for each lens test. After rubbing, the reflective faces will pass the test for optical requirements described in **Subsection 605.02D** above.

c. Impact Test. Three (3) markers picked at ran-

dom from the sample shall be impact tested.

Condition the markers in a convection oven at 130°F for one hour. While at the elevated temperature, impact the reflective face by allowing a 0.42 pound dart fitted with a 0.25 inch radius spherical head to drop 18 inches perpendicularly onto the center of the reflective surface. Cracks in the impact area shall be generally concentric in appearance. There shall be no more than two radial cracks longer than 0.25 inch. There shall be no radial cracks extending to the edge of the abrasion resistant surface.

d. Strength Test. Three (3) markers picked at random from the sample shall be load tested. Each marker shall support a minimum load of 2000 pounds as applied in the following manner:

The marker shall be centered base down over the open end of a vertically positioned hollow metal cylinder. The cylinder shall be one inch high with an internal diameter of three inches and a wall thickness of 1/4 inch. A load shall be applied to the top center of the marker by means of a 1 inch diameter solid steel plug approximately 1 inch high. The rate of loading shall be approximately 2000 pounds per minute. Failure shall constitute either breakage or significant delamination of the shell and the filler material at a load less than 2000 pounds.

e. Tolerance. The samples lots tested shall conform to the following requirements:

(1) If 10 of the first 10 markers meet the requirements as noted in **Subsection 605.02E.2.a**, the lot will be accepted. If any of the second 10 markers fail the optical test, a resample will be allowed at the request of the Con-

tractor. Nineteen (19) of the 20 markers comprising the resample must pass the optical test for the lot or shipment to be accepted. If more than 2 markers from the original sample fail the optical test, no resample will be allowed and the lot or shipment will be rejected.

(2) All markers comprising a sample must meet the requirements for the size and material for the reflective face surface for a lot or shipment to be accepted. However, should 19 markers meet this requirement, a resample will be allowed at the request of the Contractor. If all 20 markers of the resample meet the requirements for the size and material for the reflective face surface the lot or shipment will be accepted with the stipulation that if any deficient markers are detected during installation the remainder of the lot or shipment may be rejected.

The 3 markers selected from the sample for abrasion testing shall meet the requirements as outlined in **Subsection 605.02E.2.b**, of these specifications. Should one marker fail to meet these requirements, a resample will be allowed at the request of the Contractor. If one of the 3 markers tested from the resample fail the requirements as outlined in Subsection 605.02E.2.b, the lot or shipment shall be rejected.

(3) The 3 markers selected from the sample for impact testing must meet the requirements as outlined in **Subsection 605.02E.2.c**. Should one marker fail to meet these requirements, a resample will be allowed at the request of the Contractor. If one of the three markers tested from the resample fail the requirements as outlined in Subsection 605.02E.2.c, the lot or shipment shall be rejected.

(4) Should only 2 of the 3 markers selected for strength testing meet the requirements of these specifications, the lot or shipment may still be accepted provided 6 additional markers selected from the sample for strength testing all meet the requirements. If 2 or more of the original 3 markers fail the strength test the lot or shipment shall be rejected.

F. Testing and Reports. Tests of the markers to be used on the project shall be conducted by the Department's Research and Materials Laboratory, as indicated herein. Additionally, the Contractor shall furnish the Engineer four (4) copies of a notarized certified report from the manufacturer of the markers showing the results of their quality control tests.

CONSTRUCTION REQUIREMENTS

605.03 Installation.

A. Location. The lane line markers, edgeline markers, centerline markers, entrance and exit ramp markers shall be located as shown in the plans and typicals.

B. Bonding to Pavement. Markers may be bonded to the pavement by either of two methods; the epoxy method or the bituminous adhesive method.

No permanent raised markers shall be installed between December 15 and March 15 inclusive, except with the written permission of the Engineer.

The ambient temperature and/or road surface temperature during application shall be at least 50°F for epoxy and 40°F for the bituminous adhesive.

1. Certification. For either method, the manufacturer of the material used shall furnish four (4) copies of a

certification to the Engineer stating that the epoxy meets **AASHTO M 237** for the type used, or that the bituminous adhesive meets the Department's specifications.

2. Epoxy Method. Markers shall be bonded to the pavement with an epoxy adhesive that meets the requirements of AASHTO M 237, Type 1. During construction the following directions and recommendations shall be complied with:

a. Just before use, Components A and B shall be mixed in accordance with manufacturer's recommendations.

b. The temperature of the adhesive shall be maintained at 60°F to 100°F before mixing.

c. Road surface shall be cleaned by sandblasting the area to which the marker is to be bonded. Sand shall be clean and dry. Road surface where markers are to be placed shall be thoroughly dry before applying epoxy.

d. When markers shall be placed over existing traffic paint stripes, all old paint and primer, if present, must be removed down to bare concrete or asphalt.

e. Machine mixer and applicator shall be capable of accurately and uniformly proportioning Component A to Component B in a volume ratio in accordance with the manufacturer's recommendations.

f. Mixing chamber must produce the mixed adhesive with a uniform gray color with no visible evidence of streaks of either black or white on the surface or within the mixed adhesive.

g. Voids in a cured undisturbed sample 1/16 inch thick from the extrusion nozzle shall not exceed 4%.

h. Periodic checks of the proportioning equipment shall be made to determine the actual volume ratio of Component A to B. This shall be done by containers placed before the mixing chamber and the actual volume of Components A and B measured.

3. Bituminous Adhesive Method. Markers shall be bonded to the pavement with a bituminous type hot-melt adhesive that meets the following requirements:

a. The adhesive shall be suitable for bonding ceramic and plastic markers to portland cement concrete, asphaltic concrete, and chip-sealed road surfaces and applicable when road surface and marker temperatures are in the approximate range of 40°F to 160°F. The composition of the adhesive must be such that it's properties will not deteriorate when heated to and applied at temperatures up to 425°F using either air or oil-jacketed melters.

b. The adhesive shall be packaged in self-releasing cardboard containers with essentially flat and parallel top and bottom surfaces such that the packages will stack properly. Each package shall have a net weight of either 50 or 60 pounds and shall weigh within two pounds of the stated quantity. Self-releasing cardboard dividers that separate each package into sections weighing no more than 15 pounds each shall be part of the packaging. Each package shall show the manufacturer's name, net weight, and lot or batch number and shall be imprinted with "Bituminous Adhesive For Pavement Markers" or similar wording identifying the contents.

4. Prequalification. All manufacturers furnishing adhesives to meet this specification shall have their adhesives tested by the **National Transportation Product Evaluation Program (NTPEP)** as indicated on SCDOT ***Approval Policy 42*** *for Adhesives for Raised*

Pavement Markers. An approved suppliers listing will be made up from NTPEP test results. Manufacturers must be on the Department's approved suppliers list before furnishing materials for Department work.

605.04 Inspection and Acceptance of Work. All pavement markers shall be inspected at both day and night to determine whether the intent of this specification has been achieved. Any markers failing to have satisfactory appearance, either day or night, shall be reinstalled or replaced by the Contractor at his own expense.

The final acceptance of the pavement markers will be delayed for a period of one hundred and eighty (180) days after the last date of marker placement to permit observation of performance. The Contractor shall be required to replace any markers that, in the opinion of the Engineer, have not performed satisfactorily during this 180-day period due to defective materials and workmanship in manufacture and application.

605.05 Method of Measurement. Measurement of pavement markers shall be by each permanent raised retroreflective pavement marker of each color, type, and size complete in place and accepted.

605.06 Basis of Payment. The number of permanent pavement markers accepted will be paid for at the price for Permanent, Clear or Yellow, Pavement Markers, Mono-Directional or Bi-Directional, of the specified size, which price and payment shall be full compensation for furnishing raised pavement markers and adhesives, surface preparation, installation of markers, removal of existing markers where required, and all materials equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
605X005	Permanent *(color)* Pavement Markers - Mono-Directional, 4" x 4"	Each
605X010	Permanent *(color)* Pavement Markers - Mono-Directional, 5" x 2"	Each
6051100	Permanent Yellow Pavement Markers - Bi-Directional, 4" x 4"	Each
6051110	Permanent Yellow Pavement Markers - Bi-Directional, 5" x 2"	Each

SECTION 606

(RESERVED)

SECTION 607

PERMANENT TERMINAL IMPACT ATTENUATOR

607.01 Description. This work shall consist of furnishing, assembling, and installing, permanent terminal impact attenuators on or adjacent to the roadways in the state of South Carolina to protect the ends of concrete barrier walls and other hazards.

Each impact attenuator shall control the deceleration of impacting vehicles and dissipation of the vehicles' kinetic energy. When struck from the front, the unit shall bring the errant vehicle to a safe and controlled stop. When impacted from the side, the unit shall redirect the errant vehicle. Each impact attenuator shall function within the requirements as detailed by these specifications and the manufacturer's speci-

fications.

MATERIAL

607.02 Impact Attenuating Device. The impact attenuator shall be a QuadGuard System manufactured by Energy Absorption Systems, Incorporated, of Chicago, Illinois, or an approved equal and accepted by the Engineer.

Alternative impact attenuating devices shall meet all standards and requirements as specified under this specification to be considered an approved equal. Failure to meet these requirements in their entirety shall disqualify an alternative impact attenuating device as an approved equal.

The attenuator shall be 24, 30, 36, 69, or 90 inches wide and shall contain the number of bays as specified by the plans and/or the special provisions.

The Contractor shall make all corresponding shop drawings and detailed specifications from the manufacturer available for the Engineer's inspection before installation of the attenuator. The shop drawings and specifications shall include performance criteria, installation drawings, and instructions that completely describe the attenuator system. Shop drawings submittals shall conform to the requirements of **Subsection 725.02**.

607.03 Crushable Cartridges. Crushable cartridges shall be Type I and Type II as necessary.

Each cartridge shall be new. Cartridges exhibiting pulled staples, wrinkles in the plastic container package, exposed internal material, shall be considered defective and shall not be installed.

All nose assemblies shall be yellow. Supplement the nose assembly of each attenuator with road signs, either W18-2-24, W18-2R-24, or W18-2L-24, for delineation of the approach end of the unit. The Contractor shall request the nec-

essary sign drawings from the Engineer.

607.04 Performance Requirements. Impact attenuators shall meet the following performance requirements:

1. Each impact attenuator shall meet the test requirements for the **National Cooperative Highway Research Program (NCHRP)**, *Report 350*, 1993, for re-directive, non-gating terminals and crash cushions as directed by the FHWA. Each attenuator shall have approval for use from the FHWA.

2. Design, selection, and placement of terminal impact attenuators shall conform to and utilize devices described in:

a. **The American Association of State Highway and Transportation Officials (AASHTO)** publication, *Roadside Design Guide*, latest edition.

b. **U.S. Department of Transportation, Federal Highway Administration (FHWA)** *Report N5040.16*, *Crash Cushions, Selection Criteria, and Design*.

3. The impact attenuator shall decelerate and stop vehicles weighing 1800 to 4400 pounds during head-on impacts. The attenuator shall meet the occupant risk and vehicle trajectory criteria required by the NCHRP, *Report 350,* Tests 30, 31, 32, and 33. Test 31 shall also evaluate the capacity of the attenuator to absorb the energy of the standard 3/4 ton pickup truck.

4. The impact attenuator shall redirect vehicles weighing 4400 pounds that impact the unit along the sides at speeds up to 62 MPH at angles of 20 degrees or less for both right-way and wrong-way impacts. The attenuator shall redirect vehicles weighing 1800 pounds that impact the unit along the sides at speeds up to 62 MPH at angles of 15 degrees. Measure all angles from the longitudinal

centerline of the unit. The attenuator shall meet the requirements of the NCHRP, *Report 350,* Tests 36, 37, 38, and 39. These tests shall evaluate the occupant risk and vehicle trajectory criteria, re-directional capability, the structural adequacy of the attenuator, the potential for snagging, and performance during a reverse hit

5. All test result data for 4400 pounds vehicles shall include the standard 3/4 ton pickup truck.

6. The impact attenuator shall remain intact without debris during all impacts within design parameters. After side impacts within design parameters, the unit must remain capable of sustaining an additional side impact or a head-on impact at full design velocity.

7. The impact attenuator shall prevent lateral penetration at or near the "coffin corner" with a subsequent impact against the stationary hazard. The "coffin corner" is the term for the last four feet of the attenuator in front of the hazard. The impact attenuator shall prevent 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 to 4400 pounds.

CONSTRUCTION REQUIREMENTS

607.05 Assembly and Installation. The impact attenuator shall be assembled and installed in conformance with these specifications, the manufacturer's specifications, the special provisions, the plans, and as directed by the Engineer.

The Engineer will inspect each impact attenuator, including all parts and materials, before and immediately after installation to ensure conformance with all specifications.

All obstructions shall be cleared from the immediate site location. The immediate surrounding area and the approach area 50 feet long in advance of the system of curbs, islands, elevated objects, and depressions shall be dressed and cleared where possible. All approach areas in advance of the

site location shall be reasonably smooth and flat for no less than 100 feet. Unpaved approach areas shall be graded where necessary to provide smooth and flat surfaces.

Each site location may require preparations such as grading, slope flattening, and excavation and construction of a concrete pad. The immediate site location of the attenuator shall at the same grade elevation, including adjustments necessary for superelevation, as the adjacent travel lane or paved shoulder. Any location that exceeds a cross slope of 8% or has a variance in excess of 2% shall require one or more of the above site preparations.

A site location within a two-way traffic situation shall require utilization of an approved transition panel. The attenuator shall be placed on the site location to minimize exposure of the rear of the unit to opposing traffic and the possibility of a vehicle snagging the rear of the unit. Each transition panel shall be drilled to permit attachment to the hazard or existing guardrail and to the attenuator. The panel shall be attached to the unit beneath the adjacent fender panel to permit the adjacent forward set of fender panels the ability to move over the transition panel during an impact from the front. The panel shall be installed flat and securely against the side of the hazard to prevent snagging of vehicles as required by these specifications and as directed by the manufacturer's specifications.

The attenuator shall be anchored onto a concrete foundation constructed in accordance with the manufacturer's specifications. The top of each foundation shall be at the same grade elevation as the adjacent travel lane and/or paved shoulder. The foundation shall be constructed to be compatible with the anchor system.

The anchor system shall conform to the requirements of these specifications and the manufacturer's specifications.

The grout used for attenuator anchor systems shall be a two-part polyester epoxy. The grout shall be either the MP-3 Polyester Anchoring System manufactured by Energy Absorp-

tion Systems, Inc. or an approved equal.

607.06 Method of Measurement. Impact attenuators shall be measured by each permanent terminal impact attenuator furnished, assembled, installed and accepted.

607.07 Basis of Payment. The number of permanent impact attenuators accepted will be paid for at the contract unit price for the permanent terminal impact attenuator, which price and payment shall be full compensation for furnishing, assembling and installing each attenuator and all labor, equipment, tools and incidentals necessary to satisfactorily complete the work.

Included in the price and payment shall be the preparation of the site location, grading, slope flattening, excavation, concrete pad for attenuator, anchoring system, grout for the anchors if required, connection of the attenuator to the guardrail or concrete barrier where required, furnishing and installing transition panel if necessary, and all structural backing systems and concrete pads.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
6070000	Permanent Terminal Impact Attenuator	Each

SECTION 608

PERMANENT SIGNING

SIGN BLANKS

608.01 Description. This work shall consist of furnishing of

flat sheet aluminum sign blanks conforming to the requirements for size, corner radii, holes, and other details in drawings contained in **"Standard Highway Signs" Federal Highway Administration, US Department of Transportation**.

Any details not specifically addressed by the "Standard Highway Signs" book will be provided, on requested, by the Engineer.

A. Sign Blanks. The sign blanks shall be aluminum that complies with **ASTM B 209** Alloys 6061-T6, 5052-H38, or 5154-H38. The following minimum thickness of aluminum shall be used:

Sign Width* (Inches)	Blank Thickness (Inch)
Up to 48	0.080
48 or more	0.100

* For signs having a horizontal edge, width is measured on that edge. For diamond shapes and pennant shapes, the width is measured on the slope of the sign edge.

B. Fabrication. Sign blanks shall be fabricated of a single piece of aluminum. Metal shall be cut to the proper sign blank size and bolt holes provided. All edges, including holes, shall be true and smooth. Bolt holes shall be punched before surface preparation.

C. Surface Preparation. Before application of reflective sheeting, the surfaces of the sign blanks shall prepared as follows:

1. Degreasing. Blanks shall be degreased by one of two methods:

a. Immerse in a saturated vapor of trichloroethylene or perchloroethylene, or

b. Immerse in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specifications, for sufficient time to remove soil, and then rinsed thoroughly with running water.

2. Etching. After degreasing, blanks shall be well etched using one of these two methods:

a. Immerse in a tank containing a 6% to 8% phosphoric acid solution or proprietary acid etching solution and rinsed thoroughly with cold running water, followed by a hot water rinse, or

b. Immerse in a tank containing an alkaline etching solution that is controlled by titration at the temperature and concentration recommended by the solution manufacturer. Rinse thoroughly. Remove smut with an acidic, chromium compound type solution as specified by the solution manufacturer and then rinsed thoroughly.

3. Coating. After etching, blanks shall be treated with a light and tightly adherent chromate conversion coating that is free of any powdery residue, and ranging in color from a silvery iridescent to a pale yellow. This coating shall conform to **ASTM B 449**, Class 2, 10-33 mg/sq.ft., with a **median** of 25 mg/sq.ft.

D. Acceptance of Aluminum Sign Blanks. Mill Test Reports and Materials Certifications shall be furnished by the manufacturer or supplier, and shall accompany each shipment of aluminum sign blanks. The Mill Test report shall identify various heats and/or lots of aluminum. The chemical and physical properties shall conform to the requirements of the specified alloy. Production lots shall be identifiable upon receipt at the SCDOT facility. Failure to provide Mill Test Reports and Materials Certifications may result in the rejection of all materials and require replacement at the supplier's expense.

608.02 Measurement and Payment. Work and materials under this item will not be measured for separate payment, but will included in the price and payment for other items of work.

REFLECTIVE SHEETING

608.03 Description. This work shall govern the furnishing and application of reflective sheeting for traffic control devices and shall be fabricated and applied in accordance with the details shown on the plans and in conformity to the requirements of this specification and any special provision pertaining thereto.

MATERIAL

608.04 Material Requirements. Reflective Sheeting shall meet the requirements of **AASHTO M 268** *Standard Specification for Reflective Sheeting for Traffic Control*, latest edition.

In addition to the requirements of AASHTO M 268, the following provisions will apply:

A. Pre-qualification. Manufacturers wishing to supply reflective sheeting material for Department projects must submit their material for testing by the **National Transportation Product Evaluation Program (NTPEP)**. Requirements for sample submission can be obtained from NTPEP, 444 N. Capital St., NW, Suite 249, Washington, DC 20001, telephone (202) 624-5800. The NTPEP test results will be made available to the Department, and an Approved Supplier listing will be made up from NTPEP test results according to *SCDOT Research and Materials Laboratory's* ***Approval Policy 20***. Manufacturers must be on the Department's approved supplier list before furnishing sheeting for Department work.

Each delivery of material to a project shall be accom-

panied by a certificate signed by an officer of the reflective sheeting manufacturer that the material fully complies with all requirements of this specification and the provisions of the performance warranty. The Department, at its option, may require testing by an independent commercial laboratory approved by the Department. The cost of testing shall be borne by the Contractor.

B. Performance Warranty. The reflective sheeting manufacturer shall provide, upon delivery to the Department, a warranty covering the full replacement cost, including sign blank, sheeting fabrication and erection of any sheeting installed according to the recommended procedure on aluminum or any other Department approved sign blanks, which fails to meet the following performance requirements:

1. Sheeting shall maintain the following reflective intensity values for the indicated number of years:

Type I - 50% of minimum reflective values given in Table 1 of AASHTO M 268 for a service life of 7 years with the exception of orange sheeting, which shall have a service life of 5 years.

Type II - 50% of minimum reflective values given in Table 3 of AASHTO M 268 for a service life of 10 years with the exception of orange sheeting, which shall have a service life of 3 years.

Type III - 80% of minimum reflective values given in Table 4 of AASHTO M 268 for a service life of 10 years with the exception of orange sheeting, which shall have a service life of 3 years.

Type IV - 80% of minimum reflective values given in

Table 5 of AASHTO M 268 for a service life of 7 years.

2. The sheeting shall remain free of cracks, scaling, blisters, or delamination for the service life of each type specified in above.

3. The sheeting shall not show any appreciable change in color when compared to unexposed sheeting specimens.

4. The sheeting shall remain free of any form of deterioration that would render the sign ineffective for its intended purpose for the specified service life.

5. The Contractor shall replace, at his expense, any traffic control device that fails to perform satisfactorily for either its daytime or nighttime purpose, due to deterioration of the reflective material.

C. Screening Inks. The manufacturer furnishing reflective sheeting must be able to make available screening inks compatible with their sheeting. Upon request, the manufacturer shall provide a color match formula from his ink series at no charge to the Department.

Screening inks shall be warranted for the same period as the reflective sheeting on which they are applied as outlined in the Performance Warranty in **Subsection 608.04B**.

APPLICATION

608.05 Application of Reflective Sheeting. Reflective Sheeting material shall be applied in accordance with the sheeting manufacturer's specifications with the following additions:

1. Splices in reflective sheeting shall be unacceptable, ex-

cept for signs that cannot be covered with a single piece of the widest material available from the sheeting manufacturer.

2. Only one splice is permitted per sign and it shall be on a centerline of the sign or barricade.

3. Splices shall overlap not less than 3/16 inch, except for butt splices that may be used on signs processed with transparent colors.

4. In horizontal overlapped splices, the top portion shall overlap the bottom portion, as viewed when the sign is in an upright position.

5. The gap at butt splices shall not be greater than 1/32 inch.

6. No screening paints are permitted between the sheeting of overlapped splices.

7. When splicing is necessary, the reflective sheeting must be carefully matched for color to provide uniform appearance during both day and night.

8. The reflective sheeting material should always be applied evenly to surfaces so that the sheeting will be smooth and adhere firmly.

608.06 Measurement and Payment. Work and materials under this item will not be measured for separate payment, but will included in the price and payment for other items of work.

U-SECTION POSTS

608.07 Description. This work shall consist of furnishing galvanized metal rail steel U-Sections used as sign posts and

fabricated in accordance with the details shown on the plans

and typicals; and in conformity to the requirements of this specification and any special provision pertaining thereto.

608.08 Metal Sign Posts. The metal sign posts shall be of the normal dimensions required for 2-pound or 3-pound posts and shall be provided in the designated or required lengths and sizes. The 2-pound or 3-pound designation indicates the weight of the post per linear foot (± 5%) before galvanizing. They shall be made of hot-rolled rail steel or an equivalent steel conforming to the physical properties of **ASTM A 499**, Grade 60 (latest edition), and conforming to the chemical requirements of **ASTM A 1** (latest edition) for rails having nominal weight of 91 pounds or heavier per yard of length. After fabrication the full length and total area of each post shall be hot dipped galvanized in accordance with **ASTM A 123**.

Standard 3/8-inch diameter holes shall be punched before applying the galvanized finish. The 2-pound posts shall have a minimum of 58 holes one inch on center, beginning one from the top of the post. The 3-pound posts shall have holes placed one inch on center, starting one inch from top and extending to within 6 feet from the bottom, and 2 inches on center for the remainder of the post length. Additional holes, at not less than one inch on center, may be placed, if necessary, to conform to standard punching procedures.

The vendor shall furnish a certification with each shipment verifying compliance with the physical properties of **ASTM A 499** (latest edition), the chemical requirements of ASTM A 1 (latest edition) for rails having a nominal weight of 91 pounds or heavier per yard of length, and prescribed fabrication and finish.

608.09 Measurement and Payment. Work and materials under this item will not be measured for separate pay, but will be include in the price and payment of other items of work.

TELESCOPIC SQUARE TUBING

608.10 Description. This work shall consist of furnishing galvanized four-sided telescopic tubing fabricated in accordance with the details shown on the plans and in conformity to the requirements of this specification and any special provision pertaining thereto.

608.11 Square Tubing. The tubing shall be either 12 U.S.S. Gage (0.105 inch) or 14 U.S.S. Gage (0.083 inch) steel conforming to the standard specifications for hot rolled carbon sheet steel, structural quality, **ASTM A 653**, Grade 50, Class 1. The steel shall be carefully formed to size and be welded directly in the corner by high frequency resistance welding and externally scarfed to form corner radii.

The tubing shall be capable of being used in sign support systems and yielding breakaway barricade applications. The tubing shall be capable of telescoping when consecutive size tubes are telescoped one inside another with free movement and without excess side movement. The tubing shall be capable of performing as a yielding breakaway system for signs and barricades when properly installed and shall be approved by the Federal Highway Administration for use on the Highway System.

The components shall be of the dimensions as specified on the plans or in the special provisions with a length tolerance of ± 1/4 inch. The tubing shall be of good workmanship, compatible, and interchangeable with telescoping tubing systems already installed as sign supports across the state's highway system.

The tubing shall contain standard clean-punched open 7/16 (±1/64) inch diameter holes. The holes shall be punched one inch on center along the centerline of each of the four sides, beginning one inch from the tube end with vertical spacing accuracy of 1/8 inch in 20 feet of tube length. All holes and cut-off ends shall be free from plugs and burrs and will not be required to be zinc treated after fabrication.

The coating shall be hot dipped galvanized steel conforming to the requirements of ASTM A 653, Coating Designation G 90. After galvanizing, the post shall be coated with a chromate conversion coating and a clear organic polymer topcoat. Both the interior and the exterior of the post shall be galvanized.

Mill Test Reports and a Materials Certification shall accompany each shipment of square tubing. The Mill Test report shall identify various lots of tubing. The chemical and physical properties shall conform to the requirements of the specified alloy. Production lots shall be identifiable upon receipt at the SCDOT facility. Failure to provide Mill Test Reports and Materials Certifications may result in the rejection of all materials and require replacement at the supplier's expense.

608.12 Measurement and Payment. Work and materials under this item will not be measured for separate pay, but will be include in the price and payment of other items of work.

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DIVISION 700

STRUCTURES

SECTION 701

PORTLAND CEMENT AND PORTLAND CEMENT CONCRETE

701.01 Description. This work shall consist of furnishing, storing, and handling of the materials; and the proportioning, mixing, and delivery of portland cement concrete for structures.

Portland cement concrete for structures shall be composed of cement, fine aggregate, coarse aggregate, water, air-entraining admixture and other admixtures when permitted or required. Fly ash, water granulated blast-furnace slag, and silica fume may be added or used as a replacement portion of the portland cement and shall be considered as cement in the water cement ratio unless otherwise designated. The materials shall conform to the requirements hereinafter specified, and the mixture shall be prepared and delivered in accordance with these specifications.

The designation of the ten classes of concrete normally used by the Department are listed below:

New Designation	Previous Designation
Class 2500	Class B
Class 3000	Class A
Class 4000	Class D
Class 4000DS	--

Classes of Concrete (Continued)

New Designation	Previous Designation
Class 4000S	Class AA
Class 4000P	--
Class 5000	Class X
Class 6000	--
Class 6500	Class E
Class 7000	--

The following classes of concrete shall be air-entrained unless otherwise specified: Class 2500, Class 3000, Class 4000, Class 4000S, and Class 6500. The use of air-entrainment in Class 4000DS, Class 4000P, Class 5000, Class 6000, and Class 7000 concrete is left to the preference of the Contractor. When air-entrainment is used in these classes of concrete, the proportions of water, fine aggregate and coarse aggregate shall be varied from those specified to maintain the specified yield of concrete. The entrained air shall be obtained by using an approved admixture as specified in **Subsection 701.06**.

All references to water cement ratio shall be the ratio of water to cementitious materials by weight.

MATERIALS

701.02 Portland Cement. Portland cement shall conform to the requirements of the following cited specifications for the type specified or permitted and with the additional requirements stated hereafter:

Compressive strength requirements will govern and the requirements for low-alkali cement (0.6 maximum) shall be met. The maximum limits of fineness of grind of **AASHTO M 85** shall not apply for cement used in RC pipe, prestressed or precast products.

The maximum limits of fineness of grind in AASHTO M 85 for cement other than that used in RC pipe, prestressed or precast products will be controlled as follows:

1. The cement mill test reports furnished by the manufacturer shall comply with the maximum fineness (air permeability test) values as stated in AASHTO M 85.

2. Job control samples taken at random at the project sites and submitted to the Research and Materials Laboratory for testing shall have a maximum fineness limit (air permeability test) in conformance with the requirements of AASHTO M 85 with allowance for variations in sampling, presence of moisture in the sample, age of the cement production, and multi-laboratory coefficient of variation.

Type I(SM) Slag-Modified Portland Cement may be used instead of Type I and Type II cement. Type I(SM) cement shall conform to **AASHTO M 240**. It shall be an intimate and uniform blend of portland cement and granulated blast-furnace slag. In any case, the slag constituent shall be less than 25% of the total weight of the slag-modified portland cement.

The cement suppliers shall furnish certified mill test reports as outlined in the ***Policy for Cement Inspection*** adopted by the South Carolina Department of Transportation.

Incompatible brands of cement or different types of cement shall not be mixed in any continuous pour or be placed in the same cement storage bin.

The weighing and handling procedures of bulk cement shall be inspected and approved by the Engineer before use. Cement shipments shall be fully protected at all times. Questionable cement shall be inspected, sampled, and tested before being used. Cement that is lumpy, caked, discarded from used bags, or otherwise damaged shall not be used.

Cement shall be measured by weight or by the bag as packed by the manufacturer. One bag of cement shall be based on a weight of 94 pounds.

Whenever it is determined by subsequent laboratory testing of mill or job control samples that a cement shipment does not comply with the above stated specifications, use of cement from that cement mill will be discontinued for Department use until testing reveals that the problem has been corrected. The Contractor will be held responsible for replacement or otherwise making satisfactory the concrete in which any defective cement is used.

701.03 Fly Ash. Fly Ash (Type C or Type F) shall conform to the requirements of **AASHTO M 295** except that the supplementary optional physical requirements will not apply.

701.04 Water Granulated Blast-Furnace Slag. Water granulated blast-furnace slag shall be Class 100 or higher and shall conform to the requirements of ASTM C 989.

701.05 Silica Fume. Silica Fume shall meet the general requirements of **ASTM C 1240**. The raw silica fume shall meet the chemical requirements of Table 1 and Table 2 and the physical requirements of Table 3 in ASTM C 1240. The manufacturer's certification shall be furnished stating the results of tests made on samples of silica fume during production and that the applicable requirements of ASTM C 1240 have been met. A certification for each lot of each shipment shall be provided to the Engineer.

Silica Fume may be added to the mix in either dry (densified) form or a wet (slurry) form. The dry form is usually supplied in 50-pound bags. When a dry form is used, the mix design shall be adjusted to use whole bags of silica fume, (i.e., partial bag(s) shall not be used.) Silica fume in excess of the specified minimum is permitted, and to prevent overextending silica fume, a whole bag quantity that is as much as 10 pound less than the specified minimum is also permitted.

Guidelines regarding worker protection shall comply with current OSHA regulations.

When a wet (slurry) form is used, the water contained in the slurry shall be computed and deducted from the total water required in the mix. This shall be in accordance with the manufacturer's certified quality test report for the lot being used in the mix.

701.06 Air-Entraining Admixtures. Air-entraining admixtures shall comply with **AASHTO M 154**. A certified affidavit and test result evidence based on tests made in a recognized laboratory shall be submitted to the Engineer to show that the material conforms to the requirements of AASHTO M 154. Such affidavits and test results may be required every two years. Only those admixtures that appear on an **Approved List**, published by the Research and Materials Laboratory of the Department, entitled *Approved Air Entraining and Chemical Admixtures for Concrete* or otherwise approved by the Engineer shall be used.

701.07 Accelerating, Retarding, and Water-Reducing Admixtures. In the event the Contractor or the Department, or both, elect to use a chemical admixture to produce concrete with characteristics more suitable to the placing conditions, such admixture shall comply with **AASHTO M 194**.

When a retarding admixture is desired, the Contractor may 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 **Subsection 701.21**. The Type B retarding admixture will not be allowed.

A certified affidavit and test result evidence based on tests made in a recognized laboratory shall be submitted to the Engineer to show that the material conforms to the requirements of AASHTO M 194. Such affidavits and test results may be required every two years.

Only those admixtures that appear on an **Approved List**, published by the Research and Materials Laboratory of the Department, entitled *Approved Air Entrainment and Chemical Admixtures for Concrete* or otherwise approved by the Engineer, shall be used.

When admixtures are used, the Contractor shall demonstrate that the admixtures are compatible, will not adversely extend normal setting time, and will not cause excessive bleeding.

701.08 Corrosion Inhibitor. One of the two alternates indicated below shall be used when a corrosion inhibitor is required in the concrete mix. The corrosion inhibitor shall be added to the concrete while it is being batched. The Contractor shall adhere to the manufacturer's written recommendations regarding the use of the admixture including storage, transportation, and method of mixing. The solution shall be added to the mix by a dispenser meeting the requirements of **Subsection 701.19D**.

The Contractor shall furnish to the Engineer a copy of the manufacturer's certified test report showing the composition of the materials and the percent of solids for the alternate selected. Samples of the alternate selected may be taken and tested by the Department.

A. Alternate No. 1. Rheocrete 222, manufactured by Master Builders, Inc., Cleveland, Ohio, shall be added at the rate of 1.0 gallon per cubic yard.

Rheocrete 222 is a water-based organic material formulated to inhibit corrosion of steel in reinforced concrete that may be classified chemically as aqueous amines and esters. Rheocrete 222 does not accelerate the rate of hardening and has no effect on slump. The addition of Rheocrete 222 does require an increase in air-entraining admixture and an increase in mixing time to obtain the required air content. An additional 50 revolutions at mixing speed (or 30 seconds in a central mix plant) may be ex-

pected to obtain required air. The manufacturer's certification of material shall be furnished to the Engineer. Rheocrete 222 shall not be considered in the water-cement ratio.

B. Alternate No. 2. Calcium nitrite, $Ca(NO_2)_2$ as manufactured by W. R. Grace and Co., Cambridge, Massachusetts, shall be added to the mix at a rate sufficient for the hardened concrete to contain no less than 4.5 pounds of nitrite (NO_2) per cubic yard of concrete. An application rate of two (2.0) gallons of 30% solids solution per cubic yard of concrete will comply with this specification.

Use of the material and application rate may be based on Department tests. Any air-entraining, water reducing, and/or set controlling admixture used in the production of concrete shall be compatible with the calcium nitrite solution being used.

The calcium nitrite, which acts as an accelerator, may be used in conjunction with a retarder to control the set of concrete, as per manufacturer's recommendation.

The non-solids portion of the calcium nitrite solution shall be considered as part of the total water in the mix. For a 30% solids solution, 7.58 pounds of water in a gallon of solution shall be considered in the water-cement ratio.

701.09 Calcium Chloride. Calcium chloride shall comply with the requirements of **AASHTO M 144** for Type S or Type L. This material for cold weather work may be used in non-reinforced concrete in the maximum proportion of 2% by weight of cementitious material. Calcium chloride shall not be used in reinforced concrete structures unless quantity, type, grade, and class are approved by the Engineer.

701.10 Fine Aggregate for Portland Cement Concrete.
The type of sand intended for use in concrete mix designs shall be submitted and approved by the Research and Materials Engineer. Fine aggregate shall consist of natural sand,

manufactured sand or a combination of natural and manufactured sand meeting the following requirements:

A. Natural Sand. Natural sand shall be composed of clean, hard, durable, uncoated grains, free from lumps or flaky particles, organic matter, loam or other deleterious substances.

B. Manufactured Sand. Manufactured sand, FA-10M, shall be made from stone meeting all the quality requirements for coarse aggregates.

C. Mixtures of Sand. When a blend of sands is approved, the two materials shall be stored and batched separately unless otherwise approved by the Engineer.

D. Organic Impurities. All fine aggregate shall be free from injurious amounts of organic impurities. Fine aggregates subjected to the colorimetric test (**AASHTO T 21**) for organic impurities and producing a color darker than 3 shall not be used unless both of the following criteria are met:

1. Section 4.2 of **AASHTO T 71** shall be revised to read as follows:

> Mix one batch of mortar with the aggregate treated in sodium hydroxide and one batch with untreated aggregate on the same day. Mold six 2-inch cubes from each batch. Test three of the cubes from each batch at the ages of seven (7) and twenty-eight (28) days.

2. A fine aggregate with the color darker than 3 may be used provided that the relative strength at seven (7) and twenty-eight (28) days is not less than 95% when tested in accordance with the revised AASHTO T 71.

E. Soundness. When the fine aggregate is subjected to

five alternations of the sodium sulfate soundness test (**AASHTO T 104**) the weighted loss shall not exceed 10% by weight.

F. Approved Sources. Only those sand sources which appear on an **Approved List**, published by the Research and Materials Laboratory of the Department, entitled *SCDOT Quality Approved Fine Aggregate Pits for Use in Portland Cement Concrete*, or otherwise approved by the Engineer shall be used.

G. Gradation of Fine Aggregate. Fine aggregate for all classes of portland cement concrete and concrete pavement shall conform to the following gradations of FA-10 or FA-10M:

	FA-10	**FA-10M**
Aggregate No. Sieve Designation	**Percentage by Weight Passing**	**Percentage by Weight Passing**
3/8”	100	100
No. 4	96 - 100	95 - 100
No.8	75 - 100	84 - 100
No. 16	55 - 98	45 - 95
No. 30	25 - 75	25 - 75
No. 50	5 - 30	8 - 30
No. 100	0 - 9	0.5 - 20
No. 200	0 - 3	0 - 10*

*Dust of fracture essentially free from clay or shale, final job site testing only.

701.11 Coarse Aggregate. Coarse aggregate for portland cement concrete shall conform to the following requirements:

A. General. Coarse aggregate shall be clean, tough, du-

rable gravel, crushed gravel, or crushed stone. It shall be free from soft, thin, elongated or laminated pieces. It shall be sufficiently washed during production to produce a clean aggregate, free from lumps or coatings of clay, disintegrated particles, vegetation or deleterious substances and adherent coatings which may be considered injurious. The Los Angeles Abrasion loss as determined by **AASHTO T 96** shall not exceed 60%. When the coarse aggregate is subjected to 5 alternations of the sodium sulfate soundness test conducted according to AASHTO T 104, the weighted loss shall not exceed 15%.

B. Slag. Crushed slag or other inert materials having similar characteristics and approved by the Engineer, shall consist of clean, tough, durable pieces of approved slag or other inert materials, reasonably uniform in density and quality and reasonably free from thin or elongated pieces. The slag or other inert material shall be air-cooled and shall have a weight of not less than 75 pounds per cubic foot and the Los Angeles Abrasion loss shall not exceed 40%. Slag shall not contain free lime in deleterious quantities as determined by laboratory tests and shall not contain more than 15% by weight of glassy pieces.

C. Approved Sources. Only those coarse aggregate sources that appear on an **Approved List** and shown as approved for portland cement concrete, published by the Research and Materials Laboratory of the Department, entitled *Quality Tests on SC Coarse Aggregates*, or otherwise approved by the Engineer shall be used.

Aggregate from fossiliferous limestone quarries is permitted in all applications of non-reinforced concrete. When fossiliferous limestone coarse aggregate is subjected to five alternations of the sodium sulfate soundness test conducted according to AASHTO T 104, the weighted loss shall not exceed 25% when tested according to AASHTO T 96. When fossiliferous limestone aggregate is used, a sprinkler system shall be used to insure saturated aggregate during concrete batching.

D. Gradation of Coarse Aggregate. Coarse aggregate for portland cement concrete shall be No. 56, No. 57 or No. 67. Aggregate No. 78 may be used in thin sections and prestressed panels when approved by the Engineer. No. 789 or other approved gradations may be used for blending if approved by the Research and Materials Engineer. Gradations shall be as follows:

Sieve Size or Designation	Percentage By Weight Passing for Aggregate				
	No. 56	No. 57	No. 67	No. 78	No. 789
1 1/2 “	100	100	--	--	--
1”	90 – 100	95 - 100	100	--	--
3/4"	40 – 85	90 - 100	100	100	100
1/2"	10 – 40	25 - 60	--	90 - 100	90 - 100
3/8”	0 – 15	--	20 - 55	40 - 75	80 - 100
No. 4	0 – 5	0 - 10	0 - 10	5 - 25	20 - 50
No. 8	0 – 5	0 - 5	0 - 5	--	--
No. 16	--	--	--	0 - 5	0 - 6
No. 100	--	--	--	0 - 2	0 - 2

701.12 Water. Water used in mixing, fogging, or curing of portland cement concrete shall be reasonably free from salt, oil, acid, alkali, organic matter, sewage or other substances injurious to the finished product.

A comparison of the water with distilled or other satisfactory water will be made by means of standard cement test for soundness, time of setting and 1:3 mortar strength with standard sand conforming to **ASTM C 778**, using the same cement with each water. Any indication of unsoundness, change in time of setting of plus or minus 30 minutes, or a reduction of more than 10% in strength from results at age seven (7) days, obtained with mixtures containing satisfactory water, shall be sufficient cause for rejection of the water under test.

When required by the Engineer, the acidity or alkalinity of the water shall be determined in accordance with **AASHTO T 26**. Water from a public water supply may be accepted without being tested. Water from other sources shall not be used until tested and approved.

In the event an approved source reservoir is relatively shallow, the intake pipe shall be so enclosed and elevated so as to exclude silt, mud, grass or other foreign matter.

EQUIPMENT

701.13 Equipment, Inspection, and Approval. All equipment hereinafter specified shall be inspected and approved before use. Such inspections will also be conducted at least annually and at other times as considered necessary.

701.14 Weighing Equipment. The equipment used for weighing materials at all types of batch plants shall provide convenient and positive means of determining the quantities in each batch of concrete.

Individual cementitous materials shall be weighed to no less than 99% of the required weights.

The individual aggregates, as weighed, shall be within ±2% of the required weight and the total weight of aggregate shall be within ±2% of the total required weight. Scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type, or the load cell type, and shall be accurate within 0.5% when used for cement and within 1.0% when used for aggregate under operating conditions throughout the range of use. When beam-type scales are used, provisions such as a “tell-tale” dial shall be made for indicating that the required load in the weighing hopper is being approached. Poises shall be designed to lock in any position to prevent accidental change of position.

Dial scales shall be in a dust tight enclosure. The chart

shall be of durable material to insure good readability.

Scales used in batching portland cement concrete shall be periodically checked for accuracy by the Division of Weights and Measures of the State Department of Agriculture, or by other qualified scale service agents and a statement of the date of scale inspection and certifying as to their accuracy shall be posted on the scales or in the batching room. The interval between inspections shall not exceed twelve (12) months.

The cement-weighing hopper shall be properly sealed and vented to preclude dusting during weighing operations.

701.15 Central Mixing Plant. Concrete shall be thoroughly mixed in a batch mixer of an approved size and type that will insure a uniform distribution of the materials throughout the mass.

Adequate water storage shall be provided and the mixer shall be equipped with a device for accurately weighing or measuring and automatically controlling the quantity of water used in each batch. The device used shall be accurate and so calibrated that under all operating conditions it shall have an accuracy within one percent of the quantity of water required for the batch. The Contractor shall furnish the Engineer with facilities for checking the water measuring equipment whenever the Engineer deems it necessary. Scales or other means used for measuring water shall be clearly marked and accurately show the quantity used. The water measuring device shall be so arranged that there will be no loss of water from the time it is measured until it is deposited in the mixer drum and also, that the water supply will be automatically cut off while water is being discharged into the mixer. The mixer shall be equipped with an acceptable timing device capable of being locked, and shall not permit the batch to be discharged until the specified mixing time has elapsed.

Mixers shall be maintained and repaired if necessary so that the concrete will be of uniform quality. Mixers shall be

examined for changes in condition due to accumulation of hard concrete or mortar or to wear of blades. The pick-up and throw-over blades shall be replaced when any part or section is worn one inch or more below the original height of the manufacturer's design. A copy of the manufacturer's design, showing dimensions and arrangements of blades shall be available to the Engineer.

Mixers shall be equipped with a separate dispenser for each type of admixture. The dispensers may operate either automatically or manually and shall be capable of measuring and placing exactly and consistently the desired amount of the admixture in each batch.

701.16 Truck Mixers. All truck mixers shall have been pre-inspected by SCDOT and display the current unexpired SCDOT inspection sticker.

The truck mixer shall be 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 satisfactory degree of uniformity.

The volume of mixed concrete permitted in the drum of truck mixers shall not exceed the manufacturer's rating on the capacity plate. **The National Ready Mixed Concrete Association (NRMCA)** plate shall, at all times, be accessible, clear, and legible. Agitators shall similarly be capable of producing concrete with a satisfactory degree of uniformity.

If the equipment does not have attached the rating plates referred to above, the approved capacity as a mixer and as an agitator will be based on the table shown below:

Maximum Gross Volume of Drum (cubic feet)	Maximum Capacity (cubic yards)	
	As Mixer	As Agitator
261	6	7.75
306	7	9.25
329	7.5	9.75
352	8	10.5
376	8.5	11.25
399	9	12
423	9.5	12.75
446	10	13.25
493	11	14.75
540	12	16
587	13	17.5
634	14	19
681	15	20.25

The Research and Materials Laboratory will provide a SCDOT decal to be used instead of the manufacturer's rating plate showing the mixing and agitating capacity if the volume can be determined.

The truck mixer shall be equipped with a water system and measuring device. The device shall permit ready access and ready determination of the quantity of water used. The water-measuring device shall be accurate to within one percent of the total water measuring capacity of the tank when the truck mixer is stationary and essentially level.

Truck mixers and agitators of the revolving drum type must be equipped with a hatch in the periphery of the drum shell of such design as to permit access to the inside of the

drum for inspection, cleaning and repair of the drum and blades.

Truck mixers shall be provided with an electrically or mechanically actuated revolution counter that can be reset to zero. This counter shall be mounted in such a position that it can be read from the ground by both the operator and the Engineer.

Truck mixers shall be maintained and repaired if necessary so that the concrete will be of uniform quality. Blades shall be replaced when any part or section is worn one inch or more below the original design. A copy of the manufacturer's design showing dimensions and arrangement of blades shall be available to the Engineer.

CONSTRUCTION REQUIREMENTS

701.17 Care and Storage of Concrete Aggregates. The handling and storage of concrete aggregates shall be such as to prevent intermixing, segregation, and contamination by foreign materials. Each separate aggregate component of different source or grading shall be separately handled and stockpiled. The stockpile sites that have natural ground bottoms shall be cleared of vegetation and other extraneous matter and shall be generally smooth, firm and well drained. The bottom one-foot of any natural ground stockpile shall not be used except under immediate supervision of the Engineer. Should excessive segregation occur as a result of the methods employed in the stockpiling of an aggregate, the stockpile shall be constructed in layers not to exceed three (3) feet in depth.

701.18 Storage of Cement. Bulk cement shall be stored in bins or silos of weatherproof construction that will protect the cement from dampness and provide for the free flow of the cement. If the Engineer authorizes the use of bagged cement, it shall be stored in weatherproof buildings or temporary storage in the open on a raised platform with ample waterproof flooring and covering.

At a batching plant with two (2) or more silos in which different types of cement or cementitious materials are stored, each silo shall have a sign at each fill inlet. It shall be made from a durable material, with minimum two (2) inch high by 1/4 inch thick letters that are raised, indented, or cut. The sign shall identify the material that is in the silo.

If concrete is to be proportioned at the work site and only for the Department, the Contractor shall keep accurate records of the deliveries of cement and of its use in the work. Copies of these records shall be supplied to the Engineer in such form as may be required.

701.19 Measuring Materials.

A. **Portland Cement**. Portland cement and other cementitious materials shall be measured by weight unless otherwise specified. The cementitious materials shall be weighed on scales meeting the requirements of **Subsection 701.14** separate from those used for other materials. Should bagged cement be authorized, it shall be measured in bags as packed by the manufacturer. From time to time, full bags may be weighed as a check on the net weight. Batches shall be used which do not require fractional bags of cement unless all the cement for each batch is weighed.

B. **Water**. Water shall be measured by volume or by weight through an approved measuring system. The measuring system shall be capable of incorporating into the batch, through a metering or weighing device, the predetermined quantity of water, to an accuracy of one percent of the quantity of water required for the batch. Water shall be assumed to weigh 8.33 pounds per gallon.

C. **Fine and Coarse Aggregate**. Fine and coarse aggregates shall be measured separately by weight on scales meeting the requirements of Subsection 701.14. In measuring aggregates, allowance shall be made for water

in the aggregates. For determinations of the moisture content of aggregates, automatic sensing devices shall be used if available; otherwise representative samples shall be taken and investigated individually or combined in a composite sample.

D. **Admixture**. Admixtures shall be dispensed into the batch as a solution of uniform concentration and in the amounts recommended by the manufacturer. The sight tube dispensers shall be properly equipped with a graduation strip or strips that are labeled in terms of ounces or ounces per hundred pounds of cement. Graduated strips shall be so identified as to the rate at which the admixture is being measured for the particular diameter of the tube being used.

Meter and timing dispensers shall be calibrated by obtaining a metered sample and checking the accuracy of the system. The equipment shall be checked and approved during the annual inspection and at other times when deemed necessary.

The accuracy of all systems shall be maintained within ±3%. The admixture shall be discharged into the stream of water entering the mixer drum or into the pre-measured or pre-weighed water for each batch. Precautions shall be taken to prevent the dilution of the admixture in storage by rain and condensation. For actual control, the air content will be measured with air meters only. Additional admixtures may be added at any time to achieve the proper amount of entrained air. Where more severe climate conditions occur, the minimum percent air may be increased by the Engineer.

When adding Types A, C, D, or E admixtures, the dispensing equipment and procedure shall be such that the admixture will be added 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, the admixture agent will not be added until after all of

the materials are in the mixer and have been mixed for one minute if in a truck mixer, for 15 seconds if in a central-mix mixer, or at approximately midpoint of the primary mixing portion of the auger mixing chamber on a mobile concrete mixer unit.

701.20 Proportions.

A. General. The Contractor shall be responsible for designing the mixtures for all classes of concrete and determining the proportions of cement, fine aggregate, coarse aggregate, water, air-entraining admixture and water-reducing or water-reducing set retarding admixture (when used) which will produce a workable concrete mix meeting the criteria for the class of concrete specified in the **STRUCTURAL CONCRETE TABLE** including General Notes and Notes 1 through 7) found in **Subsection 701.20C**. Consideration shall be given to the amount of any air-entrainment that must be incidentally afforded by the use of water-reducing or water-reducing set retarding admixture. The proportions of ingredients shall be determined in accordance with requirements for the particular type of work and with consideration of the specific gravities of the materials to provide the desired workability and consistency. At his own expense, the Contractor may retain an independent testing laboratory, accredited by AASHTO, to design the mix for the class of concrete specified or shall use a mix design previously reviewed and used by the Department. All design mixes shall be submitted to the Engineer for review.

The design of the concrete mix shall be established using Department approved ingredients that the Contractor intends to use for the project, and all trial batches shall be made using such materials. Trial mixes designed by the Contractor shall be tested for complete conformance to these specifications by the accredited laboratory engaged by the Contractor.

No separate payment will be made for the cost of the laboratory engaged by the Contractor; or for the materials furnished and used for trial batches; or for the preparation and testing of trial batches either by the Contractor or his laboratory; or for furnishing the Engineer with the mix data, the results of the cylinder tests, and yield to be tested. These costs will be considered incidental to the work of the applicable item and will be included in the contract unit prices for the pay items shown on the plans.

Upon review of a satisfactory design mix, the mix proportions shall be used without change for all concrete of that class, unless modifications are necessary.

B. Changes in Mix Design. When changes are made in the mix design, the Contractor shall furnish to the Engineer for review the new proportioning values as necessary for batching purposes over the range of quantities to be batched.

C. Structural Concrete Table.

General Notes:

Mix designs shall be based on 4 1/2% (± 1 1/2%) entrained air. Class 4000DS, Class 4000S, Class 5000, Class 6000, and Class 7000 have no target entrainment value, but shall not exceed 4 1/2% entrained air.

Mix designs shall be based on specific gravities and saturated surface dry moisture contents obtained from current Research and Materials Laboratory aggregate source approval sheets.

The sand to stone ratio is based on volume and may be varied to obtain good workability.

STRUCTURAL CONCRETE TABLE

Aggregate Type	Minimum Cement Content (lbs./CY)	Other Cement-itious Material (lbs./CY)	Min. 28 Day Mix Design (psi)	Percent Fine to Coarse Aggregate Ratio	Max. Water to Cement Ratio
		Class 2500			
Crushed stone	494	--	2500	36:64	0.49
Gravel	494	--	2500	35:65	0.46
Fossil. Limestone	494	--	2500	40:60	0.50
		Class 3000			
Crushed stone	588	--	3000	35:65	0.46
Gravel	588	--	3000	34:66	0.44
Fossil. Limestone	588	--	3000	39:61	0.47
		Class 4000		(See Note 4)	
Crushed stone	611	--	4000	35:65	0.40
Gravel	611	--	4000	34:66	0.40
		Class 4000S			
Crushed stone	588	--	4000	38:62	0.45
Gravel	588	--	4000	38:62	0.45
		Class 4000DS		(See Notes 2 & 5)	
Crushed stone	625	--	4000	40:60	0.44
Gravel	625	--	4000	39.61	0.43

STRUCTURAL CONCRETE TABLE (Continued)

Aggregate Type	Minimum Cement Content (lbs./CY)	Other Cement-itious Material (lbs./CY)	Min. 28 Day Mix Design (psi)	Percent Fine to Coarse Aggregate Ratio	Max. Water to Cement Ratio
		Class 4000P		(See Note 6)	
Crushed stone	682	--	4000	34:66	0.43
Gravel	682	--	4000	33:67	0.38
		Class 5000			
Crushed stone	705	--	5000	35:65	0.46
Gravel	705	--	5000	34:66	0.42
		Class 6000			
Crushed stone	750	--	6000	34:66	0.44
Gravel	750	--	6000	33:67	0.39
		Class 6500		(See Notes 1 & 3)	
Crushed stone	600	CF42, FA140	4000	35:65	0.37
Gravel	600	CF42, FA140	4000	36:64	0.37
		Class 7000		(See Note 7)	
Crushed stone	800	---	7000	35:65	0.37
Gravel	800	---	7000	34:66	0.37

STRUTURAL STEEL TABLE NOTES

Note 1:

The Laboratory 56 day mix design strength shall be a minimum of 6500 psi. Acceptance of in place concrete will be based on a minimum strength of 4000 psi compression strength at a maximum of 28 days or 6500 psi at 56 days.

Note 2:

Type G or Type D admixture is required.

Note 3:

Proportioning: The Class 6500 concrete shall be designed with the following ingredients per cubic yard:

Cement (min.)……600 lbs.
Fly Ash……140 lbs.
Silica Fume……42 lbs.
Corrosion Inhibitor……(*See **Subsection 701.08***)
Entrained Air (Range)……4.5(±1.5)%
Water Cement Ratio (max.)……..0.37
High Range Water Reducer……*Required*
Aggregates……*Variable*

The total mix water content shall be based on the weight of cement, flyash, and silica fume multiplied by the water-cementitous ratio. Absorbed water in the aggregate shall not be included as mix water.

If a Type A or D admixture is used, the Contractor will demonstrate that the admixtures are compatible, will not adversely extend normal setting time, or cause excessive bleeding.

The slump of the concrete, at time of placement in the forms, shall be increased by the use of a High Range Water Reducer (HRWR). Either Type F or Type G admixture may be used. Slump shall not exceed 8 inches after addition of HRWR.

If silica fume slurry is used, it shall be added at a point that produces an acceptable mix.

The high range water reducer shall be added at the

job site. Additional mixing shall be the minimum specified in accordance with **Subsection 701.21,** but may be increased in order to obtain the necessary entrained air.

Concrete Temperature. The temperature of Class 6500 concrete shall not exceed the maximum permitted in **Subsection 701.22**.

Mix Design Review. The Contractor shall submit to the Engineer a proposed sequence of mixing and a proposed concrete mix design based on trial mixes by the concrete supplier. The Contractor shall perform the laboratory mix design with the observation and assistance from the SCDOT Research and Materials Laboratory.

There shall be no separate pay item for this mix design.

Class 6500 Trial Mix. Before placing Class 6500 concrete in the deck, the Contractor shall supply one or more small batches of Class 6500 concrete that may be used in a part of the structure as directed by the Engineer. Testing shall be performed and will include air content, slump, unit weight, temperature, cylinder for 28 day compressive strength, and time of set. The trial batch procedure shall be repeated until all desired mix properties are achieved.

No separate pay items shall be included for the trial batches. The Class 6500 concrete used in trial batches may be substituted for another class of concrete elsewhere in the project if it meets proper strength requirements. It will be paid for at the contract unit price of the concrete for which it is being substituted.

Mixing Sequence. The Contractor shall develop a proposed mixing sequence for review that will assure breakup and distribution of the dry densified silica fume. Generally, the addition of part of the water, aggregates, and silica fume along with some mixing at mixing speed will adequately disperse the silica fume. The remaining ingredients may then be added in a sequence to produce a desirable mix.

The Class 6500 concrete shall contain both silica

fume and fly ash as part of the cementitous material.

Note 4:

The water cementitous ratio for Class 4000 shall not exceed 0.40 or 244 pounds of water per cubic yard.

Note 5:

Concrete for drilled shaft construction shall be Class 4000DS.

The Contractor shall be responsible for designing the mixture for shaft concrete and determining the proportions of cement, fine aggregate, coarse aggregate, water, and water reducing retarding admixture which will produce a workable concrete mix meeting the following criteria:

Minimum cement per cubic yard……..625 lbs.
Slump……7-9 inches
Maximum water/cement ratio……..……(*See Table)*
28-day minimum compressive strength…4000 psi
Air entraining admixture…….*Not Required*
Nominal coarse aggregate size……..3/4-inch
No. 67 aggregate gradation……..*Required*

The design concrete mix shall be established using approved ingredients that the Contractor intends to use for the project. A trial mix shall be tested for complete conformance to these specifications.

The proposed mix to be used, along with test results showing full compliance with the specifications, shall be submitted to the Engineer for review.

The Contractor may 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.

Method of Measurement. No measurement will be made for concrete in drilled shafts or drilled pile foundations. Drilled shaft concrete shall be included in the contract unit price for the item Drilled Shafts. The quantity shown on the plans will be used for the item Drilled Pile Foundations Concrete unless directed otherwise by the

Engineer.

Basis of Payment. The cost of mix design, trial batches, and production concrete will be included in the contract unit price for Drilled Shafts or Drilled Pile Foundation Concrete as applicable.

Note 6:

Class 4000 concrete is preferred in non-prestressed precast items.

Note 7:

The water cementitous ratio for Class 7000 shall not exceed 0.37. The air entrainment for Class 7000 is optional, but shall not exceed 4 1/2%.

D. Nonconforming Concrete. If the 28 day compressive strength or tensile strength of the concrete test cylinders falls below the expected design strengths, the Contractor shall be subject to a strength/price reduction on the quantity of concrete represented by the nonconforming cylinders determined from the following table:

Cylinder Test Results: Percentage of Minimum Strength	Strength/Price Reduction (percent X contract unit price)	
	With Contract Unit Price	*Without Contract Unit Price
98 - 100	0	0
95 < 98	minus 5 percent	minus 17 percent
90 < 95	minus 10 percent	minus 33 percent

*If no contract unit price for concrete, use percent X supplier's invoice unit cost.

If the cylinder test result is below 90%, the Department will take cores from the concrete in structure that is represented by the nonconforming test cylinders and test the cores. The Contractor may elect to have the cores taken and tested by an independent accredited laboratory ac-

ceptable to the Department; however, this work shall be performed at the Contractor's expense. The following procedure will be used in obtaining and testing cores:

1. Applicability. When cylinder test results from structural concrete do not attain at least 90% of the minimum specified strength in twenty-eight (28) days, cores shall be obtained for testing in order to evaluate the strength of the concrete in place. Other methods may be used to give an indication of the limits of the concrete in question, but consideration for acceptance will be solely based on cores removed from the in-place concrete.

2. Obtaining Cores. Cores will be removed from the structure by the Department or an independent firm, accredited by **AASHTO**, in the presence of all parties. The location of the cores will be designated by the SCDOT representative to best represent the concrete in question. Three cores, 2 to 4 inches in diameter, shall be taken from each area of concrete that failed cylinder strength requirements. Care shall be taken to avoid damaging reinforcing steel.

3. Conditioning and Testing Cores. The cores shall be tested by the Department or an independent testing firm accredited by AASHTO in the testing of concrete.

Cores shall be tested in a wet condition after being subjected to a lime-saturated water soak for at least forty (40) hours before testing. The Department will not consider dry testing.

All conditioning and testing will be in accordance with **AASHTO T 24**. The testing laboratory shall provide a written report on the results to all parties.

4. Acceptance of Concrete. Acceptance of the concrete from which the cores are taken will be based on the test results. If access to the concrete is not practical for obtaining cores or the taking of cores would result in

irreversible damage to the structure, the Engineer will approve concrete test method **ASTM C 803** or **ASTM C 805** to determine if the concrete represents reasonably acceptable work.

If the core tests method or other approved method result is below 90% percent of the design strength, the Department will perform a design analysis of the structure to determine if the concrete can remain in place. In no case will the concrete remain in place if the test result does not meet at least 85% of the design strength.

If it is determined that the nonconforming concrete can remain in place, the Contractor shall be subject to a strength/price reduction on the quantity of concrete in question determined by the following table:

*Core Test Results: Percent of Minimum Strength	Strength/Price Reduction (percent X contract unit price)	
	With Contract Unit Price	**Without Contract Unit Price
98-100	0 percent	0 percent
95 < 98	minus 5 percent	minus 17 percent
90 < 95	minus 10 percent	minus 33 percent
85 < 90	***minus 15 percent	minus 50 percent

* Or other approved test method.
** If no contract unit price for concrete, use percentage x supplier's invoice unit cost.
*** Use 15% of contract unit price or 50% of supplier's invoice unit cost, whichever is less.

701.21 Consistency. The Contractor is responsible for obtaining the desired consistency of the concrete. The addition of pozzolans and/or admixtures may be necessary to obtain the appropriate workability and consistency. The Contractor is responsible for providing additional pozzolans and/or admixtures as necessary. These items shall be provided at no additional cost to the Department.

Concrete shall be acceptable when the slump, when measured in accordance with **AASHTO T 119**, or **SC-T-42**, is 1 to 4 inches, unless otherwise specified, provided the specified strengths are obtained.

Loads of concrete with a mix design strength of 2500 psi that have a slump not exceeding 6 inches when sampled from the first part of the load, may be used provided additional cement is added at the job site at the rate of 20 pounds of cement per cubic yard of concrete per inch of slump in excess of 4 inches. Loads of concrete with slumps greater than 6 inches shall be rejected for Department use unless otherwise permitted by these specifications. The Contractor shall have on hand at the job site a suitable amount of cement in bags for drying up over-saturated concrete. In the event additional water is required to obtain the specified slump at the job site, the Engineer may approve adding water normally at the rate one gallon per cubic yard per inch of desired slump provided a maximum water cement ratio is not exceeded. Additional need for water may indicate flash setting of the concrete, and in this case, additional water shall not be added without specific approval of the Engineer. When additional cement or water is added, a minimum of 25 revolutions of the truck mixer drum at mixing speed shall be required before discharge of the concrete.

Type F or Type G admixtures may be added to concrete for additional workability and/or to reduce the water cement ratio. Type F is a high range water reducer and Type G is a high range water reducer-retarder. When these admixtures are used, they are usually added at the job site just before

discharge. The slump of the concrete shall be measured before the addition of the high range admixture and shall not exceed the maximum slump limits described above for normal concrete. Slumps measured after adding the admixtures are not valid as the admixture causes increased flow characteristic of the mixture. Instead of slump measurements, a mixture that demonstrates good workability without excessive flow, bleeding or segregation shall be produced. The admixture may be added a second or third time to re-establish mixture flow provided the maximum time for placing the concrete after the mix water is added has not expired. The addition of the admixture will require additional mixing. Minimum mixing time shall be based on 30 seconds per cubic yard of concrete in the mixer after each addition of admixture.

701.22 Concrete Batching and Mixing.

A. Batching and Mixing in Cold Weather. No concrete shall be batched when the atmospheric temperature is below 35°F unless specifically authorized by the Engineer upon the receipt of a written satisfactory *Cold Weather Batching and Mixing Plan* developed by the Contractor. The Plan shall include how the Contractor intends to meet the following requirements. No concrete shall be batched from aggregates that contain frozen particles. Mixing water may be heated to a temperature not to exceed 170°F; the aggregates may be heated by either steam or dry heat. The heating apparatus shall be such as to heat the aggregates uniformly and avoid hot spots. The temperature of the batched concrete shall be at least 50°F when placed in the forms. The Engineer may add other requirements to the Plan at his discretion.

B. Batching and Mixing in Hot Weather. The Contractor shall consider the applicable requirements of ACI Standard 305 and shall take necessary measures to prevent the concrete mix temperature from exceeding 90°F measured before placement in the forms unless specified otherwise. Such measures may include, but are not limited to, using chilled mixing water or shaved ice to

replace part of the mixing water and considering the use of Type II cement. This requirement will not apply to concrete used in precast/prestressed members.

C. Batching. When concrete is furnished by a transit or central-mix plant, the batching equipment shall be sufficient to weigh out a load of required size in not more than 15 minutes.

A competent, SCDOT-certified Batch Plant Inspector shall be present at the plant when material is being produced for SCDOT work. The Batch Plant Inspector may be an employee of the Contractor, the concrete supplier, or an independent testing laboratory. However, it is the Contractor's responsibility to ensure that appropriately trained personnel and equipment are present and available when required. While material is being produced for SCDOT work, the Batch Plant Inspectors sole, full-time responsibility shall be to maintain quality control records and conduct physical testing of concrete and its constituent materials as outlined in the publication entitled ***SCDOT Concrete Batch Plant Inspector's Handbook***, current edition. No concrete will be accepted by the Department unless the appropriate documentation, as defined by the ***SCDOT Portland Cement Concrete Inspector's Manual***, is signed and certified by the Batch Plant Inspector and accompanies its delivery.

The Contractor shall give advance notification to the Engineer the name of the plant supplying the concrete in order to permit the Engineer to make the necessary arrangements for inspection of equipment at the plant.

D. Central Plant Mixing. Concrete shall be thoroughly mixed in a central mixer of an approved plant. The period of mixing after all materials including water are in the drum shall be a minimum of 1 1/2 minutes. During the mixing period, the drum shall be operated at drum speeds specified by the mixer manufacturer and shown on the nameplate on the machine. The first batch of concrete material

placed in the mixer shall contain an additional quantity of sand, cement, and water to coat the inside surface of the drum.

Concrete shall be mixed only in quantities required for immediate use. The mixed concrete shall be transported to the site of the work in a truck mixer operating at agitating speed.

E. Truck Mixing. Each batch shall be mixed at not less than 70 revolutions at mixing speed, after all materials, including water, have been placed in the mixer. All rotation after mixing shall be at agitating speed of 2 to 6 rpm or at the speed designated by the manufacturer of the equipment as agitating speed. Mixing speed shall be at the speed designated by the mixer manufacturer as shown on the rating plate. Mixing shall be done at the batching plant or at the job site. When concrete is in transit, the mixing unit shall be operated at agitating speed between the plant and the job site.

F. Wash Water Stabilizers. Ready mix concrete producers may use mixer drum wash water stabilizer agents in truck and central mix drums. Only those products that appear on the most recent edition of the ***Approval Sheet 32*** as published by the SCDOT Research and Materials Laboratory shall be used. These products shall be used in accordance with the Department's policy entitled *Stabilizer Agents and Methods for Mixer Drum Wash Water.* Approved stabilizer agents and methods of use will be shown in the policy. Copies of the policy can be obtained from:

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

The Engineer may eliminate the use of mixer drum wash water stabilizers if the Department's policy is not strictly adhered to or technical problems are encountered

as a result of using a stabilizer.

701.23 Mobile Concrete Mixing Plants. A truck mounted mobile portland cement concrete plant, designed for automatic volume proportioning of the concrete materials and for mixing the concrete for immediate use at the site of the work, may be used for incidental construction when authorized by the Engineer. Such plant shall be able to provide a satisfactory rate of production and shall be capable of combining the concrete ingredients into a thoroughly mixed and uniform mass and of discharging the concrete without segregation.

701.24 Use of Retarders. A water-reducing admixture or water-reducing set retarding admixture may be added to the concrete mixes for the purposes of reducing the water content and shrinkage in the concrete, improving its workability, retarding the initial set of the concrete, and/or reducing the rate of internal heat development in concrete pours without sacrificing quality or strength.

A Water Reducer-Retarder, Type D or Type G complying with **Subsection 701.07** shall be used in concrete deposited under water and also in concrete that is not likely to reach its final position in the forms before initial set takes place. The proportioning and dispensing of the admixture shall be as specified in **Subsection 701.19D**.

701.25 Use of Fly Ash and Water-Granulated Blast-Furnace Slag. The Contractor will be allowed to incorporate fly ash or water granulated blast-furnace slag into the concrete mixture. The following requirements shall be complied with when using these materials:

1. Fly ash or water-granulated blast-furnace slag may replace allowable percentages of Type I, Type II, or Type III portland cement. Fly ash or slag replacement is not allowed for mixes using Type I (SM) or any other blended cement.

2. Form removal shall be in accordance with **Subsec-**

tion 702.21.

3. Fly ash shall replace the removed portland cement by a ratio of not less than 1.2 to 1 by weight and shall not replace more than 20% of the cement originally called for in the mixture.

4. Water-granulated blast-furnace slag shall replace the removed portland cement by a ratio of 1:1 by weight and shall not replace more than 50% of the cement originally called for in mixture.

5. The Contractor shall submit a mix design to the Engineer for review seven (7) calendar days in advance of batching. The submittal shall indicate the amount of cement to be removed, the material that will replace it and compressive strength results of the mix.

6. After batching begins and as concrete is delivered to the job site, the Contractor will be responsible for furnishing concrete that contains the specified air entrainment content at the time it is discharged from the transit mixer. Concrete with the nonconforming air content shall not be used in the work.

7. Storage bins, conveying devices, weighing equipment, and weighing procedures to assure accurate batching shall be provided for each material (fly ash or slag) to be used.

8. Fly ash will be accepted only from sources that provide quality control of the product at the source and furnish with each shipment certified mill test reports.

9. Fly ash and water-granulated blast furnace slag will be accepted only from sources approved by the Research and Materials Engineer. The fly ash suppliers shall furnish certified mill test reports and shipping tickets as outlined in the Department's adopted ***Policy for Fly Ash Inspection***. Water-granulated slag suppliers

shall furnish certified mill test reports and shipping tickets as outlined in the Department's adopted ***Policy for Portland Cement Concrete and Water-Granulated Blast Furnace Slag Manufacturers***.

701.26 Method of Measurement. The quantity of concrete measured for payment shall be the number of cubic yards of concrete of each class within the neat lines of the structure as shown on the plans or revised by the authority of the Engineer except that deductions shall be made from this yardage for the volume of embedded items other than reinforcing steel, and no deduction shall be made for chamfers of 3/4 inch size or smaller.

All cost for concrete used in precast/prestressed members, bridge railing, and drilled shafts, including the cost of designing the mix, testing, engaging the laboratory and furnishing the Engineer materials for testing, shall be included in the unit price for the applicable pay item(s).

701.27 Basis of Payment. The quantity of each class of concrete, determined as provided above, will be paid for at the contract unit price, excluding precast/prestressed members, bridge railing, and drilled shaft concrete, for each class of concrete, which price and payment shall be full compensation for furnishing all equipment, tools, materials, admixtures, falsework, falsework piling, forms, bracing, labor, surface finish, curing materials and other items of expense required to complete the concrete work shown on the plans or otherwise described, with the exception of reinforcing steel.

Unless otherwise specified, payment for concrete shall also include the cost of pipe drains, French drains and weep holes, expansion joints, expansion joint materials, flashing, pipes, conduits, anchors and other similar material. Payment for concrete shall also include cost of removing and disposing of portions of existing structures as designated on the plans, where such structures are widened or reconstructed and also the costs of drilling for dowels or expansion bolts.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7011XXX	Concrete for Structures - Class *(class)*	Cubic Yard

SECTION 702

CONCRETE STRUCTURES

702.01 Description. This work shall consist of the construction of all types of structures involving the use of structural concrete, except where the requirements are specifically waived or revised by another governing section of the specification. All concrete structures shall be constructed in accordance with the design requirements and details shown on the plans and in conformity with the requirements of this specification and any special provisions pertaining thereto.

MATERIALS

702.02 Concrete. All concrete shall conform to the provisions of **Section 701**. The class of concrete for each type of structure, structural element, or concrete item shall be as specified on the plans or in the special provisions.

702.03 Expansion Material. Expansion material shall comply with the following requirements for the material involved:

A. Preformed Joint Filler. Preformed joint filler shall consist of preformed material composed of cane or other fibers of a cellular nature, securely bound together and uniformly saturated with a suitable bituminous binder and shall comply with the requirements of **AASHTO M 213**, or

a preformed material composed of 100% scrap tire rubber, shredded and fused into cohesion with a non-toxic, odorless and tasteless formulated polyurethane binder. The shreds shall be treated to resist most types of microbes, oils, fungi, and biological growth. It shall comply with the physical properties of **AASHTO M 153** (**ASTM D 1752**), Type I.

B. Hot-Poured Elastic Filler. Hot applied elastic filler material primarily for use in pavement cracks (asphalt or concrete) that are reasonably clean shall meet the requirements of **AASHTO M 173** (**ASTM D 1190**).

Hot applied filler material primarily for use in concrete pavement expansion joints that are cleaned and sealed in accordance with **Subsection 501.27** shall meet the requirements of **AASHTO M 301** (**ASTM D 3405**).

The above filler materials are allowed to contain a maximum of 20% recycled tire rubber by weight of asphalt components.

For the above provisions allowing the use of scrap tire rubber, the vendor shall furnish with each shipment a certified statement, stating the number of pounds of reclaimed scrap tire rubber that is furnished in the shipment.

C. Elastomeric Compression Seals. Elastomeric seals for bridge deck joints shall comply with the requirements of **AASHTO M 297**. The sizes furnished shall be as shown on the plans. The lubricated adhesive to be used with all seals shall comply with **ASTM D 2835**. The installation of seals shall be in accordance with the manufacturer's recommendations. No splices will be allowed.

The vendor shall furnish the Engineer three copies of the manufacturer's certification of conformance along with test results verifying that the seals and adhesive furnished meet the applicable specifications.

D. Metal Expansion Plates. Materials in plates, if required to be of stainless steel, shall comply with **ASTM A 167**, Type 301 or Type 302, No. 1 Finish. If required to be of copper alloy, the material shall comply with **ASTM B 100**, Alloy No. 510.

E. Roofing Felt. Where roofing felt is specified, it shall be 30-pound, asphalt saturated, roofing felt.

F. Copper Flashing. Copper flashing shall comply with **ASTM B 152**, Cooper No. 110 and be of the thickness or weight specified.

G. Plastic Waterstops. Flexible waterstops shall be of polyvinylchloride and shall be of the size and type specified on the plans. Unless otherwise specified on the plans, the material shall conform to the current **AASHTO Specifications**, Division 2, Section 8.

H. Cold Applied Elastic Filler. Cold applied bridge joint filler material shall be polymeric elastomeric two component sealant recommended by the manufacturer for use in bridge joints and shall meet or exceed the requirements of **ASTM D 1850** or **ASTM C 920** for a multiple component self-leveling material.

As an alternate to the above, the Contractor has the option to use a self-leveling, cold applied, rapid cure, two-part, ultra low modulus, 100% silicone rubber sealant. Material shall be packaged such that no pre-mixing or measuring is required. The sealant shall be capable of accommodating movements up to ±1/2 inch for bridge joints 1 to 3 inches wide.

The backer rod shall be of circular cross-section and consist of closed-cell polyethylene foam. Generally, it will be 1/8 inch greater diameter than the joint width.

All materials shall be installed in accordance with the

manufacturer's instructions.

Only material from sources appearing on the **Approved List** entitled *Approved Cold Applied Sealants for Bridge Joints* available from the Research and Materials Laboratory shall be used in the work. A manufacturer may request to be included on the list by successfully demonstrating that the manufacturer's material meets the specification above and performs in applications in this state or other states. Further, the manufacturer shall furnish technical data sheets describing the material and its application. For each shipment, the manufacturer shall furnish a certification stating that the material furnished meets the Department's specifications. The shipped containers shall be plainly marked with the manufacturer's name or trademark, the lot number, component type, and a clear date indicating shelf life expiration date."

I. Bridge Deck Joint Strip Seals. Bridge deck Joint strip seals shall comply with the requirements of **Section 723**.

702.04 Liquid Curing Compounds.

A. Material. Liquid curing compounds shall be white pigmented conforming to **AASHTO M 148** (**ASTM C 309**).

Type 1 is clear. Type 2 is white pigmented. Type 1D is clear with dye. Class A may be all resin or wax based. Class B is all resin (No Wax).

All products shall be VOC compliant (water-based or solvent-emulsion). Total solvent-based products are not allowed.

When tested in accordance with **AASHTO T 155** (**ASTM C 156**) procedures, Department testing variations will be allowed as follows:

1. Small oven variations will be allowed in temperature, relative humidity and velocity of air current.

2. Only one specimen will be required;

B. Application. The method of application shall be in accordance with **Subsection 702.20**.

For surfaces that are to receive a concrete final surface finish coating, a clear dissipating curing compound shall be used unless otherwise specified. It shall meet **AASHTO M 148** (**ASTM C 309**), Type 1, Class B, which is a clear all resin (No Wax) cure. After application of the curing compound, the surfaces shall be cleaned in accordance with **Subsection 702.25D** before the final coating is applied.

For applications where a clear cure is desired and no concrete final surface finish material will be applied, AASHTO M 148 (ASTM C 309), Type 1D, Class A or B shall be used.

C. Testing and Approval. Only materials from sources appearing on the Department's **Approved Material List** entitled *Curing Compound for Concrete Structures*, available from the Research and Materials Engineer shall be used in the work. A manufacturer may request to be included on the list by furnishing a certificate of analysis and performance test results, for the product proposed, verifying that it meets or exceeds the specification requirements, technical data sheets describing the product and its application procedures, a ***Materials Safety Data Sheet***, and a sample for Department testing.

After approval, the manufacturer shall furnish, with each shipment, a certificate of analysis and performance test results for each batch number furnished, verifying that it meets AASHTO M 148 (ASTM C 309) for the type and class furnished, a *Materials Safety Data Sheet* and application instructions. The shipped containers shall be plainly marked with the manufacturer's name and trademark, the batch number, the type and class of cure, and a

date of manufacture. For material shipped in bulk tankers, a label shall be furnished with each load to be placed on the project storage tank for identification purposes.

It will not be required that Department personnel sample and test each batch of curing compound as it is received at a project. A list of approved sources and products will be provided by the Research and Materials Laboratory. The Engineer will accept the material on the basis of a manufacturer's certificate of analysis and performance test results for the material used, the fact that it is on the approved list, and that container labels verify type of material.

Formulation changes after initial approval of a product shall be made known to the Department's Research and Materials Engineer along with a sample for re-evaluation.

D. Non-Compliant Producers . The above acceptance procedures will be honored by the Department until such time as:

1. Documentation of the curing compound is inappropriate,
or
2. Department testing of random field samples and/or source samples does not meet the requirements of applicable specifications.

If these conditions should occur, immediate steps will be taken by the Research and Materials Engineer to establish correct documentation or obtain additional samples for further testing. Results of these negotiations and/or tests will be used to determine the future status of the manufacturer as an authorized source.

E. Final Material Certification. A copy of the certificate of analysis and performance test results for the shipment shall be furnished to the Engineer for the purpose of final materials certification for the project.

EQUIPMENT

702.05 Falsework. Detailed plans shall be submitted for review to the Bridge Construction Engineer with a copy to the Engineer. The detailed plans shall be for items of work involving cofferdams, falsework over highways or railroads, falsework for caps adjacent to railroads or highways, sheeting, retaining walls and other items as designated in the plans or special provisions. The plans submitted shall be sealed by a South Carolina licensed Professional Engineer and comply with **Subsection 702.10**. Review of plans shall not relieve the Contractor of responsibility for results obtained by use of these plans.

702.06 Forms. Detailed plans for forms involving items of work listed in **Subsection 702.05** shall be submitted to the Bridge Construction Engineer for review with a copy to the Engineer. In addition, any new forming system used for the first time on a South Carolina project or any other detailed forms when requested by the Engineer shall be submitted for review before use. The plans shall be sealed by a South Carolina licensed Professional Engineer and comply with Subsection 702.10. Review of plans shall not relieve the Contractor of responsibility for results obtained by use of these plans.

All forms shall be of wood or metal and shall be built mortar-tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations. The interior dimensions of the forms shall be such that the finished concrete shall be of the shape and dimensions shown on the plans. Forms shall be constructed and maintained to prevent warping and the opening of joints due to shrinkage of the lumber. The forms shall be substantial and unyielding and the design shall take into account the effect of vibration of concrete as it is placed and the rate at which the forms will be filled with concrete.

702.07 Vibrators. Vibrators shall be of a type approved by the Engineer and shall be in good operating condition. The Contractor shall maintain for each pour not less than two vibrators, including two sources of power throughout the pour, in order that one may be available in event of failure of the other.

The number of vibrators required for any pour will depend upon the size of the batch, the frequency of batches, the size of the sections and the size of the vibrators used and shall be determined by the results secured as determined by the Engineer

702.08 Tremie. A tremie used in depositing concrete under water shall consist of a metal tube; other than aluminum, having a diameter of not less than 10 inches, constructed in sections having flanged couplings fitted with water-tight gaskets.

702.09 Kettles for Placing Hot-Poured Elastic Filler. In order to avoid damaging such material by excessive heating, elastic filler joint material shall be melted in double-walled, oil-bath kettles. The material shall be cut into appropriate sized pieces with a hot spade and laid over the lower surface of the kettle. Continuous stirring shall be required to prevent local overheating. The kettle shall be filled to approximately one-half its capacity at all times by adding new pieces as material is withdrawn. The kettle shall be provided with an accurate pyrometer and the material shall be heated in accordance with the manufacturer's instructions. Care shall be taken not to overheat the material. Excessive smoke is one indication of local overheating.

The joint should be filled to within 3/8 inch of the top surface of the slab. Material left over in the kettle can be re-cut into suitable size pieces and re-heated later.

702.10 Falsework/Form Design and Inspection. The requirements of this subsection shall apply to all falsework/forming systems that are used by the Contractor including forming systems for flat slabs, reinforced concrete decks, bent or pier caps, reinforced concrete columns, cofferdams, sheeting, temporary work bridges and any other temporary systems to support the structure, soils in excavations or embankments, personnel or equipment during the construction of the project.

A. Design. Falsework/form systems shall be designed to handle all vertical and horizontal loading that may be placed upon it and shall be designed with sufficient redundancy to prevent failure of the system as a result of the failure of any individual element. Falsework shall be designed for the sum of vertical dead and live loads and an assumed horizontal load. Dead loads shall include the weight of concrete, reinforcing steel, forms and falsework. The weight of concrete shall be taken as not less than 150 pounds per cubic foot for normal concrete and not less than 120 pounds per cubic foot for lightweight concrete.

Live loads shall be the actual weight of any equipment to be supported by falsework applied as concentrated loads at the points of contact and a uniform load of not less than 20 pounds per square foot applied over the area supported, plus 75 pounds per linear foot applied at the outside edge of deck overhangs.

The assumed horizontal load shall be the sum of the actual horizontal loads due to equipment, construction sequence or other causes plus not less than 50 pounds per square foot of horizontal surface area for wind, but in no case shall the assumed horizontal load be less than two percent of the total dead and live load.

The design shall also consider the effects of differential settlement. Settlement and take up of falsework shall be limited to one inch or less. Falsework shall be erected with sufficient camber and/or adjustment to compensate for deflection and settlement under the weight of concrete, so that the completed structure or part shall have the alignment and curvature shown in the plans. When footing type foundations are to be used for falsework support, the Contractor shall decide the bearing value of the soil and shall show the values assumed in the design on the drawings.

When falsework is to be placed adjacent to public roads, the design shall consider the effects of vibrations from passing vehicles and shall include provisions for protection of the falsework from errant vehicles.

If falsework from one bridge is to be used on another bridge, additional analysis shall be made to determine the new loading conditions and to verify the adequacy of the falsework system. Any adjustments or changes necessary shall be incorporated into the design.

B. Design and Drawing Submittal. The Contractor shall submit seven sets of design calculations and drawings for the falsework/form system to the Bridge Construction Engineer with a copy to the Engineer for review, a minimum of three weeks prior to erection or installation. The Contractor shall submit nine sets of design calculations and drawings for the falsework/form system on all railroad projects. The allowable stresses used for design, working loads, the load capacity of all support elements and the design specifications shall be stated on the drawings. Drawings shall be fully detailed, showing layout of falsework elements, sizes, material specifications and manufacturer's recommendations for installation. Drawings shall be submitted in accordance with **Section 725**.

Drawings and design calculations for falsework/form systems shall be prepared under the responsible charge

of a South Carolina licensed Professional Engineer practicing under Civil or Structural discipline and shall bear the PE's signature and seal.

These submittal requirements shall apply to new falsework/form systems used for the first time and to other falsework/form systems that are designated in the plans or special provisions. Falsework/form systems previously used shall be resubmitted any time that the loading conditions are changed.

C. Inspection and Certification. Falsework/form systems shall be installed in accordance with the reviewed drawings. Deviations from the drawings will not be allowed except as approved in writing by the Professional Engineer. Inspection of all falsework systems for assembly, installation, and compliance with drawings shall be required before loading the falsework. All bolted connections shall be properly installed using clean lubricated bolts. Any deficiencies found during the inspection shall be corrected to the satisfaction of the Engineer before loading the falsework system. Inspection requirements shall be based on the following categories:

1. Category I. All designated items of the structure listed in the plans or special provisions and all cofferdams or sheeting with a design height of 10 feet or more shall have the initial installation of the falsework/form system inspected and certified by a South Carolina registered Professional Engineer employed or retained by the Contractor. Certification of compliance with the approved falsework/form drawings shall be made in writing to the Engineer before loading. Additional installations of the identical falsework system on the project shall be inspected and certified by the registered Professional Engineer or a certified inspector who has been approved and certified by the Department.

2. Category II. Items other than those meeting the criteria for Category I above shall have the falsework/form system inspected by the Contractor to assure that the assembly and installation of the system is in accordance with the reviewed falsework/form drawing. The Engineer may require inspection and certification of any falsework/form system by a South Carolina registered Professional Engineer or certified inspector, if in his/her opinion the system is not assembled and installed in accordance with the reviewed drawings

D. Certified Inspector Qualifications. If the Contractor desires to use someone other than a registered Professional Engineer for inspection and certification of falsework, the Contractor shall submit to the Engineer for approval and certification the name and qualifications of the person that it desires to use. The minimum qualifications of the inspector shall be five (5) years of supervisory experience in bridge construction or an engineering degree and four years experience in structural design or bridge construction. Such inspectors shall be certified for the inspection and certification of falsework systems only.

E. Responsibility. The Department's review of falsework/form system designs and drawings shall not relieve the Contractor of any responsibility. The Contractor shall be solely responsible for the adequacy of the installation and performance of his falsework/form system. Any delays due to the failure of the Contractor to comply with this specification or due to the inadequacy of the proposed falsework/form system shall not be grounds for an extension in contract time or additional compensation.

F. Payment. No separate payment, except as noted below, will be made for compliance with this specification. All costs of the above work shall be considered incidental to the project and included in other items of work.

If the Engineer requires inspection and certification of any falsework system by a registered Professional Engineer or certified inspector as described in Category II of **Subsection 702.10C** above, payment will be made by Supplemental Agreement. However, if the inspection reveals that the falsework system does not comply with the drawings, then no payment will be due.

702.11 Forms.

A. Wood Forms. Wood forms shall be of dressed lumber or plywood. Dressed lumber shall be of good quality and free from imperfections that would affect the strength or impair the finished surface of the concrete.

Chamfer strips shall be used at corners; fillets shall be placed in concrete where shown on the plans. All chamfer strips shall be machine surfaced. Forms shall be so designed and constructed that they may be removed without injuring the concrete.

Metal anchors, bolts, struts, etc., to be used within space to be occupied by the concrete shall be designed so that no metal shall remain closer than one inch to the surface. Wire form ties of special design with a weakened section not less than 3/4 inch back from the concrete face may be used at places of minor pressure. Such ties shall be provided with wooden or plastic cones 3/4 inch deep to assure the breaking of the tie at least 3/4 inch inside the face of the concrete. Wire ties in forms other than those described above will not be permitted. Other devices may be submitted for consideration, but shall not be used without the written approval of the Engineer.

Cavities left by washers, cone nuts or falsework/form support systems shall be roughened to provide bond and then plugged with a SCDOT approved non-shrink structural grout. If the plug shows a crack after setting, it shall be removed and the cavity re-plugged. The plugged surface shall be floated flush with the adjacent surface.

Other devices may be submitted for consideration, but shall not be used without the written approval of the Engineer.

B. Metal Forms. The specifications for wood forms pertaining to design, mortar-tightness, fillets and chamfers, bracing, alignment, removal, re-use, and oiling shall apply equally to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolts and rivet heads on the formed surface shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms that do not present a smooth surface or do not line up properly shall not be used. Special care shall be exercised to keep metal forms free from rust, grease, or other foreign matter that will tend to discolor the concrete. Metal forms shall be provided with an adjustable metal section or occasional sections where wooden forms may be inserted to compensate for inaccuracies in measurements.

C. Stay-in-Place (SIP) Forms for Concrete Deck Slabs. 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, the forms shall meet the requirements outlined below:

1. Materials. Permanent steel bridge deck forms and supports shall be fabricated from steel conforming to **ASTM A 446/A 653**, Grades 40 or 50 having a coating class of G165 according to **ASTM A 525**.

2. Design. The following criteria shall govern the design of permanent steel bridge deck forms:

a. Dead Load. The steel forms shall be designed based on dead load of forms, reinforcement, and plastic concrete plus 50 pounds per square foot for construction loads. The unit working stress in the

steel sheet shall not be more than 72.5% of the specified minimum yield strength of the material furnished, but not to exceed 36,000 psi.

b. Deflection. Deflections calculated using the weight of the forms, the plastic concrete and reinforcement shall meet the following criteria, and in no case shall this loading be less than 120 pounds per square foot total. Deflections for form spans less than or equal to 10 feet shall not exceed 1/180 of the form span or 1/2 inch whichever is less. Deflections for form spans greater than 10 feet shall not exceed 1/240 of the span or 3/4 inch, whichever is less.

The permissible form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.

c. Span Length. The design span of the form sheets shall be the clear span of the form plus 2 inches measured parallel to form flutes.

d. Design Properties. Physical design properties shall be computed in accordance with requirements of the ***AISC Specification for the Design of Cold Formed Steel Structural Members***, latest published edition.

e. Reinforcing Steel. The bottom mat of reinforcing steel shall have minimum concrete cover of one (1) inch. The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.

f. Lateral Bracing. Permanent steel bridge deck forms shall not be considered as lateral bracing for compression flanges of supporting structural members.

g. Longitudinal Deck Joints. Permanent steel bridge deck forms shall not be used in panels where longitudinal deck construction joints are located between stringers.

h. Welding. Welding shall not be permitted to beam or girder flanges or to structural steel bridge elements.

i. Shop Drawings. Seven (7) sets of the fabricator's shop and erection drawings shall be submitted to the Bridge Design Engineer for review. Erection plans shall be prepared under the responsible charge of a South Carolina licensed Professional Engineer, practicing under civil or structural discipline, and shall bear his/her signature and seal. These plans shall indicate the grade of steel, the physical and section properties for all permanent steel bridge deck form sheets and details of form support devices. A copy of the transmittal letter for the above mentioned plans and drawings shall be sent to the Engineer.

3. Construction. All forms shall be installed in accordance with approved fabrication and erection plans.

Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of one (1) inch at each end. Form supports shall be placed in direct contact with the flange of stringer or floor beam. All attachments shall be made by permissible welds, bolts, clips, or other approved means. However, welding of form supports to flanges will not be permitted.

Any permanently exposed form metal where the galvanized coating has been damaged shall be thoroughly cleaned, wire brushed and painted with two

coats of zinc-oxide and zinc dust primer in accordance with **ASTM A 780**, with no color added, and to the satisfaction of the Engineer. Minor heat discoloration in areas of welds need not be touched up.

Transverse construction joints shall be located at the bottom of a flute and 1/4 inch weep holes shall be field drilled at not less than 12 inches on center along the line of the joint.

4. Placing Concrete. Concrete shall be placed in accordance with the manufacturer's recommendations and/or the special provisions. Particular emphasis shall be placed on proper vibration of the concrete to avoid honeycomb and voids, especially at construction joints, expansion joints and valleys and ends of form sheets. Contractor requested changes in pouring sequences, procedures, and mixes if specified shall be approved by the Engineer before use. Calcium chloride or any other admixture containing chloride salts shall not be used in the concrete.

5. Inspection. The Contractor's method of construction will be carefully observed during all phases of the construction of the bridge deck slab. These phases include installation of the metal forms, location and fastening of the reinforcement, composition of concrete items, mixing procedures, concrete placement and vibration, and finishing of the bridge deck. Should the Engineer determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, the Contractor shall remove at least one section of the forms at a location and time selected by the Engineer for each span in the contract. This shall be done as soon after placing the concrete as practicable in order to provide visual evidence, that the concrete mix and the Contractor's procedures are obtaining the desired results. An additional section shall be removed if the Engineer determines any change in the concrete mix or in the Contractor's pro-

cedures warranting additional inspection has occurred.

After the deck concrete has been in place for a minimum period of two (2) days, the concrete shall be tested for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer. If areas of doubtful soundness are disclosed by this procedure, the Contractor shall be required to remove the forms from such areas for visual inspection after the concrete has attained adequate strength. This removal of the permanent steel bridge deck forms shall be at no cost to the Department.

At locations where sections of the forms are removed, the Contractor will not be required to replace the forms, but the adjacent metal forms and supports shall be repaired to present a neat appearance and assure their satisfactory retention.

As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing and other defects. If irregularities are found, and it is determined by the Engineer that these irregularities do not justify rejection of the work, the concrete shall be repaired as the Engineer may direct and shall be given an initial surface finish in accordance with these specifications. If the concrete where the form is removed is unsatisfactory, additional forms as necessary, shall be removed to inspect and the slab repaired or removed as necessary. The Contractor's method of construction shall be modified to obtain satisfactory concrete in unpoured slabs. All unsatisfactory concrete shall be removed or repaired as directed by the Engineer.

The amount of sounding and form removal may be moderated, at the Engineer's discretion, after a substantial amount of slab has been satisfactorily constructed and inspected. However, the Contractor's methods of construction and the results of the inspection as outlined above must indicate that sound con-

crete is being obtained throughout the slabs.

The Contractor shall provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer's inspection procedures.

6. Measurement and Payment of Concrete Using Permanent Steel Bridge Deck Forms. The pay quantity of concrete in the bridge slabs shall be computed from the neat line dimensions shown on the plans with no allowance for form deflection. No additional payment for extra concrete required by the use of permanent steel bridge deck forms or for the forms themselves will be allowed.

D. Construction. All wood and metal forms as outlined in **Subsections 702.11A** and **702.11B** shall be set and maintained true to the line and grade until the concrete has gained sufficient strength to permit their removal. Permanent steel bridge deck forms for concrete deck slabs shall be installed in accordance with **Subsection 702.11C**. If before or during the placing of concrete the forms appear to be unsatisfactory in any way, the Engineer shall order the work stopped until the defects have been corrected.

Patchwork arrangement of forms, using small pieces, will not be permitted and joints in all lumber other than plywood shall be staggered.

For narrow walls, columns, etc., where the bottom of the forms or construction joint is inaccessible, the lower form boards shall be left loose so they can be removed for cleaning out extraneous material immediately before placing the concrete, or suitable openings and methods of closing shall be provided for this purpose.

All forms except permanent steel bridge deck forms shall be treated with oil or saturated with water immediately before placing the concrete. For rail members or

other members with exposed faces, the forms shall be treated with approved oil to prevent the adherence of concrete. Any material that adheres to or discolors the concrete shall not be used.

Forms shall be inspected during construction and before the placing of the concrete therein. All dimensions shall be checked carefully and any errors, bulges, warping, or other defects, remedied before any concrete is placed.

The back face of forms for cast-in-place box girders shall be free of screw heads, protruding nails, and any other objects that would hinder inspection of the inside for the box girder.

702.12 Handling and Placing Concrete. All concrete shall be placed during daylight and the placing of concrete shall not be started unless it can be completed and finished during daylight, except when an adequate lighting system is provided and other arrangements are made beforehand. No concrete shall be placed until the depth, character and water conditions of the foundations, the adequacy of falsework and forms, the absence of debris in the forms, the alignment and grade of the forms, the conditions of the construction joints, and the condition and spacing of the reinforcing steel have been inspected by the Engineer. No concrete shall be deposited under water unless permitted by the plans or special provisions or authorized in writing by the Engineer.

Sufficient hauling equipment shall be provided to permit continuous placing of concrete and to prevent placing of concrete on or against previously placed concrete which has begun its initial set in any one pour.

The Contractor shall establish a concrete operation such that the job site placement of concrete shall be at the minimum rate of 25 cubic yards per hour unless specified otherwise in the plans or special provisions. For bridge deck slabs, the concrete placement shall be at the minimum rate of

45 cubic yards per hour unless otherwise authorized in writing by the Engineer. Before the first concrete deck pour, a pre-pour conference shall be held between the Contractor, the concrete supplier, and the Engineer to establish a *Concrete Operation Plan*. Additional conferences shall be held if deemed necessary in the opinion of the Engineer.

Placing concrete shall be so regulated that the pressures caused by wet concrete shall not cause distortion of the forms.

The operation of depositing and compacting the concrete shall be conducted to form an artificial stone of maximum density and impermeability and uniform texture that shall have smooth surfaces when the forms are removed.

Concrete shall be deposited so that the total deflection or settlement of supporting members and the final screeding of the surface shall have occurred before initial set of the concrete takes place.

Concrete shall be placed while fresh and before initial set has occurred. Any concrete in which initial set has begun shall not be used or re-tempered. In no case will retempering of concrete be allowed. Concrete containing lumps or crusts of hardened materials shall not be used. If any concrete is found defective, it shall be removed or repaired as specified herein or as directed by the Engineer and without extra compensation.

No concrete shall be used which does not reach its final position in the forms within 75 minutes after water or cement is first added to the mix, except that this time may be extended to two (2) hours where concrete with an approved water reducing retarder is used.

Concrete shall be placed to avoid segregation of the materials and the displacement of the reinforcement. The use of chutes of over 50 feet in length for conveying concrete from the mixer to the forms will be permitted only on written author-

ity of the Engineer. If an inferior quality of concrete is produced by the use of chutes, the substitution of a satisfactory method of placing shall be employed.

Open troughs, pipes, and chutes shall be of metal or metal lined (other than aluminum). Where steep slopes are necessary, the chutes shall be equipped with baffle boards or be in short lengths that change the direction of movement.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the concrete already in place.

Except in the fabrication of prestressed concrete members, concrete shall not be dropped a distance of more than 5 feet unless flexible metal or rubber-like pipes are used and special care shall be taken to fill each part of the form by depositing the concrete as near its final position as practicable. The coarse aggregate shall be worked back from the face of the forms and the concrete forced around the reinforcement without displacing the bars. After the initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

Concrete shall be consolidated by continuous working with a suitable tool or by the use of an internal vibrator in accordance with **Subsection 702.15**. If vibration cannot be done effectively because of the obstruction of reinforcement or other cause, consolidation shall be accomplished by vibrating the form in a manner satisfactory to the Engineer.

Except in the fabrication of prestressed concrete members, concrete shall be placed in horizontal layers not more than 18 inches thick except as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in a vertical plane. To prevent injury to the green concrete and avoid surfaces of separation between the

batches, each batch in a layer shall be placed and compacted

before the preceding batch has taken initial set.

When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid as many visible joints as possible, the surface of the concrete adjacent to the forms shall be smoothed with a trowel.

702.13 Construction Joints. No construction joints will be permitted except those shown on the plans or those approved by the Engineer. Approved bulkheads and keys shall be provided as specified below.

In joining fresh concrete to that which has already set, the concrete in place and the adjacent forms shall have their surfaces thoroughly cleaned and all chalky, loose or foreign materials removed and the reinforcing steel shall be cleaned in accordance with **Subsection 703.07**. In inaccessible places, such as small columns and thin walls, the surface shall be cleaned as stated above before the setting of the forms. Immediately before placing the new concrete, the forms shall be drawn tight against the concrete already in place, the old surface shall be thoroughly wetted and coated with a thin coating of mortar, a neat cement or other suitable bonding material.

When shown on the plans, the construction joint shall be made resistant to shear by the placing of raised or depressed keys on the surface of the concrete first poured. In general, the width of the key shall be about one-third of the total width of the section and shall occupy about the middle third of the section and the height/depth of the key shall be about one third of its width. Steel dowels may, at the discretion of the Engineer, be used instead of keys.

702.14 Pumping Concrete. The equipment shall be so arranged that vibrations shall not damage freshly placed concrete. The pumping equipment shall be of a suitable type, adequacy, and capacity for the work. The operation of the

pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, if the concrete remaining in the pipeline is to be used, it shall be ejected so that there shall be no contamination of the concrete or separation of the ingredients. The concrete slump shall meet specification before pumping and shall meet entrained air requirements after being deposited in the forms.

702.15 Vibration. All classes of concrete except Class 4000DS and Class 4000S shall be vibrated during placement by vibrators as described in this Subsection and **Subsection 704.12A** for prestressed concrete.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn from the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

Vibration shall be performed in a manner that will avoid contact with forms and ties as much as is practicable. Vibrators shall not be used to move the concrete. Vibrators shall be in conformance with the requirements of **Subsection 702.07**.

702.16 Mass Concrete Placement. Mass concrete placement shall be defined as any pour in which the concrete being cast has dimensions of 5 feet or greater in three different directions. For pours with a circular cross-section, a mass

concrete placement shall be defined as any pour that has a diameter of 6 feet or greater and a length of 5 feet or greater. For all mass concrete pours, the mix temperature shall not exceed 80°F as measured at discharge into the forms. Further, the Contractor shall be required to maintain a temperature differential of 35°F or less between the interior and exterior of all mass pour elements during curing.

Before placing mass concrete, the Contractor shall submit, to the Engineer for review and acceptance, a *Mass Concrete Placement Plan* containing, but not limited to, the following:

1. An analysis of the anticipated thermal developments within mass pour placements using the proposed materials and casting methods.

2. A plan outlining specific measures to be taken to control the temperature differential within the limits noted above.

3. Details of the Contractor's proposed monitoring system.

If the Contractor is proposing a special concrete mix design as part of the temperature control plan, this mix design should also be submitted for review.

The Contractor shall provide temperature monitoring devices to record temperature development between the interior and exterior of the element at points approved by the Engineer and shall monitor the mass pours to measure temperature differential. Temperature monitoring shall continue until the interior temperature is within 35°F of the lowest ambient temperature or a maximum of two (2) weeks. The Engineer shall be provided with a copy of each set of readings as they are taken and a temperature chart for each mass pour element showing temperature readings vs. time.

If the monitoring indicates that the proposed measures are not controlling the concrete temperature differential within the 35°F specified, the Contractor shall make the necessary revi-

sions to the plan and submit the revised plan for review.

The Contractor shall assume all risks connected with placing a mass pour of concrete. Review of the Contractor's plan will in no way relieve the Contractor of the responsibility for obtaining satisfactory results. Should any mass concrete placed under this specification prove unsatisfactory, the Contractor will be required to make the necessary repairs or remove and replace the material at the Contractor's expense.

All costs associated with special temperature controls for mass concrete placement shall be included in the unit cost of the concrete cast, and will be without additional specific compensation. The control of temperatures in mass concrete pours shall be in addition to any other requirements found on the plans and/or in the special provisions that may apply to the work in question.

702.17 Depositing Concrete Under Water. When concrete is permitted to be deposited in water by the plans, special provisions, or the Engineer, the concrete and procedure shall conform to the following requirements:

A. Class 4000DS. See **Section 712** for requirements on depositing Class 4000DS concrete in water.

B. Class 4000S. Class 4000S concrete shall have a slump of approximately 8 inches. When considered desirable, a water-reducing retarder to delay the initial set of the concrete deposited under water shall be used in the proportion as accepted by the Engineer. To prevent segregation, it shall be carefully placed in a compact mass in its final position by means of a tremie, or other method approved by the Engineer, and shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit.

Unless otherwise permitted, concrete seals shall be placed continuously from start to finish and the surface of the concrete shall be kept as nearly horizontal as is practi-

cable at all times. To insure thorough bonding, each succeeding layer of a seal shall be placed before the preceding layer has taken initial set. All laitance and foreign matter shall be removed from the top surfaces before any concrete is placed upon it in the dry.

If a tremie is used to place the concrete, the tremie shall be supported so as to permit free movement of the discharge end over the entire top surface of the work, and rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be closed with an approved plug, or mechanical means, at the start of work so as to prevent water entering the tube, and the tremie tube shall be entirely sealed at all times against the entry of water. The tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end of the tremie while always keeping it in the deposited concrete. The flow shall be continuous until the work is complete. Two or more complete tremies including hoppers may be required by the Engineer for large footings and where the additional tremies are considered desirable.

702.18 Concrete Exposed to Tidal Water. Concrete structures exposed to tidal water shall be constructed to provide a maximum resistance to its disintegrating action. Where reinforced concrete is used in tidal water, the reinforcement shall be accurately placed and rigidly held in place. The clear distance from the face of the concrete to the nearest face of any reinforcement bar shall be not less than 4 inches except for precast concrete piling. Clearance for piling shall be as shown on the plans.

The original surface, as the concrete comes from the forms, below the elevation of high tide shall be left undisturbed except for the initial surface finish. In order to secure a thick and dense surface film, the form surface shall be heavily coated with shellac or acceptable form oil.

No construction joints in concrete in tidal water shall be located within the range from an elevation below extreme low tide to an elevation above extreme high tide. The Engineer will determine the limiting elevations of this range. In the Engineer's determination, consideration will be given to wave action and other conditions causing extraordinary deterioration and disintegration of concrete.

Concrete in tidal water within the range as determined above shall be deposited in the dry. In no case shall tidal water be allowed to come in direct contact with the concrete until it has been permitted to harden for at least three (3) days.

702.19 Temperature Control.

A. Concreting in Cold Weather. No concrete shall be placed unless specifically authorized by the Engineer upon receipt of a written satisfactory *Placing and Curing Plan* and in conjunction with meeting the requirements of **Subsection 701.22A**. The Contractor's plan shall provide that the air temperature surrounding the concrete shall be maintained at a temperature of 50°F or above for a period of three (3) days after the concrete is placed. When curing blankets are used, they shall conform to the requirements found in **Subsection 702.20**, and remain in place for a minimum of four (4) days. The Contractor's plan shall anticipate and include provisions for sudden temperature changes below those forecast during the curing period. When dry heat is used, means of maintaining moisture shall be provided in order to maintain the concrete in a wet condition during the curing period.

B. Concreting in Hot Weather. If concrete is placed in hot weather, the Contractor's *Placing and Curing Plan* shall consider the applicable requirements of ACI Standard 305 and may incorporate the following provisions, as necessary, to maintain the temperature of concrete below 90°F:

1. Schedule work so that concrete can be placed with the least possible delay.

2. Sprinkle coarse aggregate with water to cool by evaporation.

3. Use chilled mixing water or shaved ice to replace part of the mixing water, and also consider use of Type II cement.

4. Reduce loss of water through absorption by prewetting the subgrade and forms just before pouring so that they will not absorb water from mix.

5. Forms and reinforcing steel shall be sprayed with cool fresh water just before placement of concrete.

6. Erect windbreakers to prevent winds from drying exposed concrete surfaces while they are being finished.

7. Screed and float concrete as it is placed and start curing procedures immediately.

8. Use water curing methods to provide evaporative cooling.

C. Responsibility for Satisfactory Results of Temperature Control. The Contractor shall assume all risks connected with the placing of concrete under the above conditions, and permission given to place concrete under such conditions will in no way relieve the Contractor of the responsibility for satisfactory results. Should concrete placed under such conditions prove unsatisfactory, it shall be removed, disposed of, and replaced at the Contractor's expense.

All costs associated with special temperature controls for concrete placement shall be included in the unit cost of the concrete cast, and will be without additional specific compensation. The control of placement temperatures in concrete pours shall be in addition to any other requirements found in the plans and the special provisions that may apply to the work in question.

702.20 Concrete Curing.

A. Bridge Deck. The Contractor shall exercise caution to prevent plastic cracking from occurring in bridge decks, and shall follow the latest ACI Standards 224R and 305R guidelines on control of cracking and hot weather concreting.

All freshly placed structural concrete shall be protected from rapid drying. Immediately following the final deck screeding operation, the Contractor shall apply a curing compound that is in conformance with the requirements specified in **Subsection 702.04A**. The Contractor shall use high efficiency multiple head water foggers with individual shut-off valves to increase the humidity directly above the fresh concrete until the curing mats are placed. The fogger system shall be demonstrated and approved by the Engineer before placing concrete. The foggers shall not spray directly onto the concrete. However, condensation from the foggers that wet the concrete without causing surface damage will be acceptable. The Contractor's attention is called to the fact that these measures alone may not prevent plastic cracking of the deck. Other preventative measures may be necessary including windbreaks or delay of the pour.

The top surface of the bridge decks shall be wet cured for a minimum period of seven (7) days. Curing blankets shall remain in place but may not prevent the Contractor from placing traffic over the slab if 90% of the 28-day compressive design strength has been reached. Approval

to place traffic on the slab in less than seven (7) days shall be obtained from the Engineer. Strength shall be based on breaks of cylinders that have been cured with the deck.

A testing site and a curing box shall be provided and maintained by the Contractor to cure cylinders for 28-day breaks. The curing box shall be capable of holding cylinders at a temperature between 60°F and 80°F until shipped to the SCDOT laboratory for storage in a curing room and conducting compression breaks.

Curing shall be performed by use of curing blankets placed as soon as practicable after placing the concrete and then covered with polyethylene or by use of a natural or synthetic fiber-polyethylene mat suitable for curing concrete. The exposed side shall be a white opaque polyethylene. Edges shall be overlapped and re-wetting of mats will not be required provided the overlapped edges remain sealed and the mats remain wet during the entire seven (7) day curing period.

B. Structural Concrete Other Than Bridge Decks.
Structural concrete other than bridge decks and precast or prestressed concrete shall be wet cured for a period of four (4) days by being kept saturated with water or covered with curing blankets described in **Subsection 702.20A**. Re-wetting of the curing blankets will not be required provided the blankets remain wet and the edges remain sealed throughout the curing period. Precast and prestressed concrete members shall be cured in accordance with the requirements of **Subsection 704.12C**.

Polyethylene sheeting may be used for curing concrete columns provided extreme care is taken to insure that the overlapping edges of the adjacent wraps and the extreme edges of the sheeting are sealed and that a saturated condition is maintained at all times inside the enclosure.

Any portions of the structure that require a final finish

coating may receive the coating immediately if recommended by the manufacturer as being capable of acting as a curing membrane. Material shall be applied at the rate as specified in **Subsection 702.25**.

A clear, non-wax, water-based, dissipating membrane-curing compound may be used instead of wet curing. It shall meet the requirements of **AASHTO M 148** (**ASTM C 309**), Type 1D as specified in **Subsection 702.04A**.

The curing compound shall be applied as soon as the finishing of the concrete surface has been completed and shall be applied uniformly at a rate of at least one gallon per 150 square feet until the entire surface has a solid and vapor-tight coating of the curing compound. The compound shall be applied by means of a spray nozzle that shall be held not further than 2 feet from the concrete surface, and the spray protected from the wind by suitable means if necessary. Provision shall be made to keep the spray nozzle and other spraying equipment clean at all times.

If rain falls on the newly sprayed surface before the film has sufficiently dried, the surface shall be immediately resprayed to the specified thickness. Where the curing compound is inadvertently applied to surfaces against which new concrete is to be cast, including projecting reinforcing steel, the material shall be completely removed by the use of steel wire brushes or by other means accepted by the Engineer.

The sprayed surface film shall be protected from abrasion or damage for at least three (3) days. The placing of forms, lumber, reinforcing steel, equipment, or unnecessary walking on the surface will not be allowed until the film is at least three (3) days old.

702.21 Removal of Falsework and Forms. In order to obtain a satisfactory surface finish, forms for ornamental work,

railings, parapets and other vertical surfaces that will be exposed in the finished work shall be removed 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. In no case shall the forms be removed in less than 5 hours or more than 48 hours, unless the concrete is poured on Friday, in which case the forms would be removed the following Monday.

Forms and falsework under slabs, beams, girders, arches and structures, or parts of structures carrying loads, shall remain in place until the concrete compressive strength reaches at least 75% of the design strength.

Methods of form and falsework removal likely to cause overstressing of the concrete shall not be used. In general, the forms shall be removed from the bottom upward. Forms shall not be removed without the consent of the Engineer.

Falsework supporting concrete beams, slabs and brackets that in turn will support sidewalks, concrete railing, or other applicable items shall be struck before the sidewalk, concrete railing, or the other items are cast.

Additional strength control cylinders shall be made if the Contractor desires early removal of falsework. The falsework may be struck when these cylinders, cured under the same conditions as the concrete in the structure, have developed a unit strength of 75% of the required 28-day compressive design strength. However, such concrete shall not be subjected to a superimposed load until the compressive strength develops 90% of the required compressive design strength. The Contractor shall assist in the transporting of the additional strength control cylinders to the Materials Lab for testing.

702.22 Initial Surface Finish. The concrete in all structures shall be thoroughly vibrated and worked during the operation of placing by means of suitable tools. The vibrating and working shall be such as to force the coarse aggregate from the surface and thoroughly work the mortar against the forms

to produce a smooth finish free from water-pockets, air pockets, sand streaks or honeycomb.

As soon as the concrete has met the requirements as specified in **Subsection 702.21**, the forms may be carefully removed. The fins shall be removed, and all depressions resulting from the removal of metal ties and all other holes and rough places shall be carefully pointed with a mortar of sand and cement. The surface of all such pointed surfaces shall be made flush with the adjacent structure surface by means of a wooden float (or equivalent) before setting of the sand and cement mortar mixture occurs. All surfaces to receive the final finish in accordance with **Subsection 702.25** shall have received this initial surface finish.

702.23 Repair of Concrete Surface Defects. After initial finishing has been completed, the concrete surfaces shall be inspected by the Engineer and minor surface defects shall be repaired as specified herein. Except on the top surface of bridge decks, when it is necessary to add a thin layer of structural grout/concrete to old concrete, a suitable type of epoxy bonding compound that shall produce an adequate bond between the two layers shall be used. The structural grout/concrete shall be suitable for the type of concrete repair for which it is intended, and the epoxy compound shall meet the requirements of ASTM C 881. Both shall be approved by the Engineer before their use.

Small defective areas of concrete on the top surface of bridge decks shall be repaired in accordance with the requirements of **Subsection 702.24**. For the repair of large defective areas on top surface of bridge decks, a low slump or latex overlay shall be placed to restore the deck to an acceptable condition. The overlay shall conform to the requirements of **Section 726**. All costs associated with these repairs due to defective materials and/or procedures of the Contractor shall be at no additional cost to the Department nor shall they extend the contract completion date.

All bridge deck cracks, including construction joints, with

widths 0.016 inch or greater occurring before the bridge is opened to the traveling public shall be sealed at the Contractor's expense. The cracks shall be sealed using a low viscosity, crack healer/penetrating sealer approved by the Engineer before its use. Crack sealing shall take place before any contamination of the cracks occurs.

702.24 Repair of the Top Surface of Bridge Decks. The following procedure shall be used to repair small defective areas on the top surfaces of bridge decks:

a. Outline the defective areas and saw cut to a minimum depth of 1 1/2 inches.

b. Remove all defective and/or delaminated concrete in the outlined areas by use of a concrete milling machine to a minimum patch depth of 1 1/2 inches. A mechanical scarifier may be used on small areas. If jackhammers are used, they shall be limited to maximum weight of 15 pounds. The vertical sides of the saw cut shall not be damaged during concrete removal.

c. Remove all grease, dirt, oil, or foreign material from the areas to be patched by blast cleaning.

d. Immediately before placing patching material, remove all dust, sand, and blasting debris with oil free compressed air.

e. An approved moisture insensitive epoxy bonding compound meeting the requirements of ASTM C 881 shall be applied as per the manufacturer's recommendations to the entire surface area of the repair immediately after cleaning. The concrete surface shall be dry, and the air temperature and concrete surface temperature shall be between 50°F and 80°F.

f. While the epoxy is still tacky, place the patching material. The patching material shall have 35% by vol-

ume of Aggregate No. 89M. The Contractor shall submit a proposed mix design to the SCDOT Research and Materials Laboratory for review and furnish a copy to the Engineer.

g. Finish off the top on the new patch to the proper grade and cure the patch in accordance with **Subsection 702.20**, with the exception that the curing time shall be extended to seven (7) days.

h. All repair work shall be completed before any grooving of the bridge deck.

702.25 Final Finish of Exposed Concrete Surfaces Except Bridge Decks.

A. General. Exposed concrete surfaces of structures, except for bridge deck slabs, shall be given a final surface finish in accordance with the following requirements for a sprayed or brushed finish. Unless otherwise specified, the finish used shall be at the Contractor's option. The same finish, either the sprayed or the brushed shall be used throughout the structure. The Contractor shall notify the Engineer of the type surface finish he intends to use before the start of the finishing work. Curing compounds shall comply with **Subsection 702.04A** when applied before application of the final surface finish. The Contractor must obtain verification from the finishing material manufacturer that the curing membrane material is compatible with the specified finishing material. Generally, the final finish application shall be applied as the final operation of the structure construction just before the final inspection.

Only materials from sources appearing on the Department's **Approved List** entitled *Approved Spray-On and Brush-On Surface Coatings for Concrete Finish*, available from the Research and Materials Laboratory, shall be used in the work. A manufacturer may request to be included on the list by furnishing certified test results from an independent laboratory verifying that the proposed

product meets or exceeds the durability requirements of this specification as well as identifying the source of resin with source technical data sheets. Further, the manufacturer shall submit ***Product Data Sheets***, ***Material Safety Data Sheets*** and brochures describing application procedures showing exact equipment with which to spray the material to obtain a rate of application of 55±5 square feet per gallon of material. This rate shall apply to solvent-borne or waterborne material.

The rate of 55±5 square feet per gallon shall override any manufacturer's recommendation that exceeds 60 square feet per gallon. The Engineer and the Contractor shall agree on the number of gallons needed for the project and a system of verification for the gallons received and used shall be established by the Engineer.

After approval, the manufacturer shall furnish, with each shipment, a materials certification showing brand name, production lot numbers, recommended rate of application, S.C. File No., the shipping date and to whom it is shipped. The certificate shall contain a statement that the material meets the South Carolina Department of Transportation specifications and is essentially the same as that approved by the Department. The shipped containers shall be plainly marked with the manufacturer's name and trademark, the production lot number, a clear date indicating date of manufacture and/or shelf life expiration date, and application procedures. A *Materials Safety Data Sheet* and a *Materials Data Sheet* shall be furnished with each shipment. Formulation changes after initial approval shall be submitted for evaluation by the Engineer.

B. Sprayed Final Finish. The material for the high build spray finish coat shall be a factory mixed coating to be applied as a single spray coat at the rate of 55±5 square feet per gallon of coating. The finish coat shall be uniform in color, coverage, and texture. The uniform coverage will vary in dry mil thickness depending on the properties of the product being used and will be controlled by control-

ling the application rate. The spray coat shall be applied uniformly to dry and clean surfaces that have received the initial finish. The concrete shall be allowed to cure for 3 to 4 weeks, depending on the weather, before application is made. A shorter time may be allowed by the Engineer if it is recommended by the manufacturer of the material. The sprayed finish shall be applied strictly in accordance with the written instruction of the product manufacturer. The actual application of the material shall be done by an operator who has been especially trained for this work, and who has developed a skill in the application of the sprayed finish.

The spray material to be used shall be an exterior coating. The color shall be light gray in color (Federal Shade No. 36622) and of fine texture. The spray coating material may be solvent-borne or waterborne.

C. Brushed Final Finish. At the Contractor's option, a brushed finish may be applied to all exposed surfaces throughout the structure instead of a sprayed finish. The material used shall be applied in two separate coats to provide a uniform finish of good texture on exposed surfaces that have received the initial finish. The material shall be mixed and applied strictly in accordance with the written recommendations of the product manufacturer. The actual application of the material shall be done by workers who have been instructed in the preparation and application of the material. The final brushing of the material during application shall be done in such manner as to present a uniform and attractive appearance, with the final brushing generally being done in one direction.

The material to be used shall be the same as described for the spray finish, but also recommended for brushing or a material predominately of portland cement, with special additives, meeting the requirements of **Federal Specification TT-P-0035**. The material shall be especially manufactured for waterproofing exterior concrete surfaces, and for enhancing the appearance of the con-

crete surface. The final color of the finish shall be light gray (Federal Shade No. 36622).

The material shall be on the **Approved List** entitled *Approved Spray-On and Brush-On Surface Coatings for Concrete Finish* and the manufacturer shall furnish a certification for each shipment stating that it meets the Departments specifications for a brushed-on finish.

D. Surface Preparation for Finish Coat. All foreign matter such as dirt, dust, mildew, efflorescence and curing compound on the surfaces shall be removed by water blasting. Water used for cleaning shall be either a potable water or a clean supply approved by the Engineer that shall leave no residue that would impair bonding. The water blasting equipment shall have a manufacturer's rating capable of operating at a minimum working pressure of 3000 psi with a 15 degree tip maximum with approximately 4.5 gallons per minute, 10 HP equipment, or equivalent, equipped with a working pressure gauge near the nozzle to check the working pressure. The Engineer shall inspect and accept the surface preparation in advance of the coating application.

In the event the foreign matter is not removed by the water blast method, an alternate cleaning method such as sandblasting or higher water pressure equipment shall be used for cleaning the surface.

When a clear curing compound has been used, 20 to 45 days are required for the membrane to dissipate and then the cleaning procedure should completely remove any membrane that is left.

E. Application of Finish Coat. The coating manufacturer's recommendations as to the minimum age of the concrete before the coating is applied shall be followed.

After the surface is cleaned, the coating shall be applied before contamination occurs. If adverse weather or

other obstacles prevent a timely coating application, the surface shall be re-cleaned as determined by the Engineer. The surface shall be clean and surface dry in accordance with the manufacturer's recommendations in advance of coating application. The coating shall be sprayed with equipment approved by the manufacturer of the coating. The spray procedure shall be as approved by the coating manufacturer. Coverage per gallon of the coating shall be in accordance with these specifications not to exceed 60 square feet per gallon.

702.26 Limits of Initial and Final Finishes. All concrete surfaces shall receive the initial surface finish that shall be applied as soon as the formwork is removed. In addition, the final finish shall be applied to all exposed surfaces, unless otherwise provided for on the plans or in the special provisions. The final finish shall be discontinued 6 inches below the final ground line or at the low water surface.

For culverts and minor structures, all concrete shall receive the initial surface finish and, in addition, the final finish on all permanently exposed surfaces, and carried 18 inches back from the edges of all surfaces to be covered with earth. The final finish shall be continued at least 24 inches inside the barrels of culverts at each end.

No separate payment for the initial and final finishes for concrete structures will be made. All costs for labor, materials, and equipment shall be included in other items of work.

702.27 Treatment of Horizontal Surfaces Not Subject to Wear. All upper horizontal surfaces, such as the tops of handrails, curbs, caps, parapets, coping, and bridge seats, shall be formed by placing an excess of material in the form and removing or striking off such excess with a wooden template after a suitable interval of time, forcing the coarse aggregate below the mortar surface. The use of mortar topping for the surfaces falling under this classification shall not be permitted. All bearing surfaces shall be finished smooth and level, either with a suitable trowel or be means of a suitable

dry rub with an abrasive after the concrete is at least two (2) days old.

702.28 Finishing of Bridge Deck Slabs.

A. When Covered with Bituminous Wearing Surface. After concrete is placed in deck slab forms, the tops shall be struck off to the proper crown and longitudinal profile with an approved template. The maximum deviation of the surface from the surface indicated on the plans shall not exceed 1/2 inch.

B. When Used as the Wearing Surface. After concrete placed in deck slab forms, the tops shall be struck off to the proper crown and longitudinal profile indicated by the plans. This shall be accomplished by using adjustable longitudinal or transverse screeds, of the greatest practicable strength, supported on transverse screed templates. At the ends of the span, the longitudinal screed shall be supported on the end bulkheads set at the top surface of the slab. The concrete roadway of adjacent slabs may be used as screed templates, provided the concrete in the adjacent slabs has set sufficiently and the weight of the screed distributed sufficiently to prevent damage. The transverse screed shall be supported rigidly and unyielding so that no appreciable deflection shall be realized. In setting grades, the Contractor shall determine the dead load deflections including any falsework loading and make adjustments as necessary.

In case of concrete slab spans or concrete girder spans supported on falsework, the top surface of the slab shall be finished with a camber sufficient to offset the dead load deflection of the slab and the long-term creep of the concrete. Unless otherwise directed by the Engineer, this camber shall be 1/8 inch for spans 20 to 30 feet long.

Spans of 80 feet and under may be screeded with a longitudinal screed of length equal to the span length. When using a longitudinal screed, spans of lengths

greater than 80 feet, but not greater than 100 feet, shall preferably be screeded with screed lengths equal to the span length, but in no event shall the major screed length be less than 1/2 of the span length.

As soon as the concrete has been placed and vibrated in a section of sufficient width to permit working, the concrete shall be struck off with sufficient passes of the screed (usually one for the transverse screed and two or three for the longitudinal screed) to obtain the required grade. A slight excess of mortar shall be maintained along the entire leading edge of the screed at all times to insure the filling of low spots. The final pass of the screed shall leave the surface true to grade and free from water, laitance, or other conditions leading to an undesirable surface. Care shall then be taken to remove all such surplus material from the gutters, where final hand finishing will be permitted. All screeding shall be accomplished before the initial set of the concrete has taken place. As screeding is completed at the beginning or end of a pour, especially where fresh concrete adjoins hardened concrete, the surface of the slab shall be carefully checked in the longitudinal direction with a 20 foot straightedge. Any abrupt change that would affect the surface smoothness shall be corrected while the concrete is still plastic. Closely following the final pass of the screed, the surface shall be textured by use of a drag composed of two layers of wet burlap on a transverse screed or a Department approved broom on longitudinal screeds.

All costs for labor, equipment, and other items necessary to provide the finish described above shall be included in the unit price for Class 4000 or Class 6500 concrete as appropriate.

Immediately after the curing operation is completed, the Contractor with the Engineer present shall check the slab for smoothness by means of a rolling straightedge. The rolling straightedge shall be provided by the Contractor and equipped with devices for making irregularities in

the slab surface of 1/8 inch or more in a length of 10 feet. Details of an acceptable rolling straightedge are on file in the Bridge Division office and may be obtained upon request. In addition to the rolling straightedge, the slab shall be checked by the Engineer by other suitable means for deviations from the theoretical grade for lengths parallel to the centerline of roadway longer than 10 feet. The maximum deviation from the theoretical grade for any length disclosed by either of the above procedures shall not exceed 1/1200 of the length or 1/2 inch, whichever is smaller. The maximum deviation from the theoretical crown in a direction normal to the traffic direction shall not exceed 1/4 inch. Excessive height of ridges formed by the finishing processes shall be removed. Irregularities more than the maximum deviations stated above shall be removed or corrected in a manner satisfactory to the Engineer and at the Contractor's expense.

702.29 Bridge Deck Rideability when Contractor Provides Stakes, Lines, and Grades. If called for in the contract, the Contractor shall provide the stakes, lines, and grades in accordance with **Subsection 105.08C**. When the plans show the design (future) traffic count exceeds 1000 vehicles per day, bridge decks shall be subjected to smoothness tests using a rolling straightedge as specified in **Subsection 702.28B** above and the Rainhart Profilograph. In addition, the surface shall meet a 0.20 inch in 10 foot straight edge check made transversely across the deck. The rolling straightedge tests shall be performed first. All corrective work associated with this test shall be completed before the Rainhart Profilograph test is performed. Profiles will be obtained by the Department as directed by the Engineer to within 6 feet of the barrier or curb line. A Profile Index Value will be determined in accordance with the test method entitled "Determining Profile Index Value Using the Rainhart Profilograph." The Profile Index Value shall not exceed 12 for each wheel path and individual bumps or depressions shall not exceed 0.10 inch from the 0.20 inch blanking band. The Profile Index computation shall be predicated on a length of section not to exceed 1000 feet.

Decks not meeting the above requirements shall be corrected at the Contractor's expense. The Contractor shall provide the Engineer a written plan of corrective action for approval before implementation. Approval of the corrective plan shall in no way relieve the Contractor of responsibility for meeting rideability requirements. The Contractor's corrective work shall not reduce the concrete cover shown in the plans by more than 0.05 inch. After corrective action, all decks will be subject to re-testing to insure the compliance with specifications. The Contractor may be required to reimburse the Department for the costs of any additional re-testing after the second profilograph test. All requirements for rideability shall be satisfied before the Grooved Surface Finish is applied to the bridge deck.

Expansion joint installation shall be delayed and the joint temporarily bridged to facilitate operation of the profilograph and corrective equipment across the joint wherever feasible.

It shall be the Contractor's responsibility to schedule profilograph testing. Requests for testing shall be made through the Engineer. The Contractor shall insure that the area to be tested has been cleaned and cleared of all obstructions.

This provision shall not apply to bridges where the design traffic is less than 1000 vehicles per day unless specified otherwise in the plans or special provisions.

The costs of the above work shall be in accordance with **Subsection 105.08C**.

702.30 Bridge Deck Rideability with Partial Department Furnished Lines and Grades. The Department will furnish lines and grades for projects as specified in **Subsection 105.08A** except for all lines and grades affecting the bridge superstructure. This exception includes screed, overhang, beam, and header lines and grades as well as parapet, rail, sidewalk, curb or median lines and grades. The Contrac-

tor shall be responsible for computing and setting these lines and grades. The Engineer will make random checks of the lines and grades set by the Contractor to determine if the work is in substantial conformance with the plans. The bridge deck rideability requirements of **Subsection 702.29** shall apply to the bridge structure

702.31 Grinding and Texturing Bridge Decks. After checking the bridge deck for maximum allowable deviations and rideability requirements, irregularities and excessive deviations shall be removed by grinding and texturing the deck as necessary to meet the requirements specified.

The equipment used for grinding and texturing shall not cause damage to other bridge components and shall not damage deck concrete that is to remain. The finished texture shall be produced with machines using diamond blades.

Depth of grinding shall not exceed 1/2 inch. The textured surface shall be uniform with a high skid number, and shall not have an excessive noise level under traffic. The deck surface within 12 inches of the gutter lines and within 2 inches of expansion or deflection joints shall not be textured. The Contractor may elect to produce a textured finish simultaneously with the grinding operation.

Residue from the grinding and texturing operation shall be removed by vacuum or other methods. All residue shall be legally disposed of off the site. Residue shall not remain on the deck or be washed into the bridge drainage system.

Grinding and texturing of new bridge decks to correct irregularities and excess deviations shall be done at the Contractor's expense.

Irregularities and excessive deviations at the junction of new and existing bridge deck slabs shall be removed or corrected in the manner stated above, but the actual square yards of deck textured and accepted will be paid for at the contract unit price for Grinding and Texturing Concrete Bridge

Deck, which price and payment shall be full compensation for all material, tools, equipment, labor, and incidentals to satisfactory complete the work.

702.32 Grooved Surface Finish. After the concrete has been cured and all applicable rideability specifications have been satisfied, all deck slabs, except rehabilitated decks or decks with staged construction, shall be grooved perpendicular to the centerline or parallel to the expansion or contraction joint. The grooves shall be cut into the hardened concrete using a mechanical saw device that shall leave grooves 0.125 inch wide and 0.125 inch deep. Grooves shall have a center to center spacing that may vary randomly from 0.625 inch to 1.125 inches.

Rehabilitated decks or decks with staged construction may be grooved longitudinally or parallel to the centerline. The deck surface within 12 inches of the gutterline or the edge of any raised median shall not be grooved, except on skewed decks that are grooved parallel to the expansion or contraction joint; in which case, the grooving may extend to a point measured 6 inches from and perpendicular to the gutterline or edge of raised median. The deck surface measured 2 inches from and perpendicular to the edge of expansion or contraction joints shall not be grooved. Triangular ungrooved areas in skewed decks shall not extend beyond a point measured 8 inches from and perpendicular to the edge of expansion or contraction joints or a point measured 18 inches from and perpendicular to the gutterline or edge of any raised median. Contractor shall not groove across expansion or contraction joints. All steel armor plates shall be set at the finish roadway elevation.

Residue from the sawing operation shall be removed from the deck by vacuum or other methods. All residue shall be legally disposed of off the construction site or shall be uniformly distributed in the roadway embankment as directed by the Engineer. Residue shall not remain on the deck nor be washed into the bridge drainage system.

Grooved Surface Finish shall be measured by the square yard of the actual slab area grooved and accepted by the Engineer. Deck areas not grooved will not be measured for payment.

The area of grooved surface finish will be paid for at the contract unit price for Grooved Surface Finish, which price and payment shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals including removing residue, necessary to satisfactorily complete the work.

702.33 Joints. Fixed and expansion joints in concrete structures shall be provided at the locations shown or as specified on the plans. Joint material shall conform to the requirements of **Subsection 702.03**.

A. Open Joints. Open joints shall be constructed by the use of removable bulk-heading forms that shall be built to be removed without injury to concrete.

B. Sliding Joints.

1. Roofing Felt. When roofing felt is used, the supporting or first formed concrete surface shall be true, smooth and parallel to the direction of movement. Care shall be taken in cutting, placing, and holding the roofing felt against this surface so that it will lie smooth, fit snug, and not become displaced or damaged during concreting. The roofing felt shall be held in place by the forms or by asphalt cement and shall be carried well beyond the area of contact, then cut back after the forms are stripped and all rubbing and finishing near the joint completed; after which the entire joint shall present a neat, workmanlike appearance, with absolutely no contact between the concrete on each side of the joint and with the joint free to move in the proper direction and the required distance.

2. Metal Plates. When metal plates are used as friction joints, they shall be anchored in correct position with full bearing and all sliding surfaces shall be planed true and smooth. When placed in position, all sliding surfaces shall be thoroughly coated with graphite or other approved lubricant. Movement shall not be impeded by contacts of surfaces other than bearing surfaces.

3. Mortised Joints. Mortised joints shall be constructed as shown on the plans and, in general, shall consist of a concrete or metal element sliding in a concrete or metal socket. The construction shall permit freedom of movement in the two opposite directions, and shall be watertight and rustproof to the greatest extent practicable.

C. Fixed Joints. Fixed joints between superstructure and substructure shall be separated by a layer of 1/4 inch thick elastomeric bearing pads, unless shown otherwise on the plans. Unless otherwise specified, elastomeric bearing pads shall be furnished and paid for in accordance with **Section 724**.

D. Expansion Joints. Expansion joint materials may consist of premolded filler, elastomeric compression seals, or deck joint strip seals.

1. Filled Compression Seal Joints. Filled compression joints shall be made with elastomeric compression seals or pre-molded filler, or both, as indicated on the plans or in the special provisions or as directed by the Engineer, conforming to the requirements of **Subsection 702.03**.

The joint filler shall be cut to fit exactly, out of the least number of pieces practicable, and shall completely fill the space shown on the plans. The various pieces in any one joint must be bonded together as recommended by the manufacturer and approved by

the Engineer. Loose fitting or gaps between sections of filler or between filler and concrete or steel headers, will not be permitted. The material shall be held in place by asphalt cement, adhesive recommended by the manufacturer, or other suitable means.

2. Deck Joint Strip Seals. Installation of deck joint strip seals shall conform to the requirements of **Subsection 723.04**.

E. Special Expansion Joints. Special types of expansion joints may be used when so specified on the plans or in the special provisions.

F. Measurement and Payment of Joints. Unless otherwise specified herein, on the plans, or in the special provisions, joints will not be measured for separate payment. All materials, equipment, tools, labor, and incidentals necessary to furnish and install expansion joints, except deck joint strip seals shall be included in the contract unit price for deck slab concrete

Deck joint strips seals shall be measured and paid for in accordance with **Subsections 723.05** and **723.06**.

702.34 Pipes and Conduits. Pipes and conduits that are to be encased in the concrete will be shown on the plans or specified in the special provisions, and unless otherwise provided, shall be furnished and placed by the Contractor without extra compensation.

In cases where the Department has authorized the placement of public utilities on a structure, the necessary pipes or conduits and any devices for supporting such utilities shall be furnished by the owners of the utilities involved. The placement of such supporting devices shall be done by the Contractor without extra compensation unless otherwise specified on the plans and/or the special provisions.

702.35 Weep Holes and Drains. Weep holes and drains or grates shall be constructed in the manner and place indicated on the plans or as directed. No additional compensation will be made for such work. No deduction in measurement of concrete will be made for these openings.

A. Weep Holes and French Drains for Box Culverts. When called for on the plans, weep holes and French drains as described herein shall be constructed in box culverts that have inside vertical dimensions of 6 feet or greater. Weep holes shall be 3 inches in diameter and shall be placed through the outside walls and wings at intervals of about 8 feet at an elevation of about 12 inches above the estimated normal water elevation. The inside face of the weep hole shall be covered with a 12 inch x 12 inch square of fiberglass or plastic mesh or grid that shall allow water to pass freely and shall prevent the loss of the aggregate. These holes are to be connected with 12 inch square French drains constructed with aggregate conforming to Aggregates Nos. 5 or 57.

B. Weep Holes and French Drains in Retaining Walls. Weep holes shall be constructed in retaining walls with a height of 6 feet or more above footing. The holes shall be spaced approximately 20 feet on centers, or as shown on the plans, and located at or slightly above finished ground line elevation on the exposed side of the wall. The weep holes shall be 3 inches in diameter, or as shown on the plans, and the inside face of the weep hole shall be covered with a 12 inch x 12 inch square of fiberglass or plastic mesh or grid that shall allow water to pass freely and prevent the loss of the aggregate. The weep holes shall be connected to adjacent weep holes with 12 inch square French drains. In addition, 12 inch square French drains shall extend vertically above each weep hole to within 2 feet of the top of the retaining wall. The French drains shall be constructed with aggregate conforming to Aggregates Nos. 5 or 57

702.36 Bridge Sidewalks and Curbs. The utmost care shall be taken in placing and finishing curbs and sidewalks to insure that they are placed true to line and grade and meet ADA requirements. The surface shall be screeded and floated and accepted by the Engineer.

702.37 Measurement and Payment. Measurement and payment for concrete structures will not be specifically made under this section of the specifications. Measurement and payment will be made in accordance with other sections of these specifications that govern the items of work included in the concrete structure.

SECTION 703

REINFORCING STEEL

703.01 Description. Work under this section shall consist of furnishing and placing concrete reinforcing steel consisting of bars, wire, wire mesh, bar supports and ties.

MATERIALS

703.02 Reinforcing Bars. Reinforcing bars and dowels shall conform to **AASHTO M 31** (**ASTM 615**),*Deformed and Plain Billeted-Steel Bars for Concrete Reinforcement*, and shall be Grade 60 unless otherwise specified. Acceptance or rejection shall be based on 36 inch long samples taken in the field.

703.03 Wire and Wire Fabric. Wire for concrete reinforcement, either as such or in fabricated form, shall conform to **AASHTO M 32** (**ASTM A 82**), *Steel Wire, Plain, for Concrete Reinforcement* or **AASHTO M 225** (**ASTM A 496**), *Steel Wire, Deformed for Concrete Reinforcement*. Welded steel wire fabric for concrete reinforcement shall meet the requirements of **AASHTO M 55** (**ASTM A 185**), *Steel Welded Wire*

Fabric, Plain, for Concrete Reinforcement.

703.04 Galvanized Reinforcing Bars.

A. **Zinc-coated Galvanized Reinforcing Steel**. Zinc-coated galvanized reinforcing shall be used in the construction of structural concrete for reinforcement when shown on the plans and shall extend to the limits shown. Zinc-coated reinforcing steel for structures shall be hot-dip galvanized in accordance with **ASTM A 767**, Class II, two ounces per square foot with a minimum thickness of 3.5 mils. The bars shall be galvanized after fabrication.

Reinforcing steel produced by Thermex method (water quenching) shall not be used.

B. Repair of Materials.

1. Shop Repair of Coated Bars. Zinc-coated reinforcing steel bars that do not meet the requirements above shall be rejected and shall not be repaired.

2. Field Repair of Coated Bars. The Contractor shall be required to field repair damaged areas of the bar coating and to replace bars exhibiting severely damaged coatings. Field repair material shall have a minimum 65% zinc by weight. Thickness of repair shall not be less than 3.5 mils.

The Engineer shall be the sole judge of the severity to damaged areas for purposes of repair or replacement. A reinforcing bar having a coating determined by the Engineer to be severely damaged shall not be incorporated in the work and it shall be removed from the work site. All such bars shall be replaced in kind by the Contractor at no additional cost to the Department.

C. Handling, Placing, and Fastening. All systems for handling galvanized coated bars shall have padded contact areas for the bars, wherever possible. All bundling bands shall be padded and all bundles shall be lifted with multiple supports or a platform bridge so as to prevent bar to bar abrasion from sags in the bar bundle. The bars or bundles shall not be dropped or dragged.

The tie wire shall be plastic coated and chairs and metal supports shall, at the Contractor's option, be either zinc or plastic coated. The specific hardware that the Contractor proposes to use shall be approved by the Engineer.

703.05 Mechanical Reinforcing Couplers.

A. Materials. All coupler components shall be compatible with the reinforcing bars specified in this Subsection. Splices made with mechanical couplers shall be as detailed on the plans or authorized in writing by the Engineer. The Contractor shall supply to the Engineer detailed assembly instructions from the coupler manufacturer, of each type of coupler being used. Couplers shall provide a tensile/compressive restraint of 125% of the yield strength of the reinforcing bar without any sign of failure.

Slippage of the coupler on the rebar is considered a failure.

B. Testing. The test shall use reinforcing bar samples and couplers from production lots being used on the project. A minimum of one coupler and rebar assembly shall be tested for each size or production lot of rebar and/or coupler to be used on the project. The Contractor may have the assembly tested by an independent laboratory instead of testing by the Department. Certified test results shall be furnished to the Engineer for the independent tests. The cost of this independent testing shall be the responsibility of the Contractor. In either case, the Engineer

will witness the rebar/coupler test samples being assembled. The testing shall be conducted based on tensile loading of the coupled reinforcing through yield point and to complete failure. Written test results shall include:

1. The value of 125% of the theoretical yield point of the rebar being tested.

2. Indicate that there is no failure of the coupler at 125% of yield, and

3. The tensile strength at which the rebar/coupler assembly failed.

The SCDOT reserves the right to request check samples of rebar/coupler assemblies to verify independent laboratory results. Test assemblies shall be 36 inches in length with components being randomly selected from material delivered to the project.

C. Handling and Storage. If construction is staged such that each coupled bar is not simultaneously required to be placed, the second bar shall be stored and protected at the site under the direction of the Engineer. The mechanical coupler, if of the threaded type, shall be placed on the bar in place in the finished structure in such a way to protect the threaded end of the bar. Additionally, the open end of the coupler shall be capped. Regardless of the method of mechanical coupling used, the Contractor shall exercise extreme caution in preventing damage to reinforcing or coupling devices that will inhibit or affect the certified behavior of the device. If in the Engineer's opinion, such damage is deemed to exist, the Contractor shall supply and replace the reinforcing, couplers, or both at his own expense.

The choice of coupler shall be made with consideration given to the clearance requirements for correct installation and proper alignment of the reinforcing after installation.

703.06 Bar Supports.

A. Wire Supports. Wire supports shall comply with standard type and classes of protection as specified in **CRSI *Manual of Standard Practice***, latest edition.

Wire supports shall be spaced to provide adequate support for slab reinforcing steel. For flat slab spans the lower layer of slab steel shall be supported by Beam Bolster (BB) bar supports with one row near each end of span and interior rows spaced approximately 24 inches on center. For beam spans, the lower layer of slab steel shall be supported by Beam Bolster (BB) bar supports approximately 36 inches on center with a minimum of three rows between longitudinal beams and one row on each overhang placed not more than 12 inches from edge of slab. BB bar supports shall have Class 1 maximum protection unless shown otherwise in the plans. Top reinforcing bars shall be supported by Continuous High Chairs Upper (CHCU) or Beam Bolster Upper bars (BBU) as shown on the plan details spaced a maximum of 30 inches on centers.

Tie wire for use with galvanized coated bars shall be galvanized in accordance with **AASHTO M 232** (**ASTM A 153**), Class D or plastic coated with a material compatible with the galvanized coated bars.

B. Plastic Bar Supports. Plastic Bar Supports may be used as an alternate to wire BB and BBU bar supports. When used, plastic bar supports shall meet the following requirements:

1. Chairs and bolsters must be of adequate strength to resist a 300 pound concentrated load without permanent deformation or breakage.

2. The material from which plastic bar supports is manufactured shall be either resin or first generation recycled thermoplastic resin, be colored white, gray, or

black, and be chemically inert in concrete.

3. Plastic reinforcing bar supports shall be molded in a configuration that does not restrict concrete flow and consolidation around and under the reinforcing bar support.

C. Concrete Blocks. Where concrete is to be placed directly on soil, concrete blocks may be used to support reinforcing bars. The blocks for holding the lower reinforcing bars in position shall be cast to approved shape and dimension from concrete of the same materials and proportions as that to be used in the structure, and shall be properly cured. The blocks shall not be over 6 inches in length and shall be placed to permit their ends to be covered with concrete. The use of pebbles, pieces of broken stone or brick, metal pipe or wooden blocks, shall not be permitted.

D. Measurement. Weights of the bar supports are not included in the reinforcing steel quantities. Bar supports shall be considered incidental to the reinforcing steel and all cost of furnishing and placing bar supports shall be included in the contract unit price for Reinforcing Steel.

CONSTRUCTION REQUIREMENTS

703.07 Protection of Materials. Steel reinforcement shall be stored on platforms, skids, or other supports raised above the surface of the ground, and shall be protected as far as practicable from mechanical injury, surface deterioration, and mud splatter. When placed in the Work, it shall be free from loose or thick rust, dirt, scale, dust, paint, oil, concrete mortar, curing compound, or other foreign material. The surface condition of the reinforcement shall be subject to the Engineer's approval before placing it in the structure.

703.08 Bending. The reinforcement shall be bent accurately to the shapes shown on the plans. Competent personnel shall be employed for cutting and bending, and proper appli-

ances shall be provided for such work. Bar bending shall be in accordance with recommendations in the CRSI *Manual of Standard Practice*, unless otherwise shown on the plans. 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 bars. Overall lengths of bars shown in the steel tables are the overall lengths of bars along their centerlines after bending. Finished bars shall conform to the shapes and dimensions called for. The fabricator shall make any allowances necessary to account for creep in the bars during bending to secure the shapes and dimensions called for on the plans and in the special provisions.

703.09 Placing and Fastening. All reinforcement shall be accurately placed and, during the placing and consolidation of concrete, firmly held in the positions shown on the plans. Distances from the forms and between layers shall be maintained by means of concrete blocks, hangers, bolsters or other approved supports complying with requirements of **Subsection 703.06**.

The reinforcement shall be held together by wiring at all intersections except where the spacing is 12 inches or less in each direction, in which case alternate intersections shall be tied. Bars projecting beyond a construction joint shall be held in place by templates during concreting to insure proper position.

Before concrete is deposited in the forms, the Contractor shall replace or bend back any steel or wires that project nearer the forms than specified by the plans. Reinforcement that is not in its proper position, properly wired, and cleaned as specified in **Subsection 703.07** shall be corrected to the satisfaction of the Engineer. Concrete shall not be deposited until the Engineer has inspected the condition of the reinforcing steel and given permission to place concrete. Unless otherwise provided or permitted by the Engineer, reinforcement shall not be placed during the placing of concrete.

703.10 Splicing of Bars.

A. General. All reinforcement shall be furnished in the full lengths indicated on the plans unless otherwise permitted. Except for splices shown on the plans, splicing of bars will be permitted only with advance written approval of the Engineer. Splices shall be staggered when possible.

B. Lapped Splices. Lapped splices shall be of the length shown on the plans. If not shown on the plans, the length of lapped splices shall be in accordance with **AASHTO *Standard Specifications for Highway Bridges***, and approved by the Engineer. In lapped splices, the bars shall be placed and wired to maintain the minimum distance to the surface of the concrete shown on the plans.

C. Welded Splices. Welded splices shall be used only if detailed on the plans or with the written approval of the Engineer. Welding shall conform to the **AWS D1.4 *Structural Welding Code, Reinforcing Steel***.

Welded lap splices shall be made with Low Hydrogen type electrodes. The welding procedure and two test samples shall be submitted for approval by the Department before beginning the fabrication of the splices. Hot dipped galvanized welded bars shall be repaired by use of a zinc rich formulation subject to approval of the Engineer.

D. Mechanical Splices. Mechanical splices shall meet the requirements of **Subsection 703.05**.

703.11 Method of Measurement. Reinforcing steel bars for structures will be measured as the number of pounds of steel accepted in place.

The diameter, area, and theoretical weight of reinforcing bars will be computed using Table 1a in **AASHTO M 31**.

The weight of reinforcing wire, welded wire fabric, and plain bar of sizes other than those listed in Table 1a referenced above, will be computed from tables of weight published by CRSI or computed using nominal dimensions and an assumed unit weight of 490 pounds per cubic foot. The cross-sectional area of wire in square inches will be assumed to be equal to its MW or MD-Size Number. If the weight per square unit of welded wire fabric is given on the plans, that weight will be used.

The weight of reinforcement used in precast members, where payment for the reinforcement is included in the contract price for the member will not be measured. Threaded bars or dowels placed in the Work and used to attach such members to cast-in-place concrete after the installation of precast members will be measured.

No allowance shall be made for clips, wire, separators, wire chairs, and other material used in supporting, spacing and fastening the reinforcement in place nor for galvanizing such items. If bars are substituted upon the Contractors request and as a result more steel is used than specified, only the amount specified will be measured.

The additional steel required for splices that is not shown on the plans but is authorized as provided herein, will not be measured. Mechanical couplers will not be measured, but shall be considered incidental to the furnishing of reinforcing steel.

No allowance will be made for the weight of galvanizing in computing the weight of reinforcing steel.

703.12 Basis of Payment. Payment for the quantity of each class of reinforcing steel shown in the bid schedule will be made at the contract unit price for the appropriate item, which price and payment shall be full compensation for furnishing, fabricating, cut, splicing, repairing or replacing, placing, and

securing reinforcing steel and including all materials, equipment, tools , labor, and incidentals necessary to satisfactorily complete the work.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7031100	Reinforcing Steel for Structures (Roadway)	Pound
7031105	Reinforcing Steel for Structures (Retaining Wall)	Pound
7031200	Reinforcing Steel for Structures (Bridge)	Pound
7031210	Spiral Reinforcing Steel for Structures (Bridge)	Pound
7031400	Galvanized Reinforcing Steel for Structures (Bridge)	Pound

SECTION 704

PRESTRESSED CONCRETE

704.01 Description. This work shall consist of the manufacture, handling, and installation of precast, prestressed concrete beams, slabs, channels and other prestressed concrete members in structures. The manufacture and handling of precast prestressed concrete piles is also a part of this section. The work shall be in accordance with the plans, **Sections 701**, **702**, **703**, **709**, **712**, and other sections that are pertinent to such prestressed members, except that this section shall govern where at variance from the other section or sections. Prestressing shall be of the pretensioning or post-

tensioning type, or a combination of two methods, as required by the plans and special provisions.

MATERIALS

704.02 Concrete. Unless otherwise specified on the plans or special provisions, concrete for prestressed concrete members shall be Class 5000, and shall attain a minimum 28-day cylinder compressive strength of 5000 psi. All concrete shall conform to the provisions of **Section 701**, except for the following modification:

Slag material will not be permitted as a coarse aggregate. Type I, Type II, or Type III cement, an approved admixture to secure high-early-strength, an approved admixture to secure a retardation in the initial set of concrete, or an approved air-entraining admixture to secure more workability may be used at the Contractor's option. Where an air-entraining admixture is used, the proportions of ingredients shall be adjusted to produce 27 cubic feet per cubic yard.

704.03 Prestressing Steel. Prestressing steel shall be high-tensile-strength steel wire, high-tensile-strength seven-wire strand, or high tensile-strength alloy bars as called for on the plans or in the special provisions. All wire, strand or bars shall be assigned a lot number and tagged for identification purposes before shipment. Anchorage assemblies to be shipped shall be likewise identified. Reels of prestressing strands stored on the prestressed plant yard and intended for the Department's use shall be stored off the ground and protected from the weather by means of a building or other approved cover.

Prestressing steel shall meet the requirements of the following:

A. High-Tensile Strength Steel Wire. High tensile-strength wire shall conform to the requirements of **AASHTO M 204** (**ASTM A 421**), latest edition.

B. High-Tensile Strength Seven-Wire Strand. High-tensile-strength seven-wire strand shall conform to the requirements of **AASHTO M 203** (**ASTM A 416**), latest edition.

C. High-Tensile Strength Alloy Bars. High-tensile-strength alloy bars shall conform to the requirements of **AASHTO M 275** (**ASTM A 722**), latest edition.

704.04 Anchorage Devices. The end fitting anchorage for post-tensioning steel wire cables shall be wedge type anchorage cone approved by the Engineer. The wedge type anchorage cones shall be strong enough to develop at least 95% of the total specified ultimate strength of the tendons. The anchorage cones shall bear against embedded grids of reinforcing steel of approved type. The wedge type anchorage device for alloy bar post-tensioning shall be of sufficient strength to develop the minimum ultimate stress specified for the nominal bar diameter; and the anchorage plates shall be fabricated of hot rolled steel having physical characteristics not less than that specified for **AASHTO M 270** (**ASTM A 709**), Grade 36, latest edition.

704.05 Testing Prestressing Steel and Anchorages. Testing of prestressing steel will be arranged for by the Department without cost to the Contractor. The manufacturer shall supply the Department with typical curves obtained from mill tests of the material furnished for use in checking stresses by means of observed elongation. In addition, the manufacturer of the strand shall furnish affidavits certifying as to the required properties. Where the Engineer intends to require nondestructive testing of one or more parts of the structure, special specifications will specify the required details of the work.

All of the materials specified for testing shall be furnished without cost to the Department and shall be delivered in time for tests to be made well in advance of anticipated time of use. All samples submitted shall be representative of the lot

to be furnished and in the case of wire or strand, shall be taken from the same master roll.

The following described samples shall be selected from each lot of material by the Department's inspector:

A. Pretensioning Method. For pretensioning strands, samples consisting of two pieces, one at least 40 inches and one approximately 12 inches long, shall be furnished for each shipment, each strand size, and each heat number, per five reels or part thereof, of regular or high strength strand.

B. Post-Tensioning Method. The following lengths shall be furnished:

1. For wires requiring heading: 5 feet.

2. For wires not requiring heading:
   Sufficient length to make up one parallel-lay cable 5 feet long consisting of the same number of wires as the cable to be furnished.

3. For strand to be furnished with fittings:
   5 feet between near ends of fittings.

4. For bars to be furnished with wedge anchors:
   5 feet between faces of anchor plates.

C. Anchorage Assemblies. Two anchorage assemblies shall be furnished complete with distribution plates of each size or type to be used if anchorage assemblies are not attached to prestressed steel samples.

704.06 Steel Reinforcement. Steel reinforcement that is not prestressed, shall conform to the requirements of **Section 703**.

704.07 Post-Tensioning Grout. The grout shall consist of a commercial premix approved by the Engineer or a mixture of cement, water and sand in the proportions of one bag of cement to 50 pounds of sand (all passing the No. 30 sieve) to about 5 1/2 gallons of water. The water may be varied so that the grout shall be of the consistency of thick paint. The sand may be omitted if desired, but care shall be taken to secure the consistency stated above. The grout shall be mixed in a mechanical mixer for at least two minutes and shall be kept constantly agitated.

EQUIPMENT

704.08 Jacks. The Contractor or fabricator shall provide all equipment necessary for the construction and the prestressing. Prestressing shall be done with approved jacking equipment. If hydraulic jacks are used, they shall be equipped with accurate pressure gauges. The combination of jack and gauge shall be calibrated and a graph or table showing the calibration shall be furnished the Engineer. The calibration shall be rechecked at least once each year. Should other types of jacks be used, calibrated proving rings or other devices shall be furnished so that the jacking forces may be accurately known.

CONSTRUCTION REQUIREMENTS

704.09 General. All fabrication of prestressed concrete members in structures shall be performed by a fabricator certified in accordance with the Prestressed Concrete Institute (PCI) Plant Certification Program for the category of work to be done. The Contractor or prestressed concrete fabricator shall have a PCI certified technician at the plant at times to supervise all work done on prestressed concrete members for SCDOT projects. This technician shall insure that all prestressing operations are performed properly and shall assist the Engineer in making tests and measurements that may be necessary.

A permanent beam identification marking showing name or symbol of manufacturer, date cast, a number identifying the beam in the structure and file number shall be placed in permanent paint on each beam at a location that is readily accessible and that will not be covered by diaphragms, etc. Where orientation of the direction of the beam in the span is necessary, this information shall be painted clearly with appropriate arrows to show the proper erection of beam. Information, as described above, shall be placed on piles in an area that will not be covered by the cap.

704.10 Shop Plans. Before commencing fabrication, the Contractor shall submit for review by the Engineer seven sets of the complete shop plans sealed by a South Carolina registered Professional Engineer, showing details covering the plant, forms, equipment and method proposed to be used, including pickup devices, and tensioning and de-tensioning procedure in detail for manufacturing the precast, prestressed concrete members. These drawings shall also include strand elongation computations, procedure and sequence of jacking and release of the deflected strands and description of the devices that hold up or down the deflected strands, complete post-tensioning details and other methods or procedures that may be desired by the Engineer in order to fully describe the fabrication of the prestressed members.

Shop plans shall be prepared and submitted in accordance with **Subsection 725.02**.

After a central prestressing plant has established a satisfactory operating routine, the Department may waive some or all of the requirements for working drawings on standard prestressed members.

704.11 Forms. Forms for continual reuse shall be of steel. All forms shall have smooth joints so that the surfaces of the concrete members shall be free of fins and shall be well braced to maintain true shape and dimension. Forms ties, if used, shall be of the snap-off or threaded type so that no tie

metal will remain closer than 3/4 inch from the surface of the concrete. The bottom corners of the beams shall be formed with 3/4-inch x 3/4-inch (45 degree) chamfer whether or not the same is shown on the plans. The holes for diaphragm tie bars shall be carefully and accurately located. Where voids are formed in a prestressed member, a positive means shall be used to hold the voiding device accurately in position. All forms must be approved by the Engineer before casting any concrete. If at any time during the course of construction any form becomes damaged or deformed so that it will not produce members of the proper dimensions, it shall be repaired or replaced.

The finished prestressed girder must meet the tolerances shown on the ***Standard Beam Details*** sheet included in the plans.

704.12 Concrete Work.

A. Placing Concrete. Concrete shall not be deposited in the forms until the Engineer has inspected the placing of the reinforcement conduits, anchorages and prestressing steel; and has given his approval thereof. The concrete shall be vibrated internally and/or externally. The vibration shall be done with care and in such a manner as to avoid displacement of reinforcing, conduits, or wires.

B. Finishing Concrete. Irregularities in the surface of the beams shall not be corrected without the prior approval of the Engineer. Excessive surface defects may be cause for rejection of a member. Except for the outside faces of exterior beams, all surface air and water holes greater than 1/4 inch shall be filled with mortar and the entire surface shall be smooth and free from irregularities. The outside faces of exterior beams shall be given the surface finish as set forth in **Section 702**.

The top surfaces of beams against which cast-in-place concrete will be placed later shall be rough floated with a wooden float to bring grout to the surface and cover all

aggregate. At this time, the top surface shall be intentionally roughened to a full amplitude of approximately 1/4 inch.

C. Concrete Curing. Curing may be by the moist curing method or accelerated curing with low pressure steam or radiant heat. All wet mats and covers shall be approved by the Engineer.

1. Moist Curing Method. Under normal curing temperatures the following shall apply:

As soon as possible after the units have been cast, they shall be covered with mats that shall be kept wet until the side forms are removed. After the side forms are removed, the units shall be protected with wet mats and a vapor proof cover until they have attained the strength requirements for detensioning.

In case it is necessary to remove the protective covering to point up honeycomb areas or to give the units a surface finish, the surfaces of the units shall be kept moist during the entire time that the units are uncovered. During the curing period, the concrete shall not be exposed to temperatures below freezing.

2. Accelerated Curing with Low Pressure Steam or Radiant Heat. Low pressure steam curing or radiant heat curing shall be done under a suitable enclosure to contain the live steam or the heat. The enclosure shall cover the units as soon as possible after the concrete has been finished. The concrete shall be allowed to attain its initial set before application of the steam or the heat. The minimum time of application of the steam or the heat shall be two hours (four hours if retarders are used) after the final placement of concrete to allow the initial set of the concrete to take place. The time of initial set may be determined by the

Method of Test for Time of Setting of Concrete Mixtures by Penetration Resistance, **AASHTO T 197**, and the time limits described above may then be waived. During the waiting period, in cold weather, the temperature within the curing chamber may be maintained between 50°F and 80°F with live steam or radiant heat.

To avoid localized high temperatures, the application of steam shall not be directed on the concrete forms.

Radiant heat may be applied by means of pipes circulating steam, hot oil, or hot water, or by electric hearing elements. Moisture loss shall be minimized by covering all exposed concrete surfaces with wet mats.

During the application of live steam or radiant heat, the ambient temperature within the curing enclosure shall increase at a rate not exceeding 40°F per hour until the desired curing temperature is reached. The average curing temperature within the enclosure shall not exceed 160°F. The curing temperature at any single point shall not vary more than 10°F from the selected average curing temperature and shall not exceed 170°F maximum.

Recording thermometers shall be provided at the one-third and two-thirds points of the bed to verify the curing period and the curing temperature from the time of final placement of concrete to the time of cover removal. The covers shall be removed in a manner to avoid rapid temperature changes in the concrete.

D. Detensioning Prestressed Units. 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, they shall be detensioned as soon as possible after the required initial minimum compressive strength of the concrete has been

reached and while the concrete is still warm. Additional curing will not be required after detensioning.

E. Inspection and Testing. The Engineer or his representative shall have free access to the fabrication plant at all times for the purpose of inspecting materials, plant facilities and fabrication and curing procedures. The fabricator shall inform the Engineer of his 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 reviewing of procedures that will be used in casting the units.

F. Cylinder Molds. The fabricator shall furnish an ample supply of cylinder molds for the casting of test cylinders. All molds shall be subject to the approval of the Engineer. A mold size of 4 inches x 8 inches is acceptable.

G. Compression Machine. The fabricator shall furnish a machine capable of measuring the compressive strengths of concrete cylinders cast during the fabrication of the units. All testing machines used to determine the stress release time for the units shall be calibrated annually and by an independent recognized calibration service. Calibration reports shall be made available for review on request of the Engineer.

704.13 Tensioning Procedure.

A. General. During the course of construction, special care must be taken to protect the prestressing wire, strand or bars from damage due to use of welding or cutting equipment. This provision, however, is not to be taken as excluding 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. Care must be taken to see that no lubricant, dirt, paint or other bond-reducing material is deposited on the strand. If any is so deposited, the strand must be cleaned to the satisfaction of the Engineer. Any

loose rust shall be removed before concreting.

B. Pretensioning. The number, size and location of the strands required to induce the necessary prestress force shall be as shown on the plans. At the request of the Contractor, the Department will give consideration to the use of other size strands or to the use of strands of higher ultimate unit stress, provided approximately the same concrete stress pattern and approximately the same beam camber is obtained in the substitute beam as would have been obtained in the original beam design. Written permission must be obtained from the Department before any such changes are made. Each strand of all sizes, shall be given an initial tension as approved in the shop drawings. This initial tension shall be measured by some suitable means indicating the stress directly from the jacking gauge or a dynamometer and shall not be measured by elongation of the stands. The remaining prestressing force shall be applied to the strands by means of hydraulic jacks equipped with gauges graduated to indicate the load applied to the strands within an accuracy of two percent. In general, the final force shall be measured by elongation of the strands and checked by the calibrated pressure gauge. Any discrepancy between the pressure gauge and the strand elongation greater than 5% shall be reported to the Engineer and corrections made as directed by him.

The force applied as described above shall be maintained until the concrete is deposited and has reached a minimum compressive strength of $0.8 \times f'_c$ for beams, or $0.7 \times f'_c$ for piles, at which time the strands may be released to transfer the prestress to the concrete. The releasing of the strands shall be done so that there will not be a sudden imposition of bond stress between the concrete and the strands. The releasing shall be effected symmetrically about the vertical axis of the concrete member. Side forms may be removed when in the opinion of the Engineer the concrete has hardened sufficiently to permit such removal without damage to the concrete

member.

Where deflected pretensioned strands are required, these strands shall be first stressed in a horizontal position by a partial force in the amount as shown on the approved shop drawings. The final stress shall be secured by deflecting 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 strand will not exceed two percent.

C. Post-tensioning. Jacks used for post-tensioning shall have been re-calibrated subsequent to use if the calibration date is past six months. The calibration results of the jack and gauge shall be certified to the Engineer with a graph or table showing the calibration data. The calibration shall be rechecked every six months or the Contractor may furnish a proving ring to check calibration of the jack.

Post-tensioning of beams shall not be begun until the concrete has reached a minimum compressive strength of $0.8 \times f'_c$. All tendons in one cable must be stressed simultaneously. Tendons not on the vertical axis of beam shall be stressed in such manner that the force during tensioning on one side of the vertical axis will not be greater than that on the other side of the vertical axis to an extent to cause undesirable bending about such axis. The applied tension in each tendon shall be in accordance with that specified on the plans. Jacking shall be carried out by means of hydraulic jacks equipped with pressure gauges. The gauges shall read within 2% of the true jack force. The elongation of tendons shall be measured and the stresses checked in accordance with the requirements of the current ***AASHTO Standard Specifications***. The elongation of the tendons shall be increased by the amount of observed slip occurring in the end anchorages. The prestress force shown on the plans must be applied

to the beam. After this force has been transferred to the concrete by means of the end anchorages, the ducts containing the tendons shall be pressure grouted. The method of anchoring post-tensioning tendons must be approved by the Department before use.

The grout shall be forced 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. The outlet end and orifice shall then be closed while the grout is under pressure and the pressure increased to about 75 psi and held at this pressure for approximately ten seconds. The entrance end shall then be plugged under this pressure. Beams may be lifted before grouting, but after grouting, shall not be lifted until the grout has cured for at least 36 hours.

The plans may show the post-tensioning tendon enclosed in steel ducts. The Contractor may, at his option, form channels by means approved by the Engineer and pull the tendons into these channels instead of using ducts. The diameter of such channels shall not exceed the outside diameter of the duct shown on the plans. The ducts or channels shall be accurately located in a parabolic or a circular curve. Ducts shall be secured by wire or bar ties fastened to the vertical bars in the beams. If rubber or plastic ducts are used to form the holes, such material shall be removed before inserting the wires or strands. A lubricant shall not be used to coat the outside of the ducts for ease of removal.

D. Combined Pretensioning and Post-Tensioning.
When the plans call for or allow a combination of pretensioning and post-tensioning, all of the requirements of both the pretensioning and post-tensioning shall apply and the requirements shall overlap as necessary to fulfill the intent of this specification.

704.14 Handling and Erection. Prestressed piles, beams,

slabs, channels, and other components may be handled as necessary immediately after the pretensioned stress is released. Care shall be taken in handling, storing and transporting to prevent damage to the components by excessive vibration, impact, improper supports or other faulty methods of handling, transporting and storing. Beams shall be lifted by attachments located near the beam ends and stored 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. Prestressed members may be transported and erected or piles driven after three (3) days of curing and attainment of the required concrete compressive strength

704.15 Method of Measurement.

A. Prestressed Concrete Beams. Prestressed concrete beams and girders shall be measured by the linear feet of beam of the type and size specified, accepted, erected in place in the bridge or bridges, and in accordance with the plans and special provisions.

B. Prestressed Concrete Piling. Prestressed concrete piling will not be measured for payment under this section of the specification, but will be measured and paid for as specified in **Subsections 711.32** and **711.33**.

C. Other Prestressed Members. Other prestressed members shall be measured and paid for as specified elsewhere in the plans or special provisions.

704.16 Basis of Payment. Prestressed concrete beams will be paid for at the contract unit price, complete and in place, which price and payment shall be full compensation for furnishing all materials (including strands, cables, anchorages, bearing plate assemblies, sole plates, reinforcing steel, concrete and all other necessary material) and all equipment tools, labor, shop plans, insurance and other items necessary for fabricating, curing, hauling, erecting and furnishing the beam or girder.

Partial payment for prestressed concrete beams may be made in accordance with the schedule in **Subsection 109.06**.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
704XX00	Prestressed Concrete Beam *(type)*	Linear Foot

SECTION 705

BRIDGE RAILING

705.01 Description. This work shall consist of the furnishings and erection of bridge railing of cast-in-place concrete, precast concrete, aluminum, steel, or other specified materials, or a combination of these materials on bridges, walls, or incidental structures as shown on the plans.

Unless otherwise stated, bridge railing shall include 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.

Bridge railing shall be constructed in accordance with the details shown on the plans and shall include the necessary devices for anchoring or attaching the railing to the main structure.

MATERIALS

705.02 Concrete Railing Wall and Barrier Parapet. Concrete shall not be less than Class 4000 unless otherwise

specified and shall conform to the requirements of **Sections 701** and **702**. Reinforcing steel shall conform to the requirements of **Section 703**.

Concrete for Light-weight Concrete Bridge Barrier Parapet shall be manufactured from light-weight coarse aggregate sources approved by the Research and Materials Laboratory. Concrete shall obtain a 28-day design compressive strength equal to or greater than Class 4000 and weigh 3100 ± 50 pounds per cubic yard.

705.03 Precast Bridge Barrier Parapet. Concrete for Precast Bridge Parapet shall be not less than Class 4000 and shall conform to **Sections 701** and **702**. Reinforcing steel shall conform to the requirements of **Section 703**. Precast sections shall be cast to the dimensions shown on the plans. All installation hardware consisting of bolts, nuts, washers, inserts, and rods shall be galvanized in accordance with **AASHTO M 111** (**ASTM A 123**) or **AASHTO M 232** (**ASTM A 153**) as applicable.

705.04 Galvanized Steel Railing and Steel Handrail.

A. Post and Rail. Each fabricated steel post assembly shall conform to the same general appearances as the railing shown in the plans. The Contractor shall prepare and submit shop drawings showing complete details of all parts of the Post and Rail conforming to the requirements of **Section 725**. Unless otherwise shown on the plans, all steel rail and post components shall conform to the requirements of **AASHTO M 270** (**ASTM A 709**), Grade 36. Rail caps shall conform to the requirements of **ASTM A 245**, Grade C. All required hardware including bolts, nuts, screws, etc, shall conform to the requirements of **Subsection 705.06**.

B. Galvanizing. The steel posts and railing shall be hot dipped galvanized in accordance with the current **AASHTO M 111** (**ASTM A 123**) or **AASHTO M 232** (**ASTM A 153**) as applicable.

C. Cut Ends of Galvanized Steel Railing. After grinding smooth, the cut ends of galvanized steel railing shall be given two coats of a zinc rich paint meeting the requirements of **Federal Specification TT-P-641** or an equal material approved by the Engineer.

705.05 Aluminum Railing.

A. Extruded Aluminum. Aluminum alloy extruded rails, posts, bases, expansion bars, etc. shall conform to ASTM B 221, Alloy 6061, Condition T6.

B. Cast Aluminum. Cast Aluminum railing post and other items for permanent mold castings shall conform to ASTM B 108, Alloy G70B, Condition T61, except that the elongation in two inches shall be not less than 8%.

705.06 Stainless Steel Bolts, Nuts, Set Screws, and Washers. Galvanized steel or aluminum rail shall be fabricated with stainless steel hardware meeting the requirements of **ASTM A 276**, Grade 305.

CONSTRUCTION REQUIREMENTS

705.07 General. The railing shall be of the type specified and shall be constructed in accordance with the details shown on the plans and in conformance with the requirements herein. It shall be constructed to the alignment, grade and camber designated on the plans. Shop fabricated railing shall be of such uniformity as to insure 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 will be cause for rejection of the railing. Unless otherwise provided, railing shall not be placed until after the falsework for the span has been released. During erection of the railing, care shall be exercised to insure proper functioning of expansion joints.

Unless otherwise shown on the plans or directed by the

Engineer, railing posts shall be erected vertically, with tops of posts parallel to the roadway grade shown on the plans.

A. Metal Railing. The fabrication and erection of steel railing shall conform to the pertinent provisions of **Section 709**, and to the requirements of this specification. Fabrication of aluminum railings shall be in accordance with Division 1, Section 11 of the current **AASHTO *Standard Specifications for Highway Bridges***. Splicing of rail members will generally be near railing posts and will be permitted only as shown on the plans. Working drawings are required for metal railing in accordance with **Subsection 105.02** of these specifications.

All components of metal railing shall be carefully handled and stored in order to avoid scratching, marring, denting or otherwise damaging the railing. Aluminum members shall be separated from concrete or steel by methods called for on the plans; or if not shown on the plans, the separation shall be by an elastomeric sheet 1/16 inch thick, durometer 60, that meets the requirements of **AASHTO M 251**.

All welding of steel railing shall be done in accordance with the requirements of the current **ANSI/AASHTO/AWS D 1.5 *Bridge Welding Code***. All welding of aluminum railing shall conform to Section 10 of the current **AWS D 1.2 *Structural Welding Code - Aluminum***.

B. **Concrete Bridge Railing Wall and Barrier Parapet**. The construction of the concrete railing wall and barrier parapet shall conform to the requirements of Section **702**. Extreme care shall be exercised in the construction of railing forms in order that true grade and alignment of railing or barrier members will be obtained and no concrete shall be placed until the forms have been inspected and approved by the Engineer. Any portion of the concrete railing wall or barrier parapet that is not constructed to true grade and alignment and cannot be satisfactorily cor-

rected, in the opinion of the Engineer, shall be removed and reconstructed at the Contractor's expense.

At the option of the Contractor, the concrete bridge rail curb base or barrier parapets may be slip formed. The method of slip forming the concrete shall be submitted to the Engineer for approval. A 1 1/2 inch extension of the concrete slab is required if the Contractor elects to slip form the concrete bridge rail curb base or barrier parapets. No additional reinforcing steel is required, and the payment for the concrete in the slab will be for the quantity shown on the plans.

C. Rail Surface Finish. The Contractor shall provide either a rubbed finish or a Final Surface Finish as specified in **Subsection 702.25**.

705.08 Method of Measurement. Bridge railing of all types will be measured by the linear foot of railing including all posts and spaces between posts, complete in place and accepted by the Engineer.

The portion of the structure to be included in cast in place bridge railing shall be that portion above the top of the deck, curb, or sidewalk, but excluding all reinforcing steel in concrete members which shall be measured for payment as prescribed under **Section 703**.

Precast Bridge Barrier Parapet shall be measured by the linear foot in place and shall include all the portion above the top of the deck, curb, or sidewalk including the reinforcing steel.

705.09 Basis of Payment. Bridge Railing will be paid for at the contract unit price for the type railing shown on the plans or in the proposal, complete in place and measured as prescribed in Subsection 705.08 . This price and payment shall be full compensation for preparing and furnishing shop drawings, furnishing, preparing, and placing all concrete, expansion joint material, structural steel, metal castings, pipe,

hardware, anchor bolts, and all other materials required in the finished railing, except reinforcing steel in cast-in-place concrete members, and for all labor, tools, equipment, galvanizing, and incidentals necessary to complete the work in accordance with the plans and these specifications.

All non-prestressed reinforcing steel in concrete members will be paid for under the provisions of **Section 703**.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7051000	Concrete Bridge Barrier Parapet	Linear Foot
7051005	Precast Concrete Barrier Parapet	Linear Foot
7051010	Concrete Bridge Barrier Parapet (Lightweight)	Linear Foot
7051100	Concrete Bridge Median Barrier	Linear Foot
7053000	Steel Bridge Railing	Linear Foot
70540XX	Concrete Bridge Railing Wall *(type or height)*	Linear Foot
7055010	Steel Handrail	Linear Foot
7055100	Metal Bicycle Handrail	Linear Foot

SECTION 706

WOOD PRODUCTS FOR USE IN HIGHWAY CONSTRUCTION

706.01 Description. This specification governs treated and untreated wood products for use in highway construction and pertains only to such products that become part of the completed work. Wood products for erection purposes such as

falsework, forms, bracing, sheeting etc. shall be furnished by the Contractor without specification and direct compensation.

MATERIALS

706.02 Structural Lumber. Structural lumber shall be as described in current Southern Pine Inspection Bureau Special Products Rules. The Grade shall be Dense Structural 65 or better for use in wood bridge caps, stringers, flooring and beach groins. Where specified, treatment shall be in accordance with **Section 707**.

706.03 Dimension Lumber. Dimension Lumber shall be as described in current **Southern Pine Inspection Bureau Grading Rules**, Section 300. The Grade shall be No. 1 Dense or better for use in wood bridge components other than as described in **Subsection 706.02**. For other miscellaneous uses of lumber, the grades and sizes shall be in accordance with Southern Pine Inspection Grading Rules for the intended use. Where specified, treatment shall be in accordance with **Section 707**.

706.04 Guardrail Posts. Wood posts and offset blocks shall be Southern Yellow Pine conforming to the requirements for rough or dressed timbers as described in the current Southern Pine Inspection Bureau Grading Rules, Section 400. The grade for guardrail posts and offset blocks shall be No. 1 or better. Posts shall be sawn square with all faces perpendicular to each other. Width or thickness exceeding the dimensions specified on plans will not be allowed. Lengths shall be as shown on the plans with a tolerance of plus 2 inches. All ends shall be sawn square.

706.05 Wood Fence Posts and Braces. Wooden fence posts and braces shall be round or sawn square as specified from Southern Yellow Pine. Sawn posts and braces shall be at least No. 2 grade for dimension lumber or timbers as applicable and as described in current Southern Pine Inspection Bureau grading rules. Round posts and braces shall be sound, free from decay, excessive knots, clusters of knots, or

splits that exceed 1 1/2 times the diameter of piece. Seasoning checks not affecting serviceability will be permitted. All posts and braces shall be reasonably straight.

Line posts and post braces, unless otherwise specified, shall be round posts having a nominal diameter of 4 inches with no diameter less than 3 1/2 inches at any point or square posts sawn nominal 4 by 4 inches with no dimension less than 3 5/8 inches (rough) and 3 1/2 inches (dressed).

End, corner, gate and pull posts shall be round posts having a nominal diameter of 6 inches with no diameter less than 5 1/2 inches at any point, or square posts sawn nominal 6 by 6 inches with no dimension less than 5 5/8 inches (rough) or 5 1/2 inches (dressed).

Lengths of posts shall be so furnished as to provide a uniform height of 5 inches above the top strand of wire and a minimum embedment in firm ground of 2 1/2 feet for line posts and 3 feet for other posts.

Unless otherwise specified, treatment method of Southern Yellow Pine posts and braces shall be in accordance with **Section 707**.

706.06 Timber Piles. Timber piles either treated or untreated shall meet general quality requirements and physical characteristics as herein specified. Where specified, treatment will be in accordance with Section 707.

A. Timber Piles. Piles shall be cut from sound, live trees, except that fire killed, blight killed or wind felled timber may be used if not attacked by decay or insects. Piles shall be cut above the ground swell and with both tip and butt ends sound.

B. Knots. Sound knots shall be no larger than one sixth the circumference of the pile located where the knot occurs. Cluster knots shall be considered as a single knot, and the entire cluster cannot be greater in size than per-

mitted for a single knot. The sum of knot diameters in any one-foot length of pile shall not exceed one third of the circumference at the point where they occur. The size of a knot shall be its diameter measured at right angles to the length of the pile.

Piles may have unsound knots not exceeding half the permitted size of a sound knot, provided that the unsoundness extends to not more than 1 1/2 inches depth and that the adjacent areas of the trunk are not affected.

C. Checks, Shakes, and Splits. A check shall not extend any deeper than to the pith. There shall not be any two or more checks extending to the pith that become contiguous at the pith, except as modified under splits. A check is defined as a lengthwise separation of the wood across the rings of normal growth, extending from the surface toward the pith, but not extending through the piece.

The length of any shake or combination of shakes in the outer one half of the radius of the butt of the pile, when measured along the curve of the annual ring, shall not exceed one third of the circumference of the butt of the pile. A shake is defined as a circumferential separation of the rings of normal growth.

Splits shall not be longer than the butt diameter. A split is defined as a lengthwise separation of the wood across the rings of normal growth, extending from one surface through the piece to the opposite surface.

D. Holes and Scars. Holes less than 1/2 inch average diameter shall be permitted in piles, provided the sum of the average diameters of all holes in any one square foot of pile surface does not exceed 1 1/2 inches, and the depth of any hole does not extend to more than 1 1/2 inches.

Piles having sound turpentine scars undamaged by insects shall be permitted.

E. Sapwood in Piles for Treatment. Piles for use with preservative treatment shall contain a minimum of 1 1/2 inches of sapwood.

F. Peeling. Piles for treatment shall be peeled of bark, including the inner skin, soon after cutting so that piles are smooth and clean. Care shall be taken to remove as little sapwood as possible while peeling the bark.

The sapwood shall not be injured by unnecessary axe cuts. No pile shall be considered peeled unless all of the rough bark and at least 80% of the inner bark along the pile length, has been removed. In no case shall any piece of inner bark be over 1/2 inch in width or over 6 inches in length, and there shall be 6 inches of clean wood surface between any two strips of inner bark.

G. Taper and Surface Finish. Piles shall have a gradual taper from the point of butt measurement to the tip. Knots and limbs shall be cut flush with the surface of the pile in a manner to prevent fiber breaks around the knot. Knots may be hand-trimmed flush with the surface of the swell surrounding the knot. The butt and tip shall be sawed square with the axis of the pile to an accuracy of 1/10 inch per inch of diameter.

H. Twist of Grain. Spiral grain shall not exceed 180° of twist when measured over any 20 foot section of the pile.

All piles shall be straight to the extent that a line drawn from the center of the butt end of the center to the tip end shall lie within the middle 2/3 of the body of the pile at all points. Piles shall also be free from short crooks in which the surface deviation from straightness in any 5 feet of length exceeds 1 1/2 inches at any location as determined by a straight edge.

I. Dimensions. The diameters of piles measured under the bark shall conform to the requirements shown in the

following **Table 1**, subject to a permissible variation of minus 1/2 inch in any diameter in not more than 20% of the piles of that diameter.

Table 1
Diameter of Pile

Length (feet)	Diameter at 3 Feet from Butt (inches)		Minimum Diameter of Tip (inches)
	Minimum	Maximum	
Under 25	11	20	8
25 to 40 inclusive	12	20	8
40 to 50 inclusive	12	20	7
50 to 70 inclusive	13	20	7
70 to 90 inclusive	13	20	6
Over 90	13	20	5

The diameter of a pile in cases where the tree is not exactly round shall be determined either by measuring the circumference and dividing the number of inches by 3.14, or by taking the average of the maximum and minimum diameters at the location specified.

The specified length of piles shall be in multiples of 5 feet. For piles 40 feet and shorter, the length may exceed the specified length by one foot. For piles 45 feet and longer, the length may exceed the specified length by 2 feet.

CONSTRUCTION REQUIREMENTS

706.07 Storage of Materials. Treated and untreated wood products shall be shipped and stored by acceptable commercial methods that will prevent damage before use in the work.

706.08 Workmanship. Construction requirements shall be as set forth in other sections of these specifications that govern the items of work using the specified wood products.

706.09 Measurement and Payment. Measurement and payment for wood products will not be specifically made under this section of the specifications. Measurement and payment will be made in accordance with other sections of these specifications that govern the items of work including wood products.

SECTION 707

PRESERVATIVE TREATMENT OF WOOD PRODUCTS

707.01 Description. This specification governs preservative treatment for timber and lumber for guard rail posts, fence posts, fenders and dolphins, and piling in accordance with the following specifications. Unless otherwise specifically authorized by the Department, inspection of the material to be treated and of the treatment process will be made by the Department or by its authorized inspection agency. The material to be treated will normally be inspected before treatment and the inspection of the treatment process will be made while the process is actually taking place.

The treatment plant shall provide laboratory facilities on the premises for the Department or its authorized inspection agency. The laboratory shall include technicians, conforming to AWPA M-3, Paragraph 1.5 for determining the retention by assay method and making analysis of the treating solution. Smaller plants treating only fence posts or miscellaneous lumber will not be required to have on premise laboratory facilities for testing waterborne preservatives, but will be required to bear the expense of such testing. The Department

or its inspection agency will perform the testing in these instances.

MATERIALS

707.02 Wood. Wood products shall conform to the requirements of **Section 706**.

707.03 Preservative. The preservative to be used shall conform to the following specifications:

Creosote for Land, Fresh, Water, and Marine.	AWPA P1 / P13.
Creosote Solutions.	AWPA P2.
Creosote-Petroleum Solution.	AWPA P3.
Petroleum Oil for Blending with Creosote.	AWPA P4
Pentachlorophenol.	AWPA P8.
Solvent used in Pentachorophenol Solutions.	AWPA P9
Acid Copper Chromate.	AWPA P5
Ammoniacal Copper Arsenate.	AWPA P5
Ammoniacal Copper Zinc Arsenate.	AWPA P5
Chromate Copper Arsenate.	AWPA P5

Tests of the preservation shall be made in accordance with the requirements of **AASHTO M 133** for the particular preservative involved.

CONSTRUCTION REQUIREMENTS

707.04 Treating Equipment and Methods. Wood products shall be treated in accordance with **AWPA C14**, or the following specifications except that in the case of conflict C14 shall govern:

1. General requirements for timber treatment shall be those set forth in **AWPA C1**.

2. Lumber and sawed timber including guardrail posts and blocks shall be treated as set forth in **AWPA C2**.

3. Round timber piling shall be treated as set forth in **AWPA C3**.

4. Sawed fence posts shall be treated as set forth in AWPA C2.

5. Round fence posts shall be treated as set forth in **AWPA C5**.

707.05 Retention of Preservative. For wood products treated with creosote, creosote-coal tar solution or pentachlorophenol solution, the net retention is expressed in pounds of preservative per cubic foot of wood. For material treated with water-borne salts preservatives, the net retention is expressed in pounds of dry preservative per cubic foot of wood. The type of preservative and the minimum net retention allowed shall conform to **AWPA C14**.

All net retention shall be determined by the assay method in accordance with **AWPA M2**.

707.06 Penetration. The penetration of the preservative for treated wood products shall be determined as set forth in AWPA Standard M2. For lumber, structural timber, sawn fence post and guardrail posts, the penetration of the preservative shall be 2 1/2 inches or 85% of the sapwood. The penetration of preservative in foundation piles or in piles for land or fresh water use shall be 3 inches or 90% of the sapwood. Piles for use in coastal water, treated with creosote or creosote-coal tar solution shall have a penetration of 4 inches or 90% of the sapwood. Piles for use in coastal water, treated with waterborne preservatives shall have a penetration of 3 1/2 inches or 90% of the sapwood.

All holes made for determining the penetration of preservative shall be filled with tight-fitting treated plugs.

707.07 Handling and Storage. Care and handling of treated wood products shall be in accordance with AWPA M4.

707.08 Fabrication. Any fabrication to be performed prior to treatment or at the treatment plant shall be in accordance with **AWPA M4**, Paragraph 1.41.

707.09 Measurement and Payment. The work and materials described and specified in this Section will not be measured for the purpose of making payment, as such work and materials are to be measured and paid for in accordance with the applicable sections setting forth the materials to receive the preservative treatment.

SECTION 708

HARDWARE

708.01 Description. This work shall consist of metal used in the construction of timber structures; and all bolts, lag screws, nuts, nails, washers and turnbuckles. Hardware for other type structures shall conform to the requirements of these specifications unless shown otherwise in the plans or as directed by the Engineer.

MATERIALS

708.02 Rolled Steel. Rods, plates, shapes and eye bars shall be of structural carbon steel or malleable iron if specified, conforming to the requirements of **Section 709**.

708.03 Castings. Castings shall be cast steel or gray-iron as specified, conforming to the requirements of Section 709.

708.04 Miscellaneous Items. Bolts, drift pins, dowels, lag screws, nails and machine bolts shall be low carbon steel conforming to the requirements of Section 709. Washers shall be used on each end of all bolts, except only one washer is required for high strength bolts. Washers bearing

on wood for bolts larger than 1/2 inch shall be cast ogee or approved malleable castings. The thickness of cast ogee washers shall be at least equal to the diameter of the bolt and the thickness of malleable washers shall be at least one-half the diameter of the bolt. The diameter of cast ogee or malleable washers shall be four times the diameter of the bolt. Washers for 1/2 inch bolts or smaller and bearing on wood or metal shall be standard cut washers. Bolt heads and nuts may be square or hexagonal where the washers bear on wood and shall be hexagonal where the washers bear on metal. The plan length of bolts given is for estimating the quantity of hardware. The Contractor shall furnish bolts of the proper length. Nails shall be cut or round wire of standard form. Spikes shall be cut, wire or boat spikes as specified. All hardware shall be of standard quality and of the sizes and quantities specified.

Unless specified otherwise, hardware shall be galvanized. Galvanizing shall conform to the requirements of **AASHTO M 111**, **AASHTO M 232**, or **AASHTO M 298** as applicable. Items described in AASHTO M 232, Class C may be coated in accordance with AASHTO M 298, Class 50. Items described in AASHTO M 232, Class D may be coated in accordance with AASHTO M 298, Class 40.

CONSTRUCTION REQUIREMENTS

708.05 General. No blocking between piles and sway braces will be allowed unless specifically shown on the plans; and any extra length of bolts or extra washers used will be at the Contractor's expense. The unit weights for galvanized hardware shall be assumed to be the same as non-galvanized hardware for purposes of payment.

708.06 Method of Measurement. When hardware is to be paid for at a unit price per pound, each item of hardware called for on the plans or authorized by the Engineer and remaining in the structure will be measured at the unit weight indicated on the plans and no allowance will be made for extra lengths or additional washers.

When so indicated on the plans or in the proposal, hardware shall be measured as a lump sum unit.

708.07 Basis of Payment. This material will be paid for either on the contract unit price per pound or lump sum price whichever is stated in the contract.

A. Per Pound Price. The weights as determined herein will be paid for at the contract unit price for hardware complete in place, which price and payment shall be full compensation for all materials, galvanizing, labor, equipment, painting, if required and all work incidental thereto.

B. Lump Sum Price. When a lump sum price is stated in the contract, that price and payment shall include all costs of furnishing, galvanizing, placing and painting, if required, of all hardware necessary to complete the structure in accordance with the plans and specifications or as directed by the Engineer.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7081000	Hardware	Lump Sum
7082000	Hardware	Pounds

SECTION 709

STRUCTURAL STEEL

709.01 Description. This work shall consist of furnishing, fabricating and erecting steel structures as required by the plans and the special provisions. It shall also include incidental metal work on other structures not otherwise provided for in these specifications.

This work shall be performed in conformance with these specifications and in reasonably close conformity to the lines, grades and dimensions shown on the plans or established by the Engineer.

709.02 Design and Details of Design. Structural Steel design and details of design shall comply with the requirements of the section of the current edition of the **AASHTO Standard Specifications for Highway Bridges**, Division I, entitled *Structural Steel*, and the requirements of these specifications. In case of conflict between these specifications and the referenced AASHTO specifications, the requirements of these specifications shall govern.

709.03 Plans. The Department will furnish plans (design drawings) showing a complete design with sizes, sections, and the relative locations of the various members. Plans shall indicate camber of structural members, tolerances, finishes, type of fasteners and other information as may be required for the proper preparation of shop plans and working drawings.

709.04 Shop Drawings and Working Drawings. Upon acceptance and execution of the contract, the Contractor shall prepare and furnish shop drawings showing complete details and sizes of component parts of the structure and details of all miscellaneous parts such as nuts, bolts, drains, etc. Any additional stress sheets and working drawings requested by the Engineer shall also be submitted. Shop Drawing and

Working Drawings submissions will conform to the requirements of **Section 725**.

MATERIALS

709.05 Structural Steel.

A. General Requirements. Unless otherwise shown on the plans, all structural steel shall conform to the following requirements:

	AASHTO	ASTM
Structural Steel	M 270 Grade 36	A 709 Grade 36
High-Strength Low Alloy Steel	M 270 Grade 50	A 709 Grade 50
High-Strength Low Alloy Steel	M 270 Grade 50W	A 709 Grade 50W
Quenched and Tempered Low Alloy Steel	M 270 Grade 70W	A-709 Grade 70W
High Yield Quenched and Tempered Alloy Steel	M 270 Grades 100/100W	A 709 Grades 100/100W

Notes:

1. When these materials are specified on the plans, the longitudinal Charpy V-Notch criteria shall comply with the requirements of **AASHTO M 270**. Zone 2.

2. Sampling shall be in accordance with the H frequency in **AASHTO T 243**.

3. Testing shall be performed in accordance with **AASHTO T 266**.

Specifically, Charpy testing shall be required as follows:

1. Simple Span Rolled Beam. The beam itself as well as bottom cover plate, if applicable.

2. Simple Span Plate Girder. The web, bottom flange plate and splice plates for web, and bottom flange excluding any filler plates.

3. Continuous Span Rolled Beam. The beam itself as well as any top or bottom cover plate located in a tension region as indicated in the plans. Also, all splice plates for web and top and bottom flange plates excluding any filler plates.

4. Continuous Span Plate Girder. All web plates, the top flange plates and the bottom flange plates located in a tension region as indicated in the plans. Also, all splice plates for web and top and bottom flange plates excluding any filler plates.

5. Curved Girder. In addition to Charpy testing of web, flange and splice plates as applicable and as specified in items a through d above, all diaphragm members, connection plates and gusset plates shall require Charpy testing.

B. Copper Bearing Steel. When copper-bearing steel is specified, the steel shall contain not less than 0.20 percent copper.

C. Notch Toughness of Weld Metal. The Charpy V Notch Toughness of weld metal shall comply with the requirements of the latest edition of **ANSI/AASHTO/AWS D1.5 *Bridge Welding Code***, Table 4.1, 4.2, or 4.3 as applicable.

D. Protection of Steel. The stock steel to be used in the project shall have been protected such that all surfaces

are free from heavy rust and rust pitted areas at the start of and during fabrication.

E. Corrosion Resistant Steel. All welding shall produce weld metal with atmospheric corrosion resistance and coloring characteristics similar to that of the base metal in accordance with Section 4.1.4 of the latest edition of ANSI/AASHTO/AWS D1.5 *Bridge Welding Code*.

All Structural steel shall be cleaned to the requirements of Near White Blast Cleaning in accordance with the **Steel Structures Painting Council Surface Preparation SP10** (current edition) *No. 10 Near White Blast Cleaning Method*. Any contamination of the structural steel during erection or concrete placement shall be removed by the Contractor. All cleaning of the structural steel shall be by an acceptable method approved by the Engineer and shall restore the surface finish to the specified "Near White Blast Clean" condition.

The Corrosion Resistant Steel shall not be painted unless specifically shown on the plans.

All bolts for corrosion resistant steel shall comply with **ASTM A 325**, Type 3. All bolts, nuts, and washers shall be non-galvanized. Bolt assemblies shall contain an epoxy coated direct tension indicator with a black color.

709.06 High Strength Structural Steel Fasteners.

A. General. All high strength bolts, nuts, washers, and direct tension indicators shall be furnished in accordance with the appropriate ASTM materials specification as amended and revised herein.

Additional requirements for field or shop installation of ASTM A 325 high strength bolts are also included.

B. Material Specifications.

1. Bolts. All bolts shall meet the requirements of ASTM A 325 and the revisions contained herein.

2. Nuts. All nuts shall meet the requirements of **ASTM A 563**.

3. Washers. All washers shall meet the requirements of **ASTM F 436** and these revisions.

4. Direct Tension Indicators. The Direct Tension Indicators shall comply with **ASTM F 959**, and shall be accepted and installed in accordance with **Subsection 709.06H**.

C. Manufacturing.

1. Bolts. All Type 1 bolts shall be mechanically galvanized in accordance with **ASTM B 695** , Class 50. When atmospheric corrosion resistant steel, **ASTM A 709**, Grade 50W is required by the plans, Type 3 bolts shall be used and shall be non-galvanized.

Hardness for bolt diameters 1/2 inch to 1 1/2 inch inclusive, shall be as noted below:

Hardness Number					
Bolt Size (Inches)	Bolt Length, (Inches)	Brinell Min.	Brinell Max.	Rockwell C Min.	Rockwell C Max.
A 325 (1/2 to 1, incl.)	Length < 3 Dia.	253	319	25	33
A 325 (1/2 to 1, incl.)	Length > 3 Dia.	---	319	---	33
A 325 (1 1/8 to 1 1/2, incl.)	Length < 3 Dia.	223	286	19	30
A 325 (1 1/8 to 1 1/2, incl.)	Length > 3 Dia.	---	286	---	30

2. Nuts. Nuts shall be **ASTM A 563**, Grade DH or DH3. Nuts shall be mechanically galvanized in accordance with ASTM B 695, Class 50. Nuts for Type 3 bolts shall be Grade DH3, plain (non-galvanized).

Galvanized nuts shall be tapped oversize the minimum amount required for proper assembly. The amount of overtap in the nut shall be such that the nut will assemble freely on the bolt in the coated condition and shall meet the mechanical requirements of ASTM A 563 and the rotational capacity test herein.

Galvanized nuts shall be lubricated with a water-soluble lubricant containing a dye of any color that contrasts with the color of the galvanizing.

3. Washers. Washers for Type 1 bolts shall be mechanically galvanized in accordance with ASTM B 695, Class 50. Type 3 washers shall not be galvanized.

4. Direct Tension Indicators. The Direct Tension Indicators (DTI) for Type 1, and Type 3 bolts shall be mechanically galvanized in accordance with ASTM B 695, Class 50. In addition, DTI for Type 3 bolts shall be epoxy coated with a black color.

5. Marking. All bolts, nuts, and washers shall be marked in accordance with the appropriate ASTM specification.

D. Testing.

1. Bolts. Proof load tests ASTM F 606, Method 1 shall be required.

Wedge tests on full size bolts ASTM F 606 paragraph 3.5 are required. Tests shall be performed after galvanizing. Minimum frequency of tests shall be as specified in **ASTM A 325**, Paragraph 9.2.4.

The thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats or top of bolt head.

2. Nuts. Proof load tests **ASTM F 606**, Paragraph 4.2 are required. Minimum frequency of tests shall be as specified in **ASTM A 563**, Section 9. Tests shall be performed after galvanizing, over-tapping and lubricating.

The thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats.

3. Washers. Hardness testing shall be performed after galvanizing. Coating shall be removed before taking hardness measurements.

The thickness of the zinc coating shall be measured.

4. Direct Tension Indicator (DTI). The DTI's shall be tested in accordance with **ASTM F 959**.

5. Assembly and Verification. Rotational-Capacity tests shall be required and performed after bolts, nut and washer assemblies are galvanized by the manufacturer or distributor before shipping. Washers are required as part of the test.

The following shall apply:

a. The Rotational-Capacity test shall be performed in accordance with the requirements contained in **Subsections 709.06J** and/or **709.06K**.

b. Each possible combination of bolt production lot, nut lot and washer lot shall be tested as an assembly. Three assemblies of each combina-

tion of materials shall be sampled by the Department for verification testing.

c. A Rotational-Capacity lot number shall be assigned to each combination of lots tested.

d. The minimum frequency of testing shall be two assemblies per Rotational-Capacity lot.

e. The bolt, nut, and washer assembly shall be assembled in a Tension Measuring Device (TDM). For guidance in performing the test, use the procedure for long bolts as detailed in **Subsection 709.06J**. For short bolts which are too short to be assembled in the TDM, (see item (i.) below.) DTI's are not included in this Rotational-Capacity test.

f. The minimum rotation, from an initial tension of 10% of the specified minimum installation tension shall be:

240° (2/3 turn) for bolt lengths equal to 4 bolt diameters or less.

360° (1 turn) for bolt lengths greater than 4 bolt diameters, but not more than 8 bolt diameters.

480° (1 1/3 turn) for bolt lengths greater than 8 bolt diameters, but not more than 12 bolt diameters

(Note: These values differ from the ASTM A 325 specifications.)

g. The tension at the above rotation shall be equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn tests are shown below:

Minimum Installation Tension Requirements and Turn Test Tension (Tension in kips)									
Diameter (inches)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
A 325 Bolts	*12	19	28	39	51	56	71	85	103
Turn Test	**14	22	32	45	59	64	82	98	118

Notes:

*Installation Tension equals 70% x Min. Tensile Strength.

**Turn Test Tension equals 1.15 x 70% x Min. Tensile Strength.

h. After the required installation tension listed above has-been exceeded, one reading of tension and torque shall be taken and recorded. The torque value shall conform to the following:

Torque ≤ 0.25 x P x D

Where:
Torque = measured torque (foot-pounds)
P = Turn test tension (pounds)
D = bolt diameters (feet)

i. Bolts that are too short to test in a TDM may be tested in a steel joint. The tension requirement of **Subsection 709.06D.5.g** need not apply. The maximum torque requirement of **Subsection 709.06D.5.h** shall be calculated using a value of P equal to the turn test tension shown in the table in Subsection 709.06D.5.g. For guidance in performing the test, use the procedure for short bolts as detailed in **Subsection 709.06K**.

j. Failure of any portion of the Rotational-Capacity (RC) test for either of the two samples tested shall constitute failure of the RC lot.

6. Reporting. The results of all tests (including the zinc coating thickness) required herein and in the appropriate ASTM specification shall be recorded on the appropriate document.

Location where tests are performed and date of tests shall be reported on the appropriate document.

7. Witnessing. The tests need not be witnessed by an inspection agency; however, the manufacturer or distributor that performs the tests shall certify that the results recorded are accurate.

E. Documentation.

1. Mill Test Report(s) (MTR). MTR shall be furnished for all mill steel used in the manufacture of the bolts, nuts, and washers.

MTR shall indicate the place where the material was melted and manufactured.

2. Manufacturer Certified Test Report(s) (MCTR). The manufacturer of the bolts, nuts and washers shall furnish test report (MCTR) for the item furnished. Each MCTR shall show the relevant information required in accordance with **Subsection 709.06D.6**.

The manufacturer performing the rotational capacity test shall include on the MCTR:

a. The lot number of each of the items tested.

b. The Rotational-Capacity lot number as required in **Subsection 709.06D.5.c**.

c. The results of the test required in **Subsection 709.06D.5**.

d. The pertinent information required in Subsection 709.06D.6.

e. A statement that MCTR for the items are in conformance to this specification and the appropriate ASTM specification.

f. The location where the bolt assembly components were manufactured.

3. Distributor Certified Test Report(s) (DCTR). The DCTR shall include MCTR above for the various bolt assembly components. The Rotational-Capacity test may be performed by a distributor (instead of a manufacturer) and reported on the DCTR. The DCTR shall show the results of the tests required in Subsection 709.06D.5. The DCTR shall also show the pertinent information required in Subsection 709.06D.6. The DCTR shall show the Rotational-Capacity lot number as required in Subsection 709.06D.5.c. The DCTR shall certify that the MCTR are in conformance to this specification and the appropriate ASTM specification.

F. Shipping.

1. Marking. Each container shall be permanently marked on the side of the container with the Rotational-Capacity lot number such that identification will be possible at any stage before installation.

2. Documentation. The appropriate MTR, MCTR, or DCTR shall be supplied to the owner through the Contractor.

G. Installation. The following requirements for installation apply in addition to the specifications in **AASHTO Division II, Section 11** when high strength bolts are installed in the field or shop.

Bolts shall be installed in accordance with **AASHTO Division II, Article 11.5.6.4**. During installation, regardless of the tightening method used, particular care should be exercised so that the snug tight condition as defined in **Article 11.5.6.4.4** is achieved. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. Hardened washers are required under the turned element for all installation methods.

The rotational capacity test described in Subsection 709.06D.5 shall be performed on each Rotational-Capacity lot before the start of bolt installation. Hardened steel washers are required as part of the test.

The Contractor shall provide a TDM and a dial type torque wrench of suitable range at each job site during erection. Periodic testing shall be performed to assure compliance with the installation test procedures required in AASHTO Division II, Article 11.5.6.4. Bolts that are too short for the TDM may be tested using Direct Tension Indicators (DTI). The DTI's must be calibrated in the TDM using longer bolts.

Periodic re-testing shall be conducted as directed by the Engineer to confirm that storage has not reduced the effectiveness of the lubricant. Re-testing shall be performed by the Contractor and witnessed by the Engineer. The lot of failing assemblies shall be rejected for use.

Galvanized nuts shall be checked to verify that a visible lubricant is on the threads. When the bolt head is to become the turned element in assembly, a lubricant approved by the Engineer shall be added to the washer face under the bolt head or to the washer.

Bolts or nuts not satisfying the requirements above and bolts, nuts or washers that are weathered, rusty, or dirty shall be rejected. The Contractor may submit, for approval, a procedure for cleaning and re-lubricating rejected

fastener lots. Re-cleaned or re-lubricated bolt, nut and washer assemblies shall be re-tested before installation.

Bolt, nut and washer combinations as installed shall be from a lot represented by an accepted rotational capacity test as certified by the manufacturer or distributor.

H. Procedures for Verification and Installation of High Strength Bolts Direct Tension Indicator (DTI).

1. Verification of DTI Performance. Verification of DTI performance is required before installation of bolts in the work. In bridge work, the manufacturers are typically specifying smaller gaps in the spaces between the protrusions on the washer than either normally used in other construction or the gap specified for testing in the product specification ASTM F 959. The basic principle used in this verification test is to make sure that there is a DTI gap when the test tension is 1.05 times greater than the job installation tension requirement.

a. Equipment Required.

(1) Calibrated bolt tension measuring device with a special flat insert in place of normal bolt head holding insert. The special insert is required to allow access to measure DTI gap.

(2) Tapered leaf thickness (feeler) gauge 0.005 inch. Same gauge as to be used to inspect the bolts after installation.

(3) Bolts, nuts, and standard washers to be used in the work with the DTI's.

(4) Impact and manual wrench to tighten bolts. Equipment should be the same as to be used in the work.

b. Verification Test Procedure. Three bolts from each Rotational-Capacity lot and position of DTI shall be tested.

(1) Install bolt, nut, DTI, and standard washer into bolt tension measuring device. Assembly should match that to be used the work.

(2) Use another wrench on the bolt head to prevent rotation of the head against the DTI if the DTI is to be used under the unturned element.

(3) Tighten bolt to tension listed below (1.05 times the minimum installation tension). Use another wrench on the bolt head to prevent rotation of the head against the DTI if the DTI is to be used under the unturned element. If an impact wrench is used, tighten to a load slightly below the required load and use a manual wrench to attain the required tension. The load-indicating needle of the DTI cannot be read accurately when only an impact wrench is used.

***Bolt Tension**
(kips)

Bolt Diameter (inch)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
M 164 (A 325) Bolts	13	20	29	41	54	59	75	89	108

Note:
*****Bolt Tension equals 1.05 x Min. Installation Tension

(4) Determine and record the number of spaces between the protrusion on the DTI that a 0.005 inch feeler gauge is refused. The total number of spaces in the various sizes and grade of DTI is shown below.

Number of Spaces on DTI

Bolt Diameter (inches)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
M 164 (A325) Bolts	4	4	5	5	6	6	7	7	8

(5) The 0.005 inch thick feeler gauge should be refused in less than one half of the gaps. If the feeler gauge is refused in one half or more of the gaps, the DTI fails the verification test.

(6) The bolts should be further tightened to the smallest gap allowed in the work. Normally, this smallest gap condition is achieved when the gaps at all the spaces are less than 0.005 inch (or a gap size as approved by the Engineer), and not all gaps are completely closed. When such a condition is achieved, the 0.005 inch thick feeler gauge is refused at all spaces but a visible gap exists in at least one space. Note the load in the bolt at the smallest gap. The bolts in this installation verification test and in the actual installation should not be tightened to a no visible gap condition when all the gaps are completely closed. The load in the bolt becomes indeterminate when no gap exists. It is possible to cause failure by tightening beyond complete crushing of the washer. The bolt load at this smallest gap should not cause excessive permanent inelastic deformation of the fastener. The degree of inelastic deformation is judged by removing the fastener from the test apparatus and turning the nut by hand the full length of the threads on the bolt after the test.

(7) Remove the bolt from the calibrator and turn the nut on the threads of the bolt by hand. The nut should be able to be turned on the complete

length of the threads, excluding the thread run-out. Alternatively, if the nut is unable to go the full length, but the load at the minimum DTI gap (measured in step (6) above) is less than 95% of the bolt tension recorded at the nut rotation required in **Subsection 709.06D.5.1.f** for the Rotational-Capacity test, the assembly, including the DTI, is deemed to have passed the test. If the nut cannot be run the full thread length, and if 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 in step (6) is too large and the DTI lot shall be rejected.

(8) Bolts from Rotational-Capacity lots that are too short to fit in the tension measuring device shall be tested in accordance with **Subsection 709.06.D.5.i** by tightening to the minimum DTI gap (measured in step (6) above) and checked in accordance with step (7). The 95% alternative cannot be used since short bolts are not tested in the tension-measuring device for Rotational-Capacity. The DTI used with the short bolt should be checked in accordance with steps (1) through (5) using a longer bolt in the tension measuring device.

2. Installation of DTI.

a. The use of a DTI under the unturned bolt head requires that the element bearing against the DTI not turn. Two workers are required: 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, an additional hardened washer must be used between the turning element and the protrusion on the DTI.

b. Tighten the bolts systematically to the inspection gap. The number of spaces in which the 0.005 inch thickness gauge is refused should be equal or greater than the number shown in the table below. Tightening beyond the smallest gap established above in **Subsections 709.06H.1.b.(6)** and **709.06H.1.b.(7)** is not allowed. Bolts which have a DTI with a smaller gap or no gap shall be replaced and the bolts tightened with a new DTI.

J. Procedure For Performing Rotational-Capacity Test (Long Bolts In Tension Measuring Device).

1. Equipment Required.

a. Calibrated Tension Measuring Device (TDM) of size required for bolts to be tested.

b. Calibrated torque wrench.

c. Spacers and/or washers with hole size no larger than 1/16 inch greater than bolt to be tested.

d. Steel section to mount TDM. Flange of girder or cross frame accessible from the ground is satisfactory.

2. Procedure for Performing Rotational - Capacity Test.

a. Install nut on bolt and measure stick out of bolt when 3 to 5 threads of the bolt are located between the bearing face of the nut and the bolt head. Measure the bolt length, the distance from the end of the threaded shank to the underside of the bolt head.

b. Install the bolt into the TDM and install the required number of shim plates and/or washer (one

washer under the nut must always be used) to produce the thread stick-out measured in step a above.

c. Tighten bolt using a hand wrench to the snug tensions listed in table below (-0 kips, +2 kips):

***Initial Tension Load**
(kips)

Bolt Diameter (inches)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
A 325 Initial Tension Min.	1	2	3	4	5	6	7	9	10

Note:

*****Approximately 10% of Minimum Installation Tension.

d. Match mark the nut, bolt, and the face plate of the TDM.

e. Using the calibrated manual torque wrench, tighten the bolt to at least the tension listed below and record the torque required to reach the tension and the value of the bolt tension. Torque must be measured with the nut in motion.

***Minimum Installation Tension**
(kips)

Bolt Diameter (inches)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Tension A 325 bolts	12	19	28	39	51	56	71	85	103

Note:

*****Installation Tension equals 70% x Min. Tensile Strength.

f. Further tighten the bolt to the rotation listed below. The rotation is measured from the initial marking in step (d). Record the bolt tension. Assem-

blies that fail before this rotation either by stripping or fracture fail the test.

***Rotation**

Bolt Length (measured in step a)	4 x bolt Diameter or less	Greater than 4 bolt dia., but not more than 8 x bolt dia.	Greater than 8 x bolt Diameters
Required Rotation	2/3	1	1 1/3

Note:

*Turn Test Tension equals 1.15 x 70% x Min. Tensile Strength.

g. The bolt tension measured in step (f) after the required rotation must equal or exceed the values in the table shown below. Assemblies which do not meet this tension have failed the test (Value is 115% of Minimum Installation Tension).

Turn Test Bolt Tension (kips)

Bolt Diameter (inches)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
A 325 Bolts	14	22	32	45	59	64	82	98	118

h. Remove the fastener assembly from the TMD. There should be no signs of thread shear failure, stripping or torsion failure of the bolt. Check for stripping by running the nut on the bolt threads to where it was during the test. This should be accomplished without the use of tools. Assemblies that have evidence of stripping have failed the test.

i. Calculate and record the value of 0.25 x tension (in pounds, measured in step (e) x bolt diameter in feet). The torque measured and recorded in step e, must be equal to or less than this calculated value.

Assemblies with torque values exceeding this calculated value failed the test.

K. Procedure For Performing Rotational-Capacity Test on Bolts Too Short to Fit Tension Measuring Device.

1. Equipment Required.

a. Calibrated torque wrench and a spud wrench or equivalent.

b. Spacers and/or washers with hole size no larger than 1/16 inch greater than bolt to be tested.

c. Steel section with normal size hole to install bolt. Any available splice hole can be used with a plate thickness that will provide the number of threads under the nut required in step a below. Mark off a vertical line and line 1/3 of a turn, 120º; 1/2 of a turn, 180º; and 2/3 of a turn, 240º; from vertical in a clockwise direction on the plate.

2. Procedure for Performing Rotational-Capacity Test.

a. Install nut on bolt and measure stick out of bolt when 3 to 5 threads of the bolt are located between the bearing face of the nut and the bolt head. Measure the bolt length, the distance from the end of the threaded shank to the underside of the bolt head.

b. Install the bolt into the hole and install the required number of shim plates and/or washers (one washer under the nut must always be used) to produce the thread stick-out measured in step (a) above.

c. Snug the bolt using a hand wrench. The snug condition should be the normal effort applied to a 12 inch long wrench. The applied torque should not exceed 20% of the torque determined in **Subsection 709.06J.2.e**.

d. Match mark the nut, bolt, and plate.

e. Tighten the bolt by turning the nut using the torque wrench to the rotation listed below. A second wrench must be used to prevent rotation of the bolt head during tightening. Record the torque required to reach this rotation. Torque must be measured with the nut in motion.

Rotation for A 325 Bolts

Bolt Length (measured in step a)	4 x bolt diameters or less
Required Rotation	1/3 Turn

The measured torque should not exceed the values listed below. Assemblies which exceed the listed torque have failed the test.

***Torque**
(foot-lbs.)

Bolt dia. (inches)	1/2	5/8	3/4	7/8	1	1 1/8	1 /4	1 3/8	1 1/2
A 325 Bolts	150	290	500	820	1230	1500	2140	2810	3690

Note:

*****Torque ≤ 25% x P x D, where P is Turn Test Value from **Subsection 709.06J.2.g**, and D is bolt diameter.

f. Tighten the bolt further to the rotation required below. The rotation is measured from the initial marking in step d. Assemblies which fail prior to this rotation either by stripping or fracture fail the

test.

Rotation
(Twice the rotation listed in step (e) above)

Bolt Length, measured in step (a)	4 x bolt diameters or less
Required rotation A 325 bolts	2/3

g. Remove the fastener assembly from the TMD. There should be no signs of thread shear failure, stripping, or torsion failure of the bolt. Check for stripping by running the nut on the bolt threads to where it was during the test. This should be accomplished without the use of tools. Assemblies that have evidence of stripping have failed the test.

L. Measurement and Payment. No separate measurement or payment will be made for fasteners since they are considered incidental to the contract price bid for Structural Steel.

709.07 Miscellaneous Metals and Fasteners.

A. Metals. Metals not otherwise specified shall meet the following:

1. Steel Forging. Steel forging shall conform to the requirements of **AASHTO M 102** (**ASTM A 668**), Class C, D, F, and G).

2. Steel Castings. Steel castings shall conform to the requirements of **AASHTO M 103** (**ASTM A 27**) as designated on the plans.

3. Iron Castings. Iron castings shall conform to the requirements of **AASHTO M 105**, Class No. 30 B. Test bars shall be Type B and shall be made and tested in accordance with AASHTO M 105.

4. Malleable Iron Castings. Malleable castings shall conform to **ASTM A 668**. Grade No. 35018 shall be furnished unless otherwise specified.

5. Bronze Castings. Bronze castings shall conform to the requirements of **AASHTO M 107** (**ASTM B 22**), Alloy 913 or 911.

6. Miscellaneous Metals. Other miscellaneous metals shall conform to the requirements of the current **AASHTO Standard Specifications for Highway Bridges**, Division II, Section 23.

B. Certifications. The Contractor shall furnish five copies of a certification for the above listed metals stating that they meet all SCDOT specifications. The certification shall indicate the project file number and the number of pieces being furnished.

C Low Carbon Bolts. All bolts, nuts and washers other than high strength bolts shall conform to the requirements of ASTM A 307.

709.08 Elastomeric Bearing Pads. Elastomeric bearing pads shall meet the requirements of **Section 724**. The size and thickness of elastomeric material and laminae shall be as indicated on the plans.

709.09 Stainless Steel Bearings. All stainless steel bearing and expansion plates shall conform to the requirements of **ASTM A 167** for Type 301 or Type 302, No. 1 Finish.

709.10 Paint. Unless otherwise specified, paint and paint systems shall conform to the requirements of **Section 710**. The required paint system shall be specified on the plans or special provisions.

A. General Conditions. The painting of metal structure shall include, unless otherwise provided in the contract,

the proper preparation of the metal surfaces, the application, protection and curing of the paint coatings, the protection of pedestrians, vehicular or other traffic upon, near, or underneath the bridge structure, the protection of all portions of the structure (superstructure and substructure) against disfigurement by spatter, splashes and smirches of paint or of paint material and the supplying of all tools, tackle, scaffolding, labor, workmanship and materials necessary for the entire work.

The Contractor shall have available at each bridge the name, telephone number and address of the person(s) who shall be responsible for processing all claims. All claims shall also be processed in an expedient manner.

B Welded, Bolted, Concrete Contact, and Inaccessible Surfaces. Surfaces to be welded together in the shop or the field shall not be painted. Surfaces on which welding shall be performed shall not be painted. Surfaces to be bolted together in the shop or the field shall be painted. All surfaces to be in contact with concrete (exclusive of top surfaces of beam flanges where welded shear connectors are in place) may receive a prime coat of paint. Surfaces which will be inaccessible after assembly or erection, shall be painted before assembly or erection.

C. Slip Critical Surfaces. For friction type connections designated on the plans to be Class B Slip Critical, the contact surfaces shall be blast-cleaned and coated with an inorganic zinc-rich paint as defined in the Steel Structures Painting Council System -SSPC 10.

FABRICATION

709.11 Notice of Beginning of Work. The Contractor shall give the Engineer ample notice of the beginning of work at the fabrication shop and in the rolling mill or foundry when specified so that inspection may be provided. No work shall be performed before the Engineer has been notified and inspection is provided.

709.12 Type of Fabrication. Shop fabrication of bridge members will generally be shop welded and field bolted.

The Contractor shall provide the falsework and all tools, machinery and appliances, including drift pins and fitting-up bolts, necessary for the expeditious handling of the work.

709.13 Quality of Workmanship. Workmanship and finish shall be equal to the best general practice in modern bridge shops. Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting and chipping shall be done carefully and accurately.

All structural steel fabrication shall be performed by a fabricator certified in accordance with **The American Institute of Steel Construction (AISC) Quality Certification Program** for the category of work to be done.

709.14 Storage of Materials. Structural materials, either plain or fabricated, shall be stored at the fabricating shop above the ground upon platforms, skids or other supports. It shall be kept free of dirt, grease and other foreign matter and shall be protected a far as practicable from corrosion.

709.15 Facilities for Inspection. The Contractor shall furnish facilities for the inspection of material and workmanship in the mill and shop and the inspectors shall be allowed free access to the all parts of the work.

709.16 Inspector's Authority. Inspectors shall have the authority to reject any materials or work which does not meet the requirements of the contract. In case of dispute, the Contractor may appeal to higher authority. The acceptance of any material or finished members by the Engineer's representative shall not be a bar to 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.

Rejected material or workmanship shall be replaced promptly or made satisfactory.

709.17 Mill Test Reports and Shipping Statements. The Engineer shall be furnished with complete certified mill test reports showing chemical analysis and the physical tests for each heat of steel for all members. The Contractor shall furnish the Engineer with five certified copies of mill test reports and five copies of shipping statements.

709.18 Identification of Steels During Fabrication. Each piece of steel to be fabricated shall be properly identified for the Engineer. Pieces of steel which are to be cut to smaller size pieces shall, before cutting, be legibly marked as to heat number and piece mark. Individually marked pieces of steel which are used in furnished size, or are reduced from furnished size only by end or edge trim may be used without additional identification as long as the original heat number is legible.

The Contractor may furnish from stock, material that can be identified by heat number an mill test report. Any excess materials placed in stock for later use shall be marked with the SCDOT Project File No., the mill test report number, AASHTO/(ASTM) specification identification, when separated from the full size piece furnished by the supplier.

709.19 Straightening Material. Rolled material, before being laid off or worked, must be straight. If straightening is necessary, it shall be done by methods approved by the Engineer that will not injure the metal. In no case shall the maximum temperature of the steel exceed 1125ºF. Sharp kinks and bends shall be cause for rejection of the material.

709.20 Flame Cutting. Flame cutting of structural steel shall conform to the requirements of Article 3.2.2 of the latest edition of the **ANSI / AASHTO / AWS D1.5 *Bridge Welding Code***.

709.21 Edge Planing. Sheared edges of plate more than 5/8 inch in thickness and carrying calculated stress shall be planed, milled, ground or thermal cut to a depth of 1/4 inch.

709.22 Structural Welding. Welding of steel structures, and all subsequent references to welding, shall conform to the latest edition of ANSI / AASHTO / AWS D1.5 "Bridge Welding Code," the plans, or the special provisions. In addition, the following shall be understood:

A. Field Welding.

1. General. All field welding, except welding of reinforced pile tips, temporary false-work (unless specified), SIP formwork, armor plate at bridge ends and armor plate at expansion joints shall be considered structural welding and shall be performed by a SCDOT certified welder. All field personnel welding structural steel, steel reinforcement, steel pile splices, and other types of field structural welds shall have been qualified to perform the type of welding in accordance with the qualification procedure of the latest edition of the ANSI / AASHTO / AWS D 1.5 *Bridge Welding Code* as follows:

> A welder or tacker (hereafter known as "welder") may be qualified by preparing test specimens in accordance with section 5.22, figure 5.7A, Position 2G for limited thickness groove welding (butt welding) and section 5.23, figure 5.8A, Position 2F for fillet welding. Testing as shown in figure 5.8B will not suffice for fillet welding qualification.

The above testing is minimum and will qualify the welder for general welding at the job site. By choice of the welder, he may 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 Engineer.

The test specimens shall be prepared in the presence of and tested and evaluated by an independent laboratory person qualified as a Welding Inspector. All radiographic nondestructive testing shall be performed by an ASNT Level II or III technician. The independent laboratory shall furnish a welder qualification test report on company letterhead stationery stating the type welding approved, name of the welder, the welder's social security number, along with a statement that the welder is duly qualified as a field welder in accordance with the SCDOT requirements. The report shall show the name of the independent laboratory technician(s) making the evaluation and shall be signed by the independent laboratory manager.

The independent laboratory shall submit a copy of the report for processing to:

Research and Materials Engineer
SCDOT Research and Materials Laboratory
P.O. Box 191
Columbia, SC 29202,

The welder will be forwarded a SCDOT certification good for two years and renewable every two years provided the welder has been engaged in welding procedures during the preceding two year period.

A list of qualified independent laboratories capable of administering this testing may be obtained from the SCDOT Research and Materials Laboratory. An independent laboratory may request to be included on the list by furnishing to the Research and Materials Engineer a letter stating their qualifications to perform the testing and the names of their personnel who will be performing the evaluations.

2. Submittals. The Contractor shall notify the Engineer and the Research and Material Engineer ten (10) calendar days before performing any field welding including the welding of reinforced pile tips, armored plated at bridge joints, temporary false-work and SIP form-work. The Contractor shall document this notification by completing the form entitled ***SCDOT Sample Welding Procedure Specification*** and forwarding one copy each to the Engineer and the Research and Materials Engineer.

B. Electrodes. The electrodes used in welding structural steel shall conform to the requirements set forth in the latest edition of the ANSI / AASHTO / AWS D 1.5 *Bridge Welding Code*.

C. Preheat and Interpass Temperatures. The pre-heat and interpass temperatures required for welding structural steel shall be as specified in the latest edition of the ANSI / AASHTO / AWS D 1.5 *Bridge Welding Code*.

D. Inspection.

1. General. The structural steel fabrication including welding shall be in accordance with the latest edition of ANSI / AASHTO / AWS D1.5 *Bridge Welding Code* except as noted herein. Fabrication and Welding Quality Assurance (QA) inspection in the fabricating shops will be done by the Department's representative, either a Department Research and Materials Laboratory inspector or an inspector from a commercial testing laboratory acting for the Department.

2. Nondestructive Testing of Welds and Metals.
Radiographic, ultrasonic, magnetic particle, and dye penetrant testing of welds shall be performed on welds in conformance with the requirements of the latest edition of the ANSI / AASHTO / AWS D 1.5 *Bridge Welding Code* with the following exceptions:

a. All girder flange butt welds shall be tested radio-graphically, whether in tension or compression.

b. Quality Assurance (QA) and Quality Control (QC) nondestructive testing as referenced in AASHTO and AWS shall be interpreted as follows:

> Quality Assurance (QA) nondestructive testing required by the contract documents shall be performed by the Department's inspector or authorized inspection agency's inspector acting for the Department. At the discretion of the Department's inspector or authorized representative, Quality Control (QC) nondestructive testing, performed by the Contractor in the presence of the Department's inspector may be used to satisfy like nondestructive testing requirement(s) specified for QA. The observing inspector shall maintain test result records for the work performed.

The cost of the QC nondestructive testing shall be borne by the Contractor regardless of the Department's acceptance for QA testing. The cost of Department performed QA testing shall be borne by the Department.

The cost of re-testing of repaired welds shall be borne by the Contractor.

F. Restricted Welded Processes. Gas metal arc and flux cored arc welding shall not be used except with written approval of the Department. If authorization is granted, the procedure and operator qualifications shall be in accordance with the latest edition of the

ANSI / AASHTO / AWS D 1.5 *Bridge Welding Code*. Electro-slag and electro-gas welding shall not be permitted.

709.23 Electrically Welded Studs.

A. General Requirements. Welding of shear connector studs and all subsequent references to shear connector studs shall conform to the latest edition of the ANSI / AASHTO / AWS D 1.5 *Bridge Welding Code*. In addition the following shall be understood:

Shear connector studs shall be of a design suitable for welding to steel beams and girders with automatically timed stud-welding equipment. The type, size or diameter and length of stud shall be as specified by the plans or the special provisions and shall be listed on the Department's **Approved Electrical Weld Shear Connector Studs.**

Only approved studs shall be used. Before placing orders for studs, the Contractor shall submit to the Engineer for approval the following information on the studs to be purchased:

1. The name of the manufacturer.

2. A detailed description of the stud and arc shield to be furnished.

3. A certification from the manufacturer that the stud meets the Department's requirements.

4. A copy of a qualification test report as certified by a reputable testing laboratory.

The studs, after welding, shall be free from any defect or substance that would interfere with their function as shear connectors.

B. Materials Requirements. Shear connector studs shall conform to the requirements of **AASHTO M 169**, (**ASTM A 108**), Cold-drawn Bar, Grades 1015, 1018, or 1020, either semi or fully-killed. If flux-retaining caps are used, the steel for the caps shall be of a low carbon grade suitable for welding and shall comply with **ASTM A 109**.

Tensile properties as determined by tests of bar stock after drawing or of finished studs shall conform to the following requirements:

Longitudinal and lateral spacing of studs with respect to each other and to edges of beam or girder flanges shall not vary more than one-half inch from the dimensions shown on the plans except that a variation of one inch will be permitted where required to avoid obstruction with other attachments on the beam or where a new stud is being welded to replace a defective one.

The first two studs welded on each beam or girder, after being allowed to cool, shall be bent 45 degrees by striking the stud with a hammer. If failure occurs in the weld of either stud, the procedure shall be corrected and two successive studs successfully welded and tested before any more studs are welded to the beam or girder. The Engineer shall be promptly informed of any changes in the welding procedure at any time during construction.

When the temperature of the base metal is below 32ºF, one stud in each 100 studs welded shall be bent 45 degrees in addition to the first two bent as specified above.

D. Inspection Requirements. If visual inspection reveals any stud which does not show a full 360° weld, any stud which has been repaired by welding or any stud in which the reduction in height due to welding is less than normal, such stud may be tested by being struck with a hammer and bent 15° off the vertical. For studs showing

less than 360° weld, the direction of bending shall be opposite to the lack of weld. Studs that crack in either the weld or the shank shall be replaced.

After welding, 10 studs shall be selected at random along the top of each girder. These 10 studs shall be hammered out of line 30° toward the center of the span. Not more than one of these test studs shall show any signs of failure.

If more than one stud fails, then all studs on the girder shall be hammered (but not necessarily bent the full 30°) and all that fail shall be replaced. Before replacing the stud, the area shall be ground free of any metal left from the old weld, or in the case of a pocket, it shall be filled with E-7018 weld metal and ground flush.

In addition to the above test, if more than two studs in any group of studs checked should show the need for additional all around welding due to faulty operation of the welding gun, all the studs in the group shall be removed as required in the paragraph above and replaced.

The studs tested that show no sign of failure may be left in the bent position.

If during the progress of the work, inspection and testing indicates in the judgment of the Engineer that the shear connectors being obtained are not satisfactory, the Contractor will be required at his expense to make such changes in welding procedure, welding equipment and type of shear connector as necessary to secure satisfactory results.

At the option of the purchaser, the manufacturer of the studs may be required at any time to submit sample studs for re-qualification, at the manufacturer's expense.

709.24 Fit of Stiffeners. End stiffeners of girders and stiffeners intended as supports for concentrated loads shall have

full bearing on the flanges to which they transmit load or from which they receive load. Full bearing shall be obtained by milling, grinding or welding as shown on the plans. Stiffeners not intended to transfer load, unless shown or specified otherwise shall fit sufficiently tight to exclude water after being painted.

709.25 Camber. A camber diagram shall be furnished to the Engineer by the Fabricator, showing the camber at each panel point in the cases of trusses or arch ribs, and at the location of field splices and fractions of span length (1/4 points minimum, 1/10 points maximum) in the cases of continuous beam and girders or rigid frames. When the shop assembly is Full Truss or Girder Assembly or Special Complete Structure Assembly, the camber diagram shall show the camber measured in assembly. When any of the other methods of shop assembly is used, the camber diagram shall show calculated camber.

Girders shall be cambered before heat curving. Camber for rolled beams may be obtained by heat-cambering methods approved by the Engineer. Girders and rolled beams shall be cambered in accordance with the camber diagram as shown in the plans. Camber for rolled beams may be obtained by heat cambering methods or by cold bending with hydraulic rams. Moderate deviations from the specified camber may be corrected by a carefully supervised application of heat when approved by the Engineer. Horizontal heat curving may tend to change vertical camber. This effect may be more pronounced when the top and bottom flanges are of unequal width on a given transverse cross-section.

709.26 Bolt Holes.

A. Holes for High-Strength Bolts. All holes for bolts shall be either punched or drilled. Material forming parts of a member composed of not more than five thickness' of metal may be punched 1/16 inch larger than the nominal diameter of the bolts whenever the thickness of the material is not greater than 3/4 inch for structural steel, 5/8 inch

for high-strength steel or 1/2 inch for quenched and tempered alloy steel, unless sub-punching and reaming are required under **Subsection 709.31**.

When there are more than five thickness' or when any of the main material is thicker than 3/4 inch for structural steel, 5/8 inch for high-strength steel, or 1/2 inch for quenched and tempered alloy steel, all holes shall either be sub-drilled or drilled full size.

When required under **Subsection 709.31**, all holes shall be either sub-punched or sub-drilled (sub-drilled if thickness limitation governs) 3/16 inch smaller and, after assembling, reamed 1/16 inch larger or drilled full size to 1/16 inch larger than the nominal diameter of the bolts.

When permitted by the Bridge Design Engineer, enlarged or slotted holes are allowed with high-strength bolts.

B. Holes for Ribbed Bolts, Turned Bolts or Other Approved Bearing Type Bolts. All holes for ribbed bolts, turned bolts or other approved bearing-type bolts shall be sub-punched or sub-drilled 3/16 inch smaller than the nominal diameter of the bolt and reamed, assembled or drilled to a steel template or, after assembling, drilled from the solid at the option of the Fabricator. In any case, the finished holes shall provide a driving fit as specified on the plans or in the special provisions.

709.27 Punched Holes. The diameter of the die shall not exceed the diameter of the punch by more than 1/16 inch. If any holes must be enlarged to admit the bolts, such holes shall be reamed. Holes must be clean cut without torn or ragged edges. Poor matching of holes will be cause for rejection.

709.28 Reamed or Drilled Holes. Reamed or drilled holes shall be cylindrical, perpendicular to the member, and shall comply with the requirements of **Subsection 709.26** as to

size. Where practicable, reamers shall be directed by mechanical means. Burrs on the outside surfaces shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist drills. If required by the Engineer, assembled parts shall be taken apart for removal of burrs caused by drilling. Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match marked before disassembling.

709.29 Accuracy of Punched, Sub-punched or Sub-drilled Holes. All holes punched full size, sub-punched or sub-drilled shall be so accurately punched that after assembling (before any reaming is done) a cylindrical pin 1/8 inch smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75% of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces will be rejected. If any hole will not pass a pin 3/16 inch smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

709.30 Accuracy of Reamed and Drilled Holes. When holes are reamed or drilled, 85% of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32 inch between adjacent thickness of metal.

All steel templates shall have hardened steel bushings in holes accurately dimensioned from the centerlines of the connection as inscribed on the template. The centerlines shall be used in locating accurately the template from the milled or scribed ends of the members.

709.31 Preparation of Field Connections. Unless otherwise specified in the special provisions or on the plans, holes in all field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders and rigid frames shall be sub-punched (or sub-drilled if sub-drilling is required according to **Subsection 709.26**) and subsequently reamed while assembled onto

a steel template, as required by **Subsection 709.33**. Holes for field splices of rolled beam stringers continuous over floor beams or crossframes may be drilled full size unassembled to a steel template. All holes for floor beams and stringer field end connections shall be sub-punched and reamed to a steel template or reamed while assembled. Reaming or drilling full size of field connection holes through a steel template shall be done after the template has been located with utmost care as to position and angle and firmly bolted in place. Templates used for reaming matching members, or the opposite faces of a single member, shall be exact duplicates. Templates used for connections on like parts or members shall be so accurately located that the parts or members are duplicates and require no match-marking.

Unless otherwise authorized by the Engineer, the adjacent panels or sections of each individual truss, arch, continuous beam or girder shall be assembled in the shop before reaming or full drilling is commenced. The shop assembly shall consist of blocking up and setting the parts that make up the joint to be reamed or drilled to the exact relative position and grade that such parts will later assume in the completed bridge, and fastening such parts securely in position before and during the reaming or drilling of the holes in the joint.

For any connection, instead of sub-punching and reaming or sub-drilling and reaming, the fabricator, at his option, may drill holes full size with all thickness or material assembled in proper position.

If additional sub-punching and reaming is required, it shall be specified in the special provisions or on the plans.

Alternately, 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 Contractor shall have the option to drill or punch holes full-size in unassembled pieces and/or connections including templates for use with matching sub-sized and reamed holes by means of suitable numerically controlled (N/C) drilling or punching equip-

ment subject to the specific provisions contained in this article. Full-size punched holes shall meet the requirements of **Subsection 709.26**.

If N/C drilling or punching equipment is used, the Engineer, unless otherwise stated in the special provisions or on the plans, may require the Contractor, by means of check assemblies, to demonstrate that this drilling or punching procedure consistently produces holes and connections meeting the requirements of **Subsections 709.30** and **709.33**.

The Contractor shall submit to the Engineer for approval a detailed outline of the procedures that he proposes to follow in accomplishing the work from initial drilling or punching through check assembly, if required, to include the specific members of the structure that may be N/C drilled or punched, the sizes of the holes, the location of common index and other reference points, composition of check assemblies, and all other pertinent information.

Holes drilled or punched by N/C equipment shall be drilled or punched to appropriate size through individual pieces, or drilled through any combination of pieces held tightly together.

709.32 Fitting for Bolting. Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned and firmly drawn together before drilling, reaming or bolting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the operation. The member shall be free from twists, bends, and other deformation.

The drifting done during assembling shall be only such as to bring the parts into position and not sufficient to enlarge the holes or distort the metal.

709.33 Shop Assembly.

A. General. The field connections of main members of

trusses, arches, continuous beam spans, bents, towers (each face), plate girders and rigid frames shall be assembled in the shop with milled ends of compression members in full bearing and then shall have their sub-size holes reamed to specified size while the connections are assembled. Assembly shall be Full Truss or Girder Assembly unless Progressive Truss or Girder Assembly, Full Chord Assembly, Progressive Chord Assembly, or Special Complete Structure Assembly is specified in the special provisions or on the plans.

Check Assemblies with Numerically Controlled Drilled or Punched Field Connections and template drilled field connections of rolled beam stringers continuous over floorbeams or cross frames shall be in accordance with **Subsection 709.33G**.

Each assembly, including camber, alignment, accuracy of holes and fit of milled joints, shall be approved by the Engineer before reaming is commenced or before an N/C drilled check assembly is dismantled.

B. Full Truss or Girder Assembly. Full Truss or Girder Assembly shall consist of assembling all members of each truss, arch rib, bent, tower face, continuous beam line, plate girder or rigid frame at one time.

C. Progressive Truss or Girder Assembly. Progressive Girder Assembly shall consist of assembling initially for each arch rib, continuous beam line, or plate girder at least three contiguous shop sections. Progressive Truss Assembly shall consist of assembling initially for each truss, bent, tower face or rigid frames, all members in at least three contiguous panels, but not less than the number of panels associated with three contiguous chord lengths. Successive assemblies shall consist of not less than two sections or panels of the previous assembly (repositioned if necessary and adequately pinned to assure accurate alignment) plus one or more sections or panels added at the advancing end. In the case of structures

longer than 150 feet, each assembly shall be not less than 150 feet long regardless of the length of individual continuous panels or sections. At the option of the fabricator, sequence of assembly may start from any location in the structure provided the preceding requirements are satisfied.

Assemblies consisting of less than three shop sections or panels shall require approval of the Engineer.

D. Full Chord Assembly. Full Chord Assembly shall consist of assembling, with geometric angles at the joints, the full length of each chord of each truss or open spandrel arch or each leg of each bent or tower, then reaming their field connection holes while the members are assembled and reaming the web member connections to steel templates set at geometric (not cambered) angular relation to the chord lines.

Field connection holes in web members shall be reamed to steel templates. At least one end of each web member shall be milled or shall be scribed normal to the longitudinal axis of the member and the templates at both ends of the member shall be accurately located from one of the milled ends of scribed lines.

E. Progressive Chord Assembly. Progressive Chord Assembly shall consist of assembling contiguous chord members in the manner specified for Full Chord Assembly and in the number and length specified for Progressive Truss or Girder Assembly.

F. Special Complete Structure Assembly. Special Complete Structure Assembly shall consist of assembling the entire structure, including the floor system. (This procedure is ordinarily needed only for complicated structures such as those having curved girders or extreme skew in combination with severe grade or camber).

G. Check Assemblies with Numerically Controlled Drilled Field Connections. A check assembly shall be required for each major structural type of each project, unless otherwise designated on the plans or in the special provisions, and shall consist of at least three contiguous shop sections or, in a truss, all members in at least three contiguous panels, but not less than the number of panels associated with three contiguous chord lengths (i.e., length between field splices). Check assemblies should be based on the proposed order of erection, joints in bearings, special complex points and similar considerations. Such special points could be the portals if skewed trusses, etc.

Use of either geometric angles (giving theoretically zero secondary stresses under dead-load conditions after erection) or cambered angles (giving theoretically zero secondary stresses under no-load conditions) should be designated on the plans or in the special provisions.

The check assembles shall preferably be the first such sections of each major structural type to be fabricated.

No match marking and no shop assemblies other than the check assemblies shall be required.

If the check assembly fails in some specific manner to demonstrate that the required accuracy is being obtained, further check assemblies may be required by the Engineer for which there shall be no additional cost to the Department.

709.34 Match Marking. Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match marked and a diagram showing such marks shall be furnished to the Engineer.

709.35 Bolts and Bolted Connections. The requirements of this Subsection do not pertain to the use of high-strength

bolts. Bolted connections fabricated with high-strength bolts shall conform to **Subsection 709.36**.

A. General. Bolts shall be unfinished, turned or ribbed bolts conforming to the requirements of **ASTM A 307**, Grade A. Bolted connections shall be used only as indicated by the plans or the special provisions. Bolts shall have single self-locking nuts or double nuts unless otherwise shown on the plans or in the special provisions. Beveled washers shall be used where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

B. Unfinished Bolts. Unfinished bolts shall be furnished unless other types are specified.

C. Turned Bolts. The surface of the body of turned bolts shall meet the **ANSI** roughness rating value of 125. Heads and nuts shall be hexagonal with standard dimensions for bolts of the nominal size specified or the next larger nominal size. Diameter of threads shall be equal to the body of the bolt or the nominal diameter of the bolt specified. Holes for turned bolts shall be carefully reamed with bolts furnished to provide for a light driving fit. Threads shall be entirely outside of the holes. A washer shall be provided under the nut.

D. Ribbed Bolts. The body of ribbed bolts shall be of an approved form with continuous longitudinal ribs. The diameter of the body measured on a circle through the points of the ribs shall be 5/64 inch greater than the nominal diameter specified for the bolts.

Ribbed bolts shall be furnished with round heads conforming to ANSI B 18.5 unless otherwise specified. Nuts shall be hexagonal, either recessed or with a washer of suitable thickness. Ribbed bolts shall make a driving fit with the holes. The hardness of the ribs shall be such the ribs do not mash down enough to permit the bolts to turn in the holes during tightening. If, for any reason, the bolt

twists before drawing tight, the hole shall be carefully reamed and an oversized bolt used as a replacement.

709.36 Connections Using High Strength Bolts.

A. General. This Subsection covers the assembly of structural joints using ASTM A 325 or **ASTM A 490** high-strength bolts, or equivalent fasteners, tightened to a high tension. The bolts are used in holes conforming to the requirements of **Subsections 709.26**, **709.27**, and **709.28**.

B. Bolts, Nuts, and Washers. Bolts, nuts, and washers shall conform to the requirements of **Subsection 709.06B**.

C. Bolted Parts. The slope of surfaces of bolted parts in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material.

ASTM A 325 and **ASTM A 490** bolts shall not be galvanized nor shall they be used to connect galvanized material.

D. Installation.

1. Fit-up of Steel. Twenty-five percent (25%) of the holes shall be filled with cylindrical erection pins to fair up the metal, and the remaining holes shall be filled with high strength bolts. Twenty-five percent (25%) of the bolts, in a random pattern over the joint, shall be given an identifying mark and shall be firmly tightened in order to pull all plies of the metal into firm contact.

2. Bolt Tension. Each fastener shall be tightened to provide, when all fasteners in the joint are tight, at least the minimum bolt tension shown in **Table D-I** for the size of fastener used.

Threaded bolts shall be tightened by one of the methods described in **Subsections 709.36D.4**, **709.36D.5**, and **709.36D.6**. If required because of bolt entering and wrench operational clearances, tightening by the selected procedure may be done by turning the bolt while the nut is prevented from rotating. Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

ASTM A 490 and galvanized ASTM A 325 bolts shall not be re-used. Non-galvanized ASTM A 325 bolts may be re-used, but not more than once, if approved by the Engineer. Re-tightening previously tightened bolts that may have been loosened by the tightening of adjacent bolts shall not be considered as a re-use.

Table D-I
*Minimum Bolt Tension

Bolt Size (inches)	ASTM A 325 Bolts (pounds)	ASTM A 490 Bolts (pounds)
1/2	12,050	14,900
5/8	19.200	23,700
3/4	28,400	35,100
7/8	39,250	48,500
1	51,500	63,600
1 1/8	56,450	80,100
1 1/4	71,700	101,800
1 3/8	85,450	121,300
1 1/2	104,000	147,500

Note:

*Equal to 70% of specified minimum tensile strength of bolts.

3. Washers. All fasteners shall have a hardened washer under the element (nut or bolt head) turned in tightening. Hardened washers shall be used under both the head and nut, regardless of the element turned, in the case of ASTM A 490 bolts, if the material against which it bears has a specified yield strength less than 40 ksi.

Where an outer face of the bolted parts has a slope more than 1:20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallelism.

4. Turn-of-Nut Tightening. When the turn-of-nut method is used to provide the bolt tension specified in **Subsection 709.36D.2**, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in **Table D-II** with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation, there shall be no rotation of the part not turned by the wrench.

Table D-II			
Nut Rotation[1] from Snug Tight Condition			
	Disposition of Outer Faces of Bolted Parts		
Bolt length measured from underside of head to extreme end of point	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (bevel washer not used).	Both faces sloped not more than I:20 from normal to bolt axis (bevel washers not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
[2]Over 8 diameters but not exceeding 12 diameters	2/3 turn	5/6 turn	1 turn

Notes:

1 Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be plus or minus 30º; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45º.

2 No research work has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests in a suitable tension device simulating the actual conditions.

5. Lock-Pin and Collar Fasteners. The installation of lock-pin and collar fasteners shall be by methods and procedures approved by the Engineer.

6. Tightening by Use of a Load Indicating Fastener System. Tightening by this means is permitted provided it can be demonstrated by an accurate direct measurement procedure that the bolt has been tightened in accordance with **Table D-I**. Tightening shall be by methods and procedures approved by the Engineer.

E. Inspection. The Engineer shall determine that the requirements described below are met in the work. The Contractor shall provide the Engineer with accommodations necessary to accomplish the observations and inspections specified.

The Engineer shall observe the installation and tightening of bolts to determine that the selected tightening procedure is properly used and shall determine that all bolts are tightened and in the case of the direct tension indicator method that the correct indication of tension has been achieved. Bolts may reach tensions substantially above the value given in **Table D-I,** but this shall not be cause for rejection.

The following inspection procedure shall be used unless a more extensive or different inspection procedure is specified.

1. Either the Engineer or the Contractor in the presence of the Engineer, at the Engineer's option, shall use an inspection wrench that may be a torque wrench.

2. Three bolts of the same grade, size and condition as those under inspection shall be selected for inspection. The length may be any length representative of bolts used in the structure. The selected bolts shall be placed individually in a calibration device capable of indicating bolt tension at least once each working day. There shall be a washer under the part turned in tight-

ening each bolt if washers are so used on the structure. If no washer is used, the material abutting the part turned shall be of the same specification as that used on the structure.

3. Each bolt specified in **Subsection 709.36E.2** shall be tightened in the calibration device by any convenient means to an initial condition equal to 15% of the required tension and then the minimum tension specified for its size in **Subsection 709.36D.2**. The inspecting wrench then shall be applied to the tightened bolt and the torque necessary to turn the nut or head 5 degrees (approximately one inch at 12-inch radius) in tightening direction shall be determined. The average torque measured in the tests of three bolts shall be taken as the job inspecting torque to be used in the manner specified in **Subsection 709.36E.2**.

4. Bolts, represented by the sample prescribed in **Subsection 709.36E.2** and have been tightened in the structure, shall be inspected by applying, in the tightening direction, the inspecting wrench and its job inspecting torque to 10% of the bolts, but not less than two bolts, selected at random in each connection. If no nut or bolt head is turned by this application of the job inspection torque, the connection shall be accepted as properly tightened. If any nut or bolt head is turned by the application of the job inspecting torque, this torque shall be applied to all bolts in the connection, and all bolts whose nut or head is turned by the job inspecting torque shall be tightened and re-inspected, or alternatively, the Fabricator or Erector, at his option, may retighten all of the bolts in the connection and then resubmit the connection for the specified inspection.

The procedures for inspecting and testing the lockpin procedures and collar fasteners and their installation to assure that the required pre-load tension is provided shall be as approved by the Engineer.

709.37 Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part I:

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 ANSI 500
Bridge rollers and rockers	ANSI 125
Pins and pin holes	ANSI 125
Sliding bearings	ANSI 125

709.38 Bridge Bearing Assemblies.

A. General. Unless otherwise specified, all steel bearing plates shall be rolled steel conforming to the requirements of **AASHTO M 270** (**ASTM 709**), Grade 36.

B. Sole Plates. The exposed face of the sole plate embedded in the concrete shall be straight and truly perpendicular to the vertical axis of the concrete girder. A variation of 1/16 inch from a plane perpendicular to the vertical axis shall not be exceeded at any place.

C. Rocker and Masonry Plates. Sliding surfaces of both the rocker and the plate shall be machined to a flat ANSI 125 finish in direction of movement. If machined in a direction other than the expansion, it shall be machined to a flat ANSI 63 finish. Notice shall be given when the fabricator is ready for inspection so that arrangements may be made by the Department for inspection. Machined surfaces shall not be painted until after inspection. Plates may be cut to size by torch, and holes and slots may be cut by torch provided the ends of slots are drilled

before cutting is done. Burrs from torch cuts shall be removed. Bridge bearing components including bridge rollers, rockers and sliding bearings that are to be hot dipped galvanized shall be machined to an ANSI surface roughness requirement of ANSI 250 or better regardless of expansion direction.

D. Elastomeric Bearing Pads. Elastomeric bearing pads shall meet the requirements of **Section 724**. The size and thickness of elastomeric material and laminae shall be as indicated on the plans.

E. Flange Bearing Area. Flange surfaces bearing on sole plates shall conform to the tolerances specified in the latest edition of the ANSI / AASHTO / AWS D 1.5 *Bridge Welding Code* which requires that 75% of the projected web and stiffener area be flat within 0.01 inch and the remaining 25% of the projected area to be within 1/32 inch. In addition, the remaining contact area between the flange and sole plate shall not deviate more than 1/16 of an inch from a plane measured perpendicular to the web. The field fit-up of the flange to the sole plate shall produce a gap not to exceed 1/8 inch. Gaps exceeding 1/8 inch in fit-up shall be corrected by a method approved by the Engineer before welding the flange to the sole plate.

709.39 Abutting Joints. Abutting joints in compression members designed to transfer stress shall be faced and brought to an even bearing. Where joints are not required elsewhere to be faced or brought to even bearing, the opening shall not exceed 1/4 inch.

709.40 End Connection Angles. Floor beams, stringers and girders having end connection angles shall be built to exact length back to back of connection angles. If end connections are faced, the finished thickness of the angles shall not be less than that shown on the detail drawings.

709.41 Web Splices. At bolted web splices, the ends of the beams or girders shall be cut and ground smooth. During

shop assembly, the clearance between the ends of the members (web and flanges) shall not exceed 1/4 inch.

709.42 Bent Plates. Unwelded, cold-bent, load-carrying, rolled-steel plates shall conform to the following:

A. General. They shall be so taken from the stock plates that the bend line will be at right angles to the direction of rolling.

B. Bending. Bending shall be such that no cracking of the plate occurs. Minimum bend radii, measured to the concave face of the metal, are given in the following table:

For All Grades Of Structural Steel In this Specification					
Thickness of Plate	Up to 1/2	Over 1/2 to 1	Over 1 to 1 1/2	Over 1 1/2 to 2 1/2	Over 2 1/2 to 4
Minimum Bending Radius for Thickness, t in Inches	2t	2 1/2 t	3t	3 1/2t	4t

For break press forming, the lower die span should be at least 16 times the plate thickness. Multiple hits are advisable.

If a shorter radius is essential, the plates shall be bent hot at a temperature not greater than 1125ºF. Any plates from all ASTM or AASHTO designations inadvertently heated above 1125ºF shall be rejected or re-quenched and re-tempered using correct ASTM procedures.

Before bending, the corners of the plate shall be rounded to a radius of 1/16 inch throughout the portion of the plate at which the bending is to occur.

709.43 Finished Members at Fabrication Shop. Finished members shall be true to line, free from twists, bends, and

open joints.

709.44 Weighing Members. In case it is specified that any part of the material is to be paid for by actual weight, finished work shall be weighed in the presence of the Inspector, if practicable. In such case, the Contractor shall supply satisfactory scales and shall perform all work involved in handling and weighing the various parts.

709.45 Marking and Shipping. Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon.

The Contractor shall furnish to the Engineer as many copies of material orders, shipping statements and erection diagrams as the Engineer may direct. The weights of the individual members shall be shown on the statements. Members weighing more than 3 tons shall have weights marked thereon.

Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged.

Bolts of one length and diameter and loose nuts or washers of each size shall be packed separately. Pins, small parts and packages of bolts, washers and nuts shall be shipped in boxes, crates, kegs or barrels, but the gross weight of any package shall not exceed 300 pounds. A list and description of the contained material shall be plainly marked on the outside of each shipping container.

ERECTION

709.46 Delivery of Materials. If the contract is for erection only, the Contractor shall receive the materials entering into the finished structure free of charge at the place designated and loaded or unloaded as specified. The Contractor shall

unload promptly upon delivery any material delivered to the place designated, that he is required to unload. Otherwise, he shall be responsible for demurrage charges.

709.47 Handling and Storing Materials. Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and stored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection. If the contract is for erection only, the Contractor shall check the material turned over to him against the shipping list and report promptly in writing any shortage or injury discovered. He shall be responsible for the loss of any material while in his care, or for any damage caused to it after being received by him.

709.48 Falsework. The falsework shall be properly designed, substantially constructed, and properly maintained for the loads it is intended to support. The Contractor, if required, shall prepare and submit to the Engineer for review and acceptance, working drawings for falsework or for changes in an existing structure necessary for maintaining traffic. Review and acceptance of the Contractor's working drawings shall not be considered as relieving the Contractor of any responsibility. Working drawings for falsework shall be submitted as specified in **Section 725**.

709.49 Methods and Equipment. Before starting erection work, the Contractor shall submit to the Engineer for approval, an *Erection Plan* that fully details the method of erection he proposes to follow and the amount and type of equipment to be used. The approval of the Engineer shall not relieve the Contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be started until such approval by the Engineer has been obtained.

709.50 Bearings and Anchorages. Bridge bearings shall be set level, in exact position, and must have full an even bearing on the masonry.

Elastomeric bearing pads, if used, shall set directly on the concrete masonry.

The Contractor shall drill holes for anchor bolts and set them in Portland cement grout or preset them as shown on the plans or as specified.

Location of anchors and setting of rockers or rollers shall take into account any variation from mean temperature at time of setting and anticipated lengthening of bottom chord or bottom flange due to dead load after setting, the intention being that, as near as practicable, at mean temperature and under dead load, the rockers and rollers shall set vertical and anchor bolts at expansion bearings will center their slots. Care shall be taken that full and free movement of the superstructure at the movable bearings is not restricted by improper setting or adjustment of bearings or anchor bolt and nuts.

Bridge bearings shall not be placed on masonry bearing areas that are irregular or improperly formed.

709.51 Erection of Structure. If the substructure and superstructure are built under separate contracts, the superstructure erector shall expect reasonable variations from the theoretical distances between embedded anchor bolts, condition of bearing areas or elevation of pier caps. The superstructure erector shall verify for himself by field measurements the actual distance between embedded anchor bolts and pier caps or elevation of pier caps before fabrication of the superstructure steel so that adjustments can be made if found necessary. Necessary corrections of variations considered excessive will be paid for as extra work, when such work is authorized by the Engineer.

The Contractor shall erect the metal work, remove the temporary construction and do all the work required to complete the bridge or bridges as covered by the Contract, including the removal of the old structure or structures, if stipulated, all in accordance with the plans and these specifications.

709.52 Straightening Bent Material. The straightening of plates, angles, other shapes and built-up members, when permitted by the Engineer, shall be done by methods that will not produce fracture or other injury. Distorted members shall be straightened by mechanical means or, if approved by the Engineer, by carefully planned procedures and supervised application of a limited amount of localized heat, not exceeding 1125ºF. In no case shall the maximum temperature of the ASTM or AASHTO designated metals exceed 1125ºF nor shall the temperature exceed 950ºF at the weld metal or within 6 inches of weld metal. Heat shall not be applied directly on weld metal. The metal temperature shall be controlled by means of temperature indicating crayons, liquids or bimetal thermometers. All metal inadvertently heated above 1125ºF shall be rejected or re-quenched and re-tempered using correct ASTM procedures.

Parts to be heat straightened shall be substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

709.53 Assembling Steel. The parts shall be accurately assembled as shown on the plans and any match-marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be

erected on blocking so as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully bolted and all other truss connections pinned and bolted. Permanent bolts in splices of butt joints of compressing members or permanent bolts in railings shall not be tightened until the span has been swung. Splices and field connections shall have one-half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before bolting with high-strength bolts. Splices and connections carrying traffic during erection shall have 3/4 of the holes so filled.

Fitting-up bolts shall be of the same nominal diameter as the high-strength bolts and cylindrical erection pins shall be 1/32 inch larger.

709.54 Misfits. The correction of minor misfits involving harmless amounts of reaming, cutting and chipping will be considered a legitimate part of the erection. However, any error in the shop fabrication or deformation resulting from handling and transportation, which 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, shall be reported immediately to the Inspector and his approval of the method of correction obtained. The correction shall be made in his presence. If the contract provides for complete fabrication and erection, the Contractor shall be responsible for all misfits, errors and injuries and shall make the necessary corrections and replacements. If the contract is for erection only, the Inspector, with the cooperation of the Contractor, shall keep a correct record of labor and materials used and the Contractor shall render within thirty (30) days an itemized bill for the approval of the Engineer.

709.55 Removal of Old Structure and Falsework. If stipulated in the agreement, the Contractor shall dismantle the old structure that, unless otherwise provided, shall be the property of the Department, and shall store the material in the immediate vicinity of the bridge site as the Engineer may direct. If the old structure is to be re-erected, it shall be dis-

mantled without unnecessary damage and the parts match-marked and carefully stockpiled.

Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless materials, rubbish and temporary buildings, replace or renew any fences damaged and restore in an acceptable manner all property, both public and private, that may have been damaged during the prosecution of this work and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the Engineer. All excavated material or falsework placed in the stream channel during construction shall be removed by the Contractor before final acceptance.

709.56 Computation of Weights. Structural Steel weights shall be the computed weights, assuming the weight of steel at 490 pounds per cubic foot and the weight of cast iron at 450 pounds per cubic foot.

The weights of rolled shapes, bars and plates shall be computed on the basis of the nominal weights as given in the manufacturers' handbooks, without plus tolerances for rolled plates, using the dimensions shown on the approved shop drawings. Deduction shall be made for all copes, cuts and open holes. No allowance shall be made for overrun in weight.

The weight of high strength bolts, nuts, and washers shall be established by scale weight.

The weight of castings shall be computed from the dimensions shown on the approved shop drawings, with an addition of 5% for fillets and overrun.

The right is expressly reserved to weigh a portion or all of the material to be 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 pound price and lump sum price.

709.57 Method of Measurement. Measurement will be made on the pound price or lump sum basis, as specified in the contract. When the contract is awarded on a pound-price basis, the quantities to be paid under this Section shall be the weight in pounds of all Structural Steel actually entering into and becoming a part of the completed structure and accepted by the Engineer.

709.58 Basis of Payment. This work will be paid for either on the per pound price or on a lump sum basis. The method that will prevail will be stated in the contract. Partial payments will be made as indicated in **Subsections 109.06** and **109.07**.

A. Pound Price. Structural steel will be paid for at the contract unit price, which price and payment shall be full compensation for all materials, fabrication, erection and painting and all work and materials incidental to the completion of the structure in accordance with the plans and specifications, or as directed.

The Department's computed weights shall be final unless such weights are found in error by more than 1 1/2%.

B. Lump Sum Price. Structural steel will be paid for at the contract lump sum price for the structural steel complete in place, which price and payment shall be full compensation for all materials, fabrication, erection and painting and all work and materials necessary to complete the structure in accordance with the plans and specifications, or as directed.

The average price per pound obtained by dividing the lump sum price by the estimated weight of structural steel shall be used in adjusting changes in structural steel from that required by the contract.

Payment for this item will include all direct and indirect costs and expenses required to complete the work.

Payment will be made under:		
Item No.	**Pay Item**	**Pay Unit**
709110X	Structural Steel	Lump Sum
7091120	Structural Steel	Pound

SECTION 710

PAINT FOR STRUCTURAL STEEL

710.01 Description. This work shall consist of furnishing paint and paint materials meeting the requirements of these specifications, and of the application of paint as indicated on the plans and in accordance with the provisions and requirements of these specifications.

710.02 General Requirements. All paint shall be thoroughly ground and shall not settle excessively nor cake in the container and shall mix readily with a paddle to a smooth, uniform consistency. Small amounts of anti-skinning agents and anti-settling agents may be added during manufacture. All paint kept in storage shall retain their original characteristics for a period of not less than the stated shelf life. All containers of paint shall remain unopened until required for use. Containers that have been recently opened and premixed or blended together shall be used first. Paint that has livered, gelled, or otherwise deteriorated during storage or is beyond the stated shelf life shall not be used. Wet paint shall be protected against damage from dust, sand, blast debris, or other detrimental foreign matter to the extent practicable. During the painting operation, precautionary measures shall be taken to protect any surfaces not to be painted or which have already been painted. The Contractor will also be responsible for repairing and spot-

tions. The Contractor will be responsible for the satisfactory removal of all spillage, drippings, spattering or inadvertent applications caused by his operations. The Contractor shall comply with the manufacturer's recommendations for health and safety (***Safety Data Sheets***) when handling, storing and applying paint.

All paint shall be applied by individuals experienced (2 years minimum) in the application of the paint system being applied. The paint contractor shall have expertise (2 years minimum) in the application of the specified paint system on structural steel bridges.

710.03 Inspection, Sampling, and Acceptance. The Department reserves the right to sample all ingredients at the point of origin, and to sample finished paint either at the point of origin or at the destination and to withhold acceptance of the paint until analysis of such samples have been made.

Inspection and sampling will be done at the point of manufacture whenever practicable. When inspection and sampling is performed at the point of manufacture, all necessary assistance shall be furnished by the manufacturer so that the inspector can sample all the ingredients and the finished paint. All samples shall be forwarded to the Department's Research and Materials Laboratory for testing. The manufacturer may proceed with the making of the paint prior to receiving test results on the ingredient samples; however, should any of the ingredient materials fail to meet the specified test requirements, the paint made with the failing material will be rejected. For finished paint that is sampled at the point of destination, the manufacturer shall furnish a certification to the Engineer that the ingredient materials meet all applicable SCDOT specifications.

Only paint in compliance with the current **Environmental Protective Agency (EPA)**, the **South Carolina Department of Health and Environmental Control (SCDHEC)**, and local **City or County requirements for Volatile Organic Compounds (VOC's)** shall be approved. Only material from the

Department's approved paint list available from the Research and Materials Laboratory shall be used in the work. A manufacturer may request that his material be included on the list by successfully demonstrating that the material complies with all the requirements of the Department's specification. A copy of the Department's generic paint specifications may be obtained by writing:

Research and Materials Engineer
South Carolina Department of Transportation
P. O. Box 191
Columbia, South Carolina 29202.

Approval of the manufacturer's material may be accomplished by:

A. Documentation. The paint manufacturer shall furnish documentation acceptable to the Department that the product has been used successfully on highway bridges or other structures exposed to severe weather conditions for at least two years. Severe weather shall be considered a salt/marine environment and an extreme hot and cold temperature (plus 120ºF or a minus 15ºF environment).

B. Certified Test Report. The Manufacturer shall submit a certified test report (no older than five (5) years) by a recognized qualified testing laboratory showing specific test results which indicate that the product conforms to all quantitative and resistance test requirements of the Department's specifications. In addition, the certified test reports shall contain the lot tested, the paint manufacturer's name, the product name, the product number and the date of manufacture.

C. Certified Affidavit. The paint manufacturer shall submit a certified affidavit listing all items not covered in the independent lab test report including the composition and the properties of the vehicle.

D. Application Data. The Manufacturer shall furnish

D. Application Data. The Manufacturer shall furnish complete application instructions and recommended equipment for applying the paint, touching up damaged paint areas, and correcting areas with deficient paint film thickness.

E. Other Required Submissions. The paint manufacturer shall also furnish the Contractor and the Department their recommendation for health and safety (*Safety Data Sheets*) when handling, storing and applying their product.

Even when no change has been made in the material formulation, the manufacturer shall submit a certified affidavit biennially stating that no change in paint formulation has occurred since the product was originally approved or last approved. The product will then remain on the approved list.

710.04 Packing and Marking. Each shipment of paint shall be accompanied by written certification from the manufacturer stating that the material furnished complies with the Department's paint specifications. All paint shall be shipped in new, strong containers, properly sealed. Each container shall be plainly marked with the kind and color of paint, number of gallons, lot or batch number, the date of manufacture and the name and address of the manufacturer.

710.05 Inorganic Zinc Silicate Primer Paint. Inorganic Zinc Silicate Primer paint shall be a two-component self curing type paint that cures without the use of a separate curing solution. The detailed requirements and a list of approved sources can be obtained from the Research and Materials Laboratory. The prime coat shall be produced by the same manufacturer as the intermediate and the finish coats.

710.06 Aluminum Epoxy Mastic Paint. Aluminum Epoxy Mastic paint shall be a two component, modified epoxy bitumen primer, intermediate coat, or finish coat paint. The color shall be leafed aluminum. The detailed requirements and a list of approved sources can be obtained from the Research

and Materials Laboratory.

710.07 High Build Aliphatic Polyurethane Paint. High Build Aliphatic Polyurethane paint shall be a two component finish coat paint. The color shall be light gray (Federal Shade No. 26622) unless specified otherwise by the Engineer, the plans, or the special provisions. The detailed requirements and a list of approved sources can be obtained from the Research and Materials Laboratory.

710.08 Acrylic Paint. Acrylic paint is a single component, water reducible, 100% acrylic intermediate or finish coat paint. The color shall be a light gray (Federal Shade No. 26622) unless specified otherwise by the Engineer, the plans, or the special provisions. The detailed requirements and a list of the approved sources can be obtained from the Research and Materials Laboratory.

710.09 Paint Systems for Structural Steel.

A. Paint Zones.

1. Paint Zone A. Paint Zone A shall consist of Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry, and Jasper Counties.

2. Paint Zone B. Paint Zone B shall consist of all counties not included Paint Zone A.

B. Paint Systems.

1. Paint System NS1. All new structural steel shall receive one primer coat (3.5 mils minimum dry film thickness) of Inorganic Zinc Silicate Paint, one intermediate coat (5 mils minimum dry film thickness) of Aluminum Epoxy Mastic Paint and one finish coat (3.5 mils minimum dry film thickness) of High Build Aliphatic Polyurethane Paint in accordance with these specifications, the plans and/or the special provisions. The color of the finish coat shall be light gray (Federal

Shade No. 26622) unless specified otherwise by the Engineer, the plans, or special provisions. The primer coat of paint shall be produced by the same manufacturer as the intermediate and finish coats of paint.

2. Paint System NS2. All new structural steel shall receive one primer coat (3.5 mils minimum dry film thickness) of Inorganic Zinc Silicate Paint, one intermediate coat (2 mils minimum dry film thickness) of water reducible 100% Acrylic Paint and one finish coat (2 mils minimum dry film thickness) of water reducible 100% Acrylic Paint in accordance with these specifications, the plans, and/or the special provisions. The intermediate coat of Acrylic Paint shall be of a different color than the finish coat of Acrylic Paint. The color of the finish coat of Acrylic Paint shall be light gray (Federal Shade No. 26622) unless specified otherwise by the Engineer, the plans, or the special provisions. The primer coat of paint shall be produced by the same manufacturer as the intermediate and finish coats of paint.

3. Paint System NS3. All exposed new steel H-bearing piling, sway bracing, and casing left in place shall receive one primer coat (5 mils minimum dry film thickness) of Aluminum Epoxy Mastic Primer Paint and one finish coat (5 mils minimum dry film thickness) of Aluminum Epoxy Mastic Paint in accordance with these specifications, the Engineer, plans, or the special provisions.

4. Paint System ES1. All 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 shall receive one primer coat (5 mils minimum dry film thickness) of Aluminum Epoxy Mastic Paint , one intermediate coat (5 mils minimum dry film thickness) of Aluminum Epoxy Mastic Paint and one finish coat (3.5 mils minimum dry film thickness) of

High Build Aliphatic Polyurethane Paint in accordance with these specifications, the Engineer, the plans, or the special provisions. The color of the finish coat shall be light gray color (Federal Shade No. 26622) unless specified otherwise by the Engineer, the plans, or the special provisions. The intermediate coat of Aluminum Epoxy Mastic Paint shall be tinted so as to be clearly distinguishable from the primer coat of Aluminum Epoxy Mastic Paint. The primer coat of paint shall be produced by the same manufacturer as the intermediate and finish coats of paint.

C. Determination of Paint System. Unless specified otherwise in the plans or special provisions, the table below shall be used to determine the Paint System for use on projects for the type of material located in the specified Paint Zones.

Material	Paint Zone	Paint System
New Structural Steel:	A B A and B	NS1 NS2 NS1
Existing Structural Steel	A or B	ES1
Exposed Portions of New Steel H Bearing, Piling & Sway Braces, Casing left in place	A or B	NS3

710.10 Primer Application.

A. Inorganic Zinc Silicate Primer.

1. Surface Preparation. All structural steel shall be cleaned to the requirements of Near White Blast Cleaning in accordance with the Steel Structures Painting Council Surface Preparation SP10, (current edition) "No. 10 Near White Blast Cleaning" method. The quality of the blast cleaning shall be such that the prime

coat of Inorganic Zinc Silicate Paint specified will adhere tightly to the steel in all cases. The blast operation shall produce a surface (anchor) profile between 1.5 mils and 3 mils.

All surfaces to be in contact with concrete, areas adjacent to bolted connections and splices, including bolt holes, shall also be cleaned as stated above.

2. Application of Paint. All Inorganic Zinc Silicate Primer shall be shop applied unless specified otherwise by the Engineer or designated elsewhere in the plans and/or the special provisions. All Inorganic Zinc Silicate Primer shall be mixed and applied within 12 hours after cleaning and before any rusting occurs. All paint shall be applied in accordance with the manufacturer's written recommendations by people skilled in this type of work.

Inorganic Zinc Silicate Primer shall be applied only when the paint, the surrounding air and the steel surface temperatures are above +25ºF or the minimum temperature recommended by the paint manufacturer, whichever is higher. Paint shall not be applied upon damp surfaces nor shall paint be applied when conditions are otherwise unsatisfactory for the work, in the opinion of the Engineer. Paint shall not be applied when the surface temperature is less than 5ºF above the dew point.

3. Application Equipment and Method. The Inorganic Zinc Silicate Primer shall only be applied by spray application. The equipment used shall be suitable for the intended purpose, and painting shall be controlled by appropriate pressure regulators and gauges. The air caps, nozzles and needles shall be those recommended by the manufacturer of the paint

being sprayed. The equipment shall be kept in satisfactory condition to permit proper application. The

pressure on the paint in the pot and the air at the gun shall be adjusted when necessary for changes in elevation of the gun above the pot.

Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint to the steel surface being painted. Only solvents approved by the paint manufacturer shall be used.

4. Paint Thickness Requirements. A smooth uniform coating with a minimum dry film thickness of 3.5 mils shall be obtained without film cracking, sagging or loss of adhesion.

Before the steel is moved out of the shop paint bay to shop storage, and within 6 hours of original painting, all areas of each component found to have a dry film thickness less than 3.5 mils shall be corrected. It shall be corrected by adding touch-up coats of the Inorganic Zinc Primer, which has been thinned according to the manufacturer's recommendations for touch-up. Any areas with flaws such as mud-cracking or sags shall be corrected before shop storage. Components with severe deficiencies (i.e., areas with readings less than 2.5 mils dry film thickness, excessive mud-cracking or sagging) that in the opinion of the Engineer, cannot be easily corrected by the touch-up method, shall be recleaned as described in item 1 above and repainted.

The Inorganic Zinc Silicate Primer shall have cured a minimum of 60 calendar days (no maximum) before the Aluminum Epoxy Mastic touch-up (see below) or the intermediate coat (i.e., Aluminum Epoxy Mastic or Acrylic) or the finish coat is applied.

5. Shop Applied Field Touch-up of Damaged or Deficient Areas. When the steel is removed from shop storage to be shipped to the project, surface areas that have been damaged or found to be deficient (3.5 mils dry film thickness) shall be corrected by applying one coat (5 mils minimum dry film thickness) of SCDOT approved Aluminum Epoxy Mastic paint produced by the same manufacturer as the Inorganic Zinc Silicate Primer.

B. Aluminum Epoxy Mastic Primer.

1. Surface Preparation. All new or existing structural steel unless specified otherwise shall be cleaned to the requirements of Commercial Blast Cleaning in accordance with **Steel Structures Painting Council Surface Preparation** - SP6 (most current edition) *No. 6 Commercial Blast Cleaning Method* unless designated otherwise by the Engineer or the plans and/or the special provisions. The quality of the blast cleaning shall be such that the prime coat of Aluminum Epoxy Mastic Paint will adhere tightly to the steel in all cases. The surface (anchor) profile shall be in the range specified by the paint manufacturer of the Aluminum Epoxy Mastic Paint.

The steel surface shall meet the requirements of SSPC–SP 6 just before the application of the Aluminum Epoxy Mastic Primer Coat. All steel surfaces shall be dust free and the Aluminum Epoxy Mastic Primer Coat applied within 8 hours of blast cleaning unless specified otherwise by the Engineer.

When Aluminum Epoxy Mastic Paint is specified for existing structural steel, all surfaces to be in contact with new concrete, areas adjacent to bolted connections and splices, including bolt holes, shall be cleaned as stated above. Furthermore, this blast cleaning operation shall remove all existing paint and any layered

rust. Abrasive blasting shall be performed with recyclable steel grit abrasive. Primed surfaces damaged by blasting shall be wire brushed, or if visibly rusted, re-blasted to cleaning condition specified above.

Immediately prior to the application of any specified intermediate coat or finish coat of paint, all steel surfaces shall be cleaned of all contaminants present on the coated surface, in accordance with the paint manufacturer's written instructions unless approved otherwise by the Engineer.

2. Application of Paint. All Aluminum Epoxy Mastic Primer shall be applied within 8 hours after cleaning and before any rusting occurs. All paint shall be mixed and applied in accordance with the paint manufacturer's written recommendations by people skilled in this type of work.

Aluminum Epoxy Mastic Primer shall be applied only when the paint, the surrounding air and steel surface temperatures are above 40°F. Paint shall not be applied upon damp surfaces nor shall paint be applied when conditions are otherwise unsatisfactory for the work, in the opinion of the Engineer. Paint shall not be applied when the surface temperature is less than 5°F above the dew point.

Any required touch-up of thin areas of the applied Aluminum Epoxy Mastic Primer coat shall be made within 72 hours after application of paint. The cure time between the application of the Aluminum Epoxy Mastic Primer and any specified intermediate and/or finish coat shall be a minimum of 24 hours at the temperature of 75°F or as recommended by the manufacturer.

3. Paint Thickness Requirements. The primer paint shall be mixed and applied according to the manufacturer's application instructions. A smooth uniform

coating with a minimum dry film thickness of 5 mils shall be obtained without film cracking, sagging or loss of adhesion.

4. Application Equipment and Method. The Aluminum Epoxy Mastic Paint shall be applied by spray, brush and /or roller application. The Aluminum Epoxy Mastic Paint shall not be applied by spray if the structure is over existing traffic or within an urban area. The application of Aluminum Epoxy Mastic Paint to structures over existing traffic or within urban areas shall be by brushes and/or rollers unless an alternate method is approved by the Engineer. However, spray application may be used any time the structure is within a closed containment system.

a. Brush and/or Roller Application. A minimum of two coats shall be used in obtaining each required minimum dry film thickness of 5 mils when utilizing the brush and /or roller method of application. Brushes and rollers shall be of such quality that foreign materials are not deposited in the paint film. Only solvents approved by the paint manufacturer shall be used.

b. Spray Application. The equipment used shall be suitable for the intended purpose, and painting shall be controlled by appropriate pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the paint being sprayed. The equipment shall be kept in satisfactory condition to permit proper application. The pressure on the paint in the pot and the air at the gun shall be adjusted when necessary for changes in elevation of the gun above the pot.

Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film. Any solvents left

in the equipment shall be completely removed before applying paint to the steel surface. Only solvents approved by the paint manufacturer shall be used.

710.11 Field Painting.

A. New Superstructure Steel. Immediately prior to the application of any specified intermediate coat or finish coat of paint, all steel surfaces shall be cleaned of all rust, dirt, inorganic zinc primer dry spray, grout and/or concrete spillage or any other contaminants present on the coated surface in accordance with the paint manufacturer's written instructions unless approved otherwise by the Engineer. All field coats of paint shall be applied only when the surrounding air, the steel surface, and the paint temperatures are above 40ºF. Paint shall not be applied upon damp surfaces nor shall paint be applied when the air is misty, or otherwise unsatisfactory for work, in the opinion of the Engineer. Paint shall not be applied when the surface temperature is less than 5ºF above the dew point.

1. Surface Preparation. All surface areas and all high strength bolts, washers and nuts (except galvanized bolts, washers, and nuts) shall be cleaned as described above using wire brushes or other suitable tools of all objectionable material as listed above to the satisfaction of the Engineer. Galvanized bolts, washers, and nuts shall be cleaned of all oil, lubricant, dirt, or objectionable material using a solvent that is recommended by the paint manufacturer and approved by the Engineer. In addition to the above specified cleaning and just prior to the application of the intermediate coat of paint, all surface areas of the structural steel and all high strength bolts, washers, and nuts (plain and galvanized) shall be pressure washed (1500 psi minimum water pressure), and then, immediately blown dry with oil free and moisture free compressed air.

2. Field Touch-up Coat. A field touch-up coat of paint shall be applied to all surface areas of the 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 one touch-up coat (5 mils minimum dry film thickness) of SCDOT approved Aluminum Epoxy Mastic Paint produced by the same Manufacturer as the Inorganic Zinc Silicate Primer to the above noted steel surfaces.

The Inorganic Zinc Silicate Primer Paint shall have cured a minimum of 60 calendar days (no maximum) before application of the touch-up coat of paint. The touch-up coat of Aluminum Epoxy Mastic Paint shall have cured a minimum of 24 hours at the temperature of 75°F or cured as recommended by the paint manufacturer before application of the intermediate coat of paint.

2. Field Coats.

a. Paint System NS1. All structural steel shall receive the field coats as specified in **Subsection 710.09B.1**.

b. Paint System NS2. All structural steel shall receive the field coats as specified in **Subsection 710.09B.2**.

c. Contractor Proposed Plan. The Contractor may elect to apply the specified field coats of paint prior to casting the bridge deck concrete provided the following conditions are satisfied:

(1) The Contractor's proposed plan (including site location and applicator) for applying the required field coats of paint shall be submitted to the Bridge Construction Engineer for review and approval a minimum of thirty

(30) calendar days prior to beginning the painting work.

(2) The contact surfaces (including surfaces in contact with the nuts and bolt heads) of all bolted or welded steel work shall be masked and shall not receive the specified field coats of paint until after all steel work is totally erected and all bolted or weld connections are complete.

(3) Any required touch-up of the primer coat of paint shall be performed as noted in **Subsections 710.11A.1** & **710.11A.2** before applying any specified field coat of paint. However, the Inorganic Zinc Silicate Primer Paint's cure time shall be a minimum of sixty (60) calendar days before application of any specified field coat of paint.

(4) Any damage to the painted steelwork shall be corrected before the final inspection of the project.

(5) The Contractor shall pressure wash (1200 psi maximum) the painted steel work immediately (within 6 hours) after casting the deck so as to remove any drippings or runs of concrete from the painted steel work. Any objectionable material on the steel work not removed by pressure washing shall be removed to the satisfaction of the Engineer by other suitable means recommended by the paint manufacturer.

(6) The Contractor shall furnish the special handling procedures proposed for handling, transporting and placing the structural steel so as to minimize damage to the painted steel work. The Contractor shall furnish the

paint manufacturer's data for the minimum time before handling steel work after paint has been applied on the steel surface.

(7) The Contractor shall cure the specified finish coat of field paint a minimum of two weeks prior to casting the deck concrete.

4. Application of Paint. The Inorganic Zinc Silicate Primer Paint upon being applied to any steel work shall have cured a minimum of sixty (60) calendar days (no maximum) before application of either intermediate coat of paint specified in **Subsection 710.10**.

a. High Build Aliphatic Polyurethane Paint. All steel work which has been coated with the intermediate coat of Aluminum Epoxy Mastic Paint shall also receive a single finish coat of High Build Aliphatic Polyurethane Paint. Any required touch-up of thin areas of the applied coating shall be made within 48 hours after application of the paint. The cure time between the application of the Aluminum Epoxy Mastic Paint and the finish coat of High Build Aliphatic Polyurethane shall be a minimum of 24 hours at the temperature of 75ºF or cured as recommended by the paint manufacturer.

b. Acrylic Paint. All steel work which has been coated with the intermediate coat of Acrylic Paint shall also receive a single finish coat of the Acrylic Paint as specified in **Subsection 710.09A**. The cure time between the intermediate coat of Acrylic Paint and the finish coat of Acrylic Paint shall be as recommended by the paint manufacturer unless approved otherwise by the Engineer.

5. Paint Thickness Requirements. The applied coat shall deposit the minimum dry film thickness as specified in **Subsection 710.09A**. A smooth uniform coating

shall be applied without film cracking, sagging or loss of adhesion.

6. Application Equipment and Methods.

a. Brush and/or Roller Application. Brushes and rollers shall be of such quality that foreign materials are not deposited in the paint film. For Aluminum Epoxy Mastic Paint a minimum of two coats shall be used in obtaining each required dry film thickness of 5 mils when utilizing the brush and/or roller method of application. For all other applied coatings the brush and/or roller application shall be as specified by the paint manufacturer.

b. Spray Application. The equipment used shall be suitable for the intended purpose, and painting shall be controlled by appropriate pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the paint being sprayed. The equipment shall be kept in satisfactory condition to permit proper application. The pressure on the paint in the pot and the air at the gun shall be adjusted when necessary for changes in elevation of the gun above the pot.

Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint to the steel surface. Only solvents approved by the manufacturer shall be used.

c. Application Methods.

(1) Aluminum Epoxy Mastic Paint. The Aluminum Epoxy Mastic Paint may be applied by spray, brush and/or roller application. The Alu-

minum Epoxy Mastic Paint shall not be applied by spray if the structure is over existing traffic or within an urban area. The application of Aluminum Epoxy Mastic Paint to structures over existing traffic or within urban areas shall be by brushes and/or rollers unless an alternate method is approved by the Engineer. However, spray application may be used any time the structure is within a closed containment system.

(2) High Build Aliphatic Polyurethane Paint. The High Build Aliphatic Polyurethane Paint shall be applied by spray application unless approved otherwise by the Engineer.

(3) Acrylic Paint. The intermediate coat of Acrylic Paint shall be applied by spray application. The finish coat of Acrylic Paint may be applied by spray, brush and/or roller application. The finish coat of Acrylic Paint shall not be applied by spray if the structure is over existing traffic or within an urban area. The application of the finish coat of Acrylic Paint to structures over existing traffic or within urban areas shall be by brushes and/or rollers unless an alternate method is approved by the Engineer. However, spray application may be used any time the structure is within a closed containment system.

B. New Steel H-Bearing Piling and Sway Braces. The painting of new steel H-bearing piling and sway braces shall be as follows:

1. General. Steel H-bearing piling that will be entirely encased in earth need not be painted. All exposed portions of steel H-bearing piling shall be painted from the bottom of bent cap down to an elevation one foot below the 100 year scour line shown in the plans. When the 100 year scour line is not shown in the plans, the piling shall be painted to a depth of 5 feet

below the earth line or stream bed elevation whichever depth is greater. All exposed steel angle sway bracing welded to steel piles shall be painted. Piles to be driven through water shall be painted either before driving or before the portion of the pile on which paint is required reaches the water level.

2. Surface Preparation. The portions of the piles and sway braces as designated in **Subsection 710.11B.1** above or as designated in the plans and/or the special provisions shall be cleaned with wire brushes or other suitable tools to remove all rust, dirt, oil, grease, concrete spillage and other objectionable materials to the satisfaction of the Engineer.

3. Field Coats. The portions of the piles and sway braces as designated in **Subsection 710.11B.1** above or as designated in the plans and/or the special provisions shall be painted in accordance with **Subsection 710.09A.3**.

4. Application of Paint. Application of Aluminum Epoxy Mastic Primer. All Aluminum Epoxy Mastic Primer shall be applied within 12 hours after cleaning and before any rusting occurs. All paint shall be applied in accordance with the paint manufacturer's written recommendations by people skilled in this type of work.

Any required touch-up of thin areas of the applied Aluminum Epoxy Mastic Primer coat shall be made within 72 hours after application of paint. The cure time between the application of the Aluminum Epoxy Mastic Primer and the Aluminum Epoxy Mastic finish coat shall be a minimum of 24 hours at the temperature of 75ºF or cured as recommended by the paint manufacturer.

5. Paint Thickness. The intermediate coat and finish coat of paint shall be mixed and applied according to the paint manufacturer's application instructions. The

applied coat shall deposit a minimum dry film thickness as specified in **Subsection 710.09A.3**. A smooth uniform coating shall be applied without film cracking, sagging or loss of adhesion.

6. Application Equipment and Methods. The Aluminum Epoxy Mastic Paint shall be applied by spray, brush and/or roller application in accordance with **Subsection 710.11A.6**.

C. Existing Structural Steel. The field painting of existing structural steel shall be as follows:

1. Surface Preparation. Prior to the application of the intermediate coat and finish of paint all surface areas shall be cleaned of all dirt, oil, grease, rust, grout and/or concrete spillage and other contaminants present on the coated surface in accordance with the paint manufacturer's written instructions unless approved otherwise by the Engineer.

2. Field Touch-up Coat. All surface areas that have been damaged by the cleaning operation or surface areas with deficient primer dry film thickness shall be re-coated in accordance with **Subsection 710.10B.3**.

3. Field Coats. All structural steel shall be painted as specified in **Subsection 710.09B**.

4. Application of Paint.

a. Aluminum Epoxy Mastic Paint. All structural steel designated to receive the Aluminum Epoxy Mastic Primer Paint shall have cured a minimum of 24 hours at the temperature of 75ºF (no maximum) or cured as recommended by the paint manufacturer before application of the intermediate coat of Aluminum Epoxy Mastic Paint.

b. High Build Aliphatic Polyurethane Paint. Any

required touch-up of thin areas of the applied coating shall be made within forty (48) hours after application of the paint. The cure time between the application of the Aluminum Epoxy Mastic Paint and the finish coat of High Build Aliphatic Polyurethane shall be a minimum of twenty-four (24) hours at the temperature of 75ºF or cured as recommended by the paint manufacturer.

5. Paint Thickness. The intermediate coat and finish coat of paint shall be mixed and applied according to the manufacturer's application instructions. The applied coat shall deposit a minimum dry film thickness as specified in **Subsection 710.09B**. A smooth uniform coating shall be applied without film cracking, sagging or loss of adhesion.

6. Application Equipment and Methods.

a. Aluminum Epoxy Mastic Paint. The Aluminum Epoxy Mastic Paint shall be applied by spray, brush and/or roller application as specified in **Subsection 710.11A.6**.

b. High Build Aliphatic Polyurethane Paint. The High Build Aliphatic Polyurethane Paint shall be applied by spray application as specified in Subsection 710.11A.6.

710.12 Measurement of Dry Film Paint Thickness. Measurement of dry film paint thickness shall be performed in accordance with **Steel Structures Painting Council SSPC-PA2** (current edition), *Paint Application Specification No. 2* unless specified otherwise by the Engineer.

710.13 Method of Measurement.

A. All New Structural Steel. Painting of new structural steel will not be measured for payment.

B. Existing Structural Steel. Painting of existing structural shall be measured for payment as a lump sum unit.

710.14 Basis of Payment.

A. All New Structural Steel. The work and materials required, described and specified in the cleaning and painting of new structural steel in accordance with these specifications, the project plans and/or the special provisions will not be paid for directly, but will be considered as part of the work pertaining to the various items of construction on which paint is applied, and the cost shall be included in the contract price for each such item.

All costs of equipment materials and labor necessary to clean and paint the sway braces and steel piling in accordance with these specification shall be included in the unit price bid per linear foot for Steel H Bearing Piling.

B. Existing Structural Steel. The work and materials required, described and specified in the cleaning and painting of the existing structural steel in accordance with these specifications, the project plans and/or the special provisions will be paid for on a lump sum basis.

Payment for this item will include all direct and indirect costs and expenses required to complete the work.

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7101000	Cleaning and Painting Existing Structural Steel	Lump Sum

SECTION 711

DRIVEN PILE FOUNDATIONS

711.01 Description. This section shall consist of furnishing and installing prestressed concrete piling, steel H piling, steel pipe piling, and treated timber piling of the kind(s), dimension(s), at the location(s) and to the bearing value(s), line(s) and elevation(s) shown in the plans or as directed by the Engineer and in conformance with the plans and the special provisions.

This section shall supplement **Section 704** for the manufacture and handling of prestressed concrete piling. Prestressed pilings are those made using high ultimate strength reinforcement and subjected to a prestressing force to place the concrete in compression.

Pile points for prestressed concrete piling shall be considered the same as steel piling except in payment and shall meet all requirements of this section relative to the type of pile point used.

MATERIALS

711.02 Material Requirements for Prestressed Concrete Piling. Unless otherwise specified, prestressed concrete piling shall be made from Class 5000 concrete. All materials, equipment, construction methods, etc shall conform to the requirements of **Sections 701**, **702**, **703**, and **704** unless otherwise specified in this Section.

711.03 Material Requirements for Steel Piling.

A. Structural Steel. Structural steel H-piling shall conform to the requirements of **AASHTO M 160**, (**ASTM A 6**) and **M 270**, (**ASTM A 709**), Grade 36 unless noted otherwise in the plans. Steel pipe shall be **ASTM A 252**, Grade 2 and may be seamless or spiral welded. Chemical properties shall conform to

ASTM A 53, Grade B.

B. Concrete for Pipe Pile Anchors. Unless otherwise specified in the plans or special provisions, concrete for pile anchors for steel pipe piling shall be Class 5000.

C. Reinforcing Steel for Pipe Pile Anchors. Reinforcing for pipe pile anchors shall conform to **Section 703**.

711.04 Material Requirements for Timber Piling.

A. General. Unless specified otherwise on the plans or in the special provisions, all piling are to be treated and no untreated timber piling will be allowed.

B. Kind of Wood. Treated piling shall be of Southern Yellow Pine, unless otherwise specified and shall conform to **Section 706**.

C. Preservative Treatment. Timber piling shall be treated for preservation in accordance with **Section 707**. Dual treatment of marine piling will not be required unless specified on the plans or in the special provisions.

CONSTRUCTION REQUIREMENTS

711.05 Index Piling. When index piling is required, the Contractor shall drive index piling of the type specified and of the length(s) stipulated at the location(s) designated in the plans, subject to the approval of the Engineer. Index piling shall be driven to practical refusal as defined in **Subsection 711.14** and shall be incorporated into the final structure unless otherwise directed by the Engineer. Unless otherwise approved in writing by the Engineer, index piling shall be driven with the same equipment used in driving the production piling and are for the purpose of assisting the Engineer in determining the proper length(s) of production piling. A follower will not be allowed for driving index piles unless approved in writing by the Engineer. This work shall be done as soon, as is practical to minimize delay in determining length(s) of production

piling. The estimated production pile length(s) shown on the plans are for bid estimation purposes only. Unless approved in writing by the Engineer, no production piling will be ordered until all index piling have been driven, the data evaluated, and the piling length(s) approved by the Engineer. The Contractor will be notified by the Bridge Construction Engineer of the approved pile lengths within seven (7) working days after receipt of the Index Pile and/or Load Test data. Any claim by the Contractor for delay based on the Engineer's failure to comply with the seven (7) working day requirement shall be limited to an extension of contract time as the only possible compensation.

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 length(s) of any additional index piling after evaluating driving records from earlier index piling.

711.06 General Requirements for Prestressed Concrete Piling.

A. Form Work. Forms for concrete piling shall conform to the general requirements for concrete formwork as provided in **Sections 702** and **704**. Forms shall be such that consolidation and finishing can be accomplished with the least amount of inconvenience.

B. Reinforcement. Unless otherwise shown on the plans, reinforcement shall consist of longitudinal bars or strands in combination with spiral reinforcement in the form. All reinforcement shall meet the requirements of Section 703 or Section 704 whichever is applicable. The reinforcing system shall be rigidly wired or fastened and held to true position in the forms by means of approved devices. Splices in reinforcing steel shall be installed as detailed on the plans or approved in writing by the Engineer.

C. Casting. Piling shall be cast in a horizontal position.

Care shall be exercised to vibrate and tamp the concrete around the reinforcement, especially at the pile head, to avoid the formation of stone pockets, honeycomb or other such defects. The formation of stone pockets, honeycomb or porous places, may be cause for rejection. During the placing of the concrete, the forms may be vibrated with a hammer or wooden maul. Concrete shall be placed continuously in each pile and shall be carefully spaded, vibrated with an approved type of internal vibrator and tamped, special care being exercised to avoid horizontal or diagonal cleavage planes and to see that the reinforcement is properly embedded in the concrete. The form shall be overfilled, the surplus concrete screeded off after a suitable period of time and the top surface finished to a uniform, even texture similar to that produced by the forms.

D. Curing and Pointing. Prestressed concrete piling shall be cured in accordance with the provisions of Section 704. When concrete has cured sufficiently, the side forms shall be removed as stated above, the piling carefully inspected and all cavities and irregularities pointed with 1:2 mortar. In removing the side forms and pointing, the burlap or other covering may be turned back for a short time at the point of immediate work, but the work shall be so conducted as to keep this interference with the curing to a minimum. Prestressed piling may be transported and driven after the concrete is at least three (3) days old and has attained the minimum design compressive strength.

E. Surface Finish. All prestressed piling shall be finished in accordance with the provisions of Section 702 governing the surface finish of concrete.

711.07 Prestressed Concrete Piling in Tidal Water. Piling to be used in tidal water shall be constructed and driven as provided for in this specification, except as otherwise specified in **Subsection 702.17**.

711.08 Transporting, Storage, and Handling of Prestressed Concrete Piling. The method of transporting, storing, and handling shall be such as to eliminate the danger of cracking. Concrete piling shall be lifted by suitable devices attached to the pile at sufficient points to prevent cracking. Special care shall be exercised to avoid damage to the surface of the pile. All piling that are cracked or broken will be rejected unless a repair procedure has been approved in writing by the Department and the procedure has been completed to the satisfaction of the Engineer.

711.09 Transporting, Storage, and Handling of Steel Piling. The method of transporting, storage and handling shall be such as to avoid injury to the piling. Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained and long members shall be supported on skids near enough together to prevent injury from deflection.

For steel H-piling, one handling hole 1 1/2 inches in diameter may be placed in the web of the pile at either or both ends. For steel pipe piling, two handling holes 1 1/2 inches in diameter may be placed in the wall at one end.

711.10 Transporting, Storage, and Handling of Timber Piling. The method of transporting, storage, and handling shall be such as to avoid injury to the piling. Special care shall be taken to avoid breaking the surface of treated piling; and cant-dogs, hooks or pike-poles shall not be used. Cuts or breaks unavoidably made in the surface of treated piling shall be field treated in accordance with AWPA M 4, which requires that the repair material be the same as the original treatment or may be copper naphtenate regardless of original treatment.

Piling to be air-seasoned shall be stored by segregating according to size and length, and each layer separated by 2 inch strips so that there will be an air space of 2 inches or more underneath and between each layer. The ends of piling in alternate layers shall be reversed in order to keep the stack

level. Alleys at least 3 feet wide shall be left between rows of stacks and the space under and between the stacks shall be kept free at all times of rotting wood, weeds or rubbish. The yard shall be drained so that no water will stand under the stacks or in their immediate vicinity.

711.11 Length of Prestressed Concrete Piling. Concrete piling shall be cast to the length(s) specified on the plans or in the special provisions except in cases where index piling or load test piling is required. In such cases, piling length(s) shall be determined after evaluating the data from the index piles and any required load tests. Any piling ordered before the piling length(s) are determined shall be the sole responsibility of the Contractor. For piling with pile points, the Contractor shall ensure that the correct length of the concrete portion and steel portion of the piling has been ordered. The right is reserved to vary the casting length(s) if, in the opinion of the Engineer, the driving conditions warrant such change.

711.12 Length of Steel Piling. The length(s) of steel piling shown on the plans are to be considered as approximate and are to be used solely for comparison of bids. Unless index piling is specified, the Contractor will be required, at his own expense, to determine the length(s) of piling required by driving test piling. When index piling is specified, piling length(s) shall be determined after evaluating the data from the index piles and any required load tests. Any piling ordered before the piling length(s) are determined shall be the sole responsibility of the Contractor.

Length(s) of steel piling utilized as prestressed pile points shall be shown on the plans or as directed by the Engineer.

711.13 Length of Timber Piling. The length(s) of timber piling given on the plans are to be considered as approximate and are to be used solely for the comparison of bids. The Contractor shall determine the length(s) of piling necessary to comply with these requirements by driving test piling or other means. For treated piling, the length(s) thus determined, together with any other data used in determining such

length(s), shall be submitted to the Engineer for review before such piling are ordered.

Such review shall not to be construed in any way as relieving the Contractor of the responsibility for obtaining piling of proper length(s).

Pile cut-offs shall become the property of the Contractor and shall be disposed of by the Contractor away from the site.

Full length piling shall always be used. Splicing of timber piling will not be permitted.

711.14 Penetration. All piling shall be driven to a minimum penetration equal to 10 feet excluding any prestressed pile point, the minimum tip elevation shown in the plans or the depth at which the required ultimate bearing has been achieved, whichever is greater unless directed otherwise by the Engineer. Penetration through fill material is not to be considered as penetration.

If the required ultimate bearing value, the minimum tip elevation, and the minimum penetration are obtained before the top of pile is to grade, the driving of prestressed concrete piles and steel piles shall continue for 2 feet or until the pile reaches grade, whichever is less.

To avoid cutting off a prestressed pile, the Contractor may elect, at his/her risk, to continue driving the pile until it reaches the required elevation.

After the minimum penetration and minimum bearing value requirements have been obtained, the driving of timber piling may continue to 125% of the minimum bearing specified where a gravity hammer is used and to 150% where a mechanical hammer is used, if the Engineer so directs and if the length of pile in the leads will permit.

Any extended driving beyond the required ultimate bearing value and minimum penetration as specified above must be stopped immediately if damage to the pile occurs or if the Engineer determines that further driving would damage the pile. Such extended driving shall also be stopped if the recommendations on the driving criteria are exceeded or if the pile reaches practical refusal. Practical refusal is defined as 5 blows in 1/4 inch or equivalent multiples thereof.

If practical refusal or pile damage is encountered before reaching the minimum penetration or the minimum tip elevation, pile driving shall be stopped immediately and the Engineer shall be notified.

711.15 Driving Equipment.

A. Pile Installation Plan. Within thirty (30) calendar days after award of contract or no later than thirty (30) days before driving the first pile, the Contractor shall submit a *Pile Installation Plan* to the Bridge Geotechnical Engineer, with a copy to the Bridge Construction Engineer, and the Engineer. This plan shall provide detailed information including the following:

1. List and size of proposed equipment including cranes, driving equipment, jetting equipment, compressors and predrilling equipment, including manufacturer's data sheets on hammers.

2. Pile and Driving Equipment Data Form.

3. Methods to determine hammer energy or stroke in the field for determination of pile capacity. The submittal shall include necessary charts and recent calibrations for any pressure measuring equipment. In addition, the method for monitoring pile advancement.

4. Detailed drawings of any proposed followers.

5. Detailed drawings of templates.

6. Details of proposed load test equipment and procedures including recent calibrations of jacks and required load cells. See Pile Load Test specifications for additional requirements.

7. Sequence of driving footing piles for each different configuration of pile layout.

8. Proposed schedule for index pile program and production pile driving.

9. Details of proposed items and procedures used to protect the integrity of existing structures.

10. Required shop drawings for piles, cofferdams, etc.

11. Methods and equipment proposed to prevent displacement of piles during placement and compaction of fill within 15 feet of the piles.

12. Other information shown in the plans or required by the Engineer.

The Engineer will evaluate the *Pile Installation Plan* for conformance with the plans and special provisions. Within twenty-one (21) days after receipt of the plan, the Engineer will notify the Contractor of plan acceptance or any additional information required and/or changes that may be necessary to meet the plans and specifications requirements. Any parts of the plan that are unacceptable will be rejected and the Contractor shall resubmit changes agreed upon for re-evaluation. The Engineer will notify the Contractor within seven (7) days after receipt of proposed changes of their acceptance or rejection. All plans

accepted by the Engineer shall be subject to trial and satisfactory performance in the field. The Contractor shall make any required changes that may result from unsatisfactory field performance. No changes in the driving system shall be made after the final acceptance without the written consent of the Engineer.

No extension of contract time shall be granted for delays due to failure of the Contractor to observe these time requirements. Any claim by the Contractor for the delay based on the Engineer's failure to comply with the twenty-one (21) day or seven (7) day requirements shall be limited to an extension of contract time as the only possible compensation. The Engineer will evaluate only one pile driving system at a time for each pile type. The Contractor is strongly advised to submit only the pile driving system he intends to use for each pile type. If more than one system is submitted per pile type, delays in acceptance of the plan shall be expected and no additional compensation or extension of contract time will be given.

The criteria, which the Engineer will use 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 time. The required number of hammer blows indicated by the wave equation or dynamic pile analyzer (PDA) at the ultimate pile resistance shall be between 36 and 180 per foot for the driving equipment to be acceptable. In addition, for the driving equipment to be acceptable, the compressive stress in the pile due to driving as indicated by the wave equation or dynamic pile analyzer (PDA) shall not exceed the allowable installation stresses as indicated in **Subsection 711.20**.

Acceptance of the pile driving equipment does not relieve the Contractor of the responsibility to properly install the piling. The hammer acceptance and driving criteria will be based on commonly accepted hammer efficiencies, component properties, and soil parameters. Local soil

conditions and the actual driving system will affect the driving. If in the opinion of the Engineer, the accepted driving system fails to perform satisfactorily during actual driving, the Department reserves the right to revise the driving criteria.

B. Pile Hammers for Prestressed Concrete and Steel Piling. Piling shall be driven by means of a single acting air, steam or diesel, or double acting diesel hammer. Hydraulic hammers may be used if authorized in writing by the Engineer. Hammers shall be maintained in good operating condition and shall be operated at the manufacturer's rated number of blows per minute when driving piling. The hammer shall be fitted 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.

C. Pile Hammers for Timber Piling. Timber Piling shall be driven by means of a gravity, single-acting air, steam, diesel, or double-acting diesel hammer.

Gravity hammers shall weigh not less than 2000 pounds or more than 2800 pounds. The fall shall be so regulated as to avoid injury to the pile and shall not exceed 14 feet for 2000-pound hammers or 10 feet for 2800-pound hammers. For hammer weights between 2000 and 2800 pounds, the maximum permissible fall shall be proportionately adjusted.

Steam, air or diesel hammers shall develop an energy per blow at each full stroke of the piston of not less than 7200 foot-pounds nor more than 16,000 foot-pounds or sized as determined in **Subsection 711.15E**. The right is reserved to reduce the maximum size of hammer where hard material is encountered which will likely cause injury of the pile as determined by the Engineer. Hammers shall be maintained in good operating condition and shall be operated at the manufacturer's rated number of blows per minute when driving piling. The hammer shall be fitted 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.

D. Hammer Cushions. All pile driving equipment shall be equipped with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to insure uniform driving behavior. Hammer cushions shall be made of durable manufactured materials, provided in accordance with the hammer manufacturer's guidelines except that all wood, wire rope, and asbestos hammer cushions are specifically disallowed and shall not be used. A striker plate as recommended by the hammer manufacturer shall be placed on the hammer cushion to insure uniform compression of the cushion material. The hammer cushion shall be inspected in the presence of the Engineer 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, the hammer cushion shall be replaced by the Contractor before driving is permitted to continue.

E. Pile Cushions for Prestressed Concrete Piling. The heads of concrete piling shall be protected by a pile cushion made of plywood. The minimum plywood thickness placed on the pile heads prior to driving shall not be less than 4 inches. A new pile cushion shall be provided for each pile. The pile cushion shall be replaced if, during the driving of any pile, the cushion either is compressed more than one half of the original thickness or begins to burn. The pile cushion dimensions shall match the cross-sectional area of the pile head.

F. Caps and Collars for Timber Piling. Timber piling shall be driven with the aid of a metal casting that is so designed that it will securely hold the pile in position during driving and will distribute the load on the head of the pile to prevent splitting or brooming.

For treated timber piling, a flexible and adjustable metal collar, approved by the Engineer, shall be tightly strapped around the head of the pile below the cap casting to further prevent splitting of the pile during driving.

G. Leads. Pile driver leads for driving piling shall be constructed to afford freedom of movement of the hammer. Leads shall be supported at sufficient points to maintain position and to insure support of the pile during driving. The vertical axis of the leads and hammer shall coincide with the vertical axis of the pile.

Except where piling are driven through water, the leads shall be of sufficient length so that the use of a follower will not be necessary.

H. Templates. The Contractor shall provide an adequate fixed template to maintain the pile in proper position and alignment during driving with swinging leads or with semi-fixed leads. For piles on land, the template shall be located within 5 feet of cut-off or within 5 feet of ground line whichever is lower. For piles in water, the template shall be located within five feet of cut-off or within 5 feet of the waterline whichever is lower. Floating templates attached to a barge will not be allowed. Where practical, the template shall be placed so that the pile can be driven to cut-off elevation before the template is removed.

When driving piles with a follower using floating equipment, a double template, or other approved equipment shall be provided to maintain alignment of the hammer, follower, and pile. A double template shall consist of a pile template within five feet of cut-off elevation and a second upper support above the water surface for the leads. Where practical, the template shall be placed so that the pile can be driven to cut-off elevation before the template is removed. The individual pile positions of the second upper template shall be adjustable in size to serve as a guide for both the pile and follower. Templates shall

not restrict the vertical movement of the pile.

I. Followers. Unless specifically allowed in the plans, special provisions, or approved in writing by the Engineer, the driving of piling by use of followers shall not be permitted. In no case will followers be allowed except when pile placement is required through water. Followers will not be permitted during driving of index or test piling unless approved in writing by the Engineer. If the use of a follower is desired, the Contractor must make the hammer selection with consideration that a follower can greatly reduce the energy transferred to the pile. Any hammer and follower combination must be capable of driving the piling to the required tip elevation(s) and ultimate bearing value(s), without damaging the pile(s).

Details of any proposed follower shall be included in the information provided to the Engineer so that the proposed follower can be modeled into the pile analysis.

J. Water Jets. Water jets will not be permitted unless approved by the Engineer or specified in the special provisions or on the plans. The number of jets and the volume and pressure of water at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. The pump shall have sufficient capacity to deliver at all times at least 100 psi pressure at two jet nozzles of 3/4-inch diameter. Before the desired penetration is reached, the jets shall be withdrawn and the piling shall be driven with a hammer to secure the final penetration and bearing. When directed by the Engineer, two separate jets shall be used.

711.16 Allowable Installation Stresses.

A. Prestressed Concrete Piling. The tensile stresses in the concrete pile shall not exceed 3 multiplied by the square root of the concrete compressive strength (f'_c in psi) plus the effective prestress value:

Tensile Stresses < 3 x SQRT(f'_c) + prestress

The compressive stress shall not exceed 85% of the compressive strength of the concrete minus the effective prestress:

Compressive Stress < 0.85f'_c - prestress

Stresses shall be determined by Wave Equation Analysis or Dynamic Pile Analyzer, whichever is appropriate.

B. Steel Piling. The Compressive stresses in the steel pile due to driving shall not exceed 90% of the yield stress. Stresses shall be determined by Wave Equation Analysis or Dynamic Pile Analyzer, whichever is appropriate.

C. Timber Piling. The compressive stress in the timber pile due to driving as indicated by the Wave Equation Analysis or Dynamic Pile Analyzer shall not exceed three times the Allowable Unit Working Stress Compression Parallel to Grain for Normal Duration of Loading - σ_a. For Southern Pine, σ_a is 1200 psi, which then computes to a maximum driving stress of 3600 psi.

711.17 Preparation for Driving. Piling shall not be driven until after the excavation is complete. Any material forced up between the piling shall be removed to correct elevation before concrete for the foundation is placed.

711.18 Methods of Driving. Piling shall be driven in accordance with an accepted pile installation plan as specified in **Subsection 711.15**.

Predrilling for piling shall not be permitted except where specifically noted in the plans or approved in writing by the Engineer. When predrilled holes are allowed the pile shall be driven by the hammer to its final position and to the required

ultimate bearing. If predrilled holes are larger than the pile, the space between the pile and the predrilled hole shall be backfilled with sand, pea-gravel, or an approved material and tamped in an approved manner.

Spudding or other methods shall not be used to facilitate pile installation unless specifically approved in writing by the Engineer.

Prestressed concrete piling driven below grade shall be built up where necessary as shown in the plans or directed by the Engineer and in accordance with **Subsection 711.22**.

Steel piling driven below grade shall be spliced in accordance with **Subsection 711.23**.

711.19 Allowable Variation in Driving. Piling shall be driven with a variation of not more than 1/4 inch per foot from the vertical or from the batter indicated, with a maximum variation of the head of the pile from the position shown on the plans, or indicated, of not more than 3 inches. Piling shall be driven so that the heads may be placed in proper position without inducing excessive stresses in the piling.

Piling not within the maximum tolerances stated above shall, with the approval of the Engineer, be withdrawn and re-driven within such tolerances, or replaced by an additional pile without compensation. If impracticable to replace, piling not within the above tolerances shall be subject to an appropriate reduction in payment for unsatisfactory workmanship. Piling shall be driven so that the cap may be placed in its proper location without inducing excessive stresses in the piling. Manipulation of piling considered by the Engineer to be excessive will not be permitted and the Contractor will be required to re-drive the pile(s) or use other satisfactory corrective methods to avoid such manipulation. Applying lateral pressure to a pile while that pile is being driven will not be permitted.

711.20 Determination of Bearing Values. Pile bearing will be determined by the Engineer based on the wave equation analysis or Dynamic Pile Analyzer Test. If a bid item for Dynamic Pile Analyzer Test Set-up is provided, then the Dynamic Pile Analyzer will be utilized. If conditions warrant, the Department reserves the right to require Dynamic Pile Analyzer Tests, even if not provided for in the plans. Unless otherwise specified in the plans or special provisions, allowable pile bearing for timber piles shall be determined by the Dynamic Formula in **Subsection 711.20.C**.

A. Wave Equation Analysis. Piling shall be driven to the required ultimate bearing shown in the plans. The actual ultimate pile bearing obtained during driving shall be determined by the Engineer based on a Wave Equation Analysis.

B. Dynamic Pile Analyzer. Piling shall be driven to the required ultimate bearing shown in the plans as determined by the Engineer using the Dynamic Pile Analyzer.

If a bid item for Dynamic Pile Analyzer Test Set-up is provided, then the Engineer will be utilizing a Dynamic Pile Analyzer to monitor the driving of the index piling and a selected number of production piling as determined by the Engineer for the purpose of determining actual ultimate bearing. Before placement in the leads, the Contractor shall make each designated pile available for wave speed measurements and for pre-drilling the required instrument attachment holes. The Engineer will furnish the equipment, materials, and labor necessary for the attachment of the instruments. The Contractor shall provide a responsible person to attach the instruments to the pile after the pile is in the leads. A platform with a minimum size of 4 feet x 4 feet designed to be raised to the top of the pile while the pile is located in the leads shall be provided by the Contractor. The Contractor should anticipate short delays to allow for the attachment of the dynamic test instruments. The Contractor shall furnish electrical power for the dynamic test equipment. The power supply at the

outlet shall be 10 amp, 115 volt, 55-60 cycle, AC only. Field generators used as a power source shall be equipped with functioning meters for monitoring voltage and frequency levels.

C. Dynamic Formula. Timber pile(s) shall have the minimum bearing value required by the plans or special provisions. In the absence of requirements in the plans or special provisions, the minimum bearing value shall be 35 tons. The bearing value shall be determined by the following formulas:

The following Dynamic Bearing Formula is based on English units of measure:

For gravity hammers,

$$P = \frac{2\,WH}{S + 1.0}$$

For single acting steam, air, diesel hammers,

$$P = \frac{2\,WH}{S + 0.1}$$

For double acting steam hammers,

$$P = \frac{2\,H(W + A \times p)}{S + 0.1}$$

Where

P = Bearing value in pounds.

S = The average penetration in inches per blow for the last 3 to 10 blows for gravity hammers, and the last ten or more blows for steam, air or diesel hammers.

W = Weight, in pounds, of falling parts of hammer.

H = Height of fall in feet. The fall shall be 14 feet in testing the capacity of pile using a gravity hammer

A = Area of piston in square inches.

p = Mean effective steam pressure in pounds per square inch at the hammer.

The above formulas are applicable only when:

1. The hammer has a free fall.

2. The head of the pile is free from broomed or crushed wood fiber.

3. The penetration is at a reasonably quick and uniform rate.

4. There is no sensible bounce after the blow.

In case water jets are used in connection with the driving, the bearing value shall be determined by the above formulas from the results after driving the pile without the aid of jets.

Penetration secured by water jets, predrilling, etc., considered by the Engineer to be unnecessary, will not be permitted.

Piling that are driven and do not meet all of the requirements of these specifications shall be replaced by piling that comply with the requirements of the specifications at no additional compensation.

711.21 Restriking Piling. The Contractor may be required to restrike a number of index piling or selected production piling after initial driving. If a Dynamic Pile Analyzer is being utilized, a restrike may be required after the dynamic test instruments are attached. The length of time required between initial driving and restriking will be determined by the Engineer, but, the required time will not be greater than fourteen (14) days, unless specified otherwise in the plans or special provisions. The hammer shall be warmed up before re-driving begins by applying at least 20 blows to another pile. The maximum amount of re-driving required to determine

bearing shall be 6 inches or the total number of blows required will be 50, whichever occurs first. If the bearing has not reached the required ultimate bearing, the Contractor may be required to continue driving until the required ultimate bearing is obtained.

Payment for restriking of piling will be as specified in **Subsection 711.32J**.

711.22 Build-Ups for Prestressed Concrete Piling. When build-ups are necessary, concrete in build-ups shall be of the same quality and strength as required in the original pile. Just before placing the concrete, the pile tops shall coated with a Department approved moisture insensitive bonding epoxy. Forms shall remain in place for at least six (6) days. This period may be reduced to three (3) days if high-early-strength cement is used or if an approved admixture is used to obtain high-early strength. No payment will be made for build-ups where made necessary by damage to the pile during driving. Where build-ups are necessary, the reinforcement shall be as shown on the plans.

711.23 Splices for Steel Piling.

A. Steel H-Piling. If splices are necessary for steel H-piling, they shall be made as follows:

1. If bent during the driving process, the top portion of the lower pile shall be straightened or, if it cannot be satisfactorily straightened, cut off below the bent portion.

2. The bottom surface of the upper pile shall be beveled on the outside edge of the flanges and along one edge of the web. The bevel shall be made at an angle of approximately 45 degrees with the horizontal. A surface of 1/8 inch may be left unbeveled. Guide plates may be temporarily attached to the web or flanges to properly align the pile sections before welding.

3. The upper pile shall then be set on the lower pile and temporarily clamped thereto. The beveled edges of the upper pile shall be separated about 1/8 inch from the unbeveled edges of the lower pile and the axes of the two piling shall then be made to coincide by adjusting the clamps.

4. The entire periphery of the pile joint shall then be butt welded with a shielded-arc low hydrogen electrode of proper size and with sufficient generating amperage to fuse the root of the weld. The weld shall be made with sufficient passes to completely fill the joint, removing the slag of each pass before beginning the next pass. The weld specified here is the butt weld designated as B-U4b in the ANSI/AASHTO/AWS D1.5 *Bridge Welding Code*.

At no additional cost to the Department and with written approval of the Engineer, pre-fabricated splicers may be used. Installation will be in accordance with the manufacturer's installation recommendations. Each splice shall develop the moment, shear, and axial capacity of the pile. As a minimum, each flange shall have full penetration butt welds, and the total amount of weld provided on the web will at least equal the length of weld should a splicer not be utilized. Pre-fabricated splicers shall be of equal strength and thickness as the web.

Care shall be taken to remove all paint and/or coating from the metal at the welds before welding begins, and after all welding is complete, the slag shall be removed and the welds painted as prescribed in **Subsection 711.28**.

B. Steel Pipe Piling. If splices are necessary for steel pipe piling, they shall be made as follows:

1. The surface of one of the piling shall be beveled on the outside edge of the wall at an angle of approximately 45 degrees with the horizontal. A sur-

face of 1/8 inch may be left unbeveled. Guide bars may be temporarily attached to the pipe wall to properly align the pile sections before welding.

2. The beveled pile shall then be butted to other pile and temporarily clamped thereto. The beveled edge of the pile shall be separated about 1/8 inch from the squared edge of the other pile and the axes of the two piling shall then be made to coincide by adjusting the clamps.

3. The entire periphery of the pile joint shall then be butt welded with a shielded-arc low hydrogen electrode of proper size and with sufficient generating amperage to fuse the root of the weld. The weld shall be made with sufficient passes to completely fill the joint, removing the slag of each pass before beginning the next pass. The weld specified here is the butt weld designated as B-U4b in the ANSI/AASHTO/AWS D1.5, *Bridge Welding Code*.

Care shall be taken to remove all paint and/or coating from the metal at the welds before welding begins, and after all welding is complete, the slag shall be removed and the welds painted as prescribed in **Subsection 711.28**.

711.24 Splices and Cut-offs at Cap for Steel Piling. The tops of steel piling shall be placed to the elevation indicated on the plans or special provisions or as approved by the Engineer. Splices at concrete caps will not be required if the head of the pile, after removing pile material deformed during driving, is less than 6 inches below its plan position and extends not less than 12 inches, or the required minimum shown on the plans, into the concrete cap. Cut-offs shall be made at right angles to the axis of the pile.

711.25 Elevation of Cut-Off for Timber Piling. The tops of all timber piling shall be sawed off to a true plane at the elevation indicated on the plans or as approved by the Engineer. Piling which support timber caps shall be sawed to

plane of the superimposed structure and shall exactly fit it. Before the roofing pitch and galvanized metal or aluminum sheet are applied on such pile heads, the timber cap shall be temporarily set and any misfits shall be corrected in an approved manner. Broken, split or misplaced piling shall be withdrawn and properly replaced. Piling driven below the cut-off grade shall be withdrawn and replaced by new, and if necessary, longer piling at the expense of the Contractor. All piling raised by heaving during the process of driving adjacent piling shall be driven down again unless this requirement is waived in writing by the Engineer.

711.26 Treatment of Pile Heads for Timber Piling. After having been cut, the head(s) of treated timber piling shall be treated as follows:

The sawn surface shall be field treated by heavy applications of preservative treatment as recommended by the latest edition of AWPA M4. The preservative shall be applied until visible evidence of further penetration has ceased. The pile head shall then be covered with a heavy application of coal-tar roofing cement meeting ASTM D-4022 specifications. Upon this shall be placed a covering of 20 gage galvanized metal or aluminum sheet, which shall be bent down neatly over the sides of the pile and firmly secured thereto with large-headed galvanized nails or a galvanized wire band. Pile heads which are to be encased in concrete shall not require the galvanized metal or aluminum cap.

711.27 Welding of Steel Piling. The welding of steel piling, including bracing, caps, splices, etc., shall be in accordance with the requirements of **Section 709** of these specifications.

711.28 Painting of Steel Piling. All painting shall conform to **Subsection 710.11B**.

711.29 Encasement of Steel Piling. Where piling are to be encased in concrete, the encasement shall be in accordance with the plans or special provisions.

711.30 Prestressed Pile Points and Reinforced Pile Tips.

A. Prestressed Pile Point. When indicated on the plans the prestressed concrete piling will be supplied with prestressed pile points of the size and shape as required. Pile points will conform to the requirements for steel piling as required in this section of the specifications, and as amended by the special provisions. The Department reserves the right to extend prestressed pile points by field welding additional lengths of pile points, and to shorten lengths of pile points by cutting off pile points. Therefore, any reinforced pile tips used shall not be welded onto the pile point until directed by the Engineer, normally just prior to driving. If, in the opinion of the Engineer, splices are necessary, they shall be made as indicated in **Subsection 711.23**.

B. Reinforced Pile Tips. When specified in the contract, steel piling shall be reinforced with manufactured cast steel pile tips conforming to **AASHTO M 103** (**ASTM A 27**). The steel pile tips shall be installed in accordance with the manufacturer's recommendations except that as a minimum, the welds shall extend across the full width of each flange or the full circumference of steel pipe piles. The steel pile tips shall be approved by the Engineer before installation, and the welds shall be visually inspected by the Engineer in the field.

711.31 Pile Load Test. In special cases, it will be desirable to load test certain piling of a project in order to determine the relationship between the driving resistance of the pile and the actual load bearing capacity of the driven pile as determined by actual test loading of the pile, taking into consideration the assumed safety factor of the pile. When such is the case, the plans and special provisions will outline the work to be done and the method of payment for the portion of work to be done by the Contractor.

711.32 Method of Measurement.

A. Dynamic Pile Analyzer Test Set-ups. The number of Dynamic Pile Analyzer Test Setups shown in the plans is estimated for bid purposes only. The number of Dynamic Pile Analyzer test set-ups measured for payment will be the number of index or production pilings to which Dynamic Pile Analyzer test equipment has been attached for the purpose of testing.

Dynamic Pile Analyzer Test Set-ups required due to Contractor errors or inadequate pile driving procedures or equipment may not be counted for payment.

B. Prestressed Concrete Piling. The length of prestressed concrete piling of each size and shape to be measured for payment shall be the linear feet of prestressed concrete piling approved by the Engineer to be cast and driven, regardless of cut-offs (except those cut-offs made due to damage during driving), plus the linear feet of build-ups necessary (exclusive of build-ups due to driving damage or due to the Contractor unnecessarily driving past the designated top of pile elevation). The length of build-up will be the length above the original pile head; in addition to the length required to be chipped back on the original pile for proper installation of the build-up.

C. Pile Build-up Preparations. The number of Pile Build-up Preparations included in the plans is estimated for bid purposes only. The pile build-up preparation of each size and shape to be measured for payment shall be the number of prestressed concrete piles receiving a reinforced concrete build-up. Measurement will not include build-ups required because of driving damage or due to the Contractor unnecessarily driving past the designated top of pile elevation.

D. Prestressed Pile Points. The length of prestressed pile points of each size and weight or strength to be measured for payment shall be the linear feet of

prestressed pile points cast into the concrete piling plus any length spliced on at the direction of the Engineer. In addition, an allowance of 2 feet of pile point (Steel H-Pile or Pipe Pile) will be made for each splice eligible for payment.

E. Reinforced Pile Tips. The reinforced pile tips of each size and weight or strength to be measured for payment shall be the number of reinforced pile tips installed in the finished structure.

F. Index Piling. The length of index piling of each size and shape, weight or wall thickness to be measured for payment shall be the linear feet of piling measured in the same manner as the appropriate corresponding **Subsection 711.32B**, 711.32G, or 711.32I for the type of index pile driven.

G. Steel Piling. The length steel piling of each type, size, and weight or wall thickness to be measured for payment shall be the linear feet of accepted piling in the finished structure, with allowances for splices as follows: An allowance of 2 feet of steel H-pile will be made for each steel H-pile splice eligible for payment under **Subsection 711.23**. An allowance of 6 feet of steel pipe pile will be made for each pipe pile splice eligible for payment under Subsection 711.23. These measurements will not include piling that are not in conformance with these specifications or accepted by the Engineer.

H. Encasements of Steel Piling. Reinforced concrete encasement will be measured as the cubic yards of concrete and pounds of steel reinforcement in the finished structure placed in accordance with the plans and special provisions.

I. Timber Piling. The length of timber piling to be measured for payment shall be the linear feet in the finished structure, except where payment for cut-offs in excess of 2 feet will be made as described in **Subsection 711.33I**.

These measurements will not include piling that are not installed in accordance with the plans and special provisions, piling driven in falsework, or piling used in bracing.

J. Restrike. If a bid item for Dynamic Pile Analyzer Test Set-up is included in the contract and a Dynamic Pile Analyzer Test is performed on the pile, then the restrike will be considered as a Dynamic Pile Analyzer Test Set-up as specified in **Subsection 711.32A**, and will be considered full compensation for the restrike.

If a bid item for Dynamic Pile Analyzer Test Set-up is not included in the contract or test equipment is not attached to the pile, an allowance of 3 linear feet of piling will be made for each restrike ordered by the Engineer and eligible for payment.

711.33 Basis of Payment.

A. Dynamic Pile Analyzer Test Set-ups. The number of Dynamic Pile Analyzer Test Set-ups, determined in Subsection 711.32A, will be paid for at the contract unit price for Dynamic Pile Analyzer Test Set-up, which price and payment of shall be full compensation for mobilization, equipment, labor, materials, and incidentals required to assist the Engineer in the preparation, performance and monitoring of a Dynamic Pile Analyzer test.

The number of pile restrikes determined in **Subsection 711.32J** to be counted as Dynamic Pile Analyzer Set-ups will also be paid for at the contract unit price for Dynamic Pile Analyzer Test Set-up.

B. Prestressed Concrete Piling. The length of Prestressed Concrete Piling determined in **Subsection 711.32B** will be paid for at the contract unit price bid for Prestressed Concrete Piling for each size and shape, which price and payment shall be full compensation for furnishing all materials, equipment, jetting, removal of obstructions, drilling, tools, labor and other items necessary

for casting, curing, protecting, transporting, driving, cutting off, and finishing the piling. It shall include the furnishing and placing of any temporary bracing necessary to hold the piling in alignment and the removal of any obstructions in order to complete the work as required.

C. Pile Build-up Preparations. The number of Pile Build-up Preparations determined in **Subsection 711.32C** will be paid for at the contract unit price for Pile Build-up Preparation of the designated size and shape, which price and payment shall be full compensation for all material, equipment, labor, tools and other items necessary to drill, chip, weld, grout, or otherwise prepare the pile head to receive the build-up.

D Prestressed Pile Points. The length of Prestressed Pile Points determined in **Subsection 711.32D** will be paid for at the contract unit price for Prestressed Pile Points of each designated size and weight or strength, complete in place, which price and payment shall be full compensation for furnishing all materials, equipment, tools, labor and other items necessary for placing the pile points as required.

E. Reinforced Pile Tips. The number of Reinforced Pile Tips determined in **Subsection 711.32E** will be paid for at the contract unit price for Reinforced Pile Tips of each size and weight or strength, complete in place, which price and payment shall be full compensation for furnishing all materials, equipment, tools, labor and other items necessary for installing and welding such tips as required.

F. Index Piling. The length of Index Piling determined in **Subsection 711.32F** will be paid for at the contract unit price for Index Piling of each size and shape, weight, or wall thickness, complete in place (or removed if specified), which price and payment shall be full compensation for furnishing all materials (exclusive of steel pile encasement), equipment, tools, jetting, drilling, labor and other items necessary for driving, casting, curing, protecting,

transporting, finishing, cutting off, splicing, welding, painting, and removing such piling as required. It shall include the furnishing and placing of any temporary bracing necessary to hold the piling in alignment and the removal of any obstructions in order to complete the work as required.

Any length of Concrete Pile Build-Ups and number of Pile Build-Up Preparations necessary in conjunction with index piling and measured in Subsections 711.32B and 711.32C will be paid for at the contract unit price for Prestressed Index Piling and Pile Build-up Preparation respectively.

G. Steel Bearing Piling. The length of Steel H-Bearing Piling and/or Steel Pipe Piling determined in **Subsection 711.32G** will be paid for at the contract unit price for Steel H-Bearing Piling or Steel Pipe Piling for each designated size and weight or wall thickness, complete in place, which price and payment shall be full compensation for furnishing all materials (exclusive of encasement), equipment, tools, labor and other items necessary for driving, cutting off, splicing, welding and painting such piling as required. It shall include the furnishing and placing of any temporary bracing necessary to hold the piling in alignment and the removal of any obstructions in order to complete the work as required.

H. Encasement for Steel Piling. The quantity of Class 4000P Concrete and Reinforcing Steel for Structures used in pile encasement will be paid for at the contract unit prices for these items, which price and payment shall be full compensation therefore as prescribed in the basis of payment for these items in **Sections 701** and **703** of these specifications.

I. Treated Timber Piling. The length of Treated Timber Piling determined in **Subsection 711.32I** will be paid for at the contract unit price for Treated Timber Piling, complete in place, which price and payment shall be full compensa-

tion for furnishing all materials (exclusive of hardware), equipment, jetting, tools, labor and other items necessary for driving and cutting off such piling as are required. It shall also include the furnishing and placing of any temporary bracing necessary to hold the pile in alignment and the removal of any obstructions in order to complete the work as required.

Compensation for cut-off of treated timber piling shall be made as follows:

Cut-Off Length (in feet)	**Unit Price (per linear foot)**
3 feet and less	No compensation
Greater than 3 feet	0.4 of unit price of piling complete in place for length of cut-off in excess of 3 feet

The cost of all necessary hardware complete in place and accepted will be paid for under **Section 708**.

The cost of furnishing metal shoes when directed by the Engineer will be paid for in a Supplemental Agreement, but the placing thereof will be included in the contract price for piling.

J. Pile Load Tests. When required, Pile Load Tests will be paid for at the contract unit price for Pile Load Test of the applicable pile. In the absence of a bid item for Pile Load Test, the work shall be performed under the direction of the Engineer and paid for by a supplemental agreement.

Payment for each item will include all direct and indirect costs and expenses required to complete the work.

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7110001	Dynamic Pile Analyzer Test Set-up	Each
7110XX0	Prestressed Concrete Piling (*(size)*" Sq.)	Linear Foot
7110XX1	Pile Build-up Preparation (*(size)*" Sq.)	Each
7110XX2	Pile Load Test - Prestressed Concrete Piling (*(size)*" Sq.)	Each
71104X0	Prestressed Concrete Octagonal Piling - *(size)*"	Linear Foot
71104X1	Prestressed Concrete Octagonal Pile Build-up Preparation (*(size)*")	Each
71104X2	Pile Load Test - Prestressed Concrete Octagonal Pile - *(size)*"	Each
71111XX	Prestressed Pile Point (*(HP size)*)	Linear Foot
71113XX	Prestressed Pile Point (*(pipe diameter and Extra Strong or Dbl. Extra Strong pipe)*)	Linear Foot
71115XX	Reinforced Pile Tips (*(size)*)	Each
71117XX	Reinforced Pile Tips (*(pipe diameter and Extra Strong or Double Extra Strong)*)	Each
7110XX5	Prestressed Index Piling (*(size)*" *(shape)*)	Linear Foot
7112XX0	Steel H Bearing Piling (HP*(size)*x*(weight)*)	Linear Foot
7112XX1	Pile Load Test - Steel H-Piling (HP*(size)*x*(weight)*)	Each
7112XX2	Steel H Bearing Index Piling (HP*(size)*x*(weight)*)	Linear Foot
7113XX0	Steel Pipe Piling (*(diameter)*" Diameter**)**	Linear Foot
7113XX1	Pile Load Test - Steel Pipe Piling (*(dia.)*" Diameter)	Each

Pay Items (Continued)

Item No.	Pay Item	Pay Unit
7113XX2	Steel Pipe Index Piling (*(dia.)*" Diameter)	Linear Foot
7119100	Treated Timber Piling	Linear Foot
7119101	Pile Load Test - Treated Timber Piling	Each

SECTION 712

DRILLED SHAFTS AND DRILLED PILE FOUNDATIONS

712.01 Description. This work shall consist of furnishing all labor, materials, equipment, and services necessary for construction of portland cement concrete foundations consisting of fully cast-in-place shaft foundations and pile foundations within drilled excavations. The size and locations are shown on the plans. Work shall be in strict accordance with the plans and the special provisions. Work shall comply with the applicable requirements of **Sections 701**, **702**, and **703** of these specifications.

For the purposes of this specification:

Drilled Shafts are cast-in-place shafts with reinforcing steel, and

Drilled Pile Foundations consist of a drilled excavation of the proper size, with a pile section concreted or grouted in place. Reinforcing steel may or may not be required in a Drilled Pile Foundation.

712.02 Site Information. Data on subsurface conditions are not intended as representations or warranties of continuity of

such conditions. It is expressly understood that the Department or the Engineer will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. Data is made available for convenience of the Contractor and not guaranteed to represent conditions that may be encountered.

Available soil borings are plotted on the plans, and a copy of the boring logs is included in the proposal for the project.

The Contractor, at no additional cost to the Department, may make additional test borings and other exploratory operations.

712.03 Materials. Cast-in-place concrete shall be Class 4000DS as specified in **Section 701**. Adjustments to the mix design may be requested by the Contractor when characteristics of materials, job condition, weather, test results, or other circumstances warrant. Adjustments will be made at no additional cost to the Department, and are subject to the Engineer's acceptance.

Reinforcing steel shall conform to the requirements of **AASHTO M 31 (ASTM M 615), Grade 60**.

Any piling used in a Drilled Pile Foundation shall conform to the applicable requirements of **Section 711**.

712.04 Qualifications of Contractor. The installation of drilled shaft foundations shall be performed by personnel who specialize in drilled shaft construction. The Contractor's supervisory personnel in charge of daily operations or the Subcontractor's personnel in charge of daily operations shall have a minimum of three (3) years of work experience in the installation of drilled shaft foundations. A supervisor with at least this minimum requirement shall be on the site during the entire construction process of all drilled shafts (i.e. drilling, coring, placing of reinforcement, concreting, etc.) to troubleshoot any problems that may arise during the construction process.

After award of contract, but before the start of drilled shaft construction, the Contractor shall submit for the Engineer's approval the work experience records of the personnel, or those of the Subcontractor, it proposes to use for the installation of drilled shafts. The Engineer shall be the sole judge of the Contractor's and/or the Subcontractor's qualifications and experience to accomplish the drilled shaft work.

Failure to comply with these requirements shall result in the suspension of all work related to the drilled shafts. Work shall not begin on the drilled shafts until the Contractor provides personnel or a Subcontractor with the required qualifications and experience. The Department shall not be liable for any damages or costs of any type related in any way to the suspension of this work, nor will the project completion date be postponed for delays in furnishing the qualifications.

Minimum experience requirements may be waived for drilled pile foundations provided the Contractor or Subcontractor who installs the drilled pile foundations is knowledgeable in this type of construction.

712.05 Installation Plan. The Contractor shall submit an *Installation Plan* for the review and acceptance by the Engineer. This plan shall be submitted a minimum of thirty (30) days before the date the Contractor proposes to begin drilled shaft or drilled pile construction. The plan shall address and include, but not be limited to, the information listed below:

1. List and size of proposed equipment such as cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, tremies, concrete pumps, casings, etc.

2. Details of sequence of construction operations and sequence of shaft or pile construction in bents or in shaft or pile groups.

3. Details of the method of determining the elevation of the top and bottom of any construction casing.

4. Details of excavation methods.

5. Details of proposed methods to clean the excavation after initial drilling.

6. When slurry is required, details of methods to mix, circulate, desand, and dispose of slurry.

7. Details of the steel reinforcing cage, such as method of placement, spacers, concrete feet, supports, method of centering the cage in the shaft or pile, handling, lateral stability, prevention of buckling, etc.

8. 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 at which the top of concrete will be measured for plotting the Theoretical vs. Actual Concrete Volume graph.

9. Required submittals such as shop drawing and concrete design mixes.

10. Means of disposing of excavated materials.

11. The type and frequency of tests that the Contractor intends to perform, including but not limited to, chemical and specific gravity tests for slurry. The Contractor will also supply the name(s) of personnel that are qualified to perform these tests.

12. How the Contractor intends to check the dimensions, depth of the shaft or pile. Indicate the method for determining horizontal and vertical alignment, vertical position of the top of shaft or pile and potential movement of the reinforcing cage.

13. Construction and/or temporary casing details and dimensions, elevations, including splice details, painting, and/or casing removal details if applicable.

14. Details of the Contractor's method of protecting the integrity of the structure(s) during installation of the shafts or piles.

15. Other information required by the plans or requested by the Engineer.

The Engineer will evaluate the *Installation Plan* for conformance to the plans and special provisions. The Engineer will notify the Contractor within twenty-one (21) days of receipt of the plan if there is any additional information required and/or changes necessary for acceptance of the plan. If any part of the plan is unacceptable, the entire plan will be rejected, and the Contractor shall submit a revised *Installation Plan* for re-evaluation. The Engineer will notify the Contractor within seven (7) days after receipt of the revised plan of its acceptance or rejection. Acceptance given by the Engineer shall be subject to satisfactory performance in the field. Any claim by the Contractor for delay based on the Engineer's failure to comply with the above notification time provisions shall be limited to an extension of contract time as the only possible compensation.

The Contractor shall not commence with the installation of drilled shafts or drilled pile foundations until the Contractor's Installation Plan has been accepted by the Engineer.

Acceptance of the Contractor's Installation Plan shall in no way relieve the Contractor of its responsibility to provide sound and adequate foundations that conform to the plans and special provisions. Changes in methods or equipment will not be allowed after acceptance of the plan without the written consent of the Engineer.

For each drilled shaft or drilled pile foundation, the Contractor shall provide a Certified Drilled Shaft Report, or Certi-

fied Drilled Pile Foundation Report. The report shall record the actual elevation at bottom and top of the construction casing and shaft or pile, elevation of sound rock, final centerline location at top, variation of shaft or pile from plumb, result of tests performed, levelness of bottom, seepage of water, static water level (if any), any unusual conditions, excavation starting date, soil description at top and bottom of each stratum encountered, excavation completion date, inspection findings, testing results, and placement of concrete (including any delays placing concrete and location of construction joints in shafts).

The Certified Report shall indicate the theoretical versus actual concrete volume. The Contractor shall provide the elevation of the top of concrete after placement of each truckload of concrete or at intervals as specified by the Engineer. It is the Contractor's responsibility to provide a qualified and competent person to make the necessary measurements.

The Certified Report shall be submitted before beginning construction on other shafts or piles. The requirement may be waived should the Contractor complete more than one shaft or pile in one day, and in that case, the report shall be submitted prior to beginning construction the next working day.

If the Engineer determines that soil conditions warrant, the shafts or piles may be required to be extended below the estimated bottom elevations shown on the plans. Any additional compensation will be at the contract unit price for respective items as described in **Subsection 712.19**.

712.06 General Methods and Equipment. The Contractor shall perform the excavations required for the shafts and drilled pile foundations through whatever materials encountered, to the dimensions and elevations shown in the plans or otherwise required by the special provisions. The Contractor's methods and equipment shall be suitable for the intended purpose and the materials encountered.

712.07 Dry Construction Method. The dry construction method shall be used only at sites where the groundwater level and soil conditions are suitable to permit construction of the shaft or drilled pile foundation in a relatively dry excavation, and where the sides and bottom of the excavation may be visually inspected by the Engineer before placing the concrete. The dry method consists of drilling the excavation, removing accumulated water and loose material from the excavation, setting the reinforcing cage, and concreting the shaft or pile in a relatively dry excavation. The Contractor may elect to use a temporary casing with the dry method.

The dry construction method shall only be allowed by the Engineer when the excavation demonstrates the following:

1. Less than 6 inches of water accumulates above the base over a one-hour period when no pumping is permitted.

2. The sides and bottom of the excavation remain stable without detrimental caving, sloughing, or swelling. If immediately following the completion of the excavation, the stability of the hole is questionable, the Engineer may order up to a four-hour observation period prior to setting rebar cage and placing concrete.

3. Loose material and water can be satisfactorily removed before inspection and before concrete placement.

If the Engineer deems that the excavation meets all the criteria for the dry construction method, the setting of the rebar cage and concreting shall begin immediately after completion of the excavation, cleaning, inspection, and acceptance of the hole.

The Contractor shall use the wet construction method or the casing construction method for excavations that do not meet the above requirements for the dry construction method.

712.08 Wet Construction Method. The wet construction method shall be used at sites where a dry excavation cannot be maintained for placement of the drilled shaft or drilled pile foundation concrete. This method consists of using water, mineral slurry, or a casing to maintain stability of the excavation perimeter while advancing the excavation to its final depth, placing the reinforcing cage, and concreting the shaft or pile foundation.

712.09 Casing Method of Construction. Where drilled shafts or drilled pile foundations are located in wet subsurface conditions or in open water areas, exterior casings shall be extended from above the water elevation to protect the shaft or pile concrete from water action during placement and curing of the concrete. The exterior casing shall be installed in a manner that will produce a positive seal at the bottom of the casing so that no piping of water or other materials occurs into or from the excavation. In open water areas, exterior casings may be removed or left in place. Removal shall be in accordance with **Subsection 712.17F**. Limits of casings left in place shall conform to the requirements for construction casing in **Subsection 712.11C**.

712.10 Excavation.

A. General. The plans indicate the expected length of shaft or drilled pile, the elevation of the top of the shaft or drilled pile foundation, and the estimated elevation of the bottom of drilled shaft or drilled pile foundation. The Engineer reserves the right to alter the elevations and dimensions of the drilled shaft or drilled pile foundations based on the top of rock and/or the results of the Shaft Load Test if performed. Where drilled shaft or drilled pile foundation lengths and dimensions are altered, adjust-

ment in price will be made by applying original contract unit prices to the change in quantity with no additional expense per unit or extension of contract time.

Unless authorized by the Engineer, the drilling process for each individual excavation shall be a continuous operation. In rare cases and with written approval by the Engineer, the drilling for an individual excavation may be discontinued provided the walls can remain stable and drilling will be resumed within 12 hours. See **Subsection 712.17A** for additional requirements.

Waste material removed from excavations, concrete spillage, and other debris shall be hauled off and disposed of offsite at location(s) provided and obtained by the Contractor. Any fees or permits required for disposal of waste material shall be the Contractor's responsibility. Copies of all agreements and/or licenses for the disposal site(s) shall be submitted for Engineer's record. The disposal shall be in strict accordance with local, state and federal environmental, and pollution laws and ordinances.

The Contractor may be allowed to dispose of the waste material on the project site if the Engineer determines that the waste material can be incorporated into the project.

The Contractor shall 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. The proper OSHA safety equipment and procedures shall be supplied by the Contractor and used by the workers entering the confined space excavation.

B. Obstructions. Surface and subsurface obstructions at drilled shaft or drilled pile foundation locations shall be removed by the Contractor. The Contractor shall notify the Engineer of any obstruction deeper than ten feet below the elevation of the original ground. Such obstruc-

tions may include man-made materials such as old concrete foundations and natural materials such as boulders. Special procedures and/or tools shall be employed by the Contractor after the excavation cannot be advanced using conventional augers fitted with soil or rock teeth, drilling buckets, and/or under-reaming tools. Such special procedures/tools may include, but not be limited to, chisels, boulder breakers, core barrels, air tools, hand excavation, temporary casing, and increasing the excavation diameter. Blasting will not be permitted unless specifically approved in writing by the Engineer. All costs for removing obstructions shall be included in the unit price bid for excavation for drilled shafts or drilled pile foundations.

Drilling tools that are lost in the excavation shall not be considered obstructions and shall be promptly removed by the Contractor without compensation. All costs due to lost tool removal shall be borne by the Contractor including, but not limited to, costs associated with excavation degradation due to removal operations or the time the excavation remains open.

C. Drilled Shafts with Wet and Dry Excavation. All excavation for drilled shafts shall be considered Wet and Dry Excavation unless a bid item is included for Rock Excavation. If rock is encountered, and there is a Rock Excavation bid item, Wet and Dry Excavation shall be measured from the top of shaft to the top of rock elevation for each individual shaft. Top of rock elevation shall be determined as indicated in **Subsection 712.10E**.

D. Soil Excavation for Drilled Pile Foundations. All excavation for drilled pile foundations shall be considered Soil Excavation unless a bid item is included for Rock Excavation. If rock is encountered, and there is a Rock Excavation bid item, Soil Excavation shall be measured from the actual top of ground to the top of rock elevation for each individual pile. Top of rock elevation shall be determined as indicated in Subsection 712.10E below.

E. Classification of Rock for Pay Purposes. Rock shall be defined as any material that cannot be drilled with earth or rock augers and/or under-reaming tools, and requires the use of core barrels, rotary percussion drills, and/or blasting. For pay purposes, all earth seams, rock fragments, and voids included in the rock excavation area will be considered rock for the full volume of the excavation from the initial contact with rock.

All drilling equipment used to determine the top of rock shall be appropriate for the purpose and depths and shall be well maintained in good working condition. The Engineer shall be the sole judge of whether the drilling equipment is appropriate and in good working condition.

712.11 Casings.

A. General Requirements. Steel casings shall be smooth, clean, watertight, and of ample strength to withstand both handling and driving stresses and the pressure of both concrete and the surrounding earth materials. The outside diameter of casing shall not be less than the specified size of shaft or pile foundation.

Pre-drilling with slurry and/or over-reaming to beyond the outside of the casing may be required to install casing. Nevertheless, an oversized casing or excavation will not be allowed unless accepted in writing by the Engineer. 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. Further, if the Contractor elects to remove a casing and substitute a longer or larger diameter casing through caving soils, the excavation shall be either stabilized with slurry or backfilled before the old casing is removed. Other methods, as accepted by the Engineer, may be used to control the stability of the excavation and protect the integrity of the foundation soils. Such removal and stabilization operations will be at the

Contractor's expense.

B. Temporary Casings. Unless a bid item for Construction Casing is included in the pay quantities, all subsurface casing shall be considered Temporary Casing. All casings shall be withdrawn from excavations before the completion of the placement of concrete unless the casing is to be used as a forming system. At the Contractor's option, casing used as a forming system may be left in place in accordance with **Subsection 712.11C**.

Before the casing is withdrawn, the level of fresh concrete in the casing shall be a minimum of five feet above the hydrostatic water level. As the casing is withdrawn, care shall be exercised to maintain an adequate level of concrete within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the concrete.

Temporary casings that become bound or fouled during concreting and cannot be practically removed shall constitute a defect in the foundation. The Contractor shall be responsible to improve the defective work to the satisfaction of the Engineer. Such improvement may consist of, but is not limited to, removing the concrete and extending the shaft or pile deeper to compensate for loss of frictional capacity in the cased zone, providing straddle shafts or piles to compensate for capacity loss, or providing a replacement shaft or pile. All corrective measures including removal or re-design of structural members shall be done by the Contractor to the satisfaction of the Engineer without compensation or extension of contract time. In addition, no compensation will be paid for any abandoned casing remaining in place.

When the shaft or pile extends above ground or through a body of water, the exposed portion above ground or through a body of water may be formed with a removable or temporary casing. If the casing is removed, it shall be removed in accordance with the requirements

of **Subsection 712.17F**.

C. Construction Casing. Construction casing is 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. Portions of this casing may be left in place or removed at the Contractor's option. Construction casing will not be paid for unless it is specified in the plans, or approved in writing by the Engineer.

Construction casing shall be of the size specified in the plans or by the Engineer. The Contractor shall be responsible for determining the wall thickness of the casing. Unless otherwise directed by the Engineer, the casing shall be new steel casing conforming to **AASHTO M 183**, (**ASTM A 36**). 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. The casing wall thickness shall be increased as necessary to allow for installation within the subsurface conditions anticipated on the project. The casing shall be smooth and watertight.

The Contractor shall determine the elevation of the top and bottom of the construction casing in accordance with the method accepted in the Contractor's Installation Plan.

If the Contractor elects to leave the construction casing in place, the casing shall be removed to an elevation 3 feet below water level or 2 feet below ground level. Care shall be taken not to damage the concrete portion of the drilled shaft. Instead of removing it, the Contractor may elect to paint the casing in conformance with the requirements of **Subsection 712.11E** and **710.09B.3**.

Casing shall be installed in one continuous unit. Each unit may be fabricated from one or more sections, and each section shall be as long as feasible and spliced as described below. The use of the "telescoping" casing

method is not permitted.

Inside wall surfaces of construction casings shall be thoroughly cleaned of any organics and other materials detrimental to soundness of the shaft or pile concrete and reinforcing steel.

D. Welded Splices. If splices in casings are necessary, they shall be made as follows:

1. Splices in construction casing will not be allowed unless authorized in writing by the Engineer.

2. The surface of only one section of casing shall be beveled on the outside edge of the wall at an angle of approximately 45° with the horizontal. A surface of 1/8 inch may be left unbeveled. Guide bars may be temporarily attached to the casing wall in order to properly align the sections before welding.

3. The beveled section shall then be butted to the unbeveled section and temporarily clamped thereto. The beveled edge shall be separated about 1/8 inch from the edge of the other section and the axes of the two sections shall be made to coincide by adjusting the clamps.

4. The entire periphery of the joint shall then be butt welded with a shielded-arc low hydrogen electrode of proper size and with sufficient generating amperage to fuse the root of the weld. The weld shall be made with sufficient passes to completely fill the joint, removing the slag of each pass before beginning the next pass. The weld specified here is the butt weld designated as B-U4b in the latest edition of the ANSI/AASHTO/AWS D1.5 *Bridge Welding Code*.

Care shall be taken to remove all coatings from the metal at the welds before welding is begun, and after all welding is complete, the slag shall be removed.

Splices in temporary casing will be considered incidental and no additional compensation will be allowed for this work.

The welding of steel casing, including bracing, caps, splices, etc., shall conform to the requirements of the latest edition of the ANSI/AASHTO/AWS D1.5 *Bridge Welding Code*.

E. Painting Casing Left in Place.

1. General. Unless specified otherwise in the plans or special provisions, and at no additional expense to the Department, the Contractor may elect to paint the construction casing instead of removing. Unless specified otherwise, the casing shall be painted a minimum of 5 feet below low water level or 2 feet below ground level. If, after installing the casing, the painted portion does not meet the specified limits, the casing shall be removed to an elevation 3 feet below water level, or 2 feet below ground level. It is the Contractor's sole responsibility to determine the amount of construction casing to be painted.

2. Field Painting. Field painting of casing left in place shall be in accordance with the requirements of **Subsection 710.09B.3** and **710.11B**.

3. Basis of Payment. All costs of equipment, materials, and labor necessary to clean and paint the casing in accordance with these requirements shall be included in the contract unit price for Construction Casing.

712.12 Slurry. Mineral slurries shall be employed when

slurry is used in the drilling process unless other drilling fluids are accepted in writing by the Engineer. The slurry shall have a mineral grain size that will remain in suspension and possess sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. During construction, the level of the slurry shall be maintained at a height sufficient to prevent caving of the excavation. In case of a sudden significant loss of slurry to the excavation, the construction of the foundation shall be stopped until either a method to stop the slurry loss or an alternate construction procedure has been accepted by the Engineer.

The mineral slurry shall be premixed thoroughly with clean fresh water and an adequate time (as prescribed by the mineral manufacturer) has been allotted for hydration before introduction into the excavation. Slurry tanks of adequate capacity will be required for slurry circulation, storage, and treatment. Excavated slurry pits will not be allowed without the written permission of the Engineer. Desanding equipment shall be provided by the Contractor as necessary to control slurry sand content to less than 4% by volume at any point in the excavation. Desanding will not be required for setting temporary casing, sign post, or lighting mast foundations unless specified on the plans or in the special provisions. The Contractor shall take all steps necessary to prevent the slurry from "setting up" in the shaft. Such methods may include, but are not limited to, agitation, circulation, and/or adjusting the properties of the slurry. Disposal of all slurry shall be done offsite in suitable areas by the Contractor.

Control tests using suitable apparatus shall be carried out on the mineral slurry by the Contractor to determine density, viscosity, and pH. An acceptable range of values for those physical properties is shown in the following table:

MINERAL SLURRY
(Sodium Bentonite or Attapulgite in Fresh Water)
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
Viscosity (seconds/quart)	28 – 45	28 – 45	Marsh Cone
pH	8 – 11	8 – 11	pH paper pH meter

**Increase by 2 pcf in saltwater

Notes:

a. Tests should be performed when the slurry temperature is above 40^{o}F.
b. If desanding is required, sand content shall not exceed 4% (by volume) at any point in the bore hole as determined by the American Petroleum Institute Sand Content Test.

Tests to determine density, viscosity, and pH value shall be done during the shaft excavation to establish a consistent working pattern. A minimum of four sets of tests shall be made during the first 8 hours of slurry use. Slurry sampling and testing shall be observed by the Engineer. When the results show consistent behavior, the testing frequency may be decreased to one set every 4 hours of slurry use.

The Contractor shall insure that heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft. Before placing concrete in any shaft excavation, the Contractor shall take slurry samples using a slurry sampling tool. Slurry samples shall be extracted from the base of the shaft at intervals not exceeding 10 feet up the shaft, until two consecutive

samples produce acceptable values for density, viscosity, pH, and sand content. No concrete shall be cast before the Engineer's acceptance of the slurry.

When any slurry samples are found to be unacceptable, the Contractor shall take whatever action is necessary to bring the mineral slurry within specification requirements. Concrete shall not be poured until re-sampling and testing yield acceptable values.

Reports of all the tests required above shall be signed by an authorized representative of the Contractor and furnished to the Engineer on completion of each drilled shaft.

During construction, the level of mineral slurry in the shaft excavation shall be maintained at a level not less than 4 feet above the highest expected piezometric pressure head along the depth of the shaft. If at any time, in the opinion of the Engineer, the slurry construction method fails to produce the desired results, the Contractor shall discontinue this method and propose an alternate method for acceptance by the Engineer.

712.13 Excavation and Drilling Equipment. The excavation and drilling equipment shall have adequate capacity including power, torque and down thrust to excavate a hole of both the maximum diameter and to a depth 10 feet beyond the depth shown on the plans.

The excavation and over-reaming tools shall be of adequate design, size, and strength to perform the work shown in the plans or described herein. When the material encountered cannot be drilled using conventional earth augers with soil or rock teeth, drill buckets, and/or under-reaming tools, the Contractor shall 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. Written concurrence of the Engineer is required before excavation by blasting can be performed.

712.14 Inspection of Excavations.

A. Dimensions and Alignment. The Contractor shall provide equipment for checking the dimensions and alignment of each excavation. The dimensions and alignment of the drilled shaft or drilled pile foundation excavation shall be determined by the Contractor under the observation and direction of the Department inspectors. Generally the alignment and dimensions shall be checked during and after excavation by the following methods as necessary:

1. 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.

2. Other methods provided by the Contractor and accepted by the Engineer.

Any rod or pipe assembly, or other device used to check dimensions and alignment shall be provided by the Contractor and must be able to be inserted into the excavation to the full depth of the foundation.

B. Depth. The depth of the excavation during drilling shall be referenced to appropriate marks on the Kelly bar or other suitable methods. Final excavation depths shall be measured after final cleaning with a suitable weighted tape or other accepted methods.

C. Excavation Inspection. The Engineer will inspect each excavation for acceptance before placement of the reinforcing cage and concrete. The Contractor shall provide necessary equipment for inspecting the excavation. The inspection equipment shall be compatible with the Contractor's construction methods. The Contractor shall be 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 and shall perform any corrective work found necessary as a result of the inspections. Necessary time shall be allowed for performance of these inspections.

D. Excavation Cleanliness Requirements. The Contractor's cleaning operation will be adjusted so that a minimum of 50% of the base of each excavation will have less than 1/2 inch of sediment at the time of placement of the concrete. The maximum depth of sedimentary deposits or any other debris any place on the base of the excavation shall not exceed 1 1/2 inches. Excavation cleanliness will be determined by the Engineer using visual inspection for dry excavations and other methods deemed appropriate by the Engineer for wet excavations. In addition, for dry excavations, the maximum depth of water shall not exceed 3 inches immediately before concrete placement.

E. Construction Tolerances.

1. Drilled Shafts. The following construction tolerances shall apply to drilled shafts unless otherwise stated on the plans or in the special provisions:

a. The drilled shaft shall be within 3 inches of plan position in the horizontal plane at the plan elevation for the top of the shaft.

b. The top elevation of the shaft shall have a tolerance of from plus 1 inch to minus 3 inches from the plan elevation.

c. The vertical alignment of a vertical shaft excavation shall not vary from the plan alignment by more than 1/4 inch per foot of depth. The alignment of a battered shaft excavation shall not vary by more than 1/2 inch per foot of depth from the prescribed batter.

d. After all the concrete has been placed, the top of the reinforcing cage shall be no more than 6 inches above and no more than 3 inches below the plan position, unless otherwise ordered by the Engineer.

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, the Contractor may elect to provide a casing larger in diameter than shown on the plans. However, the Contractor will take steps to insure 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 shall be designed so that the completed shaft excavation will have a planar bottom. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of ±3/8 inch per foot of diameter.

Drilled shaft excavations and completed shafts not constructed within the required tolerances are unacceptable. The Contractor shall be responsible for correcting all unacceptable shaft excavations and completed shafts to the satisfaction of the Engineer. Materials and work necessary, including engineering analysis and re-design to complete corrections for out of tolerance drilled shaft excavations shall be furnished without cost to the Department or an extension of contract time.

2. Drilled Pile Foundations. Construction tolerances will be the same as tolerances mandated for the applicable piling as shown in **Section 711** of these specifi-

cations.

F. Foundation Integrity Testing. If a bid item for Foundation Integrity Testing (Setup) is included in the project, then the Engineer may utilize a non-destructive test to verify the integrity of selected shafts. This test will be performed by a Department Consultant on each drilled shaft selected by the Engineer. The performance of the test will be at no cost to the Contractor. If however, the Engineer has reason to believe the integrity of a drilled shaft has been compromised by the Contractor's methods or materials, the Engineer may call for a Foundation Integrity Test. If the drilled shaft is found to be faulty due to the Contractor's methods or materials, the entire cost of the setup and testing will be the responsibility of the Contractor. If the results of the test prove the foundation to be sound, the Contractor will be paid for the test setup, and the testing will be the responsibility of the Department.

The test will be conducted after the concrete has been allowed to cure at least 72 hours and the concrete reaches a compressive strength of at least 2500 psi as determined from concrete cylinder tests.

The Contractor shall notify the Engineer at the completion of each shaft that is to be tested so that the Engineer will have a minimum of 72 hours to schedule the test.

It is anticipated that all shafts for each bent or pier will be tested at the same time. Therefore, construction on the bent or pier above the shafts cannot begin until all shafts in the bent or pier have been completed, the tests performed, and the data evaluated.

The Contractor shall assist the Engineer in performing the test by providing access to the top of the shaft. The Contractor shall construct a work platform if necessary to provide access. The Contractor shall also assist the Engineer by grinding and smoothing portions of the top of the shaft as directed by the Engineer. This work will be in-

cluded as part of the bid item Foundation Integrity Test (Setup.)

If the Foundation Integrity Test indicates that the shaft is defective, the Contractor shall be responsible to improve the defective shafts to the satisfaction of the Engineer. Such improvement may consist of, but is not limited to, correcting defective portions of the shaft, installing straddle shafts to compensate for capacity loss, or providing a replacement shaft. All corrective measures including re-design of bent or pier caps caused by defective shafts shall be done by the Contractor to the satisfaction of the Engineer without either compensation or extension of contract time.

G. Shaft Load Test. Material, equipment, and procedures for a Shaft Load Test will be specified in the special provisions for the project. Measurement and Payment will also be included in the special provision.

712.15 Construction of Drilled Shaft Using Cofferdams. The Contractor may elect to use cofferdams for the construction of drilled shafts in open water or other areas where such a method of construction would be to his advantage. Obtaining of any required permits shall be the Contractor's responsibility.

If the Contractor elects to use cofferdams, the Contractor shall comply with the requirements of **Subsection 204.05** and **702.10** for design, installation, and inspection of cofferdams.

712.16 Reinforcing Cage Fabrication and Placement.

A. Cage Fabrication and Placement. The Contractor shall 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. The reinforcing cage shall be placed immediately after the ex-

cavation is inspected and accepted. The maximum time between completion of excavation and concrete placement shall not exceed 12 hours unless otherwise approved in writing by the Engineer. The Contractor shall provide the necessary temporary or permanent stiffening against distortion during assembly, lifting, and placement of reinforcing cage.

B. Splicing Cage. If the bottom of the constructed shaft or pile elevation is lower than the bottom of shaft or pile elevation shown on the plans, all longitudinal bars shall be extended the additional length. Spirals shall be continued for the extra depth and the stiffener bars shall be extended to the final depth. These bars shall be spliced by mechanical couplers, or unspliced bars of the proper length may be used. Welding of reinforcing steel will not be permitted unless called for on the plans or in the special provisions.

C. Support, Alignment, and Tolerance. The reinforcing steel in the shaft shall be tied and supported so that the location of the reinforcing steel will remain within allowable tolerances. Concrete spacers or other approved noncorrosive spacing devices shall be used at sufficient intervals (near the bottom, the top, and at intervals not exceeding 10 feet vertically) to insure concentric spacing for the entire cage length. The number of spacers required at each level will be one spacer for each foot of excavation diameter, with a minimum of four spacers at each level. Spacers shall be constructed of approved material equal in quality and durability to the concrete specified for the shaft. The spacers shall be of adequate dimension to insure a minimum 5 inch annular space between the outside of the reinforcing cage and the side of the excavation. Acceptable concrete feet (bottom supports) shall be provided to insure that the bottom of the cage is maintained the proper distance above the base of the excavation. If an oversize casing or excavation is used, spacer sizes shall be adjusted to insure concentric spacing.

The elevation of the top of the reinforcing cage shall be checked before and after the concrete is placed. If the rebar cage is not maintained within the specified tolerances, corrections shall be made by the Contractor to the satisfaction of the Engineer. No additional shafts shall be constructed until the Contractor has modified the reinforcing cage support in a manner satisfactory to the Engineer.

712.17 Concrete Placement.

A. In Drilled Shafts. Concrete shall be placed as soon as possible after placing the reinforcing steel cage. Concrete placement shall be continuous from the bottom to the top elevation of the shaft. Concrete placement shall continue until good quality concrete is evident at the top of shaft. Concrete shall normally be placed either by a tremie or concrete pump. Free fall placement of concrete from the end of the tremie or pump line shall not be permitted. Free fall from the top may be allowed in a dry hole with conditions outlined in **Subsection 712.17E** below.

The elapsed time from the beginning of concrete placement to the completion of the placement shall not exceed two hours. All admixtures, when accepted for use, shall be adjusted for the conditions encountered on the job so the concrete remains in a workable plastic state throughout the two-hour limit. Before concrete placement, the Contractor shall provide test results of both a trial mix and a slump loss test conducted by an approved testing laboratory using approved methods to demonstrate that the concrete meets the two-hour workable plastic state requirement. The Contractor may request a longer placement time provided he supplies a concrete mix that will maintain a slump of 4 inches or greater over the longer placement time as demonstrated by trial mix and slump loss tests. The trial mix and slump loss tests shall be conducted using concrete and ambient temperatures appropriate for site conditions.

B. In Drilled Pile Foundation. Concrete shall be placed

as soon as possible after placing the steel H-pile and reinforcing steel cage. The Contractor may opt to place concrete before placement of steel H-pile provided that a suitable set retarding agent is used to ensure ability to place steel H-pile to the required tip elevation before hardening of concrete. Unless approved in writing by the Engineer, concrete placement shall be continuous from the bottom to the top elevation of the pile foundation. Concrete placement shall continue until the excavation is full and good quality concrete is evident at the top of the pile foundation. Concrete shall normally be placed either by a tremie or concrete pump. The free fall placement from the end of the tremie or pump line shall not be permitted. Free fall from the top may be allowed in a dry construction excavation with conditions outlined in **Subsection 712.17E**.

The elapsed time from the beginning of concrete placement in the excavation to the completion of the placement shall not exceed 2 hours. All admixtures, when accepted for use shall be adjusted for the conditions encountered on the job so the concrete remains in a workable plastic state throughout the 2 hour limit. The Contractor may request a longer placement time provided he supplies a concrete mix that will maintain a slump of 4 inches or greater over the longer placement time as demonstrated by trial mix and slump loss tests. The trial mix and slump loss tests shall be conducted using concrete and ambient temperatures appropriate for site conditions.

The Contractor may opt to place the drilled pile foundation concrete by tremie, free-fall, or pump method as specified below before placing the steel H-pile in the excavation provided that a suitable set retarding agent is used to insure that the steel H-pile can be placed as specified. Further, a vibratory hammer may be required when using this method. The Department reserves the right to disallow this method of construction should it be determined unworkable or defects in the completed drilled pile foundations are observed.

C. Tremies. Tremies may be used for concrete placement in either wet or dry construction excavations. Tremies used to place concrete shall consist of a rigid pipe or tube of sufficient length, weight, and diameter to discharge concrete at the bottom of the excavation. The tremie shall not contain aluminum parts that will have contact with the concrete. The tremie inside diameter shall be at least 6 times the maximum size of aggregate used in the concrete mix, but shall not be less than 10 inches. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and allow unimpeded withdrawal during concreting. The wall thickness of the tremie shall be adequate to prevent crimping or sharp bends that may restrict concrete placement.

The tremie used for wet excavation concrete placement shall be watertight. Underwater placement shall not begin until the tremie reaches the bottom of the excavation. Discharge of concrete may begin at one tremie diameter above the bottom of the excavation only if a valve, bottom plate, or a plug is used. The plug shall be removed from the excavation or be of a material accepted by the Engineer that will not cause a defect in the shaft or pile if not removed. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations. The tremie discharge end shall be immersed at least 10 feet in concrete at all times after starting the flow of concrete. The flow of the concrete shall be continuous. The concrete in the tremie shall be maintained at a positive pressure differential at all times to prevent water or slurry intrusion into the concrete column.

If at any time during the concrete placement, the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft shall be considered defective. In such a case, the Contractor shall remove the reinforcing cage and concrete, complete any necessary sidewall repairs directed by the Engineer, and re-pour the shaft. All costs of replacement of defective shafts shall be the responsibility of the Contractor.

D. Pumped Concrete. Concrete pumps and lines may be used for concrete placement in either wet or dry excavations. All pump lines shall be a minimum of 5 inches in diameter and shall be constructed with watertight joints. Concrete placement shall not begin until the pump line discharge orifice is at the bottom of the excavation.

For wet excavations, a plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins. The plug shall either be removed from the excavation or be of a material accepted by the Engineer that will not cause a defect in the shaft if not removed.

The discharge orifice shall remain at least 10 feet below the surface of the fluid concrete for wet excavation concrete placement. When lifting the pump line during concreting, the Contractor shall temporarily reduce the line pressure until the orifice has been repositioned at a higher level in the excavation. If at any time during the concrete placement, the pump line orifice is removed from the fluid concrete and discharges concrete above the rising concrete level, the shaft shall be considered defective. In such case, the Contractor shall remove the reinforcing cage and concrete, complete any necessary sidewall repairs directed by the Engineer, and re-pour the shaft. All costs of replacement of defective shafts shall be the responsibility of the Contractor.

E. Free-Fall of Concrete. With the written acceptance of the Engineer, the free-fall of concrete may be allowed only under the following conditions:

1. The excavation is a dry construction method excavation as defined under **Subsection 712.07**.

2. The inspector can see the top of the rising concrete during pouring and can determine if the concrete is striking the reinforcing cage.

3. The concrete is placed in a chute with a rigid pipe to direct the concrete straight down.

4. The concrete fall is less than 75 feet.

5. The maximum size of aggregate is 3/4 inch; the slump is in the 7 inch to 9 inch range; and there are no strength problems.

6. The Contractor has a tremie or pump on site and is prepared to use it if it becomes necessary.

7. It is expressly understood by the Contractor that permission to use the free-fall method is conditional and that the Department reserves the right to require a tremie or pump on any shaft if, for any reason, the Engineer determines that the free-fall method is not producing satisfactory results.

F. Forms. When the top of shaft or pile elevation is above ground, the portion of the structure above ground shall be formed to the dimensions shown on the plans with removable forms or another accepted method.

Casing used as form and later removed to expose the concrete shall be removed in a manner that will not damage the underlying concrete. The casing may be removed in accordance with the following requirements:

1. The concrete has attained a compressive strength of 3000 psi as determined from test cylinder breaks.

2. After removal of the casing, the concrete shall continued to be cured for the full curing period in accordance with specifications.

3. The concrete is not exposed to moving water or tidal water for at least seven (7) days after removal of the casing.

712.18 Method of Measurement.

A. Drilled Shafts with Wet and Dry Excavation. The quantity to be measured for payment shall be the length in linear feet of the reinforced concrete drilled shaft of the diameter shown in the plans, completed and accepted.

If a bid item for Drilled Shaft with Rock Excavation is not included in the pay quantities, then the length for Drilled Shafts with Wet and Dry Excavation shall be the difference between the top of shaft elevation as shown on the plans and the final bottom of shaft elevation as authorized by the Engineer or the actual bottom of shaft elevation, whichever produces the lesser length. No measurement will be made for over drilling beyond the elevation authorized by the Engineer. Measurement will be made to the nearest one-tenth of a linear foot.

If a bid item for Drilled Shaft with Rock Excavation is included in the pay quantities, then the length for Drilled Shafts with Wet and Dry Excavation shall be the difference between the top of shaft elevation as shown in the plans and the top of rock elevation determined in accordance with **Subsection 712.10E**.

B. Drilled Shafts with Rock Excavation. If a bid item for Drilled Shaft with Rock Excavation is included in the

pay quantities, then the length in linear feet for Drilled Shafts with Rock Excavation shall be the difference between elevation of the top of rock determined in accordance with Subsection 712.10E and elevation of the final bottom of shaft as authorized by the Engineer or the actual bottom of shaft elevation, whichever produces the lesser length. No measurement will be made for over drilling beyond the elevation authorized by the Engineer. Measurement will be made to the nearest one-tenth of a linear foot.

If a bid item for Drilled Shaft with Rock Excavation is not included in the pay quantities, then all costs shall be included in the price bid for Drilled Shafts with Wet and Dry Excavation.

C. Soil Excavation for Drilled Pile Foundation. The quantity to be measured for payment shall be the length in linear feet of the concrete portion of the drilled pile foundation of the diameter shown in the plans, completed and accepted.

If a bid item for Rock Excavation for Drilled Pile Foundation is not included in the pay quantities, then the length for Soil Excavation for Drilled Pile shall be the difference between the elevation of the top of ground, as determined by field measurement, and the elevation of the final bottom of the drilled pile foundation as authorized by the Engineer or the actual elevation of the bottom of the concrete pile, whichever produces the lesser length. No measurement will be made for over drilling beyond the elevation authorized by the Engineer. Measurement will be made to the nearest one-tenth of a linear foot.

If a bid item for Rock Excavation for Drilled Pile Foundation is included in the pay quantities, the length for Soil Excavation for Drilled Pile Foundation shall be determined as the difference between elevation of the top ground as determined by field measurement and the authorized elevation of the top of rock determined in accordance with

Subsection 712.10E.

D. Rock Excavation for Drilled Pile Foundation. If a bid item for Rock Excavation for Drilled Pile Foundation is included in the pay quantities, then the length in linear feet for Rock Excavation for Drilled Pile Foundation shall be the difference between the top of rock excavation determined in accordance with Subsection 712.10E and the final bottom of concrete pile elevation as authorized by the Engineer or the actual bottom of drilled pile elevation, whichever produces the lesser length. No measurement will be made for over drilling beyond the elevation authorized by the Engineer. Measurement will be made to the nearest one-tenth of a linear foot

If a bid item for Rock Excavation for Drilled Pile Foundation is not included in the pay quantities, then all costs shall be included in the price bid for Soil Excavation for Drilled Pile Foundation.

E. Reinforcing Steel. The quantity of reinforcing steel measured for payment shall be the theoretical number of pounds of reinforcing steel required to construct the drilled shafts or drilled pile foundations to the dimensions and elevations as shown on the plans unless revised by the authority of the Engineer.

F. Concrete for Drilled Shafts. All costs for concrete in drilled shafts shall be included in the contract unit price for Drilled Shafts and will not be measured for payment.

G. Concrete for Drilled Pile Foundations. The quantity of drilled pile foundation concrete measured for payment shall be the theoretical number of cubic yards of concrete required to construct the drilled pile foundations to the dimensions and elevations as shown on the plans or revised by the authority of the Engineer.

H. Construction Casing. The quantity to be measured for payment shall be the length in linear feet of the Construction Casing of the diameter shown on the plans, completed and accepted.

Unless directed otherwise by the Engineer, measurement for payment shall include from the authorized top of the construction casing to final authorized bottom of casing elevation. Portions of construction casing removed will not be deducted from the pay quantities. Portions of construction casing removed shall become the property of the Contractor and shall be disposed of by the Contractor away from the site.

With written authorization of the Engineer, the Contractor may elect to use a construction system using a temporary form down to the final cut-off elevation of the construction casing. This may be done to eliminate the need for removal of construction casing below water level. If this type of system is used, the measurement for pay quantity shall be from the top of construction casing estimated on the plans to the authorized bottom of casing elevation. If this type of system is to be used, it shall be shown on the Installation Plan.

An allowance of 5 feet of construction casing will be added to the total measurement for each approved splice eligible for payment. There will not be an allowance for any splice made for the convenience of the Contractor.

Measurements shall not include casing which are not in accordance with these specifications or for those that are not as directed and accepted by the Engineer.

I. Steel H-Piling. Steel H-piling for drilled pile foundations shall be measured in accordance with **Section 711**.

J. Foundation Integrity Test Setups. The number of Foundation Integrity Test Setups shown in the plans is es-

timated for bid purposes only. The actual number of Foundation Integrity Test Setups measured for payment shall be equal to the number of each drilled shaft tested with the Foundation Integrity Test to verify the integrity of drilled shafts and result in no known defects attributable to the Contractor.

712.19 Basis of Payment.

A. Drilled Shafts with Wet and Dry Excavation. The quantity of reinforced concrete drilled shaft measured as specified in **Subsection 712.18A** will be paid at the contract unit price for Drilled Shafts with Wet and Dry Excavation, which price and payment shall be full compensation for labor, material and equipment and shall include the excavation including disposal of excavated materials, installation and removal of temporary casings, removal of obstructions, cleaning excavation, pumping out water, furnishing and placing concrete, painting casings left in place, and other incidentals necessary to satisfactorily complete the work as specified.

B. Drilled Shafts with Rock Excavation. The quantity of reinforced concrete drilled shaft measured as specified in **Subsection 712.18B** will be paid at the contract unit price for Drilled Shafts with Rock Excavation, which price and payment shall be full compensation for labor, material and equipment and shall include the excavation including disposal of excavated materials, installation and removal of temporary casings, removal of obstructions, cleaning excavation, pumping out water, furnishing and placing concrete, painting casings left in place, and other incidentals necessary to satisfactorily complete the work as specified.

C. Drilled Pile Foundations. The quantity of reinforced or non-reinforced concrete drilled pile foundations measured as specified in **Subsection 712.18C** will be paid at the contract unit price for Soil Excavation for Drilled Pile Foundations, which price and payment shall be full com-

pensation for labor, material and equipment and shall include the excavation including disposal of excavated materials, installation and removal of temporary casings, removal of obstructions, cleaning excavation, pumping out water, painting casings left in place, and other incidentals necessary to satisfactorily complete the work as specified.

D. Rock Excavation for Drilled Pile Foundations. The quantity of reinforced or non-reinforced concrete drilled pile foundations measured as specified in **Subsection 712.18D** will be paid at the contract unit price for Rock Excavation for Drilled Pile Foundations, which price and payment shall be full compensation for labor, material and equipment and shall include the excavation including disposal of excavated materials, installation and removal of temporary casings, removal of obstructions, cleaning excavation, pumping out water, painting casings left in place, and other incidentals necessary to satisfactorily complete the work as specified.

E. Reinforcing Steel. Reinforcing steel will be paid for in accordance with **Subsection 703.12**, which price and payment shall be full compensation for furnishing, tying, assembling, stiffening, and placing reinforcing steel cages. It shall also include furnishing and attaching spacers on cages and other incidentals necessary to satisfactorily complete the work as specified.

F. Concrete for Drilled Pile Foundations. Concrete for drilled pile foundations shall be paid for at the contract unit price for Drilled Foundation Concrete, which price and payment shall be full compensation for all costs of mix designs, trial batches, testing, concrete, forms, placing concrete, labor, materials and other incidentals necessary to satisfactorily complete the work as specified.

G. Construction Casing. The quantity of construction casing measured in accordance with **Subsection 712.18H** will be paid for at the contract unit price for each size of Construction Casing indicated on the plans, which price

and payment shall be full compensation for furnishing all materials, including stiffening materials, equipment, tools, labor, and other items necessary for installing, removing, and/or painting, if necessary, and disposing of specified portions, splicing, and welding as required. It shall also include any temporary bracing necessary to hold the casing in alignment and the removal of any obstructions to satisfactorily complete the work as specified.

H. Steel H-Piling. Steel H-piling for drilled pile foundations shall be paid for in accordance with **Section 711**.

I. Foundation Integrity Test Setups. The number of Foundation Integrity Test setups will be paid for at the contract unit price for Foundation Integrity Test Setup, which price and payment shall be full compensation for mobilization, equipment, labor, materials and incidental work required to assist the Engineer in the preparation, performance, and monitoring in accordance with these specifications.

Payment for each item will include all direct and indirect costs and expenses necessary to complete the work.

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7120001	Foundation Integrity Test Setup	Each
712002X	Soil Excavation for Drilled Pile Foundations - (*diameter*)" Diameter	Linear Foot
712006X	Rock Excavation for Drilled Pile Foundations - (*diameter*)" Diameter	Linear Foot
7120XX1	Drilled Shafts with Wet & Dry Excavation - (*diameter*)"Diameter	Linear Foot

Pay Items (Continued)

Item No.	Pay Item	Pay Unit
7120XX2	Drilled Shafts with Rock Excavation - (*diameter*)" Diameter	Linear Foot
7120XX5	Construction Casing - (*diameter*)" Diameter	Linear Foot
7120500	Drilled Pile Foundation Concrete	Cubic Yard

SECTION 713

MECHANICALLY STABILIZED EARTH RETAINING WALL (SEGMENTAL BLOCK)

713.01 Description. This work shall consist of furnishing and constructing a Mechanically Stabilized Earth Retaining Wall (MSERW) using segmental block concrete facing units conforming to the lines, grades, and dimensions shown on the plans. It includes erecting the segmental concrete facing units; storing, cutting, and placing the structural geosynthetic reinforcement; excavating existing material, placing and compacting wall fill material and backfill material, providing a concrete leveling pad, and installing a drainage system behind the wall.

713.02 Definitions.

1. Structural Geosynthetic Reinforcement (SGR) is a structural element formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and functions primarily as horizontal reinforcement.

2. Segmental Concrete Facing Unit is a precast concrete shape, machine made from portland cement, water, and

mineral aggregates and is manufactured specifically for mortarless reinforced earth retaining wall construction.

3. Concrete Leveling Pad is a short concrete pad at the base of the structure used as a bearing pad for the wall.

4. Free Drainage Aggregate is placed within the segmental concrete facing units and directly behind the wall used to prevent the build up of hydrostatic pressure.

5. Backfill is compacted soil within the limits of geosynthetic reinforcement and an area two feet past the outer limits of the reinforcement that acts as a restraining mass for the wall

6. Long Term Design Strength (LTDS) is the strength of the structural geosynthetic reinforcement at the end of the service life of a reinforced soil.

713.03 Referenced Specifications.

Geosynthetic Research Institute (GRI)

American Association of State Highway and Transportation Officials (AASHTO)

American Society for Testing and Materials (ASTM)

National Concrete Masonry Association (NCMA)

713.04 Structural Geosynthetic Reinforcement (SGR).
Structural geosynthetic reinforcement shall be high-density polyethylene, polyester resin or polypropylene material conforming to the following:

1. Long Term Design Strength shall meet or exceed the requirements of either the GRI Specification GG4A, *Determination of Long Term Design Strength of Stiff Geogrids* or GG4B Specification GG4B, *Determination of Long Term Design Strength of Flexible*

Geogrids, whichever applies. The Contractor shall furnish the manufacturer's certification of conformance.

2. Tension shall meet or exceed the requirements of either ASTM D 4595 or GRI Specification GG1, *Geogrid Rib Tensile Strength*, whichever is greater.

3. Creep shall meet or exceed the requirements of ASTM D 5262.

4. Site Damage and Durability shall meet or exceed the requirements of GRI Specification GR1 and GR4.

5. Required pullout resistance shall be less than the maximum pullout resistance of the SGR as determined by GRI Specification GG5, *Geogrids Pullout*; or Specification GG6, *Geotextiles Pullout*.

6. Connection strength between the Structural Geosynthetic Reinforcement and the Segmental Concrete Units shall meet or exceed the requirements of NCMA, SRWU-1 and SRWU-2.

7. The Structural Geosynthetic Reinforcement resin shall be virgin resin.

713.05 Segmental Concrete Facing Units. Segmental concrete facing units shall be precast portland cement concrete units. The concrete shall have a 28-day minimum compressive strength of 3000 psi with a maximum absorption of 8.0% and shall conform to the applicable requirements of **Section 701**.

A. Physical Dimensions. The physical dimensions of the segmental concrete facing units shall conform to the following:

Minimum width (front to back)	20 inches
Minimum height	6 inches
Maximum height	8 inches
Minimum face shell thickness in voided units	3 inches
Maximum horizontal gap between erected units	1/2 inch
Final wall batters (measured at con tract completion date)	0^{o} to 4^{o}

Tolerance for conformance to dimensions shown above shall not be more than (±)1/8 inch, except that height dimensions shall not differ by more than (±)1/16 inch as measured in accordance with ASTM C 140.

B. Finish and Appearance. All facing units shall be sound and free of cracks or other defects that would interfere with the proper placing of units.

Exposed surfaces of facing units shall be free of chips, cracks, or other imperfections when viewed from a distance of 10 feet under full light. Texture and shape of the facing units shall be beveled split-face or as specified in the plans or special provisions.

Unless specified in the plans or elsewhere in the special provisions, the color of the segmental block facing units shall be natural gray.

C. Shear Connectors. Shear connectors shall be mechanical interlocking connectors or connecting pins. Connecting pins shall be thermoset isopthal resin/pulltruded fiberglass reinforced rods. Connecting pins shall have a flexural strength of 128,000 psi and short beam shear strength of 6400 psi. Shear connectors shall be capable of holding the SGR in the position during backfilling operation.

D. Sampling and Testing. At least two weeks before starting work, the Contractor shall provide sample units to be tested for compressive strength and absorption.

713.06 Concrete Leveling Pad. The concrete leveling pad material shall consist of portland cement concrete. The concrete strength shall be as recommended by the segmental wall manufacture and shall conform to the requirements of **Section 701**.

713.07 Free Drainage Aggregate. The free drainage aggregate shall consist of Aggregate No. 5 conforming to the requirements specified in the table entitled **Gradation of Coarse Aggregates** located in the Appendix of these specifications. The free drainage aggregate shall be placed in segmental concrete facing units cores and one foot beyond the back of the units to within one foot of final grade.

713.08 Backfill Material. All backfill material used in the structure volume for MSERW structure shall be free from organic or other deleterious material and shall conform with the following gradation limits as determined by AASHTO T 27:

U.S. Sieve Size	Percent Passing
3/4 in.	100
No. 40	0 – 60
No. 200	0 – 15

The Plasticity Index (PI) shall not exceed 6.

One foot of impervious material shall be paced on top of reinforced backfill.

713.09 Acceptance of Materials. At least two weeks before placing any material, the Contractor shall submit to the Engineer the mill test report and certified test results from a recognized laboratory for the tests specified herein. The Engineer will submit these mill tests and certified test results to the Research and Materials Engineer for acceptance. Acceptance will be based on the test results meeting the specified

requirements.

All materials not conforming to the requirements of these specifications shall be considered defective, and all such materials, whether in-place or not, shall be rejected and removed immediately from the work site. unless otherwise instructed by the Engineer.

713.10 Shipping and Storage of Materials. All material shall be stored in accordance with **Subsection 106.07**.

Structural Geosynthetic Reinforcement labeling, shipment, and storage shall follow ASTM D 4873. Product labels shall clearly show manufacturer or supplier name, style number, and roll number. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.

Each Structural Geosynthetic Reinforcement roll shall be wrapped with a material that will protect the SGR from damage from shipment, water, sunlight, or contaminants. The protective wrapping shall be maintained during periods of shipment and storage.

During storage, the Structural Geosynthetic Reinforcement rolls shall be elevated off the ground and adequately covered to protect SGR form construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 160°F., and any other environmental condition that may damage the physical property values.

All materials not conforming to the requirements of these specifications shall be considered defective, and all such materials, whether in place or not, shall be rejected and removed immediately from the work site, unless otherwise instructed by the Engineer.

713.11 Plans, Specifications, and Sequence of Construction. The Contractor shall have an approved set of plans and special provisions on site at all times during construction of MSERW. The excavation shall be to lines and grades shown on the plans. If the face of the MSERW is greater than 1500 square feet, the Contractor shall have the wall system manufacturer's representative on site when the construction of the MSERW begins.

The sequence of construction shall be a follows:

1. Excavate for the leveling pad and the soil reinforcement zone.
2. Install the leveling pad.
3. Install drain pipe and aggregate as required.
4. Set one course of segmental concrete facing units.
5. Place free drainage aggregate as required
6. Backfill and compact soil to level of SGR.
7. Attach SGR to segmental block shear connectors and position SGR.
8. Place drainage aggregate and backfill and compact to top of segmental block.
9. Repeat steps 3 through 8 until last course of segmental blocks is placed and anchored.
10. Place cap on last course of segmental blocks.
11. Place and grade backfill above the wall to the lines and grades shown on the plans.

713.12 Excavation for MSERW. Existing ground shall be excavated to grades and elevations shown on plans to the limits of reinforced soil zone or as directed by the Engineer.

The actual foundation soil strength shall meet or exceed a minimum bearing strength value of 2500 psf. Soils under the foundation that do not meet the required strength will be removed for a distance beyond the foundation equal to the depth of the removal. The unsuitable material shall be replaced with material of the required strength with 1:1 side slopes. The removal and replacement of the unsuitable material shall be included in quantity for unclassified excavation.

During foundation soil examination, the Contractor's independent Soil Consultant shall perform borings to locate the elevation of existing groundwater level. The distance from the groundwater level to the bottom of the leveling pad shall not be less than 0.66 times the height of the wall. If the distance is less than required, the design of the wall shall be modified to meet site conditions before construction of the wall can begin.

Foundation soil within limits of the wall shall be compacted to 95% of Standard Proctor Maximum Dry Density determined by AASHTO T 99 and shall be inspected by the Engineer before placement of leveling pad. Compaction of foundation soil shall comply with **Subsection 301.12**.

713.13 Drainage. During construction of the MSERW, the Contractor is responsible for the drainage around the MSERW site to limit erosion and detriment of the reinforcement zone. Perforated pipe underdrain shall be placed at the lowest elevation possible to maintain gravity flow of water to the outside of the reinforced zone. The perforated pipe underdrain shall outfall at an appropriate location away from the wall at each low point or every 50 foot interval along the wall.

713.14 Installation of Concrete Leveling Pad. Concrete leveling pad shall be installed to the elevations and dimensions shown on the plans or approved by the Engineer. The first course of segmental blocks shall not be placed until the concrete in leveling pad has reached the compressive strength recommended by the segmental wall manufacturer.

713.15 Installation of Segmental Concrete Facing Units.
The first course is the most important to insure accurate alignment and acceptable construction results. Units in the first course shall be in full contact with the concrete leveling pad. All the units in a course shall be placed for the full length of a straight wall alignment before starting the next course. The Engineer shall check all courses for level from front to back and side to side.

The Contractor shall check each connecting pin or integral concrete interlocking connectors to see that they are securely attached or engaged before backfilling. The block cores of each course shall be completely filled with free drainage aggregate before proceeding to the next course. All excess aggregate and debris shall be cleaned from top of the units before installation of the next course.

Uppermost row of segmental concrete facing units or caps shall be attached by means of an acceptable adhesive material to the top underlying segmental concrete facing units. See plans for slope drainage at the top of the MSERW.

713.16 Structural Geosynthetic Reinforcement (SGR).
The Structural Geosynthetic Reinforcement shall be installed in accordance with the reinforcement manufacturer's recommendations and in compliance with the plans and these specifications. The SGR shall be oriented with the highest strength axis perpendicular to the wall alignment. SGR shall be laid horizontally on compacted backfill. The next course of concrete facing units shall be used a temporary weight and shall placed over the SGR. The SGR shall be pulled taut and anchored before backfill placement. The SGR grid shall be continuous along the principal axis. Splicing of SGR along the principal axis is not allowed.

The placement of SGR at corners and radii shall be done in accordance with Section 6.3 of the **NCMA Design Manual for Segmental Retaining Walls**.

713.17 Backfill Placement. Reinforced backfill shall be placed, spread and compacted in a manner to avoid slack, folding, or movement of geosynthetic reinforcement. Fill in the reinforcement zone shall be placed and compacted in lifts not to exceed 6 inches of loose material where hand operated compaction equipment is used and not to exceed 12 inches of loose material where heavy self-propelled compaction equipment is used. All fill placed in the reinforced zone must be compacted to a minimum of 95% of the soil's maximum dry density as determined by AASHTO T 99. Only lightweight hand operated equipment shall be allowed within 4 feet of the back of the retaining wall units, or one-half of the wall height, whichever is greater.

713.18 Method of Measurement. The quantity measured shall be the square feet of wall surface, complete in place, measured from the top of the leveling pad to the top of the designed profile. There will be no separate measurements for the structural geosynthetic reinforcement, excavation and borrow for structural backfill, leveling pad concrete, perforated pipe underdrain, free drainage aggregate, structural backfill or other incidental items required for construction. If no revisions are made to the length and/or height of the MSERW from the specified dimensions in the plans, no field measurement will be required and measurements shall be the quantity shown on the plans.

If unsuitable material is found below the leveling pad, the number of cubic yards of unsuitable material removed, determined by cross-sections, will be included in the item Unclassified Excavation for excavation and again for backfill material.

713.19 Basis of Payment. The quantity measured above in Subsection 713.18 will be paid for at the contract unit price for Mechanical Stabilized Earth Retaining Wall (Segmental Block, which price and payment shall be full compensation for furnishing and installing all materials, including the segmental concrete facing units, structural geosynthetic reinforcement, concrete leveling pad, all necessary excavation and borrow

for structural backfill, free drainage aggregate, perforated pipe underdrain, structural backfill, and any incidental items, labor, and tools necessary to complete the work in accordance with the plans and special provisions.

The excavation and backfill necessary to replace unsuitable material under the concrete leveling pad shall be paid for as Unclassified Excavation, which price and payment shall include all equipment, tools, labor, and incidentals necessary to complete the work.

Payment for each item will include all direct and indirect costs and expenses necessary to complete the work.

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7137175	Mechanically Stabilized Earth Retaining Wall (Segmental Block)	Square Foot

SECTION 714

PIPE CULVERTS

714.01 Description. This work shall consist of furnishing pipe of the size, shape, type, and dimensions indicated on the plans and installing them to provide drainage structures at places designated on the plans or by the Engineer in accordance with these specifications and true to the lines and grades shown on the plans or otherwise given by the Engineer. This work shall include the furnishing and installing of necessary tee, wye, elbow and bend joints, and making connections to existing and/or new structures, including drilling and chipping as may be necessary to complete the work.

714.02 General. Only materials specified herein shall be used for the several items that constitute the finished pipe culvert.

714.03 Circular Reinforced Concrete Culvert Pipe. Circular RC culvert pipe shall conform to the applicable requirements of **AASHTO M 170**, (**ASTM C 443**) and the ***Policy for Inspection and Acceptance of Concrete Culvert Pipe*** adopted by the Department for the specified diameters, shapes, types, and strength classes, except for the modifications stated herein. When a strength class is not specified, Class III pipe shall be used. The pipe shall be furnished in manufactured lengths from 4 to 12 feet. Circular pipe sizes through 36 inches diameter shall have the standard circular reinforcement conforming to the requirements of **AASHTO M 170**.

Reinforcement for circular pipe sizes 42 inches in diameter or larger may contain any of the reinforcement designs conforming to the requirements of AASHTO M 170. When other than circular designs are used, the pipe joint shall have a lift hole established in the top of the shell and be marked “Top." The special design reinforcement shall be placed in position and stabilized by satisfactory means to assure that it will not shift or rotate during the manufacturing process.

For classes and sizes of circular, or elliptical pipe with reinforcement designs not shown in AASHTO M 170, or **M 207**, respectively, the manufacturer shall submit to the Engineer a design that will meet the strength requirements for the specified pipe.

Portland cement shall conform to the requirements of **Subsection 701.02**.

Fly ash and water-granulated blast-furnace slag may be used at the option of the manufacturer in accordance with the following requirements:

1. Fly ash shall meet ASTM C 618 for Type F or C with a maximum Na_2O of 1.5%. Water-granulated blast-furnace slag shall meet the requirements of **ASTM C 989**, Grade 120.

2. The amount of cement to be replaced by fly ash shall not exceed 15% and the amount to be replaced by water-granulated blast-furnace slag shall not exceed 50%. Fly ash shall replace the cement in the ratio of not less than 1.2 to 1 by weight. Water-granulated blast-furnace slag shall replace the cement in the ratio of not less than 1:1 by weight.

3. Fly ash and slag will be accepted only from approved sources. Certified mill test reports shall be furnished with each shipment to verify compliance requirements.

4. The manufacturer shall submit a mix design to the Engineer for his approval in advance of batching. The submittal shall indicate the amount of cement to be removed and the material that will replace it.

5. Storage bins, conveying devices and weighing equipment and procedures to assure accurate batching shall be provided for each material (fly ash or slag) to be used.

Aggregates shall conform to the quality requirements as specified in **Section 701** for aggregates. Gradation of the aggregates shall be at the option of the manufacturer.

Steel reinforcement shall conform to the requirements of **AASHTO M 31**, **M 32**, **M 55**, **M 221**, or **M 225** as applicable.

Gasket seals shall be flexible watertight gaskets conforming to **AASHTO M 198**, Type A, or Type B. Type B gasket seals shall be of the minimum size to produce a watertight

joint in the annular space of the pipe being used. Only those gasket sources which appear on an **Approved List**, published by the South Carolina Research and Materials Laboratory, entitled *Approved Preformed Flexible Plastic Gaskets* shall be used. Approval may be obtained by furnishing the Research and Materials Engineer a certified affidavit with test results made in a recognized laboratory confirming that the material meets AASHTO M 198 along with complete instructions for installation of the material.

Water shall meet the requirements of **Subsection 701.12**.

714.04 Elliptical Reinforced Concrete Culvert Pipe. Elliptical RC culvert pipe shall meet the applicable requirements of **Subsection 714.03**. The thickness and dimensions of the pipe shall be in accordance with the plans.

714.05 Corrugated Steel Culvert Pipe. Corrugated steel culvert pipe shall meet the requirements of **AASHTO M 36**. Where elliptical pipe is called for on the plans or in the special provisions, the pipe shall be distorted from a true circle to provide an increase in the vertical diameter of approximately 5%. Distortion shall be performed at the fabricating shop. The thickness of the pipe shall be in accordance with the plans.

714.06 Corrugated Steel Culvert Pipe-Arch. Corrugated steel culvert pipe-arch shall conform to the requirements of AASHTO M 36, Type II.

Dimensions shall be in accordance with Table 4 of AASHTO M 36, Type II and shall be measured from the inside crest of the corrugations. Metal thickness of the pipe arch shall be in accordance with the plans.

End sections shall be fabricated from materials conforming to the applicable requirements of **AASHTO M 218**. Metal thickness of the end section shall be in accordance with the plans.

714.07 Bituminous Coated Corrugated Steel Culvert Pipe and Pipe-Arch. Bituminous coated corrugated steel culvert pipe and pipe-arch shall conform to the requirements of **Sub-sections 714.05** and **714.06**, and **AASHTO M 190**, Type A, Type B, or Type C. The pipe or pipe-arch shall be coated with bituminous materials as hereinafter described for the particular type specified.

Type A, Fully Bituminous Coated Culvert Pipe, shall be uniformly coated with bituminous material, inside and outside, to a minimum thickness of 0.05 inch, measured on the crests of the corrugations.

Type B, Half Bituminous Coated and Paved Culvert Pipe, shall be uniformly coated for approximately one-half of the circumference of the pipe (bottom of the pipe installed), inside and outside to a minimum thickness of 0.05 inch and in addition, the bituminous material shall be applied in such a manner that one or more smooth pavements will be formed in the invert (inside bottom of the pipe when installed), filling the corrugations for at least 25% of the circumference of a pipe and 40% of the circumference of a pipe-arch. The pavement shall have a minimum thickness 1/8 inch above the crest of the corrugations, except where the upper edges intersect the corrugations.

Type C, Fully Bituminous Coated and Paved Culvert Pipe, shall be fully coated as required for Type A above and in addition, a smooth pavement shall be provided as required for Type B above.

714.08 Corrugated Aluminum Alloy Culvert Pipe and Pipe-Arch. This pipe shall conform to **AASHTO M 196**. The thickness of the pipe shall be in accordance with the plans.

714.09 Corrugated High Density Polyethylene Culvert Pipe (12 Inch Diameter or Greater). This pipe shall conform to the requirements of **AASHTO M 294**, Type C or Type S, as required.

Type C pipe shall have corrugated, high density surface both inside and outside, and shall only be used in temporary applications.

Type S pipe shall have an outer corrugated high density pipe wall and a smooth inner liner, and shall be the only type used in permanent applications

Only materials from sources appearing on the Department's approved list entitled "Corrugated High Density Polyethylene Pipe Sources" shall be used in the work. A copy of this approval list of sources may be obtained from the Department's Research and Materials Engineer. A manufacturer may request to be included on the approval list by furnishing certified test results from an independent laboratory verifying that the proposed pipe design meets or exceeds the requirements of this specification. The request must also include a certification of materials. Further, the manufacturer shall furnish complete instructions as to installation along with technical data sheets and materials safety data sheets. The approval process may require a demonstration of installation procedures and an in-plant inspection of quality control procedures.

After source approval, the manufacturer shall furnish with each shipment of materials a certification showing brand name, S.C. File Number for the project, the shipping date and to whom it is shipped, and the quantity and size of pipe represented. The certificate shall contain a statement that the material meets the South Carolina Department of Transportation specifications and is essentially the same as that approved by the Department. The shipped pipe and fittings shall be plainly marked with the manufacturer's name, trademark and type of pipe as specified in **AASHTO M 294**. A materials safety data sheet and installation instructions shall be furnished with each shipment.

Changes in design and/or materials after initial source approval shall be submitted to the Engineer for evaluation.

714.10 Trench and Bed for Pipe. The pipe shall be laid in a trench where possible. Trenches shall be excavated to the required grade and to a width sufficient to allow for proper jointing of the pipe and for thorough compaction of the backfill material under and around the pipe. The trench bottom shall give full support to the pipe throughout its length. The trench bottom shall be carefully shaped to fit the bottom of the pipe for a depth of at least 10% of its overall height and shall have recesses shaped to fit any projecting hubs or bells.

Where pipe culverts are to be placed in new embankments, the embankments shall first be constructed to a height of approximately 1/2 the diameter of the pipe above the top of the designated pipe or to such height as directed by the Engineer. The embankment shall be constructed for a distance of not less than 5 times the diameter of the pipe on each side of the pipe location, after which the trench shall be excavated in the embankment as described above.

When a firm foundation is not encountered at the required grade, all such unstable material under the pipe and for a width of at least one diameter on each side of the pipe, except where widths are restricted by obstructions, shall be removed and the resulting excavation backfilled with suitable material and compacted and shall be shaped as described above.

When excavating for pipe culverts, if rock, hard pan, or other unyielding foundation material is encountered, the hard unyielding material shall be excavated below the elevation of the bottom of the pipe or pipe bell to a minimum depth of 8 inches. The width of the excavation shall be 12 inches greater than the outside diameter of the pipe and shall be refilled with suitable material and compacted and shall be shaped to form a firm uniform bed.

The Contractor shall provide, as may be necessary, for temporary diversion of water or pumping in order to permit the installation of the culvert in the dry. All trenches shall be kept free from water until any joint sealant material has hardened sufficiently not to be harmed.

If desired by the Engineer, the grade of the foundation shall be cambered by an amount sufficient to prevent the development of a sag in the flow line as the foundation soil settles under the weight of the embankment. In no case shall the camber be sufficient to produce an adverse grade after settlement has occurred.

714.11 Laying Pipe. Each section of pipe shall have a full firm bearing throughout its length, true to line and grade given. Any pipe which settles before final acceptance or which is not in alignment shall be taken up and re-laid by the Contractor without extra compensation. Pipe laying shall begin at the downstream end of the culvert with the bell or groove ends and outside laps upstream.

When concrete elliptical pipe with circular reinforcement or concrete circular pipe with elliptical or quadrant reinforcement is used, the pipe shall be installed in such a position that the manufacturer's marks designating the top or bottom of the pipe shall be not more than 5 degrees from the vertical plane through the longitudinal axis of the pipe.

Prior to being lowered into the trench, corrugated metal pipe sections shall be closely examined and so fitted that they will form a true line of pipe when in place. Sections that do not fit together properly shall not be used. Corrugated metal pipe shall be laid with the lap down stream.

Distorted circular metal pipes shall be placed with the major axis vertical. If rods, struts, or other means are used to maintain pipe distortion, they shall not be removed before the completion of the embankment unless otherwise permitted by the Engineer.

Before laying the pipe or during the pipe laying operations, adequate outfall ditches and inlets free of obstructions shall be constructed in order that proper drainage is provided.

When pipes are protected by endwalls or connect with drainage structures, the exposed ends shall be placed or cut off flush with the interior face of the structure. Where pipe culverts are constructed in conjunction with existing structures, satisfactory connections shall be made as directed by the Engineer.

714.12 Joints. All concrete pipe shall be laid with cement mortar joints or approved preformed flexible watertight gaskets. The mortar mixture shall be one part portland cement and two parts approved clean sand by volume. The quantity of water in the mixture shall be sufficient only to produce a stiff, workable mortar and shall not exceed 5 1/2 gallons of water per bag of cement. The pipe ends shall be thoroughly cleaned and wetted with water before the joint is made. Stiff mortar shall then be placed in the lower half of the bell or groove of the pipe section already laid.

Next, mortar shall be applied to the upper half of the spigot or tongue of the pipe section being laid. Then the spigot end of the pipe section shall be inserted in the groove end of the pipe section already laid, the joint pulled up tight so that the joint shall be pressed full. Care shall be taken to see that the inner surfaces of the abutting pipe sections are flush and even. After the section is laid, the inner circumference of the joints shall be sealed and packed with mortar and finished smooth and flush with the adjacent section of pipe. Additional mortar shall be applied from the outside and forced into the unfilled portion of the bell or groove to fill completely the annular space around the spigot or tongue. Mortar joints shall be made with an excess of mortar to form a bead around the outside of the conduit. Pipes more than 36 inches in diameter shall have beads of not less than 4 inches wide nor less than 2 inches thick. The completed joints shall be protected against rapid drying by suitable covering material. The backfilling operation shall be performed in such manner as not to

disturb the mortared joints. After placement of the earth fill, any joints found not filled with mortar due to settlement, or other reasons shall be finished smooth and even with the inside surface of the pipe.

Instead of the mortar mix type joints, the Contractor, at his option, may seal the culvert joints using flexible soil-tight gaskets conforming to the requirements of **AASHTO M 198**. The gaskets shall be continuous in the joint and shall be of the minimum size to produce a soil-tight joint in the annular space of the culvert. The gasket diameter may be varied by the Engineer to require enough seal or to prevent waste of the gasket material. When the culvert is in place, the gasket seal should be visible on the inside or the outside (not necessarily both) depending on where it was placed before the culvert joints were jointed. When seal is observed to be squeezing out of the inside or outside of the culvert joints in excess, special attention shall be given to the placing of the gasket on the section tongue to prevent this. In the event the seal is observed squeezing out on the inside and outside in excess, the gasket diameter may be reduced to prevent waste of seal material.

All culvert joints shall be forcefully pressed together to form a durable soil-tight joint. In all cases, the culvert joints shall be dry from all forms of moisture and free from dust and contaminates before the gasket is placed on the section tongue. The culvert trench shall be free from standing water and mud when section is being placed. Type A gaskets shall not be stretched more than 20% of the original circumference when seated on the spigot or tongue of the section. Type B gaskets may consist of one or more pieces and shall be used without stretching.

Corrugated high density polyethylene pipe joints may be the bell and spigot type that ensures a soil-tight joint. A bell may be manufactured either as part of the pipe on one end or separately from the pipe with materials as specified in **AASHTO M 294**. The bell, if manufactured separately from the pipe, shall be attached to the pipe when shipped. All

joints shall be provided with gaskets. Gaskets shall be preinstalled on the spigot end of the pipe or inside of the bell and covered with a removable wrap. Gaskets shall be manufactured in accordance with the requirements of ASTM F 477 and shall not have any visible cracking when tested according to ASTM D 1149. Split couplers are not approved for use.

At the Contractor's option, corrugated high density polyethylene pipe joints may be installed with reinforced mastic couplers that assure a soil-tight joint. The coupler shall consist of a band of cross laminated polyethylene with the underside coated with a rubberized mastic reinforced with a heavy woven polypropylene fabric. There shall be a peelable protective film against the exposed mastic that shall be removed when the coupler band is applied to the pipe joint. Three nylon straps, 1/2 inch wide and a minimum strength of 600 pounds each, shall be located within the mastic between the outer polyethylene layer and the reinforcing polypropylene layer. The straps shall be sheathed in tubes that isolate them from the mastic, thus allowing them to slip freely when tightened around the pipe joint. The width of the coupler band shall be determined by the pipe diameter and the spacing of the corrugations. The straps shall be spaced within the coupler to correspond to the spacing of the corrugations on the pipe. The length of the coupler band shall be the length of the outside circumference of the pipe joint plus a minimum 8 inch overlap.

When the pipe sections to be joined are butted end to end, the reinforced mastic coupler, with the protective film removed, shall be placed around the pipe, spanning the joint with the exposed mastic against the pipe. The center strap within the coupler and shall be aligned over the butted pipe ends while the two outside straps shall be aligned with the first corrugation groove on each side. The ends of the band shall be overlapped at the top of the pipe. The two outside straps shall be secured tightly around the joint with a proper tensioning tool and buckles. Only after the two outside straps are secure, the center strap shall be tightened and secured. The remaining flap, with the protective film removed, shall

cover the exposed strap and working area.

In addition to be used as an alternative to bell and spigot joints, reinforced mastic couplers may be used to join corrugated pipe with dissimilar corrugation configurations, or to join pipe of dissimilar materials.

Corrugated steel and aluminum pipe and ribbed aluminum pipe may be joined with coupling bands. The coupling band shall be fully corrugated of like material to match the same type of corrugation as the pipe that the band will join together. Pipe ends will not be re-rolled to form annular corrugations on helical pipe. Coupling bands shall conform to the requirements of **AASHTO M 196** excepted for the following: Coupling bands with projections (i.e. dimples) will not be permitted. Coupling bands shall have closed cell expanded rubber gaskets to insure a soil tight joint. The gaskets shall be 12 inches wide and approximately 3/8 inch thick. Rubber O-ring gaskets will not be allowed. Bolts for all size bands shall be 0.5 inch in diameter with nuts, and shall conform to the requirements of **ASTM A 307**.

The jointing of sections of other types of pipe shall be done in a workmanlike manner in accordance with the standard practice recommended by the pipe manufacturer.

714.13 Backfilling. The Contractor shall advise the Engineer of the time backfilling operations are expected to begin. If he is not properly advised, the Engineer may require the excavation and re-compaction of the backfill material.

The material for backfilling shall be soil that can be readily compacted. It shall not contain large stones, frozen lumps, chunks of highly plastic clay or any other material that is deemed unsuitable by the Engineer.

The backfill material shall be thoroughly compacted at the proper moisture content, in layers not exceeding 6 inches of compacted material. Compaction shall be performed by the use of mechanical tampers with the assistance of hand tamps

when necessary. Care shall be exercised to thoroughly compact the backfill under the haunches of the pipe and to insure that the backfill soil is in intimate contact with the side of the pipe. The backfill shall be brought up evenly on both sides of the pipe for its full length.

Backfill compaction may be supplemented by rolling or operating heavy equipment longitudinally parallel with the culvert, provided care is taken to avoid displacement or damage of the pipe.

In addition, compaction of backfill for the corrugated high density polyethylene pipe shall be a minimum of 95% of the **AASHTO T 99** maximum dry density. Care shall be given not to damage or misalign the pipe during the backfill operation.

714.14 Installing Pipe Culvert Under Existing Pavement. On projects where the original approach pavement structure is being retained, the pipe culvert shall be laid as herein specified. The portion of the pavement structure removed due to the excavation of the trench shall be repaired using the same type of materials used in the original construction. The Engineer may accept the use of other materials as he deems appropriate. The work shall be performed as directed by the Engineer. The cost of the materials and the labor involved shall be included in the unit bid price for the culvert pipe.

714.15 Removing Existing Pipe. Existing pipe shall be removed in accordance with the provisions of **Subsection 202.04**.

714.16 Cleaning Out Pipe. The entire length of new and relaid pipe culverts shall be thoroughly cleaned out. Retained pipe culverts shall be maintained in the same condition as existed before beginning work.

714.17 Placing Pipe Under Railroads and Other Transportation Facilities. When the plans include the installation of pipe under railroads or other transportation facilities not under the jurisdiction of the Department, the Contractor shall, unless otherwise provided, install the pipe using such methods and procedures required by the owner. There will be no extra payment for this change in methods and procedures. This requirement will not apply to the installation under roadways.

714.18 Method of Measurement. For concrete culvert pipe, the linear feet of pipe to be measured for payment shall be the net length of each size and class or thickness of culvert pipe complete in place and accepted. The net length shall be obtained by multiplying the nominal length of the pipe sections by the number of sections used. The maximum length of pipe approved for payment shall not exceed the length required if only 4 foot sections of pipe were used.

For all culvert pipe, except concrete, the quantity of pipe to be measured for payment shall be the actual number of linear feet of each size, class, thickness, or type of culvert pipe, complete in place and accepted.

Tees, wyes, elbows, bends, reducers, and increasers shall be measured by the unit for each size, kind, and class, thickness, or type of unit, complete in place and accepted. The length of each unit will not be included in the linear feet of culvert pipe when measured as provided herein.

The excavation of unyielding, unstable, or otherwise unsuitable material necessary to obtain a satisfactory foundation for pipe culverts as outlined in **Subsection 714.10,** shall be measured as provided in **Subsection 203.13**. The unstable material shall be disposed of in the manner as outlined in **Subsection 203.06**.

The excavation necessary for the removal of existing pipe

culverts that are not to be replaced by new culverts will be measured in cubic yards as set forth in **Subsection 202.06C**.

714.19 Basis of Payment. Culvert pipe, tees, wyes, bends, reducers, and increaser, measured as provided in **Subsection 714.18**, will be paid for at the contract unit price for the respective items, which price and payment shall be full compensation for furnishing, hauling and placing all pipe sections and materials, excavation and backfilling new or existing trench, removal of existing pipe to be replaced, constructing pipe joints, removal of old endwalls, cleaning out pipe, disposal of surplus materials and for all labor, equipment , tools and incidentals necessary to complete the work.

The excavation of unyielding or unstable material, measured as provided in Subsection 714.18, will be paid for at the contract unit price for Unclassified Excavation in accordance with **Subsection 203.15**.

The excavation, measured in accordance with **Subsection 714.18**, will be paid for at the contract unit price for Unclassified Excavation, which price and payment shall be full compensation for all work and costs of removal, transporting, and storing or disposing of existing pipe that is not to be replaced by a new structure.

Payment for each item will include all direct and indirect costs and expenses necessary to complete the work.

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
714XXXX	*(size) (kind)* Culvert Pipe *(class or thickness or type)*	Linear Foot
714XXXX	*(size) (kind)* Pipe Culvert Beveled End Section *(class or thickness)*	Each
714XXXX	*(size) (kind)* Pipe Culvert Flared End Section *(class or thickness)*	Each

Pay Items (Continued)

Item No.	Pay Item	Pay Unit
714XXXX	*(size) (kind)* Pipe Culvert Tee *(class or thickness or type)*	Each
714XXXX	*(size) (kind)* Pipe Culvert Wye *(class or thickness or type)*	Each
714XXXX	*(size) (kind)* Pipe Culvert *(degree)* Bend *(class or thickness)*	Each
714XXXX	*(size) (kind)* Reducer *(size)* to *(size)* Diameter *(class or thickness)*	Each
714XXXX	*(size) (kind)* Increaser *(size)* to *(size)* Diameter *(class or thickness)*	Each

SECTION 715

STRUCTURAL PLATE PIPE
STRUCTURAL PLATE PIPE-ARCH
AND
STRUCTURAL PLATE ARCH CULVERTS

715.01 Description. This work shall consist of furnishing galvanized corrugated steel structural plates or corrugated aluminum alloy structural plates, of the required shape, size and thickness; assembling such plates to form a pipe culvert, pipe-arch culvert or an arch culvert of the length, size and design indicated on the plans or specified; and installing these culverts to provide drainage structures at places designated on the plans or by the Engineer, in accordance with these specifications and to the lines and grades given.

MATERIALS

715.02 Plates, Nuts, and Bolts. Plates, nuts, and bolts shall conform to the requirements of **AASHTO M 167** or **AASHTO M 219**.

When so specified on the plans, structural plate pipe shall be vertically elongated in advance of placing backfill material. The elongation may be performed either at the fabricating shop or in the field. If the plates are fabricated to form the elongation in the shop, they shall be fabricated to provide an increase in the vertical diameter of the pipe, after assembly, of approximately 5% of the diameter. Plates shall be match-marked in order to assure that they will be placed in proper position during erection.

If pipe is elongated in the field, it shall be vertically elongated three percent by means of suitable jacks and timber strutted. The distortion may decrease uniformly to zero between the shoulder lines and the outer ends of the pipe.

715.03 Fabrication. Plates shall consist of structural units of galvanized, corrugated steel or corrugated aluminum alloy. Single plates shall be furnished in sizes to permit structural length increments of two feet.

Legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

CONSTRUCTION REQUIREMENTS

715.04 Trench and Bed for Pipe and Pipe-Arches. The trench and bed for pipe and pipe-arches shall be formed as provided in **Subsection 714.10**.

715.05 Arch Substructure and Endwalls. Arch foundation and endwalls, when required, shall be constructed according to details shown on the plans.

Each side of each arch shall be anchored to the foundation by either a galvanized angle or channel securely anchored or embedded in the substructure.

715.06 Assembling Metal Plates. Plates shall be assembled as directed by erection instructions to be furnished by the manufacturer of the material. After all bolts and nuts have been placed loosely, the nuts shall be thoroughly tightened to insure development of full joint strength. Bolts may be set, using drift pins or bars to line up the holes. Bolts shall be tightened with torque wrenches to at least 150 but not over 200 foot-pounds of torque. After all bolts have been tightened, each bolt shall be checked and tightened if found to be loose. The major axis of elongated circular structural plate pipes shall be placed vertically. Should spiraling occur, bolts shall be loosened and the pipe adjusted accordingly.

The means of holding a pipe in an elongated position shall not be removed before the completion of the embankment, unless otherwise permitted by the Engineer, but shall be moved prior to the construction of headwalls or other structures at the ends of pipe.

715.07 Backfilling Pipe, Pipe-Arches, and Arches. Suitable fill material shall be placed uniformly on both sides of the structure in accordance with the provisions of **Subsection 714.13**. Care shall be taken to avoid raising the structure above grade or forcing it off line when fill material is being placed and compacted. The necessary precautions shall be taken to avoid deflecting the flexible metal structure excessively during the backfilling and compacting operations.

715.08 Placing Structural Plate Pipe, Pipe-Arches, and Arch Culverts Under Railroad and Other Transportation Facilities. The provisions of **Subsection 714.17** shall apply.

715.09 Method of Measurement. The quantity measured for payment shall be the actual number of linear feet of each size, kind, and thickness of structural plate pipe, pipe-arches, or arches, complete in place, and accepted. The number of

linear feet shall be the average of the top and bottom lengths of pipes, the bottom centerline length for pipe-arches, or the average of the two side lengths, measured at the point of bearing, for arches.

Unstable material removed to obtain a stable foundation as provided in Subsection 714.10 shall be measured as specified in **Subsection 203.15**. The unstable material shall be disposed of in the manner as outlined in **Subsection 203.06**.

Reinforcing steel, concrete or masonry, and excavation for endwalls and foundations are not included in this item of work, and will be measured and paid for as provided under those items of work as applicable.

715.10 Basis of Payment. Structural plate pipe, pipe-arches, and arch culverts, measured as provided in **Subsection 715.09**, will be paid for at the contract unit price for the respective item, which price and payment shall constitute full compensation for removal of existing structures, for furnishing, hauling, erecting and installing the pipe, pipe-arches, or arches, and for all materials, labor, equipment, tools, and incidentals necessary to complete the items, but shall not constitute payment for concrete or masonry endwalls, and foundations or for excavation necessary for concrete or masonry foundations.

The excavation of unstable material, measured as provided in Subsection 715.09, will be paid for at the contract unit price per cubic yard for Unclassified Excavation in accordance with **Subsection 203.16**.

Payment for each item will include all direct and indirect costs and expenses necessary to complete the work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
7151XXX	*(size)* Steel Structural Plate Pipe *(thickness)*	Linear Foot
7152000	Steel Structural Plate Pipe-Arch	Linear Foot
7153000	Steel Structural Plate-Arch	Linear Foot
7154000	Corrugated Aluminum Alloy Structural Plate Pipe	Linear Foot
7155XXX	*(size)* Corr. Alum. Alloy Struc. Plate Pipe-Arch *(thickness)*	Linear Foot
7156000	Corrugated Alum. Alloy Structural Plate-Arch	Linear Foot

SECTION 716

SEWERS

716.01 Description. This work shall consist of furnishing sewer pipe of the kind, size, and dimensions indicated on the plans and installing them in conformity with the plans and these specifications, true to lines and grades given by the Engineer. This work shall include the furnishing and installing of necessary tee, wye, elbow and bend joints, and making connections to existing or new structures, including drilling and chipping, as may be necessary to complete the work.

MATERIALS

716.02 Reinforced Concrete Sewer Pipe. Reinforced concrete sewer pipe shall conform to the requirements of **Subsection 714.03** and shall be of the class indicated on the plans or in the special provisions.

716.03 Non-reinforced Concrete Sewer Pipe. Except for the aggregate and portland cement, non-reinforced concrete sewer pipe shall conform to the requirements of **AASHTO M 86** and shall be standard strength unless otherwise specified. The aggregate and portland cement shall meet the requirements specified in **Subsection 714.03**.

716.04 Vitrified Clay Sewer Pipe. Vitrified clay sewer pipe shall conform to the requirements of **AASHTO M 65**. The pipe shall be standard strength except when otherwise specified on the plans or in the special provisions.

716.05 Cast Iron Soil Pipe. Cast iron pipe and fittings shall conform to the requirements of **ASTM A 74**. Dimensions, weights, and markings shall conform to the requirements of **ANSI A 40.1**.

CONSTRUCTION REQUIREMENTS

716.06 Trench and Bed for Pipe. The trench and bed for the pipe shall be constructed as specified in **Subsection 714.10** and in accordance with the additional requirements as hereinafter provided.

The walls of the excavation shall be supported to meet OSHA standards. All existing improvements, either on public or private property, will be fully protected from damage that could result from sliding or settlement of the ground adjacent to the excavation.

716.07 Pipe Laying. When the new facilities interfere with the existing flow of sewage, the Contractor shall provide, unless otherwise specified, satisfactory bypass facilities without any additional compensation.

The pipe shall be installed without break in grade from structure to structure with the bell or groove ends upstream. When bell and spigot pipes are used, bell holes shall be dug in the pipe subgrade to accommodate the bells. The holes

shall be deep enough to insure that the bells do not bear on the bottom of the hole, but they shall not be excessively wide in the longitudinal direction of the sewer. When the pipes are installed, the barrel of each pipe shall be in contact with the quadrant shaped bedding throughout its full length exclusive of the bell. Whenever the work ceases for any reason, the end of the pipe shall be securely closed with a tight fitting plug or cover.

When pipe connects with structures, the exposed ends shall be placed or cut off flush with the interior face of the structure. Satisfactory connections shall be made.

Any pipe that is not in good alignment, shows any undue settlement, or is damaged shall be taken up and re-installed without any additional compensation.

716.08 Joints. The joints of asbestos cement and cast iron soil pipe shall be sealed with materials recommended by the pipe manufacturer and approved by the Engineer. The joint shall be constructed in such manner that a watertight joint will result. The method of connection shall be approved by the Engineer.

Unless otherwise directed by the Engineer, the joints of concrete or clay pipe shall be made with rubber gaskets and/or other materials recommended by the pipe manufacturer and approved by the Engineer. When the rubber gasket method is used, the gasket shall be a continuous rubber ring that fits snugly in the annular space between the beveled surface of the tongue and the groove ends of the pipes to form a flexible watertight seal under all conditions of service. The gaskets shall have smooth surfaces free from all imperfections.

716.09 Backfilling. Backfilling shall conform to the provisions specified in **Subsection 714.13**.

716.10 Placing Sewer Under Railroads and Other Transportation Facilities. The provisions of **Subsection 714.17**

shall apply.

716.11 Method of Measurement. The linear feet of sewer pipe measured for payment shall be the net length of each size and kind of sewer pipe, complete in place, and accepted. The net length shall be obtained by multiplying the nominal length of the pipe sections by the number of sections used. The maximum length of pipe sections approved for payment shall not exceed the total required if only 4-foot sections of pipe had been used.

The excavation of unyielding, unstable, or otherwise unsuitable material necessary to obtain a satisfactory foundation for pipe as outlined in **Subsection 714.10** shall be measured as provided in **Subsection 203.15**. The unusable excavated material shall be disposed of in the manner as outlined in **Subsection 203.12**. The measurement of excavation, except for unusable material as set forth above, will not be made.

716.12 Basis of Payment. Sewer pipe, measured as provided in Subsection 716.11 , will be paid for at the contract unit price for the respective items, which price and payment shall be full compensation for furnishing, hauling and placing all pipe sections and materials, excavation and backfilling new or existing trench, removal of existing pipe to be replaced, making pipe joints, connecting to new or existing structures, disposal of surplus materials and for all labor, equipment, tools and incidentals necessary to complete the work.

The excavation of unstable or unyielding material, measured as set forth in Subsection 716.11 , will be paid for at the contract unit price per cubic yard for Unclassified Excavation in accordance with **Subsection 203.16**.

Payment for each item will include all direct and indirect costs and expenses necessary to complete the work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
71610X0	*(dia.)*" Reinforced Concrete Sewer Pipe	Linear Foot
71620X0	*(dia.)*" Non-reinforced Concrete Sewer Pipe	Linear Foot
7163X00	*(dia.)*" Vitrified Clay Sewer Pipe	Linear Foot
7165X00	*(dia.)*" Cast Iron Soil Pipe	Linear Foot

SECTION 717

RE-LAID PIPE CULVERTS

717.01 Description. This work shall consist of removing, cleaning out and re-laying of existing pipe culverts, including the hauling and relaying of pipe culverts removed in accordance with the provisions of **Subsection 202.04**. Pipe shall be re-laid at such places as are designated on the plans or by the Engineer, in accordance with these specifications and to the lines and grades given by the Engineer.

CONSTRUCTION REQUIREMENTS

717.02 General. The existing pipe culverts shall be carefully removed and all work done in re-laying such culverts shall be performed in accordance with the requirements of **Section 714** for placing new pipe.

The Contractor shall exercise care and use the proper equipment to remove sewer pipe. Pipe that is damaged due to negligence or improper removal procedures shall be replaced with new pipe at the Contractor's expense.

Mortar or preformed gasket material shall be thoroughly removed from joints of pipe sections that are to be re-laid.

717.03 Method of Measurement. The quantities to be paid for shall be measured in accordance with **Subsection 714.18**.

717.04 Basis of Payment. The quantity of re-laid pipe culvert, measured as provided in Subsection 714.18 will be paid for at the contract unit price for the respective items, which price and payment shall be full compensation for excavating existing pipe, removing mortar or preformed flexible plastic gasket material from joints, removing headwalls, transporting, excavating, and backfilling new or existing trench, relaying pipe, constructing connections, cleaning out pipe, disposal of surplus materials and for furnishing all materials, equipment, tools, labor and incidentals necessary to satisfactorily complete the work.

The excavation of unyielding or unstable material, measured as provided in Subsection 714.18, will be paid for at the contract unit price per cubic yard for Unclassified Excavation in accordance with **Subsection 203.16**.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7170XX0	*(diameter)*" Re-Laid Pipe Culvert	Linear Foot

SECTION 718

BRICK MASONRY
RUBBLE MASONRY
AND
CONCRETE BLOCK MASONRY

718.01 Description. This work shall consist of brick, rubble or concrete block, whichever is specified, laid in full beds of masonry mortar and constructed in accordance with these specifications to conform to the plans and to the shapes, lines and grades set by the Engineer. This work shall include the placing of reinforcing steel when shown on the plans or specified in the special provisions.

MATERIALS

718.02 Clay or Shale Brick. Clay or shale brick used in the construction of manholes, catch basins and other drainage related structures shall conform to the requirements of **AASHTO M 91**, Grade MM. Clay or shale brick used in the construction of buildings, retaining walls, steps and other above the ground structures shall conform to the requirements of **AASHTO M 114**, Grade SW. Back-up brick for buildings above ground may be Grade MW.

718.03 Concrete Brick. Concrete brick and similar solid units shall conform to the requirements of ASTM C 55, Grade S-II.

718.04 Stone Rubble. Stone for rubble masonry shall be of an approved quality, sound, durable, and free from seams, cracks and other structural defects or imperfections tending to reduce its resistance to weathering. It shall be free from rounded, worn or weathered surfaces.

In general, stones shall have a thickness of not less than six inches, a width of not less than 1 1/2 times their thickness, and a length of not less than 1 1/2 times their width.

In walls 18 inches or less thick, the stone for headers shall be of sufficient length to extend entirely through the wall.

718.05 Concrete Block. Unless otherwise indicated on the plans or in the special provisions, concrete block shall be Grade A, Hollow Load-Bearing Concrete Masonry Units made from portland cement and suitable aggregates such as sand, gravel, crushed stone, bituminous or anthracite cinders, or blast-furnace slag and shall conform to the requirements of ASTM C 90.

718.06 Mortar Materials.

A. Portland Cement. Portland cement shall comply with the provisions set forth in **Subsection 701.02**.

B. Masonry Cement. Masonry cement shall conform to the requirements of **ASTM C 91** for the type necessary to make the type of **ASTM C 270** mortar specified.

C. Hydrated Lime. Hydrated lime shall conform to the requirements of **ASTM C 207**, Type S.

D. Aggregate. Aggregate shall be fine aggregate and shall conform to the requirements in **Subsection 701.10**.

718.07 Reinforcing Steel. Reinforcing Steel shall conform to the requirements of **AASHTO M 31**, Grade 60.

CONSTRUCTION REQUIREMENTS

718.08 Proportioning and Mixing Mortar. Mortar shall be prepared in accordance with the required **ASTM C 270** proportioning by blending the required materials to produce Type M, Type S, or Type N, as specified. Proportioning for each is shown as follows:

Proportions By Volume (Cementitious Materials)					
Mortar	Type	Portland Cement or Blended Cement	Masonry Cement	Hydrated Lime or Lime Putty	Aggregate Ratio (Measured in Damp Loose Conditions)
Cement-lime	M	1	---	1/4	Not less than 2 1/4 and not more than 3 times the sum of the separate volumes of cementitous materials
	S	1	---	1/4 to 1/2	
	N	1	---	1/4 to 1 1/4	
Masonry Cement	M	1	1		
	S	1/2	1	---	
	N	---	1	---	

The minimum 28 day strength of the mortar types shall be as follows:

Type M	2500 psi
Type S	1800 psi
Type N	750 psi

For general construction, the mortar shall be Type N or better. Mortar for use in constructing masonry retaining walls shall be Type S or Type M. Mortar for use in constructing masonry in contact with water shall be Type S or Type M.

The material shall be mixed dry in a mixer or in a clean tight box until a uniform mixture is produced. The appropriate amount of clean water shall be added and mixing shall be continued until the desired consistency is obtained. Mortar that is not used within sixty (60) minutes after water is added shall be discarded. Re-tempering of mortar will not be permitted.

718.09 Brickwork. Brick shall be laid to line in courses in full and close joints of mortar that shall not be less than 1/4 inch nor more than 1/2 inch thick. The thickness of the mortar joint shall be uniform throughout. All brick shall be pre-wetted and shall be moist when being laid. Adjoining courses shall break joints at 1/2 a brick as nearly as practicable. Courses shall be level except where otherwise necessary. At least one course in seven shall be composed entirely of headers. All joints shall

be finished properly as the work progresses and, on exposed faces, they shall be neatly struck. Broken or chipped brick will not be allowed in the face of the structure. In making closures, no piece of brick less than the width of a whole brick shall be used, and wherever practicable in making such closures, whole brick shall be laid with the long side at right angles to the face of the structure. The exposed surface of the masonry structure shall be thoroughly cleaned of mortar stains and pointed satisfactorily.

When Brick Masonry (Reinforced) is specified, care shall be taken to insure that the reinforcing steel is placed as specified in the plans.

718.10 Shaping Stone. All shaping and dressing of stone shall be done before the stone is laid, and no dressing or hammering that could loosen the stone already set shall be permitted.

718.11 Stonework. All stones shall be laid in full mortar beds and bonded firmly in all directions. Stratified stone shall be laid on their natural beds and not on their edges. The stones shall be laid to form good, substantial masonry of neat and finished appearance on the face. All spaces between the stones shall be flushed with mortar and then packed with spalls. Spalls will not be permitted in the beds. The joints on exposed faces shall be raked clear of loose mortar and pointed neatly with the mortar specified. The masonry shall be kept wet while the pointing is being done, and in hot or dry weather, the pointed masonry shall be protected from the sun and kept wet for a period of three (3) days after completion. Pointing will not be permitted in freezing weather and any work that is damaged by frost shall be removed and replaced.

718.12 Stonework for Walls. Foundations and bottom courses shall be composed of the larger stones, with the stones decreasing in thickness from the bottom to top of wall. At least one-quarter of the stone area of the face of the wall shall be headers, which shall extend for a distance of twice their thickness into the backing. For walls up to 18 inches

thick, the headers shall extend through the wall. The cross-section area of the header in the heart of the wall shall be approximately the same area as visible in the face of the wall. Selected stones, roughly squared and pitched to line, shall be used at all angles and ends of walls. All stones shall break joints at least four inches on the face of the wall, and no joints in the face shall be more than 2 inches thick.

Backing shall consist of large stone, well shaped and laid so as to break joints. Voids shall not be allowed in any part of the wall. The rear face of walls shall be an approximately plane surface. Walls should be provided with weep holes where called for on the plans or directed by the Engineer.

718.13 Blockwork. The provisions of **Subsection 718.09**, shall apply to laying concrete block.

718.14 Copings. Copings of the dimensions shown on the plans, or as directed, shall be placed on the tops of walls; and, unless otherwise specified, shall be constructed of Class 2500 or Class 3000 concrete complying with the requirements of **Section 701**. The coping may be cast-in-place or may be precast and shall be set in place on a full mortar bed.

The top surface of the coping shall be sloped to drain. Copings shall be constructed in sections not less than 6 feet and not more than 10 feet in length; and joints, except expansion joints, shall be completely filled with mortar.

718.15 Backfilling. The excavated areas that are not occupied by masonry shall be backfilled to the required elevation with suitable material, which shall be tamped in layers of not more than 6 inches of loose material until firm and solid.

718.16 Method of Measurement. The quantity measured for payment shall be the cubic yards of brick, rubble or concrete block masonry actually placed in the structure, completed and accepted.

Brick masonry used in manholes, catch basins, drop inlets and similar items will not be measured for payment. No separate payment will be made for masonry used in those items because they are measured and paid for per unit.

Copings constructed with brick, rubble or concrete block masonry will be measured as part of the masonry.

Excavations for masonry, except for catch basins, manholes, drop inlets and similar items, will be measured as prescribed in **Subsection 204.10C**

Reinforcing steel will not be measured for payment. The cost of the reinforcing steel shall be included in the bid price of Brick Masonry (Reinforced).

718.17 Basis of Payment. The quantity of brick masonry, rubble masonry or concrete block masonry, measured as provided above, will be paid for at the contract unit price for Brick Masonry, Brick Masonry (Reinforced), Rubble Masonry, Rubble Masonry Tree-Well, or Concrete Block Masonry, which price and payment shall be full compensation for furnishing all materials, equipment, tools, labor and work incidental thereto, including drainage openings, backfilling and disposing of surplus materials.

Excavation, measured as provided in **Subsection 718.16**, will be paid for as Unclassified Excavation as prescribed in **Subsection 203.16**.

Masonry used in constructing catch basins, drop inlets, manholes, spring boxes, junction boxes and similar items will be paid for in accordance with the provisions of **Section 719**.

Payment for each item will include all direct and indirect costs and expenses necessary to complete the work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
7181000	Brick Masonry	Cubic Yard
7182000	Brick Masonry (Reinforced)	Cubic Yard
7183000	Rubble Masonry	Cubic Yard
7183006	Rubble Masonry Tree-Well	Cubic Yard
7184000	Concrete Block Masonry	Cubic Yard

SECTION 719

CATCH BASINS
DROP INLETS
MANHOLES
JUNCTION BOXES
AND
SPRING BOXES

719.01 Description. This work shall consist of the construction or adjustment to grade of catch basins, drop inlets, manholes, junction boxes and spring boxes at the location shown on the plans or directed by the Engineer in accordance with these specifications and in conformity with the lines and grades shown on the plans or established by the Engineer.

MATERIALS

719.02 Portland Cement Concrete. Unless specified otherwise on the plans or in the special provisions, all cast-in-place concrete shall be Class 4000 concrete conforming to the requirements of **Section 701**.

719.03 Clay or Shale Brick. Clay or shale brick shall conform to the requirements of **Subsection 718.02**.

719.04 Concrete Brick. Concrete brick and similar solid units shall conform to the requirements of **Subsection 718.03**.

719.05 Mortar Materials. Mortar materials shall conform to the requirements of **Subsection 718.06**.

719.06 Castings. All iron castings for frames, grates, covers, etc., shall conform to the requirements of **AASHTO M 105**, Class 35B, and the alternate load test of **AASHTO M 306**.

Castings shall be cast in closed molds, be boldly filleted at angles. The arises shall be sharp and perfect. They shall be 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. The castings shall be clean and neatly finished. Gratings and covers shall fit firmly into their respective frames.

Steel grates and frame may be used instead of cast iron as long as the loading and hydraulic requirements are met and they conform to the following:

1. Steel grates and frame shall be hot dipped zinc coated in accordance with **AASHTO M 111**.

2. Steel grates and frame shall be dimensioned to be interchangeable with each piece of the cast iron grate and frame shown in the plans.

3. Steel grates and frames have sufficient strength to meet or exceed the loading requirements of Federal Specification RR-F-621 (latest edition).

The manufacturer shall have a testing program to verify that the castings comply with the strength requirements of

AASHTO M 105. Test bars shall be Type B and shall be made and tested in accordance with AASHTO M 105. Manufacturers desiring to be placed on the Department's list of approved sources should contact the Research and Materials Engineer for procedures.

719.07 Reinforcing Steel. Reinforcing steel shall conform to the requirements of **AASHTO M 31**, Grade 60.

719.08 Structural Steel. Structural steel shall conform to the requirements of **AASHTO M 270**, Grade 36.

719.09 Steel Tubular Section. Steel tubular sections shall conform to the requirements of **ASTM A 53**, Schedule 80.

719.10 Precast Reinforced Concrete Drainage Structures. Subject to the approval of the Engineer, the Contractor may substitute precast reinforced concrete drainage structures for constructed-in-place structures shown on the plans. If precast structures are specified on the project, or if the Contractor is allowed to substitute precast alternates, they shall conform to the details shown on the plans and the applicable provisions of this specification. Precast concrete drainage structures shall be designed for HS-25 loading. Concrete shall be Class 4000 portland cement concrete conforming to the requirements of **Section 701**. Reinforcing steel shall conform to AASHTO M 31, Grade 60. Wire Mesh shall conform to **AASHTO M 55** and **M 221**.

A. Precast Drainage Base. Drainage bases shall be manufactured to the sizes shown on the plans and in accordance with the requirements of **AASHTO M 199** as applicable. Drainage bases shall be manufactured with all required openings to accept all prescribed inlet and outlet pipes.

B. Precast Concrete Transition Section. A precast concrete transition section may be used to transition from a larger diameter riser to a smaller diameter riser. Transition sections may be either cone shaped or a flat slab as

specified on the plans. They shall be manufactured in accordance with the requirements of **AASHTO M 199**.

C. Precast Concrete Risers. Risers shall be manufactured to the diameters and lengths shown on the plans and in accordance with the requirements of AASHTO M 199. Risers shall be placed plum and backfilled in such a manner as to preserve their alignment.

D. Flat Slab Adapter. Flat slab adapters are required to change a round precast concrete risers to a rectangular openings to facilitate construction of the prescribed catch basins or drop inlets to grade. The flat slab adapters will be used as foundations for the necessary courses of brick. Flat slab adapters are not required for manholes. A flat slab top with an eccentric 24 inch diameter hole shall be used on top of the manhole riser when the casting is to be placed directly thereon and is shown on the plans. The distance from the top of the adapter to the top of the cover or casting shall not be more than 6 feet.

CONSTRUCTION REQUIREMENTS

719.11 Excavation. Excavation shall be made to the required depth and the material on which the masonry is to be constructed shall be compacted to a firm even surface. The excavation shall include the removal of all obstructions, and the removal and replacement of unstable materials as necessary for a proper foundation. Excavation will not be measured nor paid for as a separate item.

719.12 Brick Masonry. Brick masonry shall be constructed in accordance with **Section 718**.

719.13 Concrete Masonry. Concrete masonry shall be constructed in accordance with **Sections 701** and **702**. Reinforcing steel, if required, shall be placed in position as shown on the plans, and securely held in place.

719.14 Placing Pipe. Inlet and outlet pipes shall be incorporated into the structure at the elevation, direction, and grade required. These pipe connections shall be neatly and substantially held in the masonry. The inner ends of the pipe shall be placed flush with the inner faces of the walls, unless the Engineer directs otherwise.

719.15 Placing Castings. The castings shall be set in full mortar beds composed of one part portland cement to two parts of fine aggregate, meeting the requirements of **Subsections 718.06** and **718.08**.

719.16 Precast Concrete Drainage Structures. Precast concrete drainage structures shall be fabricated and installed in accordance with these standard specifications and applicable AASHTO specifications.

Components of precast concrete drainage structures must be supplied from a single source precast manufacturer. The manufacturer shall supply recommendations for all field connections of precast sections and piping.

The manufacturer shall inform the Engineer of his planned concrete placement and curing schedule in advance of the start of any fabrication work to afford time for the testing of materials, the inspection of equipment, and the review of the procedures that will be used in casting the units. The Engineer or his representative shall have free access to the fabrication plant at all times for the purpose of inspecting materials, plant facilities and fabrication and curing procedures.

Proper bedding for precast concrete drainage structures is required for proper installation and elimination of point bearing. Bedding shall be sand, gravel, or crushed stone and shall be included in the cost of the respective drainage item.

All joints shall be sealed with a butyl rubber joint sealant that meets the requirements of **Section 714** and AAHSTO M 198, Type B. The amount of sealant applied shall be in accordance with the manufacturer's recommenda-

tions, a copy of which shall be supplied to the Engineer by the Contractor.

719.17 Grade Adjustment of Existing Structure. When grade adjustment of existing structure is specified, the frames, covers, and gratings shall be removed and the walls reconstructed as required. The work shall be performed in such a manner as to use salvaged materials when practicable. The Contractor shall furnish new materials necessary to complete the adjustment.

Existing structures shall be adjusted 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.

In contracts where the pavement consists of an asphaltic mix or mixes, the casting shall, unless otherwise permitted or directed, be adjusted 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, the area shall be filled with concrete before placing the surface course.

719.18 Backfilling. The excavated areas that are not occupied by the structure shall be backfilled with suitable material that shall be placed and thoroughly compacted in layers of not more than six inches.

719.19 Method of Measurement. Catch basins, drop inlets, manholes, junction boxes, and spring boxes, both new and adjusted, complete in place and accepted, will be measured by the unit and shall include all frames, covers, gratings and fittings necessary to complete the unit.

When the depth of a catch basin, drop inlet, manhole, junction box, or spring box is greater than 6 feet, the quantity for the item Extra Depth of Box will be measured as the actual linear feet of depth in excess of 6 feet. The depth of the

drainage unit shall be measured from the top of manhole cover, concrete masonry, hood, or grate in the case of drop inlets, to the top of the bottom slab.

Precast drainage structures, complete in place and accepted, will be measured by each unit and shall include all frames, covers, gratings and fittings necessary to complete the unit. There will be no Extra Depth of Box measured for precast drainage structures. The lay length of a precast transition section shall not be included in the measurement for the precast concrete drainage structure to which it is connected.

719.20 Basis of Payment. The quantities, as measured in **Subsection 719.19**, will be paid at the contract unit price for Catch Basin, Drop Inlet, Manhole, Junction Box, or Spring Box, or the contract unit price for Adjusted Catch Basin, Drop Inlet, Manhole, Junction Box, Utility Box, or the respective precast concrete drainage structure, which price and payment shall be full compensation for furnishing all materials, equipment, tools, labor, and incidentals necessary to complete the work.

Partial payments will be allowed for Catch Basins (Types 15 16, 17, & 18) as follows:

Portion of Catch Basin Constructed	Percent of Bid Price Payable
Box only	40
Box and Bottom Concrete	70
Set Top	100

Extra Depth of Box, as measured in Subsection 719.19, will be paid for at the contract unit price for each foot of extra depth. Extra Depth of Box is not applicable to precast drainage structures.

Making connection with existing culverts or drains, 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 will not be paid for separately, but the cost thereof shall be included in the cost of the pay item that requires it.

Payment for each item will include all direct and indirect costs and expenses necessary to complete the work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
7191XX5	Catch Basin (type)	Each
7192XX0	Drop Inlet *(size)*	Each
7192105	Manhole	Each
71922XX	*(size)* Junction Box	Each
7192300	Spring Box	Each
71930XX	Precast Concrete Riser - *(size)*" Diameter	Linear Foot
71931XX	PC Drainage Base - *(size)*" Diameter	Each
719315X	PC Transition (Flat Slab) - *(size)*" to *(size)*"	Each
719317X	PC Transition (Cone) - *(size)*" to *(size)*"	Each
7196000	Extra Depth of Box	Linear Foot
7197110	Adjust Catch Basin	Each
7197120	Adjust Manhole	Each
7197130	Adjust Drop Inlet	Each
7197140	Adjust Utility Box	Each
7197150	Adjust Junction Box	Each

SECTION 720

CONCRETE CURB
CONCRETE GUTTER
CONCRETE CURB AND GUTTER
CONCRETE SIDEWALK
CONCRETE DRIVEWAY
AND
CONCRETE MEDIAN

720.01 Description. This work shall consists of the construction of portland cement concrete curb, portland cement concrete gutter, portland cement concrete curb and gutter, portland cement concrete sidewalk, portland cement concrete driveway, and portland cement concrete median in one course on a prepared subgrade in accordance with these specifications, and conforming to the dimensions, typical cross-section and notes shown on the plans, and to the lines and grades furnished by the Engineer.

This work shall include the placing of reinforcing steel in the concrete when so indicated on the plans.

MATERIALS

720.02 Portland Cement Concrete. All concrete shall be Class 2500 portland cement concrete and conform to the requirements of **Section 701**.

720.03 Expansion Joint Material. Expansion joint materials shall meet the requirements of **Subsection 702.03A**.

720.04 Reinforcing Steel. Reinforcing steel shall conform to the requirements of **AASHTO M 31**, Grade 60.

720.05 Subgrade. The subgrade shall be thoroughly compacted and finished to a smooth, firm surface, and shall be moist at the time the concrete is placed. In areas where it is impractical to use standard type rollers, compaction shall be accomplished by vibratory hand compactors. Any concrete that settles after placement shall be removed and replaced as directed by the Engineer without additional compensation to the Contractor.

720.06 Forms. Forms shall be of wood or metal and of a depth equal to the thickness of the concrete course. They shall be free from warp and shall be of sufficient strength when staked, to hold the alignment during the concrete placing and finishing operations. Before concrete is placed against them, forms shall be cleaned and oiled. Flexible or curved forms shall be used on curves as necessary in order to prevent a chord effect in the alignment of the finished work.

720.07 Existing Sidewalks and Driveways. Where a portion of an existing sidewalk or driveway is to be reconstructed, the existing section shall be cut to a minimum depth of two inches with a suitable saw at the location designated by the Engineer, and the entire section to be reconstructed shall be removed. The new sidewalk or driveway shall join the old work at this line.

720.08 Mixing and Placing Concrete. The concrete shall be batched and mixed in accordance with the provisions of Section 701.

Unless otherwise indicated on the plans, concrete curbs, concrete gutters, and concrete curb and gutters shall be constructed in uniform 10 foot sections, except where shorter sections are necessary for closures; but no section shall be less than 4 feet in length. The sections shall be separated by sheet steel templates or dividing plates set normal to the face and top of the curb. The plates shall be carefully set during

the placing of the concrete and allowed to remain in place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place.

Concrete shall be deposited in the forms in such manner that the forms will not be displaced out of grade or alignment. During the placing operations, the concrete shall be spaded or vibrated throughout the entire mass and especially against the forms and joints. The surface of the concrete shall be tamped, floated, troweled, broomed, corners edged and finished to the typical section, lines and grades as soon as practicable after the placing of the concrete. The forms shall be left in place until the concrete has set sufficiently that their removal will not injure the concrete.

720.09 Extruded or Slip-Formed Curb or Curb and Gutter Construction. Unless otherwise specified, concrete curb, except on structures, may be placed by an extrusion machine approved by the Engineer. An approved slip-form machine may be used to construct concrete curb or curb and gutter provided satisfactory results are obtained. When, in the opinion of the Engineer, satisfactory results are not being obtained, the extrusion or slip-form work shall be discontinued and the Contractor shall use the stationary form type of construction with no adjustment in compensation to the Contractor. Any unsatisfactory work shall be removed and replaced also without any additional compensation.

Expansion and weakened joints shall be constructed at the same locations as required when form construction is being used. Weakened joints, spaced at 10 foot intervals, shall be made by cutting the plastic concrete with a trowel or by other acceptable methods. The manner of construction of all joints shall meet the approval of the Engineer and shall present a workmanlike finish after edging.

720.10 Joints.

A. Expansion Joints. Preformed expansion joints shall

be 3/4 inch thick and extend the full depth of the concrete. They shall be constructed at the locations indicated on the plans and at other locations as follows:

1. Whenever a sidewalk is constructed between an adjoining substantial structure on one side and curbing on the other side, an expansion joint shall be formed adjacent to the curbing.

2. An expansion joint shall be placed between the sidewalk and the radius curbing at street intersections.

3. When concrete sidewalks or medians are constructed adjacent to existing or new concrete pavement or structures, transverse expansion joints shall be placed in the sidewalk or median opposite such joints in the concrete pavement or structure.

4. Where existing structures such as light standards, poles, fire hydrants, etc., are within the limits of the sidewalk or median area, they shall be surrounded with an expansion joint.

5. Transverse expansion joints shall be placed at intervals of not more than 100 feet in all concrete shapes.

B. Contraction Joints. The concrete slabs in sidewalks between expansion joints shall be divided into blocks 10 feet in length, by scoring transversely after floating operations are completed. Whenever the sidewalk slabs are more than 10 feet in width, they shall be scored longitudinally in the center. Transverse and longitudinal scoring shall extend for a depth of one inch and shall not be less than 1/4 inch nor more than 1/2 inch in width. They shall be edged and finished smooth and true to line.

In concrete medians, transverse contraction joints,

formed as described above, shall be located at intervals of not more than 25 feet and shall extend not less than one quarter of the depth of the median.

720.11 Final Finish.

A. Curbs and Curb and Gutters. As soon as the concrete has set sufficiently, the forms for the exposed surfaces shall be removed, and the concrete for the curb face and top shall be floated and troweled as necessary to provide a smooth uniform finish. Joint templates shall be left in place a sufficient length of time to prevent bonding or distortion at the joint.

After the surface of the gutter has been properly shaped and prepared and the water sheen has disappeared, the final finish shall be by brooming. Brooming shall be transverse to the line of traffic. All joints shall be in a vertical plane perpendicular to the curb face. Joints shall be clean and corners well rounded. All corners shall be edged to conform to the typical cross-section. Tool marks shall be eliminated.

B. Sidewalks, Gutters, Medians, and Driveways. The final finish for sidewalks, gutters, medians, and driveways shall be by brooming as outlined in Subsection 720.11 A above, unless otherwise directed. As soon as the forms are removed from concrete median, the sides shall be rubbed down to a smooth and uniform finish. Mortar or aggregate particles that spill onto the pavement shall be removed.

C. Repair of Defects. As soon as the forms are removed from all concrete shapes, honeycombed places and other minor defects shall be filled with a mortar composed of one part portland cement and two parts sand. Plastering will not be allowed. Sections will visible cracks shall be replaced at no expense to the Department.

720.12 Protection and Curing. The concrete shall be pro-

tected as specified in **Subsection 702.19** and cured with liquid membrane-forming compounds meeting the requirements of **Subsection 702.04**. Methods and rates of application of curing compounds shall be in accordance with **Subsection 702.20**.

720.13 Backfilling. After the concrete has set sufficiently and the forms removed, the spaces on both sides shall be backfilled to the required elevation with suitable material, which shall be firmly compacted and neatly graded. Concrete gutter shall be backfilled so that the earth materials are a minimum of one inch above the concrete. An earth roll on each side shall be maintained as necessary to prevent undermining of curb and gutter.

720.14 Method of Measurement. Concrete Curb, Concrete Gutter, and Concrete Curb and Gutter will be measured by the linear foot complete in place and accepted. The Concrete Curb and Gutter will be measured along the roadway face of the curb at the gutter line. The Concrete Curb and the Concrete Gutter will be measured along the roadway at the finished grade elevation. Concrete Sidewalk, Concrete Driveway and Concrete Median will be measured by the square yard of finished surface complete in place and accepted. Deduction for drainage structures such as catch basins, drop inlets, etc., shall be in accordance with the plans.

Excavation will be measured and paid for as provided in **Section 203**.

720.15 Basis of Payment. The quantity, measured as provided above, will be paid for at the contract unit price for the respective item, which price and payment shall be full compensation for all materials, labor, equipment and incidentals necessary to furnish and install the items including concrete, reinforcing steel, fine grading, compacting the subgrade, formwork, joint templates, joint materials, curing concrete, backfilling and all incidentals necessary to complete the work except excavation.

Payment for each item will include all direct and indirect costs and expenses necessary to complete the work.

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7201000	Concrete Curb (9" X 15")	Linear Foot
72020X0	Concrete Gutter *(type)*	Linear Foot
7203XX0	Concrete Curb and Gutter *(size)*	Linear Foot
7204100	Concrete Sidewalk (4" Uniform)	Square Yard
7205XX0	Concrete Driveway (*(thickness)*" Uniform)	Square Yard
7206000	Concrete Median	Square Yard

SECTION 721

BITUMINOUS CURB

721.01 Description. This work shall consist of placing a bituminous concrete curb conforming to the configuration shown on the plans on a prepared subgrade or other surface in accordance with these specifications and to the lines and grades furnished by the Engineer.

721.02 Materials. The materials shall conform to the requirements set forth in **Section 403**, *Hot Mix Asphalt Concrete Surface Course*. All requirements pertaining to the manufacture and hauling of the bituminous mixture specified in **Sections 401** and 403 shall apply.

CONSTRUCTION REQUIREMENTS

721.03 Equipment. Bituminous curb shall be constructed by use of a self-propelled automatic curb machine or a paver

with curbing attachments.

The automatic curb machine shall meet the following requirements and shall be approved prior to its use:

1. The automatic curb machine shall be so constructed and so operated to consolidate the mixture to produce a dense mass free of voids.

2. The machine shall form the curb true to line and grade and to a uniform shape and texture.

3. The Engineer 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 to be warranted. The resulting curb shall conform in all respects to the curb produced by the use of the machine.

721.04 Weather and Surface Temperature Restrictions. Bituminous curb shall not be constructed when the pavement or base is wet or frozen.

721.05 Preparation of Bed.

A. Subgrade. When the curb is to be placed directly on the subgrade, the subgrade shall be prepared in accordance with the requirements set forth in **Section 208**.

B. Existing Pavement or Base. When curb is to be placed on a portland cement concrete base, bituminous pavement or other bases, they shall be thoroughly swept and cleaned using compressed air and/or other cleaning methods as necessary to provide a clean surface. The surface shall be thoroughly dried and, when directed by the Engineer, a tack coat of bituminous material as set forth in **Subsection 401.28** shall be applied. During application, the Contractor shall prevent the spread of the tack coat to areas outside of the area occupied by the curb.

721.06 Backfilling. Backfilling, when required, shall be performed after the curb has reached ambient temperature and shall be performed promptly to afford support and protection. Backfilling shall be accomplished using such methods, equipment, and compaction to prevent damage to the curb and to obtain satisfactory results.

721.07 Painting and Sealing. When sealing or painting is required, it shall be performed only on a curb that is clean and dry and that has reached the ambient temperature.

721.08 Method of Measurement. Bituminous Curb will be measured by the linear foot along the front face of the section at the finished grade elevation. No deduction in length will be made for drainage structures installed in the curb such as intake spillway assemblies, catch basins, etc., unless otherwise noted on the plans.

721.09 Basis of Payment. The quantity, measured as provided above, will be paid for at the contract unit price for Bituminous Curb, which price and payment shall be full compensation for furnishing, mixing, hauling and placing all materials, including the asphalt cement in the mix, for fine grading and compacting the subgrade, for the tack coat, backfilling and all incidentals necessary to complete the work except excavation.

Excavation, when applicable, will be paid for as provided in **Section 203**.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
7211000	Bituminous Curb	Linear Foot

SECTION 722

PRECAST CONCRETE BOX CULVERTS

722.01 Description. This work shall consist of furnishing precast concrete box culverts of the size and dimensions indicated on the plans, installation in conformity with the plans and these specifications, and true to the line and grades established by the Engineer. This item shall include proper fabrication at the precast plant, finishing, marking and joining as required herein and any other incidental items necessary to complete the work.

MATERIALS

722.02 Precast Concrete Sections. Precast concrete sections shall conform to **AASHTO M 259** for depths of cover 2 feet and greater and to **AASHTO M 273** for depths of cover less than 2 feet with the exception of modifications as stated herein.

The sections shall be manufactured in accordance with the appropriate AASHTO designation based on the size (rise and span dimensions), loading (table designation) and earth cover as specified in the plans, and/or special provisions. At no extra cost to the Department and with prior written approval by the Engineer, box sections that exceed the minimum specified requirements may be substituted for the plan designated box sections.

722.03 Concrete. Concrete for the precast sections shall meet the requirements of **Section 701** and **714.03**, except that the aggregate gradation shall not apply. Concrete for components cast at the site shall meet the requirements of Section 701 for Class 4000 concrete.

722.04 Reinforcing Steel. Reinforcing steel shall conform to the requirements of **AASHTO M 31**, **M 32**, **M 55**, **M 221**, or **M 225** as applicable.

722.05 Joint Material. Joint seal material shall be flexible plastic gasket and shall conform to the requirements of **AASHTO M 198**, Type B.

722.06 Liquid Membrane-Forming Compounds. Liquid curing compounds shall conform to the requirements of **Subsection 702.04**.

FABRICATION

722.07 General. The precast concrete box sections may be precast by either the dry cast (machine) or wet cast method. The forms for both shall be steel and constructed so that they will be mortar-tight and of sufficient strength to prevent bulging and the misalignment of adjacent boxes when placed in the field. The forms shall also be so constructed as to permit their removal without damage to the concrete.

Offsets at form joints shall not exceed 1/8 inch. Forms shall be clean when concrete is placed and shall have a light coating of a bond-breaking material applied before concrete placement.

A maximum of four lifting holes, 2 inches in diameter or 2 inches square, shall be provided in each box. They may be formed-in-place, cut into the fresh concrete or cored from the hardened concrete.

The minimum length of the precast sections shall be 4 feet. Positive methods, acceptable to the Engineer, shall be used to support reinforcing steel and prevent displacement during the casting operation. Welding of reinforcing steel will be permitted only as shown on the plans.

Precast boxes shall be cast by a process that will provide for uniform placement of the concrete in the forms and com-

paction by mechanical devices that will assure dense well-compacted concrete. Concrete may be mixed in a central batch plant or other approved batching facilities.

Formed openings between the precast sections and any side entry of pipes or top entry of pipes or manholes shall be constructed and sealed to form a watertight joint. When pipe or manholes are to be placed directly on the top slab of the precast sections, the top slab shall receive additional steel reinforcement sufficient to compensate for the section removed.

722.08 Finishing and Marking. Finishing and marking of precast sections shall be in accordance with **AASHTO M 259** and **AASHTO M 273**.

722.09 Fabrication Tolerance. The precast sections shall meet the tolerance allowed in the applicable sections of AASHTO M 259 and AASHTO M 273.

The slab thickness and the tongue and groove joint configuration shall be cast to provide a continuous line of box sections with interior offsets at the joints less than one percent of the dimensions of the Rise and Span.

To insure the proper fit of contiguous sections, the perpendicularity tolerance of the boxes shall be checked by measuring the distance between opposite interior corners at the ends of the sections. The diagonal measurements shall not vary by more than 1/2 inch.

Deviations from the above tolerance will be acceptable if the sections can be fitted at the plant and it is determined that an acceptable joint can be made. A joint will be 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 3/4 inch.

Sections pre-fitted at the precast plant due to tolerance variations shall be match-marked when pre-fitted.

Small damaged or honeycombed areas that are purely cosmetic, may be repaired. Excessive damage, honeycomb or cracking will be subject to structural review. Repairs shall be made to the satisfaction of the Engineer and shall be sound, properly finished, and cured in accordance with Subsection 722.11 . When fine cracks or hairchecks on the surface indicate poor curing practices, further production of precast boxes shall be discontinued until corrections are made and proper curing is provided.

Precast boxes shall be stored on level blocking in a manner acceptable to the Engineer. No load shall be placed upon them until design strength is reached and curing completed. Shipment of boxes may be made when the design strength has been met and the boxes have been inspected and stamped by the Engineer.

722.10 Samples and Tests. Concrete compressive strength test cylinders shall be provided as stated in AASHTO M 259 and AASHTO M 273, except that when a wet cast method is used, a minimum of four test cylinders shall be provided for each day's production of each size and design of box. Strength tests for each production lot will be based on the average strength of two cylinders that may be tested anytime after the curing period. When design strength is attained on the initial test, further tests on that lot will not be required.

Should the initial test fail to meet the design strength, a subsequent test shall be made at 28 days unless additional cylinders were made for intermediate breaks. Low cylinder strengths may be checked by compression strength of cores. Obtaining cores for testing and repairing the core holes shall be done at no cost to the Department.

722.11 Curing. Precast concrete box culverts made in a precast plant shall be cured as stated in AASHTO M 259 or AASHTO M 273.

The boxes shall be protected from freezing during the curing period.

Test cylinders shall be cured at the same time and in the same manner as the boxes.

Concrete placed at the job site shall be cured during construction in accordance with **Subsection 702.20**.

CONSTRUCTION REQUIREMENTS (FIELD)

722.12 Bedding. Excavation for foundations for precast concrete box culverts shall conform to the requirements of **Section 204** and any details as shown on the plans. Special care shall be exercised in leveling the foundation area to insure uniform support throughout the entire width and length of the structure. Any shoring, bracing or other work necessary to achieve safe working conditions shall be performed by the Contractor without any additional compensation.

When a firm foundation is not encountered at the required grade, all such unstable material shall be removed and the resulting excavation backfilled with suitable material in accordance with **Subsection 203.10**.

722.13 Laying Sections. Sections shall be placed beginning at the outlet end of the conduit with the groove end being laid upgrade unless otherwise approved by the Engineer. Successive tongue ends shall extend fully into each adjoining groove. Positive means shall be provided to pull or push each section firmly into the previously placed section so that the joints are tightly meshed. Lift holes shall be repaired and filled with mortar or concrete and cured as directed after the sections have been installed.

722.14 Joints. Joints between the precast box sections shall be made using preformed flexible plastic gaskets. Mortar shall not be used. Installation shall be in accordance with the manufacturer's recommendation and as follows:

The gaskets shall be continuous in the joint and be of the minimum size to produce a watertight joint in the annular space of the joint. The gasket diameter may be varied by the Engineer to require enough seal or to prevent waste of the gasket material. When the culvert is in place, the gasket seal should be visible on the inside or the outside (not necessarily both) depending on where it was placed before the culvert joints were jointed. When excess seal is observed to be squeezing out of the inside or outside of the culvert joints, special attention shall be given to the placing of the gasket on the tongue to prevent this. In the event, excess seal is observed squeezing out on the inside and outside, the gasket diameter may be reduced to prevent waste of seal material.

All culvert joints shall be forcefully pressed together to form a durable watertight joint. In all cases, the culvert joints shall be dry from all forms of moisture and free from dust and contaminates before the gasket Is placed on the section tongue. The culvert trench shall be free from standing water and mud when a section is being placed. Type B gaskets may consist of one or more pieces and shall be used without stretching.

722.15 Backfilling. Backfilling materials and construction methods shall conform to the requirements of the plans and **Subsection 205.03**. When multiple barrel structures are specified, the placement of barrels and material used between them shall be in accordance with the plans.

722.16 Connections. Connections with other structures including headwalls, wingwalls, inlets, or manholes shall be in accordance with the plans.

When required, wingwalls, toe walls, parapet walls and aprons shall be cast-in-place reinforced concrete consisting of Class 4000 portland cement concrete and conform to the requirements of **Sections 701** and **702**. Reinforcing steel shall consist of **AASHTO M 31**, Grade 60 and conform to the requirements of **Section 703**.

If individual shear connectors are used to fasten adjacent top slabs together, design and installation shall be in accordance with **AASHTO M 273** and the plans.

722.17 Method of Measurement. Precast Concrete Box Culverts measured for payment shall be the number of linear feet, complete and accepted in place. The length shall be obtained by multiplying the nominal length of the box culvert sections by the number of sections used.

Structure excavation shall be measured for payment in accordance with **Subsection 204.10B** including measurement of unstable material removed as provided in **Subsection 203.10**.

The quantity of cast-in-place Class 4000 concrete used in wingwalls, toe walls, parapet walls and aprons shall be measured for payment as the number of cubic yards of Class 4000 concrete measured for payment in accordance with **Subsection 701.26**.

Reinforcing steel used in the cast-in-place portion of the culvert shall be measured for payment in accordance with **Subsection 703.11**. Reinforcing steel in the precast portion of the culvert will not be measured for payment, but will be included in the price of the precast culvert.

722.18 Basis of Payment. The accepted quantities of precast concrete box culverts of each size will be paid for at the contract unit price for Precast Concrete Box Culvert, which price and payment shall be full compensation for all materials, labor, equipment and incidentals necessary to furnish and install the sections, including joint materials and shear connectors.

Structure excavation will be paid for as specified in **Subsection 204.11** under Structure Excavation for Culverts.

The quantity of cast in place Class 4000 concrete will be paid for in accordance with **Subsection 701.27**.

The quantity of reinforcing steel other than that in precast box sections will be paid for in accordance with **Subsection 703.12** under Reinforcing Steel for Structures.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
722XXXX	*(size)* PC Box Culvert *(type)* Fill Height = *(fill height)*"	Linear Foot

SECTION 723

DECK JOINT STRIP SEAL

723.01 Description. This work shall consist of furnishing and installing expansion joints consisting of elastomeric strip seal gland with extruded steel anchoring elements on concrete bridge decks in accordance with these specifications and as shown on the plans.

The expansion joints shall be completely installed by the Contractor.

Joint manufacturer shall be pre-qualified with a five year proven history of successful product manufacture and have AISC Category I shop approval.

The deck joints shall be of sufficient strength to support, in all positions, a HS-25 highway truck loading and impact as defined in the **AASHTO Standard Specifications for High-**

way Bridges or alternate military loading of two axles four feet apart with each axle weighing 24,000 pounds, whichever produces greater stress, and shall accommodate the movements shown on the plans.

Before fabricating any joints, the Contractor shall submit shop drawings to the Engineer for review. The shop drawings shall meet the requirements of **Section 709.04** and include, but not be limited to the items listed in **Subsection 723.03**.

Prior to final acceptance of an expansion joint, the Contractor shall submit manufacturer certifications attesting that the entire expansion joint assembly including all accessories meet the requirements of the plans, specifications, and the reviewed shop drawings.

723.02 Materials. The joint shall consist of a continuous elastomeric strip seal gland with extruded steel anchoring elements.

The seal gland material for bridge deck joint shall be a vulcanized elastomeric compound using polymerized chloroprene as the only basic elastomer. The seal gland shall be installed in one continuous strip. Field splicing of the gland material will not be permitted.

The physical properties of the strip seal gland shall be in accordance with the following table and the manufacturer shall provide certified test results to the Engineer.

Physical Property	Requirements	ASTM Test Method
Tensile strength, min, psi	2000	D 412
Elongation @ break, min, %	250	D 412
Hardness, Type A durometer, points	55 ± 5	D 2240 (Modified)

Physical Property	Requirements	ASTM Test Method
Oven aging, 70h @ 212°F Tensile strength, max. % loss Elongation, max. % loss Hardness, Type A durometer, points change	 20 max. 20 max. 0 to +10	D 573
Oil Swell, ASTM Oil No. 3, 70h @ 212°F, Weight change, max., %	45	D 471
Ozone resistance, 20% strain, 300 pphm in air 70h @ 104°F	no cracks	D 1149 (Modified)
Low temperature stiffening, 7 days @ 14°F. Hardness, Type A durometer, points change	0 to +15	D 2240
Compression Set, 70h @ 212°F. max.	40%	D 395 Method B (Modified)

The steel anchoring elements shall be extruded in one piece from **AASHTO M 270**, Grade 50W Steel. The use of exposed aluminum will not be allowed. Pieces welded together in any manner to gain the final shape of the steel anchoring elements will not be allowed. The configuration shall have a minimum backwall thickness of 1/2 inch.

A lubricant/adhesive shall be used in bonding the seal to the steel elements. The lubricant/adhesive shall be a one-part moisture curing polyurethane and hydrocarbon solvent mixture meeting the requirements of ASTM D 4070-81.

Studs utilized in anchorage system shall meet the requirements of **Subsection 709.23**. Straps used for erection purposes shall be AASHTO M 270, Grade 36.

CONSTRUCTION REQUIREMENTS

723.03 Shop Plans. The Contractor shall provide shop plans for review and approval of the joint proposed for use. Shop plan submittals shall be in accordance with **Section 725**. Specific items to be included in the shop plans submission are as follows:

1. 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.

2. 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 shall not be field spliced), fabrication of metal components at barriers, curbs and parapets.

The Department will assume no responsibility for the accuracy of the shop plans, nor will the Contractor be relieved thereby of any responsibility for conformity with the special provisions and the plans.

723.04 Installation. The joint shall conform to the finished grade of the bridge deck when installed. The elastomeric component shall be recessed sufficiently from the finished grade of the bridge deck under all combinations of motion and skew angle to prevent protrusion above the deck when the joint is closed. The effects of horizontal or vertical curvature or both horizontal and vertical curvature and skew angle shall be considered in properly sizing and installing the joint.

The gland component shall be mechanically locked into place. The joint shall be installed in such a manner that it will be watertight.

The Contractor shall not start any work or installing the first joint seal on the project until a trained factory representative is on the job site to provide direction and assistance throughout the installation work. The Contractor shall notify the joint manufacturer of the scheduled installation a minimum of two weeks in advance. The factory representative is required to be present for the installation of the first joint seal and succeeding joint seals until the Contractor becomes proficient in the work.

All surfaces of any joint cover plates and the exposed surfaces of the steel extrusions shall be cleaned in accordance with the requirements of SSPC-SP10 as specified in the **Subsection 710.10**. All surfaces of any joint cover plates and the exposed surfaces of the steel extrusions, except for the areas that will be in contact with the seal gland, shall be painted with an inorganic zinc primer in accordance with Subsection 710.10. Anchor studs or straps need not be painted.

723.05 Method of Measurement. Measurement of expansion joint length will be taken along the centerline of joint from gutterline to gutterline. Payment for the measured length will be full compensation for any additional detailed extension required to terminate the joint at the face of parapet, curb or sidewalk parapet.

723.06 Basis of Payment. Payment for strip seal deck joints will be made at the contract unit price for the item Deck Joint Strip Seal, which price and payment will include the cost of furnishing and installing the strip seal system and all labor, materials including structural steel components, welded studs and straps, cleaning and painting of steel components, elastomeric gland, hardware, tools, equipment, furnishing manufacturer's technical representative, furnishing shop plans, and all incidentals necessary to complete the work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
7232310	Deck Joint Strip Seal	Linear Foot

SECTION 724

ELASTOMERIC BEARINGS

724.01 Description. This work shall consist of furnishing and installing elastomeric bearings, either "plain" (consisting of elastomer only) or "laminated" (consisting of alternating individual layers of elastomer and internal steel laminates) as shown on plans.

Elastomeric bearings may be fabricated by any manufacturer that is able to comply with the specification requirements. Pre-qualification test samples, certifications, and elastomer formulation shall be submitted to the SCDOT Research and Materials Engineer for approval prior to its first use on Department projects. The materials shall be submitted well in advance of anticipated use and contain certified test results showing the actual test values obtained when the physical properties of the elastomer to be furnished were tested for compliance with the pertinent specification requirement. Pre-qualification test samples shall consist of at least two bearings typical of the formulations and workmanship intended for use on Department projects. Sample size should be no larger than 11 inches x 17 inches.

The Department's inspection and acceptance of elastomeric bearing pads will be in accordance with the **SCDOT *Policy for Inspection and Acceptance of Elastomeric***

Bearing Pads latest edition. A list of previously qualified manufacturers may be obtained from the Research and Materials Engineer.

724.02 Materials. Materials shall consist of Polychloroprene (Neoprene) Grade 2 elastomer as shown in **AASHTO Bridge Specification, Division I, Table 14.6.5.2-2**, Temperature Zone B and for Low Temperature Brittleness. In accordance with the **Bridge Specification** Division II, Section 18, Grade 2 material does not require a brittleness test. The physical properties of the cured elastomer shall comply with the requirements shown in Table I of **AASHTO M 251**. Reinforced pads shall be 50 or 60 Durometer Hardness as specifically designated on the plans.

724.03 Fabrication. The bearing pads shall be constructed in conformance with the AASHTO M 251 and in conformance with details shown in the plans, or the AASHTO Specification for Highway Bridges where referenced.

Pin grooves in laminated bearings shall be filled with a vulcanized neoprene or a silicone material capable of bonding and maintaining integrity with the pad.

Tolerance in dimensions of completed pads shall be as listed in Table 2 of AASHTO M 251 unless other tolerances are shown on the design drawings.

724.04 Acceptance Testing. Acceptance shall be based on either Level I or Level II testing. Level I testing is applied to all bearings and Level II shall, at the discretion of the Engineer, be applied to the more critical or unusual bearings. It shall also be used to resolve differences over acceptance of bearings under Level I.

A. Level I. Level I testing shall be performed as stated in Section 8 of AASHTO M 251 except that only 10% of the bearings are required to undergo the compressive test. Results of the compressive stress-strain curve shall be submitted for record.

B. **Level II**. All Level II testing shall be performed as specified in Section 8 of AASHTO M 251. Level II certification requires that all Level I conditions are satisfied except that individual conditions may be waived by the Engineer if Level II certification is used as an arbitration of disputes.

724.05 Certifications. The bearing manufacturer shall certify that all of the pre-qualification samples submitted are of the same elastomer formulation and of equivalent cure to that used in the finished products to be furnished on Department projects.

The producer may be required to perform the complete pre-qualification testing procedure again during later production should the Research and Materials Engineer feel such action appropriate based on performance of the pad in service.

After pre-qualification approval, the inspection, sampling, and testing of actual bearing production will be performed by the manufacturer with certified laboratory test results of the following:

1. Elastomer properties on each batch or lot of elastomer used in the manufacture of the bearings, as contained in Table 1 of AASHTO M 251.

2. One Bond Strength test per lot of reinforced bearings.

3. Compressive load results required by Level I testing which requires each bearing to be load tested at 150% of maximum design load.

724.06 Installation. All bearing surfaces under elastomer must be plane to within 0.062 inch and horizontal to within 0.01 radians in accordance with plans and special provisions. Elastomeric bearings shall bear directly on the concrete sur-

face.

Nuts for anchor bolts shall be tightened finger tight then back off 1/16 inch. The threads shall then be burred with a sharp pointed tool or peened.

When sole plates are attached to the beam flange they are to be placed so as 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 1/4 inch.

Caution shall be exercised where a field weld or shop weld will be made while elastomeric bearing pad is in contact with metal. In no case shall the elastomer or elastomer bond be exposed to instantaneous temperatures greater than 400°F. Any damage to elastomeric bearing due to welding will be cause for rejection. Temperature shall be controlled by use of heat crayons furnished by the Contractor.

724.07 Method of Measurement. Elastomeric bearing shall be measured by each bearing pad which conforms to the size and dimensions specified on the plans, complete in place, and accepted by the Engineer.

724.08 Basis of Payment. All cost for furnishing and placing elastomeric bearings shall be included in the contract unit price for Elastomeric Bearing, which price and payment shall include all labor including welding sole plate, burring or peening anchor bolt threads and miscellaneous material necessary to complete the work.

Payment for the steel sole plate shall be included in the contract unit price for structural steel if structural steel beams are used, or in the contract unit price for prestressed concrete beams if prestressed beams are used.

Anchor bolts, washers, and nuts will not be included in this item, but will be paid for under the appropriate substructure item.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
7243100	Elastomeric Bearing	Each

SECTION 725

SHOP PLANS AND WORKING DRAWINGS FOR STRUCTURES

725.01 Description. The following policy shall be adhered to when submitting Shop Plans and Working Drawings for structures. Failure to follow this policy will delay processing of submittals. Any subsequence loss of construction time due to failure to follow this policy will not change the project's completion date.

725.02 Shop Plans. Shop plans are required for fabricated items that will remain a permanent part of structures. Shop plan submittals for projects designed in-house shall be forwarded to the following address:

South Carolina Department of Transportation
Bridge Design Engineer - Room 508
955 Park Street
Columbia, S.C. 29201

Shop plan submittals for projects designed for the Department by a Design Consultant shall be sent directly to the Consultant. The Contractor will be provided with the necessary mailing information at the Preconstruction Conference.

For submittals sent to the Bridge Design Engineer, a copy of the transmittal letter shall be sent to the Bridge Construction Engineer, and to the Engineer. For submittals sent directly to a Design Consultant, a copy of the transmittal letter shall also be sent to the Bridge Design Engineer, Bridge Construction Engineer, and the Engineer.

Shop plan submittals shall be clearly marked as containing "**SHOP PLANS**."

Shop plan submittals shall contain seven white print sets of drawings. Shop plans shall be on one of the following plan sizes:

Size A 22 inch x 36 inch (ISO A1 Metric size 841.0 mm x 594.0 mm is acceptable.), or

Size B 11 inch x 17 inch (ISO A3 Metric size 420.0 mm x 297.0 mm is acceptable).

The following items in the table below require shop plan submittals on the plan size A or B as indicated:

Item Requiring Submittal	Plan Size
Structural Steel Members	A
Structural Steel Parts of Expansion Joint	A
Structural Steel Parts of Bearings	A
Miscellaneous Steel Members except Piling and Sway Bracing	A
SIP Bridge Deck Forms	A
Prestressed Concrete Beam or Girder	A or B
Post-tensioned Concrete Beam or Girder	A
Prestressed Concrete Piling	B
Miscellaneous Prestressed and Post-tensioned Concrete Members	A or B
Other items as may be required as specified in the plans or in the special provisions	A or B

Shop plan shall bear the seal and signature of a South Carolina Registered Professional Engineer with the exception of the following items that are fabricated in accordance with details shown in plans.

1. Armor plates.

2. Prestressed concrete piling.

3. Bearing or sole plates, shims and booster plates.

4. Anchor bolt assemblies and tie rod assemblies.

Temporary FAX submittals will only be accepted when approved in advance by the Bridge Design Engineer and **MUST** be followed by submittal of the proper number and size of shop plans.

Fabricators shall electronically submit "as fabricated" drawings to the Bridge Design Engineer for the Department's project records. The "as fabricated" drawings shall be submitted for all required items, except for SIP Bridge Deck Forms.

725.03 Working Drawings and Design Calculations.
Working drawings and design calculations for prestressed beams, construction falsework or temporary structures shall be submitted to the Bridge Construction Engineer at the following address:

South Carolina Department of Transportation
Bridge Construction Engineer-Room 504
955 Park Street
Columbia, S.C. 29201

The Contractor shall submit to the Bridge Construction Engineer seven sets of working drawings and design calculations for review, a minimum of three weeks before erection or installation. The allowable stresses used for design, working loads, the load capacity of all support elements and the de-

sign specifications shall be stated on the drawings. Drawings shall be fully detailed, showing layout of elements, sizes, material specifications and manufacturer's recommendations for installation.

For submittals sent to the Bridge Construction Engineer, a copy of the transmittal letter shall be sent to the Engineer.

725.04 Measurement and Payment. This work will not be measured for payment. No separate payment will be made for compliance with this specification. All costs of the above work shall be considered incidental to the project and included in other items of work.

SECTION 726

BRIDGE DECK REHABILITATION

726.01 Description. This work shall consist of installing a low slump or latex modified portland cement concrete overlay over an existing portland cement concrete bridge deck. The work includes removing deteriorated concrete for the full or partial depth of the deck, preparing the area for the new concrete, placing, curing and finishing the overlay area.

MATERIALS

726.02 Overlay Materials. All overlay materials shall be approved prior to use. The moisture contents of the overlay aggregates, especially the fine aggregate, shall be controlled by the Contractor so that at the time of mixing, the moisture content of each aggregate is relatively uniform. The material shall feed uniformly when continuous type mixers are used; and the moisture contents of the aggregates are not so great that the water-cement ratio or slump requirement for the concrete mixture is violated. Any concrete produced that is not

properly proportioned or is not in conformity with the specified slump and/or water-cement ratio will be rejected by the Engineer, and shall be replaced with concrete meeting the requirements at no cost to the Department. When the water-cement ratio or slump requirements are violated, this condition shall be corrected by the Contractor at his expense before mixing operations are continued. The aggregates shall be stockpiled a minimum of 48 hours prior to placement of the overlay. The stockpiles shall be covered with white burlene or equivalent to assist in maintaining uniformity of temperature and moisture content.

A. Cement. The cement shall be portland cement conforming to the requirements of **Subsection 701.02**. The cement shall be stored in such a manner so as to prevent excessive temperature build-up that could be detrimental to the concrete mix.

B. Water. The water shall conform to the requirements of **Subsection 701.12**.

C. Fine Aggregates. The fine aggregate for the concrete mixture shall be a natural sand conforming to the requirements of **Subsection 701.10**. The Engineer will determine the moisture content of the sand in order to calculate its free water content and the resulting water-cement ratio of the concrete mixture.

D. Coarse Aggregate. Coarse aggregate for the concrete mixture shall be size no. 8M or 789 conforming to the requirements of **Subsection 701.11**. The Engineer will determine the moisture content of the coarse aggregate in order to calculate its free water content and the resulting water-cement ratio of the concrete mixture.

E. Air-Entraining Admixture. Air-entraining admixture shall conform to the requirements of **Subsection 701.06**.

F. Water-Reducing Admixture. The water-reducing admixture shall conform to the requirements of **Subsection 701.07**. The Contractor shall furnish to the Engineer a copy of the manufacturer's recommendations for use.

G. Epoxy Cement.

1. General Requirements. The epoxy cement shall be a moisture insensitive two component system meeting the requirements of **AASHTO M 235** (**ASTM C 881**), Type III. The two components shall be supplied in separate containers that are non-reactive with the materials contained therein. The containers shall be identified as "Component A - Contains Epoxy Resin" and "Component B - Contains Hardener" and shall show the type, mixing directions and usable temperature range. Each container shall be clearly marked with the name of the manufacturer, the lot or batch number, the date of packaging, the type of pigmentation, and the quantity contained therein in pounds and gallons. The epoxy shall be mixed and applied in accordance with the manufacturer's recommendations. Potential hazards shall be stated on the package in accordance with the Federal Hazardous Products Labeling Act.

2. Basis for Acceptance. The Contractor shall present to the Engineer a letter of certification from the manufacturer indicating that the epoxy cement complies with the product specifications.

3. Sampling and Testing. The Engineer may obtain separate unopened, one-quart samples of each component in each lot or shipment and forward them and the certification to the Research and Materials Laboratory. Failure of samples to conform to the applicable specification requirements shall be cause for the epoxy cement to be rejected and removed from the job site.

H. Sand for Epoxy-Sand Slurry Mixture. The fine aggregate for slurry mixtures shall be white silica sand containing no less than 90% insolubles and shall be rounded to subangular in shape, clean, dry, and nonfriable. The gradation shall be as follows:

Sieve	Percent Passing
No. 8	100
No. 50	0-40
No. 100	0-5

Material not meeting this gradation may be used, providing it produces a workable mixture and an acceptable slurry seal as approved by the Engineer.

I. Sand for Grout-Bond Coat. Sand used in the grout-bond coat shall be mortar sand conforming to the requirements of Subsection 701.10 with the exception that the graduation requirements shall not apply.

J. Latex. The Contractor shall select the latex admixture from the listing of acceptable products and their manufacturer on file at the Department's Research and Materials Laboratory. The latex admixture shall be a material that is produced in the United States.

Manufacturers desiring pre-qualification of their products shall have their product tested and evaluated by a qualified independent laboratory, in accordance with the Prequalification Test Program contained in the **U.S. Department of Transportation Research Report No. FHWA-RD-78-35**.

Certified test results from the independent laboratory and a one-quart sample of the latex admixture shall be submitted to the Department's Research and Materials Laboratory prior to the Contractor beginning work. Approval of the latex admixture will be based upon the sub-

mitted information and evaluation of the sample.

The latex admixture shall not contain any chlorides. Each shipment of latex admixture shall be accompanied by a report of tests performed in accordance with the Certification Program contained in Report No. FHWA-RD-78-35. In addition to actual test results, the report shall include the date of manufacture, batch or lot number(s), quantity represented, manufacturer's name, place of manufacture, a statement that all test results are satisfactory, and the date on which the 1-year certification period will expire.

Each lot of latex will be sampled and tested. A representative one-gallon sample shall be submitted by the manufacture. A material safety data sheet and a test report shall accompany the sample.

The latex admixture shall be packaged and stored in containers and storage facilities that will protect the material from freezing and from temperatures above 85°F. Additionally, the material shall not be stored in direct sunlight and shall be shaded when stored outside of building during moderate temperatures. No latex admixture that has been exposed to freezing or elevated temperatures (i.e. above 85°F) shall be used without approval from the Research and Materials Engineer.

If latex is used, the Contractor shall have the manufacturer of the latex material furnish a representative who will be available for technical assistance as needed during the placement of the latex overlay.

726.03 Concrete for Full Depth Patching. Concrete for full depth patching shall be Class 4000 concrete conforming to the requires of **Section 701**.

CONSTRUCTION REQUIREMENTS

726.04 General Requirements. These general requirements shall apply to both Latex Concrete Overlays and Portland Cement Concrete Overlays. For special requirements for overlays, see **Subsections 726.05** and **726.06**.

The sequence of operations shall be as follows: machine preparation of existing deck, removal of unsound concrete, rehabilitation of joints, full depth patching and blast-cleaning of the machine prepared deck, application of the grout bond coat, mixing, placing, and consolidating the concrete overlay mixture; finishing, texturing, curing, sealing joints and cracks, application of the epoxy-sand slurry, and sawing textured grooves if specified. When longitudinal construction joints are necessary, each section of overlay shall be cured in accordance with the requirements of **Subsections 726.05D** and **726.06E** before the adjacent overlay is placed.

A. Scheduling. The Contractor shall notify the Engineer at least twelve (12) hours in advance of the date and time he intends to begin placing concrete for the overlay. When placing of concrete is not begun within two (2) hours after the scheduled time, then all engineering costs from the scheduled time until the time placing actually begins or is canceled will be deducted from monies due or to become due the Contractor. No engineering costs will be deducted when placing is delayed for reasons beyond the control of the Contractor, such as inclement weather or equipment failure after placing begins. No time extensions will be granted for delay in placing concrete resulting from the Engineer receiving less than twelve (12) hours notice specified above.

B. Weather Limitations. The work on placing the concrete overlay shall be performed between the hours of 7:00 P.M. and 9:30 A.M. when the deck and weather conditions are such that the rate of evaporation does not exceed 0.2 pounds per square foot per hour for portland ce-

ment concrete overlay or 1.5 pounds per square foot per hour for latex concrete overlay. The "Nomograph For Determining Rate Of Evaporation" located in the Appendix of these specifications shall be used in determining the rate of evaporation. In no case shall the concrete overlay be placed when the air temperature is above 85°F or the air temperature away from artificial heat is less than 45°F. In all instances, all of the concrete shall be placed and kept at a temperature above 50°F for at least 96 hours. This will require approved housing and heating or insulation methods during cold weather. In no case will the concrete be placed when raining or drizzling. If during the process of placing the concrete it should begin to rain or drizzle, the placement shall be stopped and the material already in place shall be finished and protected.

C. Removal of Concrete, Restoration of Reinforcement, and Cleaning. The entire area of the deck between the parapets and the ends of the structure (i.e. 100% of the deck area) shall receive machine preparation consisting of removal of the concrete to a depth of at least 1/4 inch below the existing concrete surface. The Engineer may require removal of concrete to depths greater than 1/4 inch for designated portions of the deck in order to provide a uniform surface profile upon which to place the overlay. Unless authorized otherwise by the Engineer, the machine preparation of the deck shall be accomplished by alternate passes of the mechanical scarifiers. This operation shall be accomplished by use of mechanical scarifiers or grinders designed specifically for scarifying bridge decks and shall be subject to approval of the Engineer. The scarifier or grinder shall produce a surface matching the existing slab cross-section and each pass of the machine shall match the previous pass in elevation. If satisfactory results were not achieved, the Engineer may direct that the work be performed with other equipment. End walls will not require the machine preparation unless otherwise noted. No deductions in area will be made for existing deck drains, castings, expansion dams, patches of foreign material, etc. Epoxy, bituminous and foreign

surfaces, and patches shall be removed in a manner approved by the Engineer. Hammers exceeding 40 pounds in weight or any other equipment that may cause damage to the underlying concrete shall not be used. Generally, removal of epoxy, bituminous, and foreign surfaces (overlays) placed over the existing slab or surface profile will be listed as a separate bid item entitled *Removal of Epoxy, Bituminous, and Foreign Overlays* and will be paid for as a separate item. If, however, no bid item for the removal of these overlays is contained in the proposal, the removal shall considered as being incidental to the placement of the new concrete overlay.

All other concrete deemed unsound by the Engineer shall be removed. Removal of concrete within areas where the depth of removal exceeds 1/4 inch may be accomplished by use of hammers not exceeding 40 pounds in weight or other such small equipment approval by the Engineer. Caution shall be exercised by the Contractor not to damage any existing deck steel reinforcement. Concrete shall be removed to a depth of 3/4 inch below any reinforcement bar that is more than 1/2 exposed or any others that appear not to be bonded to the existing concrete. Caution shall be exercised to protect any underlying sound concrete and steel reinforcement. The periphery of routed areas shall be as nearly vertical. Should removal of unsound concrete extend through 1/2 of the depth of the concrete slab or more, the remaining sound concrete shall be removed and replaced as outlined herein for full depth patching. Any exposed steel reinforcement that is not tied shall be tied. Any rebar damaged by the Contractor shall be replaced at no expense to the Department.

Inferior concrete in the deteriorated or spalled areas near the joints shall be removed, and all joint filler removed. The joints shall be reformed to exact width specified and true alignment by the installation of a template made of styrofoam, or timber covered with polyethylene sheeting, or of other suitable material or as other-

wise specified in the plans. The removal of concrete within the area of the joint rehabilitation may be accomplished by use of jackhammers not exceeding 60 pounds in weight or other such small equipment down to the mid depth of the deck.

All exposed steel reinforcement and structural steel shall be blast cleaned to remove scale, rust, grease, oil, etc. Before placing concrete, deteriorated or damaged reinforcement shall be replaced or supplemented as directed by the Engineer. All dust, chips of bituminous materials, concrete, or other debris shall be disposed of in a manner approved by the Engineer. The entire area shall be cleaned with compressed air supplied by an air compressor having suitable separators and traps. The compressed air shall be free of detrimental quantities of water, oil, grease, or any other injurious substances. Leakage of oil, grease, gasoline, or other substances from the compressor(s) or other equipment on the deck shall be prohibited. Protective sheeting (plastic, tarpaulins, etc.) shall be suspended under any equipment that leaks.

Hydro-demolition instead of the above mechanical scarifiers and/or hammers may be allowed, subject to the approval of the Engineer, and compliance with all South Carolina and Federal Laws pertaining to air, water pollution, safety, and health regulations.

D. Blast Cleaning. The entire area of the deck surface shall be blast cleaned to a clean appearance that is free from curing compound, laitance, dust, dirt, oil, grease, bituminous material, paint, and foreign matter. The blast cleaning of an area of the deck shall be performed within the 24-hour period preceding placement of the overlay on the area. However, if any portion of the bridge is open to traffic, the area to be overlaid shall be blast cleaned within 12 hours before placing the overlay.

Blast cleaning may be performed by either wet sandblasting, high pressure water blasting, blasting grits,

shrouded dry sandblasting, dry sandblasting with dust collectors or other methods approved by the Engineer. The method used shall be performed to conform to air and water pollution regulations applicable to the county or city where the work site is located and to any state (**DHEC**) and federal (**EPA**) regulations. Work shall conform to applicable safety and health regulations (**OSHA**). Any method that does not consistently provide satisfactory results and does not conform to the above requirements shall be discontinued immediately and replaced by an acceptable method. All debris, including dirty water, resulting from the blast cleaning operation shall be reasonably confined during the performance of the blast cleaning work and shall be immediately and thoroughly removed from the blast cleaned surfaces and all other area where any escaped debris may have accumulated.

Water or other approved materials shall be applied by the Contractor to effectively prevent dust from becoming an air pollutant, safety hazard, or other type of nuisance during the blast cleaning operation. Failure to perform this item of work satisfactorily will be cause for deferring the processing of any pay estimates due the Contractor for the project.

When water or other material is used for control dust, no separate payment will be made as all costs for furnishing and applying the materials will be considered incidental to the pay items in the contract.

The blast-cleaned areas shall be protected, as necessary, against contamination before placement of the overlay. Contaminated areas and areas exposed more than 24 hours (12 hours when under traffic) shall be blast cleaned again as directed by the Engineer at the Contractor's expense.

E. Full Depth Patching. The area of removal of the concrete to full depth shall extend from center of girder to center of girder. In the event that the full depth holes are

small (less than 6 square feet) the Engineer will consult with a representative of the Bridge Construction Engineer's Office for the method in which they are to be repaired. Otherwise, full depth holes shall be filled with Class 4000 Concrete. Immediately before placement of concrete, the contact surface shall be dampened and surface dried, and a grout-bond coat shall then be applied by vigorously scrubbing or brushing it into the contact surfaces of full depth patch areas. The grout shall consist of a one-to-one (1:1) mixture by weight of Type I portland cement and mortar sand plus sufficient water to produce a slurry of uniform spreading consistency. The Class 4000 Concrete shall be carefully placed and tamped or vibrated into place. Full depth patched areas shall be rough finished to an elevation corresponding to the top of the scarified deck and shall be wet cured for a period of no less than seven (7) calendar days, or until the overlay is placed, by means of a double layer of wetted burlap or similar material. If the concrete surrounding a full depth concrete patch requires partial depth removal, then the full depth concrete patch shall be finished to an elevation corresponding to the bottom of the partial depth patch areas instead of the elevation of the original deck. After the concrete has hardened sufficiently to maintain the proper shape, all joint templates shall be removed in a manner to avoid chipping or breaking down the edges of the repaired joint. All forming material shall be removed prior to the completion of the project unless otherwise specified. The surfaces of all patched areas shall be blast cleaned to remove all laitance and all sand before the overlay is placed. All full depth patching in each lane shall be completed before beginning operations on another lane, unless otherwise permitted or directed.

The concrete overlay and Contractor's equipment will not be permitted on the full depth patches until the patches are at least seven (7) days old, or have developed a compressive strength of 3600 psi.

F. Partial Depth Patching. When a portland cement

concrete is used for the overlay, areas of partial depth patches shall be filled with overlay material to the level of the existing deck. These areas shall be cured until the overlay is placed over the patch or the cure time expires. When latex concrete is used for the overlay, partial depth patches may be placed monolithically with the overlay.

G. Prohibited Field Welding. Except as approved on the plans, no welding of any nature shall be performed on the load carrying members of the bridge without the written consent of the Engineer, and then only in the manner and at the locations designated.

H. Mixing and Placing. Concrete for concrete overlays shall be mixed at the work site by two-batch or two continuous mixers approved by the Engineer. Drum-type transit truck mixers or rotating drum batch-type mixers shall not be used in any circumstance for portland cement concrete overlays. All batch mixers shall be equipped with rotating blades or paddles. The maximum time between completion of mixing and placement shall be 20 minutes.

Batch-type mixers shall be equipped with or accompanied by suitable devices for accurately measuring the weight of the cement, fine aggregate, and coarse aggregate for each batch. They shall also be able to accurately determining the volume or the weight of the water, the water reducing and air entraining admixtures, and latex admixture, as applicable, for each batch. Approved methods for adding the air-entraining admixture and the water reducing admixture shall be provided. The admixtures shall be kept separated, and shall be separately added to the mixture. Batch-type mixers that entrap unacceptable volumes of air in the mixture shall not be used.

Continuous type mixers shall be equipped so that the proportions of the latex admixture (when required), cement fine aggregate and coarse aggregate can be fixed by calibration of the mixer, and thereafter shall not be changed without approval by the Engineer. The latex ad-

mixture supply portion and the water supply portion of the mixer shall be equipped with a flow meter or other suitable device for calibrating the water supply, and a cumulative type water meter that can be read to the nearest 0.1 gallon or 1 pound. The latex and water meters shall be readily accessible, accurate to within ±1%, and easy to read. Approved methods for adding the air-entraining admixture and the water-reducing admixture shall be provided. The admixtures shall be added so as to be kept separated as far as is practicable. The continuous type mixer shall be calibrated in accordance with Department procedures before starting the work. It shall be re-calibrated thereafter at least once during each 50 cubic yards production if yield checks indicate re-calibration is necessary, and at any other time the Engineer deems necessary to ensure proper proportioning of the ingredients. Continuous type mixers that entrap unacceptable volumes of air in the mixture shall not be used.

The latex admixture supply lines and the water supply line shall be separate lines and shall be connected immediately before discharge into the hopper. Connected latex admixture and water lines discharging through a single valve will not be allowed even if check valves are incorporated in the supply lines.

The mixer, whether batch or continuous type shall be kept clean and free of partially dried or hardened materials at all times. All calibration valves shall be maintained as manufactured and all gauges and dials shall be accessible, clear, and legible. It shall consistently produce a uniform, thoroughly blended mixture within the specified air content and slump limits. Malfunctioning mixers shall be immediately repaired or replaced with acceptable units.

The formation of longitudinal joints and transverse construction joints shall be held to the minimum number necessary, and both types of joints shall be thoroughly blast cleaned and coated with grout-bond coat material before fresh concrete is placed against the hardened

sides of the joints. When longitudinal joints are necessary, they shall be formed by use of a longitudinal header secured to the deck. The longitudinal header thickness shall be 1/4 inch less than the overlay. Longitudinal joints shall be located along lane lines unless otherwise permitted. After removal of the header, the overlay shall be sawed longitudinally 3 inches or more inside the formed edge and the overlay outside the saw cut removed before the adjacent overlay is placed. The volume of the overlay removed will be deducted from the volume measured for payment. Alternate methods of constructing longitudinal joints may be used on latex concrete overlays if approved by the Engineer.

I. Placing and Finishing Equipment. Equipment shall include sufficient hand tools for placement of stiff, plastic Portland Cement Concrete or Latex Concrete and for working it down to approximately the correct elevation for striking off with a screed.

Supporting rails upon which the finishing machine travels shall be placed outside the area to be surfaced, and shall extend beyond each end of the bridge a sufficient distance to accommodate the finishing machine. Anchorage for the supporting rails shall be substantial enough to provide for rigid horizontal and vertical stability of the rails. Methods proposed for anchoring the supporting rails to the deck shall be submitted to the Engineer for approval before beginning the work.

The finishing machine shall be capable of forward and reverse motion under positive control. Provision shall be made for raising the screeds to clear the screeded surface for traveling in reverse.

Closely following the final pass of the screed, the surface shall be textured by use of a drag composed of two layers of wet burlap on a transverse screed or a Department approved broom on longitudinal screeds.

1. Portland Cement Concrete Overlays. The top surface of the overlay shall be uniform, smooth, and even textured after finishing by an approved finishing machine.

The finishing machine shall be equipped with a strike off to provide a uniform thickness of concrete in front of the screeds and with two oscillating screeds set accurately to the crown specified. The screeds of the finishing machine shall be metal.

The front oscillating screed shall be designed to thoroughly consolidate the concrete by vibration to the specified density for portland cement concrete. A sufficient number of identical vibrators shall be effectively installed on the screed so that at least one vibrator is provided for each 5 feet of screed length. The bottom face of this screed shall be at least 5 inches wide with a turned up or rounded leading edge to minimize tearing of the surface of the plastic concrete. Each screed shall have an effective weight of at least 75 pounds for each square yard of bottom face area. Each screed shall be provided with positive control of the vertical position, the angle of tilt and the slope of the crown. The final screed shall oscillate and finish without vibration.

Design of the finishing machine together with appurtenant equipment shall be such that positive machine screeding of the plastic concrete will be obtained within one inch of the face of the curbs or construction joint. The vibrating screed shall be of sufficient length to extend at least 6 inches beyond an intended longitudinal joint, and to extend at least 6 inches beyond the longitudinal edge of a previously placed section of overlay.

2. Latex Concrete Overlays. The top surface of the overlay shall be uniform, smooth, and even textured after finishing by an approved finishing machine. The la-

tex concrete shall be thoroughly consolidated by vibration during the finishing operations.

The finishing machine shall be equipped with a strike off to provide a uniform thickness of concrete in front of the screeds and with two oscillating rollers set accurately to the crown specified. The screeds of the finishing machine shall be metal.

Design of the finishing machine together with appurtenant equipment shall be such that positive machine screeding of the plastic concrete will be obtained.

The vibrating screed shall be of sufficient length to extend at least 6 inches beyond an intended longitudinal joint, and to extend at least 6 inches beyond the longitudinal edge of a previously placed section of overlay.

J. Epoxy-Sand Slurry. After the overlay has been completed and cured, a thin coat (approximately 1/16 inch) of an epoxy-sand slurry shall be applied to the 12 inches of the overlay adjacent to the curbs, concrete barrier walls or other vertical walls. Unless otherwise indicated on the plans, the epoxy-sand slurry mixture shall extend up the faces of the curbs and walls for 3 inches above the overlay. The areas to receive the epoxy-sand slurry shall be thoroughly blast cleaned to a clean, bright appearance and shall be thoroughly clean and dry before the slurry is applied. The deck must be dry when the epoxy-sand slurry is started, and the deck shall not have been subject to rain within 12 hours preceding the application of the slurry. Before applying the slurry, all joints in the area receiving the application shall be protected by placing strips of masking along the joints in a manner to exclude the slurry from the joints. Masking will also be required on the deck to ensure a straight line for applying the epoxy-sand slurry.

The epoxy-sand slurry mixture shall consist of:

1 gallon of Component A
1 gallon of Component B
2 gallons of dry, white, silica sand

The above quantities shall be considered as one standard batch for the purpose of measurement and payment. The Engineer may make minor adjustments in the quantity of sand, in order to produce a more workable mixture. The ingredient materials shall be thoroughly mixed from 3 to 5 minutes. The slurry shall then be spread as smoothly and uniformly as possible so as to completely fill the blast cleaned pitted areas, cracks and rough surfaces. The finished elevation of slurry shall be no more than 1/16 inch above the elevation of the deck. Silica sand shall be sprinkled very lightly over the slurry to prevent a slippery condition.

K. Cleaning and Sealing Joints. Joints shall be reworked as shown on the plans and in the special provisions.

L. Approach Roadway Sections. When the approach roadway sections at the bridge ends are indicated on the plans to receive an overlay, they shall be overlaid and finished dependent on the type of approach pavement present.

For rigid type (concrete) approaches, a latex or portland cement concrete overlay shall be placed as indicated on the plans. The existing concrete approach roadway shall be removed as necessary to maintain the minimum specification thickness of the overlay.

For non-rigid type (bituminous) approaches a bituminous overlay shall be used.

M. Material Hauling. The hauling of all materials for latex concrete or portland cement concrete overlays by

trucks with continuous mixers or any other types of trucks shall be performed with vehicles that do not exceed the regulation for either the legal axle weights or axle spacing contained in the appropriate sections of the most current publications of the ***South Carolina Laws Covering Size, Weight, Load and Truck Operations***. Before doing any overlay work on a structure, the Contractor shall furnish to the Engineer a certified statement listing the empty weight of each hauling vehicle, the axle weights when empty, axle weights when fully loaded, the gross weight of each vehicle when loaded with a specified number of cubic yards, and the spacing of the axles. This information will be used by the Engineer for limiting the quantity of materials permitted to be hauled by the Contractor. This limitation shall be based on the capacity and condition of the bridge after unsound concrete has been removed and prior to placement of the overlay. Under no circumstances will loads that exceed legal gross or axle gross or axle load limits be permitted.

N. Damage to Structures. The Contractor is responsible for any and all damage to the structure during construction until all the work is completed, even to the replacement of entire spans at his expense, should they fail as a result of this construction.

O. Unacceptable Work. The Department will determine the overlay thickness (any coring will be done in accordance with Department procedures). The Contractor shall fill any core holes in the overlay using concrete overlay materials, at no additional cost to the Department. Areas found to be deficient in thickness no more than 1/2 inch will be paid for as specified hereinafter. Areas found deficient by more than 1/2 inch shall be removed and replaced with concrete overlay of the specified thickness at no cost to the Department.

Any areas of the overlay displaying a significant number of cracks or are not intimately bonded to the underlying deck shall be removed and replaced with acceptable

concrete at the Contractor's expense. Small cracks that exist but are not significant enough to require removal of the overlay shall be thoroughly sealed using an low viscosity polymer sealant approved by the Engineer.

P. Compensation for Altered Quantities. As provided in **Subsections 104.02** and **109.03** the following unit price adjustment formulas have been established and will be used for determining adjusted unit prices for concrete overlay when an underrun of more than 25%, or an overrun of more than 25% occurs in the quantity of this item.

726.05 Special Requirements for Latex Concrete Overlays. In addition to the requirements in **Subsection 726.04**, the latex concrete overlay shall conform to the following:

A. Pre-wetting and Grout-Bond Coat. The blast cleaned areas to receive the overlay shall be thoroughly and continuously wetted with water at least one hour before placement of the overlay is to start. The areas shall be kept wet and cooled with the water until the overlay is placed. Any accumulations of water shall be dispersed and/or removed before applying the grout-bond coat. Immediately before placing the overlay mixture, a thin coating of the latex concrete mixture to be used for the overlay shall be thoroughly brushed and scrubbed onto the wetted surface as a grout-bond coat. Accumulations of coarser particles of the mixture that cannot be scrubbed into intimate contact with the surface will not be permitted.

The grout-bond coat shall be applied only for a short distance in advance of the placement of the overlay and shall not be allowed to show any signs of drying before being covered with the overlay.

B. Proportioning. The latex concrete shall be accurately proportioned as follows and shall contain no less than 7 bags of cement nor less than 24.5 gallons of latex admixture per cubic yard.

Mix Proportions for Latex Concrete Overlay	
Type I Portland Cement	94 pounds
Latex Admixture	3.5 gallons
Fine Aggregate	210 to 250 pounds*
Coarse Aggregate	140 to 180 pounds*
Water(including free moisture on the fine and coarse aggregates)	22 pounds max.**

Notes:

*The Research and Materials Engineer will design the mixture, and will determine the actual quantity of this ingredient to be used.

**The actual quantity of water to be used within this limit shall be determined by the Contractor and shall be subject to the approval of the Engineer.

The properties of the latex concrete shall be as follows when determined by the Department's current methods:

Property	Value
Slump (Slump shall be measured 4 to 5 minutes after discharged from the mixer)	4 to 6 inches
Air Content	No more than 6 1/2%
Water Cement Ratio (Considering all the non-solids in the Latex Admixture as part of the total water)	No more than 0.40
Expected Compressive Strength at 7 calendar days	3000 psi

Table (Continued)

Property	Value
Minimum Compressive strength at 28 calendar days	4000 psi
Maximum Mix Temperature	85°F

C. Placing, Consolidating, and Finishing Overlays. The latex concrete for the overlay shall be placed on the blast cleaned and pre-wetted deck immediately after the grout-bond coat has been applied. The finishing machine shall be passed over the existing deck before placing the overlay so that measurements can be made to ensure that the proper cross slope and thickness will be achieved.

D. Curing. Immediately following the finishing operation and as soon as the overlay will not be deformed by the added weight, the overlay shall be covered with a curing blanket that shall be left in place for at least 24 hours, and shall be re-wetted if any signs of drying appear.

After the 24 hour period has ended, curing blanket shall be removed, and the overlay shall be allowed to air cure for at least 72 hours.

After the curing of the overlay has been completed, the tops of all longitudinal and transverse construction joints shall be given a thorough coating of a Department approved low viscosity polymer sealant. The coating shall be at least 2 inches wide, and shall be neatly and uniformly applied. This coating is intended to seal any minute cracks that may have developed at these locations. Use of epoxy-sand slurry to seal construction joints instead of the low viscosity polymer sealant will not be permitted. The overlay may be opened to traffic as soon as all curing is completed and a compressive strength of 3000 psi has been obtained, all joints and cracks have been sealed as specified above, and the bridge deck grooved in accordance with these specifications.

726.06 Special Requirements for Portland Cement Concrete Overlays. In addition to the requirements of **Subsection 726.04**, the portland cement concrete overlay shall conform to the following:

A. Grout-bond Coat. After the concrete surface has been blast cleaned and accepted, and immediately before placing the concrete overlay mixture on the deck, a thin coating of bonding grout shall be vigorously scrubbed into the dry, clean surface areas. The surface areas shall not be wetted before applying the grout. When the bridge deck is exposed to rain before application of the grout, application shall be delayed until the bridge deck has dried sufficiently to proceed. The length of the delay will be determined by the Engineer, but a minimum drying time of 4 hours will be required. The grout shall consist of equal parts, by weight, of portland cement and mortar sand, mixed with sufficient water to form a wet slurry. The consistency of the grout shall be such that it can be applied with a stiff brush or broom in a thin, even coating which will not run or puddle in low spots. Care shall be exercised to ensure that all areas of the blast cleaned deck receive a thorough even coating of the grout and that no excess grout is permitted to collect in any areas. The grout shall be applied only for a short distance in advance of the placement of the overlay and shall not be allowed to show any signs of drying prior to being covered with the overlay. Any areas that show any signs of drying shall be thoroughly re-coated with fresh grout.

B. Proportioning the Overlay Mix. The concrete for the overlay shall be accurately proportioned to contain 8.75 bags of cement per cubic yard and no more than 35 gallons of water per cubic yard, including free moisture on the aggregates. The Contractor shall determine the amount of water to be added to the mixture to maintain the proper slump, except that the limit of 35 gallons per cubic yard shall not be exceeded. The expected compressive strength, at seven (7) calendar days shall be 3000 psi.

The minimum compressive strength at 28 calendar days shall be 4000 psi.

The amount of fine aggregate and coarse aggregate for the concrete will be determined by the Engineer on an approximately 1:1 proportion by volume and shall be incorporated into the concrete mixture as directed by the Engineer.

The water-reducing admixture shall be added to the concrete in accordance with the manufacturer's recommendations, or as otherwise approved in writing by the Engineer.

The Contractor shall determine the amount of air-entraining mixture to be added to the concrete mixture. The air content of the concrete as determined by the pressure meter shall be 4 1/2%. A tolerance of plus or minus 1 1/2% from the specified air content will be allowed in occasional samples.

The slump of the concrete determined by the SC-T-42 procedure shall be consistently maintained at 3/4 inch. Slump shall be measured 4 to 5 minutes after discharge from the mixer. A tolerance of plus or minus 1/4 inch will be permitted for occasional samples. Concrete with a slump of more than one inch shall not be used in any circumstances and shall be wasted at the Contractor's expense. Concrete with a slump less than 1/2 inch shall not be used unless the finishing machine can finish and consolidate the concrete in accordance with requirements specified herein. Slump requirements shall be met, both at the site of mixing and at the time of placing.

C. Placing, Consolidating and Finishing the Overlay.
The finishing machine shall be passed over the existing deck before placing the concrete overlay in order that measurements can be made to ensure that proper cross slope and thickness will be achieved. Promptly after the

grout-bond coat has been applied, the concrete shall be deposited on the deck, struck off and consolidated with the finishing machine.

Consolidation using hand-held vibrators may be required when placing the mixture around steel reinforcement or structural steel members.

The concrete shall first be struck off at 1/4 inch or more above the specified final thickness and then consolidated by vigorous mechanical vibration. The in-place density of the consolidated mixture will be determined by use of a nuclear gauge immediately following the screeding operation.

Areas of concrete of deficient density shall be immediately corrected by additional passes of the finishing machine. When any concrete cannot be consolidated to the specified density, it shall be removed and replaced with acceptable concrete at the Contractor's expense. Hand finishing of the consolidated concrete with a float may be required in order to produce a tight uniform surface.

The top surface of the consolidated and finished concrete overlay shall be smooth, uniform, and tight and the surface will be checked with a 10 foot straightedge and a profilograph.

D. Use of Nuclear Gauge In Determining Overlay Density. The in-place density of the consolidated portland cement concrete overlay mixture will be determined by use of a nuclear gauge immediately following the screeding operation.

All operations of the nuclear gauge shall be carried out by personnel certified in the use of a nuclear gauge.

The procedure for determining the density of an overlay provided in the instrument's instruction manual shall be followed along with appropriate nomographs or formulas

for the nuclear gauges used by the Department. These procedures call for taking reading of the existing concrete, and the overlay, and then calculating the density of the overlay based on a nomograph or appropriate formula.

The Contractor shall cooperate in preparing sections of the existing deck for density measurements to be obtained. Preparations may include cutting and removing steel reinforcing bars in the vicinity of the density determination area. Preparations may also include adequate leveling of rough areas after the milling operation to allow density determinations to be carried out.

The density of the overlay as determined by use of the nuclear gauge will be adjusted according to the hardened concrete density by use of a nomograph or appropriate formula as supplied by nuclear gauge manufacture/supplier.

This adjusted density shall equal or exceed the target density, where the target density shall be 100% of the maximum theoretical density calculated assuming an entrained air content of 4.5%. Areas of deficient density shall be immediately corrected by additional passes of the finishing machine. When any concrete cannot be consolidated to the specified density, it shall be removed and replaced with acceptable overlay material at the Contractor's expense. Hand finishing of the consolidated concrete with a float may be required to produce a tight uniform surface.

E. Curing. Curing of the overlay shall be initiated immediately after texturing. Curing shall be accomplished by use of a curing blanket that shall be continuously and thoroughly wetted by automatic fogging or sprinkling equipment for at least 96 hours after the curing is started. Improper curing will be a basis for rejection of the concrete and non-payment for the total cost of the rejected concrete. Curing compound will not be permitted on the overlay. After the curing of the overlay has been completed, the tops of all longitudinal and transverse construction

joints shall be given a thorough coating of an approved low viscosity polymer sealant approved by the Engineer. The coating shall be neatly and uniformly applied. This coating is intended to seal any minute cracks that may have developed at these locations. Use of epoxy-sand slurry to seal construction joints instead of a Department approved low viscosity polymer sealant will not be permitted. The overlay may be opened to traffic as soon as all curing is completed, a compressive strength of 3000 psi has been obtained, all cracks and joints have been sealed with a low viscosity polymer sealant, and the specified surface texture treatment has been applied.

726.07 Method of Measurement. The quantities to be paid for will be measured in units of completed and accepted work, as hereinafter specified. In computing quantities, all dimensions used shall be those measured by the Engineer.

A. Removal and Disposal of Existing Overlays. The epoxy, bituminous and foreign overlays removed as specified, complete, and accepted shall be measured in square yards. This item will not be measured when a bid item for the removal of the epoxy, bituminous and foreign overlays is not included in the contract, but will be considered incidental to the installation of the new overlay.

B. Machine Preparation of Existing Surface. The total deck area prepared as specified, complete, and accepted shall be measured in square yards.

C. Partial Depth Removal of Unsound Concrete. The area of removal of partial depth unsound concrete as specified, complete, and accepted shall be measured in square yards. The range of this partial depth removal shall be from the upper portion of the top layer of reinforcing steel to the mid-depth of the slab.

D. Concrete Class 4000 for Full-depth Patching. The quantity to be measured for payment under this item shall be the number of cubic yards necessary to complete the

work and shall be calculated from the dimensions of the areas patched, as measured by the Engineer.

E. Reinforcing Steel. Reinforcing Steel shall be measured in accordance with **Section 703.11**.

F. Blast Cleaning. The area of the deck blast cleaned complete and accepted, including the 12 inches adjacent to the curb and the 3 inches of the vertical face of the curb to receive the epoxy-sand slurry, shall be measured in square yards. The blast cleaning of any longitudinal and transverse construction joints will not be measured for payment.

G. Concrete Overlay (Latex). The volumes of latex concrete in the completed and accepted overlay shall be measured in cubic yards. In computing the volume for payment, the dimensions used shall be those shown on the plans or as ordered by the Engineer. The volume of patches cast monolithically with the overlay shall be included in this quantity and shall be based on measurements of the patched area taken by the Engineer. The volume of material wasted or not incorporated in the finished work shall not be included in the measured quantity. Grout used for the bond coat and crack sealing is considered incidental to the latex concrete overlay and shall not be measured for separate payment.

H. Concrete Overlay (Portland Cement). The volume of portland cement concrete in the completed and accepted overlay shall be measured in cubic yards. In computing the volume for payment, the dimensions used shall be those shown on the plans or as ordered by the Engineer. The volume of patches cast monolithically with the overlay shall be included in this quantity and shall be based on measurements of the patched area taken by the Engineer. The volume of material wasted or not incorporated in the finished work shall not be included in the measured quantity. Grout used for the bond coat and crack sealing is considered incidental to the concrete

overlay and shall not be measured for separate payment.

I. Epoxy-Sand Slurry. The accepted epoxy-sand slurry will be measured by the square feet of area covered by a 1/16 inch coating of the epoxy-sand slurry.

J. Repair or Rehabilitation of Expansion Joints and Bridge Ends. Unless stated otherwise in the special provisions, the rehabilitation or repair of expansion joints and bridge ends shall be considered incidental to the work of providing the overlay and shall not be measured for payment.

K. Dust Control. All drilling, grinding and sawing of rock, shale, concrete and other similar dust-producing materials shall be performed by equipment provided with water sprays, fabric filtered collection systems or other suitable devices to prevent excessive dust from becoming airborne. Dust control shall be considered incidental to the other items of work and shall not be measured for separate payment.

726.08 Basis Of Payment.

A. Removal and Disposal of Existing Overlays. The satisfactory removal and disposal of existing overlays will be paid for at the contract unit price for Removal of Epoxy, Bituminous, and Foreign Overlay which price and payment shall be full compensation for the complete removal and disposal of the overlay as specified, including all material, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

When a bid item for this work is not included in the bid proposal, satisfactory removal and disposal of existing overlays will be incidental to the overlay installation item.

B. Machine Preparation of Existing Surface. The deck area prepared as specified, complete and accepted, will be paid for at the contract unit price for Machine Preparation of Existing Deck, which price and payment shall be full compensation for all expenses associated with machine preparation operation, including all material, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

C. Partial Depth Removal of Unsound Concrete. The measured quantity of the areas of partial deck removal will be paid for at the contract unit price for Partial Depth Removal of Unsound Concrete, which price and payment shall be full compensation for all expenses associated with the satisfactory removal of all partial depth unsound concrete including all material, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

The estimated quantities shown in the proposal for Partial Depth Removal of Unsound Concrete is for bid purposes only. The actual amount of quantities will be determined in the field by the Engineer after completing the removal of unsound concrete. The unit price bid will be adjusted by the formula shown in **Subsection 726.04P**.

D. Concrete for Full-depth Patching. The measured volume of concrete used in full depth patches will be paid for at the contract unit price for Concrete, Class 4000 for Full Depth Patching, which price and payment shall be full compensation for all expenses including all materials, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

E. Reinforcing Steel. Reinforcing Steel will be paid for in accordance with **Section 703.12**.

F. Blast Cleaning. The measured areas of blast cleaning will be paid for at the contract unit price for Blast Cleaning, which price and payment shall be full compen-

sation for all expenses associated with the blast cleaning operation, including all material, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

G. Concrete Overlay, (Latex) or (Portland Cement).
The area of a latex concrete or portland cement concrete overlay meeting the specifications will be paid for at the contract unit price for Concrete Overlay (Latex) or Concrete Overlay (Portland Cement) as applicable, which price and payment shall be full compensation for furnishing, placing, finishing, curing, and texturing of the overlay, including all material, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

Areas of concrete overlay found to be deficient in the attaining the minimum required compressive strength (4000 psi) by no more than 1000 psi will be paid at an adjusted unit price determined as follows:

$$AP = \underline{CP \times (ACS / RCS)^2}$$

Where

AP = Adjusted Unit Price
CP = Contract Unit Price
ACS = Actual Compressive Strength
RCS = Required Compressive Strength

The adjusted unit price as determined above shall be used as the contract unit price for further price adjustments due to deficiencies.

Areas of concrete overlay found to be deficient in the attaining the minimum required compressive strength by more than 1000 psi shall not be eligible for payment and shall be removed at the Contractor's expense.

If the average thickness of the concrete overlay is deficient in the required thickness by no more than 1/2 inch, the overlay will be paid for at an adjusted unit price

determined by the following table:

Average Deficiency In Thickness (inches)	Adjusted Unit Price: Percent of Contract Unit Price
0	100.0
1/16	95.0
1/8	90.0
3/16	80.0
1/4	70.0
5/16	57.5
3/8	45.0
7/16	25.0
1/2	0.0

The adjusted unit price as determined above shall be used as the contract unit price for further price adjustments due to deficiencies.

In determining the average thickness, thickness greater than the required thickness will be entered as the required thickness, and thickness 1/2 inch less than the required thickness shall not be used, because those areas shall be removed by the Contractor at his expense. Areas of overlay that are monolithic with partial depth patches shall not be used in calculation of the average thickness.

At the Contractor's option, areas with a deficiency in compressive strength of less than 1000 psi or in average thickness of no more than 1/2 inch may be removed and replaced with concrete overlay conforming to the specifications at no cost to the Department. Payment at the contract unit price will be made for areas where the deficient overlay was removed and replaced with overlay meeting all requirements specified herein.

No additional payment will be made for concrete overlay in excess of the specified thickness except as required to fill areas where partial depth removal of unsound concrete has been performed.

When it is determined by analysis that the proportion of latex in the overlay mix when discharged from the mixer is less than the specified amount, payment for the batch will be made at an adjusted unit price determined by the following formula:

$$AP = CP \times \frac{(100 - 2 \times LD)}{100}$$

Where

AP = Final Adjusted Price
CP = Contract Unit Price
LD = Latex Deficiency (percentage)

If the proportion of latex in the overlay mix when discharged from the mixer is less than the specified amount by more than 20%, the batch shall be rejected for use. These provisions for a reduction in the unit price shall apply regardless of the readings of gauges or monitoring devices on the supply lines. No adjustment in the unit price will be made for latex in excess of the minimum specified.

Payment for the accepted quantity at the contract unit price, adjusted as required, shall be full compensation for all materials, equipment, labor and incidentals necessary to construct an acceptably textured concrete overlay on the prepared bridge deck.

H. Epoxy-Sand Slurry. The quantity of epoxy-sand slurry measured will be paid for at the contract unit price for Epoxy-Sand Slurry, which price and payment shall be full compensation for furnishing all materials, equipment, labor, tools and incidentals necessary to satisfactorily complete the work.

Payment will be made under:

Item No.	Pay Item	Pay Unit
7260100	Removal of Epoxy, Bituminous and	Square Yard

	Foreign Overlay	

Pay Items (Continued)

Item No.	Pay Item	Pay Unit
7260200	Machine Preparation of Existing Surface	Square Yard
7260300	Blast Cleaning	Square Yard
7260400	Partial Depth Removal of Unsound Concrete	Square Yard
7260500	Concrete Overlay (Latex)	Cubic Yard
7260600	Concrete Overlay (Portland Cement)	Cubic Yard
7260700	Epoxy-Sand Slurry	Square Foot
7260800	Concrete Class 4000 for Full Depth Deck Patching	Cubic Yard

DIVISION 800

INCIDENTAL CONSTRUCTION

SECTION 801

AGGREGATE UNDERDRAINS

801.01 Description. This work shall consist of excavating a trench and backfilling using granular filter materials constructed at such locations indicated on the plans or designated by the Engineer, in accordance with these specifications and conforming to the lines and grades given.

MATERIALS

801.02 Coarse Aggregate. The coarse aggregate backfill material shall consist of crushed stone, gravel, slag, recycled glass aggregate, or tire chips, and shall meet the requirements of Aggregate No. 789, except that the slag and the recycled glass aggregate shall not have more than 60% abrasion loss when tested according to **AASHTO T 96**. Tire chips are not required to be tested for abrasion loss. Only aggregate obtained from Department approved sources shall be used.

Recycled glass shall be free of organic and toxic materials, hypodermic needles and any hazardous materials, and must meet **South Carolina DHEC** regulations as a non-hazardous material. The impurities (non-glassy materials) in the accepted quantities of recycled glass aggregate shall not exceed 1% by dry weight of the glass aggregate. The lead content for the glass aggregate shall not exceed 5 ppm and the silver content shall not exceed 5 ppm. The aggregate shall also meet the limits established by the **EPA** for primary and secondary drinking water standards. The glass supplier, prior to any glass being placed on projects, shall furnish the Department with certified test results showing that the glass

meets the requirements listed above. These test results shall be no more than one year old at the time they are furnished to the Department.

Tire chips shall be dry, clean, and free of grease, oil, or any other contaminant that could leach into groundwater or aid in starting a fire. The chips shall be free from wood fragments, wood chips, fibrous organic matter, or residue of previously burned tires. The tire chips must have at least one sidewall detached and shall be generated from whole tires shredded using shear shredding equipment. The Hammermill process is not acceptable. The tire subgrade material shall have no more than 1% by weight of free steel (metal fragments not attached to rubber) in its composition. Metal that is partially embedded in the tire rubber shall extend no more than 1 inch from the cut edge of any chip on 75% of the pieces and no more than 2 inches on 100% of the pieces.

801.03 Fine Aggregate. The fine aggregate specified in the bid item for underdrain material, shall be porous and shall be free of clay lumps, humus, or other objectionable material, and shall meet the following gradation requirements:

Sieve Designation	Percentage by Weight Passing	
	Aggregate No. FA-12	Aggregate No. FA-13
3/8 inch	100	100
No. 4	90 - 100	90 - 100
No. 16	50 - 86	40 - 80
No. 50	2 - 20	0 - 10
No. 100	0 - 5	0 - 3

Recycled glass aggregate or tire chips meeting the quality requirements in **Subsection 801.02** and the gradation requirements for Aggregate No. FA-12 or FA-13 may be used as Fine Aggregate Underdrains.

Only aggregate obtained from Department approved sources shall be used.

CONSTRUCTION REQUIREMENTS

801.04 General. A trench 12 inches wide shall be excavated to the required depth. The bottom of the trench shall be finished to the grade as directed by the Engineer; shall have a gradient of at least 1/2 inch in 10 feet; shall be smooth and firm; and shall be tamped if necessary.

When aggregate underdrains are constructed as a transverse drain for use in removing water from porous foundation courses, the aggregate shall extend to the bottom of the porous foundation material. The aggregate backfill shall be placed, when used as a transverse drain, to a depth of 10 inches unless directed otherwise by the Engineer and shall be compacted.

Aggregate underdrains, used as longitudinal drains or at other locations that are determined necessary by the Engineer, shall be constructed 12 inches in width and to the depth as directed by the Engineer.

The remainder of trenches not filled with aggregate shall be filled with suitable earth that shall be placed and thoroughly compacted in four-inch layers. Suitable outlets shall be provided and protected with small dry stone box openings. The outlets shall be maintained so that they will function properly at all times.

When aggregate underdrain is used to backfill the trenches of pipe underdrains (constructed in accordance with **Section 802**) above the top of the No. 789 aggregate, the width of the trench for the aggregate underdrain shall be the same as required for the pipe underdrain.

When recycled glass or tire chips are used as the underdrain aggregate, they shall be covered with a minimum of 6

inches of mineral aggregate or suitable earth material and thoroughly compacted and shall not be exposed to the elements.

801.05 Method of Measurement. Aggregate Underdrain will be measured by the linear foot or cubic yard as specified for the type indicated, constructed to the specified neat lines, complete in place and accepted. Aggregate Underdrain paid for on a linear foot basis authorized to be placed in excess of 10 inches in depth shall be directly proportioned to a 10 inch depth.

801.06 Basis of Payment. The accepted quantities, measured as provided above, will be paid for at the contract unit price for Aggregate Underdrain of the type specified, which price and payment shall be full compensation for all excavation (except as hereinafter specified), backfilling, furnishing, hauling and placing all materials, disposing of surplus materials, and including all equipment, tools, labor, and incidentals necessary to complete the work.

When stone box outlets are constructed, they will be paid for as aggregate underdrains.

If it is necessary to place the bottom of the aggregate underdrains more than 24 inches below the subgrade or cross-section lines to which the roadway is graded, or the ground surface when the drain is constructed outside of the roadway lines, all additional excavation in excess of the 24 inch depth, but that is not authorized for aggregate backfill, will be paid for at the contract unit price for Unclassified Excavation in accordance with the provisions of **Section 203**, which price and payment shall include backfilling and tamping over the underdrain, and all equipment, tools, labor, and incidentals necessary to complete the work.

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

Payment will be made under:

Item **No.**	**Pay Item**	**Pay Unit**
8011XX0	Aggregate Underdrain *(Agg. No.)*	Linear Foot
8011XX0	Aggregate Underdrain *(Agg. No.)*	Cubic Yard

SECTION 802

PIPE UNDERDRAINS

802.01 Description. This work shall consist of constructing underdrains using pipe and granular filter material and constructing underdrain pipe outlets, where designated on the plans or directed by the Engineer, in accordance with these specifications and in conformity with the lines and grades given. This work shall include furnishing pipe of the kind, size and length specified; excavation and backfilling with coarse aggregate; the furnishing and construction of proper joints and connections to other drains, pipes, catch basins, etc., and the removal and disposal of surplus materials which may be required to complete the work.

MATERIALS

802.02 Corrugated Polyethylene Underdrain. Corrugated polyethylene drainage tubing used as underdrain shall conform to the requirements of **AASHTO M 252**.

802.03 Perforated Concrete Pipe Underdrain. Perforated concrete pipe underdrain shall conform to the requirements of AASHTO M 175 for the type pipe specified.

802.04 Perforated Corrugated Metal Pipe Underdrain. Perforated corrugated metal pipe underdrain shall conform to the requirements of **AASHTO M 36** for Type III metallic (zinc or aluminum) coated corrugated steel underdrains.

802.05 Perforated Bituminized-Fiber Pipe Underdrain. Bituminized-fiber pipe underdrain, except for the modification permitted or stated herein, shall conform to the requirements of AASHTO M 177. The pipe may be of the laminated wall type construction. The couplings shall be of the same material as the pipe or of material having equal or superior physical and chemical properties.

802.06 Perforated Corrugated Aluminum Alloy Pipe Underdrain. Corrugated aluminum alloy pipe underdrain shall conform to the requirements of **AASHTO M 196** for Type III corrugated aluminum alloy underdrains.

802.07 Polyvinyl Chloride (PVC) Pipe Underdrain. PVC pipe shall conform to the requirements of **AASHTO M 278** for Class PS 46 having a cell classification of 12454-B as defined in **ASTM D 1784**. **ASTM D 3034**, SR 35 pipe is considered an equal.

In all underdrain applications of Section 802, polyethylene (PE) pipe may be substituted where PVC PS 46 pipe is specified. The polyethylene pipe shall meet **AASHTO M 252** with the following exceptions:

1. Corrugated Polyethylene Pipe Underdrain, in nominal sizes of 4 inches through 10 inches, shall have 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 as specified in the plans.

2. Polyethylene Pipe Underdrain shall meet the minimum Pipe Stiffness (PS) of AASHTO M 278 (latest edition) at 5% deflection when tested in accordance with **ASTM D 2412**.

3. Acceptance of Polyethylene Pipe Underdrain shall be based on conformance with the above specifications. Sampling of the pipe shall be in accordance with

paragraph 7-58 of the **Construction Manual**.

802.08 Coarse Aggregate No. 789. The aggregate shall consist of crushed stone, crushed slag, or gravel conforming to the requirements as specified in **Subsection 801.02**.

CONSTRUCTION REQUIREMENTS

802.09 Construction Requirements. Trenches for underdrains shall be excavated to a width equal to the outside diameter of the pipe, plus 8 inches and to a depth as is required to permit the pipe to be laid to the desired grade. Where the underdrains are placed in cut sections, the bottom of the trench shall be of sufficient depth below the side ditch or median ditch to adequately intercept the water.

A layer of Aggregate No. 789 coarse aggregate shall be tamped in the bottom of the trench to a depth of 4 inches. The pipe shall be placed in the center of the trench and bedded firmly on the bottom course of aggregate. If pipe of the bell and spigot type is used, the bell end shall be laid upgrade. Perforated pipe shall be laid with the perforations on the underside of the pipe, except that when the pipe is being used strictly for outlet purposes. For outlet purposes, the pipe shall be laid with the perforations on the upper side of the pipe. The joints of butt-end drain tile shall be covered with burlap, roofing paper, or other approved material that is not less than 6 inches in width, is of sufficient length to cover the joint, turns outward, and lays flat on the bottom course of stone a distance of 3 inches on each side of the pipe. Bell and spigot or tongue and groove pipe shall be laid without mortar in joints and the lengths shall be pressed firmly together to prevent infiltration of the aggregate. Lengths of perforated metal pipe, aluminum alloy pipe and bituminous-fiber pipe shall be joined by couplers. Lateral connections shall be made with suitable tee, wye, bend, reducer, or increaser specials as required. The up-grade end not terminating in a structure shall be capped or plugged in a satisfactory manner.

After the pipe has been laid and has been inspected and approved, Coarse Aggregate No. 789 shall be placed around the pipe. The aggregate shall be placed above the bottom of the pipe for a minimum depth of 20 inches. For large diameter pipe underdrains, the depth of the coarse aggregate shall be increased to provide a minimum cover of 4 inches over the top of the pipe. The aggregate shall be placed in a careful manner so as not to disturb the pipe. The remainder of the trench shall be filled with suitable earth or, when directed by the Engineer, aggregate underdrain shall be used instead of earth backfill. The backfill material shall be satisfactorily compacted in 4 inch layers. Aggregate underdrain, when used, shall be paid for at the contract unit price and constructed in accordance with **Section 801**.

Pipe outlets shall be constructed when directed by the Engineer. When directed by the Engineer, they shall be protected by endwalls. The outlet pipe may be of the same type as the underdrain, or may require the use of bell and spigot type pipe meeting the requirements specified herein. In all cases, the outlet pipe joints shall be connected and sealed in accordance with **Section 714** or shall be connected and sealed with materials recommended by the pipe manufacturer.

The trench for pipe outlets shall be filled with suitable earth material instead of aggregate, and the earth material shall be placed and compacted in four-inch layers. Endwalls for pipe outlets shall be constructed of Class 2500 or Class 3000 concrete, whichever is specified, in accordance with **Sections 701** and **702**.

802.10 Method of Measurement. Pipe underdrains will be measured by the linear foot for pipe of the type and size specified, measured along the center of each line or lateral.

802.11 Basis of Payment. The accepted footage, measured as provided above, will be paid for at the contract unit price for Pipe Underdrain or Tile Underdrain of the size and

type specified, which price and payment shall be full compensation for excavating (except as otherwise hereinafter specified), backfilling and disposal of surplus materials, furnishing, hauling and placing all the materials, including pipe, aggregate, incidental concrete, wye, tee, bend joints and other connections, and including all labor, tools, equipment and incidentals necessary to complete the work.

Endwalls, when required, will be paid for at the contract unit price for Class 2500 or Class 3000 concrete, whichever is specified and used.

If it is necessary to place the bottom of the underdrain more than 36 inches below the subgrade or cross-section lines to which the roadway is graded, or the ground surface when the drain is constructed outside the roadway lines, all additional excavation in excess of the 36 inch depth will be paid for at the contract unit price for Unclassified Excavation in accordance with the provisions of **Section 203**, which price and payment shall include the costs of backfilling and tamping over the underdrain.

Pipe outlets will be paid for as Pipe Underdrain.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
80211XX	*(size)*" Pipe Underdrain	Linear Foot
80212XX	*(size)*" Perforated Pipe Underdrain	Linear Foot
802140X	*(size)*" Perforated Concrete Pipe Underdrain	Linear Foot
802160X	*(size)*" Perforated Corrugated Metal Pipe Underdrain	Linear Foot
80217XX	*(size)*" Perforated Bituminized Fiber Pipe Underdrain	Linear Foot

Pay Items (Continued)

Item No.	Pay Item	Pay Unit
802180X	*(size)*" Perforated Corrugated Aluminum Alloy Pipe Underdrain	Linear Foot
802190X	*(size)*" Polyvinyl Chloride (PVC) Pipe Underdrain	Linear Foot
802200X	*(size)*" Corrugated Polyethylene Underdrain	Linear Foot

SECTION 803

PIPE SLOPE DRAINS

803.01 Description. This work shall consist of furnishing and installing intake spillway assemblies and pipe slope drains; constructed on the shoulders, slopes and at other designated locations and shall be of the types, sizes and dimensions shown on the plans or specified in the proposal, all in accordance with these specifications and in conformity with the lines and grades set by the Engineer.

This work shall include the furnishing and construction of joints, connections, bends and elbows as may be required to complete the construction indicated.

MATERIALS

803.02 Corrugated Metal Pipe. Corrugated metal pipe shall conform to the requirements of **AASHTO M 36** for Type I Culvert Pipe.

803.03 Bituminized-Fiber Pipe. Bituminized-fiber pipe shall conform to the requirements set forth in **Subsection 802.05**, except that it shall not be perforated.

803.04 Class PS 46 Polyvinyl Chloride (PVC) Pipe. PVC pipe shall conform to the requirements of **AASHTO M 278** for Class PS 46 having a cell classification of 12454-B as defined in ASTM D 1784. ASTM D 3034 SR 35 pipe is considered equal.

803.05 Metal Intake Spillway Assembly. Metal intake spillway assemblies shall be fabricated from either steel sheet conforming to the requirements of **AASHTO M 218**, or aluminum conforming to the requirements of **AASHTO M 196**.

803.06 Corrugated Polyethylene (PE) Pipe. Corrugated polyethylene pipe shall conform to the requirements of **AASHTO M 294**, Type S. The pipe shall be on the Department's source approval sheet for smooth interliner polyethylene pipe. The manufacturer shall furnish a certification with each shipment stating that it meets the requirements of AASHTO M 294.

CONSTRUCTION REQUIREMENTS

803.07 Pipe Slope Drains. Pipe slope drains and intake assemblies shall be constructed in conformity with details indicated on the plans and at locations designated by the Engineer. The laying of the pipe and all construction shall be in accordance with all applicable provisions and requirements stipulated in **Section 714**. The pipe joints shall be clamped together by bands or couplings in such a manner that separation will be prevented and the connections shall be watertight.

Intake assemblies shall be installed so that they will function properly and efficiently. Water shall be prevented from percolating under or around them.

On occasions when intake assemblies are not used in conjunction with the installation of pipe slope drains, the area around and in front of the inlet shall be paved with approved

asphalt surfacing to prevent erosion and undermining of the pipe. The pipe, forming the entrance, may be field cut when necessary to provide a satisfactory entrance.

803.08 Methods of Measurement. Pipe slope drains will be measured by the linear foot of pipe of the kind and size specified, installed and accepted, complete in place.

Intake spillway assemblies will be measured as complete units installed.

No measurement will be made for excavation necessary for the construction and installation of the above items.

803.09 Basis of Payment.

A. Pipe Slope Drains. The accepted quantities, measured as provided above, will be paid for at the contract unit price for Pipe Slope Drain of the types and sizes of pipe called for in the proposal, complete in place, which price and payment shall be full compensation for furnishing all materials, including bends, elbows, bands, couplings, asphalt surfacing, etc., hauling and placing all materials, excavation and backfilling, constructing connections, disposal of surplus material, and including all labor, equipment, tools, and incidentals necessary to complete the work.

B. Intake Spillway Assembly. Intake spillway assemblies, measured as provided above, will be paid for at the contract unit price for Metal Intake Spillway Assembly, which price and payment shall be full compensation for furnishing all materials, excavation and backfilling, constructing connections, disposal of surplus material, and including all labor, equipment, tools, and incidentals necessary to complete the work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
8031XX0	*(size)*" Corrugated Metal Pipe Slope Drain	Linear Foot
8032XX0	*(size)*" Bituminized-Fiber Pipe Slope Drain	Linear Foot
8033XX0	*(size)* " Polyvinyl Chloride (PVC) Pipe Slope Drain	Linear Foot
8034XX0	*(size)* " Pipe Slope Drain	Linear Foot
8035000	Metal Intake Spillway Assembly	Each

SECTION 804

RIP-RAP AND SLOPE PROTECTION

804.01 Description. This work shall consist of placing protective coatings of broken stone or concrete (which may or may not be grouted), bagged sand and cement, polyvinyl chloride coated wire enclosed rock gabions, precast concrete slabs or slope protection in accordance with these specifications and in conformity with the lines, grade and thickness shown on the plans or established by the Engineer. This work shall also consist of placing an approved fabric on a prepared slope beneath the rip-rap.

MATERIALS

804.02 Stone for Rip-Rap. Stones shall be hard quarry or field stone and shall be of such quality that they will not disintegrate on exposure to water or weathering. The stone shall be suitable in all respects for the purpose intended. Only stone obtained from an approved source shall be used.

Rip-rap shall be well graded stone with test samples falling between the following gradation limits:

Stone Size Range (Feet)	Stone Weight Range (Pounds)	Percent of Gradation Smaller Than
1.5 D_{50} to 1.7 D_{50}	3.0 W_{50} to 5.0 W_{50}	100
1.2 D_{50} to 1.4 D_{50}	2.0 W_{50} to 2.75 W_{50}	85
1.0 D_{50} to 1.15 D_{50}	1.0 W_{50} to 1.5 W_{50}	50
0.4 D_{50} to 0.6 D_{50}	0.1 W_{50} to 0.2 W_{50}	15

Rip-rap gradation classes shall conform to the following table:

Rip-Rap Class	Rock Size (Feet)	Rock Size[2] (Lbs.)	Percent of Rip-Rap Smaller Than
A	0.75	37	100
	0.50	11	50
	0.20	0.7	15
B[1]	1.30	200	100
	0.95	75	50
	0.40	5	10
C[1]	1.80	500	100
	1.30	200	50
	0.40	5	10
D[1]	2.25	1000	100
	1.80	500	50
	0.95	75	10
E[1]	2.85	2000	100
	2.25	1000	50
	1.80	500	5
F[1]	3.60	4000	100
	2.85	2000	50
	2.25	1000	5

1 Based on AASHTO Gradations.

2 Assuming specific gravity of 2.65.

804.03 Stone for Foundation Rip-Rap. Stone pieces used for the protection of foundations, piers, abutments, and walls shall range in weight from a minimum of 25 pounds to a maximum of 250 pounds. At least 60% of the stone pieces shall weigh more than 150 pounds.

804.04 Concrete for Rip-Rap. Acceptable concrete, broken into proper size pieces, with no exposed reinforcing steel, and meeting the requirements as specified in these specifications may be used in lieu of stone for hand placed rip-rap, with written permission of the Engineer.

804.05 Bagged Sand-Cement Rip-Rap.

A. Bags. Bags shall be made of burlap or other approved material and shall have a capacity of one to two cubic feet. Bag sizes shall be approved by the Engineer before use.

B. Sand. Sand shall conform to the requirements of **Subsection 701.10**.

C. Portland Cement. Portland cement shall conform to the requirements set forth in **Subsection 701.02**.

804.06 Grouted Rip-Rap. The rip-rap stone shall conform to the requirements of Class B rip-rap as shown in **Subsection 804.02**.

The grout shall be composed of one part portland cement conforming to the requirements of Subsection 804.05C and three parts sand conforming to the requirements set forth in Subsection 804.05B. The water content of the grout shall be such as to permit gravity flow into the interstices or voids with limited spading and brooming.

804.07 Precast Concrete Rip-Rap. Precast concrete rip-rap shall consist of unreinforced portland cement concrete units of the thickness specified and shall conform to the details shown on the plans. The concrete for precast rip-rap

shall conform to the requirement for Class 2500 concrete as set forth in **Section 701**.

804.08 Polyvinyl Chloride Coated Wire Enclosed Gabions. PVC Coated Wire Enclosed Gabions consist of mats of baskets with uniformly sized partitions fabricated from galvanized and PVC coated wire mesh which is then filled with stone, connected together, and anchored to the slope or channel bottom to be protected. The finished gabions shall meet the following requirements:

1. Polyvinyl Chloride (PVC) Coated Wire. The wire mesh manufactured for use in gabions shall have the following properties:

Physical Property	Gabions
Wire Diameter (gage)	0.105 inch (12 gage)
Tensile Strength of Wire	60,000 psi
Mesh openings	3 inches X 3 inches
Galvanizing	In accordance with **ASTM A 641**, Class 3
PVC Coating, gray in color	0.015 inch thick min.
Lacing Wire diameter (gage)	0.087 inch (13.5 gage)
Spiral Binder diameter (gage)	0.105 inch (12 gage)

The longitudinal and transverse members of the wire mesh shall be securely connected at each intersection. The openings formed shall be substantially square or rectangular. PVC coating of the wire mesh shall be accomplished after fabrication of the fabric.

The PVC coating must be resistant to the destructive effects of immersion in acidic, salt, or polluted water, exposure to ultraviolet light and abrasion, and shall retain these characteristics after a period of not less than 3000 hours under tests in accordance with **ASTM G 23**.

2. Rock. Rock used to fill the PVC Coated Wire units shall meet the requirements of **Subsection 804.02** of the standard specifications. The rock used shall be well-graded and 70%, by weight, shall exceed in least dimension the wire mesh opening. The maximum size of stone, measured normal to the slope, shall not exceed the thickness of the gabion.

3. Lacing Wire, Spiral Binder Wire, and Stiffeners. Lacing wire and spiral binder wire, which are used to assemble, interconnect, and close gabion units, and stiffeners, which support units by forming diagonal braces, shall have the same PVC coating as the wire mesh.

4. Geotextile Fabric. Geotextile Fabric used shall be in accordance with **Subsection 804.11**.

804.09 Concrete for Slope Protection. Concrete for slope protection shall conform to the requirements for Class 2500 concrete as set forth in **Section 701**.

804.10 Fiber Reinforced Concrete Slope Protection. Fiber reinforced concrete for slope protection shall conform to **ASTM C 94**, **ASTM C 1116**, **ASTM C 1018**, **ASTM E 119**, and the following characteristics:

1. Chemical. The fiber reinforcement shall be virgin polypropylene which is inert to alkali and chemical attack; fiberglass or polyester-based fibers are unacceptable.

2. Physical. The reinforcement shall be fillibrated, twisted-bundle form; monofilament or untwisted fibers are unacceptable.

3. Length. The minimum fibrous length shall be based on the top-size coarse aggregate – Multi Design Gradation

804.11 Geotextile Fabric for Slope Protection. This fabric shall be an engineering fabric type capable of reducing soil erosion. Only fabrics appearing on the Department's approval listing will be allowed to be used. The manufacturer's literature concerning the proposed product and proof of satisfactory performance shall also be submitted to the Engineer.

Geotextiles used for erosion control under rip-rap applications shall conform to the physical requirements given below:

1. Strength Property Requirements (all fabrics)

	Class 1 Fabric Protected **1**	Class 2 Fabric Unprotected
Grab Strength **ASTM D 4632**	90 lbs.	200 lbs.
Seam Strength **2** ASTM D 4632	80 lbs.	180 lbs.
Puncture Strength **ASTM D 4833**	40 lbs.	80 lbs.
Burst Strength **ASTM D 3786**	140 psi	250 psi
Trapezoid Tear Strength **ASTM D 4533**	40 lbs.	80 lbs.
Elongation at Failure ASTM D 4632	15% minimum	15% minimum
Ultraviolet Degradation at 500 Hours **ASTM D 4355**	50% Strength Retained	50% Strength Retained

[1] Fabric is said to be protected when cushioned from rock placement by a sufficient layer of sand or gravel at least 6 inches thick or by zero height placement. All other conditions are said to be unprotected.

[2] Values apply to both field and manufactured seams. Seams should be sewn upwards for inspection.

2. Piping Resistance (Soil Retention) & Permittivity Requirements:

	AOS (ASTM D 4751)	Permittivity (ASTM D 4491)
Type A	=No. 30 Std Sieve	=0.7 sec^{-1}
Type B	=No. 40 Std Sieve	=0.2 sec^{-1}
Type C	=No. 60 Std Sieve	=0.1 sec^{-1}
Type D	AOS and fabric permittivity requirements will be based on site specific design and will be indicated in the special provisions of the proposal	

Type A fabric will generally be specified for soils with less than 15% particles by weight passing the No. 200 sieve.

Type B fabric will generally be specified for soils with 15% to 50% particles by weight passing the No. 200 sieve.

Type C fabric will generally be specified for soils with more than 50% particles by weight passing the No. 200 sieve.

Type D fabric will generally be specified for Critical/Severe Applications

804.12 Granular Filter. When so specified on the plans, granular filter will be used instead of geotextile filter fabric under rip-rap. It shall consist of a layer or layers of well-graded crushed stone or gravel meeting the gradations specified on the plans. The gradation of each layer shall conform to the following relationship with the gradation of the underlying material, either soil or filter material.

$$\frac{D_{15}\ (\text{coarser layer})}{D_{85}\ (\text{finer layer})} \leq 5 \leq \frac{D_{15}\ (\text{coarser layer})}{D_{15}\ (\text{finer layer})} \leq 40$$

Where:

D_{15} is the diameter of the particle size that 15% of the material is smaller than.

D_{85} is the diameter of the particle size that 85% of the material is smaller than.

No more than 5% of the filter material should pass the No. 200 sieve.

CONSTRUCTION REQUIREMENTS

804.13 Placing Rip-Rap. Rip-rap shall be placed on a prepared slope or area that shall conform to the lines, grades, and thickness shown on the plans. It shall be placed on either a fabric or a granular filter as specified on the plans. For larger rip-rap sizes, the plans or the Engineer may call for a layer of sand to be placed over the fabric to prevent puncture. The thickness of the rip-rap shall be equal to the maximum stone diameter or the thickness specified in the plans, whichever is greater.

The rip-rap shall be placed either mechanically or by hand in such a manner that the larger stones are well distributed and the entire mass of stone conforms to the specified gradation. It shall be placed so that there are the minimum practical percentage of voids. The rip-rap shall be placed to its full thickness in one operation and in such a manner as to avoid displacing the underlying material. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.

When called for on the plans at bridge end fills, a trench shall be dug along the toe of the fill 2 feet deep and the rip-rap will be placed from the bottom of the ditch to the specified height, unless the plans specify a different toe treatment.

804.14 Placing Foundation Rip-Rap. The stone, graded so that the smaller stone is uniformly distributed throughout the mass, may be placed by dumping, and shall be placed to the required thickness on approved slopes at locations designated on the plans or at other locations designated by the Engineer.

804.15 Placing Sand-Cement Rip-Rap. The preparation of the slope and trench shall be as specified in **Subsection 804.13**. The bags shall be filled with sand and cement with sufficient water to moisten the mix in the ratio of 5 parts sand to one part cement. Upon filling, the bags shall be securely tied closed. Placing shall commence at the bottom and progress upward with the tied ends of the bags turned inward. The joints shall be broken and the bags shall be manipulated so that the bag surfaces shall be in full contact to the extent feasible.

Terminal cutoff walls will be placed at each end of the bagged sand-cement rip-rap treatment. Cutoff walls, 3 feet wide by 3 feet deep shall be placed approximately every 30 feet along the length of the treatment or as directed by the Engineer.

Whenever placement of sand cement bags is delayed sufficiently to affect the bond between succeeding courses, a small trench, one half sack depth, shall be excavated back of the last row in place and the trench filled with concrete before the next layer laid. At the start of each day's work, or when a delay of over 2 hours occurs during the placing of successive layers of sacks, the previously placed sacks shall be moistened and dusted with cement to develop bond.

804.16 Grouted Rip-Rap. The aggregate, preparation of the slope and method of placing the rip-rap for grouted rip-rap shall be as specified in Subsection 804.13. After the rip-rap has been placed and approved, all interstices or voids between the stones shall be filled with mortar to a depth of not less than 4 inches below the surface of the stone. The face or surface of the stones shall be left reasonably free of grout.

Plastering of the rip-rap will not be permitted. The spaces between the stones shall be reasonably free of sand or other material and shall be wet during the placing of the grout.

The edges on the ends of the grouted rip-rap shall be tied to solid rock, formed into smooth transitions, or trenched well back into the bank to prevent undermining. The bottom of the grouted rip-rap shall be founded on solid rock or extended below the depth of possible scour. Weep holes shall be provided through the grout blanket to relieve any hydrostatic pressure behind the blanket.

804.17 Placing Precast Concrete Rip-Rap. The slope on which the rip-rap is to be placed shall conform to the typical cross-section shown on the plans or as directed by the Engineer and shall be prepared as specified in Subsection 804.13. Placing shall begin in a trench below the toe of the slope and progress upward. Each piece shall be placed by hand perpendicular to the slope. It shall be firmly embedded against the slope in such manner that the vertical and horizontal joint space between individual units does not exceed 3/8 inch, unless otherwise permitted. Half blocks, odd shaped blocks, or Class 2500 concrete shall be used to fill the voids at the end of the sections to be placed or on curved shaped sections. The top course shall conform as nearly as practicable to the prescribed berm or shoulder elevation.

Any adjustment necessary to achieve this shall be obtained by constructing a wedge course as directed. This wedge course, when required, shall consist of Class 2500 concrete. Toe walls, when required, shall consist of Class 2500 concrete. All concrete shall be jointed and textured as directed to blend with the precast blocks.

804.18 Placing Geotextile Fabric for Slope Protection. Geotextile fabric for slope protection shall be placed in accordance with plan details at locations shown on the plans or as directed by the Engineer. The slope on which the fabric is to be placed shall be within reasonable conformity with the plans and shall be in a relatively smooth condition free from

obstructions, debris or sharp objects that may puncture the fabrics. Construction equipment should not operate directly on the fabric.

The fabric shall be placed with the long dimension parallel to the toe of the slope and shall be laid smooth and free of tension, stress, folds, wrinkles, or creases. If more than one strip is necessary, the strips shall overlap a minimum of 18 inches. Transverse laps shall be placed so the upstream strip laps over the downstream strip. Horizontal laps shall be placed so the lower strip laps over the upper strip. Laps may be eliminated provided the joint is sewn using an approved method.

Approved fastener pins shall be installed through both strips of overlapped fabric at no less than 5 foot intervals along a line through the midpoint of the overlap, and at any other locations as necessary to prevent any slippage of the fabric.

When placing material on the fabric, the height of the drop shall be limited in order to prevent damage to the fabric. The Contractor shall demonstrate that the placement technique will prevent damage to the fabric. Placement of the material shall begin at the toe of the slope and proceed upward.

Any fabric damaged during installation or during placement of filter materials, slope protection, or other materials shall be repaired or replaced by the Contractor with no additional compensation. Extensively damaged fabric shall be removed and replaced as directed by the Engineer. When the majority of the fabric is undamaged, individual isolated cuts, tears, or punctures may be repaired by placing a patch of geotextile fabric over the damaged areas. The patch shall extend at least 18 inches beyond the damage in all directions, or the entire perimeter of the patch shall be fastened by an approved sewing method.

The Contractor shall cover the fabric with the specified material before damage or deterioration from ultraviolet light

occurs. Fabric not covered within thirty (30) calendar days after placement shall be removed and replaced without any additional compensation. If damage or deterioration is evident before thirty (30) days after placement as determined by the Engineer, the fabric shall also be removed and replaced without any additional compensation.

804.19 PVC Coated Wire-Enclosed Gabions. Before the installation of gabions the channel shall be excavated as shown in the plans or as directed by the Engineer. The resulting subgrade shall be 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.

Geotextile Fabric meeting the requirements of **Subsection 804.11** (Class 2) shall be required for all gabions and shall be placed on the prepared subgrade. Adjacent strips shall be overlapped a minimum of 2 feet. Care shall be exercised in placing and anchoring the empty PVC coated wire mesh units to ensure proper alignment and to avoid damage to the geotextile fabric. Should the geotextile be damaged, it shall be replaced or repaired at the Contractor's expense as directed by the Engineer.

Placement of the units shall begin at the vertical abutment wall and proceed upstream or downstream. The empty units shall be placed on the geotextile fabric and the vertical ends bound together with lacing or spiral binder wires sufficiently to allow stretching of the units to remove any kinks. Stretching methods will be at the option of the Contractor. Once the units are placed in proper alignment, stakes, pins, or other approved methods shall be used to secure the units. Adjacent units shall be interconnected at intervals not to exceed six inches with lacing or spiral binder wire.

The empty units shall be filled carefully with rock placed by hand or machine to maintain alignment of the units with the rock placed uniformly in the units, with a minimum of voids between the rock, and avoiding bulging of the side or

top mesh. Dropping of the rock shall be limited to a height that prevents damage to the PVC coating or 36 inches, whichever is less. Once filled, the lid of the units shall be closed and secured with lacing or spiral binder wire. When space limitations along the channel bottom or slope prevents the use of a complete unit, the unit shall be cut to fit as directed by the Engineer.

Any excavation voids existing along the edges of the completed gabions shall be backfilled in a manner acceptable to the Engineer.

804.20 Slope Protection. Slope protection shall be cast in place concrete slope protection consisting of either Class 2500 concrete meeting the requirements of **Subsection 804.09**, or fiber-reinforced concrete meeting the requirements of **Subsection 804.10**. It shall be constructed in accordance with the plans at the locations indicated or where directed by the Engineer. The slope on which slope protection is to be placed shall conform to that shown on the plans unless otherwise directed.

Reinforcement when specified shall conform to the requirements of **Section 703** and shall be placed in accordance with plan details. The surface of the slope shall be finished uniformly with floats and textured by dragging with wet burlap. After finishing, the slope protection shall be cured in accordance with the requirements in **Subsection 501.24**.

804.21 Method of Measurement. Hand placed rip-rap, foundation rip-rap and dumped rip-rap will be measured in tons or cubic yards. Sand-cement rip-rap will be measured in cubic yards. Grouted rip-rap and precast concrete rip-rap (including the area occupied by the wedge course) will be measured in square yards parallel to the slope. Gabions shall be measured by the cubic yard of PVC Coated Wire-Enclosed Rock Gabion of specified thickness. Slope protection and geotextile fabric for slope protection will be measured in square yards.

804.22 Basis of Payment. The accepted quantities will be paid for at the contract unit price for the type of Rip-Rap placed, which price and payment shall be full compensation for all excavation, backfilling, preparation of slopes and footing trench, disposal of surplus materials, and for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

Payment at the contract unit price for Grouted Rip-rap shall include furnishing and placing the grout only. The aggregate (stone) will be paid for as a separate item. When reinforcement is required in slope protection, payment at the contract unit price shall be full compensation for furnishing all materials, including reinforcement.

Payment at the contract unit price for PVC Coated Wire-Enclosed Rock Gabions shall be full compensation for all rock, excavation, geotextile fabric, stakes, fasteners, backfill, disposal of excess material, including all material, labor, equipment, tools, and incidentals necessary to complete the work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
8041100	Hand Placed Rip-Rap	Ton
8041200	Hand Placed Rip-Rap	Cubic Yard
8042100	Foundation Rip-Rap	Ton
8042200	Foundation Rip-Rap	Cubic Yard
8043100	Dumped Rip-Rap	Ton
8043200	Dumped Rip-Rap	Cubic Yard
8043350	Sand Cement Rip-Rap	Cubic Yard
8043370	Grouted Rip-Rap	Square Yard

Item No.	Pay Item	Pay Unit
8043390	Precast Concrete Rip-Rap	Square Yard
8044100	PVC Coated-Wire Enclosed Rock Gabion	Cubic Yard
8047040	Slope Protection 4" Concrete	Square Yard
8047041	Slope Protection 4" Concrete (Fiber Reinforced)	Square Yard
80482XX	Geotextile For Erosion Control Under Rip-Rap (Class *(class)*) Type ((*type*))	Square Yard

SECTION 805

GUARDRAIL

805.01 Description. This work shall consist of constructing guardrail, of the type specified, in accordance with these specifications and in conformity with the lines and grades shown on the plans or established by the Engineer. The types of guardrail shall be in accordance with the plans and proposal and are designated as follows:

1. Steel Beam Guardrail (W-Beam)
2. Adjustable Guardrail
3. Steel Beam Guardrail (Double Layer)
4. Steel Beam Guardrail (Thrie)
5. Steel Beam Guardrail (Thrie-Double Layer)
6. Box Beam Median Barrier
7. Tubular Beam Guardrail (Bridge Railing)
8. Temporary Guardrail
9. Concrete Median Barrier
10. Temporary Concrete Median Barrier

The construction of the various types of guardrail shall include the construction of anchor blocks and anchorage at the approach and off ends of bridges of the specified kind and dimensions, terminal and end anchor sections and blockouts; and shall include the assembly and erection of all component parts and materials complete at the locations shown on the plans or as directed.

MATERIALS

805.02 Steel Beam Guardrail. The rail elements shall be corrugated sheet steel beams of the shape W-beam or Thrie as specified, conforming to the requirements of **AASHTO M 180** for Class A, Type 2.

When guardrail is to be erected on radii of 150 feet or less, the Contractor shall, in cooperation with the Engineer, before fabrication, make such field measurements as necessary to determine the proper curvature of the rail elements. The rail elements shall be shop fabricated to conform to the curvature of the radii. Whenever field fabrication as approved by the Engineer requires cutting or drilling, the cut or drilled members shall be coated as specified in **Subsection 805.04A**.

805.03 Adjustable Guardrail. Steel Beam Guardrail (W-Beam) may be adjusted as shown in the plans.

Work shall consist of the careful removal of the existing rail element and adjusting the blockout assembly to raise the height of the guardrail and reinstalling the rail as shown on the plans.

All materials used shall conform to the material requirements shown on the plans.

The Department may allow the substitution of composite or plastic blockouts in place of treated wood blockouts provided they meet the requirements shown on plans, and as

stated in **Subsection 805.05B**.

Any additional materials, which may be required to adjust the guardrail as shown on the plans, will be included in the bid price per linear foot for Adjusted Guardrail.

805.04 Posts. Guardrail posts may be wood or steel for W-Beam Guardrail. Wood guardrail posts may not be used with Thrie Beam Guardrail. Posts for Adjustable W-Beam Guardrail may be wooden or steel manufactured with the appropriate holes for blockout attachment. Additional holes may be field drilled or punched.

A. Steel Posts. Guardrail posts shall conform to the requirements of **AASHTO M 270**, Grade 36 steel. The dimensions and weight of the posts shall be as shown on the plans. The posts shall be fabricated from structural steel complying with the requirements of **Section 709**. The posts shall be galvanized in accordance with **ASTM A 123** after fabrication.

Construction details shall be as shown on the plans. Whenever field fabrication, as approved, requires cutting or drilling, the cut or drilled member shall be protected by applying two coats of 90% minimum zinc rich cold galvanizing compound.

B. Wood Posts. Wood posts shall be southern pine conforming to the requirements for guardrail posts as set forth in **Section 706**, unless otherwise provided on the plans.

C. Extra Length Posts. When a guardrail post is required to be longer than the standard 6 feet, the additional length beyond 6 feet shall be measured and paid for as Additional Length of Guardrail Posts. Posts shall meet requirements in Subsection 805.04A or **805.04B**.

805.05 Blockouts.

A. Wood. Wooden blockouts shall be southern pine con-

forming to the requirements for guardrail posts as set forth in Section 706 unless specified otherwise on the plans. The dimensions of the blockout will be as described herein or as shown on the plans.

B. Composite or Plastic. The Department may allow approved composite or plastic blockouts to be substituted for wood blockouts. All dimensions are nominal and subject to manufacturing tolerances. An approval list for allowable composite or plastic blockouts may be obtained from the Department's Research and Materials Lab.

C. Steel. Steel blockouts shall comply with the requirements for steel post. Steel blockouts on steel posts are not allowed with use of the W-Beam Guardrail System.

805.06 Box Beam Median Barrier.

a. Hollow structural tubing shall conform to the requirements of **ASTM A 500**, Grade B or **ASTM A 501**, and shall conform in all respects to the plan details and dimensions. The beams shall be hot dipped zinc coated in accordance with **AASHTO M 111**.

b. Hot dipped zinc coated steel posts shall be of the section and length shown on the plans and shall conform to the requirements of **Subsection 805.04A**.

c. Splice bolts, anchor bolts and nuts shall conform to the requirements of **ASTM A 307** and shall be galvanized in accordance with **Subsection 708.04**.

d. The rail hardware shall include end caps, bolts, nuts, splice joints, anchor assemblies and all other items to complete the railing. The rail hardware, except bolts and nuts, shall meet the requirements of **AASHTO M 270** and shall be galvanized in accordance with ASTM A 123.

e. All fabrication shall be complete and ready for assembly before hot dipped zinc coating, and no punching, drill-

ing, cutting or welding will be permitted after hot dipped zinc coating. Each rail length shall be furnished with splice joint at one end as required. All welding shall conform to the current edition of **AWS** specifications.

805.07 Temporary Guardrail. Due to the staging of projects at locations shown in the plans, guardrail may be required on a temporary basis. This guardrail shall meet all requirements given in the plans and these standard guardrail specifications.

Temporary guardrail shall be placed at the locations shown in the plans. Removal of temporary guardrail shall be dictated by the staging requirements.

Carefully removed guardrail materials may be reused in permanent installations, provided they are undamaged and have been properly stored and maintained after their removal.

Guardrail shall be thoroughly cleaned and given two coats of 90% minimum zinc rich cold galvanizing to all steel parts that are reused that are not galvanized. All materials to be reused must be approved by the Engineer before installing them permanently.

805.08 Guardrail Hardware and Accessories for Steel Beam Guardrail. Blockouts and brackets shall be of the type shown on the plans and shall meet the same requirements as the posts.

Bolts of the sizes specified on the plans shall conform to ASTM A 307. Nuts shall conform to **ASTM A 563**. Washers shall conform to the requirements of **AASHTO M 180**. The bolts, nuts, and washers shall be coated after fabrication in accordance with **AASHTO M 232**. Post bolts used with steel or timber posts and timber or composite blockouts shall be long enough to extend through the nut and one washer but, not so long as to extend more that two inches beyond the nut and two washers.

End anchor sections and other guardrail appurtenances

shall conform to the requirements shown on the plans.

805.09 Concrete and Reinforcing Steel. Concrete for filling around posts shall be Class 2500. Concrete for Concrete Median Barrier and Temporary Concrete Median Barrier shall be Class 3000. Each class shall conform to the requirements set forth in **Section 701**. Reinforcing steel shall conform to the requirements set forth in **Section 703**.

CONSTRUCTION REQUIREMENTS

805.10 Posts. Posts shall be set plumb, in hand or mechanically dug holes, driven in place, or set in concrete as hereinafter specified. Dissimilar metal-to-metal post or rail installations shall have contact surfaces separated by an approved protective coating. When posts are placed within paved areas, any pavement disrupted shall be restored to a depth of 4 inches in like kind.

A. Wooden Posts. Wood posts may be set in dug holes or driven. Excavated postholes shall have a firm bottom and be backfilled with suitable material and thoroughly compacted. The driving of posts shall be accomplished with approved methods and equipment that will leave the posts in their final position free from any distortion, battering, burring or any other damage. The Contractor will refrain from sawing treated posts.

B. Steel Posts. Steel posts may be set in dug holes or driven. Steel posts may be anchored to, but not set in concrete.

805.11 Rail Elements. Rail elements shall be erected at the proper height in a manner resulting in a smooth, continuous installation. All bolts, except those required at expansion joints, shall be drawn tight. Bolts through expansion joints shall be drawn as tight as practicable and still allow rail elements to slide past one another longitudinally.

Rail elements shall be supplied in such lengths that

splices will occur at posts and shall be lapped in the direction of adjacent traffic.

Hot dipped zinc coated surfaces which have been abraded so that the base metal is exposed and cut ends of bolts shall be protected by applying two coats of 90% minimum zinc rich cold galvanizing compound.

When new guardrail is being erected on a project that is open to traffic, work shall be done so in the direction of traffic flow, so that unfinished sections will not be facing oncoming traffic. The Contractor shall not begin work on any section of guardrail until preparations have been made to complete the installation of the section, including posts, rail, anchors and hardware as a continuous operation. Once the work has been initiated on a section, the work shall be continued to its completion unless inclement weather or other conditions beyond the control of the Contractor interfere with the work. Should leave-out sections be allowed, they will be adequately marked with barricades or other devices to protect the traveling public.

805.12 Reset Guardrail. This work shall consist of the careful removal of existing guardrail and, if necessary, storing it in a careful manner, and then erecting it where shown on the plans or as directed.

All steel parts, if not galvanized, shall be thoroughly cleaned and given two coats of 90% minimum zinc rich cold galvanizing compound.

When resetting or replacing existing guardrail, only that length of guardrail shall be removed that can be replaced or reset in the same day. Any reset guardrail shall be reset to the new guardrail standards with any additional materials necessary to perform this work being included in the contract price per linear foot of Reset Guardrail. All materials, including hardware, that remain from the resetting or replacing work shall be removed from the roadway immediately so that it will not create an obstacle for the traveling public. This material may be placed behind a completed section of guardrail or

stored neatly in an area at least 30 feet from the travelway unless otherwise specified.

805.13 Adjustable Guardrail Blockouts and Post. This work shall consist of the careful removal of the existing rail element and adjusting the blockout assembly to raise the height of the guardrail as shown on the plans and reinstalling the rail where shown on the plans or as directed by the Engineer. Thrie Beam Guardrail is not adjustable. Steel blockouts are not allowed with adjustable "W-Beam" Guardrail. Any additional materials which may be required to adjust the guardrail as specified on the plans will not be paid for separately but will be included in the bid price per linear foot for Adjusted Guardrail. When the guardrail is adjusted, the area under and adjacent to the guardrail will be raised by adding Unclassified Excavation, Borrow Material or Asphalt Paving, in order to provide the proper height specified. Earthwork will be placed in accordance with **Section 203**. Adjustable Guardrail shall comply with all other applicable requirements of **Section 805** of the standard specifications.

If wood guardrail posts are used, the nominal dimensions of the guardrail blockout shall be 6 inches x 8 inches x 14 inches. The blockout is to be mounted to the wood post by means of a 5/8 inch bolt, of the necessary length, placed through a 3/4 inch diameter hole located 7 inches from the top and 3 inches from either side. An additional 3/4 inch hole shall be placed 11 inches from the top of the blockout and 3 inches from either side which will be used on the final adjustment which requires an additional bolt at that time. For initial installation and the first 2 inch adjustment, two 16d hot dipped zinc coated nails or corrugated fasteners (5/8 inch x 1 1/8 inch minimum) shall be driven through the blockout and into the post after the post bolt is installed to prevent the block from rotating.

If steel guardrail posts are used, the nominal dimensions of the guardrail blockout shall be 6 inches x 8 inches x 14 inches. A slot measuring 4 1/2 inches (maximum width) x 14 inches (nominal height) x 1/4 inch (minimum depth) shall

be created, centered along the back of the blockout, to facilitate mounting to the steel guardrail post and to prevent rotation. The slot shall be created to allow a 7 1/2 inch minimum offset from the post. The blockout is to be mounted to the steel guardrail post by means of a 5/8 inch bolt, of the necessary length, placed through a 3/4 inch diameter hole in the blockout located 7 inches from the top of the blockout and 1 5/8 inches from the side. An additional 3/4 inch hole shall be placed 11 inches from the top of the blockout and 1 5/8 inches from the same side as shown in the plans. Both holes will be used on the final adjustment and will require an additional bolt at that time.

805.14 Removal of Existing Guardrail. This work shall consist of the removal of existing guardrail. The removed guardrail components shall become property of either the Department or the Contractor, as stated in the contract.

A. If Property of the Department. If the guardrail that is removed is to remain the property of the Department, it shall be stored within the limits of the project, and shall be protected by the Contractor until it is removed from the project by the Department or for a period of thirty (30) days, whichever comes first.

B. If Property of the Contractor. If the guardrail that is removed is to become the property of the Contractor, the Contractor shall store the removed guardrail safely away from the traveling public until it is removed from the project.

805.15 Concrete Median Barrier. Concrete median barrier shall be constructed in accordance with plan details and the applicable provisions of **Section 702**. Concrete median barrier may be placed on pavement or directly on an earth or other foundation. Drill holes may be required in existing concrete pavement to accommodate dowel bars. Dowel bars, as shown on the plans, shall be grouted with approved grout.

When a trench is required, the trench for the base of the

barrier shall be excavated to the lines and grades shown on the plans or established. The bottom of the trench shall be compacted, watered and shall be approved before placing concrete.

An approved slip-form machine may be used to construct concrete median barrier provided satisfactory results are obtained. When, in the opinion of the Engineer, satisfactory results are not being obtained, the work shall be discontinued and the Contractor shall use form type of construction with no adjustment in compensation. Any unsatisfactory work shall be removed and replaced without any additional compensation.

Where median paving is removed or damaged in placing the barrier, the Contractor shall furnish an acceptable mix and shall repair the pavement without additional compensation.

805.16 Temporary Concrete Median Barrier. Temporary Concrete Median Barrier shall conform to the requirements as shown on the plans and the applicable provisions of Section **702**. The barrier shall be installed at locations as shown on the plans or as directed by the Engineer.

805.17 Method of Measurement. Guardrail of the type specified will be measured by the linear foot along the centerline of the rail from end to end of completed and accepted rail and barrier as shown on the plans, including transitions and terminal sections, but excluding end anchorages and bridge end connectors. End anchorages and bridge end connectors will be measured by the actual number placed and accepted.

Temporary guardrail will be measured by the linear foot in the same way as permanent guardrail.

Additional length of guardrail posts will be measured by the linear foot. The quantity of Additional Length Guardrail Post will be that amount of required post that is in excess of the standard six foot length.

805.18 Basis of Payment. Minor excavation, disposal of

surplus materials, painting, making necessary repairs to pavement, and other incidental items needed to complete the work as specified will not be paid for separately, but shall be included in the cost of the guardrail or related guardrail work items. In these specifications, the items "guardrail" and "median barrier" are measured and paid for similarly.

Guardrail will be paid for at the contract unit price for Guardrail of the type specified complete in place, which price and payment shall be full compensation for furnishing and installing the guardrail, including anchorages to bridge ends, when a bridge end connector is not installed.

Removal of existing guardrail will be paid for at the contract unit price for Removal of Existing Guardrail, which price and payment shall be full compensation for dismantling, storing and protecting the guardrail and components, backfilling and compacting postholes, and all materials, equipment, labor, and work incidental to complete the work.

Resetting of guardrail will be paid for at the contract unit price for Reset Guardrail, which price and payment shall be full compensation for its removal, any necessary storage, resetting and replacement of damaged or missing parts. Reset Guardrail includes providing all new post as required.

Temporary guardrail will be paid for at the contract unit price for Temporary Guardrail, which price and payment shall include placing, anchoring guardrail to structures, maintaining (under traffic and after removal), removing, and all material, equipment, labor, and incidentals necessary to complete the work. This unit price and payment shall also include the disposal of any guardrail materials that cannot, or will not, be reused on the project.

Payment for end anchorages shall be at the contract unit price for End Anchors and shall include all concrete, reinforcing steel, structural steel, rail segments, cable, rods, turn buckles, anchor bolts, backing rail, soil tubes, plates, nuts, bolts, washers, attachments, transition sections, and all other

work necessary to complete the work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
8051100	Steel Beam Guardrail	Linear Foot
8051101	Adjustable Guardrail Initial Installation	Linear Foot
8051102	Adjustable Guardrail 2 Inch Adjustment	Linear Foot
8051103	Adjustable Guardrail Final Adjustment	Linear Foot
8051110	Removal of Existing Guardrail	Linear Foot
8051200	Steel Beam Guardrail (Double Face)	Linear Foot
8051300	Steel Beam Guardrail (Thrie)	Linear Foot
8051400	Steel Beam Guardrail (Thrie-Double Face)	Linear Foot
8051600	Box Beam Median Barrier	Linear Foot
8051800	Temporary Guardrail	Linear Foot
8053000	Additional Length Guardrail Post	Linear Foot
8058XXX	Concrete Median Barrier *(type)*	Linear Foot
8059XXX	Temporary Concrete Median Barrier	Linear Foot
8051900	Reset Guardrail	Linear Foot
80522X0	End Anchors (Type *(type)*)	Each

SECTION 806

FENCE

806.01 Description. This work shall consist of the construction of fence and gates in accordance with these specifica-

tions at the location shown on the plans or designated by the Engineer, and in conformity with the lines and grades shown on the plans or established.

The types of fence covered by these specifications are:

1. Woven Wire
2. Barbed Wire
3. Chain-Link
4. Ornamental Steel Picket

MATERIALS

806.02 Wood Posts and Braces. Wooden posts and braces shall meet the requirements of **Subsection 706.05**.

If approved by the Engineer, galvanized studded T-posts may be used instead of wood posts for Reset or Woven Wire Fence. The T-posts shall be used for line installation only, and shall not be allowed as corner or pull posts. T-posts shall meet the requirements of **ASTM A 702**, and galvanizing shall meet **ASTM A 123**.

806.03 Steel Fence Posts. Steel fence post shall conform to the size, shape and dimensions shown on the plans. Tubular steel fence posts shall be galvanized in accordance with **ASTM A 120**. All other posts shall be galvanized in accordance with ASTM A 123. All anchor plates attached to posts shall be galvanized in accordance with **ASTM A 153**. Cut ends that are not placed underground shall be protected by applying two coats of a 90% minimum zinc rich cold galvanizing compound. Posts and anchor plates for line posts shall be of good commercial quality steel and of the shapes, weights and dimensions shown on the plans. All tubular section posts shall have heavy malleable iron caps made to provide a drive-fit over the outside of the section to exclude moisture. The weight per linear foot for tubular posts and braces shall be no less than 95% of the weight specified. All end, pull, and brace posts for farm-field type fence shall be

furnished with braces and all fittings and details required to make a complete installation as shown on the plans. All line posts for farm-field fence shall be furnished with anchor plates. If fastenings are necessary for attaching the fence to the posts they shall be either No. 9 galvanized wire or galvanized clamps of the manufacturer's standard design. A sufficient quantity of individual tie-wires or clamps shall be furnished to provide for 5 attachments of the fencing to each line post and one tie-wire for each strand of barbed wire.

All line posts for chain-link type fence shall be furnished with the necessary tie-wires or fabric bands for fastening the fabric to the posts. These fastenings shall be either of aluminum strip or wire of approved gage and design or of galvanized steel wire and may be in accordance with the manufacturer's standard design. If galvanized steel wire ties are furnished, the wire shall be no smaller than No. 9 gage. A sufficient quantity of individual ties or bands shall be furnished to provide for attaching the fabric to each line post every 12 inches or as called for on the plans.

806.04 Woven Wire. Woven wire shall conform to the requirements of **ASTM A 116**, Class I zinc coating for wire with 12 1/2 gage stay wires or ASTM A 116, Class II zinc coating for wire with 11 gage stay wires whichever is specified, or it shall conform to the requirements of **ASTM A 584**, Class II coating. The type of woven wire fabric shown on the plans shall meet the Department's design specifications.

806.05 Barbed Wire. Barbed wire shall consist of two No. 12 1/2 gage or heavier steel wires or two No. 15 1/2 gage high tensile strength steel wires with 14 gage or heavier four point round barbs placed no more than five inches apart. Zinc coated (galvanized) steel barbed wire shall conform to the requirements of **ASTM A 121** with Class I (or better) coating. Aluminum-coated steel barbed wire shall conform to the requirements of **ASTM A 585**, Type I.

806.06 Chain-Link Fence Fabric. Chain-link fence fabric and required fittings and hardware, shall conform to

AASHTO M 181 for the kind of metal, coating, sizes of wire and mesh as specified on the plans.

806.07 Ornamental Steel Picket Fencing. Ornamental steel picket fencing materials shall meet the following requirements:

Tubing	Cold roll steel sheet meeting **ASTM A 924**/ A 653 LFQ RS Coating G90 C10088/C1010, Grade C. Roll to **ASTM A 787-846** type 2AWG, light oil 1008/1010.
Welds	1/8 inch Fillet Butt Weld, 2 sides with 50,000 psi tensile strength
Pickets	1 inch x 1 inch x 16 gage galvanized cold roll steel
Rails	1 inch x 2 inches x 14 gage galvanized cold roll steel
Posts	2 1/2 inches x 2 1/2 inches x 14 gage galvanized cold roll steel
Post Caps	Pressed steel to fit over post
Concrete	Class 3000
Post Embedment	9 inch dia. x 36 inches deep for MSE walls, 4 inches x 9 inches x 12 inches deep for brick walls
Paint	Finish color shall be black

806.08 Gates.

A. Chain-Link Fence. Gates for chain-link fence shall conform to design details and **AASHTO M 181** for the kind of metal, coating, sizes of wire and mesh specified.

B. Farm Fence. Gates for farm type fence shall be in accordance with plan details. In the absence of plan details, gates shall be as directed by the Engineer to be in keeping with the type fence being erected and the purpose it will serve.

806.09 Staples. Staples used to attach woven wire and barbed wire to wooden fence posts shall meet one of the following characteristics:

1. The staples shall be made of galvanized steel wire of not less than No. 9 gage and shall be not less than 1 1/2 inches in length.

2. Pneumatically driven staples shall be two inches in length, 16 gage stainless steel made from 304 stainless steel and coated with adhesive.

CONSTRUCTION REQUIREMENTS

806.10 General. The Contractor shall perform such clearing and grubbing as may be necessary to construct the fence to the required grade and alignment. Existing fences, trees, brush, stumps, logs, weeds or other debris that interfere with the construction of the fence shall be removed and disposed of as directed.

The surface of the ground beneath the fence shall be graded to a reasonable contour to prevent the bottom strand from coming in contact with the ground, provide for spaces between the various types of wire, viz., barbed wire and fabric as shown on the plans, and prevent excessive openings between the ground and the bottom of the fence, prior to erecting the fabric. Openings under fences, caused by crossing ditches or small ground depressions where it is not practicable for the fencing to follow closely the contour of the ground, shall be fenced or otherwise closed to retain livestock or serve the purpose intended.

Where new fences are to be constructed to replace existing fences, the Contractor may be required to erect the new fence before the existing fence is removed. The Contractor shall be responsible for any crop or property damage caused by livestock escaping or entering through gaps left in fences during erection.

At locations where breaks in a run of fencing are required, or at intersections with existing fences, appropriate adjustment in post spacing shall be made to conform to the requirements for the types of closure indicated.

Unless otherwise permitted, no materials shall be installed on posts or strain placed on guys and bracing set in concrete until four (4) days have elapsed from the time of placing the concrete.

The tops of all posts shall be set to the required grade and alignment. Cutting of the tops of treated wooden posts or metal posts will be allowed only with the approval of the Engineer and under the conditions specified.

Wire or fencing of the type required shall be firmly attached to the posts and braces in the manner indicated on the plans or in these specifications. All wire shall be stretched taut and be installed to the required elevations.

At each location where an electric transmission, distribution or secondary line crosses any of the types of fences covered by the specifications, the Contractor shall furnish and install a ground conforming to the requirements of Section 9 of the ***National Electric Safety Code***.

Whenever farm type fence is erected for farm purposes, the Contractor shall construct access gates at locations of existing access points, when directed and at such other locations when, in the opinion of the Engineer, such access is essential to the farming or other land use operations.

806.11 Setting Posts. Unless otherwise directed, posts, including the concrete base for posts for fence to be erected for control of access purposes, shall be so set that the entire fence is inside the right of way and such that the fence can be placed on the side of the post facing the mainline pavement. Posts and related items for fence to be erected for land use purposes shall be so set that the entire fence is outside the right of way

and such that the fence can be placed on the side of the post facing the pavement.

Unless otherwise indicated on the plans, the posts shall be spaced the same as in the fence being replaced, with a maximum distance of 12 feet on centers for woven wire and barbed wire fences and a maximum of 10 feet for chain-link fence.

Posts shall be accurately spaced, lined, set plumb and placed to a uniform height before the fabric is erected. End, corner, gate and pull posts shall be set to a minimum depth of 3 feet. Line posts shall be placed to a minimum depth of 2 1/2 feet. At the option of the Contractor, posts may be driven into place provided the method of driving does not damage the post. Treated posts that are to be driven may have the small end machine pointed at the plant before being treated or may be driven with the end not pointed. When the posts are hand set, the holes shall be backfilled and thoroughly compacted in layers not exceeding 6 inches in depth and in such a manner that the post will be securely held.

Corner, end, gate posts, and pull posts, at intervals of not more than 500 feet, shall be securely braced as may be indicated on the plans or as directed by the Engineer. Changes in line where the angle of deflection is 30 degrees or more shall be considered as corners and corner post shall be installed. All corner and pull posts shall be braced in two directions. End and gateposts shall be braced in one direction. Posts at intersecting fences shall be properly braced to withstand the pull of the intersecting fence.

Extra length posts will be required at stream crossings and at other locations where it is not practicable for the fencing to follow closely the contour of the ground. Such extra length posts shall be furnished by the Contractor without additional compensation.

When sections of fence are to be erected in low, swampy areas where due to the nature of the soil and water conditions, the posts will not be firmly held with a penetration into the earth

of 2 1/2 feet and 3 feet for line posts and for pull and corner posts, respectively and when included in the proposal, the Contractor shall install posts of such length as directed by the Engineer. Before ordering posts for these areas, the Engineer will furnish the length of posts required.

Unless otherwise indicated on the plans, all metal posts shall be set in Class 2500 concrete crowned at the top to shed water. Such concrete is to be furnished by the Contractor without additional compensation.

806.12 Installing Woven Wire. The wire fabric shall be stretched taut and securely attached to each wood post with a galvanized staple in each horizontal wire and as many additional staples as may be required to secure a workmanlike installation. Stretching shall be done with an approved stretcher that will produce equal tension in each line of wire. At each end, corner, or gatepost, each strand of wire shall be wrapped around the post and securely fastened by winding the end around the beginning of the loop near the post. Splicing of fence between posts will not be permitted, unless splicing devices recommended by the fence manufacturer are used and are satisfactory.

806.13 Installing Chain-Link Fabric. Chain-link fabric shall be stretched and securely attached to the end, corner, gate, and pull posts with stretcher bars and stretcher bands as indicated on the plans. The fabric shall be fastened to line posts, top rail and tension wires with wires or bands so specified and spaced as indicated.

806.14 Installing Barbed Wire. Barbed wire, whether used in conjunction with chain-link fabric, woven wire fabric or as a separate fence, shall be stretched and fastened to each wood post by means of galvanized staples and to metal posts by means of suitable fasteners. The ends of wire shall be wrapped around wood posts and securely fastened by winding the end around the wire near the post. Splicing of fence between posts will not be permitted.

806.15 Installing Ornamental Steel Picket Fencing. The ornamental steel picket fencing shall be constructed in accordance with the plans. All posts shall be set plumb and painting shall be performed as follows:

1. Clean, degrease, and prime welded panels and posts.

2. Powder coat primed panel, post, and cap with one coat.

3. Touch up paint for field welds with cold galvanized primer and enamel spray paint.

4. Finished color shall be black.

806.16 Method of Measurement. Fence will be measured by the linear foot along the top of the fence from outside to outside of end posts for each continuous run of fence and shall include gates, unless gates are included in the proposal. Gates, when included as pay item in the proposal, will be measured as complete units of the size and type specified and installed.

Additional length of posts, when included as a pay item in the proposal will be measured by the linear foot for the number of feet in excess of the normal post lengths specified.

806.17 Basis of Payment. The accepted quantity of fence will be paid for at the contract unit price for Fence of the type and size specified and shall include gates, unless otherwise provided. The price and payment shall be full compensation for furnishing and installing fence including posts, rails, post caps, braces, and shall include clearing and grubbing, grading, excavation, backfill and disposal of surplus materials; and shall include all materials, equipment, labor, and incidentals necessary to complete the work.

The accepted quantity of ornamental steel picket fencing will be paid for as Ornamental Steel Picket Fence of the height specified, which price and payment shall be full compensation for furnishing and installing all materials including pickets, rails, posts, post caps, concrete, paint, powder coat, prime, welds,

and all equipment, labor, and incidentals necessary to complete the work in accordance with these specifications and the plans.

The accepted quantity of gates, when listed as a pay item in the proposal, will be paid for at the contract unit price for Gate of the types and sizes specified, complete in place.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
8061XXX	*(size)* Woven Wire Fence *(type)*	Linear Foot
8062XXX	*(no. of strands)* Barbed Wire Fence	Linear Foot
8063XXX	*(size)* Chain Link Fence	Linear Foot
8064XXX	*(size)* Gate *(type)*	Each
8066000	Additional Length of Post	Linear Foot
8068148	Ornamental Steel Picket Fence – *(size)*"	Linear Foot

SECTION 807

RESET FENCE

807.01 Description. This work shall consist of the removal of existing fence within the limits of the improvement and, if necessary, storing it in a careful manner and then resetting it where shown on the plans, or as may be designated, in accordance with the requirements of these specifications and in conformity with the plans. Reset fence shall be classified as follows:

1. Reset Chain-Link Fence

2. Reset Fence

Reset chain-link fence shall consist of fence of chain-link fabric mounted on metal or concrete posts irrespective of the height of the fabric. Chain-link fabric attached to wooden posts will not be considered or classified as Reset Chain-Link Fence.

Reset fence shall consist of all types of fences necessary to be relocated, except chain-link fence as described above. Reset fence shall include board or timber fences, unless otherwise provided.

CONSTRUCTION REQUIREMENTS

807.02 General. The Contractor will be required to remove and rebuild the fences at the location designated on the plans or by the Engineer, using materials from the original fence and such new materials as may be necessary to complete the fence. The fence shall be left in as good condition as it was before removal. The fence shall be rebuilt using the same type of construction as was used in the original fence and all new posts, braces, wire or other materials required in this reconstruction shall be of the same character, size and type as in the original fence and shall be furnished by the Contractor without extra compensation. If new wood posts are required in the reconstruction, and posts of the same type as used in the original fence are not available, equivalent posts meeting the requirements of **Subsection 706.05** may be used by the Contractor without any additional compensation. However, posts of different types shall not be used in the same fence. Posts shall be spaced the same as the original fence, with a maximum distance of 16 feet on centers, except the maximum distance for chain-link fence shall be 12 feet. All trees, brush, stumps, logs or other debris that interfere with the reset fence shall be removed and disposed of as directed.

Rebuilt fences shall be true to line and shall be set vertical. All wires shall be taut. Barbed wire and mesh wire shall be stapled to each post and chain-link fabric shall be attached

to each post as set forth in **Section 806**. When resetting is finished, the fence shall present an acceptable appearance.

All gates shall be removed and restored for service at the new location. Any damage to fence and gates due to removal and rebuilding shall be repaired by the Contractor.

The Contractor shall be responsible for any crop or property damage caused by livestock or other animals escaping or entering through gaps left in fences by his workmen. When the reset fence crosses ditches or low areas, the openings under the fence shall be fenced or otherwise closed to retain livestock.

807.03 Method of Measurement. The quantity to be paid for shall be the linear feet, including gates, of completed fence that has been removed, rebuilt and accepted, determined by measuring along the top of the fence from outside to outside of each post for each continuous run of fence.

807.04 Basis of Payment. The accepted quantities of fence reset will be paid for at the contract unit price for Reset Fence or Reset Chain-link as the case may be, which price and payment shall include clearing and grubbing, grading, excavation, backfill, furnishing new materials, disposal of surplus material and all labor, equipment and incidentals necessary to complete the work.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
8071000	Reset Fence	Linear Foot
8072000	Reset Chain-Link Fence	Linear Foot

SECTION 808

RELOCATION OF STRUCTURES AND OTHER ITEMS (MOVING ITEMS)

808.01 Description. This work shall consist of the removal and relocation of buildings or miscellaneous structures of all types and including all utility connections, septic tanks and other appurtenances; the providing of new wells and the transplanting of trees, shrubbery, bulbs, etc., appertaining to the building or structure or individually in accordance with these specifications and as indicated on the plans.

MATERIALS

808.02 General. The suitability of materials salvaged from the existing structure for use in the removed and relocated structure shall be determined by the Engineer.

Brick or concrete block used in exterior walls, pillars, and chimneys unable to be moved with the structure shall be new material. Mortar used in masonry shall meet the requirements as specified in **Subsection 718.06**.

Concrete driveways and walkways constructed to replace existing drives and walks shall be constructed in accordance with the requirements of **Section 720**. The thickness shall be 6 inches uniform for driveways and 4 inches uniform for walkways.

All well casings, water pipes, and materials for steps are to be new unless the material salvaged from the old structure is acceptable.

Septic tanks and sewer pipes thereto shall be of new materials.

New materials shall conform to the applicable section of these specifications.

CONSTRUCTION REQUIREMENTS

808.03 General. Structures shall be prepared for removal, moved, and placed in their new locations as shown on the plans or as designated by the Engineer. They shall be set plumb, level, and each entire structure, including appurtenances, shall be left in as good condition in all respects as it was before moving.

The Contractor shall not make any change or alteration in the work specified to be done unless such change is approved by the Engineer.

The sizes of structures, distances to be moved, and elevations to be placed as shown on the plans and descriptions are approximate only. The Engineer may require the Contractor to move, without additional compensation, any structure an additional distance of 50 feet, raise or lower from the final elevation as shown on the plans a distance of 18 inches, or turn the structure through an angle of 15 degrees more than called for on the plans. In no case shall the bottom of wooden sills of a structure be less than 12 inches above ground. The Contractor shall investigate each item to determine the actual work involved in the moving and relocation of each item.

Steps, outside stairways, porches, sheds, and other appurtenances forming an integral part of the building are to be considered as part of the building and shall be moved and relocated accordingly. Cellars, cellar steps, drains, walls, concrete or masonry porches or floors, concrete brick and masonry foundations and supports, septic tanks, fireplaces, chimneys, and other appurtenances attached or connected to the building, but not movable as an integral part of the building, shall be removed, relocated, and replaced with such appurtenances of the same size, type, and character as existed

before the building was moved, unless otherwise specified. All driveways and walkways shall be replaced to conform to the new location of the building. All shrubbery and miscellaneous items appertaining to the structure shall be relocated to maintain the symmetry existing prior to relocation, unless otherwise specified.

Where work involves new materials or the reuse of salvaged materials in the removal and relocation of structures, in the cutting off of buildings or structures, or in the construction of new buildings or structures, all such work shall be painted in accordance with the requirements of **Section 710**.

Whenever sanitary sewers, water, gas, electric, or telephone service lines are connected to the building being removed and relocated, they shall be moved and reconnected without unnecessarily inconveniencing the occupants of the building. Utilities not reconnected shall be plugged or otherwise satisfactorily disconnected in a manner preventing infiltration of foreign matter. The Contractor shall arrange for and be responsible for the removal of all utility connections to mains where such will interfere in any way with the construction of the road. All work and costs incidental to removing and relocating these utilities shall be included in the contract price for moving the building to which they are attached. All connections and installations shall be in accordance with any codes, ordinances, or regulations governing such work. The Contractor will be responsible for all notices to public utility companies and shall pay all fees charged by the utilities concerning the moving operation.

The moving operation shall be so conducted as to allow the operator of any business to render service to his customers without undue interruption and after work is started on any building, a sufficient force shall be maintained to insure satisfactory progress. Work on any building, weather permitting, shall not be discontinued without consent of the Engineer.

Materials in existing foundations, drives, walks, concrete

or masonry floors, chimneys, etc., where not used in the reconstruction of appurtenances to structures being moved, shall be removed and disposed of as directed by the Engineer.

The contract prices for moving items shall include all costs of necessary clearing, grubbing and grading for the new site of structures being relocated, except as otherwise provided for on the plans.

The relocation of a building, any part of which is used as a service station, shall include the removal, relocation, and installation of all pumps, tanks, pipes, signs, grease pits or lifts and other accessories appurtenant to the service station or building.

The content of all structures shall be moved and relocated along with the structure to its new site. In the event that it is not practicable to move the structure with the contents therein, the contents shall be removed and replaced. Necessary precautions shall be taken to prevent damage to or loss of the contents.

All foundations for pillars, underpinning or chimneys shall be carried a minimum of 12 inches below ground and/or to a solid bearing. Footings shall be 6 inches wider than pillars or underpinnings and 12 inches wider than chimneys proper.

Septic tanks, tile drainage fields and privy installations shall meet the requirements of the South Carolina Department of Health and Environmental Control.

New wells and pumps shall furnish an adequate supply of potable water and shall in all cases furnish at least the amount of water as the pump or well being replaced. New pumps or wells shall be in service before the old units are made ineffective.

Moving items shown on the plans as parts of power transmission or other public utility lines are approximate as to

distance to be moved, materials to be furnished, and appurtenances. This work shall be performed in accordance with the owner's standard practice and to his satisfaction. The Contractor shall contact the owner of such items to determine and satisfy himself as to the amount of work to be performed.

Whenever the plans specify that buildings, structures, etc. are to be dismantled or salvaged, they shall be dismantled with sufficient care to preserve the salvage value of the materials therein. The Contractor will be required to store all salvage materials at locations shown on the plans or designated by the Engineer. The Contractor shall dispose of all discarded material, rubbish, or debris as directed by the Engineer.

All transplanting work required in the removal and relocation of buildings and structures, and as may be indicated on the plans, shall be performed in accordance with the requirements of **Section 811**.

808.04 Method of Measurement. Removal and relocation, when scheduled on the plans or in the proposal, will be measured in structure units and incidental improvements or appurtenances such as shrubbery, walkways, driveways, hog or chicken pens, fences, steps, pipe lines, septic tanks, pumps, grease pits or lifts and signs of service stations, which are not an integral part of the structure to be removed and relocated, and not necessarily shown on the plans, but the moving of which is made necessary because of the removal and relocation of the structure, shall be removed and relocated and such work shall be considered as incidental to the removal and relocation of the structure and included in the work to be performed under the moving item.

Transplanting, when scheduled on the plans and in the proposal, will be measured by actual count of plants transplanted or on a lump sum basis, whichever is stated in the proposal.

Other miscellaneous moving items included on the plans

and in the proposal will be measured by each complete unit.

808.05 Basis of Payment. The structures and other items removed, relocated, and accepted by the property owner and the Department, will be paid for at the contract price for the Moving Item of the corresponding schedule number, which price and payment shall constitute full compensation for furnishing all materials, tools, equipment, labor and incidentals necessary to complete the work.

Transplanting of trees, shrubbery, etc., will be paid for at the contract unit price for the Moving Item of the corresponding schedule number, which price and payment shall be full compensation for excavating, moving, preparing planting pits, setting, backfilling and watering the transplanted items, including all material, tools, equipment, labor and incidentals necessary to complete this work.

Payment will not be made on any item until the Contractor secures a statement from the property owner or owners certifying that the work has been performed to the property owner's satisfaction and that the Department and Contractor are released from all responsibility and liability in connection with the work. In extreme cases when, in the opinion of the Engineer, this requirement is being abused by the property owner, the Department, at its option, may waive the procurement of the owner's release.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
8081000	Moving Item No. *(schedule no.)*	Lump Sum

SECTION 809

RIGHT OF WAY MARKERS

809.01 Description. This work shall consist of furnishing and installing portland cement concrete land markers or rebar marker caps in accordance with these specifications at the locations and in conformity with the sizes, dimensions, and designs shown on the plans or as directed by the Engineer.

MATERIALS

809.02 Portland Cement Concrete. The portland cement concrete shall conform to the requirements for Class 3000 or better as specified in **Section 701** or shall be concrete of equivalent compressive strength with at least 6 bags of cement per cubic yard.

809.03 Reinforcing Steel. Reinforcing steel shall conform to the requirements specified in **Subsection 703.02**.

809.04 Marker Caps. Rebar caps used as right of way markers shall be Berntsen International, Inc. RBX6325, 3 1/4 inch, 6000 series, orbital forged aluminum, domed cap, or an approved equal, and shall meet the Department's specifications.

CONSTRUCTION REQUIREMENTS

809.05 General.

A. Concrete Markers. The right of way markers of the dimensions specified shall be precast in approved forms. The letters for creating the lettering as shown on the plans shall be rigidly attached to the forms. When the concrete has set the required time, the forms shall be removed in a manner that is not damaging to the marker lettering. All surfaces shall be finished to a smooth workmanship-like finish by removing the fins and form marks with a carborundum rubbing stone and pointing all holes with mor-

tar. The surface of all such pointed areas shall be made flush with the adjacent surfaces. No further finishing will be required unless necessary to create an acceptable workmanship-like finish. Curing shall be performed as specified in **Section 702**.

Right of way markers shall be placed plumb and accurately at the location specified and shall be backfilled with suitable material in layers not exceeding six inches loose measurement. Each layer shall be thoroughly compacted.

B. Rebar Cap. Rebar cap right of way markers shall be installed following the manufacturer's installation instructions where directed by the Engineer. The markers shall be set on 3/4 inch reinforcing steel a minimum of 2 feet in length. The top of the marker shall be set slightly below the ground surface to eliminate conflict with mowing and other maintenance operations.

809.06 Reset Right of Way Markers. When the proposal provides for existing right of way markers to be reset, the Contractor shall remove the existing markers and, if necessary, store, protect and reset them at designated locations as set forth in **Subsection 809.05**.

809.07 Method of Measurement. Right of way markers and reset right of way markers will be measured by the number of units installed.

809.08 Basis of Payment. The accepted quantities of right of way markers or reset right of way markers will be paid for at the contract unit price for Right of Way Marker, Right of Way Marker (Rebar Cap), or Reset Right of Way Marker, which price and payment shall include excavation, backfill and all materials, tool, equipment, labor, and incidentals necessary to complete the work.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
8091000	Right of Way Marker	Each
8091010	Right of Way Marker (Rebar Cap)	Each
8092000	Reset Right of Way Marker	Each

SECTION 810

SEEDING

810.01 Description. This work shall consist of seeding, fertilizing, liming when specified, mulching, and applying nitrogen when specified on all areas shown on the plans or where directed by the Engineer all in accordance with these specifications.

The Contractor shall coordinate seeding with the construction of fill and cut slopes. In order to limit the area of erodible material, the Engineer may require that partially completed slopes be brought to the required slope and that the Contractor perform seeding operations at that time.

MATERIALS

810.02 General. The Contractor shall, at the time of delivery, furnish the Engineer invoices of all materials received in order that the application rate of materials may be determined.

810.03 Seed. All seed shall conform to all State laws and to all requirements and regulations of the **South Carolina Department of Agriculture**.

The several varieties of seed shall be individually packaged or bagged and tagged to show name of seed, net

weight, origin, percentages of germination and purity, lot number and other information required by the Department of Agriculture.

The Department reserves the right to test, and reject or approve all seed before seeding.

Mixtures of different types of seed called for in the seeding schedule shall be weighed and mixed in the proper proportions at the site of the work in the presence of the Engineer.

810.04 Seeding Schedule. Unless otherwise provided, the Contractor may select the type of seeding from the table shown below for the upper State and the lower State as applicable to the project.

The upper State shall consist of all counties west of the counties of Aiken, Lexington, Richland, Kershaw, and Chesterfield. The lower State shall consist of the above cited counties and all counties east.

The total seed rate in pounds per acre shall be the sum total shown for all the varieties of seed opposite the schedule number in the seeding schedules below:

Seeding Schedule For Permanent Vegetation - Upper State				
Schedule No.	Common Name of Seed	Rural Rate	Urban Rate[1]	Planting Dates
1	Common Bermuda (hulled)[3]	23	23	March 15 to Aug. 14
	Sericea Lespedeza (scarified)[2]	50	50	
	Kentucky 31 Fescue	50	60	
	Weeping Lovegrass[2]	10	10	

Seeding Schedule For Permanent Vegetation - Upper State (Continued)				
Schedule No.	Common Name of Seed	Rural Rate	Urban Rate[1]	Planting Dates
2	Kentucky 31 Fescue	50	80	Aug. 15 to March 14
	Sericea Lespedeza (unhulled, unscarified)[2]	80	80	
	Common Bermuda (unhulled)	30	30	
	Weeping Lovegrass[2]	10	10	
	Reseeding Crimson Clover[4]	20	0	
	Rye Grain	20	0	

Seeding Schedule For Permanent Vegetation - Lower State				
Schedule No.	Common Name of Seed	Rural Rate	Urban Rate[1]	Planting Dates
3[5]	Common Bermuda (hulled)[3]	30	30	March 1 to Aug. 14
	Weeping Lovegrass[2]	10	10	
	Sericea Lespedeza (scarified)[2]	50	50	
4[5]	Common Bermuda (unhulled)[3]	40	40	Aug. 15-Feb. 28
	Weeping Lovegrass[2]	10	10	
	Sericea Lespedeza (unhulled, unscarified)[2]	80	80	
	Reseeding Crimson Clover[4]	20	0	
	Rye Grain	20	0	

Notes:

[1] Includes rural areas adjacent to well-developed lawns.

[2] Not required on shoulders, medians, etc., and slopes under 5 feet in

height.

[3] Giant Bermuda seed, including NK-37, shall not be used.

[4] Reseeding Crimson Clover shall be inoculated in accordance with **Subsection 810.05**. Do not plant clover in medians or in rural areas adjacent to well-developed lawns.

[5] Pensacola Bahia shall be allowed only as shown in Seeding Schedules 3 and 4 at the rate of 50 pounds per acre **only** when seeding pit areas that are governed by the **South Carolina Mining Act**. Otherwise, do not include Bahia seed in the mix.

The Contractor may include quantities of rye grain and millet in Schedule 1 and 3 in order to establish quick ground cover for erosion control purposes.

Seeding Schedules For Temporary Vegetation Upper And Lower State

Schedule No.	Common Name of Seed	Rate per acre (Lbs.)	Planting Dates
1	Annual Sudan Grass (Sweet or Tiff)	40	April 1 - August 15
2	Brown Top Millet	50	April 1 - August 15
3	Rye Grain	55	August 16 - March 31

Oat grain is to be added to all schedules, if seeding date is between March 1 and April 16, at the rate of 10 pounds per acre.

810.05 Inoculants. The inoculant for treating reseeding crimson clover seed shall be a pure culture of nitrogen-fixing bacteria selected for a maximum vitality and ability to transform nitrogen from the air into soluble nitrates and deposit them into the soil. Inoculants shall consist of purebred cultures and shall not be more than one year old. All cultures shall be subject to the approval of the Engineer.

810.06 Commercial Fertilizer. Commercial fertilizers shall

comply with State fertilizer laws.

In a mixed fertilizer such as 10-10-10, the first number shall represent the minimum percent of nitrogen required, the second number shall represent the minimum percent of available phosphoric acid required and the third number shall represent the minimum percent of water soluble potash required in the fertilizer.

810.07 Lime. Lime shall be agricultural grade, standard ground limestone conforming to the current ***Rules, Regulations and Standards of the Fertilizer Board of Control***. These rules, regulations and standards are promulgated and issued by the Fertilizer Board of Control at Clemson University in accordance with Section 16 of the ***South Carolina Liming Materials Act***. Each bag shall have affixed in a conspicuous manner a tag or label, or in the case of bulk sales, a delivery slip showing brand or trade name, calcium carbonate equivalent, percent by weight passing prescribed U. S. Standard sieves and other pertinent information to identify lime as being agricultural grade, standard ground limestone.

Liquid Lime may be substituted for ground lime provided it meets all requirements for Agricultural Lime, except percent by weight passing U.S. Standard Sieves, which is waived for Liquid Lime.

810.08 Tackifiers.

A. Emulsified Asphalt. Emulsified Asphalt shall meet the requirements of **Subsection 406.05**. Emulsified asphalt shall be diluted at the manufacturing plant with water, if necessary, to provide a homogenous and satisfactory material for spraying.

B. Chemical Tacking Agents. A chemical mulch binder shall consist of a polymer synthetic resin, polypectate, liquid latex, or other material that will give similar adhesive properties as asphalt emulsion when sprayed on straw and cellulose fiber mulches. Chemical tacking agents

shall be approved by the Engineer

810.09 Straw Mulch. Straw mulch material shall consist of straw or hay. Straw shall be stalks of wheat, rye, barley, oats or other approved straw. Hay shall consist of Timothy, Peavine, Alfalfa, Coastal Bermuda or other grasses from approved sources. These materials shall be reasonably dry and shall be reasonably free from mature seed-bearing stalks, roots or bulblets of Johnson Grass, Nutgrass, Sandburg, Wild Garlic, Wild Onion, Wild Mustard, Crotolaria, Pigweed, Witchweed and Cocklebur. The Contractor shall also comply with all State and Federal domestic plant quarantine regulations.

810.10 Wood Fiber Hydroseeding Mulch. Wood fiber hydroseeding mulch shall be made from wood chip particles manufactured particularly for discharging uniformly on the ground surface when dispersed by a hydraulic water sprayer. It shall remain in uniform suspension in water under agitation and blend with grass seed and fertilizer to form a homogeneous slurry. The fibers shall intertwine physically to form a strong moisture-holding mat on the ground surface and allow rainfall to percolate the underlying soil. The fiber material shall be heat processed and contain no germination or growth-inhibiting factors. It shall be dyed (non-toxic) an appropriate color to facilitate the application of material.

Suppliers shall be prepared to certify that laboratory and field testing of their product has been accomplished, and that it meets all of the foregoing requirements based upon such testing.

Weight specifications of this material from suppliers and for all applications shall refer only to air dry weight of the fiber material. Absolute air dry weight is based on the normal weight standard of the Technical Association of the Pulp and Paper Industry for wood fiber hydroseeding mulch and is considered equivalent to 10% moisture. Each package of the wood fiber hydroseeding mulch shall be marked by the manufacturer to show the air-dry weight content.

810.11 Cellulose Fiber Hydroseeding Mulch. Cellulose fiber hydroseeding mulch shall consist of recycled magazine stock products that are shredded into small pieces for application by hydraulic seeding equipment. It shall mix readily and uniformly under agitation with water and blend with grass seed and fertilizer to form a homogeneous slurry. When applied to the ground surface, the material shall form a strong moisture-holding mat, allow rainfall to percolate the underlying soil and remain in place until the grass root system is established. The material shall contain no growth inhibiting characteristic or organisms. Suppliers shall be prepared to certify that their product meets these requirements.

810.12 Wood/Cellulose Fiber Mix Hydroseeding Mulch. Wood/cellulose fiber mix hydroseeding mulch shall consist of a combination of **Subsections 810.10** and 810.11, at a ratio recommended by the manufacturer. The two mulches may be combined by the Contractor, depending on the site situation.

CONSTRUCTION REQUIREMENTS

810.13 Stand of Grass. Before acceptance of the seeding performed for the establishment of permanent vegetation, the Contractor will be required to produce a uniform perennial vegetative cover with a density of 70% of the seeded area. The root system shall be developed sufficiently to survive dry periods and winter weather and be capable of re-establishment in the spring.

Before acceptance of the seeding performed for the establishment of temporary vegetation, the Contractor will be required to produce a stand of grass sufficient to control erosion for a given area and length of time before the next phase of construction or the establishment of permanent vegetation is to commence.

810.14 Seeding Dates and Rates of Application. Seeding shall be performed during the periods and at the rates speci-

fied in the seeding schedules in **Subsection 810.04**. Seeding work may, at the discretion of the Contractor, be performed throughout the year using the schedule prescribed for the given period. Seeding work shall not be conducted when the ground is frozen or excessively wet. The Contractor will be required to produce a satisfactory stand of grass meeting the requirements of **Subsection 810.13** regardless of the period of the year the work is performed.

810.15 Preparation of Ground Before Seeding. The areas to be seeded shall be uniform and shall conform to the finished grade and cross-section shown on the plans or as otherwise designated. Minor shaping and evening of uneven and rough areas outside the graded section shall be performed as directed by the Engineer in order to provide for more effective erosion control and for ease of subsequent mowing operations.

The seedbed (including cut slopes) shall be loosened to a minimum depth of 3 inches before agricultural lime fertilizer or seed is applied. The areas to be seeded shall be cleared of stones larger than 2 1/2 inches in any dimension, roots, and other debris.

810.16 Applying Organic Topsoil. At areas to be grassed where the existing seed bed has little or no topsoil, the Contractor may furnish and place topsoil on the seed bed in order to ensure a good stand of grass. Organic Topsoil furnished and placed by the Contractor shall be measured and paid for by the cubic yard.

810.17 Applying Lime and Fertilizer. Following advance preparation and placing selected material for shoulders and slopes when called for in the contract, lime and/or fertilizer shall be spread uniformly over the designated areas and shall be thoroughly mixed with the soil to a depth of approximately two inches. Fertilizer shall be applied at the rate of 1000 pounds per acre unless otherwise directed. Lime shall be applied at the rate of 2000 pounds per acre, unless otherwise specified in the proposal, or as authorized by the Engi-

neer. Unless otherwise provided, lime will not be applied for temporary seeding. On steep slopes subject to slides and inaccessible to power equipment, the slopes shall be adequately scarified. Fertilizer and lime may be applied by approved mechanical spreaders or by hydraulic methods as a mixture of fertilizer and seed. When fertilizer is applied in combination seed and fertilizer drills, no further incorporation will be necessary. The fertilizer and seed shall be applied together when the hydraulic method of seeding is used. Any stones larger than 2 1/2 inches in any dimension, larger clods, roots or other debris brought to the surface shall be removed.

The Contractor may substitute a fertilizer of a different analysis than that specified on the plans. If a different fertilizer is used, the fertilizer shall be applied at such a rate per acre as to give at least the amount of nitrogen, phosphoric acid and potash as would have been accomplished had the specified fertilizer been used and applied at the specified rate. If the substitute fertilizer meets the minimum analysis of at least one or more of the three basic ingredients, the excess shall not be considered in calculating the required quantity of the substituted fertilizer. The Contractor will be paid for the number of tons of fertilizer which would have been required if the specified fertilizer had been used at the specified rate.

810.18 Permanent Vegetation. The Contractor shall obtain a satisfactory stand of perennial vegetation whose root system shall be developed sufficiently to survive dry periods and winter weather, and be capable of re-establishment in the spring. The perennial vegetative cover shall have a minimum coverage density of 70% for the seeded areas. Using the seed specified in Subsection 810.04, the Contractor shall determine all rates of application necessary to produce the required stand of grass, and shall follow the application procedures as specified herein.

810.19 Temporary Vegetation. The Contractor shall obtain a satisfactory stand of vegetation that is capable of erosion control. Using the seed specified in Subsection 810.04, the

Contractor shall determine all rates of application necessary to produce the required results. The temporary vegetation shall provide minimum density coverage of 70% of the seeded area.

810.20 Temporary Seeding. Seed shall be sown within 24 hours following the application of fertilizer and preparation of seedbed as specified in **Subsection 810.15**. Seed shall be sown at the specified rate by hand or by methods as outlined in Subsection 810.21 . The seeded areas shall be compacted or covered as specified in Subsection 810.21 On small areas inaccessible to machinery, the seed may be covered by hand rakes or other methods satisfactory to the Engineer. Fertilizer shall be applied at the rate of 500 pounds per acre or as directed by the Engineer. Lime will not be required in temporary seeding unless otherwise specified. No tackifiers or mulches will be required for temporary seeding.

Temporary seeding may be used in isolated problem areas or where it is not feasible or practicable to bring an area to final slope, grade and finish so that permanent seeding can be performed without subsequent serious disturbance by additional grading.

810.21 Seeding (Unmulched). Seeding without mulch (unmulched) shall conform to Methods A or B as prescribed below, except that Method A shall not be used in urban areas or in areas adjacent to sidewalk, guardrail, curb, curb and gutter, or concrete median.

Method A: **Seeding (Emulsified Asphalt Tackifier)**. Seed shall be sown within twenty-four (24) hours following the application of fertilizer and lime and preparation of the seedbed as specified in Subsections 810.15 and 810.17. Seed shall be uniformly sown at the rate specified by the use of approved mechanical seed drills, rotary hand seeders, hydraulic equipment, or any other type of equipment that will produce a uniform application of the seed.

Except on steep slopes where mechanical equipment

cannot operate satisfactorily, all seeded areas shall be lightly compacted by means of a cultipacker or light roller. Compaction will not be necessary if seeds are planted by mechanical seed drills that perform a compaction procedure. On slopes inaccessible to compaction equipment, the seed shall be covered by dragging spiked-chains, by light harrowing or by other satisfactory methods.

Within twenty-four (24) hours following compaction of the seeded areas, emulsified asphalt, diluted at the manufacturing plant with an equal amount of water, shall be uniformly applied over the seeded areas at a rate of 0.15 to 0.32 gallon of the dilution per square yard. The exact amount shall be as fixed by the Engineer.

Method B: **Seeding (Wood Fiber Mulch Tackifier, Cellulose Fiber Mulch Tackifier, or Wood/Cellulose Fiber Mix Tackifier**.) This work shall consist of applying lime and preparing the ground as shown on the plans or as directed by the Engineer, in accordance with **Subsections 810.15**, **810.16**,**and 810.17**. One of the tackifiers listed above, chosen by the Contractor, shall be applied at the rate of 1500 pounds per acre in a mixture of water, seed, and fertilizer. Hydraulic equipment shall be used for the application of fertilizer, seed, and slurry of the prepared mulch. This equipment shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry of the specified amount of mulch, fertilizer, seed and water. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles that will provide even distribution of the slurry on the various areas to be seeded. The slurry tank shall have a minimum capacity of 1000 gallons.

The seed, fertilizer, mulch and water shall all be combined into the slurry tank for distribution of all ingredients in one operation by the hydraulic seeding method specified herein. The materials shall be combined in a manner recommended by the manufacturer. The slurry mixture

shall be so regulated that the amounts and rates of application shall result in a uniform application of all materials at rates not less than the amounts specified. Using the color of the mulch as a guide, the equipment operator shall spray the prepared seedbed with a uniform visible coat. The slurry shall be applied in a sweeping motion, in an arched stream, to fall like rain, allowing the mulch to build upon each other until an even coat is achieved.

810.22 Seeding (Mulched). Seeding with mulch (mulched) shall conform to Methods A, B, or C as prescribed below, except that Method A shall not be used in urban areas or in areas adjacent to sidewalk, guardrail, curb, curb and gutter, or concrete median.

Method A: **Seeding (Straw or Hay Mulch)**. Seed shall be sown as specified in Method A of **Subsection 810.21**. Within twenty-four (24) hours following covering of the seed, straw or hay mulch material shall be uniformly applied at the rate of 2 tons per acre. Mulch may be spread either by hand, by appropriate mechanical spreaders or by blowers. The mulch shall not only allow sunlight to penetrate and air to circulate, but also partially shade the ground and conserve soil moisture. The newly laid mulch shall be held in place by emulsified asphalt meeting the requirements of **Subsection 810.08**, or other approved tacking agent.

Emulsified asphalt shall be diluted at the manufacturing plant with an equal amount of water and shall be uniformly applied over the mulch material as a film. The film shall be applied at approximately 0.20 gallon of dilution per square yard and shall be sufficient to bond together the mulch particles without giving a heavy coating of the asphalt material and shall prevent wind erosion. Other tacking agents that may be used shall be applied at the manufacturer's recommended rate. Displaced mulch shall be replaced.

Method B: **Seeding (Straw and Hydroseeding Mulch)**. Seed shall be applied as in Method A in Subsection 810.21, then cover with straw tacked with manufacturer's recommended rate of wood, cellulose, or a wood/cellulose mix hydroseeding mulch; or straw tacked with manufacturer's recommended rate of a combination of tacking agent and any of the aforementioned hydroseeding mulches.

Method C: **Seeding (Hydroseeding)**. Hydroseed using 1500 pounds per acre wood, cellulose, or a wood/cellulose mix hydroseeding mulch with the manufacturer's recommended rate of an approved tacking agent.

810.23 Protection of Structures. Before spraying emulsified asphalt, the Contractor shall cover any parts of bridges, culverts, guardrail, signs, sidewalk, curb and gutter, catch basins, pipe ends, and other structures as necessary to prevent discoloration.

810.24 Application of Nitrogen. As soon as the plants show satisfactory growth, nitrogen shall be applied evenly at the rate of 48 pounds per acre on the areas designated by the Engineer. Unless otherwise permitted, the nitrogen shall be applied in a solid form rather than in a liquid state. Nitrogen shall not be applied to stands of sericea lespedeza. Unless otherwise provided, nitrogen will not be applied to temporary vegetation.

810.25 Mowing. This work shall consist of the mowing of areas seeded or sodded under the contract or other areas as necessary to provide adequate sight areas and to maintain the project in a satisfactory manner. Mowing shall be performed by the Contractor where directed by the Engineer and such mowing shall commence within three (3) business days following verbal notification by the Engineer. Failure of the contractor to comply with the above may be grounds for stopping work on the project or withholding payment of the Monthly Construction Estimate.

Mowing equipment used by the Contractor shall be equipped with safety devices designed to prevent injury or property damage caused by flying debris propelled from under the mowing equipment. All mowing equipment shall be kept in good operating condition and shall be maintained to provide a clean, sharp cut of vegetation at all times. If the Engineer determines the equipment is defective to the point that the quality of work or safety is affected, the equipment shall be immediately repaired or replaced.

Mowing shall result in a vegetation height of 4 to 6 inches, unless otherwise directed by the Engineer. The Contractor shall mow as closely as possible to all fixed objects, exercising care not to damage trees, plants, shrubs, signs, delineators or other appurtenances which are a part of the facility. Hand trimming around such objects may be required of the Contractor.

The Contractor shall immediately remove and properly dispose of any debris thrown on the roadway by the mowing operation. Mowed grass will not normally be removed unless it becomes a hazard as determined by the Engineer.

Mowing will not be performed when in the opinion of the Engineer, soil and weather conditions are such that rutting or other damage to the project may occur. The 3 business day period noted above shall be extended by such time that the soil and weather conditions prevent mowing of the project.

810.26 Maintenance. The Contractor will be required to do all maintenance necessary to keep seeded areas in a satisfactory condition until the work is finally accepted. This includes mowing and repairing washes and additional seed, fertilizer and mulch applied to areas where a satisfactory stand of grass has not been achieved.

810.27 Method of Measurement. The quantity of Permanent Vegetation, Temporary Vegetation, Temporary Seeding, Seeding (Unmulched) or Seeding (Mulched) to be paid for shall be the actual number of thousand square yards (MSY),

measured along the surface of the ground of surface area, seeded and completed.

Fertilizer and lime will be measured by the ton. Nitrogen (actual) will be measured by the pound. Weights will be determined by approved scales or by guaranteed weight of sacks shown on the manufacturer's tag. The Contractor shall furnish the Engineer with invoices of the above materials received on the project.

The quantity of mowing to be paid for will be the actual number of thousand square yards (MSY), measured along the surface of the ground, which has been mowed at the direction of the Engineer. Separate measurements will be made each time the area is mowed.

The quantity of topsoil to be paid for will be the actual number of cubic yards measured and placed on site.

810.28 Basis of Payment. The accepted quantities of vegetation areas will be paid for at the contract unit price for Permanent Vegetation or Temporary Vegetation, which price and payment shall be full compensation for furnishing all materials (including fertilizer, lime and nitrogen when called for), labor, tools, equipment and incidentals necessary to complete the work herein prescribed in a workmanlike and acceptable manner.

The accepted quantities of seeded areas will be paid for at the contract unit price for Temporary Seeding, Seeding (Unmulched) or Seeding (Mulched), which price and payment shall be full compensation for furnishing all materials (excluding fertilizer, lime, nitrogen and selected material for shoulders and slopes), including all, tools, equipment, labor and incidentals necessary to complete the prescribed work in an workmanlike and acceptable manner. Payment to the Contractor shall not exceed 90% of the contract unit price for these items until a satisfactory stand of grass meeting the requirements of **Subsection 810.13** has been obtained.

Fertilizer furnished, applied, complete in place and measured as provided in **Subsection 810.27**, will be paid for at the contract unit price for Fertilizer, which price and payment shall be full compensation for furnishing and applying fertilizer, including all materials, tool, equipment, labor, and incidentals necessary to complete the work.

Lime furnished, applied, complete in place and measured as provided in Subsection 810.27, will be paid for at the contract unit price for Lime, which price and payment shall be full compensation for furnishing and applying lime, including all materials, tool, equipment, labor, and incidentals necessary to complete the work.

Nitrogen (actual) furnished, applied, complete in place and measured as provided in Subsection 810.27, will be paid for at the contract unit price for Nitrogen, which price and payment shall be full compensation for furnishing and applying nitrogen, including all materials, tool, equipment, labor, and incidentals necessary to complete the work.

The quantity of mowing, measured as provided in Subsection 810.27, will be paid for at the contract price for Mowing, which price and payment shall be full compensation for all materials, tools, equipment labor, and incidentals necessary to complete the work. No adjustments in unit price will be made in case of overrruns or underruns.

The quantity of topsoil, measured as provided in Subsection 810.27 will be paid for at the contract unit price for Organic Topsoil, which price and payment shall be full compensation for furnishing and placing topsoil and all materials, tools, equipment, labor, and incidentals necessary to complete the work.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
8100001	Permanent Vegetation	MSY
8101000	Seeding (Mulched)	MSY
8102100	Seeding (Unmulched)	MSY
8103000	Temporary Seeding	MSY
8103001	Temporary Vegetation	MSY
8104X00	Fertilizer *(analysis)*	Ton
8105000	Lime	Ton
8106000	Nitrogen	Pound
8109900	Mowing	MSY
8101100	Organic Topsoil	Cubic Yard

SECTION 811

PLANTING TREES, SHRUBS, VINES, AND GROUNDCOVERS

811.01 Description. This work shall consist of furnishing, delivering, and planting trees, shrubs, vines, and groundcover plants of the type and size indicated on the plans or in the special provisions. This work shall also including all materials and incidental operations (including plant maintenance and guarantee) completed in accordance with these specifications and in conformity with the locations and elevations shown on the plans or specified by the Engineer.

811.02 Plant Materials.

A. Quality of Plant Materials. All Plants shall be first-class representatives of their normal species or varieties unless otherwise specified as “street-tree,” “extra heavy,” “clump,” and other of like import, according to the particular exception.

Unless otherwise specified, all plants shall be nursery grown stock that has been transplanted or root-trimmed two or more times, according to the kind and size of plants. The branch system shall be normal development and free from disfiguring knots, sun-scald, injuries, abrasions of the bark, dead or dry wood, broken terminal growth or other objectionable disfigurements. The trunks shall be undamaged. Trees shall have reasonably straight stems and shall be well branched, symmetrical shaped, and typical of their species.

B. Plant Names. All scientific and common plant names of the items specified shall conform to the edition of ***Standardized Plant Names***, as adopted by the **American Joint Committee on Horticultural Nomenclature** that is in effect at the time of the invitation for bids. Names of varieties not included therein conform generally to names accepted in the nursery trade.

All plants delivered shall be true to name and legibly tagged with the names and sizes of the plant. In all cases, botanical names shall take precedence over common names.

C. Substitutions. There shall be no substitutions, deletions, or additions without approval of the Engineer. The Engineer may allow substitutions after award of contract only upon submission of proof in writing that a plant is not obtainable and authorization for use of the nearest equivalent obtainable size or variety of plant having the same

essential characteristics. Should this approved substitution result in the use of a smaller or less valuable plant, a supplemental agreement will be issued with an equitable adjustment in contract price.

D. Grading Standards. Grading of plants shall conform to the ***American Standard for Nursery Stock (ASNS)***, as approved by the **American Nursery & Landscape Association** in effect at the time of invitation for bids and to any further requirements that may appear in the special provisions. This includes measurements, branching, grading, quality of balling, and burlapping standards.

E. Nursery Inspection & Plant Quarantine. All plants shall be free from plant diseases and insect pests. All shipments of plants shall comply with all nursery inspection and plant quarantine regulations of the States of origin and destination, as well as with Federal regulations governing interstate movement of nursery stock. A valid copy of the certificate of inspection shall accompany each package, box, bale, or carload shipped or otherwise delivered.

F. Balled and Burlapped Plants. Balled and burlapped plants shall be dug so as to retain as many fibrous roots as possible and shall come from soil which will form a firm ball. The soil in the ball shall be the original and undisturbed soil in which the plant has been grown. The plant shall be dug, wrapped, transported, and handled in such manner that the soil in the ball will not be so loosened that it would cause stripping of the small and fine feeding roots or cause the soil to drop away from such roots.

G. Container Grown Plants. Plants that are furnished in containers shall be well rooted and established in the container in which they are shipped. An established container grown plant shall be a plant transplanted into a container and grown in that container sufficiently long for the new fibrous roots to have developed so the root mass will retain its shape and hold together when removed from the con-

tainer. Container grown stock shall not be removed from containers until planting time.

H. Bare Rooted Plants. The minimum root system of bare rooted trees or scrubs shall conform to the standards stated in the *ASNS*. Bare rooted plants shall be dug only when the air temperature exceeds 35°F. Particular attention shall be given to the fibrous roots. The maximum time lapse between loading for shipment and delivery to the work or approved storage site shall be four (4) days unless other shipping arrangements are approved.

I. Collected Plants. Collected plants, when specified in connection with any species or variety, shall not be nursery grown, but shall have been grown under natural conditions at the location from which they were procured. They may be balled and burlapped or bare root as specified in the plant list on the plans. In either case, the collected material shall conform to the applicable requirements given in the current issue of *ASNS* for quality, size, ball and grade.

J. Forms, Shapes, and Condition of Plants.

1. Vines and ground cover plants shall conform to grades and specifications shown in the *ASNS* unless otherwise specified.

2. Plants. Plants larger than specified in the plant list may be used if approved by the Engineer, but use of such plants shall not increase the contract price. Plants designated on the plans as street trees, specimen, extra heavy, clump or of other import shall conform to the standards as given in the *ASNS* for the special type specified.

3. Trees shall have straight trunks, be well branched and have symmetrical tops. There shall be no cuts of limbs over 3/4 inch in diameter that have not completely healed over. Each tree shall have the top and

root characteristics of its variety and growth that are typical of such trees in this region. Deciduous trees, unless otherwise specified, shall have branching between one quarter and one half of the distance of their height from the ground. Street trees, if so specified, shall be of uniform branching height. Bush form, when specified, shall be branching at the base of the plant or within one foot of the base. Clumps, when specified, shall have three or more main leaders or trunks starting at the ground. At least two of these shall be of the caliber specified.

K. Inspection. Plant materials shall be subject to inspection at any time during the life of the contract. Such inspection shall not be construed as final acceptance of the plants involved. Any stock which does not conform to these specifications will be rejected and shall be removed from the project by the Contractor. The Contractor shall notify the Department's representative in advance when he expects to have the stakes set to show position of holes for all trees and shrubs; when he expects to have the holes dug to receive trees, shrubs or vines; when the plant materials will be assembled for inspection before planting; and when the planting will be done.

L. Shipment. All precautions that are customary in good trade practice shall be taken to insure the arrival of the plants in good condition. Plants shall be packed or covered in such a manner to insure adequate protection against damage while in transit. The roots of bare root plants shall be carefully protected with wet straw or other suitable material to insure the arrival at destination with the roots in a moist condition. When shipment is made in an enclosed vehicle, the vehicle shall be adequately ventilated to prevent overheating of the plants in transit.

M. Certificate of Compliance. The Contractor shall furnish certificates of compliance from all plant supply sources certifying that all plants furnished comply with the requirements specified in these specifications.

811.03 Topsoil. Topsoil shall consist of fertile, friable soil and shall contain a normal amount of organic matter. It shall be reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than one inch in size, coarse sand, noxious seeds, brush, litter or other deleterious substances. Topsoil shall be free from toxic amounts of either acid or alkaline elements and shall be capable of sustaining healthy plant life. Topsoil shall not be stripped below the average depth of fertility and in no case more than 12 inches. All topsoil will be subject to inspection during the planting period and any material that does not meet the specifications will be rejected.

811.04 Fertilizer and Lime. Fertilizer and lime shall conform to the requirements specified in **Subsections 810.06** and **810.07**, respectively.

811.05 Super-phosphate. Super-phosphate shall be composed of finely ground phosphate rock as commonly used for agricultural purposes containing not less than 18% available phosphoric acid.

811.06 Mulch Materials. Mulch shall consist of medium grade, pine bark, or shredded pine wood containing bark, or other approved material. The mulch shall contain no noxious weed seeds, soil, sawdust, or any substance toxic to plant growth and shall be considered incidental to the planting operation and no separate payment will be made therefore.

811.07 Miscellaneous Material.

A. Water. Water used in the planting or care of vegetation shall be free from oil, acids, alkalis, salts or any substance injurious to plant life. Water from streams, lakes, ponds or similar sources shall not be used unless approved.

B. Stakes for Bracing and Anchoring. Stakes for bracing or supporting trees shall be of cedar, locust, oak, or other approved wood free from knots, rot, cross grain, or other defects that would impair the strength of the stake for which it is to be used. Stakes shall be a minimum 2 inches by 2 inches square in cross-section and of adequate length. The bracing stakes shall be painted or stained dark green.

C. Weed Control Cloth. The weed control cloth shall be an approved geotextile landscape fabric made of polypropylene, black in color, and UV stabilized. It shall weigh from 4.8 to 5.3 ounces per square yard. Black plastic film is not acceptable.

D. Porous Material. Porous material for tree root protection may be gravel, crushed stone, slag or other porous material varying in size from 1 to 3 inches and shall be approved before being used.

E. Pipe. Pipe for underdrains shall comply with Section **802** for the size and type specified.

CONSTRUCTION REQUIREMENTS

811.08 Clearing and Grubbing. The scope and method of work shall be as described in these specifications for Clearing and Grubbing, **Section 201** with the following additions or exceptions. Some selective thinning or removal of trees or plants may be required. Trimming may be required on selected trees which are to remain in place.

811.09 Grading. The scope and method of work shall in general be as prescribed in these specifications for Roadway and Drainage Excavation, **Section 203**, with the following addition. Special attention is to be given to the elimination or reduction of construction scars. The slopes are to have transitions blending into each other to give a pleasing appearance and to reduce cost of maintenance. The first operation

of grading should be the stripping of topsoil as directed by the Engineer and the piling of it for convenient later use in the planting of grass, trees, shrubs, vines, etc. This topsoil will be paid for as excavation or be subject to the requirements of **Subsection 104.09**, Rights of the Use of Materials Found on the Work.

811.10 Planting Season. All planting of trees, shrubs, vines, etc., shall be done from the first of November to the middle of March, preferably just after the fall of the leaves of deciduous plants. The Engineer may permit planting at other times when necessary. Work shall not be done when, in the judgment of the Engineer, the weather and soil conditions are unfavorable.

811.11 Reception and Care of Plant Materials. All plants shall be handled so that the roots are adequately protected at all times from drying out, freezing or from other injury. The balls of balled and burlapped plants that are not planted immediately on delivery shall be well protected with moist soil or other acceptable material. If bare-rooted plants are not planted on delivery, they shall be healed-in immediately in moist soil and kept watered until planted.

The Contractor is responsible for loss due to theft. The Contractor shall replace all plants lost due to theft at no additional charge to the Department, until the Initial Construction Inspection is completed.

811.12 Locating Planting Pits. The Contractor shall place a stake where each plant is to be planted. This staking shall be approved by the Engineer before the planting pits are dug. The Engineer may require variations from the plans. No plant material shall be planted in drainage ditches, or within the minimum setback distance from the edge of travelway.

811.13 Preparation of Planting Pits. The area within a radius of five feet of the center of each plant shall be cleared of weeds, brush, etc.

Planting pits and beds shall be prepared before or concurrently with digging of the plants so that no delay will occur as a result of the planting area not being ready. All plant materials shall be planted in pits, except those specifically designated on the plans to be planted in beds.

All planting pits shall be circular in outline, have vertical sides and flat bottoms. The depths of planting pits, specified below, shall be measured from finished grade. Minimum depth of pits for trees shall be 2 feet and this depth shall be increased as much as may be necessary to accommodate the ball or roots when the tree is set to finished grade. Diameter of pits for trees shall be at least 2 feet greater than the diameter of the ball, container or spread of roots. Minimum depth of pits for all shrubs and vines shall be 16 inches and this depth shall be increased as much as may be necessary to accommodate the ball or roots when the plant is set to grade. Diameter of pits for all shrubs and vines, except those supplied bare-rooted, shall be at least 2 feet greater than the ball. Bare-rooted shrubs and vines shall be planted in pits at least one foot greater in diameter than the spread of roots.

During the excavation of planting pits, any soil that meets the specifications for topsoil shall be placed in piles separate from the poorer subsoil.

It is the responsibility of the contractor to verify that each excavated tree or shrub pit will percolate (drain) before adding topsoil and installing trees or shrubs. The contractor shall fill the bottom of selected holes with 6 inches of water. This water should percolate within a twenty-four (24) hour period. The Engineer shall verify accuracy and effect of percolation testing. If the soil at given area does not drain properly, a PVC drain or gravel sump shall be installed or the plantings relocated. It the soil is consistent throughout the project site, then selective tree or shrub pits may be tested for drainage.

Should the contractor encounter unsatisfactory surface or subsurface drainage conditions, soil depth, latent soils, hard

pans, steam or other utility lines or other conditions that will jeopardize the health and vigor of the plants, he must advise the Engineer in writing of the conditions prior to installing the plants. Otherwise, the Contractor warrants that the planting areas are suitable for proper growth and development of the plants to be installed.

No excavation or planting pit shall be left unattended or open overnight, except pits for percolation tests.

Each pit shall be approved by the Engineer and after approval, partly filled and compacted with the backfill mixture to a depth of 6 inches. This operation may be performed either before or after the depth of the pit is tested for the individual plant to go in it, but must be repeated if the loose soil is removed to deepen the pit. The mixed soil in beds shall be moist, but shall not contain excessive water to cause puddling or undue compaction at the time plants are set.

811.14 Preparation of Soil for Backfill. Backfill mixture for filling plant pits shall consist of 75%, by volume, acceptable topsoil and 25%, by volume, composted organic matter or other approved matter. During planting, 3 pounds of 4-12-12 or equivalent fertilizer shall be added to each cubic yard of backfill mixture. The topsoil, organic matter and fertilizer shall be thoroughly mixed before being placed into the pits or beds. Slow-release fertilizer tablets may be used, at rates according to manufacturer's instructions. All backfill materials are considered incidental to the planting and payment of this work will be included in the unit price for trees, shrubs, and ground covers.

811.15 Special Acid Soil Mixture. Rhododendron, Kalmia, Azalea and other members of the Heath family (Ericaceae); Thea, Camellia, Gardenia, and other members of the Tea family (Theaceae); and a few other shrubs that require an acid soil will have the notation in the legend "Require Acid Soil". The backfill around them shall be composed of "Woods Earth" or rich topsoil and leaf mold or rich topsoil and peat moss. One pound of cottonseed meal to each 5 cubic feet of

backfill shall be well mixed in. No commercial fertilizer of unknown composition, bone meal, lime ashes, limestone soil, fresh manure or other alkaline material shall be placed around them.

811.16 Planting. Before setting plants, a minimum of 3 inches of prepared soil as described above shall be placed in the pits for all shrubs and trees with root balls less that 2 foot in diameter. Plants shall be set at such level that, after settlement, they will bear the same relation to the level of the surrounding ground as they bore to the ground from which they were dug; they shall be planted upright and faced to give the best appearance. When shrubs vary in height, the larger shall be placed in the center of the group or at its wider parts. In the case of balled plants, all burlap, cloth, twine, wire, etc. shall be removed from the tops and sides of the balls, but no burlap or cloth shall be pulled out from under the balls. Roots of bare-root plants shall be spread out to approximately their original position and the prepared soil mixture carefully worked in among them. All broken or frayed roots shall be cut off cleanly. The backfill shall be put in and tamped in successive 8 inch layers. When the hole has been nearly filled, water shall be poured in and allowed to soak so that all voids or air pockets under or around the roots are eliminated. After the water has soaked down, the hole shall be filled with the prepared soil. A shallow saucer, capable of holding water, shall be formed around each plant by placing a mound of topsoil around the edge of each pit.

Pre-emergent herbicides shall be used unless indicated otherwise in the notes on the plans or special provisions. After planting, tree, shrub, and ground cover beds shall be treated with Ronstar G., Treflan, or a comparable pre-emergent herbicide, which will not harm the type plants to be installed in the beds. These herbicides shall be used strictly according to manufacturer's direction as to application quantity, methods, and precautions to be used for effectively and safely applying such a toxic product.

811.17 Mulching. Mulch material satisfactory to the Engi-

neer shall be carefully placed as a top layer on the backfilled plant hole after all planting operations have been completed. In general, the depth of this layer of mulch shall be up to three inches, but shall vary according to the climatic conditions and to the type of material used, and shall be determined by the Engineer. Mulch shall be placed within forty-eight (48) hours after planting.

Weed control cloth shall be used unless otherwise directed in the plans or special provisions, and shall meet the specifications of **Subsection 811.07C**.

811.18 Transplanting Selected Trees and Shrubs. Plants on the project that are to be moved will be indicated or listed on the plans or in the special provisions. Diameter of ball or root system, method of planting for each kind and size of plant, etc. will be specified in a list on the plans or in the special provisions. One of the following methods will be specified:

A. Ball and Burlap. This method shall consist of digging the plants with a ball of earth that shall be securely wrapped in burlap. Due care shall be used to preserve the solidity of the ball. Only experienced nursery workers shall be use for this work. This method will be employed for evergreens and other plants likely to be injured by moving without a ball.

B. Canvas and Platform. This method shall consist of digging with large ball which shall have its circumference wrapped in a canvas and rope apparatus made for the purpose and shall then be placed and fastened on a platform made for the purpose. Apparatus and procedure shall meet the approval of the Engineer. Only experienced nursery workers shall be used for this work. A truck with a windlass may be required. This method shall be employed for plants with balls of earth weighing over 800 pounds.

C. Tree-Moving Machinery. This method shall consist of

moving by tree-moving machinery, both apparatus and procedure to be approved by the Engineer. Only experienced machinery operators shall be used for this work. This method shall be used for trees of over 6 inches in diameter.

D. Loose Ball. This method shall consist of moving the plant with all dirt practicable adhering to the roots, but without wrapping the ball in burlap or necessarily keeping it solid. The plant shall be dug without shaking the dirt from the roots and shall be placed carefully on a piece of burlap and carried to the new position by two or more persons or in a wheelbarrow and carefully placed in the pit with or without taking it off the burlap. Great care shall be used not to have the dirt fall off the roots. This method will be specified for most shrubs and some evergreens that do not have to be moved more than two hundred feet.

E. Bare Root. This method shall consist of digging and moving the plant without keeping any dirt on the roots. It will be specified for plants that are not ordinarily injured greatly by moving and that do not readily hold the dirt to their roots.

In all respects other than those outlined above, the planting of plants from the project shall be done as specified for plants purchased from outside, including preparation of pits, planting, pruning, wrapping, etc.

811.19 Wrapping. Trees shall not be wrapped unless indicated in the plant list on the plans. If indicated, trees shall be wrapped as follows:

Promptly after planting, the trunks of all deciduous thin-barked trees shall be wrapped spirally from the ground line to the height of the second branches or to the height directed by the Engineer, using burlap or heavy crepe paper strips 6 to 10 inches wide, which shall be securely tied with twine.

811.20 Top Pruning. Pruning shall be done as directed by the Engineer. The general principles of pruning shall be as follows:

Remove all undesirable branches; those that are weak or damaged; that tend to cross the plant; that detract from the appearance of the plant; and tree branches that hang too low. Cut back until enough of the branches are removed to balance roots cut in digging on all kinds of plants that usually receive a severe setback by being transplanted, such as Oaks (Quercus), Hawthorn (Cratagus), Firethorn (Pyracantha), etc.

811.21 Retaining Walls and Tree-Wells. Retaining walls around the roots of trees or shrubs and tree-wells around the trunks of trees or shrubs shall be constructed at the locations and to the shape and dimensions shown on the plans or as otherwise designated. They shall be of mortar and rubble masonry, dry rubble masonry, or other type, and shall conform to the requirements of **Section 718**. Only dry rubble masonry shall be used in any portion of tree wells extending below the top of contiguous porous material used for tree root protection. The inside face of a tree well shall be no less than 2 feet from the outside edge of the trunk of the tree or shrub. No material shall be placed between the tree trunk and the wall of the tree-well.

811.22 Tree Root Protection. Where tree root protection is specified, the entire area of the root spread shall be protected. The limits of this area shall be as designated, but in general, this area will correspond to the area of the ground surface lying beneath the limb spread of the tree. This area shall first be thoroughly cleaned of all vegetation and debris. Porous material as specified in **Subsection 811.07** shall then be placed uniformly over the area to a depth in proportion to the height of fill, varying proportionally from 3 inches for fills of one foot or less to 12 inches for fills of 4 feet or more, or to such other depths as may be designated. A layer of No. FA-12 or No. FA-13 sand or other approved material shall then

be placed in sufficient quantity to choke the top layer of porous material and will be measured and paid for as porous material.

Where the earth fill is less than 12 inches and tree root protection is specified without the construction of a tree-well, the thickness of the porous material at the tree trunk shall be increased to the height of the fill and extend outward from the tree trunk in collar form for a distance of 12 inches, unless otherwise shown on the plans. Rubble aggregate as specified in **Section 718** shall be used for placement against the tree trunk.

No fill shall be placed over the root spread of any tree or shrub that is to be protected in the above manner until the required depth of porous material has been placed.

811.23 Pipe Underdrains. Pipe underdrains, when so shown on the plans or directed, shall be placed to drain tree-wells or porous material for tree root protection. These shall be placed under applicable provisions of **Section 802**.

811.24 Staking. All trees having a diameter of 2 1/2 inches or less shall be staked. Stakes shall be approximately 8 feet in length and shall be driven into firm ground at least 2 feet if driven outside the planting pit and at least 2 1/2 feet if driven through the pit. The trees shall be tied to the stakes by garden hose through which wire has been strung or nylon strips with eyelets manufactured specifically for tree staking in such a manner as not to injure the trees. The Contractor shall make every effort to stake the trees in an approved manner that will present the most satisfactory appearance.

811.25 Guying. All trees over 2 1/2 inches in diameter shall be guyed with 3 guys consisting of 2 strands of No. 12 gage galvanized wire placed at approximately equal distances from each other. Guys shall be tightened by twisting the strands together. Wires shall not come in direct contact with the tree, but shall be covered with rubber hose or heavy cloth padding at the point of contact. They shall be fastened to the tree in

such a manner as to avoid pulling crotches apart. Wires shall run from the trunk of the tree at about 8 feet above the ground at an angle of about 45 degrees to stakes driven in the ground. As far as possible, wires shall be placed so as to avoid danger of persons tripping over them. All wires to be placed with brightly colored uniform flagging for easy sighting.

811.26 Clean-Up. At the conclusion of the work, all unused soil, all sticks, stones, other refuse and unsightly materials shall be removed and disposed of as directed by the Engineer. Holes left by moving plants shall be filled and tamped. The planted area shall be smoothed and dressed. Streets and paved areas shall be cleaned regularly to remove construction materials and other debris resulting from the Contractor's work.

811.27 Inspection.

A. Initial Construction Inspection. The Initial Construction Inspection will be held within fifteen (15) days after the Engineer has been notified that all work including final cleanup has been completed. This inspection will serve to check the Contractor's workmanship. No plants will be accepted or rejected except as set forth in **Subsection 811.02K**.

B. Final Inspection. The Final Inspection will be held on or before the end of the establishment period. At that time, it will be determined as to which plants are rejected or missing and need replacing.

C. Replacements. Plants that are rejected or designated to be replaced during the Final Inspection will be replaced within thirty (30) calendar days following the Final Inspection or during the next planting season as determined by the Engineer.

Replacements of plant material shall be done using the methods and procedures outlined previously for initial plantings. The Contractor shall furnish, install, and care

for the replacement plantings for a thirty (30) day period without any additional compensation.

If any of the replacement plantings are defective, missing, or otherwise unsatisfactory at the end of the thirty (30) day period, they shall be replaced with satisfactory plantings.

D. Establishment Period Inspection. Regular inspections will be made throughout the plant establishment period. These shall serve as an inspection of the care and maintenance performed by the Contractor. After notification of a problem with the care and maintenance performed by the Contractor, the problem shall be corrected by ten (10) working days. Failure to perform maintenance may result in a delay in the payment to the Contractor midway through the plant establishment period as specified in **Subsection 811.31**.

811.28 Establishment Period. The plant establishment period shall be that time from planting through and including twelve months following the initial construction inspection.

811.29 Plant Establishment Work. Plant establishment work shall include fertilizing as described below, watering as necessary as described below, adding mulch to saucers, pruning, weeding, pest control, repair, and adjustment of guys and stakes and saucers, and any other work deemed necessary by the Engineer. These maintenance items shall be considered incidental to the tree planting work and will be included in the unit price for tree planting.

All transplanted plant material shall be fertilized in midspring with 16-4-8 fertilizer as follows:

Ground cover beds and small shrubs, apply 2 pounds per 100 square yard. For shrubs, apply 0.5 cup to each shrub. For trees, at the rate of 1.5 pounds per inch of trunk diameter. Spread fertilizer

evenly in the area under the end of the branches. The plants shall be thoroughly watered afterwards.

Watering shall be done as follows:

Water trees, shrubs, and ground covers by filling plant saucers a minimum of once every two weeks during dry periods. A dry period is a period of less than one inch of rain for one week, as recorded weekly. Each tree shall receive a minimum of 5 gallons of water and each shrub shall receive a minimum of 2 gallons of water. Watering is required only during March, April, May, June, July, August, September, and October.

At the end of the plant establishment period, or when directed by the Engineer, the Contractor shall remove all stakes, wire, hoses, etc., used to stake trees. All materials shall be disposed of off-site.

811.30 Method of Measurement. Furnishing and planting trees, shrubs and vines will be measured by the number of units of each type specified, installed and accepted. Rubble masonry and rubble masonry tree-well, either or both grouted or dry as specified, will be measured and paid for as specified in **Subsections 718.16** and **718.17**; porous material for root protection by the ton; and drain tile or pipe by the linear foot. Herbicide, weed control cloth, mulch, and other items used in preparation of planting shall be considered incidental to the planting, and no separate measurement will be made for this work.

811.31 Basis of Payment. The number of trees, shrubs and vines of each species or variety planted (determined as provided above) will be paid for according to the progress payment schedule below for each landscape pay item. Final payment will constitute full compensation for furnishing all material, tools, equipment, labor, and incidentals necessary to complete the work according to the plans and specifications except for items set out as separate pay items in pro-

posal.

Progress Payment Schedule For Planting Trees, Shrubs And Vines. Payment of 90% of the contract unit price for each landscape pay item will be made when the tree, shrub or vine has been completely and satisfactorily planted. The remaining portion of the payment will be for maintenance and plant replacement required during the plant establishment period. At the midway point of the plant establishment period, the Contractor may be paid an amount that is not to exceed 95% of the contract unit price for each landscape pay item. After the final inspection, the Contractor shall be paid 100% of the contract unit for each landscape pay item that was accepted during the final inspection. Final payment will be made after replacements are planted and final acceptance is made.

Payment will be made at the contract unit price for Rubble Masonry Wall, Rubble Masonry Tree-Well, Porous Material for Root Protection; and Drain Tile or Pipe all complete in place, which price and payment shall be full compensation for all material, tools, equipment, labor, and incidentals necessary to satisfactorily complete the work.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
8111XXX	Plant *(type)*	Each
7183000	Rubble Masonry	Cubic Yard
7183006	Rubble Masonry Tree-Well	Cubic Yard
8114000	Porous Material for Root Protection	Ton
8115XXX	Drain Tile or Pipe, *(diameter)*"	Linear Foot

SECTION 812

SPRIGGING

812.01 Description. This work shall consist of furnishing and planting sprigs of live grass plants on slopes and shoulders and other areas as designated by the Engineer, all in accordance with these specifications.

MATERIALS

812.02 Sprigs. Sprigs shall be healthy living stems (stolens or rhizomes) with attached roots of perennial turf-forming grasses of the kinds shown on the plans or in the special provisions, harvested without adhering soil and obtained from approved sources where sod is heavy and thickly matted. The presence of Johnson grass, Nutgrass or other objectionable grasses, weeds or other detrimental materials will be cause for rejection.

812.03 Fertilizer. Fertilizer shall meet the requirements as specified in **Subsection 810.06**.

812.04 Lime. Lime shall meet the requirements specified in **Subsection 810.07**.

CONSTRUCTION REQUIREMENTS

812.05 Stand of Grass. Before acceptance of the work, the Contractor shall be required to produce a satisfactory stand of grass.

812.06 Harvesting Sprigs. The Contractor shall notify the Engineer at least five (5) days before sprigs are to be harvested and the source shall be approved by the Engineer before harvesting begins.

Before being harvested, the grass shall be mowed to a height of 2 to 3 inches and all clippings removed. Sprigs shall then be loosened by cross-disking, shallow plowing or other

acceptable methods. After the sprigs have been loosened from the soil, they shall be gathered in small piles or windrows, watered and kept moist until planted.

Not more than twenty-four (24) hours shall elapse between harvesting and planting sprigs, except that when weather or other uncontrollable conditions interrupt the work, a time extension may be granted, provided sprigs are still moist and viable. Sprigs that have heated in stockpiles, that have become frozen, allowed to become dry or otherwise seriously damaged during harvesting or delivery will be rejected and shall be disposed of as directed.

812.07 Advance Preparation. Advance preparation shall be performed as specified in **Subsection 810.15**.

812.08 Applying Lime and Fertilizer. Following advance preparation and placing selected material for shoulders and slopes when called for in the contract, lime if called for and fertilizer shall be spread uniformly over the designated areas and shall be thoroughly mixed with the soil to a depth of approximately two inches. Fertilizer shall be applied at the rate of 500 pounds per acre for the initial application unless otherwise directed by soil tests. Lime shall be applied at the rate specified in the proposal, by soil tests, or as authorized by the Engineer. In all cases where practicable, approved mechanical spreaders shall be used for spreading fertilizer and lime. On steep slopes subject to slides and inaccessible to power equipment, the slopes shall be adequately scarified. Fertilizer may be applied on steep slopes by hydraulic methods. Any stones larger than 2 1/2 inches in any dimension, larger clods, roots or other debris brought to the surface shall be removed.

812.09 Topsoil. At areas to be grassed where the existing soil bed has little or no topsoil, the Contractor may furnish and place topsoil on the seedbed in order to ensure a good stand of grass.

812.10 Planting Sprigs. Sprigging shall be done only within

the periods stipulated in the special provisions. Sprigging shall not be done during windy weather or when the ground is dry, excessively wet, frozen or otherwise untillable. If the soil is not sufficiently moist when the sprigs are being set, water shall be applied until the soil contains sufficient moisture as determined by the Engineer.

Sprigging shall be performed as specified in Method A. Method B or C will not be permitted except where indicated in the special provisions.

Method A: **Broadcast Sprigging**. Sprigs shall be broadcast by hand or by suitable equipment in a uniform layer over the prepared surface with spacing between sprigs not to exceed 6 inches. The sprigs shall then be forced into the soil to a depth of 2 to 4 inches with a satisfactory tool or with a disk harrow or other equipment set to cover the sprigs to the required depth.

Method B: **Row Sprigging**. Furrows shall be opened along the approximate contour of slopes at the spacing and depth indicated on the plans. Sprigs shall be placed without delay in a continuous row in the open furrow with successive sprigs touching and shall be covered immediately.

Method C: **Spot Sprigging**. Spot sprigging shall be performed as specified under row sprigging, except that instead of planting in continuous rows, groups of four sprigs or more shall be spaced 18 inches apart in the rows or as otherwise indicated in the special provisions.

812.11 Compacting. After the planting of sprigs has been completed and before compacting, the surface shall be cleared of stones larger than 2 1/2 inches in any dimension, large clods, roots, and other litter brought to the surface during sprigging.

The sprigged areas shall be compacted within twenty-four (24) hours from the time sprigging has been completed, weather and soil conditions permitting, by cultipackers, rollers, or other satisfactory equipment. Compaction shall not be done when the soil is in such condition that it is being picked up by the equipment, nor shall clay soils be compacted if so directed by the Engineer.

812.12 Second Application of Fertilizer. After the plants have become established, fertilizer shall be applied uniformly in dry form at the rate of 500 pounds per acre, or as directed by soil tests on the sprigged areas. Fertilizer may, at the discretion of the Engineer, upon receipt of satisfactory evidence of its feasibility from the manufacturer, be applied in liquid form.

Unless otherwise stated, centipede grass sprigging shall receive half of the above rate of fertilizer, or as directed by soil tests on the sprigged areas. Centipede shall not be fertilized between August 1 and April 1.

812.13 Maintenance. The Contractor will be required to do all maintenance necessary to keep the sprigged areas in a satisfactory condition until the work is accepted. Maintenance includes watering, mowing, repairing washes; and additional sprigging and fertilizing where a satisfactory stand of grass has not been obtained.

812.14 Mowing. If it is a pay item, Mowing shall be performed as specified in **Subsection 810.25**.

812.15 Acceptance. Inspection to determine acceptance of sprigging will be made by the Engineer, upon Contractor's request. The Contractor shall be required to produce a satisfactory stand of perennial grass. Sprigged areas will be acceptable provided all requirements, including maintenance, have been complied with, and a healthy, even colored viable lawn is established. The root system shall be sufficient to survive dry periods, winter weather and be capable of rees-

tablishing in spring.

812.16 Method of Measurement. The quantity of sprigging to be paid for shall be the actual number of thousand square yards (MSY) of surface areas sprigged, complete and accepted.

Fertilizer and lime shall be measured as provided for in **Subsection 810.27**.

Topsoil will be measured as provided in Subsection 810.27.

812.17 Basis of Payment. The accepted quantity of sprigging will be paid for at the contract unit price for Sprigging, which price and payment shall be full compensation for furnishing all materials (excluding fertilizer, lime and selected material for shoulders or slopes); labor, tools, equipment, and incidentals necessary to complete the work.

Fertilizer and lime will be paid for as provided in **Subsection 810.28**.

Topsoil will be paid for as provided in Subsection 810.28.

Mowing will be paid for as provided in Subsection 810.28.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
8121000	Sprigging	MSY
8104XXX	Fertilizer *(analysis)*	Ton
8105000	Lime	Ton

SECTION 813

SODDING

813.01 Description. This work shall consist of furnishing and laying sod of perennial turf-forming grasses on slopes and shoulders and other areas as designated by the Engineer, all in accordance with these specifications.

MATERIALS

813.02 Sod. Sod shall be living, well-established growth, predominantly of the grass specified in the special provisions. It shall be vigorous, well rooted, healthy turf, free from disease, insect pests, weeds, other grasses, stones and any other harmful or detrimental materials. Sod shall be machine stripped at a uniform soil thickness of approximately one inch. The minimum acceptable soil thickness shall be 3/4 inch. The measurement for thickness shall exclude top growth and thatch. Sod shall be rolled or folded prior to lifting. Handling of sod shall be done in a manner that will prevent tearing, breaking, drying or any other damage.

813.03 Fertilizer. Fertilizer shall meet the requirements specified in **Subsection 810.06**.

813.04 Lime. Lime shall meet the requirements specified in **Subsection 810.07**.

CONSTRUCTION REQUIREMENTS

813.05 Advance Preparations. Advance preparations shall be performed as specified in **Subsection 810.15**.

813.06 Apply Lime and Fertilizer. Lime and fertilizer shall be applied as set forth in **Subsection 810.17**, or according to soil tests.

813.07 Topsoil. At areas to be grassed where the existing soil bed has little or no topsoil, the Contractor may furnish and place topsoil on the soil bed in order to ensure a good stand of grass.

813.08 Laying Sod. Sod shall be laid on the prepared sod bed within twenty-four (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 five (5) days. Sod shall be protected against drying from sun or wind and from freezing if necessary. The moving and laying of sod shall, as far as possible, be done when weather conditions and soil moisture are favorable.

Solid sodding shall be laid when soils are moist. Dry sod beds shall be well moistened before sod is laid. Sections of solid sod shall be laid edge to edge with staggered joints. Openings shall be plugged with sod or filled with acceptable loamy topsoil. After laying and joint filling, sod shall be rolled or tamped with approved equipment to eliminate air pockets and provide an even surface.

813.09 Maintenance. The sod shall be watered when laid and kept moist by the Contractor until final acceptance of the contract. The Contractor will be required to do all maintenance, including watering, repairing washes and additional sodding and fertilizing where a satisfactory stand of grass has not been achieved, until the work is accepted. Centipede shall not be fertilized between August 1 and April 1.

813.10 Method of Measurement. The quantity of sodding to be paid for shall be the number of square yards of surface area sodded, complete and accepted.

Fertilizer and lime will be measured as provided for in **Subsection 810.27**.

Topsoil will be measured as provided in Subsection 810.27.

813.11 Basis of Payment. The accepted quantity of sodding will be paid for at the contract unit price for Sodding, which price and payment shall be full compensation for furnishing all materials (excluding fertilizer, lime and selected material for shoulders or slopes); labor, tools, equipment and incidentals necessary to complete the work.

Fertilizer and lime will be paid for as provided in **Subsection 810.28**.

Topsoil will be paid for as provided in Subsection 810.28.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
8131000	Sodding	Square Yard
8104XXX	Fertilizer *(analysis)*	Ton
8105000	Lime	Ton

SECTION 814

WATERPROOFING

814.01 Description. This work shall consist of the application of waterproofing materials for the waterproofing or dampproofing of cement concrete surfaces in accordance with these specifications and in conformity with indications on the plans or special provisions.

Two methods of substructure waterproofing are given in the following applicable subsections. The first, unless otherwise indicated on the plans or in the special provisions, is to

be used for the protection of bents, piers, abutments and other structures to be placed or constructed in salt water, excluding prestressed concrete piles. The second method is to be used for protecting the inside of spandrel-filled arches, backs of abutments, retaining walls, etc.

Bridge deck waterproofing shall be used when specified on the plans or special provisions. This waterproofing system is to be placed before the placing of an asphalt concrete overlay and shall serve as a barrier against penetration of water, salt solutions, and other contaminants that cause the deterioration of bridge deck concrete.

MATERIALS

814.02 Substructure Waterproofing.

A. First Method. The material following shall be furnished:

1. Creosote Priming Coat. Creosote for priming coat shall conform to the requirements of **AASHTO M 121**.

2. Coal Tar Pitch Seal Coat. Coal tar pitch shall conform to the requirements of **AASHTO M 118**.

B. Second Method. The following material shall be furnished:

1. Asphalt Priming Coat. The asphalt priming coat shall conform to the requirements of **AASHTO M 116**.

2. Asphalt for Mop Coats. The asphalt for the mop coats shall conform to **AASHTO M 115**, Type A where used below ground level and Type B where used above ground level.

3. Fabric. The waterproofing fabric shall conform to **AASHTO M 117**, and the asphalt used for saturation shall comply with Type A or Type B as required in

Subsection 814.02 B2 immediately above.

814.03 Bridge Deck Waterproofing. At the option of the Contractor, one of the following waterproofing systems shall be applied 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.

Only materials on the Department's approved list shall be used. To be approved, the manufacturer shall submit appropriate test results to the Engineer to verify that the material to be approved meets the requirements of this specification. A certification shall be furnished with each shipment of material to the Engineer stating that the material meets the Department's specifications.

A. Type I: **Reinforced Preformed Rubberized Asphalt Membrane**. The reinforced preformed rubberized asphalt membrane shall consist of a bottom layer of rubberized asphalt with adhesive qualities and synthetic fabric reinforcement sheet as a top layer. The membrane shall have the following properties:

Physical Property	Required Values	Test Method
Thickness (Minimum)	65 mils	
Tensile Strength	50 pounds per inch width	ASTM D 882, modified for 1 inch opening, or ASTM D 1000 modified for 4 inch grip opening.
Permeanance	0.10 perms	ASTM E 96, Method B
Puncture Resistance (Min.)	200 lb.	ASTM E 154
Pliability	No cracks or splits @ 180° bend. (Select one method)	1/2 in. Mandrel @ 0° F, or 1/2 in. Mandrel @ -10° F, or 1 in. Mandrel @ 125° F

B. Type II: **Reinforced Coal-Tar Preformed Membrane**. The reinforced coal-tar preformed membrane is composed

of coal-tar, modified with synthetic resins and reinforced with synthetic non-woven fabric. The membrane shall have the following properties:

Physical Property	Required Values		
Thickness	70 mils plus or minus 5		
Water Penetration	Water penetration of the membrane shall be zero when tested under a hydrostatic head of one (1) meter for 24 hours in accordance with **ASTM D 583**, Method 3.		
Tensile Strength: (ASTM D 882, Crosshead speed 2 in./min., average of three samples)	Temp. at 0°F at 40°F at 120°F	Longitudinal 1500 psi 900 psi 400 psi	Transverse 1400 psi 700 psi 300 psi
Elongation: (ASTM D 882, Crosshead speed 2 in./min., avg. 3 samples, Method A, 1 in. wide strip.)	Temp. at 0°F at 40°F at 120°F	Longitudinal 30% 40% 50%	Transverse 25% 30% 35%
Softening Point	230°F minimum, in accordance with **ASTM D 36**.		
Pliability	The membrane shall pass 1 inch mandrel bend test at minus 10°F when tested in accordance with **ASTM D 146**.		
Density	The material shall not weigh less than 0.45 lb./sq.ft.		

C. Type III: **Reinforced Bituminous Resin Preformed Membrane**. The reinforced bituminous resin preformed membrane shall consist of a heat modified bituminous resin composition with inner layers of open weave fiberglass mesh and a top surface of polyester to bond to the wearing surfacing. The membrane shall have the following properties:

Physical Property	Required Values
Thickness	60 mils plus or minus 5.
Color	Black
Softening Point	Ring & Ball - 240°F minimum, in accordance with **ASTM D 36**.
Needle Penetration	40 to 50 mm at 77°F, 5 sec., 100 g in accordance with **ASTM D 5**.
Weight Per Square Yard	2.6 lbs. min.

CONSTRUCTION REQUIREMENTS

814.04 Substructure Waterproofing.

A. First Method. Concrete surfaces to be waterproofed shall be water-cured for the period described in **Section 702** (curing compound not allowed), and then allowed to dry for a period of approximately two (2) days. It shall then be thoroughly coated with 3 coats of tar primer coat for absorptive treatment, applied cold with a brush, and each coat shall be absorbed before the succeeding one is applied. After the absorption of the final coat, a tar seal coat shall be applied at a temperature of approximately 80°F and thoroughly brushed into all surfaces. The seal coat shall be allowed to dry for at least four (4) days, or as long as necessary to harden before any water or earth is allowed to come against it. No coat shall be applied when the concrete or the preceding coat is damp or during any time that moisture may fall on any surface. A drying period of longer than two (2) days after the curing period and before the first application of the tar for absorptive treatment shall be avoided whenever practicable.

B. Second Method.

1. Inspection and Delivery. Factory inspection is preferred but, instead thereof, the Engineer may order that representative samples, properly identified, be sent to him for test before shipment of the materials. After delivery of the materials, representative check

samples will be taken, which shall determine the acceptability of the materials. All materials shall be delivered on the work in original containers, plainly marked with the manufacturer's brand or label.

2. Storage of Fabric. The fabric shall be stored in a dry, protected place. The rolls shall not be stored on end.

3. Preparation of Surface. All concrete surfaces that are to be waterproofed shall be reasonably smooth and free from projections or holes that might cause puncture of the membrane. The surface shall be dry so as to prevent the formation of steam when the hot asphalt is applied, and immediately before the application of the waterproofing, the surface shall be thoroughly cleaned of dust and loose materials. No waterproofing shall be done in wet weather nor when the temperature is below 35°F without special authorization from the Engineer. Should the surface of the concrete become temporarily damp, it shall be covered with a 2-inch layer of hot sand, which shall be allowed to stand from one to two hours, after which the sand shall be swept back, uncovering sufficient surface for beginning work, and the operation repeated as the work progresses.

4. Application of Waterproofing of Large Areas.
The surface to be waterproofed shall be given a thorough coat of asphalt primer which shall be permitted to set thoroughly before the first mop coat is applied. If considered desirable by the Engineer, the primer shall be thinned to a suitable consistency with an approved volatile solvent. The asphalt for mop coat shall be heated to a temperature not less than 300°F and not more than 350°F, with frequent stirring to avoid local overheating. The heating kettles shall be equipped with thermometers. In all cases, the waterproofing shall begin at the low point of the surface to be waterproofed so that water will run over and not against or along the laps. The first strip of fabric shall be of half

width; the second shall be full width lapped the full width of the first sheet; and the third and each succeeding strip shall be full width and lapped so that there will be two layers of fabric at all points, with laps not less than 2 inches wide. All end laps shall be at least 12 inches. Beginning at the low point of the surface to be waterproofed, a section about 20 inches wide and the full length of the surface shall be mopped with the hot asphalt and there shall be rolled into it, immediately following the mop, the first strip of fabric, of half width, which shall be carefully pressed into place so as to eliminate all air bubbles and obtain close conformity with the surface. This strip, and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric being used, shall then be mopped with hot asphalt, and a full width of the fabric shall be rolled into this, completely covering the first strip, and pressed into place as before. This second strip, and an adjacent section of the concrete surface, shall then be mopped with hot asphalt and the third strip of fabric "shingled" on so as to lap the first strip not less than 2 inches. This process shall be continued until the entire surface is covered, each strip of fabric lapping at least 2 inches over the last strip. The entire surface shall then be given a final mopping of hot asphalt. The completed waterproofing shall be a firmly bonded membrane, composed of an asphalt prime coat, two layers of fabric, and three moppings of asphalt. Under no circumstances shall one layer of fabric touch another layer at any point or touch the surface, as there must be at least three complete moppings of asphalt. In all cases, the mopping on concrete shall cover the surface so that no gray spots appear, and on fabric it shall be sufficiently heavy to completely conceal the weave. On horizontal surfaces not less than 12 gallons of mopping asphalt shall be used for each 100 square feet of finished work, and on vertical surfaces not less than 15 gallons shall be used. The work shall be so regulated that, at the close of a day's work, all fabric that is laid shall have received the final

mopping of asphalt. Special care shall be taken at all laps to see that they are thoroughly sealed.

5. Application of Waterproofing of Small Areas. Where cracks or construction joints are to be waterproofed, the waterproofing shall be applied essentially as specified above for large areas except that it will not be necessary to lap the fabric as described. The layers of fabric shall be sufficiently wide to extend beyond the joint or crack at least 12 inches each way. Where the strips are lapped at ends, the laps shall be at least 12 inches. The waterproofing shall consist of an asphalt prime coat, and three moppings of hot asphalt alternated with two layers of the asphalted fabric.

6. Details. At the edges of the fabric and at any points where it is punctured by such appurtenances as drains or pipes, suitable provisions shall be made to prevent water from getting between the waterproofing and the waterproofing surface.

All flashing at curbs and against girders, spandrel walls, etc. shall be done with separate sheets lapping the main membrane not less than 12 inches. Flashing shall be closely sealed either with a metal counterflashing or by embedding the upper edges of the flashing in a groove poured full of joint filler.

Joints that are essentially open joints, but that are not designed to provide for expansion, shall first be caulked with oakum and lead wool and then filled with hot joint filler.

At expansion and contraction joints, the membrane shall be carried across the joint in such manner that movement in the joint will not cause rupture of the membrane.

At the ends of the structure, the waterproofing shall be carried well down on the abutments and suitable provision made for all movement.

7. Damage Patching. Care shall be taken to prevent injury to the finished waterproofing by the passage over it of people or wheelbarrows, or by throwing any material on it. Any damage that occurs shall be repaired by patching. Patches shall extend at least 12 inches beyond the outermost damaged portion, and the second ply shall extend at least 3 inches beyond the first.

814.05 Bridge Deck Waterproofing. Regardless of the system used by the Contractor, the application of the waterproofing system shall be in accordance with the written application procedure as furnished by the manufacturer of the membrane material. Primer shall be applied to clean concrete surfaces from which all asphalt, grease, oil, tar, dirt, sand and gravel have been removed and the surface has been finally cleaned by air blast. The primer and mastic shall be as recommended and applied at the rate as specified by the manufacturer of the membrane.

814.06 Method of Measurement. The work described and specified under Substructure Waterproofing-First Method in this section will not be measured for payment.

The quantity to be paid for under Substructure Waterproofing-Second Method and Bridge Deck Waterproofing shall be the number of square yards of waterproofing complete in place and accepted.

814.07 Basis of Payment. The work and material described and specified under First Method in this section will not be paid for directly, but will be considered as subsidiary work pertaining to the various items of construction on which the waterproofing is applied, and the cost is to be included in the contract price for the item on which the waterproofing is applied.

The accepted quantity of Substructure Waterproofing-Second Method and Bridge Deck Waterproofing, measured as provided above, will be paid for at the contract unit price per square yard. This price and payment shall be full compensation for furnishing all equipment, tools, materials and labor necessary for the satisfactory completion of the waterproofing.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
8142100	Waterproofing (Substructure - Second Method)	Square Yard
8143000	Waterproofing (Bridge Deck)	Square Yard

SECTION 815

EROSION CONTROL

815.01 Description. This work shall consist of temporary erosion control measures as specified in these specifications, as specified in the special provisions, or ordered during the life of the contract to control erosion and water pollution, through the use of berms, sediment basins, sediment dams, fiber roving, erosion control blanket, silt fences, floating turbidity barriers, brush barriers, baled straw erosion checks, temporary flexible pipe slope drains and temporary seeding.

Temporary erosion control measures shall be performed promptly when problem conditions exist or when potential problems are anticipated in certain areas in order to minimize soil erosion and siltation. The temporary erosion control measures shall be properly maintained until permanent erosion control features are functioning properly.

The temporary erosion control provisions contained herein shall be coordinated with the permanent erosion control features provided elsewhere in these specifications to the extent practical to assure economical, effective and continuous erosion control during construction. Permanent seeding, sodding, rip rap, concrete gutter, asphalt gutter, slope drains and concrete slope protection are considered permanent erosion control items and are covered in other sections of these specifications.

MATERIALS

815.02 Fiber Roving.

A. Fiberglass Roving. Fiberglass roving shall consist of fiberglass material formed from continuous fibers drawn from molten glass, coated with a chrome-complex sizing compound, collected into strands and lightly bound together into a roving without the use of a binding agent or other deleterious substances. The roving shall be wound into a package such that the material can be continuously withdrawn using a compressed air ejector to expand the fiber roving into a mat on the soil surface.

The fiberglass roving shall be an electrical grade material with the following characteristics:

Physical Property	Limits	Test Methods
Strands/Rove	50 - 70	End Count
Fiber Diameter, in (Nominal)	0.00035 - 0.00045	**ASTM D 578**
Yards/lb. of Rove	170 - 300	ASTM D 578

B. Polymer Roving. The material shall be formed from continuous strands of fibrillated polymer yarns, collected into a roving without the use of a binding agent or other deleterious substances. The roving shall be packaged such that it can be continuously withdrawn using a compressed air ejector to expand the roving into a mat of polymer fibers on the soil surface. Fibrillation is defined as a net-like

physical structure of the yarn created by splitting the yarn in a precise pattern during the manufacturing process.

Physical Property	Limits	Test Methods
Strands/Rove	20 - 30	End Count
Yards/lb. of Rove	170 - 520	ASTM D 1907
Organic Content % Max.	1.0	ASTM D 1907
UV Stability	70% Strength Retained	ASTM D 4355

815.03 Permanent Erosion Control Mat. The permanent erosion control mat shall be a three dimensional structure of entangle filaments. The filaments shall either be bonded by heat fusion at the intersections or stitched with polyolefin, nylon or polyester threads between two UV-Stabilized nettings. The mat shall be resistant to chemical and environmental degradation. The mat shall promote and maintain the integrity of the grass root system.

The material properties of the mats shall conform to the following specifications:

Physical Property	Test Method	Value[1]
Weight	ASTM D 5261	10 oz/yd[2]
Thickness	ASTM D 5199	0.4 inch
Tensile Strength[2]	ASTM D 4595	90 x 50 lb./ft.
Tensile Elongation[2]	ASTM D 4595	75% x 75% (max.)
Porosity[3]	Calculated	90%
Resiliency[4]	ASTM D 5199	80%
Ultraviolet Stability[5] (1000 hr.)	ASTM D 4355	80%

Notes:

[1] All values are Minimum Average Roll Values unless otherwise indicated. Lot sampled according to **ASTM D 4354**.

[2] Values of both machine and cross machine direction under dry or saturated conditions.

[3] Porosity calculated based on unit weight, thickness and specific gravity.

[4] Resiliency defined as percent of original thickness retained after 3 cycles of a 100 psi load for 60 seconds followed by 60 seconds without load. Thickness measured 30 minutes after load is removed.

[5] Tensile strength of **ASTM D 4632** after 1000 hours in a Xenon ARC weatherometer.

Ground fasteners shall be one or a combination of the following:

1. T-Staple (wire)

2. Broad Wire U-Staple

3. Narrow wire U-Staple

All staples shall be 8 to 11 gage wire with a minimum staple width of one inch and a minimum penetration of 8 inches.

815.04 Erosion Control Blanket. The blanket shall be of organic, biodegradable mulch material such as straw, curled wood cellulose, coconut fiber or any combination of these materials. The ECB materials must be evenly distributed and secured, at least on one side, to a mesh. The mesh must be of biodegradable polypropylene or other plastic material fused at the strand intersections. The blanket shall be a minimum width of 48 inches and a minimum average weight of 0.5 pounds per square yard. U-Shaped staples with at least 8 inch legs and one inch crowns shall be used to secure the

erosion control blanket.

815.05 Baled Straw. Baled straw shall consist of standard size (18 inches X 48 inches) rectangular, mechanically produced bales.

815.06 Silt Fence. All material used in silt fence shall comply with requirements as shown by the plan details or as approved by the Engineer.

A. Posts. Either wood or steel posts may be used. Wood posts shall be a minimum of 6 foot long with minimum dimensions of three diameter for round posts, 2 inches by 4 inches for rectangular posts, or 3 inches for square posts. Steel posts shall be a minimum of 5 feet long, weigh a minimum of 1.3 pounds per foot, and have projections to aid in fastening the wire or fabric. Steel posts shall also have a metal plate welded near the bottom such that when the post is driven to the proper depth, the plate will be below the ground level for added stability. In areas where conditions warrant, larger posts or reduced post spacing may be required to provide an adequate fence to handle the stress from sediment loading.

B. Woven Wire. Woven wire fence, when used for backing for the filter fabric, shall conform to the requirements of **ASTM A 116**, Class I zinc coating for wire. The fence shall be at least 32 inches high and shall have at least six line (horizontal) wires. Stay (vertical) wires shall be spaced 12 inches apart. The top and bottom wires shall be 10 gage. All other wires shall be 12 1/2 gage.

C. Filter Fabric. Only fabric appearing on the Department's current approval sheet for Filter Fabric shall be used. Filter fabric shall be composed of fibers consisting of long chain synthetic polymers composed of at lease 85% be weight of polyolefins, polyesters, or polyamides. The fibers shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other. The filter fabric shall be free of any treatment

or coating which might adversely alter its physical properties after installation. The fabric shall be free of defects or flaws which significantly affect its physical and/or filtering properties. The fabric shall have a minimum width of 36 inches.

The filter fabric shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure before placement.

The filter fabric shall meet the following minimum physical requirements:

Physical Property*	**Test Method**	**Required Value**
Tensile Strength	ASTM D 4632	90 lbs.
Elongation	ASTM D 4632	<50% - fabric self supporting ≥50% - fabric requires woven wire backing
Apparent Opening Size (AOS)	**ASTM D 4751**	# 20 Sieve (Min.)
Permittivity	**ASTM D 4491**	0.01 Sec.[1]
Ultraviolet Stability (retained strength after 500 hrs of ultraviolet exposure)	ASTM D 4355	70%

[1] Unless otherwise indicated, numerical values represent the minimum average roll value.

815.07 Floating Turbidity Barrier. The purpose of the floating turbidity barrier is to provide sediment protection for fill that is placed in water or areas affected by tidal flow.

Materials used in the floating turbidity barrier shall meet the following requirements:

	Light Duty	Medium Duty	Heavy Duty
Fabric – Polyester Reinforced Vinyl (oz/yd^2)	18	22	22
Floatation (lb/ft) *	13	22	22
Top Load Cable	---	---	5/16" Galvanized 10K#
Stress Plates	---	---	5/8" Polypropylene
Rope Retainer	5/8" Polypropylene	5/8" Polypropylene	5/8" Polypropylene
Grommets	#4 Brass	#4 Brass	#4 Brass
Seams Heat Welded	Yes	Yes	Yes
Bottom Load Chain	1/4" Galvanized 0.63 lbs/ft (min)	5/16" Galvanized 0.95 lbs/ft (min)	5/16" Galvanized 0.95 lbs/ft (min)
Connecting Hardware	Galvanized Steel	Galvanized Steel	Galvanized Steel
Standard Depth	5 ft.	5 ft.	5 ft.
Standard Length**	50 & 100 ft.	50 & 100 ft.	50 & 100 ft.

***** Floatation for barriers of depths greater than 10 feet is to be 60 pounds per foot. Floatation must be sufficient to maintain the top of the barrier at an elevation 3 inches above the water.

****** The maximum length for barriers of depth greater than 10 feet is 50 feet.

Buoys used in conjunction with the floating turbidity barrier shall comply with the **South Carolina Department of Natural Resources Marine Law Enforcement Buoy Specifications**.

815.08 Inlet Structure Filters. Inlet structure filters shall be used during construction to trap sediment before it enters the catch basins when so called for on the plans. Type A filters shall be used on existing catch basins, and Type B filters shall be used on new or rehabilitated catch basins.

815.09 Corrugated Metal Pipe for Sediment Dams. Corrugated Metal Pipe shall comply with the requirements of **Section 714**.

815.10 Temporary Seeding. All materials shall conform to the requirements of **Section 810** as applicable.

EQUIPMENT

815.11 Equipment. Equipment necessary to satisfactorily perform the work as specified in this section shall be furnished by the Contractor. Equipment for applying fiber roving and asphalt shall include the following:

1. Pneumatic ejector capable of applying fiber roving at the rate of 2 pounds per minute (approximately 8 square yards per minute).

2. Air compressor capable of applying 40 cfm at 80 to 100 psi and acceptable air base for supplying air to areas inaccessible to compressor.

3. Asphalt distributor with hoses and hand spray bar for areas inaccessible to distributor.

CONSTRUCTION REQUIREMENTS

815.12 General. Erosion control measures shall be coordinated with the grading operations throughout the duration of the project in accordance with **Subsection 107.26**, Environmental Protection and Water Pollution Control.

Temporary erosion control measures will be used to correct conditions where problems are anticipated or to correct conditions that develop during construction.

After permanent vegetation has been established and other permanent erosion control items have been completed in an area and are properly functioning, the Engineer may require certain temporary erosion control items to be removed if, in his opinion, these items are no longer needed. The Contractor shall restore these areas to a condition similar to the surrounding areas.

815.13 Brush Barriers. Brush barriers shall be used as shown on the plans or as directed by the Engineer. Brush barriers shall consist of selected materials from the clearing and grubbing operation.

Brush barriers used for erosion control measures shall be constructed as soon as brush is readily available from the clearing operation. The barriers shall not be used in residential or commercial areas, or in areas where development is anticipated within the next few years. Brush barriers will generally be used parallel to the toes of slopes where the proposed embankments will be constructed of erodible material to heights of 15 feet or more. The brush barriers will be used when natural ground is level or sloping away from project. The brush barriers will remain in place, and shall not be constructed at any site that would be easily and routinely seen and would detract from the appearance of either the adjacent property or the completed highway.

The brush barriers shall be formed by placing brush, limbs and small trees and other vegetative growth in small continuous ridges or piles as close as practicable and no more than 15 feet outside of and generally parallel to the toes of the proposed embankments with some of the heavier material being placed on top to properly secure the barrier. The brush logs and tree laps shall be intermingled so that a solid dam will not be formed, but will allow water to filter through. If gutter is proposed as a permanent erosion control measure along the toe of an embankment, the brush barrier, if used, shall be placed outside the construction limits of the gutter. The barriers may be constructed with mechanical equipment and shall be "walked down" with a bulldozer in order to produce barriers that are dense and have relatively uniform heights between 3 and 5 feet and widths between 5 and 10 feet.

815.14 Fiber Roving. The fiber roving shall be placed within twenty-four (24) hours after seeding operations have been performed in accordance with Section 810, except that no mulch shall be applied to the area onto which fiber roving is to

be placed.

Fiberglass (Type A) roving shall be spread uniformly over the designated areas at a minimum rate of 0.30 pounds per square yard. Polymer (Type B) roving shall be spread uniformly over the designated areas at a minimum rate of 0.15 pounds per square yard.

Immediately after the roving has been placed, it shall be anchored to the ground with the same type asphalt material meeting the requirements of Section 810 as used in the seeding operation. The asphalt shall be applied uniformly over the specified fibers at a rate of 0.25 to 0.35 gallons per square yard. At the upgrade and downgrade ends, the roving shall be buried to a depth of one foot to insure that water will not pass under the roving.

815.15 Permanent Erosion Control Mat. Embankment slopes and ditches shall be shaped and dressed in accordance with the specifications at the location and grade as shown on the plans or as directed by the Engineer. The mat placement and installation shall be as recommended by the manufacturer.

Seeding operations shall conform to the requirements of Section 810 of the standard specifications and may be performed before or after placement of the mat as recommended by the manufacturer.

If soil filling is recommended by the manufacturer, only an approved top soil should be placed on the mat. The top soil shall then be lightly brushed or raked into the voids.

815.16 Erosion Control Blanket. The areas to be protected shall be shaped and dressed in accordance with the specifications shown on the plans or designated by the Engineer. Erosion Control Blanket having a mesh on one side shall be installed mesh side up. The upslope ends shall be buried in a six inch deep vertical slot, stapled at the bottom of the slot at one foot intervals, backfilled and tamped. Adjoining sections

shall be tightly butted and stapled at the ends and sides without overlapping. All staples must be driven flush with the soil surface in a staggered pattern and at intervals recommended by the manufacturer.

815.17 Baled Straw Erosion Checks. Baled straw erosion checks shall be constructed in accordance with details as shown on plans and in accordance with these specifications. The straw bales shall be used at locations and in a manner as directed by the Engineer. They shall be placed, anchored by approved means and maintained throughout the life of the project in order to provide the maximum control of erosion.

815.18 Silt Fence. Silt fence shall be constructed in accordance with plan details or as approved by the Engineer. Silt fences should be in place before the major construction in an area is begun.

The silt fence shall be maintained until its capacity has been reached or erosion activity in the area has stabilized.

Silt fence shall be inspected by the Contractor immediately after each rainfall and at least daily during prolonged rainfall. Any deficiencies shall be immediately corrected. Filter fabric shall be removed and replaced whenever it has deteriorated to such extent that it reduces the effectiveness of the silt fence. In addition, the Contractor shall make a daily review of the location of silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist, additional silt fences shall be installed as directed by the Engineer.

If a silt fence, or portion of a fence, is located in an area where removing the sediment is not possible, then a second silt fence shall be installed, if necessary, at the discretion of the Engineer. In this case, both silt fences or portions involved, will be measured and paid for at the unit price for silt fence.

Silt fence shall remain in place until the Engineer directs that it be removed. Upon removal, the Contractor shall dress the area to give a pleasing appearance, and vegetate all bare areas in accordance with the contract requirements. The fence materials will remain the property of the Contractor and may be used at other locations provided the materials meet the appropriate requirements contained in this specification and/or in the plans.

815.19 Floating Turbidity Barrier. Floating turbidity barriers shall be placed at the location shown on the plans, and in accordance with the manufacturer's recommendations. The end points shall be anchored on the undisturbed shoreline with sufficient support to secure the barrier in place during turbulent conditions. Vertical supports and/or anchors shall be placed along the barrier as necessary to prevent the barrier from drifting. The floating turbidity barrier shall be maintained until such time as all disturbed areas have stabilized sufficiently to control erosion.

815.20 Silt Basins. Silt basins shall be constructed by excavating basins in berm ditches, parallel roadway ditches, at culvert inlets and outlets and other locations as directed by the Engineer. The basins shall be constructed in accordance with plan details. Sediment shall be removed as necessary to insure proper functioning of the basin.

815.21 Silt Ditch. Temporary silt ditches shall be constructed in accordance with plan details at locations shown on the plans or as directed by the Engineer. Silt ditches will generally be constructed adjacent and parallel to the toe of the slope in relatively rolling areas where there is a possibility that property may be damaged from sheet-type erosion. This type ditch is not intended to carry large volumes of water, but to catch sediment from runoff.

815.22 Sediment Dam. Temporary sediment dams shall be constructed in accordance with plan details at locations shown on the plans or as directed by the Engineer.

815.23 Inlet Structure Filters. Inlet Structure Filters shall be constructed as shown on the plans or as directed by the Engineer.

Type A. Type A inlet filters consist of a concrete block wall placed around the top of the catch basin with one block on each wall placed so that the openings are horizontal to de-water the basin. The outside of the blocks shall be lined with hardware fabric, and No. 5 aggregate placed around the wall on a 3:1 slope.

Type B. Type B inlet filters are constructed by backfilling around the new or rehabilitated catch basin as directed. Three 3/4 inch weep holes are constructed on each side of the catch basin at the backfilled ground level. The exposed sides of the basin shall then be covered by hardware fabric, and No. 5 aggregate placed around the catch basin on a 3:1 slope.

When the design sediment storage volume is reduced to half by accumulated sediment deposits, the sediment shall be removed and disposed.

815.24 Temporary Flexible Pipe Slope Drains. Temporary flexible pipe slope drains shall be constructed in accordance with plan details at locations shown on the plans or as directed by the Engineer. The flexible pipe shall be of sufficient size to carry the anticipated volume of water, but in no case, less than 8 inches in diameter.

Temporary slope drains shall be installed as a part of the grading operation where applicable, and adjusted as directed by the Engineer.

An earth berm at the top of cut or fill sections shall be constructed to channel the water into the slope drain and to prevent collected water from spilling over the edge of the slope.

When the temporary slope drains are removed, the Con-

tractor shall dress and seed the area in accordance with Section 810. The removed pipe drain shall become the property of the Contractor and may be used again at other temporary locations provided they are in a condition acceptable to the Engineer.

815.25 Temporary Seeding. Temporary seeding shall be performed in accordance with Section 810 as applicable.

815.26 Method of Measurement.

a. The quantity of fiber roving, permanent erosion control mat, or erosion control blanket, measured for payment shall be the actual number of square yards of ground covered by the roving, matting or blanket, completed and accepted.

b. Baled straw placed satisfactorily in accordance with the plans will be measured by the unit.

c. Silt fence, complete and accepted will be measured in place by the linear foot.

d. Floating Turbidity Barrier will be measured by the square foot or linear foot of barrier in place, as stated in the contract.

e. Excavation performed during the construction of silt basins, silt ditches and sediment dams will be measured and paid for as Unclassified Excavation as provided in **Subsection 203.15**. Sediment will be removed as directed by the Engineer, with material removed being measured by the cubic yard and paid for as Silt Basins. Measurements will be taken each time sediment is removed. Corrugated metal pipe used in sediment dams will be measured by the linear foot in accordance with **Subsection 714.18**.

f. Brush barriers will not be measured directly but will be considered incidental to the clearing and grubbing operation.

g. Inlet Structure Filters of the type specified shall be measured by the unit. Sediment removed from Inlet Structure Filters shall be paid for as Silt Basin.

h. Temporary flexible pipe slope drains shall be measured by the linear foot in accordance with **Section 803**.

i. Temporary seeding will be measured in accordance with **Subsection 810.27**.

815.27 Basis of Payment. The pay quantities for the items covered in this section will be paid for at the contract unit price per unit of measurement as specified in **Subsection 815.26**, which price and payment shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work.

Payment for Floating Turbidity Barrier will include all labor, materials, equipment, and incidentals to install, maintain, and remove the barrier. Payment will also include all attachments to the shore, anchors, vertical supports, anchor buoys, buoyed warning signs, and lighted buoys. The removal of accumulated silt will be paid for as Silt Basins.

Brush barriers will not be paid for directly but shall be included in the contract lump sum price for clearing and grubbing.

Inlet Structure Filters of the type specified will be paid for at the contract unit price, which shall include all labor, equipment, materials, including hardware fabric concrete block, and aggregate, removal and disposal of filter, sealing weep holes, and backfilling as necessary.

Temporary Seeding will be paid for in accordance with

Subsection 810.28.

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

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
8151000	Fiber Roving	Square Yard
8151100	Permanent Erosion Control Mat	Square Yard
8151110	Erosion Control Blanket	Square Yard
8152000	Baled Straw	Bale
8153000	Silt Fence	Linear Foot
8153XXX	Floating Turbidity Barrier *(type)*	Linear Foot
8153XXX	Floating Turbidity Barrier *(type)*	Square Foot
8154000	Silt Basins	Cubic Yard
8155000	Silt Ditches	Cubic Yard
8156000	Sediment Dams	Cubic Yard
815621X	Inlet Structure Filter Type *(type)*	Each
8157XXX	Temporary Flexible Pipe Slope Drains	Linear Foot

SECTION 816

SEDIMENT CONTROL BASINS AND STORM WATER DETENTION PONDS

816.01 Description. This work shall consist of the construction of ponds for temporary and permanent sediment control basins and storm water detention ponds. It includes construction of the dam, primary spillway, emergency spillway,

excavation for storage, fencing, seeding, erosion protection of outlet, removal and disposal of sediment, and removal of and site restoration for temporary ponds.

MATERIALS

816.02 Polyethylene Pipe. Polyethylene pipe shall meet the requirements of **AASHTO M 294**.

816.03 Corrugated Aluminum Pipe. Corrugated aluminum pipe shall meet the requirements of **AASHTO M 196**.

816.04 Corrugated Steel Pipe. Corrugated steel pipe shall meet the requirements of **AASHTO M 36**.

816.05 Reinforced Concrete Pipe. Reinforced concrete pipe shall meet the requirements of **AASHTO M 170**.

816.06 Concrete. Concrete shall meet the requirements of **Section 701**.

CONSTRUCTION REQUIREMENTS

816.07 Temporary and Permanent Sediment Control Basins. The sediment control basin shall consist of a basin storage area, a dam, a principle spillway consisting of a riser and an outflow pipe, emergency spillway, and a fence. The basin and dam shall be located and constructed in accordance with the plans. The silt basin shall be constructed before any other earthwork is performed.

The principal spillway, designated as the sediment control structure, shall consist of a riser pipe connected to an outflow pipe. All pipe connections shall be watertight. The riser pipe shall be supported by a 6 inch treated wooden post, connected by a wire strap as shown on the plans. The riser and the wooden post shall be anchored in Class 2500 concrete, or higher, as directed by the Engineer. For temporary silt basins, the riser and outflow pipe may be either polyethylene (Type C) or corrugated steel pipe. For permanent silt basins,

the riser and outflow pipes shall be corrugated aluminum pipe or reinforced concrete pipe. Both corrugated aluminum alloy pipe and corrugated steel pipe must be in accordance with **Section 714** of these specifications. Pipe sizes shall be as shown on the plans. Three-quarter inch diameter holes shall be drilled in the riser pipe, starting one foot above the top of the outflow pipe. These holes shall be spaced at intervals of one foot horizontal and one foot vertical. A trash rack and an anti-vortex plate shall be placed over the top of the riser as shown on the plans. There shall be a de-watering orifice in the riser opposite and on the same grade as the outlet pipe. The orifice shall be covered with 1/2 inch hardware cloth and No. 5 aggregate to a depth of 6 inches above the top of the outlet pipe. The diameter of the orifice and the riser and outlet pipes shall be as shown on the plans.

For sediment basins, the bottom of the basin and the outflow pipe will be placed on a 0.5 percent slope. As indicated on the plans, the outfall channel from the outlet pipe shall be lined with rip-rap or a stilling basin shall be installed. The rip-rap shall be placed over geotextile for erosion control.

The dam shall be constructed in accordance with **Subsections 816.09** and **816.10**. All surface areas of the sediment basin, dam, and emergency spillway shall be seeded in accordance with **Section 810,** except for the bottom of the basin. If the inflow into the basin is from a pipe or from a ditch with a flow line higher than the bottom of the basin, rip-rap will be placed at the end of the ditch or pipe to prevent erosion. A woven wire fence, Type 1 without barbed wire, shall be placed as directed by the Engineer.

When grading operations have been completed and permanent grassing in place, the area occupied by the sediment basin shall be restored as nearly as practical to the original ground line and seeded according to Section 810 of these specifications.

816.08 Storm Water Detention Basin. The storm water detention basin is a permanent structure that consists of a

basin storage area, a principle spillway, an emergency spillway, and a security fence. The basin and dam shall be constructed as indicated on the plans.

The principle spillway shall consist of a riser and an outlet pipe. The riser may be either a pipe or a concrete box. If the riser is a pipe, it will have a trash rack and an anti-vortex plate. Box type risers will have a grate. Both types of risers shall have a stub out de-watering pipe at the same flow line as the outlet pipe as shown on the plans. The pipes shall be reinforced concrete or aluminum alloy. All connections shall be watertight.

In rural areas, a woven wire fence, Type 1 without barbed wire, shall be placed as shown on the plans or as directed by the Engineer. In urban areas, a standard chain-link security fence shall be placed as shown on the plans or as directed by the Engineer.

816.09 Earth Dam. The dam shall be constructed to the dimensions shown on the plans. A cutoff trench shall be constructed which shall extend through the entire length of the dam and into original ground at the abutments. The cutoff trench will be a minimum of 4 feet deep, or deeper as shown on the plans, and have 1:1 side slopes. The dam core shall have a top width of 8.0 feet level with the flow line of the emergency spillway. It shall be constructed to the dimensions shown on the plans with 1:1 side slopes. Both the core and the cutoff trench will consist of clay or other impervious materials that meet the following **AASHTO Classifications: A-2-6**, **A-2-7**, **A-6**, and **A-7**.

An aggregate diaphragm shall be constructed parallel to the dam, around the outlet pipe immediately at the outlet side of the cutoff trench. The diaphragm shall be 2.0 feet thick and shall extend three times the pipe diameter vertically and horizontally, extending a minimum of 18 inches beneath the pipe. The top of the diaphragm shall have at least 2.0 feet fill material over it. An aggregate drain for the diaphragm will be

constructed around the outlet pipe to the down stream edge of the dam. It shall be 1.5 times the diameter of the pipe or a minimum of 1.0 foot around the pipe. The aggregate for both the diaphragm and the drain shall be FA-10 fine aggregate. Where the drain and the outlet pipe exit the fill, a rip-rap pad shall be placed on the fill over a fabric filter. It shall extend at least 2.0 feet outside the aggregate drain in all directions. The rip-rap shall meet the requirements for Class B rip-rap as shown in **Subsection 804.02**.

An emergency spillway shall be constructed on original ground at the grades and locations shown on the plans. A spillway outfall channel will be constructed to the main outfall channel as shown on the plans. The sides and bottom of the emergency spillway and spillway outfall channel will be seeded in accordance with Section 810 unless otherwise specified in the plans.

816.10 Placing An Earth Dam. The earth dam shall be placed in accordance with the plans. The entire area of the basin, dam, and emergency spillway will be cleared and grubbed in accordance with **Section 201**. In the foundation area of the dam, all holes shall be filled with suitable material, and compacted to 95% compaction.

The area shall be turned to a depth of 6 inches with a disk harrow and compact it so that the surface material of the foundation meets the compaction requirements of the subsequent layer of the fill. Excavate the cutoff trench to the dimensions shown on the plans. The material removed from the trench may be used for full for the back one third of the dam. Before back filling the cutoff trench, it must be pumped free of water, then turned and compacted as described above. It shall be backfilled in horizontal layers not exceeding 8 inches in depth and compacted to 95% compaction. The moisture content of the fill material shall be adequate for obtaining the required compaction. Fill adjacent to pipes or other structures shall be placed in 4 inch layers and compacted by hand or by manually directed tampers or plate vibrators. The fill over pipes should be at least 2 feet thick be-

fore equipment is allowed to run over it. Fill adjacent to concrete structures shall not be placed or compacted until the concrete has had sufficient time to gain enough strength to support the load.

The aggregate diaphragm and the aggregate drain are constructed by first bringing up the fill and then excavating the required shape and backfilling with the aggregate.

As soon as final grades are reached, all areas will be seeded in accordance with Section 810.

816.11 Method of Measurement. All earthwork required to construct and maintain the Temporary or Permanent Sediment Control Basin will be measured in cubic yards of Silt Basin. Backfilling and grading of temporary sediment control basins shall be measured in cubic yards of Silt Basin.

All earthwork required to construct and maintain storm water detention basins will be measured by the cubic yard of Detention Pond.

Permanent Sediment Control Structures and Temporary Sediment Control Structures will be measured by each unit completed and accepted.

The quantity of pipe to be measured for payment shall be the number of linear feet of the type pipe specified in the plans placed and accepted.

Rip-rap will be measured in tons or cubic yards, as specified in the contract. During the removal of a temporary sediment control basin, removal and disposal of rip-rap located in the basin will be measured in cubic yards as Silt Basin.

The quantity of Geotextile for Erosion Control Under Rip-rap will be the number of square yards placed and accepted, measured parallel to the slope.

Seeding will be measured in accordance with Section 810.

The aggregate diaphragm and aggregate drain will be measured in cubic yards of Aggregate Diaphragm.

816.12 Basis of Payment. The quantity of each item, measured as provided above, will be paid at the contract unit price for that item, which shall be full compensation for furnishing all labor, equipment, tools, and incidentals necessary to complete the work herein prescribed in a workmanlike and acceptable manner.

Price and payment for Temporary Sediment Control Structures and Permanent Sediment Control Structures shall include all materials, including concrete, reinforcing steel, trash rack, anti-vortex plate, hardware fabric, 6 inch treated wood post, No.5 aggregate, riser, and four feet of outlet pipe. Temporary Sediment Control Structures shall also include removal of the structure, pipe and all appurtenances connected to the structure, rip-rap at the end of the outlet pipe, and the fence and gate surrounding the basin.

The quantity of pipe, measured as provided in **Subsection 816.11**, shall be paid at the contract unit bid price per linear foot for each type or class called for in the plans, completed and accepted in place.

Aggregate Diaphragm will be paid for at the unit bid price per cubic yard which shall be full price and payment for all materials, labor and equipment necessary to complete the work in accordance with the plans and specifications.

Seeding operations will be paid for in accordance with **Subsection 810.28** of these specifications.

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

Payment will be made under:

Item No.	Pay Item	Pay Unit
8154000	Silt Basin	Cubic Yard
81600X0	Temporary *(riser dia.)*" x *(outlet dia.)*" Sediment Control Structure	Each
81602X0	Permanent *(riser dia.)*" x *(outlet dia.)*" Sediment Control Structure	Each
8161000	Detention Pond	Cubic Yard
8161100	Aggregate Diaphragm	Cubic Yard

APPENDIX

BITUMINOUS SURFACING - (SINGLE TREATMENT)

SEQUENCE OF OPERATIONS	QUANTITIES PER SQUARE YARD		
	Type 1	**Type 2**	**Type 3**
Clean surface.			
Apply asphalt binder. (gallons)	0.38 - 0.43	---	---
Apply CRS-2. (gallons)	---	0.38 - 0.43	0.25 - 0.30
Spread immediately Aggregate No. 6M. (lbs.)†	28 - 32	28 - 32	---
Spread immediately Aggregate No. 89M. (lbs.)‡	---	---	17 - 22
Roll with steel wheel and pneumatic rollers, all types.			
Continue rolling with pneumatic rollers until aggregate are firmly seated.			
Broom off excess aggregate.			

† The amount of aggregate spread shall be between these limits and shall be the amount necessary to obtain a complete and satisfactory cover.

‡ The Engineer may not require the use of a steel wheel roller.

BITUMINOUS SURFACING (DOUBLE TREATMENT)

SEQUENCE OF OPERATIONS	QUANTITIES PER SQUARE YARD		
	Type 1	**Type 2**	**Type 3**
Prime: †			
Clean surface.			
Apply MC-30, RC-30 or EA-P Special. (gallons)	0.25 – 0.28	--	--
Allow to cure, all types.			
First Layer:			
Apply CRS-2 or asphalt binder. (gallons)	0.35 - 0.40	--	--
Apply CRS-2. (gallons)	--	0.40 - 0.43	0.30 - 0.35
Spread immediately Aggregate No. 5. (lbs.) ‡	40 - 50	40 - 50	--
Spread immediately Aggregate No. 6M. (lbs.)	--	--	28 - 32
Roll immediately with steel wheel and pneumatic roller, all types.			
Second Layer **§**			
Apply CRS-2. (lbs.)	0.17 - 0.20	0.22 - 0.23	0.25 - 0.30
Spread immediately Aggregate No. 789. (lbs.)	22 - 24	22 - 24	18 - 22
Apply CRS-2. (lbs.)	0.30 - 0.32	0.35 - 0.37	--
Roll with steel wheel rollers as soon as possible, all types.			
TOTALS:			
Bituminous material (not including prime) (gallons)	0.82 - 0.92	0.97 - 1.03	0.55 - 0.65
Aggregate (lbs.)	62 - 74	62 - 74	46 - 54

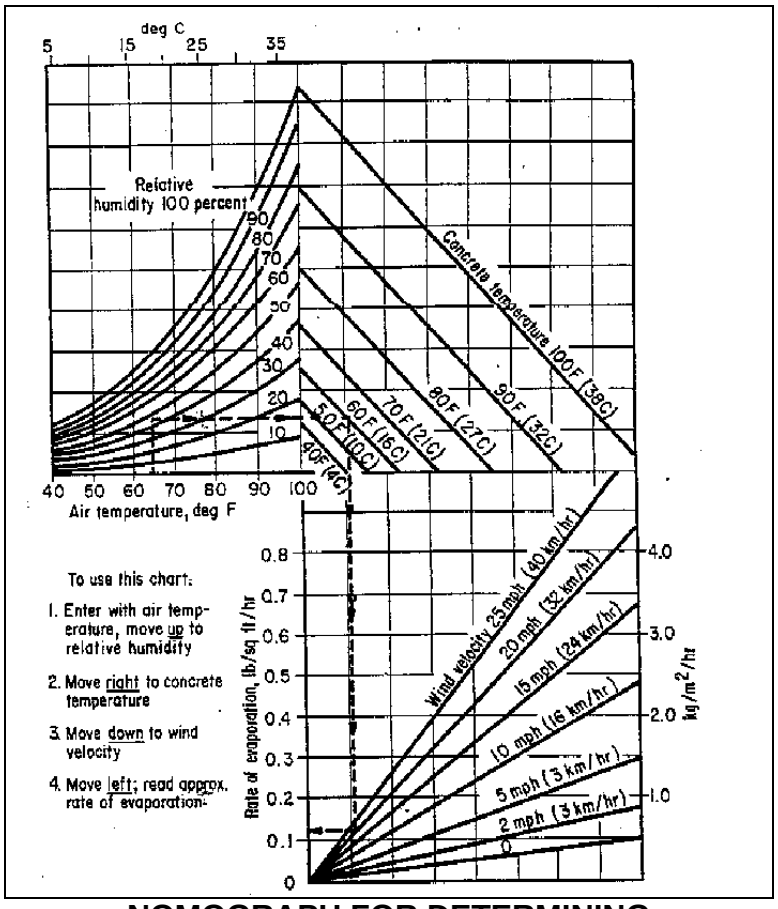
† When the base consists of marine (fossiliferous) limestone, the prime rate shall be from 0.10 to 0.15 gallon per square yard.

‡ The amount spread shall be within these limits and shall be the amount necessary to obtain a complete and satisfactory cover.

§ The Engineer may direct a change in the sequence of operations as provided in this section.

BITUMINOUS SURFACING
(DOUBLE TREATMENT)
CLASS A SPECIAL

SEQUENCE OF OPERATIONS	QUANTITIES PER SQUARE YARD
Clean Surface.	
Apply CRS-2. (gallons)	0.30 – 0.35
Spread mat Aggregate No. 6M. (lbs.)	28 – 32
Roll promptly with one to two passes using steel wheel roller and continue with pneumatic roller until mat is thoroughly keyed in asphalt.	
Remove excess mat aggregate.	
Apply CRS-2. (gallons)	0.16 – 0.20
Spread Aggregate No. 89M. (lbs.)	14 – 16
Apply CRS-2. (gallons)	0.20 – 0.25
Spread Aggregate No. 89M. (lbs.)	6 – 8
Roll with steel wheel and pneumatic roller.	
TOTALS:	
Bituminous Materials (excluding prime) (gallons)	0.66 – 0.80
Aggregates (lbs.)	48 - 56



NOMOGRAPH FOR DETERMINING RATE OF EVAPORATION

This chart provides a graphic method of estimating the loss of surface moisture due to concrete and air temperatures, relative humidity, and wind velocity. To use the chart, follow the four steps outlined. If the rate of evaporation approaches 0.2 lbs./ft.^{2}/hr., precautions against plastic shrinkage cracking are necessary.

GRADATION OF FINE AGGREGATES

Percentage by Weight Passing Sieves Having Square Openings

Sieve Designation	Aggregate No.		
	FA-10	FA-12	FA-13
1/2 Inch	--	--	--
3/8 Inch	100	100	100
No. 4	96 - 100	90 - 100	90 -100
No. 8	75 - 100	--	--
No. 16	55 - 98	50 - 86	40 - 80
No. 30	25 - 75	--	--
No. 50	8 - 30	2 - 20	0 - 10
No. 100	0 - 9	0 - 5	0 - 3
No. 200	0 - 3	--	--

AGGREGATE USES

Aggregate No.	Applications
5	Bituminous Surfacing (double Treatment) Types 1 and 3 Bituminous Surfacing (triple treatment) Type 1
6M	Bituminous Surfacing (single treatment) Types 1 and 2 Bituminous Surfacing (triple treatment) Type 2
57	Portland Cement concrete for structures
67	Portland Cement concrete pavement
89M	Bituminous Surfacing (triple treatment) Type 2 Bituminous Surfacing (single treatment) Type 3 Bituminous Surfacing (double treatment - Class A Special)
789	Aggregate underdrains Bituminous Surfacing (double treatment) Types 1, 2, and 3 Bituminous Surfacing (triple treatment) Type 1 Pipe underdrains
CR-14	Soil-aggregate subbase
FA-10	Portland Cement concrete for structures Portland Cement concrete pavement
FA-12	Aggregate underdrains
FA-13	Aggregate underdrains Bituminous Surfacing (triple treatment) Types 1 and 2

GRADATION OF COARSE AGGREGATES

Percentage by Weight Passing Sieves Having Square Openings

Sieve Designation	Aggregate No.							
	CR-14	5	57	67	6M	8M	789	89M
2 inches	100	--	--	--	--	--	--	--
1 1/2 inches	95 - 100	100	100	--	--	--	--	--
1 inch	70 - 100	90 - 100	95 - 100	100	100	--	--	--
3/4 inch	--	20 - 55	--	90 - 100	90 - 100	100	100	--
1/2 inch	35 - 65	0 - 10	25 - 60	--	--	95 - 100	95 - 100	100
3/8 inch	--	0 - 5	--	20 - 55	0 - 20	75 - 100	80 - 100	98 - 100
No. 4	10 - 40	--	0-10	0 - 10	0 - 5	10 - 35	20 - 50	20 - 70
No. 8	--	--	0-5	0-5	--	--	--	2 - 20
No. 16	--	--	--	--	--	0-5	0 - 6	--
No. 100	--	--	--	--	--	0-2	0 - 2	0 - 3

BITUMINOUS SURFACING
(TRIPLE TREATMENT)

SEQUENCE OF OPERATIONS	QUANTITIES PER SQUARE YARD	
	Type 1	**Type 2**
Prime: †		
Clean surface		
Apply MC-30, RC-30 or EA-P. (gallons)	0.25 - 0.28	0.25 - 0.28
Allow to cure, all types.		
First Layer:		
Apply CRS-2. (gallons)	0.35 - 0.40	0.30 - 0.35
Spread immediately Aggregate No. 5. (lbs.)‡	40 - 50	---
Spread immediately Aggregate No. 6M. (lbs.)	---	28 - 32
Roll Immediately with steel wheel roller and pneumatic tired roller, all types.		
Second Layer:		
Apply CRS-2 (gal.)	0.20 - 0.23	0.16 - 0.20
Spread immediately Aggregate No. 789. (lbs.)	17-19	---
Spread immediately Aggregate No. 89M. (lbs.)	---	14 - 16
Third Layer:		
Apply CRS-2. (gallons)	0.30 - 0.32	0.25 - 0.30
Spread immediately Aggregate No. FA-13. (lbs.)	10-12	---
Spread immediately Aggregate No. FA-13 or washed screenings. (lbs.)	---	10 - 12
Roll with steel wheel and pneumatic rollers, broom, continue alternating with pneumatic roller and broom, all types.		
TOTALS:		
Bituminous material (not including prime) (gallons)	0.85 - 0.95	0.71 - 0.85
Aggregate (lbs.)	67 - 81	52 - 60

† When the base consists of marine (fossiliferous) limestone, the prime rate shall be from 0.10 to 0.15 gallons per square yard.

‡ The amount spread shall be within these limits and shall be the amount necessary to obtain a complete and satisfactory cover.

SCHEDULE OF CONTRACT ITEMS

Item No.	Pay Item	Pay Unit
1031000	Mobilization	Lump Sum
1040010	Value Engineering (Contractor's Portion)	Lump Sum
105080X	Construction Stakes, Lines, and Grades	Each
105081X	Construction Stakes, Lines And Grades (For Bridge Only)	Each
1071000	Traffic Control	Lump Sum
2011000	Clearing and Grubbing within Right of Way	Lump Sum
2012000	Clearing and Grubbing within Roadway	Lump Sum
2013050	Clearing and Grubbing Ditches	Acre
2021000	Removal of Structures and Obstructions	Lump Sum
20220XX	Removal & Disposal Item No. *(number)*	Lump Sum
2023000	Removal & Disposal of Existing Pavement	Square Yard
2024100	Removal & Disposal of Existing Curb	Linear Foot
2024200	Removal & Disposal of Existing Bituminous Curb	Linear Foot
2025000	Removal & Disposal of Existing Asphalt Pavement	Square Yard
20281XX	Removal & Disposal of Existing Bridge	Lump Sum
20285XX	Removal & Disposal of Existing Culvert *(width)* ft. × *(height)* ft.	Each
2031000	Unclassified Excavation	Cubic Yard
2031200	Site Excavation	Lump Sum
2032000	Rock Excavation	Cubic Yard
2033000	Borrow Excavation	Cubic Yard
2034000	Muck Excavation	Cubic Yard
2035000	Station Grading	Station

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
2036000	Geotextile for Separation of Subgrade and Subbase or Base Course Material	Square Yard
2041000	Structure Excavation for Culverts	Cubic Yard
2041005	Structure Excavation for Retaining Walls	Cubic Yard
2042000	Dry Excavation for Bridges	Cubic Yard
2043000	Wet Excavation for Bridges	Cubic Yard
2043500	Wet & Dry Excavation for Bridges	Cubic Yard
2044000	Rock Excavation for Bridges	Cubic Yard
2045000	Cofferdam	Each
2045010	Cofferdam - Type 1 (0 – 10,000 CF)	Each
2045020	Cofferdam - Type 2 (10,001 – 20,000 CF)	Each
2045030	Cofferdam - Type 3 (20,001 – 30,000 CF)	Each
2045040	Cofferdam - Type 4 (30,001 – 40,000 CF)	Each
2045050	Cofferdam - Type 5 (40,001 – 50,000 CF)	Each
2045060	Cofferdam - Type 6 (>50,000 CF)	Each
2047000	Temporary Sheet Piling	Linear Foot
2047200	Permanent Sheet Piling	Square Yard
2061000	Embankment In-Place	Cubic Yard
2071000	Overhaul	Cubic Yard Half-Mile
2091000	Select Material for Shoulders and Slopes	Cubic Yard
2103000	Flowable Fill	Cubic Yard
3011XXX	Cement Modified Subbase ((*thickness*)" Uniform)	Square Yard
3013000	Portland Cement for Cement Modified Subbase	Ton

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
3021000	Soil Aggregate Subbase Course Aggregate No. CR-14	TON
3022000	Aggregate No. CR-14	TON
30310XX	Sand-Clay Base Course (*(thickness)*" Uniform)	Square Yard
30411XX	Coquina Shell Base Course (*(thickness)*" Uniform)	Square Yard
30501XX	Graded Aggregate Base Course (*(thickness)*" Uniform)	Square Yard
3050199	Graded Aggregate Base Course	Ton
30710XX	Cement Stabilized Earth Base Course (*(thickness)*" Uniform)	Square Yard
3072000	Portland Cement for Cement Stabilized Earth Base Course	Ton
30810XX	Cement Stabilized Aggregate Base Course (*(thickness)*" Uniform)	Square Yard
3082000	Portland Cement for Cement Stabilized Aggregate Base Course	Ton
30910XX	Hot Mix Sand Asphalt Base Course Type 1 (*(thickness)*" Uniform)	Square Yard
3091100	Hot Mix Sand Asphalt Base Course Type 1	Ton
30920XX	Hot Mix Sand Asphalt Base Course Type 2 (*(thickness)*" Uniform)	Square Yard
3092100	Hot Mix Sand Asphalt Base Course Type 2	Ton
310XXXX	Hot Mix Asphalt Aggregate Base Course Type *(1or 2)*	Ton
401100X	Liquid Asphalt Binder *(grade)*	Ton

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
4019000	Milled-In Rumble Strip	Mile
402XXXX	Hot Mix Asphalt Binder Course (Type *(1 or 2)*)	Ton
403XXXX	Hot Mix Asphalt Surface Course (Type *(1, 1B, 1C, 3, or 4)*)	Ton
4037000	Hot Mix Asphalt Surface Course for Ditch Paving	Ton
4041000	Cold Mix Asphalt Binder Course	Ton
405XXXX	Cold Mix Asphalt Surface Course (Type *(1, 2, or 3)*)	Ton
406XXXX	Bituminous Surfacing (Double Treatment) Type *(1, 2, 3, or Class A Special)*	Square Yard
407XXXX	Bituminous Surfacing (Single Treatment) Type *(1, 2, or 3)*	Square Yard
408XXXX	Bituminous Surfacing (Triple Treatment) Type *(1 or 2)*	Square Yard
5011XXX	Portland Cement Concrete Pavement - *(thickness)*" Uniform	Square Yard
5012XXX	Portland Cement Concrete Pavement for Ramps - *(thickness)*" Uniform	Square Yard
50210XX	Full Depth Concrete Pavement Patch - *(thickness)*"	Square Yard
5029000	Portland Cement Concrete (Special Use)	Cubic Yard
5031000	Grinding and Texturing Existing Concrete Pavement	Square Yard
5041100	Clean and Seal Longitudinal Joints	Linear Foot
5041200	Clean and Seal Longitudinal Shoulder Joints	Linear Foot

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
5041300	Clean and Seal Transverse Joints	Linear Foot
5041400	Clean and Seal Transverse Joints at Bridge	Linear Foot
5051000	Rout, Clean, and Seal Cracks	Linear Foot
6020105	Construction Zone Electric Changeable Message Sign	Each
6021X0X	Pavement Markings (Temporary - Removal) *(width)*" *(color)* Broken Lines	Linear Foot
6021XXX	Pavement Markings (Temporary - Removal) *(width)*" *(color)* Solid Lines	Linear Foot
6021030	Pavement Markings (Temporary - Removal) White Single Arrow	Each
6021035	Pavement Markings (Temporary - Removal) White Word Message "Only"	Each
6021040	Pavement Markings (Temporary - Removal) White Combination Arrow	Each
6021045	Pavement Markings (Temporary - Removal) Railroad Crossing Symbols	Each
60240X0	Portable Terminal Impact Attenuator - *(3 or 6)* Bay	Each
60240X5	Portable Terminal Impact Attenuator - *(3 or 6)* Bay - 2.0' Wide	Each
60240X6	Portable Terminal Impact Attenuator - *(3 or 6)* Bay - 2.5' Wide	Each
60241X1	Anchor Kit - Portable Attenuator *(3 or 6)* Bay - 6.5" Studs	Each
60241X5	Anchor Kit - Portable Attenuator *(3 or 6)* Bay - 18" Threaded Rods	Each
6020005	Permanent Construction Signs	Square Feet

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
6025001	Temporary Concrete Barrier	Linear Foot
6023015	Temporary Clear Pavement Markers Mono-Directional, 4"X4"	Each
6023025	Temporary Yellow Pavement Markers Mono-Directional, 4"X4"	Each
6023055	Temporary Yellow Pavement Markers Bi-Directional, 4"X4"	Each
6028020	Temporary Sheet Piling for Traffic Control	Linear Foot
6040X0X	*(width)*" *(color)* Broken Lines (Gaps Excluded) - Fast Dry Paint	Linear Foot
6040X1X	*(width)*" *(color)* Solid Lines (Pavement Edge Lines) - Fast Dry Paint	Linear Foot
6040015	8" White Solid (Crosswalk & Channelization) - Fast Dry Paint	Linear Foot
6040020	12" White Solid Lines (Stop Lines) - Fast Dry Paint	Linear Foot
6040025	24" White Solid Lines (Stop Lines / Diagonal Lines) - Fast Dry Paint	Linear Foot
6040030	White Single Arrow (Left, Straight, or Right) - Fast Dry Paint	Each
6040031	White Single Bike Lane Arrow (Left, Straight, or Right) - Fast Dry Paint	Each
6040035	White Word Message ("Only") - Fast Dry Paint	Each
6040043	White Lane Drop Arrow (Right or Left) - Fast Dry Paint	Each
6040045	Railroad Crossing Symbol - Fast Dry Paint	Each
6040050	Handicap Symbol - Fast Dry Paint	Each

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
6040055	Bike Lane Symbol - Fast Dry Paint	Linear Foot
6040112	6" Yellow Solid Lines on Curb / Median - Fast Dry Paint	Linear Foot
6040113	6" Yellow Solid Lines on 6" Concrete Curb (Top & Side) - Fast Dry Paint	Linear Foot
6040115	24" Yellow Diagonal Lines - Fast Dry Paint	Linear Foot
6041X0X	*(width)*" *(color)* Broken Lines (Gaps Excluded) - Thermoplastic - 90 mil.	Linear Foot
6041X1X	*(width)*" *(color)* Solid Lines (Pavement Edge Lines) - Thermoplastic - 90 mil.	Linear Foot
6041X15	*(width)*" *(color)* Solid Lines - Thermoplastic - 125 mil	Linear Foot
6041020	12" White Solid Lines (Stop Lines) - Thermoplastic - 125 mil.	Linear Foot
6041025	24" White Solid Lines (Stop Lines / Diag. Lines) - Thermoplastic - 125 mil.	Linear Foot
6041035	White Word Message "Only" - Thermoplastic - 125 mil.	Each
6041040	White Combination Arrows (Straight & Right or Straight & Left) - Thermoplastic - 125 mil.	Each
6041045	Railroad Crossing Symbols - Thermoplastic - 125 mil.	Each
6041050	Handicap Symbol - Thermoplastic - 125 mil.	Each
6042X0X	*(width)*" *(color)* Broken Lines (Gaps Excluded) - Epoxy Paint	Linear Foot
6042X1X	*(width)*" *(color)* Solid Lines (Pavement	Linear Foot

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
	Edge Lines) - Epoxy Paint	
6042021	12" White Solid Lines (Diagonal Lines) - Epoxy Paint	Linear Foot
6042015	8" White Solid (Crosswalk & Channelization) - Epoxy Paint	Linear Foot
6042020	12" White Solid Lines (Gore Markings) - Epoxy Paint	Linear Foot
6042021	12" White Solid Lines (Diagonal Lines) - Epoxy Paint	Linear Foot
6042025	24" White Solid Lines (Stop Lines / Diagonal Lines) - Epoxy Paint	Linear Foot
6042030	White Single Arrows (Left, Straight, or Right) - Epoxy Paint	Each
6042035	White Word Message ("Only") - Epoxy Paint	Each
6042040	White Combination Arrows (Straight & Right or Straight & Left) - Epoxy Paint	Each
6042043	White Lane Drop Arrow (Right or Left) - Epoxy Paint	Each
6042045	Railroad Crossing Symbol - Epoxy Paint	Each
6042114	12" Yellow Solid Lines (Diagonal Line) - Epoxy Paint	Linear Foot
6042115	24" Yellow Diagonal Line - Epoxy Paint	Linear Foot
605X005	Permanent *(color)* Pavement Markers - Mono-Directional, 4" x 4"	Each
605X010	Permanent *(color)* Pavement Markers - Mono-Directional, 5" x 2"	Each

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
6051100	Permanent Yellow Pavement Markers - Bi-Directional, 4" x 4"	Each
6051110	Permanent Yellow Pavement Markers - Bi-Directional, 5" x 2"	Each
6070000	Permanent Terminal Impact Attenuator	Each
7011XXX	Concrete for Structures - Class *(class)*	Cubic Yard
7031100	Reinforcing Steel for Structures (Roadway)	Pound
7031105	Reinforcing Steel for Structures (Retaining Wall)	Pound
7031200	Reinforcing Steel for Structures (Bridge)	Pound
7031210	Spiral Reinforcing Steel for Structures (Bridge)	Pound
7031400	Galvanized Reinforcing Steel for Structures (Bridge)	Pound
704XX00	Prestressed Concrete Beam *(type)*	Linear Foot
7051000	Concrete Bridge Barrier Parapet	Linear Foot
7051005	Precast Concrete Barrier Parapet	Linear Foot
7051010	Concrete Bridge Barrier Parapet (Lightweight)	Linear Foot
7051100	Concrete Bridge Median Barrier	Linear Foot
7053000	Steel Bridge Railing	Linear Foot
70540XX	Concrete Bridge Railing Wall *(type or height)*	Linear Foot
7055010	Steel Handrail	Linear Foot
7055100	Metal Bicycle Handrail	Linear Foot
7081000	Hardware	Lump Sum

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
7082000	Hardware	Pounds
709110X	Structural Steel	Lump Sum
7091120	Structural Steel	Pound
7101000	Cleaning and Painting Existing Structural Steel	Lump Sum
7110001	Dynamic Pile Analyzer Test Set-up	Each
7110XX0	Prestressed Concrete Piling (*(size)*" Sq.)	Linear Foot
7110XX1	Pile Build-up Preparation (*(size)*" Sq.)	Each
7110XX2	Pile Load Test - Prestressed Concrete Piling (*(size)*" Sq.)	Each
71104X0	Prestressed Concrete Octagonal Piling - *(size)*"	Linear Foot
71104X1	Prestressed Concrete Octagonal Pile Build-up Preparation (*(size)*")	Each
71104X2	Pile Load Test - Prestressed Concrete Octagonal Pile - *(size)*"	Each
71111XX	Prestressed Pile Point (*(HP size)*)	Linear Foot
71113XX	Prestressed Pile Point (*(pipe diameter and Extra Strong or Dbl. Extra Strong pipe)*)	Linear Foot
71115XX	Reinforced Pile Tips (*(size)*)	Each
71117XX	Reinforced Pile Tips (*(pipe diameter and Extra Strong or Double Extra Strong)*)	Each
7110XX5	Prestressed Index Piling (*(size)*" *(shape)*)	Linear Foot
7112XX0	Steel H Bearing Piling (HP*(size)*x*(weight)*)	Linear Foot
7112XX1	Pile Load Test - Steel H-Piling (HP*(size)*x*(weight)*)	Each

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
7112XX2	Steel H Bearing Index Piling (HP*(size)*x*(weight)*)	Linear Foot
7113XX0	Steel Pipe Piling (*(diameter)*" Diameter)	Linear Foot
7113XX1	Pile Load Test - Steel Pipe Piling (*(dia.)*" Diameter)	Each
7113XX2	Steel Pipe Index Piling (*(dia.)*" Diameter)	Linear Foot
7119100	Treated Timber Piling	Linear Foot
7119101	Pile Load Test - Treated Timber Piling	Each
7120001	Foundation Integrity Test Setup	Each
712002X	Soil Excavation for Drilled Pile Foundations - *(diameter)*" Diameter	Linear Foot
712006X	Rock Excavation for Drilled Pile Foundations - *(diameter)*" Diameter	Linear Foot
7120XX1	Drilled Shafts with Wet & Dry Excavation - *(diameter)*" Diameter	Linear Foot
7120XX2	Drilled Shafts with Rock Excavation - *(diameter)*" Diameter	Linear Foot
7120XX5	Construction Casing - *(diameter)*" Diameter	Linear Foot
7120500	Drilled Pile Foundation Concrete	Cubic Yard
7137175	Mechanically Stabilized Earth Retaining Wall (Segmental Block)	Square Foot
714XXXX	*(size) (kind)* Culvert Pipe *(class or thickness or type)*	Linear Foot
714XXXX	*(size) (kind)* Pipe Culvert Beveled End Section *(class or thickness)*	Each
714XXXX	*(size) (kind)* Pipe Culvert Flared End Section *(class or thickness)*	Each
714XXXX	*(size) (kind)* Pipe Culvert Tee *(class or*	Each

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
	thickness or type)	
714XXXX	*(size) (kind)* Pipe Culvert Wye *(class or thickness or type)*	Each
714XXXX	*(size) (kind)* Pipe Culvert *(degree)* Bend *(class or thickness)*	Each
714XXXX	*(size) (kind)* Reducer *(size)* to *(size)* Diameter *(class or thickness)*	Each
714XXXX	*(size) (kind)* Increaser *(size)* to *(size)* Diameter *(class or thickness)*	Each
7151XXX	*(size)* Steel Structural Plate Pipe *(thickness)*	Linear Foot
7152000	Steel Structural Plate Pipe-Arch	Linear Foot
7153000	Steel Structural Plate-Arch	Linear Foot
7154000	Corrugated Aluminum Alloy Structural Plate Pipe	Linear Foot
7155XXX	*(size)* Corr. Alum. Alloy Struc. Plate Pipe-Arch *(thickness)*	Linear Foot
7156000	Corrugated Alum. Alloy Structural Plate-Arch	Linear Foot
71610X0	*(dia.)*" Reinforced Concrete Sewer Pipe	Linear Foot
71620X0	*(dia.)*" Non-reinforced Concrete Sewer Pipe	Linear Foot
7163X00	*(dia.)*" Vitrified Clay Sewer Pipe	Linear Foot
7165X00	*(dia.)*" Cast Iron Soil Pipe	Linear Foot
7170XX0	*(diameter)*" Re-Laid Pipe Culvert	Linear Foot
7181000	Brick Masonry	Cubic Yard
7182000	Brick Masonry (Reinforced)	Cubic Yard
7183000	Rubble Masonry	Cubic Yard

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
7183006	Rubble Masonry Tree-Well	Cubic Yard
7184000	Concrete Block Masonry	Cubic Yard
7191XX5	Catch Basin *(type)*	Each
7192XX0	Drop Inlet *(size)*	Each
7192105	Manhole	Each
71922XX	*(size)* Junction Box	Each
7192300	Spring Box	Each
71930XX	Precast Concrete Riser - *(size)*" Diameter	Linear Foot
71931XX	PC Drainage Base - *(size)*" Diameter	Each
719315X	PC Transition (Flat Slab) - *(size)*" to *(size)*"	Each
719317X	PC Transition (Cone) - *(size)*" to *(size)*"	Each
7196000	Extra Depth of Box	Linear Foot
7197110	Adjust Catch Basin	Each
7197120	Adjust Manhole	Each
7197130	Adjust Drop Inlet	Each
7197140	Adjust Utility Box	Each
7197150	Adjust Junction Box	Each
7201000	Concrete Curb (9" X 15")	Linear Foot
72020X0	Concrete Gutter *(type)*	Linear Foot
7203XX0	Concrete Curb and Gutter *(size)*	Linear Foot
7204100	Concrete Sidewalk (4" Uniform)	Square Yard
7205XX0	Concrete Driveway *(thickness)*" Uniform	Square Yard
7206000	Concrete Median	Square Yard
7211000	Bituminous Curb	Linear Foot

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
722XXXX	*(size)* P C Box Culvert *(type)* Fill Height = *(fill height)'*	Linear Foot
7243100	Elastomeric Bearing	Each
7260100	Removal of Epoxy, Bituminous and Foreign Overlay	Square Yard
7260200	Machine Preparation of Existing Surface	Square Yard
7260300	Blast Cleaning	Square Yard
7260400	Partial Depth Removal of Unsound Concrete	Square Yard
7260500	Concrete Overlay (Latex)	Cubic Yard
7260600	Concrete Overlay (Portland Cement)	Cubic Yard
7260700	Epoxy-Sand Slurry	Square Foot
7260800	Concrete Class 4000 for Full Depth Deck Patching	Cubic Yard
8011XX0	Aggregate Underdrain *(Agg. No.)*	Linear Foot
8011XX0	Aggregate Underdrain *(Agg. No.)*	Cubic Yard
80211XX	*(size)*" Pipe Underdrain	Linear Foot
80212XX	*(size)*" Perforated Pipe Underdrain	Linear Foot
802140X	*(size)*" Perforated Concrete Pipe Underdrain	Linear Foot
802160X	*(size)*" Perforated Corrugated Metal Pipe Underdrain	Linear Foot
80217XX	*(size)*" Perforated Bituminized Fiber Pipe Underdrain	Linear Foot
802180X	*(size)*" Perforated Corrugated Aluminum Alloy Pipe Underdrain	Linear Foot
802190X	*(size)"* Polyvinyl Chloride (PVC)	Linear Foot

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
	Pipe Underdrain	
802200X	*(size)*" Corrugated Polyethylene Underdrain	Linear Foot
8031XX0	*(size)*" Corrugated Metal Pipe Slope Drain	Linear Foot
8032XX0	*(size)*" Bituminized-Fiber Pipe Slope Drain	Linear Foot
8033XX0	*(size)*" Polyvinyl Chloride (PVC) Pipe Slope Drain	Linear Foot
8034XX0	*(size)*" Pipe Slope Drain	Linear Foot
8035000	Metal Intake Spillway Assembly	Each
8041100	Hand Placed Rip-Rap	Ton
8041200	Hand Placed Rip-Rap	Cubic Yard
8042100	Foundation Rip-Rap	Ton
8042200	Foundation Rip-Rap	Cubic Yard
8043100	Dumped Rip-Rap	Ton
8043200	Dumped Rip-Rap	Cubic Yard
8043350	Sand Cement Rip-Rap	Cubic Yard
8043370	Grouted Rip-Rap	Square Yard
8043390	Precast Concrete Rip-Rap	Square Yard
8044100	PVC Coated-Wire Enclosed Rock Gabion	Cubic Yard
8047040	Slope Protection 4” Concrete	Square Yard
8047041	Slope Protection 4” Concrete (Fiber Reinforced)	Square Yard
80482XX	Geotextile For Erosion Control Under Rip-Rap (Class *(class)*) Type (*(type)*)	Square Yard

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
8051100	Steel Beam Guardrail	Linear Foot
8051101	Adjustable Guardrail Initial Installation	Linear Foot
8051102	Adjustable Guardrail 2 Inch Adjustment	Linear Foot
8051103	Adjustable Guardrail Final Adjustment	Linear Foot
8051110	Removal of Existing Guardrail	Linear Foot
8051200	Steel Beam Guardrail (Double Face)	Linear Foot
8051300	Steel Beam Guardrail (Thrie)	Linear Foot
8051400	Steel Beam Guardrail (Thrie-Double Face)	Linear Foot
8051600	Box Beam Median Barrier	Linear Foot
8051800	Temporary Guardrail	Linear Foot
8053000	Additional Length Guardrail Post	Linear Foot
8058XXX	Concrete Median Barrier *(type)*	Linear Foot
8059XXX	Temporary Concrete Median Barrier	Linear Foot
8051900	Reset Guardrail	Linear Foot
80522X0	End Anchors (Type *(type)*)	Each
8061XXX	*(size)* Woven Wire Fence *(type)*	Linear Foot
8062XXX	*(no. of strands)* Barbed Wire Fence	Linear Foot
8063XXX	*(size)* Chain Link Fence	Linear Foot
8064XXX	*(size)* Gate *(type)*	Each
8066000	Additional Length of Post	Linear Foot
8068148	Ornamental Steel Picket Fence – (*size*)"	Linear Foot
8071000	Reset Fence	Linear Foot
8072000	Reset Chain-Link Fence	Linear Foot
8081000	Moving Item No. *(schedule no.)*	Lump Sum

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
8091000	Right of Way Marker	Each
8091010	Right of Way Marker (Rebar Cap)	Each
8092000	Reset Right of Way Marker	Each
8100001	Permanent Vegetation	MSY
8101000	Seeding (Mulched)	MSY
8102100	Seeding (Unmulched)	MSY
8103000	Temporary Seeding	MSY
8103001	Temporary Vegetation	MSY
8104X00	Fertilizer *(analysis)*	Ton
8105000	Lime	Ton
8106000	Nitrogen	Pound
8109900	Mowing	MSY
8101100	Organic Topsoil	Cubic Yard
8111XXX	Plant *(type)*	Each
8114000	Porous Material for Root Protection	Ton
8115XXX	Drain Tile or Pipe, *(diameter)*"	Linear Foot
8121000	Sprigging	MSY
8105000	Lime	Ton
8131000	Sodding	Square Yard
8104XXX	Fertilizer *(analysis)*	Ton
8105000	Lime	Ton
8142100	Waterproofing (Substructure - Second Method)	Square Yard
8143000	Waterproofing (Bridge Deck)	Square Yard
8151000	Fiber Roving	Square Yard

SCHEDULE OF CONTRACT ITEMS (Continued)

Item No.	Pay Item	Pay Unit
8151100	Permanent Erosion Control Mat	Square Yard
8151110	Erosion Control Blanket	Square Yard
8152000	Baled Straw	Bale
8153000	Silt Fence	Linear Foot
8153XXX	Floating Turbidity Barrier *(type)*	Linear Foot
8153XXX	Floating Turbidity Barrier *(type)*	Square Foot
8154000	Silt Basins	Cubic Yard
8155000	Silt Ditches	Cubic Yard
8156000	Sediment Dams	Cubic Yard
815621X	Inlet Structure Filter Type *(type)*	Each
8157XXX	Temporary Flexible Pipe Slope Drains	Linear Foot
8154000	Silt Basin	Cubic Yard
81600X0	Temporary *(riser dia.)*" x *(outlet dia.)*" Sediment Control Structure	Each
81602X0	Permanent *(riser dia.)*" x *(outlet dia.)*" Sediment Control Structure	Each
8161000	Detention Pond	Cubic Yard
8161100	Aggregate Diaphragm	Cubic Yard

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Table of External Links

Some of the items referred to in this publication are provided by outside organizations. Listed below are links to those organizations.

Organization	Link
AASHTO	http://www.aashto.org
American Institute of Steel Construction	http://www.aisc.org/
American Nursery & Landscape Assn	http://www.anla.org
American Welding Society	http://www.aws.org/
Approval List	
ASTM	http://www.astm.org
Best's Insurance Report	http://www.ambest.com/
Coastal Zone Management Act	http://laws.fws.gov/lawsdigest/reslaws.html
Code of Federal Regulations	http://www.access.gpo.gov/nara/cfr/
Code of Laws of SC	http://www.lpitr.state.sc.us/
Concrete Reinforcing Steel Institute	http://www.crsi.org/
Department of Insurance	http://www.doi.state.sc.us/index.asp
Environmenal Protection Agency	http://www.epa.gov
Federal Water Pollution Control Act (Section 404)	http://laws.fws.gov/lawsdigest/reslaws.html
FHWA	http://www.fhwa.dot.gov/
Floodplain Management	http://www.fema.gov/fima/floodplain.shtm
Geosynthetic Research Institute	http://www.geosynthetic-institute.org/
National Cooperative Highway Research Program	http://nationalacademies.org/trb/
National Electrical Code	http://www.nfpa.org/catalog/home/index.asp
NCMA Design Manual for Segmental Retaining Walls	http://www.ncma.org/
National Ready Mix Concrete Assn	http://www.nrmca.org/
National Transportation Product Evaluation Program	http://www.ntpep.org
Notice to Contractors	http://www.scdot.org/doing/currentletting.asp
OSHA	http://www.osha.gov/
SC Department of Agriculture	http://www.scda.state.sc.us/
SCDOT Research and Materials Lab	http://www.scdot.org/doing/rm_lab.html
SC DHEC	http://www.scdhec.net/
SC DNR	http://www.dnr.state.sc.us/

SC Liming Materials Act	http://hubcap.clemson.edu/~blpprt/SClimelinks.html
SC Mining Act	http://www.lpitr.state.sc.us/code/titl48.htm
SCMUTCD	http://www.scdot.org/doing/trafficengineering.html
Society for Protective Coatings (SSPC)	http://www.sspc.org/
Southern Pine Inspection Bureau	http://www.spib.org/
Standard Highway Signs	http://mutcd.fhwa.dot.gov/ser-shs_millennium_eng.htm
United States Standard Measures	http://www.nist.gov/
US Army Corps of Eng	http://www.usace.army.mil/
US Coast Guard	http://www.uscg.mil/
US Department of Agriculture	http://www.usda.gov
US Department of Transportation	http://www.dot.gov/
US Soil Conservation Service	http://soils.usda.gov/soil_survey/main.htm