DIVISION 700
Structures

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

May 2004

Table of Contents

Section **Page**

701 PORTLAND CEMENT AND PORTLAND CEMENT CONCRETE 701-1

701.1 DESCRIPTION OF WORK 701-1

701.2 PRECONSTRUCTION CONSIDERATIONS 701-1

701.2.1 Concrete Quality and Temperature Control 701-1
701.2.2 Certification of Concrete QC / QA Personnel 701-2
701.2.3 Responsibilities of Concrete QC / QA Personnel 701-2
701.2.4 PCC Mix Materials 701-3

701.2.4.1 Material Source Approval 701-3
701.2.4.2 Cementitious Materials 701-3
701.2.4.3 Aggregate Materials 701-5
701.2.4.4 Water and Stabilizer Agents 701-6
701.2.4.5 Admixture Materials 701-6

701.2.5 PCC Plant and Hauling Equipment 701-7

701.2.5.1 Certification and Inspection 701-7
701.2.5.2 Scales and Metering Devices 701-8
701.2.5.3 Concrete Mixers 701-9

701.2.6 PCC Mix Design 701-9

701.3 INSPECTION DURING CONSTRUCTION 701-10

701.3.1 Batching and Mixing 701-10
701.3.2 Sampling and Testing 701-10

701.4 POST-CONSTRUCTION CONSIDERATIONS 701-11

701.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 701-11

702 CONCRETE STRUCTURES 702-1

702.1 DESCRIPTION OF WORK 702-1

702.2 PRECONSTRUCTION CONSIDERATIONS 702-1

702.2.1 Pre-Pour Conference and Checklist 702-1
702.2.2 Concrete Quality and Temperature Control 702-1
702.2.3 Mass Concrete Placement Plan 702-1
702.2.4 Crane Safety Considerations 702-1
702.2.5 Material Considerations 702-2

702.2.5.1 Material Source Approval 702-2
702.2.5.2 Portland Cement Concrete 702-2

Table of Contents (continued)

Section **Page**

702.2.5.3 Reinforcing Steel 702-2
702.2.5.4 Expansion and Joint Sealant Materials 702-2
702.2.5.5 Curing Materials 702-3
702.2.5.6 Surface Coatings for Concrete Finish 702-4

702.2.6 Falsework and Forms 702-4
702.2.7 Joints and Other Embedded Features 702-5
702.2.8 Dry-Run Check for Bridge Deck Pours 702-5

702.3 INSPECTION DURING CONSTRUCTION 702-5

702.3.1 Concrete Placement 702-5
702.3.2 Concrete Vibration 702-6
702.3.3 Wet Depth Checks 702-6
702.3.4 Removal of Falsework and Forms 702-6
702.3.5 Initial Surface Finish 702-7
702.3.6 Concrete Curing 702-7
702.3.7 Final Non-Wearing Surface Finish Coat 702-7
702.3.8 Sidewalks and Curbs 702-7

702.4 POST-CONSTRUCTION CONSIDERATIONS 702-7

702.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 702-8

703 REINFORCING STEEL 703-1

703.1 DESCRIPTION OF WORK 703-1

703.2 PRECONSTRUCTION CONSIDERATIONS 703-1

703.3 INSPECTION DURING CONSTRUCTION 703-2

703.4 POST-CONSTRUCTION CONSIDERATIONS 703-3

703.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 703-3

704 PRESTRESSED CONCRETE 704-1

704.1 DESCRIPTION OF WORK 704-1

704.2 PRECONSTRUCTION CONSIDERATIONS 704-1

704.2.1 Shop Plans and Working Drawings 704-1
704.2.2 Materials and Fabrication Considerations 704-1

704.3 INSPECTION DURING CONSTRUCTION 704-2

704.4 POST-CONSTRUCTION CONSIDERATIONS 704-2

704.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 704-2

Table of Contents (continued)

Section **Page**

705 BRIDGE RAILING 705-1

705.1 DESCRIPTION OF WORK 705-1

705.2 PRECONSTRUCTION CONSIDERATIONS 705-1

705.3 INSPECTION DURING CONSTRUCTION 705-1

705.4 POST-CONSTRUCTION CONSIDERATIONS 705-2

705.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 705-2

706 WOOD PRODUCTS FOR USE IN HIGHWAY CONSTRUCTION 706-1

707 PRESERVATIVE TREATMENT OF WOOD PRODUCTS 707-1

708 HARDWARE 708-1

709 STRUCTURAL STEEL 709-1

709.1 DESCRIPTION OF WORK 709-1

709.2 PRECONSTRUCTION CONSIDERATIONS 709-1

709.2.1 Shop Plans and Working Drawings 709-1
709.2.2 Materials and Fabrication Considerations 709-1

709.2.2.1 Structural Steel Members 709-1
709.2.2.2 Structural Steel Fasteners 709-2
709.2.2.3 Miscellaneous Metal and Other Fasteners 709-2
709.2.2.4 Elastomeric Bearing Pads 709-3
709.2.2.5 Electrically Welded Shear Connector Studs (Field Installed) 709-3

709.3 INSPECTION DURING CONSTRUCTION 709-3

709.3.1 Inspection of Materials Upon Delivery 709-3
709.3.2 Falsework 709-4
709.3.3 Bearings and Expansion Devices 709-4

709.3.3.1 Bridge Expansion and Contraction 709-4
709.3.3.2 Bearing Devices 709-4
709.3.3.3 Expansion Devices 709-5
709.3.3.4 Installation and Adjustment 709-6
709.3.3.5 Inspection Guidelines 709-6

709.3.4 Field Welding Considerations 709-7
709.3.5 Assembly and Erection Considerations 709-9

709.3.5.1 Positioning Steel Members 709-9

Table of Contents (continued)

Section **Page**

709.3.5.2 Drift Pins and Temporary Bolts 709-9
709.3.5.3 Connection Adjustments 709-9
709.3.5.4 High-Strength Bolts 709-10

709.4 POST-CONSTRUCTION CONSIDERATIONS 709-10

709.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 709-10

710 PAINT FOR STRUCTURAL STEEL 710-1

710.1 DESCRIPTION OF WORK 710-1

710.2 PRECONSTRUCTION CONSIDERATIONS 710-1

710.2.1 Materials and Equipment Considerations 710-1
710.2.2 Environmental and Safety Considerations 710-1

710.3 INSPECTION DURING CONSTRUCTION 710-1

710.3.1 Cleaning Steel Surfaces 710-1
710.3.2 Brushing and Rolling 710-2
710.3.3 Spray Painting 710-2

710.4 POST-CONSTRUCTION CONSIDERATIONS 710-2

710.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 710-2

711 DRIVEN PILE FOUNDATIONS 711-1

711.1 DESCRIPTION OF WORK 711-1

711.2 PRECONSTRUCTION CONSIDERATIONS 711-2

711.2.1 Certification of Inspection Personnel 711-2
711.2.2 Pile Installation Plan 711-2
711.2.3 Index Piling and Pile Load Tests 711-2
711.2.4 Excavation and Embankment Construction 711-3
711.2.5 Staking and Utilities 711-3
711.2.6 Welder Certification 711-3
711.2.7 Material Considerations 711-3

711.2.7.1 Prestressed Concrete Piles 711-3
711.2.7.2 Steel Piling Materials 711-3
711.2.7.3 Treated Timber Piles 711-4

711.2.8 Equipment Considerations 711-4

711.2.8.1 Acceptance Inspection 711-4
711.2.8.2 Drop Hammers 711-4
711.2.8.3 Power Hammers 711-5

Table of Contents (continued)

Section **Page**

711.2.8.4 Caps and Driving Heads 711-5
711.2.8.5 Points and Tips 711-6
711.2.8.6 Leads and Followers 711-6

711.3 INSPECTION DURING CONSTRUCTION 711-6

711.3.1 Pile Preparation 711-6
711.3.2 Pile Location and Orientation 711-6
711.3.3 Water Jetting 711-7
711.3.4 Pile Penetration 711-7
711.3.5 Pre-Drilling for Piles 711-7
711.3.6 Precautions and Driving Difficulties 711-7
711.3.7 Cutting and Splicing Considerations 711-8
711.3.8 Encasement of Steel Piling 711-9

711.4 POST-CONSTRUCTION CONSIDERATIONS 711-9

711.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 711-9

712 DRILLED SHAFTS AND DRILLED PILE FOUNDATIONS 712-1

712.1 DESCRIPTION OF WORK 712-1

712.2 PRECONSTRUCTION CONSIDERATIONS 712-1

712.2.1 Certification of Inspection Personnel 712-1
712.2.2 Drilled Shaft Installation Plan 712-1
712.2.3 Boring Log and Geological Reports 712-2
712.2.4 Staking and Utilities 712-2
712.2.5 Welder Certification 712-2
712.2.6 Material Considerations 712-2
712.2.7 Equipment and Explosives Considerations 712-3

712.3 INSPECTION DURING CONSTRUCTION 712-3

712.3.1 Drilling Operation 712-3
712.3.2 Reinforcement Cage and Steel Casing 712-4
712.3.3 Concrete Placement 712-4

712.4 POST-CONSTRUCTION CONSIDERATIONS 712-5

712.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 712-5

713 MECHANICALLY STABILIZED EARTH RETAINING WALL 713-1

713.1 DESCRIPTION OF WORK 713-1

713.2 PRECONSTRUCTION CONSIDERATIONS 713-1

713.3 INSPECTION DURING CONSTRUCTION 713-1

Table of Contents (continued)

Section **Page**

713.4 POST-CONSTRUCTION CONSIDERATIONS 713-2

713.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 713-2

714 PIPE CULVERTS 714-1

714.1 DESCRIPTION OF WORK 714-1

714.2 PRECONSTRUCTION CONSIDERATIONS 714-1

714.2.1 Concrete Pre-Pour Conference and Checklist 714-1
714.2.2 Safety Considerations 714-2
714.2.3 Staking and Utilities 714-2
714.2.4 Materials Considerations 714-2

714.2.4.1 Reinforced Concrete Pipe and Clay Pipe 714-2
714.2.4.2 Metal Pipe and Structural Plate Pipe 714-2
714.2.4.3 Polyethylene Pipe 714-3
714.2.4.4 Other Materials 714-3

714.3 INSPECTION DURING CONSTRUCTION 714-3

714.3.1 Field Adjustment Considerations 714-3

714.3.1.1 Overview 714-3
714.3.1.2 Small Stream Considerations 714-4
714.3.1.3 Culvert Skew 714-4
714.3.1.4 Culvert Grade 714-4
714.3.1.5 Inlets and Outlets 714-5

714.3.2 Marking Culvert Locations 714-5
714.3.3 Trench Excavation 714-5
714.3.4 Foundation and Bedding 714-6
714.3.5 Pipe Placement 714-6
714.3.6 Joining Pipe Sections 714-7
714.3.7 Inspection Prior to Backfilling 714-7
714.3.8 Backfilling and Compaction 714-7
714.3.9 Structural Plate Pipe Considerations 714-8

714.3.9.1 Pipe Bedding 714-8
714.3.9.2 Pipe Assembly 714-9

714.3.10 Trenchless Pipe Method 714-9

714.4 POST-CONSTRUCTION CONSIDERATIONS 714-10

714.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 714-10

715 STRUCTURAL PLATE PIPE, PIPE-ARCH AND ARCH CULVERTS 715-1

Table of Contents (continued)

Section **Page**

716 SEWERS....716-1

717 RE-LAID CULVERTS....717-1

718 BRICK, RUBBLE AND CONCRETE BLOCK MASONRY....718-1

718.1 DESCRIPTION OF WORK....718-1

718.2 PRECONSTRUCTION CONSIDERATIONS....718-1

718.3 INSPECTION DURING CONSTRUCTION....718-1

718.4 POST-CONSTRUCTION CONSIDERATIONS....718-2

718.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS....718-2

719 CATCH BASINS, DROP INLETS, MANHOLES & BOXES....719-1

719.1 DESCRIPTION OF WORK....719-1

719.2 PRECONSTRUCTION CONSIDERATIONS....719-1

719.3 INSPECTION DURING CONSTRUCTION....719-1

719.4 POST-CONSTRUCTION CONSIDERATIONS....719-2

719.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS....719-2

720 CONCRETE CURB, GUTTER, SIDEWALK, DRIVEWAY & MEDIAN....720-1

720.1 DESCRIPTION OF WORK....720-1

720.2 PRECONSTRUCTION CONSIDERATIONS....720-1

720.2.1 Review of Plans and Adjacent Property....720-1
720.2.2 Utilities and Staking....720-2
720.2.3 Materials and Equipment Considerations....720-2
720.2.4 Subgrade....720-2
720.2.5 Forms....720-2

720.3 INSPECTION DURING CONSTRUCTION....720-2

720.4 POST-CONSTRUCTION CONSIDERATIONS....720-3

720.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS....720-3

721 ASPHALT CURB....721-1

721.1 DESCRIPTION OF WORK....721-1

Table of Contents (continued)

Section **Page**

721.2 PRECONSTRUCTION CONSIDERATIONS 721-1

721.3 INSPECTION DURING CONSTRUCTION 721-1

721.4 POST-CONSTRUCTION CONSIDERATIONS 721-1

721.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 721-1

722 PRECAST CONCRETE BOX CULVERTS 722-1

723 DECK JOINT STRIP SEAL 723-1

723.1 DESCRIPTION OF WORK 723-1

723.2 PRECONSTRUCTION CONSIDERATIONS 723-1

723.3 INSPECTION DURING CONSTRUCTION 723-1

723.4 POST-CONSTRUCTION CONSIDERATIONS 723-2

723.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 723-2

724 ELASTOMERIC BEARINGS 724-1

724.1 DESCRIPTION OF WORK 724-1

724.2 PRECONSTRUCTION CONSIDERATIONS 724-1

724.3 INSPECTION DURING CONSTRUCTION 724-1

724.4 POST-CONSTRUCTION CONSIDERATIONS 724-1

724.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 724-2

725 SHOP PLANS AND WORKING DRAWINGS FOR STRUCTURES 725-1

726 BRIDGE DECK REHABILITATION 726-1

726.1 DESCRIPTION OF WORK 726-1

726.2 PRECONSTRUCTION CONSIDERATIONS 726-1

726.3 INSPECTION DURING CONSTRUCTION 726-1

726.4 POST-CONSTRUCTION CONSIDERATIONS 726-1

726.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS 726-2

Section 701
Portland Cement and Portland Cement Concrete

701.1 DESCRIPTION OF WORK

The requirements for Portland cement and Portland cement concrete are governed by the provisions of Section 701 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. The Contractor will be responsible for furnishing the required component materials, properly storing and handling the materials and for proportioning, mixing and delivering an acceptable concrete mixture of the specified class.

701.2 PRECONSTRUCTION CONSIDERATIONS

701.2.1 Concrete Quality and Temperature Control

The Contractor is responsible for all personnel, methods and procedures to control the quality of work and materials during the project, which must be consistent with the QC/QA requirements specified in the Contract and required by the Research and Materials Engineer. The minimum level of Quality Control, Quality Acceptance and Independent Assurance Samples and Tests are presented in Section 106. During periods of extreme hot or cold temperatures, concrete production will not be permitted without a Cold and Hot Weather Batching and Mixing Plan accepted by the District Construction Engineer. The Cold and Hot Weather Batching and Mixing Plan describes methods that will be used to control concrete temperatures within specified limits during batching, mixing, placement and curing. Control methods include, but are not limited to:

- scheduling finishing and curing immediately behind the pour;
- heating of mixing water and using heated and insulated aggregate bins;
- using insulated forms and curing blankets (requires product data sheet);
- using tarps and dry heat, while maintaining moisture during curing;
- sprinkling of aggregate and using chilled mixing water, shaved ice or special cement;
- prewetting forms and subgrade, where applicable;
- erecting windbreaks;
- using a fog spray to promote evaporative cooling without damaging surface; and
- rescheduling.

Temperatures must be in accordance with the Contract Specifications for the type of work. The Contractor will submit the Cold and Hot Weather Batching and Mixing Plan and the topic of quality and temperature control will be discussed at the Preconstruction Conference or Pre-Pour Conference, if required. Do not permit the Contractor to begin work until the methods of quality and temperature control have been discussed and agreed upon. Prior to beginning work, ensure that the required materials for temperature control are at the job site. During construction, observe Contractor operations and monitor the temperature of the concrete for compliance at the plant and prior to placement. Contact the District Office or Bridge Construction Engineer, as needed, for assistance.

701.2.2 Certification of Concrete QC / QA Personnel

The Department requires certification of all SCDOT and Contractor personnel involved with inspecting, sampling and testing concrete. All such personnel must be certified by the SCDOT Certification Program. It is the responsibility of the Resident Construction Engineer to ensure that all Concrete QC / QA Technicians and Concrete Technicians are SCDOT-certified. See the SCDOT Technician Certification Policy for additional information.

701.2.3 Responsibilities of Concrete QC / QA Personnel

The provisions of the Contract will define the QC / QA sampling and testing responsibilities of SCDOT and Contractor personnel. If Contractor QC / QA is specified, the SCDOT Inspector will observe the Contractor's Concrete QC / QA Technician perform the required QC / QA sampling and testing; otherwise, the SCDOT Inspector will perform these duties. The SCDOT Inspector has the authority to instruct the Contractor to correct minor problems; however, if major problems are encountered, notify the Contractor to halt work and contact the Resident Construction Engineer. The Resident Construction Engineer will assess the situation and determine the best course of action to take in the interest of the Department, which may include:

- rejecting the work or material and requiring replacement at no additional cost,
- accepting the work or material with a reduction in payment to the Contractor, or
- requiring the work or material to be modified or improved to correct the deficiency.

The SCDOT Inspector will document the work performed each day, including material quantities and any noteworthy observations. These records will be recorded in the Daily Work Report and appropriate SCDOT Construction Forms for use by the Resident Construction Engineer. The disposition of all failing materials will be reported on SCDOT Form 100.09 – Report of Disposition of Materials Failing to Meet Specifications. The Resident Construction Engineer will approve the Daily Work Reports in SiteManager's Daily Diary and, at the end of each month, will use the approved entries as the basis for generating the Monthly Estimate, which will be forwarded to the Central Office to initiate payment to the Contractor.

When structural concrete is furnished by a transit or central-mix plant (e.g., Ready-Mix plant), an SCDOT-certified Concrete Technician must be present, who may be an employee of SCDOT, the Contractor, a concrete supplier or an independent testing laboratory, as defined in the Contract. The Concrete Technician will maintain records of mix design, batch proportioning and quantities of materials delivered to the project. Retain copies of these records in the project files, and do not accept delivery of batched concrete without proper compliance documentation, which must be signed and certified by the Concrete Technician on SCDOT Form 700.04 – Ready Mix Concrete Report. Note that, unless otherwise directed by the Resident Construction Engineer, these provisions are not required for Class 2500 concrete.

701.2.4 PCC Mix Materials

701.2.4.1 Material Source Approval

Many materials used for concrete construction are supplied from pre-approved sources. The Research and Materials Engineer is responsible for the evaluation and approval of these sources. SCDOT Inspectors will be responsible for ensuring that materials required for concrete construction are supplied from sources listed on the following SCDOT Approval Sheets:

- Approval Sheet 1 – Fine Aggregate Sources for Concrete,
- Approval Sheet 2 – Coarse Aggregate Sources,
- Approval Sheet 3 – Fly Ash for Portland Cement Concrete,
- Approval Sheet 5 – Chemical Admixtures and Air Entrainment Agents for Concrete,
- Approval Sheet 6 – Authorized Portland Cement and Non-Steel Slag Manufacturers,
- Approval Sheet 18 – Authorized Type I (SM) Slag-Modified Portland Cement Manufacturers,
- Approval Sheet 28 – Ready-Mix Concrete Plants Inspected by SCDOT,
- Approval Sheet 32 – Stabilizer Agents for Mixer Drum Wash Water, and
- Approval Sheet 53 – Corrosion Inhibitors for Concrete.

The Contractor is responsible for notifying the Resident Construction Engineer prior to any change in material source, which may require submission of a new Mix Design for review by the Research and Materials Engineer.

701.2.4.2 Cementitious Materials

The cementitious material used in concrete is primarily Portland cement, but may also include fly ash, silica fume or water-granulated blast-furnace slag. The maximum allowable quantity of fly ash and slag will be defined in the Contract Specifications. Verify that cementitious materials are supplied from a source listed on SCDOT Approval Sheet 3, SCDOT Approval Sheet 6 or SCDOT Approval Sheet 18, as appropriate, and that its source is the same as that designated on the Mix Design. Sampling and testing will be performed in accordance with SC-T-47 (see Appendix C) and the frequency schedules presented in Section 106. Obtain the Mill Test Reports for fly ash, slag and cement. All Mill Test Reports must contain the required statement of certification. Ensure that a properly completed Sample Identification Card (see Appendix B) is affixed to the sample when shipped to the Research and Materials Laboratory with a copy of the Mill Test Report. Consider the following when completing the Sample Identification Card:

1. Portland Cement. For Portland cement, the Sample Identification Card must contain the following:

   - manufacturer;
   - type of cement;
   - silo number and grind date for domestic cement;
   - ship name and arrival date for foreign cement;
   - supplier source and location;
   - quantity shipped;
   - date shipped; and
   - destination.

2. Fly Ash. For fly ash, the Sample Identification Card must contain the following:

   - supplier source and location;
   - shipping identification (e.g., silo, truck, as appropriate);
   - quantity shipped;
   - date shipped;
   - purchaser; and
   - destination.

3. Slag. For slag, the Sample Identification Card must contain the following:

   - producer, source and location;
   - grade;
   - date of shipment;
   - tanker number;
   - silo number; and
   - date of production.

4. Silica Fume. Do not sample. Obtain the certification and send it to the Research and Materials Engineer.

The Research and Materials Laboratory will perform tests on samples received. If tests confirm that a shipment is not in compliance, use of the source will be discontinued until compliance can be verified. Material that fails compliance testing will be promptly removed so that it will not be incorporated in the work. The Contractor is responsible for replacing Portland cement concrete produced with defective cement.

Cementitious materials from different sources and of different types must be stored separately in weatherproof facilities. Bulk cement is typically stored in bins or silos and bagged cement is typically stored in buildings or covered pallets. This material must be kept dry. Dark clumps are a sign of previous wetting and may be grounds for rejection. Material that is lumpy, caked, or discarded from open or otherwise damaged bags must not be used. In addition, the material must be handled in such a manner to prevent loss due to dusting, which can greatly affect the water-cement ratio of a batch. During production, cement will be measured by weight in a

certified weigh hopper that is separate from that used for aggregate material. Do not permit the use of fractional bags of cement, unless the cement is being proportioned by weight in a weigh hopper.

701.2.4.3 Aggregate Materials

The Mix Design assumes aggregate to be in a saturated surface-dry condition. As such, determining the amount of free moisture is necessary to ensure that the maximum allowable water-cement ratio is not exceeded. A minimum of two moisture tests should be performed daily on fine aggregate. The moisture of the coarse aggregate is assumed to be 0.5%. The need for additional testing will depend on the uniformity of the supply and any appreciable changes in weather, such as after it rains. Consider the following:

1. Fine Aggregate. Fine aggregate will be natural sand, manufactured sand, or a blend of the two, supplied from a source listed on SCDOT Approval Sheet 1. If a blend is used, the components must be stored and batched separately. Fine aggregate must meet specified criteria for organic impurity (AASHTO T 71), soundness (AASHTO T 104) and gradation and will be subject to sampling and testing as discussed in Section 106. Upon delivery, visually inspect the fine aggregate for unacceptable lumps, organics, trash and debris. Sampling and Testing Methods SC-T-2, SC-T-3 and SC-T-4 will apply (see Appendix C).

2. Coarse Aggregate. Coarse aggregate will be clean, tough, durable gravel, crushed gravel, crushed stone, crushed slag or an approved combination supplied from a source listed on SCDOT Approval Sheet 2 and appropriate for the concrete type being used. Where routine testing of material has not been performed during prolonged stockpiling, obtain and forward samples to the Research and Materials Laboratory prior to use. Coarse aggregate must meet specified criteria for Los Angeles Abrasion (AASHTO T 96), soundness (AASHTO T 104), gradation and will be subject to sampling and testing as discussed in Section 106. Sampling and Testing Methods SC-T-1, SC-T-3 and SC-T-4 will apply (see Appendix C).

Aggregate materials from different sources or of different grading must be separately maintained in stockpiles and bins to avoid intermixing, segregation and contamination. Check the location and preparation of stockpiles, the use and maintenance of bins and the handling of aggregate materials for compliance. Stockpiles should generally be constructed on a clean, well-drained foundation in 3-foot layers without coning. Become familiar with the appearance of the graded aggregate and monitor its handling from stockpile to bin. Check for signs of segregation, intermingling, contamination and breakage. Segregation is common and typically begins with improper handling. Serious segregation is grounds for rejection. In addition, the Mix Design assumes the aggregate to be in a saturated surface-dry condition. Excessively dry conditions may warrant wetting at night and sprinkling during the day, with the excess water being allowed sufficient time to drain (i.e., typically 12 hours). Verify that moisture tests are conducted as specified, and require additional testing as conditions warrant. Such monitoring is critical to maintaining slump and the water-cement ratio within tolerance. The water content must be field adjusted to compensate for changes in moisture in the aggregate. All moisture adjustments must be made in accordance with the batch chart supplied by the Structural

Materials Engineer for the Mix Design. During production, each fine and coarse aggregate fraction for the batch will be weighed separately in the weigh hopper on certified scales. Once established for production, do not permit a change in material source without written authorization from the Research and Materials Engineer.

701.2.4.4 Water and Stabilizer Agents

Water used in mixing, fogging or curing concrete and for mixer drum washing must meet the requirements of the tests defined in the Contract Specifications. Stabilizer agents used for mixer drum wash water must be supplied from a source listed on Approval Sheet 32. Water from a public supply or a previously approved source does not need to be sampled or tested prior to use. However, water from other sources must be tested and approved by the Research and Materials Engineer and frequently monitored for compliance. A minimum of 1 gallon of water will be submitted to the Research and Materials Laboratory in a plastic container. Metal containers must not be used. Testing of water samples requires a minimum of 8 calendar days, so the sample should be submitted well in advance of the proposed date of use. Where water is drawn from a stream or reservoir, ensure that the pipe intake is covered with wire mesh and maintained clean. Where water is hauled to the job site, check that haul containers are clean and properly covered.

Water used in the concrete mix will be measured by either volume or weight, assuming 8.33 pounds per gallon. If measured by volume, a calibrated auxiliary tank may be used. If weighed, it must be weighed separately on a certified scale. The accuracy of measuring water will be frequently checked to ensure that the quantity delivered is within specified tolerance. Pay particular attention to leaks in water containers and dispensing lines that would reduce the quantity once measured for a batch.

701.2.4.5 Admixture Materials

Admixtures are those ingredients in concrete, other than Portland cement, water and aggregate materials, that are added immediately before or during mixing to adjust properties of concrete, such as workability, finishability, strength, durability, watertightness and wear resistance. The primary reasons for using admixtures are to achieve certain properties in concrete more effectively than by other means; to ensure concrete quality during mixing, transporting, placement and curing in adverse weather conditions; and to overcome certain emergencies during concrete placement. Admixtures commonly used in concrete include:

1. Air-Entraining Admixtures. Air-entraining admixtures are used to entrain very small air bubbles in the concrete. Air-entrainment will dramatically improve the durability of concrete exposed to moisture during cycles of freezing and thawing and chemical deicers. The workability of fresh concrete is also improved significantly and segregation and bleeding are reduced or eliminated. Air-entrainment is required for Class 2500, Class 3000, Class 4000, Class 4000S and Class 6500. Also, certain structural elements require air-entrainment, regardless of the class, as specified in the Contract Specifications.

2. Water-Reducing Admixtures. Water-reducing admixtures may be used to reduce the quantity of mixing water by 5% to 30%. Water reducers may be added to concrete without reduction in water to improve workability. The major benefit of reducing mixing water is the increase in concrete strength.

3. Retarding Admixtures. Retarding admixtures are used to retard the rate of setting when concrete is exposed to high temperature during placement, hauled a long distance, or a large quantity is being placed. A practical alternative is to cool the mixing water or the aggregates. A water-reducing set retarding admixture is commonly used in concrete that is deposited under water and in concrete that is not likely to reach its final position in the forms prior to taking its initial set. Some reduction in strength at an early age will accompany the use of retarders.

4. Accelerating Admixtures. Accelerating admixtures are used to accelerate the strength development of concrete at an early age. This, however, can also be achieved by using high-early strength Portland cement, lowering the water-cement ratio by adding cement and by curing at higher temperatures. Calcium chloride is commonly used as an accelerating admixture, but may cause drying shrinkage, corrosion and discoloration. Calcium chloride is forbidden in steel reinforced concrete.

5. Corrosion Inhibitors. Where a corrosion inhibitor is specified, verify that it is supplied from the source specified on the Mix Design.

Sampling and testing of approved admixtures will not be required during the project; however, SCDOT Inspectors must ensure that the admixture is properly identified, is supplied from a source listed on SCDOT Approval Sheet 5 and appears in good condition. If material quality is questionable, suspend use and contact the Research and Materials Engineer.

Admixtures from different sources and of different types must be stored separately in closed containers to prevent contamination and dilution. Admixtures will be dispensed in the proportion recommended by the manufacturer. The accuracy of the dispensing method (e.g., graduated sight tube, metering device) will be frequently checked to ensure the quantity is within specified tolerance. Pay particular attention to leaks in containers and dispensing lines that would reduce the quantity once measured for a batch. The most common admixture used is an air-entraining agent. The addition of air-entraining admixture to adjust air content is permitted after mixing using the method prescribed in the Contract for the class of concrete being produced.

701.2.5 PCC Plant and Hauling Equipment

701.2.5.1 Certification and Inspection

Prior to producing concrete for SCDOT projects, the Contractor will make arrangements for a thorough compliance inspection of concrete production and transport facilities (e.g., batch plant, Ready-Mix plant, scales, meter proportioning equipment, trucks, field laboratory, sampling and testing equipment, material sources, mix design, batch charts, personnel) to be performed by the Research and Materials Engineer on an annual basis. These items will be inspected for Contract compliance and any required certifications from SCDOT. Inspections then will be performed at least annually and at other times during production, as deemed necessary. Note

that Ready-Mix plants will be inspected and approved in accordance with SCDOT Approval Policy 28 and, if proposed for use on the project, must be listed on SCDOT Approval Sheet 28. The Plant Approval Letter must be current and accurately document the concrete to be supplied for the project (e.g., type, batch size). The Plant Approval Letter will include the following information:

- plant identification, type and capacity;
- date of last inspection;
- list of SCDOT-approved stockpiled materials;
- date of last scale certification;
- date that scales need to be re-certified; and
- a list of approved truck mixers to be used on the project.

Mixing drums will have a manufacturer's rating plate showing drum capacity and recommended drum or blade operating speed (i.e., revolutions per minute). Each truck mixer will receive an SCDOT approval decal showing truck identification number and maximum gross volumetric drum capacity for both agitating and mixing operations. The concrete volume in the drum cannot exceed the maximum rating, and truck identification numbers must be used to document the concrete supplied to the project. Prior to production, ensure that production and transport facilities have been inspected and approved, displaying current un-expired SCDOT approval decals. Become familiar with typical operation and condition and periodically check for signs of unacceptable use or condition. Do not adjust equipment settings, scales or metering equipment, because this is the Contractor's responsibility.

701.2.5.2 Scales and Metering Devices

The Contractor is responsible for maintaining and calibrating scales and metering devices used for proportioning materials for concrete batches. Although SCDOT Inspectors will verify and document checks of scales and metering devices, they should never attempt to repair or adjust such equipment. If problems are encountered, halt production and ensure that the device is serviced and recalibrated by a qualified technician. Consider the following:

1. Scale Certification. If the concrete plant is within South Carolina, scales will be inspected annually for accuracy by the Division of Weights and Measures, South Carolina Department of Agriculture or by other qualified scale service agents. The Letter of Certification or Seal on the scale indicates only that the device was within tolerance at the time it was tested. Periodic checks must be made to ensure compliance, because dirt on balance arms, wear of knife edges and foundation settlement can change scale sensitivity and accuracy.

2. Metering Device Checks. Water and admixture dispensers should be checked at frequent intervals. Such devices can be checked by drawing off and measuring a quantity of material to determine if the proportion is within specified tolerance of the quantity required for the batch. If the device fails to meet this criteria, inform the Contractor to halt production and have the problem corrected. Repeat the test to verify proper recalibration of the device.

701.2.5.3 Concrete Mixers

The purpose of the mixer is to combine the proportioned component materials into a homogenous mass, ensuring that all aggregates are thoroughly coated with cement paste. The purpose of the truck mixer, when used as an agitator, is to prevent segregation of the mix en route to the site. Mixing time and number of revolutions will be specified and should be checked periodically using the drum revolution counter after zero reset. This criteria may be adjusted for field conditions based on the recommendations of the Research and Materials Engineer. Mixers should be inspected periodically for accumulation of hardened mortar and wear of blades. Such inspections are critical to ensuring optimum mixer performance. Consider the following:

1. Blade Wear. The mixer's blades should be carefully inspected and monitored for wear. The majority of wear will occur at the center of the blade with very little wear at the tips. If worn 1 inch or more below the original height of the manufacturer's design, discontinue use of the mixer until the blades can be repaired or replaced. The Contractor is responsible for providing the manufacturer's brochure showing the original dimensions and arrangement of the blades. To check blades for excessive wear, permanent marks (e.g., holes 0.25 inches in diameter) can be provided 1 inch from the edge of new blades near the midpoint of the length of each blade. This will provide a quick visual check for excessive blade wear.

2. Cleaning. The throat of the drum and the mixing blades can become fouled with hardened or semi-hardened concrete and, if left unchecked, can cause ineffective mixing and fouling of subsequent batches. Ensure that mixers are properly cleaned at suitable intervals. Causes of obvious mortar leaks and spills should be corrected immediately.

3. Wash Water and Stabilizers. Wash water, if not completely drained from the mixer, will invariably be used in a succeeding batch. During daily production, require the mixer to be completely drained between batches. If a stabilizer agent is used for overnight or weekend treatment, ensure the procedure complies with current SCDOT policy for the brand of stabilizer used. These provisions must be strictly enforced.

701.2.6 PCC Mix Design

Many factors can influence the physical properties of concrete. As such, several trials may be necessary to initially establish an acceptable concrete mix. The design process will begin at least 45 days prior to concrete placement and will include the evaluation of trial batches mixed from component materials proposed for the project. The allowable material proportions for the class of concrete required will be defined in the Contract Specifications. The Mix Design will be developed by either an AASHTO-accredited independent laboratory or the Contractor's Concrete QC / QA Technician in an SCDOT-approved laboratory. The Contractor will submit the Mix Design, including mixing sequence, to the Research and Materials Engineer for review. The Mix Design will address the following specified criteria:

- mix proportioning for the required class of Portland cement concrete;
- required type and gradation of aggregate;

- allowable fine-to-coarse aggregate ratio, based on volume and adjusted for workability;
- saturated surface-dry aggregate and specific gravities of materials;
- minimum Portland cement content;
- allowable percentage and ratio by weight of other cementitious materials;
- maximum water-cement ratio (i.e., water to all cementitious material by weight);
- allowable range of air-entrainment and other needed chemical admixtures;
- minimum 28-day compressive strength;
- maximum concrete temperature; and
- consistency and workability (i.e., slump) for the method of concrete placement.

Upon satisfactory review, the Mix Design will be used to produce an initial trial batch, which will be sampled and tested for air content, slump, unit weight, temperature, 28-day compressive strength and time of set. As needed, proportioning will be adjusted and additional trial batches will be produced, sampled and tested until the Mix Design and mixing sequence demonstrate that the concrete meets specified criteria. Testing of trial-batches will be performed by either the Research and Materials Laboratory or the Contractor's Concrete QC / QA Technician in an SCDOT-approved laboratory under the direct supervision of Research and Materials Laboratory personnel. The Mix Design, documenting the mix proportions and water-cement ratio required to produce concrete of the specified strength, will be forwarded to the Contractor and Resident Construction Engineer.

701.3 INSPECTION DURING CONSTRUCTION

701.3.1 Batching and Mixing

Portland cement concrete will be batched and mixed in an SCDOT-approved plant and transported to the project site. Material proportioning will be performed using pre-approved scales and metering equipment, based on an Mix Design. Compliance of concrete production and hauling cannot be overemphasized. These operations are key to producing a high-quality concrete. Quality greatly depends on the attention given during each step of production and placement. No amount of extra effort at the job site can compensate for errors at the plant. For the purpose of checking yield, the volume occupied by the concrete should be computed based on the Mix Design. The Batch Chart will specify the weights to be used in the batching process depending on the moisture condition of the aggregate. A decrease in cement content or the addition of water in excess of that allowed on the Batch Chart will not be permitted unless authorized in writing by the Resident Construction Engineer. Do not accept any concrete that is not within the specified slump, air content, or temperature and pay particular attention to compliance with the criteria specified for the elapsed time of haul after water has been added to the cement. Where truck mixers are used and all materials have been charged into the mixer, the revolution counter must be set to zero and mixed at mixing speed for the specified number of revolutions before leaving the plant.

701.3.2 Sampling and Testing

Accurate and representative sampling of work and materials cannot be overemphasized. An improperly taken sample may not be truly representative; and if testing is performed on such a non-representative sample, the test results will be meaningless with respect to assessing quality

and adherence to specified requirements. Section 106 documents the sampling and testing required to monitor concrete mix properties (e.g., slump, air content, temperature, cylinders). Review the sampling and testing procedures required (see Appendix C). See Appendix B for information on Sample Identification Cards. At a minimum, slump and air tests should be performed when cylinders are made. When the results of slump tests or air content tests are not within specified tolerance, reject the mix and inform the Contractor. Verify that concrete test cylinders are made at the proper schedule and in accordance with the specified test procedure. When specified, the Contractor will provide a satisfactory curing box for the 28-day test cylinders to maintain the cylinders at specified temperature until they can be shipped for testing. Additional cylinders may be used to assess the timing for form removal and opening to traffic.

The minimum frequency of sampling concrete for structures will be every 50 cubic yards placed on small pours and every 100 cubic yards placed on large pours. However, this frequency is insufficient for bridge and culvert pours in which the total amount of concrete placed is less than 50 cubic yards. On pours of less than 50 cubic yards, a sample of concrete must be obtained for each pour of each structural item (i.e., one sample per each footing, column, culvert wall, etc.). If one truck load of concrete is used to pour more than one structural item (e.g., one truck load used to pour two footings), only one sample is required. This will increase the number of samples taken, but ensure that each structure meets Contract Specifications.

701.4 POST-CONSTRUCTION CONSIDERATIONS

If testing of cylinders indicates that the concrete has not attained the specified 28-day design strength, enforce a reduction in payment, as specified. Pay particular attention to concrete that has not attained at least 90% of the minimum specified strength and enforce the provisions of the Contract with respect to obtaining core samples or other approved methods for acceptability testing. The Resident Construction Engineer and, as needed, the Bridge Construction Engineer and Bridge Design Engineer will determine the limits of concrete that can remain in-place at a reduced price or that must be removed and replaced entirely. If prestressed concrete has not attained the minimum specified strength, notify the Bridge Construction Engineer for additional requirements. Watch for damage to reinforcing steel during coring and ensure the Contractor properly fills all core holes with an approved non-shrink structural grout material. SCDOT Inspectors must keep accurate records of sampling and testing on SCDOT Form 700.04 – Ready Mix Concrete Report including slump, air, temperature, location of truck unloading, etc.

701.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The quantity of concrete measured for payment will be the number of cubic yards of concrete of each class within the neat lines of the structure as shown on the Contract Plans or as approved by the Bridge Construction Engineer or Road Construction Engineer. Deductions will be made from the quantity for the volume of embedded items other than reinforcing steel and other minor items such as drains, anchor bolts, etc. No deduction will be made for chamfers of 0.75 inch size or smaller. Document these quantities in the Daily Work Report. Retain all materials certifications, invoices and similar documentation.

Section 702
Concrete Structures

702.1 DESCRIPTION OF WORK

The Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying that the work and materials required for each structural element are in compliance with the requirements of the Contract Plans and Specifications, including applicable Special Provisions and Working Drawings.

702.2 PRECONSTRUCTION CONSIDERATIONS

702.2.1 Pre-Pour Conference and Checklist

A Pre-Pour Conference will be held prior to all bridge deck construction and for other structural pours as deemed necessary by the Bridge Construction Engineer or Resident Construction Engineer. Review the minutes of the Pre-Pour Conference, if held, and use SCDOT Form 700.01 – Concrete Pour Inspector's Checklist.

702.2.2 Concrete Quality and Temperature Control

Ensure that the Contractor's Cold and Hot Weather Batching and Mixing Plan has been accepted by the District Construction Engineer. See 701.2.1 for additional information on concrete quality and temperature control.

702.2.3 Mass Concrete Placement Plan

If mass concrete placement will be performed, as defined in the Contract, ensure the Contractor has submitted a Mass Concrete Placement Plan and that the Bridge Construction Engineer has accepted the Plan.

702.2.4 Crane Safety Considerations

Ensure that the Contractor has provided the Crane Safety Submittal List to the Resident Construction Engineer, that the requisite plans have been reviewed and that the Contractor, or subcontractor, operates in accordance with the crane safety requirements.

702.2.5 Material Considerations

702.2.5.1 Material Source Approval

The Research and Materials Engineer is responsible for evaluating material sources. SCDOT Inspectors will be responsible for ensuring that materials required for concrete structures are supplied from sources listed on the following SCDOT Approval Sheets:

- Approval Sheet 7 – Spray-On / Brush-On Surface Coatings for Concrete Finish,
- Approval Sheet 8 – Silicone Sealants for Portland Cement Concrete Pavement Joints,
- Approval Sheet 9 – Waterproofing Membrane Under Asphalt Overlay for Concrete Pavement Joints,
- Approval Sheet 33 – Curing Compound for Concrete Structures, and
- Approval Sheet 36 – Approved Monomolecular Polymer Film Products.

702.2.5.2 Portland Cement Concrete

Verify that the Contractor has obtained a Mix Design for the class of concrete to be used for the structure. Verify that truck mixers and other production and hauling equipment have been certified for use on the project. Upon delivery, verify that the Concrete Technician's concrete batch documentation on SCDOT Form 700.04 – Ready Mix Concrete Report indicates compliance with the Mix Design and contains the required information. Ensure that the required samples have been tested and approved. Check and record the discharge time, mix temperature, water-cement ratio, air content, slump and drum revolutions at mixing speed. See Section 701 for additional information.

702.2.5.3 Reinforcing Steel

Verify compliance of the type, size and condition of reinforcing steel. Do not allow the pour to begin without notification of material test approval. Verify that reinforcing steel is properly stored off the ground to prevent rusting and damage. Check compliance of placement, location, size, clearance, cover, ties, dowels and support. See Section 703 for additional information.

702.2.5.4 Expansion and Joint Sealant Materials

Verify compliance of the expansion materials required with respect to type, dimension, length, thickness, weight and condition. Consider the following:

1. Preformed Joint Filler. Fiber / asphalt and fused rubber materials meeting the Contract Specifications will be sampled at the job site and submitted to the Research and Materials Laboratory for compliance testing. Each sample will consist of a strip or section at least 24 inches long by 6 inches wide. If a material Lot has been pretested, it will be so marked and the Resident Construction Engineer will notify the Research and

Materials Engineer of the brand and Lot Number to obtain the Test Reports for the material.

2. Hot-Poured Elastic Filler. Hot-poured elastic filler is primarily used in cracks and expansion joints. Verify that the material meets the Contract Specifications and submit a copy of the manufacturer's certification to the Research and Materials Engineer. Verify compliance of the kettles used for placing hot-poured elastic filler. Excessive smoke is an indication of overheating, which is prohibited. The joint should be filled as shown in the Plans.

3. Elastomeric Compression Seals. Verify compliance of the elastomeric compression seals and the lubricated adhesive for bridge deck and pavement joints. Obtain a copy of the manufacturer's certification and certified test results. Forward a copy to the Research and Materials Engineer. Verify that installation is in accordance with the manufacturer's recommendations.

4. Silicone Sealant. Silicone sealant is a cold placed sealant typically used to fill sawed transverse and longitudinal joints in concrete pavements. It is accepted on the basis of certification and the product must be listed on SCDOT Approval Sheet 8. It is not necessary to submit a sample to the Research and Materials Laboratory. The supplier is required to furnish the following with each shipment:

   - manufacturer's certification showing brand name, shipping date, recipient, quantity and a statement indicating that the material meets SCDOT specifications;
   - container label plainly indicating the manufacturer's name, Lot Number, trademark, type of silicone and end-of-shelf-life date; and
   - a Material Safety Data Sheet (MSDS) and installation instructions.

   Silicone sealant must be installed over a backer rod to prevent the sealant from bonding to the bottom of the joint. A manufacturer's certification is also required for the backer rod or other bond breaking material.

5. Bridge Deck Joint Strip Seals. Verify compliance of bridge deck joint strip seals. See Section 723 for additional information on bridge deck joint strip seals.

702.2.5.5 Curing Materials

Curing materials are used on green concrete to prevent moisture evaporation. The materials most commonly used include burlap cloth, sheet material (e.g., waterproof paper, polyethylene film, white burlap-polyethylene sheeting) and liquid membrane-forming compounds. Verify that curing materials are supplied from a source listed on SCDOT Approval Sheet 7 or Approval Sheet 33, as appropriate. Ensure that each shipment is furnished with a proper manufacturer's certification, Materials Safety Data Sheet and application instructions and that the containers show the manufacturer's name, trademark, batch number, type and class of material and date of manufacture. Retain the manufacturer's certification for final materials certification. Note that

liquid curing compounds are usually pressure-sprayed on the surface of the green concrete and usually arrive in 55-gallon drums, which can settle during storage. Verify that the material is properly stirred prior to application. Verify that the material is applied at the specified rate.

702.2.5.6 Surface Coatings for Concrete Finish

Ensure that suppliers of spray-on or brush-on surface coatings for concrete finish are listed on SCDOT Approval Sheet 7. Obtain the manufacturer's certification, certified test results, Product Data Sheets and Material Safety Data Sheets. The letter of certification must contain a statement that the material meets SCDOT specifications. Verify that the containers are marked with the manufacturer's name, trademark, production Lot number, date of manufacture, shelf life and application procedure. Only unopened original containers will be acceptable. Verify that the surface coatings are applied in accordance with the manufacturer's recommendations (e.g., coverage rate, equipment, temperature). No additives will be allowed at the site (e.g., gasoline, kerosene, diesel fuel).

702.2.6 Falsework and Forms

Verify that Working Drawings for falsework and forms have been submitted and reviewed by the Bridge Construction Engineer (see Section 725). Verify that the Contractor's falsework and forming operations comply with the details of the Working Drawings. Use telltales, as needed, to monitor unacceptable movement during erection, fastening and when the concrete is poured. Immediately notify the Contractor of any non-compliance or safety concerns. Contact the Resident Construction Engineer or Bridge Construction Engineer, as needed, for assistance. See Section 702.10 of the *Standard Specifications*. Consider the following:

1. Forms. Check compliance of the type, size and condition of the forms prior to erection and ensure that unsuitable form materials are rejected and removed from the job site. Check that the forms are of adequate thickness and design to remain true to shape and that they present a smooth surface finish.

2. Falsework and Form Erection. Verify that falsework is erected in conformance with the Working Drawings. Ensure that the Contractor, a certified Inspector or registered professional engineer inspects and certifies the erection of falsework and forms, as specified. Deviations from the Working Drawings are not allowed without written approval by the Contractor's professional engineer. Verify that form joints align properly. Verify acceptability of the form ties being used. Forms should be mortar tight and sufficiently rigid to prevent excessive deflection during the pour. Check that forms are properly located with respect to grade and alignment.

3. Form Preparation. Verify that all embedded materials (e.g., conduits, drains, utility blockouts, anchoring devices) are placed and adequately secured and that all required chamfer strips are in place. Verify that the inside surfaces and cavities are cleaned of all dirt, mortar, chips, sawdust and other foreign materials and that an acceptable form oil is being used. The form release agent must be compatible with the finish coating to be applied once the forms are removed. Ensure that forms are wetted down and thoroughly moistened prior to the pour.

4. Stay-in-Place Forms. Where stay-in-place steel bridge deck forms are used, closely inspect the forms for compliance. Verify that the erection and installation of the forms are in accordance with the details of the Contract Plans and Working Drawings and that tack welds, screws and other attachments are made by approved methods. Check to ensure that the Contractor has prevented any welding from contacting steel girders. No welding is allowed on permanent steel members for falsework erection (see Section 702.11(c) of the *Standard Specifications*).

5. Traffic and Safety Issues. Verify that provisions with respect to protecting vehicular and pedestrian traffic have been adequately addressed and that all safety items, including hand rails and toe rails, have been installed to protect workers and the traveling public. Ensure that the Contractor's competent safety person verifies that all OSHA requirements are met.

702.2.7 Joints and Other Embedded Features

Check that open joints, sliding joints (e.g., roofing felt, metal plates, mortis), fixed joints, elastomeric bearing pads (see Section 724), expansion joints and deck joint strip seals (see Section 723) are installed in accordance with the Contract Plans and Specifications and Shop Drawings. No construction joints will be permitted except those shown on the Contract Plans or approved by the Bridge Construction Engineer. Ensure that the Contractor has materials on hand for emergency bulkheads during bridge deck placements. Verify that construction joints are adequately cleaned and that any loose concrete has been removed. Ensure that construction joints are made only at approved locations. Verify compliance of the location, elevation, size and installation of pipes, conduits and drains to be encased in the concrete.

702.2.8 Dry-Run Check for Bridge Deck Pours

For bridge deck pours, require a dry run to check that the support for the screed is rigid and unyielding. Take depth measurements in all bays between beams at quarter points and near the ends of the span. For long spans, it may be necessary to take additional depth checks. The maximum distance between depth checks will not exceed 25 feet. Check reinforcing bar clearance at the same time depth measurements are taken and check the slab depth and clearance along all longitudinal and transverse construction joints. Notify the Bridge Construction Engineer of any variance greater than ±0.5 inch from Plan dimension. Measurements taken should be recorded on SCDOT Form 700.05 – Dry Run Depth Checks for Bridge Deck Pours. Any adjustments should be made prior to concrete placement.

702.3 INSPECTION DURING CONSTRUCTION

702.3.1 Concrete Placement

Do not permit the concrete pour to begin until the Resident Construction Engineer has approved preliminary items such as depth, character and water conditions of foundations, adequacy of falsework and forms, absence of debris in forms, alignment and grade of forms, conditions of construction joints and condition and spacing of reinforcing steel. Verify that the concrete is

placed in accordance with the approved placement sequence and Cold and Hot Weather Batching and Mixing Plan. Verify that the concrete is placed to avoid segregating the mix or displacing the reinforcing steel or embedded items. Verify that the concrete is not dropped into forms from a height in excess of that specified. Do not allow the use of concrete that will not reach its final position in the forms within the specified time limit. The Inspector should monitor specified pouring rates. If mass concrete placement will be performed, as defined in the Contract, ensure that the Contractor operates within the requirements of the approved Mass Concrete Placement Plan. Carefully monitor the temperature of the concrete during mass concrete placement. Where concrete will be placed under water, Class 4000DS (see Section 712) and Class 4000S concrete will typically be used with special requirements for slump and water-reducing retarders. Verify compliance of the tremie used for underwater placement with respect to type, size and condition. Where the concrete will be poured in tidal water, verify compliance of placement with respect to high and low tide elevations.

702.3.2 Concrete Vibration

All classes of concrete, except Class 4000DS and 4000S for underwater pours, will be vibrated. Ensure that an adequate number of vibrators is available. This will depend on the scope of the pour. At least two are required to ensure backup in case of breakdown. Verify condition, frequency and amplitude for compliance. Vibration will be applied at the point of deposit. Verify that the vibrators are inserted and withdrawn from the concrete slowly. The vibration should be of sufficient duration and intensity to thoroughly compact the concrete without segregating the mix. Points of insertion should be uniformly spaced no farther than twice the radius over which the vibration is visibly effective. Do not allow vibrators to come into contact with forms, ties or reinforcing steel. Spading may be necessary along form surfaces and in corners. Do not allow the use of vibrators to move concrete from one place to another.

702.3.3 Wet Depth Checks

Require a wet depth check to verify slab thickness and reinforcing steel clearance for bridge deck pours. Measurements will be taken in all bays using the longitudinal screed and SCDOT Form 700.07 – Wet Depth Checks for Bridge Decks – Longitudinal. Measurements will be taken for the transverse screed if required by the Resident Construction Engineer and recorded on SCDOT Form 700.06 – Wet Depth Checks for Bridge Decks – Transverse. These forms may be modified to accommodate all bridge configurations. Notify the Bridge Construction Engineer of any variance greater than ±0.5 inch from Plan dimension.

702.3.4 Removal of Falsework and Forms

The falsework and forms should not be removed until the concrete has set in the forms for the minimum specified period and has attained the minimum specified strength. The falsework and forms will be removed as soon as practicable without damaging the structure (e.g., camber) or the concrete surface in accordance with Section 702.21 of the *Standard Specifications*. Watch for damage to the structure and to concrete surfaces during removal of the falsework and forms.

702.3.5 Initial Surface Finish

After the forms are removed from structural elements, verify that fins are removed and depressions, holes and rough surfaces are filled and pointed as specified. Inspect the surface for cracks, defects and damage and require repairs based on the provisions of the Contract. Verify compliance of the screed and burlap or broom drag finish during bridge deck pours. Limit the use of bull floats and do not permit the Contractor to sprinkle or spray water on the deck for the purpose of finishing. Check that the crown and longitudinal profile are within specified tolerances and are verified using a rolling straightedge as specified.

702.3.6 Concrete Curing

The purpose of the curing operation is to prevent rapid drying and uncontrolled cracking, especially during dry, hot weather. Ensure the Contractor's method of curing has been accepted. Immediately following the final screeding operation of bridge decks, verify the proper use of fog spray to increase the humidity directly above the fresh concrete until the curing material is in place. Do not permit the fogger to spray directly onto the concrete surface. This will weaken the surface and cause premature failure. Ensure that the proper curing compound is applied at the specified rate to all surfaces and edges. Verify the installation and acceptability of other protective measures, such as windbreaks. Such measures must be in conformance with the accepted Cold and Hot Weather Batching and Mixing Plan. Pay particular attention to any gaps in the coverage of curing material and require correction, as necessary. Ensure that each structural item is cured as specified. If unsatisfactory results are obtained, the Contractor will submit modified procedures to the Resident Construction Engineer before the next pour.

702.3.7 Final Non-Wearing Surface Finish Coat

The final exposed concrete surface of structural elements, except for bridge decks, will be given a final sprayed or brushed surface finish coat in accordance with the Contract Specifications. Generally, this treatment will be applied as the final operation prior to final inspection. Verify that the specified period has elapsed and that the concrete surface is dry, clean and at the proper temperature prior to application of the coating. Verify compliance of the color, coverage, coats, texture, thickness and rate of application. The material will be applied in strict accordance with the written instructions of the product manufacturer.

702.3.8 Sidewalks and Curbs

Carefully inspect the line, grade and texture of sidewalks and curbs. They must meet the requirements of the Contract Plans and Specifications.

702.4 POST-CONSTRUCTION CONSIDERATIONS

Where stay-in-place forms for bridge decks are installed, test the concrete soundness and bonding of the forms by sounding with a hammer and inspect the underside of the deck by

requesting removal of form sections, as needed to ensure quality. Examine the concrete surface for cavities, honeycombing and other defects. Require repair work to be performed in accordance with the provisions of the Contract. Do not permit traffic on wearing surfaces until the specified design strength has been achieved, as indicated from testing cylinders or other approved testing methods. Verify that bridge decks are tested for smoothness in accordance with the Contract Specifications. Check compliance of specified tolerance and, as needed, required the surface to be corrected. All rideability corrections must be performed prior to grooving the bridge deck. The Contractor is responsible for notifying the Resident Construction Engineer when ready for this testing. The Resident Construction Engineer is responsible for notifying the Pavement Evaluation Unit to schedule the testing. After curing and all grinding of the deck surface has been completed to meet rideability requirements, check that the surface of the deck slab is grooved as specified. Pay particular attention to the limits of grooving, joints and the depth, width and spacing of the grooves. Ensure that all residue is properly cleaned up and removed from the site prior to final acceptance. No residue will be allowed to fall into open water.

702.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measurement and payment for concrete structures will not be specially made under Section 702 of the Standard Specifications. Measurement and payment will be made in accordance with other Sections, as defined in the Contract Specifications. Document all field notes in the Daily Work Report. Retain all materials certifications, invoices and similar documentation.

Section 703
Reinforcing Steel

703.1 DESCRIPTION OF WORK

The design strength of reinforced concrete structures cannot be fully realized unless the specified reinforcing steel is placed as designated on the Contract Plans. The type and size of reinforcing steel; bar location, spacing, and clearance; and the bond developed between the concrete and the bar surface are critical factors to consider during inspection. Section 703 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the work and materials related to reinforcing steel that is used on concrete pavements and structures, including deformed bars, wire, wire mesh, bar supports, dowels and tie bars. The Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying compliance of the material furnished and placed on the project.

703.2 PRECONSTRUCTION CONSIDERATIONS

Upon delivery, compare bar bundle tags with Mill Test Reports to ensure that bar size, material grade, and coating meet specified requirements. Spot check bar identification markings for proper steel grade. Check compliance of the reinforcing steel furnished with respect to size, grade and coating, if specified. Ensure that the material has been sampled, tested and approved for use prior to the concrete being poured. Ensure that reinforcing steel is stored on blocks, dunnage, etc. above ground to prevent rusting from standing water. Consider the following:

1. Deformed Rebars. The Research and Materials Engineer does not pre-approve sources or pretest shipments of reinforcing steel bars. Acceptance or rejection will be based on testing 40 inch long samples (30 inch long samples when shipped to SCDOT's Charleston Laboratory) taken in the field upon delivery. Samples of each size bar are to be taken in a random manner and submitted to the Research and Materials Laboratory. The supplier usually furnishes a short piece of each size bar to repair the bar from which the sample is taken. Do not submit this short piece as a sample. If a sample fails to meet specified requirements, obtain and submit a check sample as discussed in Section 106. When check samples are required, the samples should be from the same manufacturer and heat.

2. Galvanized Reinforcing Bars. When specified for use in concrete structures, verify that galvanized reinforcing bars are of the size and grade required. Pay particular attention to the method of bundling, lifting and handling this material to prevent damage to the coating. Tie wires must have a plastic coating to prevent damage to the galvanization. Pay particular attention to damage to the galvanization and require replacement or repair in accordance with the provisions of the Contract.

3. Wire and Wire Fabric. Where designated, verify that the wire and wire fabric reinforcement complies with the requirements of the Contract Plans and Specifications.

4. Mechanical Couplers. Where mechanical couplers are used, verify that the Contractor has furnished the manufacturer's assembly instructions. Acceptance testing will be based on a minimum of one rebar/coupler sample for each size. Test assemblies will be at least 40 inches in length with components being randomly selected from the materials delivered to the project. Witness the assembly of the rebar and coupler test sample and submit the sample to the Research and Materials Laboratory for testing. Ensure that threads and open couplers are protected from damage, debris and weather.

5. Bar Supports. Bar supports and ties are typically used to seat and secure the steel reinforcement within PCC structures. Verify that the wire supports, plastic bar supports and concrete blocks meet specified requirements. Plastic or coated chair supports are typically required to prevent rusting and to meet specified rebar clearances.

703.3 INSPECTION DURING CONSTRUCTION

Consider the following during inspection of reinforcing steel for concrete structures:

1. Bar List. Verify that the Contractor's bar list conforms to the Contract Plans with respect to bar size, quantity and bending details.

2. Bar Condition. Check that reinforcing bars are free of foreign materials. Concrete will only bond with a clean bar surface. In addition, check bars for straightness, and ensure that they are protected from damage. Ensure that any damage to bar coating is adequately repaired.

3. Bar Bending. Become familiar with the bar bending details. Where field bending is required, ensure that the proper procedures are being followed, and verify whether the application of heat is permissible.

4. Bar Alignment and Spacing. Check that bar alignment and spacing conforms with the Contract Plans. Verify that all bars and other embedded items are correctly placed so that the concrete can be adequately consolidated.

5. Handling of Rebar Cages. Verify that the Contractor has an accepted method for lifting large rebar cages for drilled shafts and columns and caps to prevent racking or loosening of the rebar ties.

6. Bar Clearance. Check bar clearance and depth of concrete cover for compliance. Ensure that the proper minimum clearance is obtained between the top mat of deck bars and the surface of the concrete.

7. Bar Splicing. Check bar splices to ensure that they are the proper length for the type and size of bar placed. Verify that bar splices are correctly staggered, if specified.

8. Bar Supports. The type, number and spacing of supports must be adequate to minimize sagging, displacement and damage of reinforcing bars. Plastic or coated supports are required for coated bars. Any damaged bar supports will be replaced or repaired.

9. Securing of Bars. To minimize displacement, bars must be securely tied. Verify that the bars are tied at all intersections or as otherwise designated in the Contract Specifications. Do not permit welding of bars except as noted on the Contract Plans. Note that the use of coated ties are required for coated bars.

10. Post-Tensioned Concrete. Adjustments made to reinforcement in post-tensioned concrete require approval by the Bridge Construction Engineer.

703.4 POST-CONSTRUCTION CONSIDERATIONS

Final approval of the type, placement and condition of the reinforcing steel for concrete structures must be obtained from the Resident Construction Engineer prior to the concrete pour. See Form 700.01 – Concrete Pour Inspector's Checklist.

703.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Reinforcing steel for structures will be measured by the weight of reinforcement placed and accepted. Payment for the quantity of each class of reinforcing steel shown in the plans will be made at the Contract unit price for the appropriate item. Document all measurements, calculations and field notes in the Daily Work Report and appropriate SCDOT Construction Forms. Retain all materials certifications, delivery tickets and similar documentation.

Section 704
Prestressed Concrete

704.1 DESCRIPTION OF WORK

Prestressed concrete differs from conventionally reinforced concrete in that the member is stressed prior to structural loading. Pre-compression is achieved by tensioning high-strength steel bars or stranded wires placed within the member. The prestressing force will be applied before the concrete is placed or after it has cured. Pre-tensioning is the method of applying the force before the concrete is placed, where the bars or wire strands will develop a continuous bond with the concrete. Post-tensioning is the method of applying the force after the concrete has cured, where the bars or wire strands will be mechanically anchored at each end of the member. Once prestressed, the member will undergo creep and camber. Creep is the shortening of the member after it has been prestressed. The actual shortening is slight and will taper off after a couple of months. Because the prestressing force is applied eccentrically, a noticeable uplift, or camber, will occur, which is anticipated during design. If a member cambers beyond tolerable limits, corrective action will be necessary. Precast girders are typically fabricated and prestressed at a precast yard and shipped to the project site for erection. Be aware that girder age and mishandling can produce additional camber that may render the girder unacceptable. When prestressed concrete beams, piling or other structural members are specified in the Contract, the Research and Materials Engineer will be responsible for verifying that the work and materials are in compliance with the Contract Plans and Specifications, including Shop Plans and Working Drawings.

704.2 PRECONSTRUCTION CONSIDERATIONS

704.2.1 Shop Plans and Working Drawings

The Contractor will submit the required Shop Plans and Working Drawings for fabrication, handling and erecting the prestressed concrete members, which should be clearly understood prior starting work. See Section 725 for additional information.

704.2.2 Materials and Fabrication Considerations

Once the Research and Materials Laboratory Inspector has inspected and approved the structural member, it will be marked with permanent paint in an unobscured location with the following information:

- date cast and manufacturer name or symbol;
- structural member identification number;
- directional arrow of member orientation, if applicable, and;
- SCDOT File Number and approval stamp.

704.3 INSPECTION DURING CONSTRUCTION

Prior to accepting delivery of prestressed members, pay particular attention to any damage that may have occurred to the members during storage, handling and transport. Check that each member complies with the dimensional tolerances shown on the standard details in the Contract Plans. This is especially important for cambered members. Excessive camber may cause a girder to project into the deck slab, interfering with the concrete deck panel or placement of reinforcing steel. Notify the Bridge Construction Engineer in such situations. Ensure that prestressed members are stamped for approval (see Section 704.2.2). During erection, verify that the members are lifted by the attachments provided for such purpose. Temporary lateral bracing may be required to avoid buckling during storage and once placed. Beams must be stored on level supports to prevent warping. Check that members are placed at the proper line and grade as they are erected. Take checkpoint elevations, as needed, to monitor compliance.

704.4 POST-CONSTRUCTION CONSIDERATIONS

Inspect the final structure to verify that all temporary supports have been removed, all chipped corners, tie rod holes, etc., have been patched and that bearings and expansion devices are properly installed.

704.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Prestressed concrete beams and girders will be measured by the unit length of the type and size specified, erected and accepted in place. See Section 711 for information on prestressed concrete piling. Partial and final payments will be made at the Contract unit price, in accordance with the provisions of the Contract. Document all measurements, calculations and field notes in the Daily Work Report. Retain all materials certifications and similar documentation.

Section 705
Bridge Railing

705.1 DESCRIPTION OF WORK

Bridge railing is generally constructed along bridge decks, curbs, sidewalks and retaining walls for the protection of pedestrian and vehicular traffic and may consist of cast-in-place or precast concrete, aluminum, steel or a combination of these materials. The Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring that the work and materials comply with the Contract Plans and Specifications, including Shop Plans and Working Drawings, when required.

705.2 PRECONSTRUCTION CONSIDERATIONS

Verify that the Contractor has an approved set of Shop Plans and Working Drawings (see Section 725). Ensure that the method of concrete placement has been determined (e.g., fixed form, slip form). Verify compliance of form location, height, dimension, connection, cleanliness and release agent. Verify that the Contractor has a Mix Design for the concrete class required (see Section 701). Verify compliance of the type, grade, size and placement of reinforcing steel (see Section 703). Verify that metal posts and rails are as required by the Shop Plans with respect to type, size, grade, dimension and coating. Require repair or replacement of any rails with damaged coating. Check all fastener hardware for compliance with respect to type, grade, dimension and coating. Obtain Mill Test Reports and material certification for all metal posts, rails and fasteners.

705.3 INSPECTION DURING CONSTRUCTION

Do not permit the construction of railing to begin until the falsework for the span has been released. Pay particular attention to compliance with the details of rail construction across expansion joints. The section of deck under the bridge railing must be finished smooth. Check compliance of concrete railing with respect to height, alignment, grade, camber, lifting and fastening details. Forms and reinforcing steel must be approved by the Resident Construction Engineer prior to placing concrete. Check concrete curing and finishing for compliance. Ensure that the lifting holes of precast sections are properly filled with approved material. Pay attention to the connection details of different types of barrier rail. Where metal railing is installed, verify the spacing of posts and that rails are properly connected without bending or kinking. Watch for proper splicing of metal rails and that they are handled without damaging the coating. Ensure that rail anchor bolts are placed using a template. Require repair to damaged coating based on the provisions of the Contract. Where aluminum rail is installed, verify the proper installation of elastomeric separation sheet. When welding is required, ensure that it is performed by an SCDOT-certified welder as indicated on SCDOT Approval Sheet 41.

705.4 POST-CONSTRUCTION CONSIDERATIONS

Check the grade and height of the rail for compliance. The alignment of the barrier should be checked for compliance using a 10-foot straightedge.

705.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Bridge railing will be measured by the unit length of the type installed and accepted in place. See Section 703 for information on measuring reinforcing steel. Payment will be made at the Contract unit price for the type specified. Document all measurements, calculations and field notes in the Daily Work Report. Retain all materials certifications and similar documentation.

Section 706
Wood Products for Use in Highway Construction

Section 706 and Section 707 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the requirements of treated and untreated wood products used in highway construction that will become a permanent part of the completed work, including structural lumber for wood bridge caps, stringers and flooring; dimensional lumber for wood bridge components and other miscellaneous uses; guardrail posts and offset blocks; fence posts and bracing; and timber piles. Section 706 of the *Standard Specifications* covers the type, grading, workmanship, quality, dimensional tolerance and other similar specifications. Section 706 of the *Standard Specifications* specifically covers the preservative treatment of such wood products. Wood products are pre-inspected by an SCDOT-approved Independent Inspection Agency. Ensure that wood products bear the Agency's hammer mark of approval. Obtain and forward to the Research and Materials Engineer a copy of the Agency's Inspection Report and Supplier's Certification. Ensure that wood products are stored and handled to prevent damage. Measurement and payment for wood products will not be performed separately, but will be included in other pay items in the Contract.

Section 707
Preservative Treatment of Wood Products

See Section 706 for information on treated and untreated wood products used in highway construction.

Section 708
Hardware

Section 708 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material and construction requirements of rolled steel, castings and miscellaneous hardware used in the construction of timber structures, including bolts, lag screws, nuts, nails, washers and turnbuckles. Hardware under this section will either be paid for based on lump sum or weight, as specified in the Contract. If based on weight, the weight designated on the Contract Plans will be that used for payment at the Contract unit price.

Section 709
Structural Steel

709.1 DESCRIPTION OF WORK

Section 709 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material, fabrication, assembly and erection requirements for steel structures. The inspection of steel structures requires a great deal of coordination, attention to detail and a thorough working knowledge of the Contract documents. Prior to the start of work, review appropriate documentation to become familiar with the responsibilities of SCDOT and Contractor personnel; QC/QA sampling and testing requirements; fabrication, assembly and erection details; welding and painting requirements; dimensional tolerances; acceptance criteria and safety requirements.

709.2 PRECONSTRUCTION CONSIDERATIONS

709.2.1 Shop Plans and Working Drawings

The appropriate design office should distribute stamped Workings Drawings and Shop Plans to the Resident Construction Engineer. Consider the following:

1. Shop Plans. These Plans will include the State project number, Federal project number, bridge name and number, Contractor's name, fabricator's name and the detail of all structural components and miscellaneous parts, including: material identification, dimensions, sizes and plate rolling direction.

2. Working Drawings. These Drawings will include the proposed method of erection, including: details of all falsework bents, bracings, guys, dead-men, lifting devices and attachments to bridge members; sequence of erection; location of cranes and barges, crane capacities, location of lifting points and weights of members. Working Drawings must be sealed by a South Carolina registered professional engineer. See Section 702.2.4 for information on Crane Safety Considerations. See Section 725 for additional information.

709.2.2 Materials and Fabrication Considerations

709.2.2.1 Structural Steel Members

Structural steel is primarily used in bridge and sign construction. Steel "H" piles, pipe piles and sway bracing is generally shipped to the job without prior inspection. Other structural members, including hand railing, is usually fabricated off-site, inspected by SCDOT personnel or an SCDOT-approved Inspection Agency, delivered to the job, erected and field bolted. Check compliance of structural steel materials with respect to type, member, grade, marking, dimension, weight, lubrication, coating, connection and condition, as applicable. Each piece will be marked with the heat number, piece mark and SCDOT File Number. Consider the following:

1. Not Inspected at Shop. For structural steel materials that are not inspected prior to delivery to the job site, the Resident Construction Engineer will obtain from the Contractor the required Mill Test Reports and certified test results furnished by the manufacturer or distributor, as appropriate, and furnish a copy of this documentation to the Research and Materials Engineer. It will not be necessary to obtain samples of these materials; however, it is important to visually inspect the materials for signs of damage and evidence of non-compliance.

2. Pre-Inspected at Shop. For structural steel materials that are inspected and approved by an SCDOT Inspector or SCDOT-approved Inspection Agency at the fabrication facility, verify that each member is properly stenciled and undamaged upon delivery. For inspection performed by an SCDOT-approved Inspection Agency, the inspection work will be continuously monitored by the Research and Materials Engineer. The Research and Materials Engineer will receive Inspection Reports for all fabricated members that have been inspected and approved, which will contain all necessary compliance documentation. Therefore, it will not be necessary for the Resident Construction Engineer to obtain this documentation from the Contractor. The Inspection Reports will be forwarded to the Resident Construction Engineer as they are received by the Research and Materials Engineer.

709.2.2.2 Structural Steel Fasteners

Structural bolts are shipped to the field a short time before steel erection begins. The manufacturer's certifications for the fasteners should be received with the fasteners. The certifications include the test results for the rotational capacity tests performed by the fastener manufacturer or distributor, whoever combines the fastener assemblies. Upon receipt of the fasteners, the certifications should be checked with the containers of fasteners to ensure the correct assemblies and the correct number of fasteners was shipped. Samples of the fastener assemblies from each production lot should be pulled and shipped to the Research and Materials Laboratory. This should be done as soon as possible after receipt of the fasteners. The fasteners must be stored in a trailer or building prior to use in the structure. During use, the fastener container should be carefully opened so that they can be resealed to protect the fasteners from deterioration prior to installation. If deterioration (e.g., oxidation, loss of lubricant, dirt accumulation) occurs prior to installation, the fasteners must be cleaned, relubricated and retested prior to installation. See Section 709.06 of the *Standard Specifications* for sampling requirements.

709.2.2.3 Miscellaneous Metal and Other Fasteners

Check compliance of miscellaneous metals and other fasteners with respect to type, size, grade, marking, dimension, weight, lubrication, coating, connection and condition, as applicable. Obtain from the Contractor the manufacturer's certification stating that the material complies with the requirements of the Contract Plans and Specifications.

709.2.2.4 Elastomeric Bearing Pads

Verify compliance of the type, size and thickness of elastomeric bearing pads and that they are supplied from a source listed on SCDOT Approval Sheet 24. See Section 724 for additional information on elastomeric bearing pads.

709.2.2.5 Electrically Welded Shear Connector Studs (Field Installed)

Verify compliance of the type, size, diameter and length of electrically welded shear connector studs and ensure they are supplied from a source listed on SCDOT Approval Sheet 25. Obtain from the Contractor and furnish a copy to the Research and Materials Engineer the following information:

- manufacturer name,
- detailed description of the stud and arc shield to be used,
- manufacturer's certification,
- certified test results, and
- welding procedure.

Pay particular attention to the visual and hammer inspection tests that are specified in the Contract once installation is complete.

709.3 INSPECTION DURING CONSTRUCTION

709.3.1 Inspection of Materials Upon Delivery

SCDOT Inspectors have the authority to reject materials and work that do not meet the requirements of the Contract. Acceptance of any material or fabricated member by an SCDOT representative at the shop does not, however, bar subsequent rejection if found defective upon delivery or when erected. Inspect compliance of materials and fabricated members, whether previously inspected or not, upon delivery and after erection and require repair or replacement within the provisions of the Contract. Consider the following:

1. Storage and Handling. Girders, beams and other structural members must be handled to prevent damage, and they must be stored above ground on level platforms or skids to keep them free from dirt and grease. Pay particular attention to how members are lifted and supported. Workers must not be permitted to fasten chains or cable hooks to girder stiffeners, diaphragm connectors or gusset plates when lifted. Long, non-cambered structural members must be laid flat on supports that are placed fairly close together. Cambered members must be stored so that the proper camber will be maintained. As practicable, like members should be stored together and lined up so that errors of length can be easily detected. Check girders and beams for deflection, cracked welds, bends, twists, kinks and dents. If such damage is found, notify the Resident Construction Engineer to ensure that the problem has been satisfactorily addressed. Verify that girders and beams are stored upright and shored and that long members are placed to

prevent damage by deflection. Do not allow bent or damaged steel members to be erected and incorporated in the work without prior approval of the Resident Construction Engineer.

2. Damaged Members. Pay attention to the approved method used for straightening members to prevent overheating or damaging the member. Sharp kinks and bends are grounds for rejection. All approved repairs are to be visually inspected. If fractures are suspected, magnetic particle and dye penetration testing may be required for verification. Contact the Research and Materials Engineer in such cases. Watch for damage to shop coating caused by mishandling, and require the Contractor to repair the work in accordance with the provisions of the Contract.

3. Match Marking. Check match marks on members to ensure that they are arranged, assembled and erected properly based on the Contractor's Shop Plans and Working Drawings.

709.3.2 Falsework

Falsework for steel structures, if necessary, is entirely the Contractor's responsibility. The Contractor is responsible for submitting Working Drawings as discussed in Section 725. These Drawings must be designed and sealed by a South Carolina registered professional engineer. The Resident Construction Engineer and SCDOT Inspectors should not discuss the acceptability of Working Drawings with the Contractor. If, however, noncompliance with the Working Drawings is noticed (e.g., temporary struts or ties that are improperly located) or that falsework is distorting flanges or webs of structural members, immediately notify the Contractor of the need for corrective action. Contact the Bridge Construction Engineer, as needed, for assistance.

709.3.3 Bearings and Expansion Devices

709.3.3.1 Bridge Expansion and Contraction

A typical bridge has a fixed end and an expansion end. At the fixed end, the superstructure cannot move. At the expansion end, the superstructure can expand and contract a limited distance along its span during fluctuations in temperature and loading. The expansion device, at the expansion end, and the bearings, on which the superstructure rests, are installed to accommodate this movement.

709.3.3.2 Bearing Devices

Many different types of bearing devices are available, including rockers, rollers and elastomeric bearings. Elastomeric bearings are generally used in structures to level the structure, support the vertical loads of structural members and isolate specific movements (i.e., longitudinal, transverse, rotational). Stringent quality control governs the manufacture of these devices. Elastomeric bearings may be classified as either laminated (i.e., reinforced with laminate sheeting) or plain (i.e., non-reinforced). Leveling pads are generally not laminated. Fabrication differs with each bearing type and includes component materials such as elastomeric materials,

laminate sheeting materials, adhesives, sealing pots, pistons and anchor bolts. Note that lubricants are not used in bearing devices. Depending on the application and thickness required, some elastomeric bearings may be designated as either laminated or plain and may require a sole plate, radius plate or an upper and lower sliding element. Other elastomeric bearings are fabricated to accommodate vertical loads and horizontal movement (i.e., longitudinal, transverse, rotational) due to factors such as thermal expansion and contraction, camber changes and the creep and shrink of structural members. These devices include the following types of designs:

1. Fixed Bearings. Fixed bearing designs accommodate rotation, but not longitudinal or transverse movements.

2. Guided Expansion Bearings. Guided expansion bearings accommodate rotational and longitudinal movements, but restrict movement in the transverse direction.

3. Non-Guided Expansion Bearings. Non-guided expansion bearings accommodate rotational, longitudinal and transverse movements.

4. Pot Bearings. Pot bearings are equipped with a piston and may be designated as either guided or non-guided, based on the need to accommodate or restrict movement.

5. Disc Bearings. Disc bearings are equipped with an elastomeric rotational disc and may be designated as either guided or non-guided, based on the need to accommodate or restrict movement.

6. Isolation Bearing. A bearing that is designed to isolate part of the structure from the full intensity of the seismic forces and to dissipate a large amount of energy.

Prior to fabricating these types of elastomeric bearings, the Contractor will submit Shop Plans, design calculations and load data to the designer of record. Review these drawings to become familiar with the storage, handling and installation procedures (e.g., alignment, offset) and the method of protecting the bearings during welding and painting of the structure. If required by the Contract Plans, verify that the Contractor has notified the manufacturer of the bearing to make available a representative to guide and inspect initial installation.

709.3.3.3 Expansion Devices

Generally, the concrete back wall should not be built until all superstructure steel and the concrete deck have been placed. At the fixed end, a bearing is installed that will inhibit movement of the deck. At the expansion end, a specified space is left between the deck slab and the back wall, and a bearing is installed that will allow the end of the deck to easily slide toward or away from the back wall. For expansion devices that have been strapped as a unit, spacing must be allowed relative to temperature as specified in the Contract Plans before the concrete is placed in the back wall. Any straps across the joint must be removed as soon as the concrete is strong enough to hold the seat angle in position. If they are not removed promptly, movement of the end of the deck slab may cause failure of the anchorage in the back wall.

709.3.3.4 Installation and Adjustment

After the falsework has been removed and the superstructure is bearing its full dead load, bearings and expansion devices must be checked for proper adjustment. The method and amount of adjustment depends on the ambient temperature, the type of device and the manufacturer's recommendations. At 68ºF, the bearings should be nearly centered or vertical, and the anchor bolts of expansion devices should be nearly centered in their slotted holes. If the ambient temperature is higher or lower than 68ºF when these devices are set, they must be adjusted off-center or at an angle from vertical in the proper direction along the span. The magnitude of adjustment depends on the coefficient of expansion. This coefficient is assumed to be 0.0000067 inch of movement/inch of span/degree Fahrenheit from 68ºF. Adjustments should be made while the steel has a uniform temperature. For example, if the ambient temperature is 85ºF and the span is 90 feet, the change in span length (i.e., expansion) would be: 0.0000067 x 1080 inches x 17ºF = 0.123 inches = 1/8 inches. The steel would be 1/8 inches longer at 85ºF than it would be at 68ºF. To allow for this difference, each device would be initially set so that it is centered or vertical and then would be shifted or angled away from the span a distance of 1/8 inches. The allowable tolerance of adjustment is generally ± 1/16 inch.

709.3.3.5 Inspection Guidelines

Pay particular attention to the location and setting of bearing devices, expansion devices, rockers, rollers and anchor bolts. Verify that anchor bolts are set in either concrete or grout, as specified. Verify proper adjustment to accommodate temperature variation and lengthening of the bottom flange under dead load. Verify that movement is not hindered by anchor bolts, nuts or other obstructions. Consider the following guidelines:

1. Anchor Bolts. Verify the required anchor bolt installation procedure. Generally, anchor bolts are cast monolithically with the cap; however, under certain requirements, they will be installed after the cap is cast.

2. Concrete Surface/Bearing Seat. The concrete surface and bearing seat must be level at the required elevation. Verify that the concrete surface is clean and free of cracks. Check bearing seats for irregularities and proper elevation. If the bearing seat is not properly cleaned and prepared to match the pad surface, the edge of the pad will be loaded sufficiently to cause premature failure of the device. Do not permit elastomeric bearing pads to be used for leveling purposes.

3. Installation and Adjustment. Bearing devices must be set level at right angles to the length of the member it supports, in exact position, with full and even bearing on the masonry. The final bearing elevation and alignment must be checked for compliance. Ensure that sole plates are positioned at the correct grade and superelevation and are in full contact with the bottom flange of the girder. Verify proper adjustment for temperature, post tensioning and shrinkage. Watch for interference between anchor bolts and the upper part of the bearing device.

4. Protection of Bearings. Where welding is performed in proximity to non-metallic bearing pads, check for the proper use of heat indicators to monitor the heat generated and

prevent damage to the pads. Heat shields may be required. Where the structure is painted, verify protection from overspray and contamination.

5. Metal Railing Considerations. At a location where a rail crosses an expansion joint, provision must be made to allow free movement of the rail section as expansion and contraction of the structure occurs. When provision for this movement is made by means of metal sleeves that are fitted inside hollow rail members, the sleeves should be welded in place on the downgrade side of the joint. Any bends or dips in a railing are easily detected. Care must be taken to ensure that all posts and rails are set to a uniform line and grade.

6. Final Check. Perform a final check of the bearing devices and require corrective work based on the provisions of the Contract. Following completion of the superstructure, inspect the installation and alignment of each device in the presence of the Contractor.

709.3.4 Field Welding Considerations

SCDOT prohibits field welding of structural members for the purposes of attaching erection hardware. Absolutely no field welding will be permitted unless special circumstances arise and approval is given by the Bridge Construction Engineer.

The Contractor is responsible for submitting to the Resident Construction Engineer for review by the Research and Materials Engineer the proposed field welding procedure on SCDOT Form 700.16 – Welding Procedure. This policy must be strictly enforced. Where permitted, each weld should be inspected after the slag has been removed. The SCDOT Inspector should mark each weld that has been inspected and approved in such a manner that it can be easily identified. Consider the following:

1. Welder Certification. Field welders must be pre-approved by SCDOT for the type of field welding to be performed. Ensure that field welders are listed on SCDOT Approval Sheet 41. Certification requirements will be listed under the Contract Special Provision for field welding. In general, this Special Provision requires that the welder be tested and certified by an Independent Laboratory listed on SCDOT Approval Sheet 26.

2. Welding Procedure. Steel members to be field welded must be set in the proper position and held securely in place during welding to prevent bending or twisting. The method of securing must not interfere with the welding. The surfaces of the members to be welded should be cleaned thoroughly for a distance of not less than 1 inch beyond the edges of the weld on all sides. When two pieces of steel are to be butt-welded, the ends of the pieces must be beveled, and rough edges should be made smooth. Where joints are to be field welded, ensure that they are drawn tightly together before welding. If not, the opening may be large enough to allow the weld to pass between the members and tack to the flange under the joint. These welds appear normal on the surface, are difficult to visually detect, and may cause significant damage to the structure (e.g., fatigue cracks produced by stress risers).

3. Characteristics of Quality Welds. A finished dependable weld of good workmanship should have the following characteristics:

- a uniform cross-section with flat or slightly bulging face and smooth surface;
- a reasonably straight edge flowing into the base metal;
- a well-defined crater approximately 1/16 inches deep;
- a surface with ridges or ripples spaced closely and uniformly; and
- a bright surface of uniform color after it has been cleaned with a wire brush.

4. Common Weld Defects. Common defects in welds and their causes and remedies are as follows:

a. Overlap. Overlap, the term used when the edge of the weld is loose and extends over the base metal, is caused by poor fusion. If the overlap is very small and if the weld need not have its full strength, the weld may be accepted. If the overlap is large or if the full strength of the weld is needed, the weld should be removed and a new weld made.

b. Undercutting. Undercutting is evidenced by not having enough electrode metal. The weld should be thoroughly cleaned and built up to standard size with additional weld metal.

c. Shallow Craters. Shallow craters are caused by not getting enough penetration. Unless the weld is for sealing purposes only, it should be removed and a new weld made.

d. Pits and Pockets. Pits, porosity and gas pockets are caused by improper procedure. The weld should be removed and a new weld made.

e. Inclusions. Slag and oxide inclusions are caused by improper procedure. Unless the weld is for sealing purposes only, it should be removed and a new weld made.

f. Spatters. If spatters are large and scattered over a wide area, they are caused by the use of an arc that is too long or by poor fusion without enough penetration. The weld should be thoroughly checked, and if there is any doubt about the quality of the weld, the weld should be removed and a new weld made.

g. Irregular Ridge Spacing. Irregular spacing of ridges is caused by variation in the speed of welding. The weld may be accepted unless the arc has been jumped forward so as to leave a space with not enough penetration. Such a fault may be corrected by increasing the length of the weld.

5. Size and Length. The size and length of each fillet weld must be compared with the dimensions shown on the Contract Plans. The size or length may be slightly greater than specified.

6. Stay-in-Place Forms. Where stay-in-place deck forms are installed, do not allow welding or striking of arcs on the flanges of structural steel members.

709.3.5 Assembly and Erection Considerations

709.3.5.1 Positioning Steel Members

If the steel has top coats applied prior to erection, check to ensure there is no overspray on the faying surface (i.e., area under splice plates) and that there is no paint top coat on any surface of connections where bold heads and nuts are located. Top coats of paint tend to creep out from under fasteners resulting in loose fasteners. The SCDOT Inspector should make certain that all members are placed in the proper position, and that main supporting members are in correct vertical and horizontal alignment. The marks painted on the steel for identifying pieces should agree with those shown on the Shop Plans and Working Drawings, and careful attention should be given to match marks at connections. The SCDOT Inspector should recheck the relative positions of bearing connections in the substructure and superstructure just before the steel is put in place. Bearing surfaces and other contact surfaces must be checked to see that they are clean and free from dirt, grease and rust. After the structural steel has been erected, the SCDOT Inspector should check the bearings to be sure that each bearing part makes full contact.

709.3.5.2 Drift Pins and Temporary Bolts

Before splicing is begun, the members are usually held together by drift pins and temporary erection bolts. The SCDOT Inspector must make certain that these temporary connections are made in accordance with the requirements of the *Standard Specifications*. Members to be spliced together must be held in their correct position so that the connection can be made properly. Drift pins of the proper size are usually installed first in a few sets of holes, to bring the parts into their proper relative position and to keep the holes in alignment. The required bolts are installed in the remainder of the holes in the connection, brought to snug tight and then fully tensioned. The next step is to remove the drift pins and install the remaining bolts.

709.3.5.3 Connection Adjustments

Structural steel should fit together with little distortion or strain. A slight adjustment with drift pins is to be expected. If the holes are too far out of place, a workman should not be allowed to force the parts into position with drift pins. Improper use of drift pins may damage the material around the holes and will prestress the members. Striking a member with a heavy sledge hammer should not be allowed. No reaming should be allowed in a splice in a main tension member, unless specific permission is obtained from the Bridge Construction Engineer. Any error which cannot be corrected by light drifting should be reported to the Bridge Construction Engineer. The proposed method of correcting the fault must be approved by the Bridge Construction Engineer before the method is used. Checks and any necessary corrections should be made as the work progresses. Also, before the members are connected permanently, the SCDOT Inspector should check the work again to make sure that all members are aligned properly and set to the required camber. This final checking should prevent any poor alignment from being built into the final structure.

709.3.5.4 High-Strength Bolts

After the members have been drawn together tightly by temporary bolts, the Contractor will tighten the permanent high-strength bolts to the required tension by using the method specified in the Contract. The nut on each permanent bolt will first be turned snug tight and then given additional rotation to final tension. Each connection should be checked by the SCDOT Inspector immediately upon completion, because of the tendency of the bolts to freeze. Direct Tension Indicators will be placed under the unturned element. See the *Standard Specifications* for additional information on rotational capacity and turn-of-the-nut testing.

709.4 POST-CONSTRUCTION CONSIDERATIONS

Final inspection should be performed after all falsework is removed and prior to painting. See Section 710 for information on painting structural steel. Check compliance of surface preparation of structural steel prior to painting and that all deficient or damaged areas are field coated. Check that the actual camber complies with the theoretical camber and the vertical and horizontal clearances over highways and railroads prior to casting the deck. Final acceptance is the responsibility of the Resident Construction Engineer, with any needed support being provided by the Bridge Construction Engineer and Research and Materials Engineer.

709.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Structural steel will be measured either by unit weight or lump sum, as specified. This includes all materials, fabrication, erection and painting of new structures; however, re-painting existing structures will be measured and paid for in accordance with Section 710. Partial and final payments for lump sum work will be made at the Contract unit price in accordance with the provisions of the Contract and recorded in the Daily Work Report. Retain all material certifications, invoices and similar documentation.

Section 710
Paint for Structural Steel

710.1 DESCRIPTION OF WORK

Section 710 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material, equipment and work related to shop painting of new structural steel members and field painting of new and existing steel structures. When pay items under Section 710 are specified in the Contract, the Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying that the work, equipment and materials comply with the requirements of the Contract Plans and Specifications.

710.2 PRECONSTRUCTION CONSIDERATIONS

710.2.1 Materials and Equipment Considerations

Inspect all materials and equipment upon arrival at the job site. Verify that the primer and paint materials are supplied from a source listed on SCDOT Approval Sheet 19. The materials used for intermediate and top coats must be supplied by the same manufacturer as the primer coat. Verify that each paint container is plainly marked with the correct paint type, color, number of gallons, Lot Number, Batch Number, date of manufacture and the name and address of the manufacturer. The painting system required for the project will be defined in the Contract Specifications. Obtain from the Contractor and forward copies to the Research Materials Engineer the manufacturer's certifications, application and equipment recommendations and product safety data sheets.

710.2.2 Environmental and Safety Considerations

Prior to painting, review the specified weather limitations. Know the requirements specified for environmental protection that are defined in the Contract Specifications. This is especially important if lead-based paint removal and disposal is part of the Contract. Know the precautions that must be in place to protect the environment and workers. Ensure that the Contractor is adequately prepared to protect pedestrians and vehicular traffic on, near and underneath the structure. Obtain from the Contractor the name, telephone number and address of the person who will be responsible for processing claims.

710.3 INSPECTION DURING CONSTRUCTION

710.3.1 Cleaning Steel Surfaces

Verify that steel is cleaned and inspected just prior to painting. Only as much surface should be cleaned in one day as can be painted on that day. Ensure that only approved methods of cleaning are used. Oil, grease and lubricants will be removed using an approved cleaning agent. Pay particular attention to the required treatment of slip-critical surfaces.

710.3.2 Brushing and Rolling

Thorough mixing of the paint before it is applied is essential. A mechanical mixer should be used for stirring the paint. Paint should be spread smoothly and uniformly. Paint should be worked into all corners, joints and other hard to reach areas. A sheepskin dauber may be used to coat any surface that cannot be reached with a brush. The first field coat is started by applying paint only to such surfaces as rivet heads, bolt heads, nuts, edges of plates, angles and other rolled shapes. Then, as soon as this paint has dried thoroughly, the first coat is completed by painting all surfaces, including those covered previously.

710.3.3 Spray Painting

The paint should be applied in a uniform layer. The pattern to be followed in applying the paint should make it possible to obtain a uniform thickness of not less than the specified mil thickness. There must be some overlapping at the edges of strips covered on successive strokes of the spray gun. The spray gun should be held at right angles and at the correct distance to the surface being painted. Runs and sags must be brushed out right away, or the paint must be removed and the surface repainted.

710.4 POST-CONSTRUCTION CONSIDERATIONS

Final inspection is the responsibility of the Resident Construction Engineer. Prior to approval, ensure the acceptability of the quality of workmanship and compliance with specified criteria. Check that any overspray of paint is properly cleaned and repaired.

710.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The shop painting of structural steel and the field painting of new structures will not be measured and paid for separately, but will be included under the provisions of Section 709 of the *Standard Specifications*. Painting of existing structures will be paid on a lump sum basis. Check the Contract Specifications for documentation, measurement and payment requirements for the removal of lead-based paint. Pay quantities should be recorded in the Daily Work Report. Retain all material certifications, invoices and similar documentation and forward a copy to the Research and Materials Engineer.

Section 711
Driven Pile Foundations

711.1 DESCRIPTION OF WORK

Piles are load-bearing members made of steel, prestressed concrete or treated timber. They are generally used in locations where the upper soil is too weak or too compressible to support the structure. In such locations, piles are used to transfer loads from the structure to stronger underlying layers of soil or rock. These piles are driven within tolerance into natural ground to help support the structure and minimize settlement. Without a solid foundation, the attention given to constructing a quality structure is meaningless. The Resident Construction Engineer must thoroughly and competently inspect the foundation piling provided for structures.

Many types of piles are available for foundation designs, and each design will differ based on the specific conditions at the site. The Contract Plans and Specifications will designate criteria such as pile type, number, length, horizontal arrangement, orientation (i.e., plumb, batter) and driving specifications such as design load. Driving energy, depth and number of blows will be determined from the Contractor's proposed pile driving plan and WEAP analysis performed by the designer. Each pile that is driven to specification will provide a bearing capacity that will support a fraction of the structure's total load (i.e., design load). The pile's bearing capacity results from a combination of resistant forces, including the surface friction between the pile and natural ground and the bearing pressure of the pile tip on the substrata material (e.g., bedrock).

Although it is equally important to check items such as pile type, location and orientation, it is important to continuously inspect the driving operation with respect to the number of blows each pile receives. The decision to continue or halt the operation must be made quickly. If driving is stopped too soon, the pile will not have developed the required bearing capacity to resist the design load, and the structure may eventually settle due to a lack of support. If overdriven, the pile may incur structural damage, increasing the chance that the foundation will settle or otherwise fail at the location of the damaged pile. It is important to note that the Resident Construction Engineer is responsible for determining the acceptability of the pile with respect to its load bearing capacity. The procedures, methods and criteria by which this determination is made will be specified in the Contract.

Section 711 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material, equipment and construction requirements for driving various types of piles. When a pay item under Section 711 is specified in the Contract, the Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying that the Contractor performs the work in accordance with the Contract Plans and Specifications.

711.2 PRECONSTRUCTION CONSIDERATIONS

711.2.1 Certification of Inspection Personnel

SCDOT requires that inspection personnel on all projects requiring inspection of driven pile foundations, drilled shafts and drilled pile foundations be certified for the work to be performed. See the SCDOT publication *Foundation Inspector's Certification Manual for Pile Driving and Drilled Shafts* for additional information.

711.2.2 Pile Installation Plan

The Contractor is responsible for submitting a Pile Installation Plan to the Bridge Geotechnical Engineer, with a copy to the Bridge Construction Engineer and the Resident Construction Engineer, which will include the following information:

- all equipment, including manufacturer's data sheets on hammers;
- schedule for index pile and production pile driving;
- Shop Plans and Working Drawings for piles, cofferdams, etc.;
- Crane Safety Requirements, as discussed in Section 702.2.4;
- Pile and Driving Equipment Data Form;
- methods of monitoring hammer energy, stroke and pile advancement;
- detailed drawings of followers and templates;
- details of load test equipment meeting pile load test specifications;
- sequence of driving footing piles for each pile layout;
- plan for protecting the integrity of existing structures; and
- plan for preventing pile displacement during placement and compaction of fills.

The Bridge Geotechnical Engineer and the Bridge Construction Engineer will evaluate the Pile Installation Plan for compliance with the Contract Plans and Specifications and, upon acceptance, will notify the Contractor to proceed. All plans accepted by the Bridge Construction Engineer are subject to proof of satisfactory field performance. Work cannot begin until this review has been completed. The Plan will be on-site during all driving operations, and the appropriate pile driving logs will be completed by the Inspector for each pile installation.

711.2.3 Index Piling and Pile Load Tests

When index piling is specified in the Contract, it will be performed to determine required lengths of production piling. Verify compliance of the types, lengths and locations of all index piles. Generally, index piles will be driven to practical refusal and will be incorporated into the final structure. Note that a follower is not permitted when driving index piles. Production piles cannot be ordered until all index piles have been driven, the data evaluated and the pile lengths approved by the Bridge Construction Engineer. In special cases, it will be desirable to load test piling to determine the relationship between the driving resistance and the actual load bearing capacity of the driven pile. If specified, the requirements for load testing will be defined in the Special Provisions of the Contract.

711.2.4 Excavation and Embankment Construction

Unless otherwise directed or shown on the Contract Plans, excavation and embankment construction must be completed and accepted prior to driving foundation piles.

711.2.5 Staking and Utilities

Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the operation begins. Check to ensure that all pile locations have been properly staked in accordance with the Contract Plans.

711.2.6 Welder Certification

Field welders must be pre-approved by SCDOT for the type of field welding to be performed. Ensure that field welders are listed on SCDOT Approval Sheet 41. Certification requirements will be listed under the Contract Specification for field welding. See Section 709.3.4 for additional information on field welding.

711.2.7 Material Considerations

711.2.7.1 Prestressed Concrete Piles

The Research and Materials Laboratory Inspectors will perform the inspection work during the casting of prestressed piles. Once approved, the piles will be marked with an SCDOT approval stencil prior to shipping to the job site. Test Reports for the materials used in the piles will be forwarded to the Resident Construction Engineer when the samples are tested. The Resident Construction Engineer will inspect the piles for damage during shipping and notify the Bridge Construction Engineer of any problems identified. See Section 701, Section 702, Section 703 and Section 704 for additional information on the materials and methods used to fabricate prestressed concrete piles. Check for damage of the piles upon delivery and during handling. Concrete piles that are cracked or broken must be rejected, unless the Bridge Construction Engineer provides written approval of repair work. Check compliance of the pile dimensions. The lengths of concrete piles will be specified in the Contract, except in cases where index piling or load test piling will be used to determine lengths prior to casting.

711.2.7.2 Steel Piling Materials

Structural “H” piles and steel pipe piles are not inspected prior to delivery to the job site. The Resident Construction Engineer will obtain from the Contractor the required Mill Test Reports and manufacturer’s certifications furnished by the manufacturer or distributor, as appropriate, and furnish a copy of this documentation to the Research and Materials Engineer. It will not be necessary to obtain samples of these materials; however, it is important to visually inspect the materials for signs of damage and evidence of non-compliance. Steel piles should be stored on skids above ground to prevent rusting and deflection. Handling holes may be used for lifting purposes. Check compliance of the type, weight and dimension of the structural steel piles.

The lengths of steel piles specified in the Contract are approximate. The Contractor will drive test piles to determine the lengths of steel piles required; otherwise, the Plan pile lengths will be ordered and driven. Payment will be made for in-place lengths. Cut offs are not to be paid for. Paint and application of paint on steel piles will be as discussed in Section 710.

711.2.7.3 Treated Timber Piles

Section 706 and Section 707 describe the type of wood and treatment for treated timber piles. Treated timber piles will be pre-inspected by an SCDOT-approved Independent Inspection Agency. The Agency will inspect the wood, treatment and final product and, upon passing, will place the Agency's hammer mark of approval on the pile with a special metal hammer. Upon delivery, ensure that the treated timber piles bear the Agency's hammer mark of approval. The mark is usually placed on the ends of the pile. Do not use unmarked treated timber piles. Obtain and forward to the Research and Materials Engineer a copy of the Agency's Inspection Report and Supplier's Certification. Ensure that wood products are stored and handled to prevent damage and handled to avoid breaking the surface of the treatment. As needed, require the treated surface to be repaired as specified. The lengths of timber piles specified in the Contract are approximate. The Contractor will drive test piles to determine the required lengths of timber piles or proposed driving lengths, which will be reviewed by the Bridge Construction Engineer prior to ordering. Full length piling will always be used. Splicing of timber piling is not permitted.

711.2.8 Equipment Considerations

711.2.8.1 Acceptance Inspection

Various types of drop hammers and power hammers are available for driving piles. They are generally operated by steam, diesel-oil combustion or compressed air. Power hammers may be single acting or double acting. Energy-rating data for pile drivers can be obtained from the manufacturer of the equipment. Equipment selection depends on the type and size of piles to be driven. More than one type of driver may be required for the project. Pile driving work cannot begin until the pile driving system for the types of piles to be driven has been evaluated for acceptability, as specified in the Contract with respect to wave equation results, dynamic pile analyzer (PDA), required number of blows per foot and the stresses developed during driving. Acceptance by the Bridge Geotechnical Engineer will be based on commonly accepted hammer efficiencies, component properties and soil parameters. Local soil conditions and the actual driving system may affect the driving. Other equipment also must be inspected for acceptability, including pile cushions, caps, collars, leads, templates, followers and water jets, when their use is permitted. This equipment must comply with the Contractor's accepted Pile Installation Plan.

711.2.8.2 Drop Hammers

A drop hammer may be used for driving steel or timber piles on bridges requiring load bearing capacities. However, a drop hammer should not be used for driving concrete piles, unless authorized by the Bridge Construction Engineer. Consider the following:

1. Hammer Weight. The hammer should weigh at least as much as the combined weight of the driving head and the pile. Obtain the actual hammer weight from the Contractor and make sure it meets the minimum specified requirements. As needed, use a certified scale to weigh the hammer and pile cap.

2. Hammer Drop. Hammer drop should generally not exceed 15 feet for steel and timber piles and 8 feet for concrete piles. Greater drops, especially when a relatively heavy hammer is used, may damage the pile. The use of a relatively heavy hammer and lower fall will usually result in greater pile penetration per blow with less damage to the pile, because there is a greater blow rate and less chance for the soil to compact around the pile between blows. This is especially important in hard ground.

3. Hoisting Line. The hoisting line for a drop hammer must be mounted on a rotating drum that can turn freely for the full length of the hammer drop, and the line must be slack during the fall. If there is any drag of the cable, adjustment will be necessary.

711.2.8.3 Power Hammers

Read the manufacturer's literature to understand the operating characteristics of the equipment. The equipment should be in good working order and adjusted for the specified rating (e.g., energy per blow, blows per minute). The weight of the ram must bear the proper relation to the weight of the pile, and the ram must have the proper speed when it hits the pile. The ram not only must strike the pile with enough energy to overcome the inertia of the pile and the resistance of the soil, but also must be heavy enough to avoid the loss of too much energy during the impact. There will be a great loss of energy if the ram causes damage to the top of the pile. As a general rule, piles should be driven with the heaviest available ram that can be used to obtain the greatest penetration without causing serious damage to the pile. For the first few piles, carefully watch the performance of the hammer. When adjusted properly, it should move through its full stroke for the required number of blows per minute. It is important to note that the pressure gauge on the air compressor may not indicate the pressure delivered to the ram, due to leaks in valves, rings, bushings and hoses. For this reason, compressors should be able to furnish 25% greater air pressure than that required at the ram. Nearly all manufacturer's literature specify number of blows per minute based on a mean effective air pressure of 80 psi. Once started, the driving of a pile should be continuous. If stopped for a short period of time, the soil becomes compacted and increases frictional resistance around the pile and may cause pile damage when driving is resumed.

711.2.8.4 Caps and Driving Heads

A pile cap and cushion must be used on all concrete piles. Pile caps or collars should be used on timber piles to avoid damage to the top of the pile. A driving head should be used on steel piles when driving conditions cause damage to the pile. Where a driving head is required, verify compliance with the manufacturer's recommendations. Hammer cushions and striker plates are typically used to ensure uniform driving behavior and minimize damage to the pile. Where required, verify conformance with respect to type and size. Extra pile cushions and striker plates should be on hand so that, if damaged, they can be quickly replaced.

711.2.8.5 Points and Tips

When specified for use with prestressed concrete piling, verify compliance of the size and shape of prestressed pile points. When specified for use with steel piling, verify compliance of the type, size and shape of reinforced pile tips.

711.2.8.6 Leads and Followers

Leads are required for all pile driving operations. Pile driving leads are used to guide the movement of the hammer, thus ensuring the pile receives a concentric impact with each blow. It is essential that the fall of the hammer be in line with the pile; otherwise the head of the pile may be severely damaged, the hammer may be damaged, the energy of the hammer may be reduced or the pile may change direction. Leads must be straight, true, rigid and so constructed that free movement of the hammer is provided. The lead channels should be greased to prevent the hammer from sticking. Leads must be held in position by guys or stiff bracing to ensure support of the pile during the driving operation. The stiffness of the leads is an important factor in holding the pile in line, and this requirement must not be overlooked. The leads should be long enough to accommodate, at a minimum, the pile length and the length of the hammer. It is generally good practice to use a somewhat longer length as a contingency. Where followers are permitted, verify their proper use.

711.3 INSPECTION DURING CONSTRUCTION

711.3.1 Pile Preparation

Before the pile is lifted to the leads, stretch a tape along the pile and place keel marks along its entire length at 1-foot intervals. At least every fifth mark should be numbered to show the distance from the pile tip.

711.3.2 Pile Location and Orientation

Depending on the design requirement, the pile may need to be driven on a batter or slope. The amount of batter will be designated on the Contract Plans. If a pile is to be driven on a batter, the leads and the path of the hammer must be set to the required batter. After the pile has been placed in the leads but before driving is started, the tip of the pile must be carefully placed in the correct location and orientation. A template should be used as a guide. Verify that the pile is set within tolerance of its designated location. Also, check the pile alignment for deviation from allowable tolerance. Where structural steel shapes are used, verify that flanges are oriented as designated on the Contract Plans. If a pile for a bridge pier or abutment is found to be out-of-tolerance, the Contractor may be given the option of driving an offset pile or pulling and re-driving the original pile. These situations should be referred to the Bridge Construction Engineer.

711.3.3 Water Jetting

Water jets are commonly used to aid the driving of piles in sandy soils, especially concrete piles. This method must be approved by the Bridge Construction Engineer prior to use and included in the Pile Installation Plan. The jet of water should be started as soon as the tip of the pile is set in position and before driving begins. The jet pipe should be placed close to the pile. As the soil is softened and washed away by the water, the pile should sink under the weight of the hammer. If not, light hammer taps should be used. The jet should be raised from time to time, and the hammer should be used without the jet to permit the penetration per blow to be determined. Just before the proper elevation is reached, the jet pipe should be pulled out and the pile should be driven to solid bearing by the hammer alone.

711.3.4 Pile Penetration

Know the criteria established for minimum penetration, minimum tip elevation, ultimate bearing value and the method for evaluating pile penetration acceptance. When driving first begins, the hammer should strike relatively light blows. After the pile has been driven approximately 3 feet into the ground, the alignment of the pile should be checked before driving is continued as specified. During the operation, carefully monitor the location and alignment of each pile. Piles must be driven to practical refusal into natural ground or the penetration per blow is at the specified limit. Penetration readings should be recorded often so that rate of penetration at various depths will be known. If the driving becomes difficult or if the pile begins to rebound, place 1-inch marks on the pile and carefully monitor the penetrations per blow. Complete Form 700.15 – Pile Driving Log for each pile that is driven as soon as practicable after the data is obtained.

711.3.5 Pre-Drilling for Piles

Pre-drilling for piles will not be permitted except where specifically noted in the Contract Plans or approved in writing by the Bridge Construction Engineer. Where permitted and used, verify compliance of the drilling, driving and backfilling for the type of pile being installed.

711.3.6 Precautions and Driving Difficulties

Pay particular attention to the following precautions and difficulties which are commonly encountered during the driving of piles:

1. Springing / Bouncing. Watch for pile springing and hammer bouncing. Springing can occur where spliced members are not properly aligned, the pile head is not squared properly or the pile and hammer are misaligned. Bouncing can occur where the pile has reached the point of practical refusal, a hammer of insufficient weight is used or too much steam or air pressure is used in double-acting hammers.

2. Changes in Direction. Watch the pile as it is driven for sudden changes in direction. This is a good indication that the pile has failed below the ground due to an obstacle.

Near vertical rock strata can also contribute to this problem. In such cases, contact the Bridge Construction Engineer for guidance. Corrective action may be necessary.

3. Sudden Changes in Penetration. Monitor the pile for sudden changes in penetration between blows. This usually indicates that the pile has failed or an unusually soft subsurface strata has been encountered. In such cases, contact the Bridge Construction Engineer for guidance. Corrective action may be necessary.

4. Boulders/Rock Strata. Where a pile is driven in an area known to have boulders or varying rock strata, as indicated by boring logs, carefully monitor the operation for a sudden decease in the pile's penetration per blow. Such a rapid change can cause binding and an actual break in the pile. Care must be taken to avoid overdriving the pile. Contact the Bridge Construction Engineer for guidance. Pre-drilling may be required.

5. Adjacent Piles. Where piles are driven close together into a layer of soft material below firmer soil, the driving of the piles tends to build up pressure in the soft layer. If the pressure becomes high enough, driving more piles will cause piles that have already been driven to push up. Such piles have little or no bearing value; and, if not corrected, serious settlement of a structure can occur. The elevation of the top of each pile in a footer should be determined just after the pile has been driven, and each elevation should be compared with the elevation of the corresponding pile after the driving of the whole group has been completed. Piles raised by the driving of nearby piles should be re-driven until the proper penetration per blow is obtained. No pile should be driven within 15 feet of a cast-in-place concrete pile until the concrete has gained at least 85 percent of its required strength.

6. Embankment Considerations. When an abutment is to be supported on an embankment and piles must be driven into the embankment, compaction of the embankment material to meet specified requirements can make penetration difficult. To prevent damage to the piles, pre-drilling may be necessary. In such cases, the use of water jets is not permitted.

711.3.7 Cutting and Splicing Considerations

If a pile has been driven and accepted, but its top is above the elevation shown on the Contract Plans, it may be cut off square with its longitudinal axis. Steel piles and steel reinforcing bars in cast-in-place concrete piles should be cut off. On a trestle bent where the cut-offs of the several piles in the bent are on an inclined plane, because of skew or superelevation, special care must be taken in establishing the correct elevation and slope for each cut-off. The elevation will be determined by the location of the pile with respect to the reference line and the amount of superelevation. Each pile should be cut off so that there will be full and uniform bearing between the piles and the cap and so that the top of the cap will be at the correct elevation. If a pile is found to be too short, or one has been cut off too low, it may be extended or built up, as approved by the Resident Construction Engineer. Careful inspection is particularly important in the case of a concrete pile. The SCDOT Inspector must make sure that the work is performed in accordance with the Contract Plans and Specifications.

711.3.8 Encasement of Steel Piling

Where steel piling is to be encased in concrete, verify that the concrete is placed and cured in accordance with the Contract Plans and Specifications. Pay particular attention to the Special Provisions of the Contract.

711.4 POST-CONSTRUCTION CONSIDERATIONS

Contact the Bridge Construction Engineer for any piles that are driven out of tolerance prior to driving any other piles. Watch for damage and out-of-tolerance piles. Verify that restriking of piles is performed, as directed. Final acceptance is the responsibility of the Resident Construction Engineer, with any needed support being provided by the Bridge Construction Engineer and Research and Materials Engineer.

711.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Driven pile foundations will be measured and paid for as defined in the Contract under Section 711 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. Maintain accurate records in the Daily Work Report and on SCDOT Form 700.15 – Pile Driving Log of the work performed and accepted. Retain all material certifications, invoices and similar documentation. SCDOT Form 700.17 – Pile Record must be submitted with the final plans.

Section 712
Drilled Shafts and Drilled Pile Foundations

712.1 DESCRIPTION OF WORK

Drilled shafts are relatively large-diameter, under-ground columns of reinforced cast-in-place concrete that are constructed in pre-drilled holes to provide foundation support for structures. They are designed to transfer and distribute structural loads to underlying support strata or bedrock. In general, the construction consists of drilling a hole at a designated location, depth and diameter; constructing and placing a cage of reinforcing steel; and placing and finishing concrete to the elevation required by the foundation details of the Contract Plans. The work for drilled pile foundations includes a drilled excavation of the proper size, with a pile section concreted or grouted in place. Reinforcing steel may or may not be required for a drilled pile foundation. Section 712 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material, equipment and construction requirements for drilled shafts and drilled pile foundations. When a pay item under Section 712 is specified in the Contract, the Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying that the Contractor performs the work in accordance with the Contract Plans and Specifications. Review the Contract Plans and Specifications with respect to the requirements for drilling equipment, materials for reinforcing steel and concrete, and shaft location, depth, diameter and elevation. Pay particular attention to the operation sequence and dewatering requirements.

712.2 PRECONSTRUCTION CONSIDERATIONS

712.2.1 Certification of Inspection Personnel

The Contractor and any subcontractors directly involved in this work must meet the specified qualifications for constructing drilled shafts and drilled pile foundations. SCDOT requires that inspection personnel on all projects requiring inspection of driven pile foundations, drilled shafts and drilled pile foundations be certified for the work to be performed. See the SCDOT publication *Foundation Inspector's Certification Manual for Pile Driving and Drilled Shafts* for additional information.

712.2.2 Drilled Shaft Installation Plan

The Contractor is responsible for submitting a Drilled Shaft Installation Plan to the Bridge Geotechnical Engineer, with a copy to the Bridge Construction Engineer and the Resident Construction Engineer, which will include the following information:

- all equipment to be used on the project, including manufacturer's data sheets;
- sequence of construction operations;
- Shop Plans, Working Drawings and Mix Design;
- casing details, including dimensions, elevation, splicing, painting and removal;

- Crane Safety Requirements, as discussed in Section 702.2.4;
- type and frequency of sampling and testing, including personnel;
- method of determining top and bottom elevation;
- excavation, cleaning and disposal methods;
- method of using slurry;
- details of steel reinforcing cage construction, placement and support;
- details of concrete placement;
- method of checking depth and horizontal and vertical alignment; and
- method of protecting the integrity of adjacent structures.

The Geotechnical Design Engineer and the Bridge Construction Engineer will evaluate the Installation Plan for compliance with the Contract Plans and Specifications and, upon acceptance, will notify the Contractor and the Resident Construction Engineer. All plans accepted by SCDOT are subject to proof of satisfactory field performance. Work cannot begin until this review has been completed. The Plan will be on-site during all operations. The Certified Drilled Shaft Reports or Certified Drilled Pile Foundation Reports (SCDOT Form 700.09 through SCDOT Form 700.14), as appropriate, will be submitted by the Contractor for each installation.

712.2.3 Boring Log and Geological Reports

Review the boring log and geological reports. This information is provided to the Contractor for informational purposes only. The Contractor may perform pre-installation soil boring analyses to confirm actual field conditions. Become familiar with the appearance of the type of material anticipated at the depth of the bearing strata.

712.2.4 Staking and Utilities

Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the operation begins. Check to ensure that all drilled shaft locations have been properly staked in accordance with the Contract Plans.

712.2.5 Welder Certification

Field welders must be pre-approved by SCDOT for the type of field welding to be performed. Ensure that field welders are listed on SCDOT Approval Sheet 41. Certification requirements will be listed under the Contract Special Provision for field welding. See Section 709.3.4 for additional information on field welding.

712.2.6 Material Considerations

Inspect compliance of all materials upon arrival at the job site. Verify that concrete, slurry, reinforcement, casing and other required materials conform to the requirements specified in the Contract. Check that the Contractor has a Mix Design of the class designated in the Contract. See Section 701 and 702 for information on concrete and concrete structures. See Section 703

for information on reinforcing steel. See Section 711 for information on foundation piling. Where steel casing is used, verify conformance with respect to wall thickness, strength, diameter and condition. Paint and application of paint on steel casing will be as discussed in Section 710. Pay particular attention to the sampling and testing requirements for slurry.

712.2.7 Equipment and Explosives Considerations

Verify that a heavy-duty drilling rig in good operating condition is provided for the work. The rig must be capable of drilling to the required depth and penetrating the underlying bearing material or bedrock. Verify that the equipment and drilling accessories comply with the requirements of the Contractor's Drilled Shaft Installation Plan. The use of explosives is not permitted for drilled shaft construction without written approval from the Bridge Construction Engineer.

712.3 INSPECTION DURING CONSTRUCTION

712.3.1 Drilling Operation

Consider the following inspection guidelines during the drilling operation:

1. Location and Depth. Check the horizontal and vertical alignment of the shaft to ensure it is within allowable tolerances. Document the depth drilled into the target bearing strata, and compare the excavated material with geological information to ensure that adequate bearing material has been reached. If, during excavation, the rock elevation varies more than ±2 feet from the soils report, contact the Bridge Construction Engineer.

2. Diameter. Check the hole diameter and sides to ensure compliance of size, vertical orientation and allowable tolerance. Where caving is encountered, halt the operation until the situation can be evaluated and corrected. Contact the Resident Construction Engineer for assistance. Protective steel casing may be needed.

3. Excavation. Verify that excavated material is disposed of properly. Check to ensure that the hole is dewatered and cleaned of all loose material. The Inspector should verify that the bottom of the hole is clean and flat. If dewatering is not practical, the provisions of the Contract with respect to placing concrete under water will govern.

4. Protective Cover. Once the hole has been accepted, verify that protective covering is installed to prevent persons and materials from falling into the hole.

5. Slurry. Ensure that the slurry being utilized is a mixture of sodium bentonite and clean, fresh water. Tidal water is not allowed. The mineral slurry must be premixed and adequate time, as prescribed by the manufacturer, must be allotted for hydration prior to introduction into the shaft excavation. During construction, the level of slurry must be maintained at a height sufficient to prevent caving of the hole. Verify that slurry properties (e.g., density, viscosity, pH) are maintained in accordance with the Contract Specifications. Check sand content to ensure compliance with the Contract Specifications. If it is too high, desanding may be required.

712.3.2 Reinforcement Cage and Steel Casing

The concrete reinforcement generally consists of a single-unit cage of reinforcing steel. The cage must be inspected prior to being placed into the drilled hole. Consider the following:

1. Cage Construction. Inspect the cage for proper bar size, spacing and fastening. Check the cage height and diameter for conformance.

2. Steel Casing. Where designated or as directed, ensure that the proper size of steel casing is installed and oiled prior to placing the cage, support system and concrete.

3. Installation Timing. After the hole and cage have been inspected, the cage and support system must be installed in the hole just prior to pouring concrete. If the concrete is not immediately poured, require removal of the cage, re-inspect the hole for loose material and check the surface condition of the steel for acceptability.

4. Support System. A support system must be provided so that the cage does not sit on the bottom nor lean against the wall of the hole. Check bottom and side clearances. Check conformance with respect to the number and interval of spacers along the length of the cage. Verify that the support system does not rack or skew the cage, and require additional steel as needed to stiffen the cage.

712.3.3 Concrete Placement

Acceptability of the placement method used for concrete will depend on whether or not the hole is considered dry or wet. Just prior to placement, check the depth of water at the bottom of the hole. If the depth, without pumping, is less than 6 inches over a 1-hour period, the hole may be considered dry for the purpose of method approval. Otherwise, the hole should be considered wet. Consider the following guidelines:

1. Dry-Hole Placement. Where the hole is dry, the concrete may be poured continuously in a free fall from the surface with the use of an approved device. Check to ensure that the concrete does not hit the reinforcing cage nor the sides of the hole on the way down.

2. Wet-Hole Placement. Concrete should be placed immediately after installation of the reinforcing cage, provided the excavation has been checked for bottom cleanliness and meets the requirements of the Contract Specifications. Concrete placement will be placed continuously from the bottom to the top of the excavation with a tremie tube. Concrete placement will continue after the shaft excavation is filled until good quality concrete is evident at the top of the shaft. During placement, ensure that the discharge end of the tremie tube remains immersed at least 10 feet into the concrete. To prevent slurry intrusion into the shaft concrete, ensure that the level of concrete within the tremie tube is always above the level of the slurry.

3. Removal of Water-Diluted Concrete. Where water-diluted concrete has floated to the top of the concrete during the pour, verify that the minimum depth of the top surface is removed and wasted.

4. Steel Casings. See Section 712.11 of the *Standard Specifications* for information on steel casings.

5. Concrete Curing. Check that the top surface of the concrete is properly cured. Pay particular attention to compliance of the curing method and period.

6. Adjacent Construction. Where other piles or shafts are to be installed adjacent to the freshly poured concrete, check compliance with respect to minimum lateral clearance and compressive strength prior to initiating the adjacent work.

712.4 POST-CONSTRUCTION CONSIDERATIONS

Obtain from the Contractor the required Certified Drilled Shaft Reports or Certified Drilled Pile Foundation Reports, as appropriate, for each drilled shaft or drilled pile installation. These Reports will be submitted before beginning construction on the next day's shafts or piles. Check the top elevation for tolerance compliance. Verify that the projecting reinforcing steel is in the correct location and properly cleaned of mortar. When specified in the Special Provisions of the Contract, the Department's on-call geotechnical consultant will perform the crosshole sonic logging test (CSL) prior to acceptance. Final acceptance is the responsibility of the Resident Construction Engineer, with any needed support being provided by the Bridge Construction Engineer and Geotechnical Design Engineer.

712.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Drilled shafts and drilled pile foundations will be measured and paid for as defined in the Contract under Section 712 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. Maintain accurate records in the Daily Work Report and appropriate SCDOT Forms 700.09 – 700.14 of the work performed and accepted. Retain all material certifications, invoices and similar documentation.

Section 713
Mechanically Stabilized Earth Retaining Wall

713.1 DESCRIPTION OF WORK

Section 713 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, govern the material, equipment and construction requirements for mechanically stabilized earth retaining walls. When specified in the Contract, the Resident Construction Engineer and SCDOT Inspectors will be responsible for verifying that the Contractor performs the work in accordance with the Contract Plans and Specifications.

713.2 PRECONSTRUCTION CONSIDERATIONS

Upon delivery to the job site, check compliance of the materials required for the project, including structural geosynthetic reinforcement, precast segmental concrete facing units, concrete leveling pad, perforated pipe underdrain, free drainage aggregate and backfill material. See Section 802 for information on perforated pipe underdrain. Obtain from the Contractor the required samples, Mill Test Reports, manufacturer's certification and certified test results. Forward this documentation to the Research and Materials Engineer. Acceptance will be based on the test results meeting the specified requirements. Do not allow work to begin until notified of material acceptance. Check for damage to materials upon delivery and ensure they are properly labeled, stored and handled. Pay attention to the storage requirements for structural geosynthetic reinforcement.

713.3 INSPECTION DURING CONSTRUCTION

Check the limits, grade and elevation of the excavation. Check for proper compaction of the soil. Verify that perforated pipe underdrain is installed properly at the correct location and spacing. Check compliance of the outfalls. Verify that the proper erosion control and drainage has been installed and is functioning to minimize washouts during installation. Check the dimensions and elevations of the installation of the concrete leveling pad. Do not allow the first course of segmental blocks to be placed until the concrete has reached its compressive strength. Monitor the installation of the segmental concrete facing units. Pay attention to the first course to ensure proper alignment. If required based on the size of the wall, ensure that the manufacturer's representative is on-site during construction. Continually monitor the wall for plumbness so that corrections can be effectively made. Check connections for compliance and that the block cores are backfilled with free draining aggregate before the next course is laid. Check compliance of the lift thickness and compaction of the backfill and the installation of the structural geosynthetic reinforcement. Verify that the top course is properly capped.

713.4 POST-CONSTRUCTION CONSIDERATIONS

Prior to final acceptance, check the quality of the workmanship and that the drainage is functioning. Final acceptance is the responsibility of the Resident Construction Engineer.

713.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Measure mechanically stabilized earth retaining wall by the unit area of wall surface accepted in place, as measured from the top of the leveling pad to the top of the cap. Payment will be made at the Contract unit price. Maintain accurate records in the Daily Work Report including area measurements and calculations, all materials received and materials certifications.

Section 714
Pipe Culverts

714.1 DESCRIPTION OF WORK

A highway drainage system typically includes an interconnecting system of slopes, open ditches, underdrains and culverts of various types, sizes and shapes. The drainage system is constructed to prevent water from saturating and weakening the soil, prevent water from infiltrating the base and subbase, and intercept and carry the water away from the roadway. Culverts are an important part of this system. A culvert is an opening under the roadway with a clear span of less than 20 feet. A larger span is classified as a bridge. Culverts must function both hydraulically and structurally and are designed to accommodate the water flow, the pressure of surrounding soil and the traffic load above them. Culverts are typically placed at low points in the profile of natural ground and at intervals along long grades to carry water under the roadway. They may also be installed to accommodate the passage of pedestrians and wildlife.

A culvert with a rectangular opening is called a box culvert, which typically is cast in place or precast reinforced concrete (Section 722 of the *Standard Specifications*). A culvert with a round, arch or elliptical shape is called a pipe culvert (Section 714 of the *Standard Specifications*). Pipe culverts may be made of reinforced concrete, corrugated aluminum, galvanized corrugated steel or corrugated plastic. Sometimes culverts will consist of structural plates of galvanized corrugated steel or corrugated aluminum, which must be fabricated off-site and bolted in the field (Section 715 of the *Standard Specifications*). The type, size, number and location of culverts will be designated on the Contract Plans and will depend on many factors, such as application, drainage area, soil type and acidity, overhead load, surrounding soil pressure, cost and the likelihood that the pipe will be eroded.

The cost of installing pipes for culvert and sewer applications is very expensive, and therefore, warrants close inspection. When pay items are specified for pipe installations (i.e., Section 714, Section 715, Section 716 and Section 722 of the *Standard Specifications*), the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring that the work and materials comply with the respective requirements of the Contract Plans and Specifications, including applicable Supplemental Specifications and Special Provisions.

714.2 PRECONSTRUCTION CONSIDERATIONS

714.2.1 Concrete Pre-Pour Conference and Checklist

As applicable for reinforced concrete work for culverts (e.g., precast operations, cast-in-place headwalls), review the minutes of the Pre-Pour Conference, if held, and use SCDOT Form 700.01 – Concrete Pour Inspector’s Checklist.

714.2.2 Safety Considerations

Do not begin construction until all necessary traffic control is in place in accordance with the *MUTCD*. See Section 601, Section 602 and Section 603 for additional information. Do not enter manholes, inlets, vaults, trenches or other confined spaces without proper safety precautions and proper equipment. Unless alternative methods, such as laybacks or trench boxes are used, the sides of trenches must be securely held by shoring and bracing where trenches are excavated in material other than rock. Shoring and bracing is especially important where heavy construction equipment will be operated near the trench or where material thrown out of the trench is piled on one side. The spoil bank formed by the soil removed from the trench should be trimmed back from the edge of the trench. The weight of the soil in the spoil bank tends to overload the sides of the trench and may cause slides or cave-ins. As specified, shoring and bracing will be designed and stamped by the Contractor's South Carolina registered professional engineer.

714.2.3 Staking and Utilities

Verify that utility locations have been thoroughly checked and marked and that any known conflicts have been resolved before the operation begins. Check to ensure that culvert alignment and grade have been properly staked. Check that the elevations, alignment and locations meet the requirements for existing field conditions. Check inlet ditches and outfall ditches to see if planned elevations will properly drain existing conditions in the field. Make adjustments, if necessary.

714.2.4 Materials Considerations

714.2.4.1 Reinforced Concrete Pipe and Clay Pipe

Precast reinforced concrete pipe and box culverts will be inspected by Research and Materials Laboratory Inspectors at the fabrication facility. Once approved, an SCDOT stencil will be placed on the pipe. Do not accept any culvert material without this stencil. Precast reinforced concrete pipe will be stenciled in black with the markings "SC-3," "SC-4" or "SC-5," depending on the class of pipe inspected. Check that pipe sections are handled properly. If the method used causes damage, caution the Contractor and enforce the provisions of the Contract with respect to repairs or replacement. Pipe sections must be lowered carefully and not dumped or dropped from the truck to the ground.

714.2.4.2 Metal Pipe and Structural Plate Pipe

The sheet gauge and the type and size of corrugations for metal pipe culverts will be specified. Also, the pipe may need to be galvanized, coated with asphalt material, lined with clay or fiber bonded. If the corrugations in only the lower part of the pipe are filled, the pipe is said to have a paved invert. If the corrugations are filled all the way around the pipe, it is said to be fully paved. Metal culvert and structural plate pipe materials are not pre-inspected by SCDOT. Obtain and forward to the Research and Materials Engineer the Mill Test Reports, manufacturer's certification and certified test results. Do not allow use of the material without

notification of material acceptance. It will not be necessary to submit samples, unless a problem is suspected. Upon delivery, check compliance with respect to type, size, shape, paving, thickness, length and coating. Ensure that structural plates, nuts and bolts conform to specified requirements. Verify that structural plates are matchmarked to ensure proper position during erection. Check for damage and defects. Reject non-conforming materials.

714.2.4.3 Polyethylene Pipe

Where designated for use on the project, ensure that polyethylene pipe is of the type and size specified and is supplied from a source listed on SCDOT Approval Sheet 30. Upon delivery, visually inspect the material for damage and take samples as described in Section 106.

714.2.4.4 Other Materials

Many other types of materials also may be required, including concrete and reinforcing steel for headwalls, field paving materials, joint sealant material, joint gaskets, and bedding and backfill material. Ensure that these materials conform to the requirements of the Contract. Pay attention to compliance of the type, shape and size of end sections, reducers, increasers, wyes and bends specified for the work.

714.3 INSPECTION DURING CONSTRUCTION

714.3.1 Field Adjustment Considerations

714.3.1.1 Overview

Water flowing over the ground will follow natural drainage channels at low points along the surface. When an embankment is built across a channel, water will pond, unless it can flow through the embankment. A culvert will be placed through the embankment at every natural drainage channel. Drainage-relief culverts will be installed to intercept water on excessively long grades. Drainage plans are generally based on survey data taken long before clearing and grubbing begins. Field conditions may be encountered that will require a different culvert installation. SCDOT Inspectors must study drainage conditions throughout the project. If a modification is suspected, immediately notify the Resident Construction Engineer for assistance.

Study all proposed culvert locations carefully to ensure that the Plan location, skew angle, etc., are best suited to accommodate field conditions. If the criteria appears inadequate, take corrective action. If water needs to be diverted from its natural channel but is not designated on the Contract Plans, give careful consideration to any consequential damage SCDOT may be held accountable for. Remember, the basic purpose of a culvert is to pass surface water from one side of the roadway to the other, as directly and economically as practicable, without damage to the highway or private property. Use sound engineering judgment when assessing any needed adjustments. For example, make certain that culverts are placed at low points and that outfalls are within the right-of-way. Perform field verification of all drainage features after installation. The use of energy dissipaters may be required, especially where excessive surcharges are expected.

714.3.1.2 Small Stream Considerations

Where a culvert is to carry water from a small stream through an embankment, the centerline of the culvert will typically be placed near the centerline of the stream. In addition, the bottom elevation of the culvert should be about the same elevation as the stream bed. Natural drainage channels should be used as much as practicable. Changing the course of a stream may result in property owner claims for damages due to flooding or intercepting too much water. The size, location and grade of each culvert must be constructed as defined in the Contract Plans, unless field conditions warrant adjustment. If an adjustment in location or elevation appears warranted, immediately notify the Resident Construction Engineer.

714.3.1.3 Culvert Skew

Where a culvert is provided at a natural drainage channel or where a drainage-relief culvert is required on a minor grade, the culvert will generally be set at a right angle to the roadway centerline; otherwise, the culvert will be skewed. Culverts are skewed to allow rapidly flowing water to more readily enter the inlet. Drainage-relief culverts installed along excessive grades typically will be skewed at angles of 15° to 45° with the roadway centerline. The degree of skew will be designated on the Contract Plans. In addition, the culvert will typically be set at approximately the same grade of the ditch that feeds the inlet.

714.3.1.4 Culvert Grade

The grade of a culvert is the line along its lowest inside surface, which will be designated on the Contract Plans. The flowline elevation should be set and checked at each cross-section along the culvert's profile. The flow line grade should, in general, be the same as that of the channel on each side of the culvert; however, the minimum grade should be at least 1.0% to promote self cleaning. Where pipes are laid on a relatively flat grade under high fills or yielding ground, sufficient camber must be placed in the culvert foundation to allow for settlement to avoid sag in the grade line. Settlement under high fills is much greater between roadway shoulders than near the ends of the pipe. Consider the following guidelines with respect to culvert grade:

1. Siltation. The grade of the culvert should not be so flat as to cause pipe siltation.

2. Inlet Elevation. The elevation of the flowline at a culvert's inlet should be set low enough to carry surface water away rapidly to prevent flooding adjacent land and to drain water from underdrains without backing up when the culvert is running full.

3. Outlet Elevation. The elevation of the flowline at a culvert's outlet should be set as close as practical to the existing ground. Less excavation will then be required for the outfall ditch, and the cost of maintenance will be less. In addition, where no endwall is provided at the outlet, the culvert should extend at least 2 feet beyond the toe of the embankment; and the culvert outlet may need to be treated with slope paving, a spillway or a rock dispersion pad to prevent erosion.

714.3.1.5 Inlets and Outlets

The entrance ditch to the pipe should be dug large enough to permit full use of the pipe during heavy rains. The ditch adjacent to either end of the pipe should be such that there is no abrupt change in the direction of the flow. The inlet elevations of a pipe should be carefully considered to avoid any ponding of water on private property.

714.3.2 Marking Culvert Locations

Several techniques can be used to establish culvert locations, including batter boards and stringlines, offset grade stakes and GPS technology. A common procedure is as follows:

- Stakes should be set along the centerline of the roadway at intervals of 25 feet to 50 feet for 200 feet on each side of the proposed location of the pipe.

- From each centerline stake, the distance from the roadway centerline to the planned outer edge of the shoulder will be measured in each direction at right angles to the roadway, and long stakes will be set along these shoulder lines.

- The toe of the slope will be established at a right angle to the centerline station where the end of the pipe will be located.

- A stringline should be used to set and control flowline elevation. A mark will be made on each stake either at the elevation of the flowline or at a certain uniform distance above or below the flowline elevation. The stringline, passing through these marks, will be pulled tight and secured in position on the stakes. If the stringline is not at the elevation of the flowline, the distance above or below the flowline must be marked on the stakes.

714.3.3 Trench Excavation

A pipe culvert should never be installed by simply laying it on the ground and piling fill material against it. Every pipe culvert must be laid in a trench; because the ability of the pipe, especially corrugated metal pipe, to support the load at its top depends on the support provided by the pressure of the compacted soil along its sides. Where a pipe is laid in a trench dug in compacted ground or embankment material and the void in the trench on each side of the pipe is backfilled and compacted, the resistance of the pipe to crushing is greatly increased. A trench should only be wide enough to allow room for compacting the backfill around the lower half (i.e., haunches) of the pipe. In general, the width of the trench should not be less than that required for making proper joints and compacting the backfill, and the trench must be deep enough to permit the top of the pipe to be at least the specified depth below the top of the trench. Trench excavation should always start at the low end, and the bottom of the excavation should be maintained even and sloped so that the trench will drain during construction. Trench excavation depends primarily on the type and size of the culvert being installed. See the *Standard Specifications* and *Standard Drawings* for trench excavation requirements.

714.3.4 Foundation and Bedding

An ideal condition is to have uniformity of foundation throughout the length of the pipe culvert; however, this is often not possible unless pockets or sections of material supplying unequal bearing are removed. Ensure that any unsatisfactory foundation material (e.g., soft, spongy material, rock or hard pan) is removed and replaced with suitable backfill material to the specified width and depth. Pipe culverts should not be placed directly on rock or other unyielding material because such conditions prevent proper distribution of load. If the bottom of the trench becomes soft and muddy, it may be best to undercut (i.e., dig below the normal grade) and backfill with granular material or earth selected from excavation. Only enough granular material to make a firm bottom should be used. Otherwise, water may run beneath and undermine the pipe. The contact between a pipe and the foundation on which it rests is the pipe bedding. It has an important influence on the supporting strength of the pipe. In most instances, the type of bedding to be used will be noted on the Contract Plans. Flexible pipe should generally be bedded so that the groove formed in the bottom of the trench has a width between one-half and three-fourths of the diameter of the pipe. The bottom of the trench, for a specified distance on each side of the pipe centerline, must be shaped to fit the curve of the pipe being laid with proper camber provided for flexible pipe. Where bell-and-spigot pipe is used, check that holes are properly dug in the trench to accommodate the barrels and allow the pipe to be in full contact with the foundation. It is of utmost importance that the Contractor be required to shape and prepare the pipe bedding in accordance with specified requirements. Consider the following:

1. Concrete Cradle. Where a concrete cradle is specified, the suggested method of construction is as follows:

    - The cradle below the lowest point on the pipe should be made of a concrete mix having a very stiff, dry consistency.

    - The concrete should be placed before the pipe is placed in the trench, and the surface of the concrete should be brought accurately to the grade for the bottom of the pipe. If bell-and-spigot pipe is used, the surface of the concrete should be at the grade of the line through the bottoms of the bells. Looped wires may be placed in the concrete before it hardens and later used to tie the pipe in position.

    - After the concrete below the pipe sets hard enough to be worked on, the pipe should be laid in its correct position on the concrete.

    - Fairly wet concrete should be used to complete the cradle or to encase the pipe.

2. Natural Ground Preparation. Where pipe is to be supported by natural ground, the trench bottom must be fine-graded to the proper grade, camber and shape so that the pipe will bed properly.

714.3.5 Pipe Placement

Various methods are used for lowering pipe into the trench. Mechanical equipment must be used for large pipe sections. Rigid pipe sections are typically lifted using hairpin-shaped hooks that can be inserted into the opening of the section or in special lifting holes or eye connectors.

This allows each section to be lifted and set into proper position without damage. Note that bell-and-spigot pipe sections must be laid with the bell end upstream and the laying operation must start at the downstream end of the trench. Each section should be pointed in the proper direction before it is lowered into the trench. Where reinforced concrete oval pipe is being laid, verify that the "TOP" label is uppermost. Where flexible pipe is placed in the trench, it should be lowered carefully. If a section of pipe is dropped, it may be dented or the galvanization or paving may be knocked off. If coating is knocked off or damaged, ensure that it is repaired as specified. Reject damaged pipe when conditions warrant. Before lowering the pipe into the trench, flexible pipe should be turned so that the lengthwise lap is at one side. This lap should never be at the top or bottom. The Contractor may often use different lengths of pipe sections to place the proper length of staked pipe. Should different lengths of pipe be furnished, the longer sections should be placed at each end of the pipe.

714.3.6 Joining Pipe Sections

Bell-and-spigot joints are used for small sizes of concrete pipe, and large sizes of concrete pipe usually have tongue-and-groove joints. Because bell-and-spigot pipe is laid with the bell end upstream and laying it started at the downstream end of the trench, the spigot end of the section being set in place must be inserted in the bell of the section previously placed. The methods used in joining sections of tongue-and-groove and bell-and-spigot pipe should be such that the ends of the sections are fully entered and the inner surfaces are reasonably flush and even. Typical sealants include mortar, preformed gasket material and approved sealants as listed on SCDOT Approval Sheet 13. Verify that the methods of joining pipe comply with specified requirements.

714.3.7 Inspection Prior to Backfilling

All pipe must be inspected in place before backfilling is started. Joints in large pipes should be inspected from within the pipe to make certain that they are properly filled. Any damaged joints should be repaired. Any section of pipe that has been critically cracked or broken should be taken out and replaced. At the end of each day, the trench with no pipe in it should be blocked off by a temporary dam or tight bulkhead located a short distance beyond the end of the pipe. The end of the pipe should not be blocked, because water filling the trench would then float the pipe and break the joints. Frequent observation of concrete pipe culverts should be made following the initial placement of the structure through the completion of the roadway fill and pavement. These frequent inspections throughout the duration of the project should establish the point at which damage occurs, if any, and also the extent of the Contractor's responsibility.

714.3.8 Backfilling and Compaction

Inspection of the backfilling around and over a pipe is one of the most important duties of the SCDOT Inspector. Proper backfilling under the lower half of the pipe helps prevent rigid pipe from being crushed under heavy loads. Also, if the trench is not properly filled and compacted, a depression will usually develop in the finished roadway surface. Pay particular attention to the quality control testing and density acceptance requirements. The use of flowable fill must be

approved by the Resident Construction Engineer. Check that the granular backfill material conforms to specified requirements and is free of muck, large stones, lumps and debris so that uniform compaction can be achieved. Care should be taken so as not to disturb mortared joints during backfilling.

Contractors frequently want to shove backfill material into the trench with a dozer which almost inevitably results in the backfill being placed in lifts that are too thick, especially near the trench sidewalls. Should the Contractor elect to use this method of placing earth in the trench, the SCDOT Inspector should, after each layer is placed, mark the pipe (with crayon) or by sticking stakes into the trench sidewalls to where the next layer should be. The material shoved in by the dozer will have to be redistributed along the pipe in a uniform layer. Layer thicknesses can be controlled in this manner. Backfill should be brought up uniformly on both sides of the pipe at the same time. Failure to do so produces unequal earth pressures that have not been designed for and could result in damage to the pipe. The use of mechanical equipment with buckets is much preferred.

To obtain uniform pressure around the pipe, the backfill material must be placed in layers of the specified thickness and thoroughly compacted. Mechanical tampers are normally used. The compacted layers should not exceed the specified thickness. Water should be added as needed to bring the material to optimum moisture content for maximum consolidation. To avoid displacing or unduly stressing the pipe, verify that backfilling is performed equally on both sides of the pipe simultaneously. Special care should be given to tamping material under the haunches of the pipe. Excessive compactive effort under the haunches may raise the pipe above the intended grade.

The compacted backfill should extend at least to the top of the trench. All field personnel should be cautioned to carefully observe the few feet of fill placed directly over the pipe to prevent the incorporation of any large rocks in this area. Heavy equipment can maneuver rock into this critical area. Pipe culverts should be adequately protected from damage before heavy equipment is operated near or over them. Water can sometimes be used to facilitate the settlement of granular backfills.

714.3.9 Structural Plate Pipe Considerations

Detailed instructions for erecting structural plate pipe will be shipped with the material. Obtain a copy of these instructions from the Contractor and study them carefully. Prior to beginning the work, perform a check measurement to ensure that the design length will be sufficient to fit the designated grade and alignment.

714.3.9.1 Pipe Bedding

The width of bedding for structural plate pipe need not exceed the width of the bottom plates. The percent overall height requirements for bedding will not apply except when the pipe is first assembled and then placed in the trench. Where pipe is laid on existing ground, special care must be taken to ensure full uniform support along the barrel of the pipe.

714.3.9.2 Pipe Assembly

Assembly of structural plate pipe should be started at the upstream end. The bottom plates are lapped and offset. Bolt holes near the center should be lined up and the bolts should be inserted and nuts fastened as soon as each plate is set. The longer bolts are used at points where three plates overlap. The longest bolts are used first to draw the plates together and these bolts are then replaced with standard bolts. After enough bottom plates are connected, the side plates just above them are added and held in place with a few bolts. The additional side plates and top plates are then assembled. When all plates are in position, any missing bolts should be installed and the nuts snugged. Nuts should be tightened uniformly, those at the upstream end being adjusted first. After all nuts have been tightened, they should be retightened. This adjustment may be started at either end. Check bolt lubrication and use a torque wrench and the manufacturer's recommendations, as specified, to inspect bolts and nuts.

A structural plate pipe arch is assembled in much the same manner as a structural plate pipe. The work is begun at the upstream end. After the base angles have been placed, the lowest side plates are set on them. Some other side plates and some top plates are then fastened in place with a few bolts on which the nuts are snugged but not tightened. Next, the remaining side plates and the top plates of one complete ring of the arch should be bolted into place. At this time, just enough bolts should be used to hold the plates in place, and the nuts should not be tightened securely. Drift pins will be helpful in matching the bolt holes, and temporary props can be used to help hold the plates in place until connections can be made. After one complete arch is in place, the next set of plates is assembled. Plates should be overlapped by one corrugation. After all the arch sections are in placed, all bolts and nuts should be installed. Then the nuts should be progressively tightened and retightened, as described. If the assembly procedures are not strictly followed when field assembling structural plate pipes and arches, rotation or spiraling of the barrel of the unit will usually result. Once this condition starts, it becomes worse as succeeding sections are assembled, causing the arch and invert to rotate out of position. This condition weakens the load carrying capacity of the structural plate pipe or arch, necessitating complete removal or removal to a point where a rotation is within acceptable limits, at which point correction plates must be installed. This removal or correction results in unnecessary delays to construction of the project.

714.3.10 Trenchless Pipe Method

When the trenchless method (jack and bore) is designated in the Contract Specifications or approved by the Resident Construction Engineer, ensure compliance. Any departure from the directives must be approved in writing by the Resident Construction Engineer. The Contractor is responsible for ensuring that the strength of the pipe can adequately withstand the jacking force. Pay particular attention to the requirements for approach trench, pipe guides, collars, jacking equipment and the allowable tolerance of deviation from Plan alignment and grade. The jacking operation should be performed continually to prevent the pipe from "freezing" in place. Lubrication may be required. Verify that joining of sections and backfilling are performed as directed.

714.4 POST-CONSTRUCTION CONSIDERATIONS

Unless adequate cover is provided, the impact load of heavy earthmoving equipment may damage the pipe culvert installations. During the grading work, pipe culverts should be reinspected at regular intervals by the SCDOT Inspector for damage due to this cause. Also, pipes under embankments should be inspected to see if any damage has occurred due to accumulated live and dead load. The Contractor should be advised immediately when an unsatisfactory condition is found to exist so that the condition can be corrected. The pipe is to be replaced if necessary. Where a pipe has to be replaced for reasons of improper installation or due to loads applied by the Contractor's heavy equipment, the Department will not bear any of the cost of the replacement. Verify that all pipe and structures are clean prior to acceptance and ensure trenches in the roadway have been resurfaced prior to opening to traffic. Where work on sewer systems has been completed, the Resident Construction Engineer must notify the owner of the system so they can inspect the sewer system for final acceptance. Ensure pipes are flush with the inside walls of the manholes.

714.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Document the measurements for payment (e.g., length, number of units installed) in the Daily Work Report for the respective pay items under pipe culverts, structural plate pipes, sewers and precast concrete box culverts. The method of measurement and basis for payment will be defined in the Contract for the respective pay items under Section 714, Section 715, Section 717 and Section 722 of the *Standard Specifications*. All field measurements of the pipe as installed are to be documented and retained for submittal with the As-Built Plans. The notes should indicate the type of pipe, its class, size, length and other relative information. The location of the pipe should be identified by station number. Notes for cross-line pipe should include the skew angle and notes for side-line pipe should indicate the side of the roadway on which the pipe was placed. Include a field sketch, as needed, to more clearly show the pipe layout. Include on the sketch the station number, length, size and skew angle in relation to the survey centerline. Where it is necessary to remove part of a section of concrete pipe as at a connection to a drainage structure, the entire joint length of pipe should be shown for payment. Pipe will be paid for in 4-foot increments. A copy of the As-Built Plans should be provided to the Resident Maintenance Engineer.

Section 715
Structural Plate Pipe, Pipe-Arch and Arch Culverts

Structural plate pipe, pipe-arch and arch culverts are governed by the requirements of Section 715 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer will be responsible for ensuring that the work and materials are in compliance with the requirements of the Contract Plans and Specifications. See Section 714 for additional guidance on inspecting the work and materials related to structural plate pipe, pipe-arch and arch culverts.

Section 716
Sewers

Sewers are governed by the requirements of Section 716 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer will be responsible for ensuring that the work and materials are in compliance with the requirements of the Contract Plans and Specifications. See Section 714 for additional guidance on inspecting the work and materials related to sewers.

Section 717
Re-Laid Culverts

Where culverts are to be re-laid, the Contractor will be required to remove, clean, haul and re-lay the existing pipe culverts at the locations designated on the Contract Plans and as directed by the Resident Construction Engineer. Verify that existing pipe culverts are removed, handled and stockpiled in a manner that will not damage the pipe material. Enforce the provisions of the Contract with respect to replacing damaged pipe. Contact the Resident Construction Engineer for any needed assistance in assessing damaged pipe. Ensure that all mortar or preformed gasket material is removed from the joints of all pipe sections and that the joints are thoroughly cleaned and prepared for re-jointing. See Section 714 for guidance on inspecting the laying of pipe culverts. Re-laid culvert will be measured by the unit length of culvert re-laid and accepted. Payment will be based on the Contract unit price. Document all measurements and field notes in the Daily Work Report.

Section 718
Brick, Rubble and Concrete Block Masonry

718.1 DESCRIPTION OF WORK

The material and construction requirements for brick, rubble and concrete block masonry are defined in Section 718 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance with the requirements of the Contract Plans and Specifications.

718.2 PRECONSTRUCTION CONSIDERATIONS

Verify that clay or shale brick, concrete brick, stone rubble, concrete block, mortar materials (e.g., Portland cement, masonry cement, hydrated lime, aggregate) and reinforcing steel have been sampled and approved prior to the work. See Section 106 for the required schedule of sampling and testing. See Section 701 for additional information on Portland cement concrete materials and Section 703 for additional information on reinforcing steel. Note that masonry cement is used in only small amounts on most projects. When it is used, Mill Test Reports, if available, should be obtained from the supplier and forwarded to the Research and Materials Engineer. The Resident Construction Engineer will inspect the cement to ensure that it has not been contaminated by moisture or otherwise. Ensure that mortar materials have been proportioned and mixed in accordance with the specified requirements. See Section 718.08 of the *Standard Specifications* for mortar requirements.

718.3 INSPECTION DURING CONSTRUCTION

For brick and concrete block work, ensure that a full bed of mortar is placed between the block or brick. Ensure that at least one course in seven is composed entirely of headers. Verify that brick in the faces of structures are in good condition and not broken or chipped. Verify that joints are finished and exposed surfaces cleaned of mortar stains, and filled and pointed satisfactorily. All joints should be visible on the inside of the catch basin. If reinforcing steel is required, ensure that the steel has been placed as required by the Contract Plans. See Section 106 for sampling requirements.

For stone work, verify compliance of the shaping and dressing of the stone before it is laid. Note that no dressing or hammering will be permitted that will loosen stone already set. Ensure that stones are being laid in a full mortar bed and being placed so as to bond firmly in all directions. Ensure that the stone is being laid to achieve substantial masonry of a neat and finished appearance. When constructing walls, the bottom course is generally composed of the larger stones. Verify that one quarter of the stone area of the face of the wall is composed of headers. Verify compliance of the joints in the face of the wall and that weep holes are provided where necessary. Verify compliance of copings with respect to class of concrete, slope for drainage and length. Verify that excavated areas are backfilled with suitable material and tamped in proper layers.

718.4 POST-CONSTRUCTION CONSIDERATIONS

Prior to acceptance, the Resident Construction Engineer will inspect the work with respect to quality of workmanship, location and dimension.

718.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Brick, rubble and concrete block masonry will be measured by the unit volume installed and accepted. Payment will be made based on the Contract unit price. Document all measurements and field notes in the Daily Work Report. Retain all Mill Test Reports, materials certifications, and similar documentation.

Section 719
Catch Basins, Drop Inlets, Manholes & Boxes

719.1 DESCRIPTION OF WORK

The material and construction requirements for catch basins, drop inlets, manholes, junction boxes and spring boxes are defined in Section 719 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance with the requirements of the Contract Plans and Specifications.

719.2 PRECONSTRUCTION CONSIDERATIONS

The location of catch basins, drop inlets and manholes shown on the Contract Plans should be studied carefully for any field adjustment that can be made to improve the drainage conditions. Consideration must be given to proposed driveways, pedestrian traffic and other factors that may influence locations. Verify that utility lines have been staked and relocated, if needed. For concrete pours, use SCDOT Form 700.03 – Concrete Pre-Pour Checklist for Non-Bridge and Non-Culvert Items. Verify that concrete is of the proper class and that the cement, aggregate and admixtures have been approved. Ensure that brick, mortar, castings, reinforcing steel, structural steel and steel tubular sections have been sampled and approved. See Section 106 for the schedule of required samples and tests. If structures are precast, ensure that they conform to the Contract Plans and Specifications and check for the SCDOT approval stencil upon delivery. Verify that precast drainage items are supplied from a source listed on SCDOT Approval Sheet 14, metal basin covers from SCDOT Approval Sheet 15, steel grates and frames for catch basin covers from SCDOT Approval Sheet 45 and surface adjustment risers from SCDOT Approval Sheet 48. Gray iron castings will be accepted on the basis of certification and visual inspection at the job site. The Contractor will furnish the Resident Construction Engineer with a certification stating that material meets specified requirements, including strength, weight, dimension and workmanship. The Resident Construction Engineer will visually inspect the delivered castings and may spot weigh units to check their conformity to the weight requirements as shown on the Contract Plans.

719.3 INSPECTION DURING CONSTRUCTION

The location and elevation of catch basins and drop inlets should be such that the intakes will function properly. Too often, when catch basins and drop inlets are not constructed in conjunction with curb and gutter, the water by-passes the intake resulting in an ineffective structure. This is to be avoided. Verify that the foundation of structures are compacted to a firm, even surface and that obstructions and unstable material have been removed. Ensure that brick and concrete masonry is constructed in accordance with Section 718 and the *Standard Drawings*. Verify that inlet and outlet pipes are placed at the proper elevation, direction and grade and that pipes are substantially and neatly placed in the masonry of the structure flush with the inner faces. Verify that castings are adequately set in mortar in accordance with the

Standard Drawings. If the grade of an existing structure is being adjusted, verify that the work is being performed to use salvaged materials where practicable and that castings have been properly replaced in mortar. Verify that excavated areas are backfilled with suitable material and compacted in specified layers. The Contractor should be required to place and compact the backfill material as required with added emphasis being placed on backfill areas which are to support the pavement structure. The Contractor should be encouraged to use a mechanical tamp, because hand tamps do not thoroughly compact unless the proper tamps and effort are utilized. For structures that exceed standard depth, ensure that the excess depth has been properly measured for payment and that steps have been placed in the structure according to the *Standard Drawings*.

719.4 POST-CONSTRUCTION CONSIDERATIONS

Prior to acceptance, ensure that all weep holes have been plugged, where required. The Resident Construction Engineer will inspect the work with respect to quality of workmanship, location and dimension prior to final acceptance.

719.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

See Section 719 of the *Standard Specifications* for the method of measurement and basis of payment. Final field measurements of catch basins, drop inlets, manholes and similar items as constructed are to be recorded in the Daily Work Report and noted on the As-Built Plans. The notes should indicate the type and depth of structure and its location. The location of the item should be given in relation to the survey station number so that the work will be properly oriented.

Section 720
Concrete Curb, Gutter, Sidewalk, Driveway & Median

720.1 DESCRIPTION OF WORK

Incidental concrete construction includes the construction of concrete sidewalks, driveways, medians, curbs, gutters and curb and gutter. This work, like bridge structures and pavements, is viewed by the public, and the quality of workmanship and inspection is readily apparent from the lines, grades and appearance of the finishing. It is important that the work be constructed to proper line, grade and finish for appearance and proper drainage functioning. The material and construction requirements are defined in Section 720 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance with the requirements of the Contract Plans and Specifications.

720.2 PRECONSTRUCTION CONSIDERATIONS

720.2.1 Review of Plans and Adjacent Property

Before beginning sidewalk, curb or curb and gutter construction, the Contract Plans should be studied carefully. The elevations shown on the Contract Plans for these items should be verified.

When concrete curb and gutter is to be constructed on flat grades and at superelevated curves, the grades should be carefully studied to prevent a sag which will not drain properly. Where the new curb and gutter and sidewalk is higher than the existing property, provisions must be made for removal of any water impounded by the new construction. It may be necessary to make a grade adjustment if no other means of correcting the situation is available. The elevations of the proposed work may also be lower than the adjacent property. Where the grade is too low, field adjustments may be required.

In urban areas, the new construction usually requires that water meters, valves and other such devices be relocated. They are often installed in the grass plot or sidewalk area. Where the relocated work is placed within the new concrete work, the proper authorities should be contacted so that all adjustments may be made with as little inconvenience to the Contractor as possible. The Contract Plans, as well as the adjacent building structures, should be studied for any downspouts from roofs that should tie into the new work. This can usually be taken care of by running a small pipe under the sidewalk and through the curb or by connecting the downspout to a storm drain.

720.2.2 Utilities and Staking

Check that the line and grade have been staked in accordance with the Contract Plans and any needed field adjustments. Pay particular attention to compliance of the location of accessible ramps for the disabled.

720.2.3 Materials and Equipment Considerations

Verify that all materials to be used (e.g., cement, aggregates, admixtures, reinforcing steel, source of water, joint material, curing compound) comply with the requirements of the Contract. See Section 701 for information on Portland cement and Portland cement concrete materials, production and delivery. See Section 703 for information on reinforcing steel. Sampling and testing is discussed in Section 106. Use SCDOT Form 700.03 – Concrete Pre-Pour Checklist for Non-Bridge and Non-Culvert Items. The concrete class for this work will generally be Class 2500. Slump and air content are required to be checked when test cylinders are made and when a problem is observed. The results of the slump and air tests should be recorded on the concrete delivery ticket. Verify that the Contractor is adequately prepared to protect the concrete from rain and extreme hot or cold temperature, when necessary.

720.2.4 Subgrade

Section 720 of the *Standard Specifications* does not always require that the subgrade be compacted to a specific density, but does state that the subgrade should be thoroughly compacted. In areas where it is impractical for rollers to operate, mechanical tampers are very helpful in obtaining thorough compaction. The subgrade should be left slightly high until the forms are placed so that the concrete will not be placed on a new layer of fill material. After placement of the forms, the subgrade can then be graded down to the required grade. Subgrade should be moist at the time of placing the concrete so as to prevent the subgrade from absorbing water from the concrete. Before placement of the concrete, check the subgrade, form widths and alignment to ensure that the area of the typical section and alignment are being complied with.

720.2.5 Forms

Verify compliance of the grade, alignment and condition of the forms. Do not allow the Contractor to use forms that will produce objectionable results. Ensure that forms are clean and are properly oiled. Prior to concrete placement, the Resident Construction Engineer is required to approve the line and grade of the forms.

720.3 INSPECTION DURING CONSTRUCTION

See Section 702 for information on concrete work. Verify that expansion joints have been properly placed and checked. Ensure that the proper number of joints and joint material are placed at the proper location, line and grade. Do not permit curb sections of less than 4 feet in length. Verify that the concrete is being placed in the forms in such a manner as not to disturb

or cause the forms to be moved out of line or grade. Verify that the concrete is being discharged from the truck within the specified time limit. Verify compliance of the floating, shaping and troweling of the concrete, the proper tooling of joints and the concrete finish.

Side forms are usually removed after the concrete has set sufficiently. Verify that forms are removed at the proper time. Once removed, ensure that the Contractor patches honeycombed areas. Upon removal of the forms and completion of any rubbing or necessary pointing up, the exposed surfaces are to be immediately sprayed with curing compound. When the forms remain in place for a period exceeding 72 hours it will not be necessary to cure the sides.

The Contractor may cure the concrete in several different manners. However, curing compound is commonly used. Curing compound is applied as a liquid spray which is used as a waterproof coating on the surface and prevents moisture from evaporating from the concrete. Moisture is necessary to the curing process of Portland cement concrete. When sufficient moisture is not present, little or no improvement in strength or quality of the concrete is obtained. Section 720 of the *Standard Specifications* requires that the curing compound be white-pigmented. This serves a two-fold purpose. The white-pigmented type reflects radiant heat from the sun, which results in less of an increase in temperature within the concrete throughout the curing period. Also, with the use of the white-pigmented type, it is possible to detect non-uniform application by visual inspection provided the pigment has been uniformly mixed in the liquid at the time of application.

The SCDOT Inspector should determine the approximate area of concrete to be cured and require the Contractor to spray the required quantity of uniformly mixed curing membrane on the area. During windy conditions, it may be necessary to apply additional curing compound material. The SCDOT Inspector should become thoroughly familiar with the appearance of a properly sprayed surface as a guide for inspecting the curing requirements. The curing compound must be applied immediately after the final finishing; however, should a water sheen be on the surface, the application of the curing material should be delayed until the water has disappeared.

720.4 POST-CONSTRUCTION CONSIDERATIONS

The Resident Construction Engineer will inspect the work with respect to quality of workmanship, location and dimension prior to final acceptance.

720.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The SCDOT Inspector should keep a daily record of the incidental concrete construction items poured each day. Where possible the location of the work should always be identified by station numbers. Field measurements of the work as constructed are to be recorded in the Daily Work Report. These notes will be retained by the Resident Construction Engineer. The notes should indicate the lengths, widths, etc., and the location of the completed work so that a pay quantity can be correctly computed. The location of the item should be given in relation to the survey station number so that the work will be properly oriented. See Section 720 of the *Standard Specifications* for information on the method of measurement and basis of payment.

Section 721
Asphalt Curb

721.1 DESCRIPTION OF WORK

The material and construction requirements for asphalt curb are defined in Section 721 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer and SCDOT Inspectors will be responsible for ensuring compliance with the requirements of the Contract Plans and Specifications.

721.2 PRECONSTRUCTION CONSIDERATIONS

The materials used for asphalt curb will be Surface Course as defined in Section 403 of the Standard Specifications. Verify that the proper mixture is used for the project. See Section 401 for information on materials, production, hauling, placement and compaction requirements for HMA. Verify that the location and layout have been staked according to the Contract Plans. Pay attention to compliance of drainage requirements.

721.3 INSPECTION DURING CONSTRUCTION

If specified in the Contract, verify compliance of painting and sealing. If placed directly on the subgrade, verify that the soil has been compacted and graded properly. If placed on existing pavement, ensure that the surface has been properly cleaned. Verify the proper application of asphalt tack coat. Verify that the curb is being backfilled properly without damaging the curb.

721.4 POST-CONSTRUCTION CONSIDERATIONS

The Resident Construction Engineer will inspect the work with respect to quality of workmanship, location and dimension prior to final acceptance.

721.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The method of measurement and basis of payment will be as defined in Section 721 of the Standard Specifications. Record all measurements and field notes in the Daily Work Report.

Section 722
Precast Concrete Box Culverts

Precast concrete box culverts are governed by the requirements of Section 722 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions. When specified, the Resident Construction Engineer will be responsible for ensuring that the work and materials are in compliance with the requirements of the Contract Plans and Specifications. See Section 714 for additional guidance on inspecting the work and materials related to precast concrete box culverts.

Section 723
Deck Joint Strip Seal

723.1 DESCRIPTION OF WORK

Where deck joint strip seal is designated for a bridge deck, the Resident Construction Engineer will be responsible for verifying that the Contractor furnishes and installs the expansion joint in accordance with the requirements of the approved Shop Plans and the Contract Plans and Specifications. Expansion joint devices must not allow water to seep through the deck.

723.2 PRECONSTRUCTION CONSIDERATIONS

Prior to fabrication, the Contractor will submit Shop Plans to the designer of record (see Section 725). Verify that the Shop Plans have been accepted. Review the Shop Plans, the manufacturer's brochure and the Contract Plans and Specifications. The fabricator will notify the Research and Materials Engineer prior to fabrication. Pay attention to the dimension table establishing the joint opening at variable temperatures, the treatment of direction changes, field splicing and anchoring details. Verify that the joints delivered are supplied from a manufacturer that has been pre-approved by the Research and Materials Engineer. Ensure painting requirements are met. Obtain from the Contractor and copy the Research and Materials Engineer the manufacturer's certification and certified test results, indicating compliance with specified criteria. Verify compliance of the lubricant/adhesive for bonding the seal to the steel elements, the studs used in the anchorage system and the straps used for erection purposes. Contact the Bridge Construction Engineer for any needed assistance. Verify that the Contractor has submitted any required field welding procedures for review and that the plates are welded together with the specified butt weld. Welders must be certified for the type of welding required, as listed on SCDOT Approval Sheet 41. Ensure that the Contractor has notified the manufacturer's representative 2 weeks prior to installation, if required. After the second concrete pour, any steel supports, such as bolts or straps holding the two sections together, must be cut or removed before the next day.

723.3 INSPECTION DURING CONSTRUCTION

Check the joint opening for proper alignment, grade and dimensions and that the opening has been properly cleaned and prepared. During the installation of the first expansion joint, verify that the manufacturer's representative is on-site to assist in verifying proper installation, if required. Pay attention to the manufacturer's comments and recommendations and apply the guidance received during subsequent inspections. Check for the proper installation of all steel components, studs, straps and hardware. The Contractor will set the joint opening in accordance with the temperature chart. Verify that the device is properly set, supported, and secured. Verify that steel surfaces are cleaned and painted as specified and that the lubricant/adhesive material is applied as recommended by the manufacturer. Monitor the installation of the elastomeric strip for acceptability. Protrusions above the deck surface are not permitted when the joint is closed. A clearance of 0.375 inch to 0.5 inch is recommended. Do not permit the strip to be spliced. It must be installed in one continuous length.

723.4 POST-CONSTRUCTION CONSIDERATIONS

Prior to acceptance, check that the opening of the expansion joint has been properly set and that the elastomeric material will not protrude above the deck surface once the joint is closed. See Section 723.3 for recommended clearance criteria. Test the joint for evidence of water seepage. If the test fails, require immediate correction, and retest the joint. The joint must be watertight. Final acceptance is the responsibility of the Resident Construction Engineer. Contact the Bridge Construction Engineer for any needed assistance.

723.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Joint deck strip seal will be measured by the unit length installed and accepted. Payment will be made based on the Contract unit price. Document all measurements and field notes in the Daily Work Report. Retain all materials certifications, delivery tickets and similar documentation.

Section 724
Elastomeric Bearings

724.1 DESCRIPTION OF WORK

Elastomeric bearing devices are used in structures to allow movement (i.e., longitudinal, transverse, rotational) due to such factors as temperature change, post tensioning and girder rotation. Where installed, the Resident Construction Engineer will be responsible for verifying that the Contractor's work and materials are in compliance with the Contract Plans and Specifications.

724.2 PRECONSTRUCTION CONSIDERATIONS

Review the Contract Plans and Specifications. Elastomeric bearings will be either plain (i.e., consisting of elastomer only) or laminated (i.e., consisting of alternating individual layers of elastomer and internal steel laminates). Verify that the elastomeric bearings delivered are of type required and ensure they are supplied from a manufacturer listed on SCDOT Approval Sheet 24. For each elastomeric bearing delivered, obtain from the Contractor and copy the Research and Materials Engineer the manufacturer's certification and certified tests results, indicating compliance with specified criteria. Ensure compliance of results of the required acceptance tests.

724.3 INSPECTION DURING CONSTRUCTION

Elastomeric bearings will be placed directly on the concrete surface. Check to ensure that the concrete surface and bearing seat are within tolerance of the required elevation. Verify that the concrete surface is clean and free of cracks. Verify compliance of nut tightening and thread burring. Where sole plates are to be installed, ensure they are attached properly with respect to alignment with anchor bolts. Verify that sole plates are positioned to the correct grade and superelevation and are in full contact with the bottom flange of the girder. Check bearing alignment for compliance. Verify proper adjustment for temperature. Watch for interference between anchor bolts and the upper part of the bearing device. Pay attention to elastomer damage due to welding in the vicinity of the bearing. Field welding must be performed as shown on the Contract Plans. The welder must be certified for the type of welding to be performed, as listed on SCDOT Approval Sheet 41.

724.4 POST-CONSTRUCTION CONSIDERATIONS

Check the tolerance of the alignment of the bearing and sole plate. Final acceptance is the responsibility of the Resident Construction Engineer.

724.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

Elastomeric bearings will be measured by the number of units installed and accepted. Payment will be made based on the Contract unit price. Document all measurements and field notes in the Daily Work Report. Retain all materials certifications, delivery tickets and similar documentation.

Section 725
Shop Plans and Working Drawings for Structures

Shop Plans and As-Fabricated Drawings will be required for fabricated items that will remain a permanent part of the structure, such as structural steel members, expansion joints, bearings, stay-in-place bridge deck forms, prestressed and post-tensioned concrete beams and girders and prestressed concrete piling. Working Drawings will be required for construction falsework and temporary structures, which will include allowable stresses, working loads, load capacity of support elements and design calculations and specifications. Section 725 of the *Standard Specifications*, including applicable Supplemental Specifications and Special Provisions, will govern the requirements of Shop Plans and Working Drawings, including plan size, content, number of sets, distribution and timing of submittal. Submittal requirements and coordination will be discussed at the Preconstruction Conference. Although the designer of record will review submittals for completeness, design integrity and compliance with Contract requirements is the responsibility of the Contractor. The Resident Construction Engineer will receive copies of all submittals. During construction, verify that Contractor complies with the requirements of the Shop Plans and Working Drawings. This work associated with the preparation of Shop Plans and Working Drawings for structures will not be measured and paid for separately, but will be included in other pay items in the Contract.

Section 726
Bridge Deck Rehabilitation

726.1 DESCRIPTION OF WORK

Bridge deck rehabilitation will be governed by the provisions of Section 726 of the *Standard Specifications*. In general, the Contractor will be responsible for removing deteriorated concrete, patching (i.e., full or partial depth patching), preparing the surface and placing, curing and finishing either a low-slump or latex-modified Portland cement concrete overlay. The Resident Construction Engineer will be responsible for verifying that the work and materials comply with the requirements of the Contract Plans and Specifications.

726.2 PRECONSTRUCTION CONSIDERATIONS

Ensure that the Research and Materials Engineer has been notified and provided the Mix Design for review at least 14 days prior to the work. All materials used for the overlay must be approved prior to use. See Section 701 and 702 for information on Portland cement, Portland Cement concrete and materials and construction requirements for concrete work for structures. Verify that the epoxy cement is of the proper type and properly stored. For acceptance, obtain the letter of certification from the manufacturer indicating that the epoxy cement complies with the Contract Specifications. If suspected, obtain separate unopened, one-quart samples of each component in each Lot or shipment and forward them and the certification to the Research and Materials Laboratory for testing. Do not permit the material to be used until notified of compliance. Check compliance of the gradation of sand for the epoxy-sand slurry mixture and the sand for the grout-bond coat, as appropriate. Ensure that the latex material is supplied from a source listed on SCDOT Approval Sheet 12.

726.3 INSPECTION DURING CONSTRUCTION

For latex concrete or Portland cement concrete overlays, verify that the machine preparation of the existing deck is properly performed and that all unsound concrete is removed. Ensure that joints are rehabilitated, as specified. Ensure that areas requiring partial- or full-depth patching are properly treated. After patching, verify that the machine prepared deck is cleaned of debris. Verify the proper application of the grout bond coat and the proper mixing, placing and consolidating of the concrete overlay mixture. Check compliance of the surface finish, texture and curing method and period. Ensure that joints and cracks are properly sealed. Verify the proper application of the epoxy-sand slurry and the sawing of textured grooves, if specified.

726.4 POST-CONSTRUCTION CONSIDERATIONS

The Resident Construction Engineer will inspect the work with respect to quality of workmanship prior to final acceptance.

726.5 DOCUMENTATION AND PAYMENT CONSIDERATIONS

The method of measurement and basis of payment will be as defined in Section 726 of the *Standard Specifications*. Record all measurements and field notes in the Daily Work Report. Retain Mill Test Reports, delivery tickets and other similar documentation.