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 re-

quired 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.

CONSTRUCTION REQUIREMENTS

702.10 Falsework/Form Design and Inspection. The re-

quirements 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 as-

sure 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 Engi-

neer.

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 b-cated 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 procedures 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 concrete 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 con-

crete. 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 authority of the Engineer. If an inferior quality of concrete is produced by the use of chutes, the substitution of a satisfac-

tory 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 com-

pleted, 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 revisions 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 practicable at all times. To insure thorough bonding, each succeeding layer of a seal shall be placed before the preced-

ing 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 re-sprayed 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 be-

fore 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 volume 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 proce-

dures 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 controlling 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 concrete 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 re-

quest. 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 cor-

rected 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 Contractor 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 fric-

tion 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*.