

# **CSX BRIDGE Z270.19 OVER I-85**

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It is South Carolina Department of Transportation's intent that this project shall be constructed generally in accordance with the 2007 South Carolina Department of Transportation Specifications for Road and Bridge Construction (SCDOT Standard Specifications). There are cases where SCDOT has chosen to modify these specifications for the purposes of this project. The following provides Technical Specifications for such work.

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### **TECHNICAL SPECIFICATIONS**

| <u>Project Spec. No.</u> | <u>Description</u>                |
|--------------------------|-----------------------------------|
| 000110                   | EROSION CONTROL                   |
| 000115                   | TEMPORARY SHORING                 |
| 000130                   | CAST-IN-PLACE CONCRETE            |
| 000131                   | CONCRETE FOR STRUCTURES – 4000DS  |
| 000135                   | CONCRETE REINFORCING BARS         |
| 000155                   | WALL 3 (SOIL NAIL RETAINING WALL) |
| 000190                   | STRUCTURAL STEEL                  |
| 000195                   | BEARINGS AND ANCHORAGE            |
| 000205                   | HANDRAIL                          |
| 000250                   | SUBBALLAST                        |
| 000260                   | MONITORING STRUCTURES             |
| 000270                   | DEWATERING                        |

## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A. This work includes placement, maintenance, and later removal, of sedimentation, dust, and erosion control facilities that are shown on the plans, permits, and/or are required by federal, state, and local agencies. This includes but is not limited to the following items: construction ingress/egress; water quality monitoring and sampling; temporary ditch checks; and straw bale barriers.

### **1.2 SUBMITTALS**

- A. CONTRACTOR must follow the provisions of the approved plan that is included in the plans. Sediment and erosion control plans including, a construction schedule for erosion control, shall be submitted to ENGINEER for review and approval before any work is begun.

### **1.3 MEASUREMENT AND PAYMENT**

- A. Measurement for the item EROSION CONTROL shall be by the lump sum.
- B. Payment for the item EROSION CONTROL will be made at the lump sum price bid. Payment shall be full compensation for all necessary labor, materials, hardware, excavation, backfill, and incidental expenses.

| Item Number | Item Description | Unit |
|-------------|------------------|------|
| 000110      | Erosion Control  | LS   |

## **PART 2 - PRODUCTS**

### **2.1 MATERIAL**

- A. Rock used for the construction of check dams and rock filters shall be submitted to ENGINEER for approval.
- B. Rock used for the facing of the rock filters and sediment traps shall be submitted to ENGINEER for approval.

## **PART 3 - EXECUTION**

### **3.1 EROSION CONTROL**

- A. CONTRACTOR shall control erosion by planning and scheduling construction operations carefully.
- B. CONTRACTOR shall construct the permanent drainage structures as soon as possible during the progress of the grading work. CONTRACTOR shall coordinate erosion and sedimentation control measures with the final system so as to achieve an economical, continuous and effective erosion and sedimentation control program.
- C. Methods and measures of erosion control shall be applied to erodible materials exposed during the progress of the work. Erodible areas where work has been suspended shall be stabilized to protect against erosion until the final erosion control methods and measures have been applied.
- D. Methods and measures shall include, but not be limited to, berms, dikes, dams, sediment basins, sediment traps, filters, fiber mats, netting, gravel or crushed stone, mulch, grass, slope drains, seeding, etc.

- E. Unless otherwise provided, all roadbed slopes shall be prepared, fertilized, seeded and mulched to produce a stand of erosion protection grass of an annual variety. In addition to permanent seeding and mulching, the contractor will be required to protect temporary or intermediate slopes within 30 days or time period required by the Environmental permitting of exposing the earth, as designated by the ENGINEER, from erosion by temporary seeding or as required by the environmental permitting.
- F. All work and materials shall be in accordance with the applicable Specifications of the local State Department of Transportation, for the soil, the area and the planting season. The CONTRACTOR shall confer with the proper Department of Transportation authority on the subject and shall follow its recommendations.
- G. The Contractor shall be responsible for the proper maintenance of the seeded areas during the period when the grass is being established and providing a satisfactory cover. The maintenance of grass shall begin immediately upon completion of any portion of the grassing and shall extend until the desired cover is established. A satisfactory stand is defined as a cover of living grass in which gaps larger than 18 inches in diameter do not occur at the time of acceptance by the ENGINEER.

### 3.2 DUST CONTROL

- A. CONTRACTOR shall pay for and apply all the necessary methods to control dust on the job site. Dust control is applicable in all areas of excavation, roadways (temporary and permanent) and all other areas within the limits of the work.
- B. CONTRACTOR will be held responsible for all suits or damage arising from dust.
- C. Execution: CONTRACTOR shall control dust by sprinkling all dust prone surfaces with water or suitable chemicals and in compliance with all local ordinances.
- D. CONTRACTOR will be required to maintain all haul roads, permanent access roads, and all other work areas within or without the project boundaries free from dust which would cause the standards for air pollution applicable to the project area to be exceeded or which would cause a hazard or nuisance to others. Approved temporary methods of stabilization consisting of sprinkling, chemical treatment or similar methods will be permitted to control dust. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and CONTRACTOR must have sufficient competent equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs. No separate or direct payment will be made for dust control, and the cost thereof shall be considered incidental to and included in the contract prices for excavation and embankments.

### 3.3 ENVIRONMENTAL PROTECTION

- A. The work covered under this subsection consists of furnishing all labor, materials and equipment and performing all work required for the prevention of environmental pollution during and as a result of construction operations under the contract. For the purpose of this specification, environmental pollution is defined as the presence of chemical, physical or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balance of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and recreational purposes. The control of environmental pollution requires consideration of air, water and land, and involves noise, solid waste management and management of radiant energy and radioactive materials, as well as other pollutants.
- B. In order to prevent and to provide for abatement and control of all environmental pollution arising from the construction activities of CONTRACTOR, CONTRACTOR shall comply with all applicable federal, state and local law, and regulations concerning environmental pollution control and abatement, and all applicable provisions of the Corps of Engineers' manual, EM 385-1-1, entitled General Safety Requirements, in effect on the date of solicitation, as well as the specific requirements stated elsewhere in the contract specifications.

- C. ENGINEER will notify CONTRACTOR in writing of all non-compliance with the foregoing provisions and the action to be taken. CONTRACTOR shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to CONTRACTOR or its authorized representative at the site of the work, shall be deemed sufficient for the purpose. If CONTRACTOR fails or refuses to comply promptly, ENGINEER may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made subject of a claim for extension of time or for excess costs or damages by CONTRACTOR unless it was later determined that CONTRACTOR was in compliance.
- D. Compliance with the provisions of this section by subcontractors shall be the responsibility of CONTRACTOR.
- E. Prior to commencement of the work, CONTRACTOR will:
1. Submit in writing its proposals for implementing this section for environmental pollution control.
  2. Meet with ENGINEER to develop mutual understandings relative to compliance with this provision and administration of the environmental pollution control program.
- F. Location of Construction Facilities: The location on company property of CONTRACTOR's storage and other construction buildings, required temporarily in the performance of the work, shall require written approval of ENGINEER. The preservation of the landscape shall be an imperative consideration in the selection of the site and in the construction of buildings. Plans showing storage and other construction facilities shall be submitted for the approval of ENGINEER.
- G. Protection of water resources:
1. CONTRACTOR shall not pollute any waterway with fuel, oils, bitumen, calcium chloride, acids or harmful materials. It is the responsibility of CONTRACTOR to investigate and comply with all applicable federal, state, county and municipal laws concerning pollution of rivers and streams. All work under this contract shall be performed in such a manner that objectionable conditions will not be created in streams through or adjacent to the project area.
  2. At all times of the year, special measures shall be taken to prevent chemicals, fuels, oils, greases, bituminous materials, waste washings, herbicides and insecticides, and cement and surface drainage from entering public waters.
  3. Disposal of all materials, wastes, effluents, trash, garbage, oil, grease, chemicals, etc., in areas adjacent to streams shall be subject to all Federal, state and local guidelines. If any waste material is dumped in unauthorized areas, CONTRACTOR shall remove the material and restore the area to the condition of the adjacent undisturbed area. If necessary, contaminated ground shall be excavated, disposed and replaced with suitable fill material, compacted and finished with topsoil, all at the expense of CONTRACTOR.

### 3.4 QUALITY ASSURANCE

- A. Structural methods shall conform to the publication "Standards and Specifications for Erosion and Sediment Control in Developing Areas", Soil Conservation Service, U. S. Department of Agriculture.
- B. The amount of clearing, grubbing, and grading shall be limited to the amount which can be effectively controlled by CONTRACTOR's proposed erosion control program.

**END OF SECTION 000110**

## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A. Due to the potential for construction adjacent to existing structures, temporary shoring systems shall be implemented as required. The Contractor shall account for the effects of installation and removal of temporary shoring on nearby structures including an appropriate monitoring program to measure movement of the existing bridge foundations. The monitoring program and acceptable movement thresholds shall be determined in accordance with CSX requirements. See Special Provision 000260 Monitoring Structures.

### **1.2 GENERAL**

- A. Temporary shoring that experiences live load surcharge from vehicular traffic shall be designed in accordance with SCDOT Standard Specifications and Special Provision 34 of Exhibit 5.
- B. Temporary shoring that experiences live load surcharge from rail traffic shall be designed according to AREMA Chapter 8 Part 28.

### **1.3 MEASUREMENT AND PAYMENT**

- A. Payment for the accepted temporary shoring system, as specified herein, measured in accordance with this specification, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for the Department's acceptance of the Temporary Shoring installation, maintenance and removal as required in the Plans and Project Specifications.

The Department will pay for the accepted quantities at the contract prices as follows:

| Item    | Description       | Unit |
|---------|-------------------|------|
| 2047000 | TEMPORARY SHORING | EA   |

## **PART 2 - MATERIAL (NOT USED, SEE PART 1)**

## **PART 3 - EXECUTION (NOT USED, SEE PART 1)**

**END OF SECTION 000115**

## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A.** This Section includes:
  - 1. Cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B.** Contractor: The Contractor shall furnish all labor, tools, equipment and material necessary for the manufacture, forming, transporting, placing, finishing and curing concrete in accordance with the Plans and as specified herein.
- C.** Where cast-in-place concrete work is performed in close proximity to railroad operations, all cast-in-place concrete work shall be conducted so as not to interfere with, interrupt, or endanger the operations of trains or damage, destroy, or endanger the integrity of railroad facilities.

### **1.2 SUBMITTALS**

- A.** Submittals: The Contractor shall prepare and deliver technical submittals for review and approval of the Engineer. All submittals must be approved before related work may begin. Listed below are submittals required for this item of work, additional submittals may be required due to site conditions or the nature of the work. In order to maintain correspondence records each submittal shall be assigned a submittal number and transmittal number for use by the Contractor and the Engineer.
- B.** Product Data: For each type of product, including the ready-mix concrete and re-bar manufacturer.
- C.** Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D.** Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- E.** Form and Formwork Design: Formwork Drawings that detail fabrication, materials and placement, including design calculations for above grade forms with bracing and backstop anchors identified and detailed.
- F.** Submittal Review: Approval by the Engineer is only for the purpose of confirming compliance with the Contract Plan and Specifications. Approval shall not relieve the Contractor from responsibility for correctness, quantity and quality, nor for completeness of work in accordance with the plans and specifications.
- G.** Material and Mill Certificates: For each of the following, signed by manufacturers:
  - 1. Cementitious materials.
  - 2. Admixtures.
  - 3. Form materials and form-release agents.
  - 4. Steel reinforcement and accessories.
  - 5. Bonding agents.
  - 6. Color admixtures for red concrete.
- H.** Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

**I. Field quality-control reports.**

**1.3 QUALITY ASSURANCE**

- A. Installer Qualifications:** A qualified installer with a minimum of 5 years experience performing work of similar size, scope and complexity in Texas.
- B. Manufacturer Qualifications:** A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- C. Testing Agency Qualifications:** An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- D. Red Color Admixture:** The quality of the red color admixture for concrete encasement of electrical duct banks shall be evaluated by the Engineer during the initial placement of colored concrete. Based on the Engineer's evaluation, the Contractor shall make required adjustments to the colored concrete mix design.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Steel Reinforcement:** Deliver, store, and handle steel reinforcement to prevent bending and damage.

**1.5 FIELD CONDITIONS**

- A. Cold-Weather Placement:** Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement:** Comply with ACI 301 and as follows:
  1. Maintain concrete temperature below 90 degrees F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

**1.6 MEASUREMENT OF PAYMENT**

**A. Methods of Measurement**

1. Measurement of CAST-IN-PLACE CONCRETE, as shown on the drawings, as specified in this Section and as accepted in the final work, shall be on a cubic yard (CY) basis. This measurement shall be based on the volume to the nearest one-tenth (1/10) cubic yard in place, computed from the neat line dimensions and within the payment limits shown on the Plans. The volume of the embedment of the concrete piles will be deducted. No deductions will be made for rounded or beveled edges or volume occupied by reinforcing bars, anchor bolts or other embedded metal.

**B. Basis of Payment**

1. Payment of CAST-IN-PLACE CONCRETE, measured as stated above, will be at the contract unit price per cubic yard bid. Said unit price shall be full compensation for furnishing all labor, materials, tools, equipment, forms, supplies, accessories, supervision, engineering and all other items of expense to furnish, place and cure the substructure concrete.

| Item Number | Item Description       | Unit |
|-------------|------------------------|------|
| 000130      | Cast-in-Place Concrete | CY   |

**PART 2 - MATERIAL****2.1 CONCRETE, GENERAL**

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301
2. ACI 117

**2.2 FORM-FACING MATERIALS**

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
1. Plywood, metal, or other approved panel materials.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- C. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

**2.3 STEEL REINFORCEMENT**

- A. Reinforcing Bars: ASTM A 706, Grade 60, deformed bars of new billet steel.
- B. Welded Wire fabric shall conform to the requirements of ASTM A185.
- C. All reinforcement shall be protected, as far as practicable, from mechanical injury or surface deterioration from rusting or other cause. When placed in forms the reinforcement shall be free from dirt, scaly rust, loose mill scale, paint, oil, grease, and other foreign substances.
- D. Reinforcement shall be bent cold to conform accurately to the dimensions and shapes shown on the approved working drawings. Bends shall be made accurately in a suitable bending machine. Unless otherwise specifically approved by the Engineer, bars shall be shop bent before shipment and shall not be bent in the field.



## 2.4 CONCRETE MATERIALS:

- A. Cementitious Materials:** Portland Cement: ASTM C 150/C 150M, Type I, IA, or Type II The Contractor shall obtain and furnish to the Engineer a statement signed by an officer or chemist of the cement manufacturer, certifying that the cement furnished does not exceed 0.6 percent alkali equivalent, as measured by the percent of sodium oxide plus 0.658 times the percent of water potassium oxide.
- B. Normal-Weight Aggregates:** ASTM C 33/C 33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
1. **Course Aggregate:** Course aggregate shall be hard, durable, broken rock or gravel with a maximum coarse-aggregate size of 3/4 inch maximum.
  2. **Fine Aggregate:** Fine aggregate shall be coarse, sharp, hard strong durable natural sand free from adherent coating, and washed to remove clay, loam alkali, organic matter or other substances with deleterious reactivity to alkali in cement. Grading shall be in accordance with AREMA recommendations. The amount of clay or loam in the fine aggregate shall not exceed 1.5 percent by weight. Unless otherwise specified, all fine aggregate shall conform to the requirements of ASTM C33. Particular attention is directed to the requirements of testing for: Organic Impurities – ASTM Method C40, Soundness – ASTM Method C88, and Reactivity – ASTM Method C289. Fine aggregate considered potentially reactive by the Engineer shall not be used.
- C. Water:** ASTM C 94/C 94M and shall be potable, clean, clear, and free from oil, acid, alkali or vegetable matter and shall be obtained from a suitable source.
- D. Fly Ash:** Use of fly ash is prohibited in all material unless approved by the Engineer and it meets ASTM C618.
- E. Coloring Admixture:** Provide concentrated red pigment specially processed for mixing into concrete and complying with ASTM C979.
- F. Coarse Aggregate:** The Contractor shall furnish hard, durable, broken rock or gravel graded between the limits specified and conforming to the requirements prescribed in AREMA recommendations, for size number 67.

**NOTE: Use only aggregate No. 67 with a maximum aggregate size of 3/4" in drilled shafts.**

- G. Air-entraining Agent:** Air entraining agents conforming to the requirements of ASTM C260 shall be added to normal portland cement at the mixer for all concrete. The air-entraining agent used shall be a type which will control the entrainment of air within the limits specified, and shall be compatible with the cement used.
- H. Admixtures, except air-entraining agents, to be used to alter the normal properties of concrete, either densifying, cement dispersion, retarding, accelerating, plasticizing or coloring shall be used only upon the written permission of the Engineer. Acceptable evidence must be presented concerning the material proposed for use, showing that the material will perform in the manner claimed and that the strength, coloring, appearance and durability of the concrete will not be adversely affected. The water reducing admixture, when used in a trial batch in proportions recommended by the manufacturer and compared to a control trial batch using the same cement, aggregates, water and air-entraining agent without water-reducing admixtures, shall, when tested in accordance with ASTM standard methods:**
1. Reduce the required volume of water by at least 5 percent;
  2. Not reduce the 28-day cylinder strength;
  3. Not reduce the durability as measured by freezing and thawing tests to less than 95 percent that of the comparative control batch;
  4. Not corrode the reinforcing steel.

- I. Grout shall be approved non-shrink epoxy resin filled with clean silica sand (Grade 20-40), prepared exactly as directed by the manufacturer.
- J. Bonding compound shall be a two-component epoxy-resin system. The epoxy concrete adhesive shall conform to the requirements of ASTM C881, Type II, Grade 2, Class B or C. The class supplied shall be governed by the range of temperatures for which the material is to be used. The two-component adhesive shall be furnished by the manufacturer in containers individually marked to clearly identify each component. Packaging: The epoxy adhesive shall be packaged in a kit with each component in a separate container. The containers of each kit shall be filled with the adhesive components in exact mixing proportions and one container shall be large enough to mix both of the components. The size of the kit shall be the total volume of the mixed adhesive which shall be one gallon for five gallons as specified. The manufacturer shall supply mixing instructions. Prior to approval and use of the two-package adhesive materials, the Contractor shall submit a notarized certification by the formulator of these materials, stating that they meet the requirements as set forth herein.

## 2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: The water for use with cement in mortar or concrete shall be potable, clean, clear, and free from oil, acid, alkali or vegetable matter and shall be obtained from a suitable source.

## 2.6 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
  - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

## 2.7 CONCRETE MIXTURES FOR EQUIPMENT AND LIGHTPOLE FOUNDATIONS

- A. All Normal-weight Ready-Mixed concrete will have a minimum compressive strength of 4000 psi at 28 days, or as indicated on the plans.

## 2.8 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
  - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
  - 2. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## 2.10 HANDLING AND STORING MATERIALS

- A. Reinforcement shall be stored in racks in such a manner as to avoid contact with the ground. If reinforcement is to remain on the site for more than one month, it shall be covered to protect it from weather. If reinforcement

accumulates heavy rust, dirt, mud, loose scale, paint, oil or any other foreign substance during storage, it shall be cleaned before being used. Severe deterioration of this kind may be a basis for rejection.

## **PART 3 - EXECUTION**

### **3.1 FORMWORK INSTALLATION**

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
  - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Construct forms for easy removal without hammering or prying against concrete surfaces.
- F. Chamfer exterior corners and edges of permanently exposed concrete.
- G. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- H. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- I. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- J. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### **3.2 EMBEDDED ITEM INSTALLATION**

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

### **3.3 REMOVING AND REUSING FORMS**

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

### **3.4 STEEL REINFORCEMENT INSTALLATION**

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Splicing: Reinforcing bars shall be cut to the lengths indicated on the Plans or longer as approved by the Engineer. Splices which are permitted, unless otherwise shown on the Plans, shall be designed in accordance with applicable AREMA recommendations. Where practicable, the locations of the laps shall be staggered so the neighboring bars will not have adjacent laps.
- G. Placing: Reinforcement shall be placed accurately in the position indicated on the Plans and shall be firmly held in place during the deposition and vibration of the concrete. This shall be accomplished by fastening the bars at all intersections and splices by wires or approved clips, by the use of bars or other suitable spacers, or as otherwise approved by the Engineer. Suitable supports of approved number and character shall be used to support and retain the reinforcement in the locations required and at proper distances from the forms. If such supports are to be left in place in the concrete, they shall be of metal and all parts of such metal supports extending to within one inch of what will be an exposed concrete surface shall be galvanized.
- H. Grouting: Reinforcing bars grouted into existing concrete and / or masonry as shown on the Plans will be grouted using a 2-compound epoxy mixed with suitable mineral filler. The mineral filler shall be as recommended by the epoxy manufacturer. The method of mixing and application shall be as recommended by the manufacturer. Cost of grouting materials and cost of installation shall be considered as part of this item.

### 3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
  - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
  - 2. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

### 3.6 EXECUTION

- A. Proportions: The proportions of the materials for a workable mix of the required strength shall be determined by the Contractor in accordance with AREMA recommendations, and submitted to the Engineer for review. Review of the mix proportions shall not relieve the Contractor of his/her responsibility for producing concrete of the strength required throughout the work.
- B. Minimum strength: Structural concrete, which shall be used for all reinforced concrete, shall have minimum 28-day strength of 4,000 lbs. per square inch and shall contain a minimum of six (6) bags of cement per cubic yard of concrete.
- C. Entrained Air: Air content shall be 6 percent unless otherwise approved by the Engineer.
- D. Slump: Slump for substructure units shall be 3 inches and slump for the deck superstructure shall be 4 inches, as placed in forms unless otherwise approved by the Engineer.

- E. W/C Ratio:** Water – cement ratio shall be in accordance with AREMA recommendations.
- F. Modified Proportions:** Proportions are subject to modification by order of the Engineer. All solid materials shall be measured by weighing. Coarse aggregate and fine aggregate shall be weighed separately. Water shall be measured by weight or volume.
- G. Consistency:** The consistency of the concrete shall be kept as uniform as practicable.
- H. Sampling / Testing:** Unless otherwise provided in these specifications, methods of sampling and testing for all concrete materials and processes shall conform to the requirements of ASTM C39. The Contractor shall provide for all required laboratory tests of concrete aggregates and concrete test cylinders. The laboratory and the person(s) collecting specimens shall be ACI certified.
- I. Aggregate Samples:** At least three (3) weeks before the first concrete is scheduled to be placed, the Contractor shall deliver to a testing laboratory acceptable to the Engineer in the amounts specified, representative samples of fine and coarse aggregates taken directly from aggregate stockpiles proposed for use on the subject work. No concrete shall be placed in substructure units until approval of all aggregate samples is obtained from the Engineer. Additional aggregate samples may be required during the course of construction.
- J. Substitutions:** Certified copies of tests previously made on aggregates may be accepted by the Engineer in lieu of additional tests.
- K. Mill Certificate:** Mill certificates showing that cement meets specification requirements shall be furnished to the Engineer by the Contractor.
- L. Air / Slump Tests:** Air content and slump tests shall be made of the first batch mixed each day and as often thereafter as the Engineer considers necessary to maintain the uniformity of the concrete.
- M. Entrained Air Test:** The air content shall be determined by either the volumetric method, ASTM C173, or by the pressure method, ASTM C231, and shall be tested once for every fifty (50) cubic yards placed each day but at least twice daily. A tolerance of two (2) percent over or under the designated air content will be acceptable.
- N. Slump Test:** The slump test shall be performed in accordance with ASTM C143, “Slump of Hydraulic Cement Concrete”. Each slump determination shall be the average of three (3) tests made in a standard slump mold.
- O. Acceptance:** The Contractor shall provide the equipment and shall perform all concrete slump and entrained air tests required by the Engineer. Concrete that fails to meet the above specifications will be rejected and shall be removed from the site at the Contractor’s expense.
- P. Strength Test:** The “28-day Design Strength” of concrete, as herein used, refers to compression strength of concrete cylinders made and stored under moist curing conditions at approximately seventy (70) degrees F. according to ASTM C31, and tested in accordance with ASTM C39.
- Q. Strength Sampling:** The Contractor shall provide the molds and equipment and shall make 6” x 12” concrete test cylinders for determining strengths of the concrete used in the construction, shall cure the test cylinders as specified, and shall deliver them at proper times for 7-day and 28-day tests to a testing laboratory acceptable to the Engineer. In general, a set of four (4) cylinders will be made for each pour (1 – 7 day; 2 – 28 day; 1 – spare). In any case, the Engineer may require a greater or lesser number of cylinders be made at any time. Separate compensation for making, curing, delivering and testing concrete test cylinders will not be made.
- R. Records:** Written records of all concrete tests shall be kept by the Contractor and delivered to the Engineer in a timely manner.
- S. Date Marks and Location:** The Contractor shall cast the date of construction in figures and letters, of approved size and character, at an approved location in the face of the location (e.g. abutment, pier, etc.) and the piers as directed by the Engineer. No direct payment will be made for casting such dates and numbers, and all costs in

connection therewith shall be considered as completely covered under payments made for the scheduled items of concrete.

### 3.7 MIXING CONCRETE

- A. General:** All concrete shall be mixed in mechanical mixers of an approved type. The mixer shall be operated at 1 ½ minutes after the last ingredient, including water, is deposited in the mixer. Batches shall be proportioned on the basis of integral bags of cement. The concrete mixer shall operate at the speed for which it has been designed but this speed shall not be less than fourteen (14) nor more than twenty (20) revolutions per minute. The entire contents of the mixer shall be removed from the drum before materials for the succeeding batch are deposited. Concrete shall be mixed in quantities required for immediate use and shall be deposited while fresh and before the initial set has taken place. Tempering or remixing, with or without additional cement, aggregate or water, will not be permitted for concrete or mortar which has partially hardened or reached its initial set. Hand mixing the concrete will not be allowed except in an emergency, and only with the special permission of the Engineer. When hand mixing is permitted, it shall be done on a watertight platform and in accordance with the direction of the Engineer. Concrete mixed in transit mixers will be acceptable, provided the foregoing requirements are met, and in addition, the mixer and the mixing conform to Sections B and C following.
- B. Truck Mixer:** The size of the batch shall not exceed the maximum rated capacity of the mixer as approved by the National Ready Mixed Concrete Association and as stamped in metal at a prominent place on the mixer. The mixer shall be watertight when closed, and shall be equipped with a discharge mechanism which permits the discharging of concrete without segregation. No additional water will be added at the job site without the Engineer's separate permission for each load. Furthermore, all concrete shall meet the slump requirements specified, and the Engineer will require additional slump tests if, in his/her opinion, it appears that excessive water has been added.
- C. Mixing:** Each batch of concrete shall be mixed for fifty (50) revolutions or more of the drum after all of the water has been added. The rate of rotation of the drum shall be that specified by the mixer manufacturer. Additional mixing shall be at the rate of rotation designated by the manufacturer as the agitating speed. The concrete shall be mixed at least thirty (30) seconds after arrival at destination and immediately before being discharged.

### 3.8 CONCRETE PLACEMENT

- A.** Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B.** Concrete shall be placed at such a time that finishing operations can be completed during daylight hours unless adequate lighting facilities are provided by the Contractor, and the Engineer's approval is given.
- C.** Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.
- D.** Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- E.** Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
  2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

- F.** Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  2. Maintain reinforcement in position on chairs during concrete placement.
  3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  4. Slope surfaces uniformly to drains where required.
  5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- G.** Concrete shall not be placed until the Engineer is satisfied that the rate of producing and placing concrete will be sufficient to complete the proposed pour and the finishing operations within the scheduled time, that experienced concrete finishers will be employed to perform all required finishing work, and that all necessary finishing tools and equipment are on hand at the site of the work and are in satisfactory condition for use.
- H.** Concrete shall be placed in the forms immediately after each mixing. If concrete cannot be placed in forms within sixty (60) minutes from the time water is first added to the mix, a retarding admixture may be added at time of mixing, provided the Engineer approves each such use in advance. The admixture must be used in strict accordance with the manufacturer's instructions. In no case shall concrete be used which does not reach its final position in the forms within ninety (90) minutes after the time that water is first added to the mix. The method and manner of placing shall be such as to avoid the possibility of segregation of the aggregates or the displacement of the reinforcement. Sufficient capacity of placing equipment and manpower shall be provided so that the work may be kept free from cold joints.
- I.** The use of long chutes for conveying concrete from the mixing plant to the forms will be permitted only on written authority from the Engineer. If chutes are allowed, and the quality of concrete as it reaches the forms or the methods of placing or working it therein are not satisfactory, the Contractor shall, upon orders from the Engineer, discontinue the use of chutes and re-equip his/her plant of placing the concrete in a satisfactory manner.
- J.** Troughs / Pipes: Troughs, pipes or short chutes used as aids in placing concrete shall be arranged and used in such a manner that the ingredients of the concrete are not separated. Where steep slopes are required, the chutes shall be equipped with baffle boards or shall be in short lengths that reverse the direction of movement. When pipes are used, they shall be kept full of concrete and their lower ends shall be kept buried in fresh concrete. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing them with water after each run. Water used for flushing shall be discharged clear of the concrete in place and waterways. Open troughs made of aluminum or aluminum lined will not be permitted. Concrete shall be deposited into the forms or onto the grade as near to its final position as practicable and in such a manner that the concrete will completely fill the forms, but will not bulge or distort the forms. The use of vibration as a method of moving concrete horizontally after placing will not be allowed. Wherever concrete is placed on a slope, placement shall begin at the lowest end of the slope and progress upward. Concrete contacting reinforcing steel or forms in descent shall not be deposited where the drop is greater than six (6) feet in unexposed work or three (3) feet in exposed works unless it is deposited through "elephant trunks" or pipes. Where "elephant trunks" or pipes are necessary, they shall be located at a maximum of 10-foot intervals.
- K.** Concrete Face: Special care shall be taken to work the coarser aggregate back from the face and to force the concrete under and around the reinforcement bars without displacing them. After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcement.

- L. Compaction:** Concrete shall be compacted by continuous working with suitable tools in a manner acceptable to the Engineer. All faces shall be well spaded and the mortar shall be flushed to the surface of the forms by continuous working with a concrete spading implement acceptable to the Engineer.
- M. Vibrators:** During placement of all concrete, the Contractor shall furnish power-driven vibratory tools of and approved character, which shall be thrust into the concrete and operated internally in accordance with the best accepted practice. Vibrators shall not be applied to forms or reinforcing steel. The vibrators shall operate at a minimum frequency of 4,500 impulses per minute. The number of vibrators in operation for the various parts of the structure and extent of operation shall meet the approval of the Engineer. Concrete shall be thoroughly and completely vibrated, not merely worked down to a horizontal surface. However, precautions should be taken not to over-vibrate to the point that segregation results.
- N. Defective:** The operation of depositing and compacting the concrete shall, in general, be conducted so as to form dense, impervious artificial stone of uniform texture which shall show smooth faces on exposed surfaces. If any section of concrete is found to be defective, it shall be removed or repaired as directed by the ACE – Structures or designee.
- O. Metalwork:** Wherever metalwork, other than reinforcing, such as embedded plates and anchor bolt assemblies, is required to be built into the concrete, such metalwork shall be accurately positioned and securely held in place during concrete placement. The concrete shall be deposited with care to prevent honeycomb or other defects in the concrete adjacent to the embedment. Where necessary, bolts and other parts shall be supported by accurate templates until the concrete has set.
- P. Construction joints:** Construction joints shall be placed as indicated on the Plans or as directed by the Engineer and shall be formed so as not to impair the strength or appearance of the structure. When the work of placing concrete is delayed until the concrete shall have taken its initial set, the point of stopping shall be deemed a construction joint. The method and manner of placing concrete shall be so regulated as to place all construction joints across regions of low shearing stress and in such location that they will be hidden from view to the greatest possible extent. The method and sequence of placing concrete shall be as specified herein for the particular type of construction involved.
- Q. Continuous placement:** Unless otherwise directed by the Engineer, placing of concrete shall continue regardless of weather conditions, and the Contractor shall be prepared to continue operations without cessation through months of winter weather, and to properly place and cure concrete during hot weather.
- R. Placement:** Concrete shall be placed in horizontal layers, the thickness of which generally shall not exceed ten (10) to twelve (12) inches. The placing of concrete shall be continuous until completion of the substructure unit. Construction joints in addition to those provided on the plans will not be allowed unless authorized by the Engineer. When it is necessary by reason of an emergency, to place less than a complete horizontal layer at one operation, such layer shall terminate in a vertical bulkhead. In any given layer, the separate batches shall follow each so closely that each one shall be placed and compacted before the preceding one has taken initial set, in order that the green concrete shall not be injured and that there shall be no line of separation between batches. Each layer of concrete shall have an amplitude of 3/8" to secure efficient bonding with the next layer above. A succeeding layer placed before the underlying layer has become set shall be compacted in a manner that will entirely break up and obliterate the tendency to produce a construction joint between the layers. Layers completing a day's work or placed just prior to temporarily discontinuing operations shall generally be cleaned of all objectionable material as soon as the surface has become sufficiently firm to retain its form. To avoid, as far as possible, visible joints upon exposed faces, the top of the concrete adjacent to the forms shall be finished by being smoothed with a plasterer's trowel. Horizontal layers so located as to produce a construction joint at a location where a "feather edge" might be produced in the succeeding layer, shall be so formed by inset formwork that the succeeding layer will end in a body of concrete having a thickness of not less than six (6) inches. Between levels of extreme low water and extreme high water as determined by the Engineer, water shall not come in direct contact with the concrete for a period of not less than 30 days. Water



shall not be allowed to come in contact with other concrete that will be in or exposed to water until it is hardened for at least four (4) days. Concrete may be deposited in water only when so approved by the Engineer.

- S. Concrete Finishing:** The upper surface of the piers and abutments which are not formed shall be given a float surface finish, except as noted below for bearing surfaces. The bearing seats on the caps and abutments shall be thoroughly worked and floated by hand with a wooden float to leave a fine, clean, smooth, sandy texture. Bearing areas shall be ground level. Top surfaces of substructure units, not covered by bearing pads, shall be sloped to drain as shown on the Plans.
- T. Curing Concrete:** All concrete, other than concrete below ground surface and not in forms, and except as elsewhere specified, shall be cured by keeping all surfaces continuously wet for a period of at least seven (7) days after pouring by frequent and thorough sprinkling of the concrete and forms. If the forms are removed within seven (7) days, the concrete shall be cured by providing approved protection from the sun with suitable canvas or burlap, or other satisfactory covering and keeping such covering and the concrete wet for the period specified. Whenever placing of concrete is discontinued, the concrete already placed shall be kept continuously wet by adequate sprinkling of the concrete and forms until concreting is resumed. Such sprinkling of the concrete, forms and coverings shall be adequate to keep the parts thoroughly soaked with water. During the curing, no parts of forms, concrete or coverings shall be permitted to become dry. The use of curing water, burlap, canvas, or other materials which discolor the concrete will not be permitted.
- U. Surface Repairs:** Immediately following the removal of forms, all fins and irregular projections shall be removed from all exposed surfaces. All metal devices used to tie the forms together and hold them in correct alignment and location shall be removed in such a manner that no metal shall remain within one inch of the surface of the concrete. The method of removal of such ties shall not cause injury to the surface of the concrete. The cavities produced by form ties, and all other holes, honeycomb spots, broken edges or corners, and other defects shall be thoroughly cleaned, saturated with water, and carefully pointed and trued with mortar consisting of cement and fine aggregate mixed in the proportions used in the concrete. The mortar used in the pointing shall be not more than one hour old. Surfaces which have been restored in this manner shall be kept moist for a period of 24 hours. A rubbed surface finish will not be required for formed surfaces, provided the concrete has a finished appearance from honeycomb and surface irregularities. In case any part of the exposed surface is honeycombed, the area affected, and as much more of the exposed surface as will be required to provide satisfactory finish appearance, must then be given a rubbed surface finish so that the rubbed area blends into the adjacent surface. The amount and extent of rubbing required will depend on the character of surface produced by the forms. In no case shall a cement paint or plaster be applied to the surface of the finished concrete.

### **3.9 COLD WEATHER CONCRETE**

- A. General:** When the atmosphere temperature is 40 degrees or lower, or is forecast to drop below that temperature within 24 hours of the time concrete is to be placed, special methods shall be used in producing, placing and protecting the concrete. The exact methods of placing, producing, protecting and curing concrete to be followed during all such cold weather work shall be specifically approved by the Engineer for each type of construction before concreting will be permitted to start. Notwithstanding such approval by the Engineer, the Contractor shall assume all risks connected with placing concrete under cold weather conditions prove unsatisfactory; it will be rejected and shall be removed and replaced with satisfactory concrete. No allowance shall be made for removing and replacing the defective concrete. In general, and unless otherwise directed by the Engineer, the methods of producing, placing and protecting the concrete in cold weather shall meet the requirements of Section B through D following. Also, refer to ACI 306.
- B. Production:** Adequate equipment for heating the concrete materials shall be provided. No ingredient that is frozen or contains ice shall be placed in the mixer. Concrete ingredients shall be heated to produce concrete having a temperature at time of delivery of not less than 50 degrees F nor greater than 70 degrees F. A temperature of 60 degrees F is preferred. Heating shall be accomplished by heating either the aggregates or the mixing water, or both.

When the water temperature is above 165 degrees F, the aggregate shall be premixed with the water for at least one (1) minute before cement is added. Cement shall not be mixed with water or aggregates having a temperature above 165 degrees F.

- C. Placing and Finishing: Concrete shall not come in contact with forms and equipment containing ice or snow. If required by the Engineer, the formed area shall be covered and an air temperature of 50 degrees F maintained for 24 hours on all surfaces against which the concrete is to be placed. During placing and finishing, the temperature of concrete shall be maintained between 50 degrees F and 70 degrees F.
- D. Protection: When freezing temperatures are forecast, facilities meeting the approval of the Engineer shall be provided, prior to beginning concrete placement, capable of maintaining the ambient air temperature at the surface of the concrete or forms at not less than 50 degrees F for five (5) days or 70 degrees F for three (3) days. Protective measures shall be maintained for at least four (4) days beyond the period specified above. During this period, the concrete temperature shall not be allowed to drop below 40 degrees F. Sudden cooling (in excess of 20 degrees F temperature change in any 24-hour period) of ambient air temperature at the surface of the concrete or forms will not be permitted.

### **3.10 HOT WEATHER CONCRETE**

- A. General: When the atmospheric temperature is 80 degrees F or higher, or is forecast to rise above that temperature within 24 hours of the time concrete is to be placed, special methods shall be used in producing, placing and protecting the concrete. The exact methods of placing, producing, protecting and curing concrete to be followed during all such hot weather work shall be specifically approved by the Engineer for each type of construction before concreting will be permitted to start. Notwithstanding such approval by the Engineer, the Contractor shall assume all risks connected with placing concrete under hot weather conditions proving unsatisfactory; it will be rejected and shall be removed and replaced with satisfactory concrete. No allowance shall be made for removing and replacing the defective concrete. In general, and unless otherwise directed by the Engineer, the methods of producing, placing and protecting the concrete in hot weather shall meet the requirements of Section B through D following. Also, refer to ACI 305.
- B. Production: Stockpiled aggregates shall be saturated and the surface shall be kept moist by intermittent sprinkling or continuous fog spray. Mixing water shall be kept cool by adequate protection of storage tanks and piping. Supply lines shall be shaded, insulated or buried. When necessary to produce and maintain concrete at an acceptable temperature, chopped or crushed ice shall be added directly into the mixer, up to the limit of 50% by weight of the total water required. Ice shall be added at a rate and in a manner that it will be completely melted during the mixing period. Chilled mixing water will be acceptable in lieu of chopped or crushed ice. Retarding admixtures may be used when and as approved by the Engineer.
- C. Placing and Finishing: The temperature of concrete when placed shall not exceed 75 degrees F. Forms and reinforcing shall be wet-down immediately before concrete is placed. Wetting down of areas around the work to cool the air and increase humidity is recommended.
- D. Protection: If, in the opinion of the Engineer, proper protection is not being provided, he/she may order concrete operations to be suspended until adequate protective measures are provided. Concrete shall be kept cool and moist during the specified curing period. When air temperature exceeds 90 degrees F and soon as practicable, without damage to the surface finish, all exposed concrete shall be kept continuously moist by means of fog sprays, wet burlap, cotton mats or other effective means.

### **3.11 FORMS AND FALSEWORK FOR CONCRETE**

- A. Strength: The Contractor shall provide falsework and forms adequate in strength to support the imposed loads safely and without excessive deformation or settlement. Working drawings of the formwork, falsework and erection plans, after having been certified and stamped by a registered Professional Engineer, shall be submitted to the Engineer for

review before concreting operations are begun. Forms and falsework shall be designed for minimum pressures from a fluid weight of 50 lbs. per square foot. In addition, forms for all substructures pier units are to be watertight.

- B. Surface:** Forms shall be adapted to the kind of surface required on the concrete; shall be substantially and tightly built so as to remain true to line and in position without bulging, sagging or other deformation. Forms shall be maintained in a manner that will prevent the formation of joints due to shrinkage of lumber.
- C. Chamfers / Bevels:** Chamfers or bevels on concrete members shall be formed by one of two methods. If the Plans call for a bevel having a dimension of the square side greater than four inches, it shall be formed with the same type of form lining used for adjacent forms. However, if the dimension required is less than four inches, the bevel shall be formed with a wooden, triangular 45 degree chamfer strip. The chamfer strip shall be shaped in a planing mill, shall be surfaced on all sides, and shall have uniform dimensions throughout its length.
- D. Edges / Corners:** Unless otherwise indicated on the Plans, all exposed concrete edges and corners which are sharper than 90 degrees shall be formed with a wooden chamfer strip, meeting the foregoing requirements, except that the dimensions of the square sides shall be not more than one (1) inch or less than  $\frac{3}{4}$  inch.
- E. Plywood Forms:** Forms for concrete surfaces which will be exposed to view shall be made of plywood not less than  $\frac{5}{8}$  inch thick or plywood lining on one-inch boards. Plywood forms or plywood-lined forms shall be sanded on the face adjacent to the concrete. Joints in plywood panels shall be carefully fitted to reduce form marks in the concrete to a minimum. Sections of forms to be reused on concrete exposed to view shall be thoroughly repaired, replacing any plywood that has warped or bulged. Offsets at abutting panels shall be eliminated by renailing and planing. Metal plates shall not be used for covering old form rod holes.
- F. Metal Forms:** Metal forms may be used, provided they are maintained in good condition, free from dents, deformities and misalignment, and provided the finished concrete surface is equivalent in appearance to that obtained through the use of plywood forms. If wood forms are used in combination with metal forms, the wood shall be treated in a manner which will produce a finished surface similar to that produced by the metal forms. Approval of the use of metal forms may be withdrawn at any time the above requirements are not met, and the work completed using wood forms. No additional payment will be made in the event the use of metal forms is disapproved.
- G. Steel Rods:** Steel rods shall be used for form ties. Rods may be embedded in the concrete, provided their ends are not closer to the surface than one (1) inch, and the holes left by removal nuts shall be filled and pointed. Mortar for pointing and filling holes shall have the same proportions of cement and sand as the concrete.
- H. Plywood Form Sealer:** All forms shall be thoroughly drenched with water immediately before the concrete is placed therein. Wooden forms for concrete exposed to view shall be sealed with a copolymer resin "Pre-Form", which shall meet the following criteria: Corp of Engineers CEGS-03300, Section 10.8 Form Coating, V.O.C. compliant, and 100% biodegradable. Submit technical datasheet to Engineer for compliance.
- I. Formwork Removal:** Before the removal of forms, concrete shall have attained sufficient strength to endure such removal without being damaged. Forms shall be removed carefully so that neither the forms nor the tools used in their removal will deface the concrete. Unless noted otherwise or as directed by the Engineer, falsework shall not be removed until such time as the concrete supported by it is able to sustain itself and any load that is likely to come upon it with absolute safety to the concrete. In general, side forms carrying no loads may be removed after 24 hours to facilitate concrete. In all cases, the Contractor is responsible for and must repair at his/her own expense, any damage arising from inadequate forms or falsework, or from the premature removal of same.
- J. Formwork Payment:** No special payment shall be made for forms and falsework, but the cost thereof shall be included in the unit price of the individual concrete bid items.

### **3.12 FINISHING FORMED SURFACES**

- A. Rough-Formed Finish:** As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

- B. Related Unformed Surfaces:** At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### **3.13 FINISHING EQUIPMENT SLABS**

- A. General:** Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish:** Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
- C. Broom Finish:** Apply a broom finish to exterior concrete equipment foundations, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

### **3.14 MISCELLANEOUS CONCRETE ITEM INSTALLATION**

- A. Equipment Bases and Foundations:**
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
  2. Minimum Compressive Strength: 4000 psi at 28 days.
  3. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

### **3.15 CONCRETE PROTECTING AND CURING**

- A. General:** Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Formed Surfaces:** Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.
- C. Unformed Surfaces:** Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:**
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

### **3.16 CONCRETE SURFACE REPAIRS**

- A. Defective Concrete:** Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

- B. Patching Mortar:** Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces:** Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
- D. Repairing Unformed Surfaces:** Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  2. After concrete has cured at least 14 days, correct high areas by grinding.
  3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

### **3.17 FIELD QUALITY CONTROL**

**A. Inspections:**

1. Steel reinforcement placement.
2. Verification of use of required concrete design mixture.

**B. Concrete Compressive Strength:**

1. Submit previous satisfactory test data to the Engineer showing that the proposed mix design conforms to this Specification.

**END OF SECTION 000130**

## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A. This section contains specifications for the materials, equipment, construction, measurement, and payment for CONCRETE FOR STRUCTURES – CLASS 4000DS in conformity with the Plans and the Specifications or as directed by the Owner. The requirements of this Specification only apply to drilled shafts that have a diameter of 6 feet or greater and a length of 5 feet or greater and shall consist of furnishing all necessary submittals and materials for providing drilled shaft concrete placement and temperature control in accordance with the details shown on the plans and the requirements of this specification.

### **1.2 Materials**

- A. CSL tubes placed in accordance with Section 727 of the SCDOT Standard Specifications may be used for monitoring. Subsection 727.4.1 shall be modified to require an additional tube in the center of the shafts. The central CSL tube shall match the size and material requirements of Section 727 of the SCDOT Standard Specifications.

### **1.3 SUBMITTALS**

- B. Submittals: The CONTRACTOR shall prepare and deliver technical submittals for review and approval of the ENGINEER. All submittals must be approved before related work may begin. Listed below are submittals required for this item of work, additional submittals may be required due to site conditions and / or the nature of the work. In order to maintain correspondence records each submittal shall be assigned a submittal number and transmittal number for use by the CONTRACTOR and the ENGINEER. Rejection of a procedure or the correction of shop drawings will not be considered as cause for delay. For additional information regarding each submittal to be submitted, refer to the appropriate section of this specification.
1. Drilled Shaft Concrete Placement Plan: At least 30 days before placing drilled shaft concrete, submit to the ENGINEER for review and acceptance a Drilled Shaft Concrete Placement Plan containing, but not limited to, the following:
    - Analysis of the anticipated thermal developments within the drilled shafts using the proposed materials and casting methods,
    - Temperature Control Plan outlining specific measures to control the temperature differential within the limits noted above,
    - Details of how the central CSL access tube will be held in place during cage installation and concrete placement, and
  - C. Details of how the concrete will be placed to accommodate the central CSL tube and the associated support elements. Shop Drawings: CONTRACTOR shall furnish one (1) complete electronic copy of detailed shop drawings for approval prior to starting fabrication. By approving and submitting shop drawings, the CONTRACTOR thereby represents that they have determined and verified all field measurements, field construction criteria, materials, catalog numbers and similar data, or will do so, and that they have checked and coordinated the shop drawings with the requirements of the work and of the contract documents. After approval of shop drawings, the CONTRACTOR shall supply the SCDOT with one (1) set of reproducible approved drawings.
  - D. Submittal Review: Approval by the ENGINEER is only for the purpose of confirming compliance with the Contract Plan and Specifications. Approval shall not relieve the CONTRACTOR from responsibility for correctness, quantity and quality, nor for completeness of work in accordance with the plans and specifications.

### **1.4 MEASUREMENT AND PAYMENT**

- A. No measurement will be made for CONCRETE FOR STRUCTURES – CLASS 4000DS.
- ~~B.~~ Payment for CONCRETE FOR STRUCTURES – CLASS 4000DS will be included in pay items 000230 and 000235 including the costs of additional reinforcing or other supports necessary to hold the central tube in place.

## **PART 2 - MATERIAL**

### **2.1 MASS CONCRETE MIX DESIGN**

- A. Refer to Spec. 000130 Cast-In-Place Concrete.
- B. Do not use High-early-strength (ASTM C150 Type III or ASTM C1157 HE) cement, metakaolin, silica fume, calcium chloride and accelerating type admixtures unless an adiabatic temperature study is completed and accepted by the ENGINEER showing temperature rise significantly less than that of plain unmodified cement.

## **PART 3 - EXECUTION**

### **3.1 CONCRETE PLACEMENT**

- A. Concrete Curing Temperature: The maximum concrete temperature during curing shall not exceed 160 °F within the drilled shaft.
- B. Temperature Monitoring Devices: During the heat of hydration, Department personnel or a Department designated representative will monitor the drilled shaft temperature differential between the interior and exterior CSL access tubes using Thermal Integrity Profiling equipment. Differential temperature monitoring will be performed for the entire length of the shaft. Monitoring will continue at least until the peak heat of hydration has occurred.
- C. Temperature Monitoring Results: If the monitoring indicates that the proposed measures are not controlling the concrete curing temperature with the maximum concrete temperature specified, make the necessary revisions to the Temperature Control Plan and submit the revised plan for review.

### **3.2 CONTRACTOR'S RESPONSIBILITY**

- A. The CONTRACTOR assumes all risks connected with placing a large diameter drilled shaft pour of concrete. ENGINEER review of the Contractor's Drilled Shaft Concrete Placement Plan will in no way relieve the CONTRACTOR of the responsibility for obtaining satisfactory results. Should any drilled shaft concrete placed under this Specification prove unsatisfactory, make the necessary repairs or remove and replace the material at no expense to the Owner.

**END OF SECTION 000131**

## **PART 1 – GENERAL**

### **1.1 DESCRIPTION**

- A. CONTRACTOR:** The CONTRACTOR shall furnish all labor, tools, equipment and material necessary for REINFORCING BARS in accordance with the plans and as specified herein.
- B.** All operations shall be conducted so as not to interfere with, interrupt, or endanger the operation of trains or damage, destroy, or endanger the integrity of SCDOT facilities.

### **1.2 SUBMITTALS**

- A. Submittals:** The CONTRACTOR shall prepare and deliver technical submittals for review and approval of the ENGINEER. All submittals must be approved before related work may begin. Listed below are submittals required for this item of work, additional submittals may be required due to site conditions or the nature of the work. In order to maintain correspondence records each submittal shall be assigned a submittal number and transmittal number for use by the CONTRACTOR and the ENGINEER. For additional information regarding each submittal refer to the appropriate section of this specification.
  - 1. Detail drawings;
  - 2. Shop drawings;
  - 3. Mill test reports;
  - 4. Working drawings.
- B. Shop Drawings:** CONTRACTOR shall furnish one (1) complete electronic copy of detailed shop drawings for approval prior to starting fabrication. By approving and submitting shop drawings, the CONTRACTOR thereby represents that they have determined and verified all field measurements, field construction criteria, materials, catalog numbers and similar data, or will do so, and that they have checked and coordinated the shop drawings with the requirements of the work and of the contract documents. After approval of shop drawings, the CONTRACTOR shall supply the SCDOT with one (1) set of reproducible approved drawings.
- C. Submittal Review:** Approval by the ENGINEER is only for the purpose of confirming compliance with the contract plan and specifications. Approval shall not relieve the CONTRACTOR from responsibility for correctness, quantity and quality, nor for completeness of Work in accordance with the plans and specifications.

### **1.3 MEASUREMENT AND PAYMENT**

- A.** Measurement of Payment, REINFORCING BARS, as shown on the drawings, as specified in this Section and as accepted in the final work, shall be on a per POUND basis.
- B.** Payment for REINFORCING BAR, measured as stated above, will be at the contract unit price per POUND bid. Said unit price shall be full compensation for furnishing all labor, materials, tools, equipment, forms, supplies, accessories, supervision, placing, splicing, engineering and all other items of expense for REINFORCING BAR.

| Item Number | Description      | Unit |
|-------------|------------------|------|
| 000135      | Reinforcing Bars | LBS. |



## **PART 2 - MATERIAL**

### **2.1 GENERAL**

- A. Reinforcing bars shall be deformed bars of new billet steel conforming to the requirements of ASTM A706, Grade 60.
- B. Welded wire fabric shall conform to the requirements of ASTM A185.
- C. All reinforcement shall be protected as far as practicable from mechanical injury or surface deterioration from rusting or other cause. When placed in the Work, the reinforcement shall be free from dirt, scaly rust, loose mill scale, paint, oil, grease, and other foreign substances.
- D. Reinforcement shall be bent cold to conform accurately to the dimensions and shapes shown on the approved working drawings. Bends shall be made accurately in a suitable bending machine. Unless otherwise specifically approved by the Engineer, bars shall be shop bent before shipment and shall not be bent in the field.

### **2.2 HANDLING AND STORING MATERIALS**

- A. Reinforcement shall be stored in racks in such a manner as to avoid contact with the ground. If reinforcement is to remain on the site for more than one month, it shall be covered to protect it from weather. If reinforcement accumulates heavy rust, dirt, mud, loose scale, paint, oil, or any other foreign substance during storage, it shall be cleaned before being used. Severe deterioration of this kind may be a basis for rejection.

## **PART 3 - EXECUTION**

### **3.1 EXECUTION**

- A. CONTRACTOR shall, before proceeding with the work, field check all dimensions and submit for review, complete shop drawings. No work shall be done until the shop drawings review is completed. In case of correction or rejection, the CONTRACTOR shall revise and resubmit the drawings until they are acceptable to the ENGINEER and such procedure will not be considered as a cause for delay.
- B. Fabrication: Reinforcing bars shall be detailed and fabricated in accordance with AREMA recommendations.
- C. Splicing: Reinforcing bars shall be cut to the lengths indicated on the Plans or longer as approved by the ENGINEER. Splices which are permitted, unless otherwise shown on the Plans, shall be designed in accordance with applicable AREMA recommendations. Where practicable, the locations of the laps shall be staggered so the neighboring bars will not have adjacent laps.
- D. Placing: Reinforcement shall be placed accurately in the position indicated on the Plans and shall be firmly held in place during the deposition and vibration of the concrete. This shall be accomplished by fastening the bars at all intersections and splices by wires or approved clips, by the use of bars or other suitable spacers, or as otherwise approved by the ENGINEER. Suitable supports of approved number and character shall be used to support and retain the reinforcement in the locations required and at proper distances from the forms. If such supports are to be left in place in the concrete, they shall be of metal and all parts of such metal supports extending to within one inch of what will be an exposed concrete surface shall be galvanized.
- E. Grouting: Reinforcing bars grouted into existing concrete and / or masonry as shown on the Plans will be grouted using a 2-compound epoxy mixed with suitable mineral filler. The mineral filler shall be as recommended by the epoxy manufacturer. The method of mixing and application shall be as recommended by the manufacturer. **Cost of grouting materials and cost of installation shall be considered as part of this item.**

**END OF SECTION 000135**

## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A. The work covered under this Specification includes the furnishing of all materials, labor, tools equipment, and other incidental items for the designing, detailing, construction, and testing of permanent soil nailed retaining wall. The Contractor shall submit the proposed surface finish and provide a sample on-site for Department approval prior to wall construction.
- B. The soil nailed retaining wall shall be constructed from the top down as the soil in front of the wall is removed and the nails are installed and grouted at each level. The exposed soil face shall be protected with a welded wire reinforced shotcrete facing. Drainage systems shall be installed prior to applying shotcrete, as required. A structural cast-in-place or precast concrete facing shall be constructed and suitably attached to the soil nailed retaining structure. Attachment method for facing shall be designed by the Contractor and submitted to the Regional Production Group Structural for review prior to installation. Where pre-cast concrete panels are attached to the soil nail walls, the panels have a similar finish to MSE Wall panels.
- C. The soil nail walls addressed in this special provision are part of combination walls, with Mechanically Stabilized Earth (MSE) walls planned above the MSE walls at some locations. The design and construction of Soil Nail Walls shall be coordinated with the MSE Wall designer and installer.
- D. Unless otherwise specified, section references in this specification are to the South Carolina Department of Transportation Standard Specifications for Highway Construction, Edition of 2007.
- E. The Contractor shall select the nail installation method and may increase the drill hole diameter or length, within the property constraints shown on the plans or within the property acquired by Contractor for the project, to develop the required design loads. The Contractor will also be required to locate any underground utilities and adjust location of soil nails accordingly.

### **1.2 SUBMITTALS**

- A. Shotcrete material, equipment, preparation, and application. Submit the following to the Engineer for acceptance at least 30 days before placing shotcrete:
  - 1. Description of proposed equipment for mixing and applying shotcrete conforming to Section V. Include the manufacturer instructions, recommendations, literature, performance, and test data.
  - 2. Proposed shotcrete mix design conforming to Section VI with mix proportions.
  - 3. Representative samples of shotcrete material, if requested by the Engineer.
  - 4. Results of all shotcrete preconstruction testing conforming to Section VII.
  - 5. Proposed method for applying and curing shotcrete conforming to Sections VIII, IX, and X.
  - 6. Other information necessary to verify compliance with ACI 506.2.
  - 7. Certification that shotcrete conforms to the standards specified herein.
  - 8. Submit the following to the Engineer for acceptance at least 30 days before placing shotcrete:
  - 9. Project references: Include project name, owner's name, and phone numbers for completed projects as described in "Contractor Qualifications."
  - 10. Nozzle Operator's experience and training; For each nozzle operator, include shotcrete application experience on at least two projects of comparable nature and showing that they meet the qualifications described in "Contractor Qualifications."

11. Shotcrete Supervisor experience: Include direct shotcrete application experience on at least three comparable projects and showing that they meet the qualifications described in "Contractor Qualifications."
  12. Testing Laboratory certification; Include documentation that the strength-testing laboratory complies with ASTM C 1077 and has the experience to perform the tests specified in this section. The testing laboratory shall be AASHTO accredited for ASTM C 1077 or demonstrate the ability to perform the requisite tests.
- B.** The above submittals shall be prepared and sealed by the Design Engineer who must be registered as a Professional Engineer in the State of South Carolina. Design the soil nail walls in accordance with "FHWA Geotechnical Engineering Circular No. 7 - Soil Nail Walls Reference Manual" FHWA Publication No. FHWA-NHI-14-007.
- C.** The Contractor will be notified by the Resident Construction Engineer of acceptance or rejection of submissions within 21 days of receipt of each submission.
- D.** Work shall not be started and no materials shall be ordered until the all submissions have been approved in writing by the Engineer. If work is suspended due to the substitution of unqualified personnel, the Contractor shall be fully liable for additional costs resulting from the suspension of the work and no adjustments in contract time resulting from the suspension will be allowed.
- E.** The Department will be the sole judge of the adequacy of the information submitted. The review and acceptance of the final design plans, shop plans, and methods of construction by the Department shall not in any way relieve the Contractor of his responsibility for the successful completion of the work or the proper design of soil nailed retaining wall. Contractor delays due to untimely submissions and insufficient information shall not be considered as justification for time extensions.

### 1.3 CONTRACTOR QUALIFICATIONS

- A.** The Contractor or Subcontractor shall be experienced in the design and installation of permanent soil nailed retaining walls. His staff shall include at least one Registered Professional Engineer licensed in the State of South Carolina. The Contractor or Subcontractor shall have the following qualifications:
1. Design:
    - The designer shall have designed a minimum of three permanent soil nailed retaining walls in the past three years, with one permanent soil nailed retaining wall of at least 20 feet in height. The Design Engineer shall be available at any time during the life of the Contract to discuss the design of the soil nailed structure directly with the Department.
    - Design the soil nail walls in accordance with "FHWA Geotechnical Engineering Circular No. 7 - Soil Nail Walls Reference Manual" FHWA Publication No. FHWA-NHI-14-007.
  2. Construction:
    - The Supervising Engineer shall have constructed a minimum of three permanent soil nailed retaining walls in three years, with one permanent soil nailed retaining wall of at least 20 feet in height.
    - The Foreman shall have constructed a minimum of three permanent soil nailed retaining walls in three years, with one permanent soil nailed retaining wall of at least 20 feet in height.
    - The Drill Operator shall have installed soil nails on a minimum of three permanent soil nailed retaining walls in three years, with one permanent soil nailed retaining wall of at least 20 feet in height.
    - Shotcrete Supervisor shall have supervised the application of shotcrete on projects of comparable nature or work for at least three years
    - Shotcreting Nozzle Operators shall have at least 1 year experience in the application of shotcrete on projects of comparable nature or work under the immediate supervisions of a foreman or instructor with at least 2 years of such experience.

## 1.4 MEASUREMENT AND PAYMENT

- A. Unless directed otherwise by the Owner, the Contractor shall conform to the measurement and payment provisions of this specification. Measurement and payment shown below shall be the sole measurement and payment provided for Wall 3 regardless of wall type chosen, final geometry of wall, or combination of wall types to accommodate the required geometry of the CSXT Access Drive and Dewberry Road.

| Item Number | Description | Unit |
|-------------|-------------|------|
| 000155      | Wall 3      | LS   |

## **PART 2 - MATERIAL**

### 2.1 SHOTCRETE MATERIALS

- A. USE SCDOT STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION, EDITION 2007 FOR THE FOLLOWING:

1. Air-entraining admixture, Section 701.2.5.1 (wet mix only)
2. Chemical admixtures, Section 701.2.6 (wet mix only)
3. Curing material, Section 702
4. Cement, Section 701
5. Pozzolans, Section 701
6. Reinforcing steel, 703 (also see above)

**B. SHOTCRETE AGGREGATE**

1. For fine aggregate, furnish rounded particles conforming to AASHTO M 6 Class B including the reactive aggregate supplementary requirement, except as amended or supplemented by the following:
  - Material passing 75- $\mu$ m sieve, AASHTO T 11/ASTM C 117: 3.0% max
  - Sand equivalent value, AASHTO T 176: 75 min. referee method
2. For coarse aggregate, conform to AASHTO M 80 Class B, except as amended or supplemented by the following:
  - Los Angeles abrasion, AASHTO T 96/ASTM C 131: 40% max
  - Combine the aggregates to meet the designated gradation in Table 1.

**Table 1: Shotcrete Gradation Limits for Combined Aggregates**

| Sieve Size | Percent by Mass Passing Designated Sieve (AASHTO T 27) |        |       |
|------------|--|--------|-------|
|            | Grading Designation                                    |        |       |
|            | A  | B      | C     |
| 19 mm      | 100  | 100    | 100   |
| 12.5 mm    | 100  | 100    | 80-95 |
| 9.5 mm     | 100  | 90-100 | 70-90 |
| 4.75 mm    | 95-100   | 70-85  | 50-70 |
| 2.4 mm     | 80-100   | 50-70  | 35-55 |
| 1.2 mm     | 50-85  | 35-55  | 20-40 |
| 600 µm     | 25-60  | 20-35  | 10-30 |
| 300 µm     | 10-30  | 8-20   | 5-17  |
| 150 µm     | 2-10   | 2-10   | 2-10  |

**C. Reinforcing**

1. Contractor may elect to use deformed bar reinforcing steel instead of welded wire reinforcement.

**D. General**

1. Conform to the following:
  - ACI 506R: Guide to Shotcrete
  - ACI 506.2: Specifications for Proportioning Application of Shotcrete
  - AASHTO C 311: Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Concrete
  - ASTM C 1077: Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

**E. Steel Nails:**

1. AASHTO M 31/ASTM A 615. Threaded, a minimum of 6 inches on the wall anchorage end, to allow proper attachment of bearing plate and nut. Threading may be continuous spiral deformed ribbing provided by the bar deformations (continuous thread bars) or may be cut into a reinforcing bar. If threads are cut into a reinforcing bar, provide the next-larger bar number designation from that shown on the Plans, at no additional cost.

**F. Corrosion Protection:**

1. Provide Class B corrosion protection in accordance with FHWA Geotechnical Engineering Circular No. 7. Corrosion protection shall consist of the following:
  - Galvanized tendons encapsulated in grout or shotcrete with 3” minimum cover. Epoxy coated tendons will not be allowed. Galvanizing shall be done in accordance with applicable AASHTO standards.

**G. Steel Welded Wire Fabric**

1. Steel Welded Wire Fabric shall conform to the requirements of AASHTO M 55/ASTM A 185.

**H. Reinforcing Steel**

1. All steel used for reinforcement other than soil nails shall be ASTM A 706.

**I. Shotcrete Specifications**

1. This work consists of constructing one or more courses of shotcrete on a prepared surface. Refer to shotcrete specifications at the end of this section. The shotcrete will be a permanent facing and shall have a minimum of 6 inches thickness.

**J. Grout for Nails**

1. Provide neat cement or a sand/cement mixture with a minimum 3-day compressive strength of 1,500 psi and a minimum 28-day compressive strength of 3,000 psi, per AASHTO T 106/ASTM C 109 to be used in soil nail anchorage consisting of a pumpable mixture. Admixtures that control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to review and acceptance by the Engineer. Accelerators are not permitted. Expansive admixtures may only be added to grout used for filling sealed encapsulations. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer’s recommendations. No admixtures will be allowed that could have corrosive properties. The Contractor shall submit documentation to the Engineer showing that the admixtures used will not be detrimental to the nails.

**K. Fasteners and Attachment Devices**

1. Provide high strength nuts conforming to AASHTO M 291, Grade B, Hexagonal, or equivalent. Hexagonal nut shall be fitted with beveled washer or spherical seat to provide uniform bearing. Provide plates conforming to AASHTO M 183/ASTM A 36 or equivalent. Shear connector studs on bearing plates shall be in accordance with Section 709.2.2. Provide only plastic centralizers of a minimum diameter of 1 in. smaller than the nominal diameter of the drill hole which permit free flow of grout.

**L. Centralizers**

1. Centralizers shall be manufactured from Schedule 40 PVC pipe securely attached to the soil nail. The centralizers shall be sized to position the soil nail within 1 inch of the center of the drill hole, sized to allow trimie pipe insertion to the bottom of the drill hole, and sized to allow grout to freely flow up the drill hole. Centralizers must be provided inside and outside of encapsulated nail assemblies and shall be spaced no further than 8 ft. apart. Centralizers shall also be located no further than 1.5 ft. from each end of end of the soil nails.

**M. Geocomposite Wall Drains**

1. See Exhibit 5 of the RFP.

**2.2 EQUIPMENT**

- A. **Water Supply System:** For dry mix, provide a water storage tank at the job site. Provide a positive displacement pump with a regulating valve that is accurately controlled to provide water in the pressures and volumes recommended by the delivery machine manufacturer.
- B. **Mixing:** Use equipment capable of handling and applying shotcrete containing the specified maximum size aggregate and admixtures. Provide an air hose and blowpipe to clear dust and rebound during shotcrete application.
- C. **Air Supply System:** Use an air supply system capable of supplying the delivery machine and hose with air at the pressures and volumes recommended by the machine manufacturer. Do not use air supply systems that deliver oil-contaminated air or are incapable of maintaining constant pressure.
- D. **Delivery Machine:** Use a delivery machine capable of supplying material to the delivery hose at a uniform rate. The ejection from the nozzle must adhere to the treated surface with minimum rebound and maximum density when the nozzle is held in the range of 3 to 6 ft from the target surface.

### **2.3 COMPOSITION (SHOTCRETE MIX DESIGN)**

- A. Design and produce shotcrete mixtures conforming to Table 2 for the type of shotcrete specified. Use the amount of water required to produce shotcrete of suitable strength, consistency, quality, and uniformity with the minimum amount of rebound. Use the same material types and sources as submitted with the mix design in the field trials and production work.
  - 1. **Hydration stabilizing admixtures:** Hydration stabilizing admixtures may be used to extend the allowable delivery time for shotcrete. Dosage is based on the time needed to delay the initial set of the shotcrete for delivery and discharge on the job. Design shall include discharge time limit in the dosage submittal. Dosage required to stabilize shotcrete shall be determined using job site material and field trial mixtures. The extended-set admixture shall control the hydration of all cement minerals and gypsum. The maximum allowable design discharge time is 3.50 hours.
  - 2. If a hydration-stabilizing admixture is approved for use in the concrete mix, concrete shall be delivered and placed within the approved design discharge time limit. An approved and compatible hydration activator may be used at the discharge site to insure proper placement and testing.
  - 3. Dosage and type of extended-set admixture shall be included with proposed mix design. When requested, the admixture manufacturer shall provide the service of a qualified person to assist in establishing the proper dose of extended-set admixture and make dosage adjustments required to meet changing job site conditions.

**Table 2: Composition of Shotcrete**

| Type of Shotcrete Process | Minimum Cement Content | Maximum W/C <sup>(1)</sup> | Air Content Range | Minimum 28-Day Compressive Strength <sup>(3)</sup> |
|---------------------------|------------------------|----------------------------|-------------------|--|
|                           | (lb/cy)                | Ratio                      | (%)               | (psi)  |
| Wet                       | 550                    | 0.55                       | NA                | 150  |
| Dry                       | 550                    | 0.50                       | NA                | 150  |
| Wet (w/EA) <sup>(2)</sup> | 550                    | 0.45                       | 5 min             | 150  |
| Dry (w/EA) <sup>(2)</sup> | 550                    | 0.45                       | 5 min             | 150  |

**Notes:**

1. W/C = Water/Cement (by weight)
2. EA = Entrained Air
3. According to AASHTO T 23

**PART 3 - EXECUTION****3.1 DESIGN CALCULATIONS**

- A. The design calculations shall include, but not be limited to:
1. A written summary report which describes the overall soil nailed retaining wall design.
  2. Applicable code requirements and design references.
  3. Soil nailed retaining wall design cross-section(s) geometry including soil/rock strata and location, magnitude, and direction of design slope or external surcharge loads and piezometric levels.
  4. Design criteria including soil/rock shear strengths (friction angle and cohesion), unit weights, ground-grout pullout resistances, and drillhole diameter assumptions for each soil/rock strata.
  5. Partial safety factors/strength factors (for Service Load) used in the design of the pullout resistance, surcharges, soil/rock unit weights, nail head strengths, and steel, shotcrete, and concrete materials. Minimum required global stability soil factor of safety for SLD design or minimum required global stability soil resistance/ load ratio for LRFD design.
  6. Seismic design acceleration coefficient.
  7. Design calculation sheets with project number, wall location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. Provide an index page with the design calculations.
  8. Design notes including an explanation of any symbols and computer programs used in the design.
  9. Soil nail wall final design cross-section(s) geometry including soil/rock strata and location, magnitude, and direction of slope or external surcharge loads and piezometric levels with slip critical surface shown along with a minimum calculated global stability soil factor of safety for SLD design or for minimum global stability soil resistance/load ratio for LRFD design and required nail lengths and strengths (nail bar sizes and grades) for each nail row.



10. Any other geotechnical parameters used in the design that are not mentioned above.
11. Any other necessary design calculations, such as for the connection of architectural facing to the soil nailed retaining wall and connections of soil nailed retaining wall and architectural facing around drainage facilities.

### 3.2 CONSTRUCTION

1. Excavation: Excavation to be made to the limits and construction stages indicated on the plans. Excavation shall proceed in stages, exposing the minimum amount of soil or rock face which will allow the practical and expeditious application of the initial layer of shotcrete and the installation of soil nails while assuring stability of the excavated face and minimizing ground movements.
2. Shotcreting: After each stage cut, in anticipation of shotcreting, clean surfaces of all loose material, mud, rebound from previously placed shotcrete and other foreign material that will prevent bond of shotcrete. Dampen surface before shotcreting. Install permanent drainage as specified in the submitted plans. Connect drainage system at the bottom of the wall in such a manner as to carry the water away from the toe. Use weep holes, horizontal drains, or other methods to control seepage.
3. Control thickness, method of support, air pressure and water content of shotcrete to preclude sagging or sloughing off.
4. Shotcrete shall emerge from the nozzle in a steady uninterrupted flow.
5. Attachment of Nail Head Bearing Plate and Nut: Attach a bearing plate, washers, and nut to each nail head as shown on the plans. While the shotcrete construction facing is still plastic and before its initial set, uniformly seat the plate on the shotcrete by hand-wrench tightening the nut. Where uniform contact between the plate and the shotcrete cannot be provided, set the plate in a bed of grout. After grout has been set for 24 hours, hand-wrench tighten the nut. Ensure bearing plates with headed studs are located within the tolerances shown on the plans.
6. Shotcrete Facing Tolerances: Construction tolerances for the shotcrete facing from the plan location and plan dimensions are as follows:
  7. Horizontal location of welded wire mesh and reinforcing bars: 0.4 in
  8. Spacing between reinforcing bars: 1 in
  9. Reinforcing lap, from specified dimension: 1 in
  10. Complete thickness of shotcrete:
    11. If troweled or screeded: 0.6 in
    12. If left as shot: 1.2 in
  13. Planeness of finish face surface-gap under 10 ft straightedge:
    14. If troweled or screeded: 0.6 in
    15. If left as shot: 1.2 in
  16. Nail head bearing plate deviation from parallel to wall face: 10 degrees
17. Nail Installation: Drill holes for soil nails at the locations required in the submitted plans. Provide nail length and nail diameter necessary to develop load capacity to satisfy testing acceptance criteria for the design load required. Core drilling, rotary drilling, or auger drilling can be used. It shall be the Contractor's responsibility to choose drilling methods that will maintain open holes and do not promote mining and loosening of the soil at the perimeter of the drill hole or fracture soils with weak stratification planes by use of high flush volumes and

pressures. At the ground surface, the drill hole shall be located within 6 inches of the location shown on the submitted plans. At the point of entry, the nail angle shall be within plus or minus 3 degrees of that shown on the approved plans. Subsidence or physical damage by such operations shall be cause for immediate cessation of operations and repair at Contractor's expense.

18. Inject grout at the lowest point of the drill hole. Pump grout through grout tubes, casing, or drill rods such that the hole is filled to prevent air voids with grout progressively from the bottom to the top. Grout until the hole is completely filled with grout and clean grout is seen to run from the top of the hole.
19. Provide grouting equipment capable of continuous mixing and producing a grout free of lumps. Nails shall be placed in each drilled hole within 15 minutes of the grout injection.
20. Mortar packing and secondary grouting to the wall face shall be accomplished as soon as practical after nail installation.

### 3.3 NAIL TESTING:

1. Equipment: A dial gauge capable of measuring to 0.001 of-an-inch shall be used to measure movement. A hydraulic jack and gauge calibrated as a unit shall be used to apply the test load. The pressure gauge shall be graduated in 100 psi increments or less and used to measure the applied load. The test loads shall be applied incrementally.
2. Verification Testing: Install 1 nail per horizontal row but no more than 1 percent of the total number of nails as non-service nails for Verification Testing. Verification Testing shall be performed in accordance with Section 9.4.3 of FHWA Geotechnical Circular No. 7. The shop drawing submittal shall identify location of test nails, bond length, Verification Test Load (VTL), and detailed Verification Test Loading Schedule.
3. All nail test results shall be submitted to the Regional Production Group Structural and Geotechnical Engineer for review.
4. Proof Testing: Proof test a minimum of 5 percent of production nails in accordance with Section 9.4.4 of FHWA Geotechnical Circular No. 7. The shop drawing submittal shall identify Proof Test Load (PTL) and provide a detailed Proof Test Loading Schedule.
5. All nail test results shall be submitted to the Regional Production Group Structural Engineer for review.
6. Acceptance Criteria: The nail is deemed acceptable if:
  - No pullout occurs at loads less than 1.0 PTL or VTL.
  - The total soil nail movement ( $\Delta_{PTL}$  or  $\Delta_{VTL}$ ) measured at PTL or VTL is greater than 80 percent of the theoretical elastic elongation of the unbonded length, as defined below. Where:

$$\Delta_{PTL} > 0.8 \frac{PTL L_{UB}}{E A_t} \quad \text{and} \quad \Delta_{VTL} > 0.8 \frac{VTL L_{UB}}{E A_t}$$

- The creep movement does not exceed the criteria presented in Section 9.4.5 of FHWA Geotechnical Circular No. 7
7. Construction Sequencing: Closely follow the construction sequence on the approved plans.
  8. Storage and Handling: Nails, cement, bars and drainage material shall be kept dry and stored in a protected location. Bars shall be placed on supports to prevent contact with ground. Replace any bars that exhibit

abrasions, cuts, welds, weld splatter, corrosion, or pitting. Bars shall be replaced or repaired that exhibit damage to encapsulation or epoxy coating.

9. Movement Monitoring: Contractor shall establish a movement monitoring program. The monitoring program shall include the installation of horizontal and vertical survey monuments on the shotcrete facing. Monuments shall be measured daily during soil nail wall construction with the first measurement taken within 24 hours of placing the first lift of shotcrete. The contractor shall adhere to the following thresholds:
  - Warning Threshold: The warning threshold occurs when the vertical or horizontal measured wall displacements exceed 0.5% of the wall height. When the warning threshold is reached, the contractor shall submit a remedial plan to demonstrate methods to reduce or eliminate additional wall deformations.
  - Stop Work Threshold: The contractor shall stop work immediately if the vertical or horizontal wall displacements exceed 1.0% of the wall height. The contractor shall submit a remedial action plan once the threshold is exceeded.
10. The contractor shall immediately notify the Regional Production Group Structural and Geotechnical Design Engineer if either threshold values are exceeded.

### 3.4 PRECONSTRUCTION TESTING

- A. Conduct preconstruction shotcrete field trials before starting shotcrete production. Allow the Engineer the opportunity to witness all phases of the preconstruction testing.
  1. Field Trials: Construct wood forms at least 6 in. thick by 3 ft by 3 ft in size. Have each proposed nozzle operator make test panels on two vertical wood forms. Cure the test panels according to AASHTO T 23/ASTM C 31, without immersing the panels.
  2. Coring: Drill six 3 in. diameter cores from each test panel according to AASHTO T 24/ASTM C 42. Trim the ends of the cores according to AASHTO T 24/ASTM C 42 to make cylinders at least 3 in. long. Test panel shall be allowed to cure in accordance with current AASHTO and ASTM standards prior to coring.
  3. Compressive Strength Testing: Soak the cylinders in water for 40 hours immediately before testing. Test three cylinders from each test panel four days after field trial and test the remaining three cylinders 28 days after the field trial. Perform tests according to AASHTO T 23/ASTM C 31. All specified strength requirements shall be satisfied before the shotcrete mix design will be considered for acceptance.
  4. Mix Design Acceptance: The Engineer will accept or reject the shotcrete mix design based on the results of the preconstruction field trials and testing. Before approving any changes to a previously accepted mix design, the Engineer may require additional preconstruction testing at no additional cost to the Department.

### 3.5 SHOP PLANS

- A. The shop plans shall include, but not be limited to:
  1. A plan view of the wall identifying:
  2. A reference baseline and elevation datum.
  3. The offset from the construction centerline or baseline to the face of the wall at its base at all changes in horizontal alignment.
  4. Beginning and end of wall stations.

5. Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structures, or other potential interferences. The centerline of any drainage structure or drainage pipe behind, passing through, or passing under the wall.
6. Limit of longest nails.
7. Subsurface investigation locations shown on a plan view of the wall alignment with appropriate reference baselines to fix the locations of the explorations relative to the wall.
8. An elevation view of the wall identifying:
  9. The elevation at the top of the wall, at all horizontal and vertical break points, and at least every 10 feet along the wall.
  10. Elevations at the finished grade at front of architectural finished face, at front face of soil nailed wall base and the top of the leveling pad for architectural faced wall, if split faced block or cast-in-place facing are used.
11. Beginning and end of wall stations.
12. The distance along face of wall to all steps in the wall base.
13. Wall elevation view showing nail locations and elevations, vertical and horizontal nail spacing, the location of wall drainage elements, and the location of permanent facing expansion/contraction joints along the wall length (if applicable).
14. Existing finished grade profiles both behind and in front of the wall.
15. Design parameters and applicable codes.
16. General notes for constructing the wall including construction sequencing or other special requirements.
17. Horizontal and vertical curve data affecting the wall and wall control points, as necessary. Match lines or other details to relate wall stationing to centerline stationing, as necessary.
18. A list of the quantities showing estimated surface area of wall face and other pay items.
19. Soil nailed wall typical sections staged excavation lift elevations, wall and excavation face batter, nail and spacing inclination, nail bar sizes, and corrosion protection details.
20. A typical detail of production and test nails defining nail length, minimum drill hole diameter, inclination, and test nail bonded and unbonded test lengths.
21. Details, dimensions, and schedule for all nails, reinforcing steel, wire mesh, bearing plates, headed studs, etc. and attachment devices of architectural facing.
22. Dimensions and schedules of all reinforcing steel including reinforcing bar bending details.
23. Details and dimensions for wall appurtenances such as barriers, coping, drainage gutters, fences.
24. Details for constructing wall around drainage facilities.
25. Details for terminating wall and adjacent slope construction.
26. Facing finishes, color and architectural treatment requirements for permanent wall facing elements.

### 3.6 SURFACE PREPARATION AND APPLICATION OF SHOTCRETE

- A.** Surface Preparation: Clean loose material, mud, rebound, and other foreign matter from all surfaces to receive shotcrete. Remove curing compound on previously placed shotcrete surfaces by sandblasting. Install approved depth gages to indicate the thickness of the shotcrete layers. Install depth gages on 6 ft centers longitudinally and transversely with no less than two gauges per increment of surface area to receive the shotcrete. Moisten all surfaces.
- B.** Weather Limitations: Place shotcrete when the ambient temperature is 41 °F(5 °C) or higher. Do not perform shotcrete operations during high wind and heavy rains.
- C. Shotcrete Application:**
1. Do not apply shotcrete to frozen surfaces.
  2. Use acceptable nozzle operators who have fabricated acceptable test panels and have meet qualifications described above.
  3. Apply shotcrete within 45 minutes of adding cement to the mixture. Apply shotcrete at a temperature between 50 °F(10 °C) and 86 °F(30 °C).
  4. Direct the shotcrete at right angles to the receiving surface except when shooting ground reinforcing bars. Apply shotcrete in a circular fashion to build up the required layer thickness. Apply shotcrete in a steady uninterrupted flow. If the flow becomes intermittent, direct the flow away from the work area until it becomes steady.
  5. Make the surface of each shotcrete layer uniform and free of sags, drips, or runs.
  6. Limit the layer thickness of each shotcrete application to 2 in. Thicker applications may be approved if the Contractor can demonstrate that no sloughing or sagging is occurring. If additional thickness is required, broom or scarify the applied surface and allow the layer to harden. Dampen the surface before applying an additional layer.
  7. Remove laitance, loose material, and rebound. Promptly removed rebound from the work area.
  8. Taper construction joints to a thin edge over a distance of at least 1 foot. Wet the joint surface before placing additional shotcrete on the joint. Do not use square construction joint.
- D.** Production Summary: Prepare and submit a summary of shotcrete production application for each shift. Furnish the summary to the Engineer within 24 hours. Include the following information in the report:
1. Quantity and location of shotcrete applied including sketches.
  2. Observations of success or problems of equipment operation, application, final product conditions, and any other relevant issues during production and application.
  3. Description of placement equipment.
  4. Batch number(s) if applicable.

### 3.7 QUALITY CONTROL RECORDS

- A.** Submit field quality control test reports within two working days of performing the tests. Include the following information in the reports:
1. Sample identification including mix design and test panel number and orientation.
  2. Date and time of sample preparation including curing conditions and sample dimensions.
  3. Date, time, and type of test.
  4. Complete test results including load and deformation data during testing, sketch of sample before and after testing, and any unusual occurrences observed.

5. Names and signature of person performing the test.
6. Location of steel reinforcement, if used, covered by shotcrete.
7. Name of nozzle operator.

### **3.8 REDESIGN**

- A. If anchors fail during performance tests or proof tests, the Contractor shall modify the design or construction procedures, subject to review by the Department. These modifications may include reducing the soil nail load by increasing the number of nails, increasing the grout pressure, requiring post-grouting or increasing the bond length (within parameters of the plans). Any modification of design or construction procedure shall be at no cost to the Department. The redesigned anchors shall be installed and tested as previously defined at no cost to the Department. Those nails that fail the performance tests may be incorporated in the structure. The Contractor shall propose a reduced Design Load and retest as noted above. Acceptance of such anchors will be at the discretion of the Department.

### **3.9 PROTECTION AND CURING**

- A. Protect and cure the surface according to Section 702.4.4.2. Protect and maintain shotcrete at a temperature above 41°F (5°C) until shotcrete has achieved a minimum strength of 750 psi.

### **3.10 ACCEPTANCE**

- A. Material for concrete will be evaluated by visual inspection of the work, conformance testing and by certification for materials manufactured off-site. Compressive strength will be evaluated by conformance testing using Table 2 for specification limits. See Table 3 for minimum sampling and testing requirements and acceptance quality category.

**Table 3: Sampling and Testing of Shotcrete**

| Material or Product | Property or Characteristic | Category | Test Methods or Specifications                     | Frequency  | Sampling Point                          |
|---------------------|----------------------------|----------|--|--|---|
| Shotcrete           | Air content                | --       | AASHTO T 152/ASTM C 231 or AASHTO T 196/ASTM C 173 | 1 per load <sup>(1)</sup>  | Truck, mixer or agitator <sup>(2)</sup> |
|                     | Unit Mass                  | --       | AASHTO T 121/ASTM C 138                            | 1 per load <sup>(1)</sup>  | Truck, mixer or agitator <sup>(2)</sup> |
|                     | Compressive strength       | II       | AASHTO T 23/ASTM C 31                              | 1 set per 33 CY, but not less than 1 set each day <sup>(3)</sup> | Production test panels <sup>(3)</sup>   |

(1) When continuous mixing is used sample every 10 CY.

(2) Sample according to AASHTO T 141/ASTM C 172

(3) Prepare production test panels according to Section VII. Obtain two 3-in. diameter core specimens from each panel according to AASHTO T 24/ASTM C 42. A single compressive strength test result is the average result from two 3-in. diameter core specimens from the same test panel tested according to AASHTO T 23/ASTM C 31 at 28 days.

**END OF SECTION 000155**

## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A. CONTRACTOR:** The CONTRACTOR shall furnish all labor, tools, equipment and material necessary for the furnishing, fabrication, transportation, preparation, assembly, erection, welding, and painting of all steel shown in the plans. The work of constructing all steel portions of this bridge shall comply with the applicable provisions of AREMA recommendations, except as modified herein or in the Plans. The CONTRACTOR is responsible for performing all steel construction operations in compliance with the current local, state, federal, and CSXT policies, rules, and regulations.
- B.** All operations shall be conducted so as not to interfere with, interrupt, or endanger the operation of trains or damage, destroy, or endanger the integrity of RAILROAD facilities.

### **1.2 SUBMITTALS**

- C. Submittals:** The CONTRACTOR shall prepare and deliver technical submittals for review and approval of the ENGINEER. All submittals must be approved before related work may begin. Listed below are submittals required for this item of work, additional submittals may be required due to site conditions and / or the nature of the work. In order to maintain correspondence records each submittal shall be assigned a submittal number and transmittal number for use by the CONTRACTOR and the ENGINEER. Rejection of a procedure or the correction of shop drawings will not be considered as cause for delay. For additional information regarding each submittal to be submitted, refer to the appropriate section of this specification.
  - 1. Mill Certificates;
  - 2. Fabrication (shop) drawings;
  - 3. Welder certifications;
  - 4. Material cut sheets;
  - 5. Fabricator Quality Plan;
  - 6. Girder loading diagram;
  - 7. FCM handling procedures;
  - 8. Erection plan.
- D. Shop Drawings:** CONTRACTOR shall furnish one (1) complete electronic copy of detailed shop drawings for approval prior to starting fabrication. By approving and submitting shop drawings, the CONTRACTOR thereby represents that they have determined and verified all field measurements, field construction criteria, materials, catalog numbers and similar data, or will do so, and that they have checked and coordinated the shop drawings with the requirements of the work and of the contract documents. After approval of shop drawings, the CONTRACTOR shall supply the SCDOT with one (1) set of reproducible approved drawings.
- E. Submittal Review:** Approval by the ENGINEER is only for the purpose of confirming compliance with the Contract Plan and Specifications. Approval shall not relieve the CONTRACTOR from responsibility for correctness, quantity and quality, nor for completeness of work in accordance with the plans and specifications.

### **1.3 MEASUREMENT AND PAYMENT**

- A.** Measurement of STRUCTURAL STEEL shall be by the pound unless otherwise indicated on the plans.



- B. Payment:** The payment for STRUCTURAL STEEL, measured as stated above, will be made at the unit price bid for STRUCTURAL STEEL and shall be full compensation for furnishing all materials, equipment, quality control testing, shop drawings and labor necessary for fabricating and erecting the STRUCTURAL STEEL as detailed in the plans.

| Item Number | Description      | Unit |
|-------------|------------------|------|
| 000190      | Structural Steel | LBS. |

## **PART 2 - MATERIAL**

### **2.1 GENERAL**

- A. Structural Steel:** All design, material erection and its fabrication shall be in accordance with the current AREMA recommendations and as specified in the Contract Documents. All fracture critical members shall be identified on the plans and shall be fabricated in accordance with the Fracture Control Plan stated in the AREMA recommendations. Structural Steel shall be ASTM A709 Grade 50. The toughness shall be T2 for non-fracture critical members or F2 for fracture critical members. Other types of steel may be used if approved by the ENGINEER. Steel construction shall be cleaned and painted in accordance with the Painting Specifications.
- B. Fabricator:** Fabricator shall be certified under the AISC Quality Certification Program as follows:
1. Welded Plate Girders Category III
  2. Certified Bridge Fabricator – Intermediate (or) Advanced
- C. Bolts / Nuts / Washers:** Bolts, nuts, and washers shall be furnished by the same supplier to ensure proper fit. High Strength Bolts shall meet the current requirements of ASTM A490 Specifications. Nuts shall meet the current requirements of ASTM A563 Specifications. Washers shall meet the current requirements of ASTM A436 Specifications. Swedge anchor bolts shall conform to ASTM F1554 Grade 105.
- D. Bolt / Nut / Washer Testing:** Rotational capacity tests shall be performed on all black or galvanized bolt, nut and washer assemblies by the manufacturer or distributor prior to shipping. Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly and a rotational capacity lot number assigned to each combination of the lots tested. The manufacturer or distributor shall furnish, to the ENGINEER, a manufacturer's certified test report or a distributor's certified test report for each rotational capacity lot furnished. The reports shall include the results of all tests, location of where bolt assembly components were manufactured; the date and location of the tests; results of the tests and a statement that the materials represented by the test report conform to the specifications.
- E. Welding:** Welding inspection shall verify that all welds and welding procedures meet the requirements of the American Welding Society specifications, current edition and all addenda to it. Welding electrodes for arc welding shall meet the current requirements of the Specifications.
- F. Falsework:** Falsework materials shall be in accordance with the CONTRACTOR's drawings, when applicable, and approved by the ENGINEER.
- G. Bearing Pads:** Bearing pads shall be in accordance current ASTM Specifications for Plain and Steel-Laminated Elastomeric Bearings.

### **2.2 HANDLING AND STORING MATERIALS**

- A. Handling:** All material shall be handled in a manner which will prevent members from being distorted or damaged. Stored material shall be piled securely, and no material shall be placed closer than 25 feet to the centerline of the nearest tracks. Material shall be placed on level platforms, skids, or other supports above the ground and shall be kept clean and properly drained. Girders and beams shall be supported on skids placed near enough together to prevent damage from deflection.
- B. Fracture Critical Members:** For those members designated as fracture critical members (FCMs), the following shall apply:

1. Extraordinary care shall be taken in the handling of FCMs. Lifting dogs, tongs, grips, chains, cables, or other lifting devices placed in direct contact with the FCM which may gouge, scratch, score, scrape, or otherwise damage the surface, edges or corners of FCMs shall not be used.
  2. Procedures for handling FCMs using lifting straps, timber cushions or other protective devices shall be developed, submitted to the ENGINEER, and receive written approval by the ENGINEER before handling any material for or members designated as FCM.
- C. Shipping: All materials shall be carefully loaded so as to avoid damage in transit. Members weighing more than 3 tons shall have the weight marked thereon. All small parts such as rivets, bolts, pins, washers, and small connection plates shall be packed in containers of adequate strength. The contents of each unit shall be plainly marked on the top of each container.
- D. Girder Protection: Girders shall be shipped in an upright position and adequately blocked and braced to prevent damage during shipping. The Fabricator shall submit girder loading diagrams to the ENGINEER for approval well in advance of the anticipated shipping date. These diagrams shall include proposed blocking, bracing and tie-down details.

## **PART 3 - EXECUTION**

### **3.1 EXECUTION**

- A. Inspection: The OWNER may arrange for inspection by an independent inspection firm under a separate contract. The CONTRACTOR shall submit, to the OWNER, a Fabricator's Quality Control Program.
- B. Fabricator: The Fabricator shall notify the OWNER and its inspector of the scheduled date for beginning fabrication, and shall not begin fabrication until the OWNER's Inspector is present, if applicable. The Fabricator shall meet the AREMA recommendations for Fracture Control Plan for all members and components designed as fracture critical.
- C. Welding: Welding Inspection shall verify that all welds and welding procedures meet the requirements of the American Welding Society (AWS) Bridge Welding Code, current edition and all addenda to it. All welds shall be inspected visually and by use of nondestructive testing. All nondestructive testing shall be performed by the Fabricator and witnessed by the OWNER's Inspector. Witnessing of weld inspection shall be done in a timely manner without disruption of normal shop operations. Copies of all weld inspections and nondestructive testing reports shall be submitted to the OWNER.

The Fabricator shall perform the following weld inspection and testing:

1. All transverse tension groove welds in FCM members, when allowed by the ENGINEER, shall be RT and UT tested 100%. In non-FCM components of FCM's all transverse groove welds shall be RT and UT tested 100%.
  2. Butt welds in both girder flanges and girder webs shall be 100% radiographed.
  3. 50% of flange to web welds shall be inspected by ultrasonic inspection method.
  4. 10% of all other welds shall be inspected by ultrasonic or magnetic particle procedures.
  5. Deck plate to floor beam or longitudinal girder welds may be visually inspected.
- D. Welded Connections: Workmanship and technique, qualification of welders and welding operators, and inspection for field welded connections shown on the plans or authorized by the ENGINEER shall be in accordance with the ANSI/AASHTO/AWS D1.5 Bridge Welding Code. Only submerged arc welding (SAW) or shielded metal arc welding (SMAW) may be used. No other process will be allowed.

### **3.2 ERECTING**

- A. Methods: Before starting work, the CONTRACTOR shall submit the method they proposes to follow, and the amount and character of equipment their proposing to use, which shall be subject to the approval of the ENGINEER. The approval of the ENGINEER shall not be considered as relieving the CONTRACTOR of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the plans, specifications and special provisions.

- B. Field Welding: No field welding or flame cutting will be allowed on the steel spans unless shown on the Plans or authorized in writing by the ENGINEER. Tack welding, for the purpose of eliminating field erection bolts or for holding steel parts together while bolting, will not be permitted.
- C. Falsework: The CONTRACTOR shall provide the falsework, special erecting devices and all tools, machinery work. Drift pins sufficient to fill at least  $\frac{1}{4}$  of the bolt holes for main field connections shall be provided. The falsework shall be constructed in accordance with the CONTRACTOR's plans, approved by the ENGINEER, and shall be properly maintained. Equipment for removing falsework shall not be operated upon or attached to any portion of the new structure.
- D. Placement: All steel beams or girders placed shall be securely tied and/or braced to prevent overturning immediately after erection, and until diaphragms, floor beams or cross frames are permanently in place. The methods to be used shall be submitted on the erection drawings. When railroad or roadway traffic must be maintained beneath girders or beams already placed, traffic shall be protected against falling objects during the erection of diaphragms and other structural members, during the placing of cast-in-place concrete and during the erection and dismantling of forms. The protection shall consist of nets and/or flooring with no larger than 1-inch openings.

### 3.3 ASSEMBLING STEEL

- A. Accuracy: All parts shall be accurately assembled as shown on the plans and any match marks carefully followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will damage or distort the members will not be permitted. Drifting done during erection shall be only such as required to bring the parts into position and enlarging the holes or distorting the metal will not be permitted.
- B. Bolts: Fitting up bolts shall be  $\frac{1}{16}$  inch less in diameter than the hole, and cylindrical erection pins shall be  $\frac{1}{32}$  inch less in diameter than the hole.
- C. Truss Spans: Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber until all lower chord splices are fully connected, as called for on the plans, and all other connections are made with pins and fitting up bolts. Trusses erected by the cantilever method shall have all lower chord splices fully connected before the span is swung on intermediate falsework or permanent shoes. If necessary, such as in the case of high falsework subject to settlement, jacks shall be provided under panel points to enable making necessary adjustments to facilitate fitting up without heavy drifting. Splices of butt joints in compression members shall not be fully connected until the span has been swung. Full bearing shall be secured on milled surfaces that are designed to bear.
- D. Sole Plates: Sole plates on beams and girders shall be in full contact with bearings before diaphragm, cross frame, or floor beam connections are made. Connections shall be adjusted as necessary, under the direction of the ENGINEER, to obtain full contact.
- E. Handrails: Bridge handrails shall be erected plumb and in line in accordance with the drawings. Maximum vertical tolerance is  $\pm \frac{1}{4}$  inch from plumb line over the full vertical height. Maximum horizontal tolerance is  $\pm \frac{1}{2}$  inch over the full length of the bridge rail.

### 3.4 MISFITS AND STRAIGHTENING OF BENT MATERIAL

- A. Corrections: The correction of minor misfits involving harmless amounts of reaming, cutting, and chipping, and the straightening of minor cases of bent bars, plates, and the outstanding legs of angles, etc., shall be considered a legitimate part of the erection and shall be done by the CONTRACTOR at his expense. However, any error in the shop fabrication, or deformation resulting from handling and transportation which prevents the proper assembling and fitting up of parts by the moderate use of drift pins, or by a moderate amount of reaming, slight chipping or cutting, shall be reported immediately to the ENGINEER who will specify the method of correction to be used by the CONTRACTOR. The correction shall be made in the ENGINEER's presence.
- B. Straightening: The straightening of bent materials, when permitted by the ENGINEER, shall be done by methods that will not produce fracture or other damage. Distorted members shall be straightened by mechanical means or, if approved by the ENGINEER, by the carefully planned and supervised application of a limited amount of localized heat. The temperature of the heated area shall not exceed 1200 degree F (a dull red which may not be visible in bright sunlight) as controlled by temperature indicating crayons, liquids or bimetal thermometers. Parts to be heat straightened shall be substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat. After heating and straightening, the metal shall be cooled as slowly as possible. Following the straightening of a bend or buckle, the surface of the metal shall be carefully

inspected for evidence of fracture.

### 3.5 BEARINGS AND ANCHORAGE

- A. Bearing Surfaces: Bearing surfaces shall be cleaned of all dirt, loose rust and mill scale, grease, and paint just before the members are assembled. Wire brushes, scalers, solvents or flame shall be used to clean the surfaces under the direction of the ENGINEER. The area of concrete under bearings shall be bush-hammered if necessary to provide a full and even bearing at the correct elevation. When the bridge seat is more than 1/8 inch below plan elevation, the bearings shall be raised to grade on steel plate of the same size as the bearing. The plates shall be provided by the CONTRACTOR at his expense and attached to the bearings in a manner satisfactory to the ENGINEER.
- B. Setting: Portland cement in a stiff paste form shall be spread over the bush-hammered areas just before the bearings are set. The maximum amount of cement which will be permitted will be no more than necessary to remove irregularities in the concrete with no intent of raising the bearings. Bearings shall be set level in exact position and shall have full and even bearing upon the bridge seat areas. All bearings shall be set so as to be at the proper location at a temperature of 60 degree F under full dead load. At this temperature, rockers shall be vertical, bearings shall be centered under the structure center line of bearing, and sliding plates shall be centered on the bearing plates. Finished surfaces of bearings in moving contact shall be cleaned and greased when the bearings are placed.
- C. Anchor Bolts: Every effort shall be made by the CONTRACTOR to have all anchor bolts cast-in-place. If necessary, the following procedure shall be followed for installing anchor bolts after concrete has set. Holes for anchor bolts shall be drilled in the bridge seat in exact locations. Holes shall be approximately 1/4 inch larger in diameter than the bolt. An approved liquid type epoxy supplied by the CONTRACTOR at his expense shall be used to set the anchor bolts. Before placing the bolts, the holes shall be cleaned of all dust and loose material by flushing with water, after which holes shall be blown dry. After all steel is in place and the bearings are set, the anchor bolts shall be set accurately with sufficient epoxy placed in the bottom of the holes so that after a bolt is inserted, the hole will be completely filled. The bolts shall not be disturbed in any way for at least 24 hours, or until the epoxy is set. Mixing and use of epoxy shall be as recommended by the manufacturer of the epoxy. If the CONTRACTOR has an alternative method, he shall submit the complete procedure to the ENGINEER for approval.

### 3.6 CONNECTIONS

- A. Pin Connections: All packing washers, if any, must be in place when the work is assembled. While pins are being driven into place, threads shall be protected by pilot and driving nuts supplied by the CONTRACTOR. After nuts are tightened, the threads adjacent to the nut shall be burred a minimum of two threads at two locations opposite of each other.
- B. High Strength Bolted Connections: Connections shall be accurately fitted up before high strength bolts are placed. A sufficient number of the holes at a connection point shall be filled with erection pins to "fair-up" all holes. Light drifting will be permitted, but drifting to match unfair holes will not be permitted. Such holes shall be reamed or drilled under the direction of the ENGINEER. All material within the grip of the bolt shall be steel. There shall be no compressible material such as gaskets or insulation within the grip. Unless otherwise indicated on the plans, bolts oriented vertically shall be installed with the heads on top of the connected pieces.
- C. Surface Conditions: All joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of dirt, loose rust, loose scale, burrs and other matter that will prevent solid seating of the parts. Unless otherwise shown on the plans, faying surfaces of all non-galvanized joints, including splice plates, shall be given a blast cleaning, in accordance with the requirements of the Steel Structures Painting Council Specifications SSPC-SP7 Brush-Off Blast Cleaning, and shall be free of loose rust prior to final bolting. Galvanized faying surfaces shall be roughened by hand wire brushing prior to final bolting. When shown on the plans, faying surfaces shall be blast cleaned and coated with a paint that provides the specified mean slip coefficient as determined by the "Test Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints" as adopted by the Research Council on Structural Connections. Coated joints shall not be assembled before the coating has cured for the minimum time used in the qualifying test.

### 3.7 FASTENERS

- A. Handling and Storage of Bolts and Nuts: Bolts and nuts shall be protected from dirt and moisture at the job site. Only as many fasteners as are anticipated to be installed and tightened during a work day shall be taken from protected storage. Fasteners not used shall be returned to protected storage at the end of the day. Fasteners shall not be cleaned of lubricant that is present in the as-delivered condition. Fasteners that show signs of rust or dirt shall be cleaned and

lubricated prior to installation. Any additional lubrication required must be applied prior to installing bolts in the holes. ASTM A325 or A490 bolts and associated nuts and washers shall be identified by rotational-capacity lot number and stored in a manner that will retain this identification.

- B. Installation:** Bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element to be turned in the tightening. In addition, a hardened washer shall be used under the non-turned element of ASTM A490 bolts if the material against which it bears has a specified minimum yield point less than 40 ksi.
1. Bolts must be used with nuts and washers from the same rotational-capacity lot.
  2. Tightening of high strength bolts shall be accomplished by the “turn-of-nut” method according to sub-section 3.7.C. A Skidmore-Wilhelm Bolt Calibrator or equal is required on each job per sub-section 3.7.C.
  3. Hole Diameter: If the hole diameter is more than 1/16 inch greater than the nominal bolt diameter, hardened washers shall be placed under both head and nut. Where necessary, washers may be clipped on one side to a point not closer than seven-eighths of the bolt diameter from the center of the washer.
  4. Surfaces of bolted parts in contact with the bolt head, nut or flat hardened washer shall not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. When an outer face of the bolted parts has a slope of more than 1:20, a smooth hardened beveled washer shall be used to compensate for the lack of parallelism. If required because of bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. All bolts shall be tightened to give at least the required minimum bolt tension values shown in Table 1 on completion of the joint:

**Table 1: Bolt Tension**

| Nominal Bolt Size,<br>Inches | Minimum Tension in Pounds |                 |
|------------------------------|---------------------------|-----------------|
|                              | ASTM A325 Bolts           | ASTM A490 Bolts |
| 1/2                          | 12,000                    | 15,000          |
| 5/8                          | 19,000                    | 24,000          |
| 3/4                          | 28,000                    | 35,000          |
| 7/8                          | 39,000                    | 49,000          |
| 1                            | 51,000                    | 64,000          |
| 1-1/8                        | 56,000                    | 80,000          |

**C. Turn-of-Nut Tightening:**

1. Sample: A representative sample of not less than three bolts and nuts of each diameter, length and grade to be used in the work shall be checked at the start of work in a device capable of indicating bolt tension (Skidmore-Wilhelm Bolt Calibrator or equal). The test shall demonstrate that the method of estimating the snug tight condition and controlling turns from snug tight to be used by the bolting crews develops a tension not less than 5 percent greater than the tension required by Table 1.
2. Tightening: Bolts shall be installed in all holes of the connection and brought to a snug tight condition. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Snug tightening shall progress systematically from the most rigid part of the connection to the free edges, and then the bolts of the connection shall be retightened in a similar systematic manner as necessary until all bolts are simultaneously snug tight and the connection is fully compacted.
3. Rotation: Following this initial operation, all bolts in the connection shall be tightened further by the applicable amount of rotation specified in Table 2. During the tightening operation, there shall be no rotation of the part not turned by the wrench. Tightening shall progress systematically from the most rigid part of the joint to its free edges. Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. For bolts installed by 1/2

turn and less, the tolerance should be plus or minus 30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.

**Table 2: Nut Rotation from Snug Tight Condition**

| Bolt length (Under side of head to end of bolt) | Disposition of Outer Face of Bolted Parts |   |   |
|---|---|---|---|
|   | Both faces normal to bolt axis            | One face normal to bolt axis and other face sloped not more than 1:20 (beveled washer not used) | Both faces sloped not more than 1:20 from normal to the bolt axis (beveled washer not used) |
| Up to and including 4 diameters                 | 1/3 turn                                  | 1/2 turn  | 2/3 turn  |
| Over 4 diameters but not exceeding 8 diameters  | 1/2 turn                                  | 2/3 turn  | 5/6 turn  |
| Over 8 diameters but not exceeding 12 diameters | 2/3 turn                                  | 5/6 turn  | 1 turn  |

- 4. Torque: ASTM A490 bolts and galvanized ASTM A325 bolts shall not be reused after having once been fully torqued. These same type bolts may be used for both fitting up and final bolting if tightened to no more than snug fit during fitting up. Other ASTM A325 bolts may be reused after having been torqued only once if approved by the ENGINEER.

**END OF SECTION 000190**

## **PART 1 – GENERAL**

### **1.1 DESCRIPTION**

- A. **CONTRACTOR:** The CONTRACTOR shall furnish all labor, tools, equipment and material necessary for BEARINGS AND ANCHORAGE in accordance with the plans and as specified herein.
- B. All operations shall be conducted so as not to interfere with, interrupt, or endanger the operation of trains or damage, destroy, or endanger the integrity of RAILROAD facilities.

### **1.2 SUBMITTALS**

- A. **Submittals:** The CONTRACTOR shall prepare and deliver technical submittals for review and approval of the ENGINEER. All submittals must be approved before related work may begin. Listed below are submittals required for this item of work, additional submittals may be required due to site conditions or the nature of the work. In order to maintain correspondence records each submittal shall be assigned a submittal number and transmittal number for use by the CONTRACTOR and the ENGINEER. For additional information regarding each submittal refer to the appropriate section of this specification.
  - 1. Detailed plans signed and sealed by a Licensed Engineer in the State which the project is in.
- B. **Shop Drawings:** CONTRACTOR shall furnish one (1) complete electronic copy of detailed shop drawings for approval prior to starting fabrication. By approving and submitting shop drawings, the CONTRACTOR thereby represents that they have determined and verified all field measurements, field construction criteria, materials, catalog numbers and similar data, or will do so, and that they have checked and coordinated the shop drawings with the requirements of the work and of the contract documents. After approval of shop drawings, the CONTRACTOR shall supply the SCDOT with one (1) set of reproducible approved drawings.
- C. **Submittal Review:** Approval by the ENGINEER is only for the purpose of confirming compliance with the contract plan and specifications. Approval shall not relieve the CONTRACTOR from responsibility for correctness, quantity and quality, nor for completeness of Work in accordance with the plans and specifications.

### **1.3 MEASUREMENT AND PAYMENT**

- A. Measurement of Payment, BEARINGS AND ANCHORAGE, as shown on the drawings, as specified in this Section and as accepted in the final work, shall be on a LUMP SUM basis.
- B. Payment for BEARINGS AND ANCHORAGE, measured as stated above, will be at the contract unit price per LUMP SUM bid. Said unit price shall be full compensation for furnishing all labor, materials, tools, equipment, forms, supplies, accessories, supervision, engineering and all other items of expense for FURNISHING AND INSTALLING BEARINGS AND ANCHORAGE.

| Item Number | Description           | Unit |
|-------------|-----------------------|------|
| 000195      | Bearing and Anchorage | LS   |

## **PART 2 MATERIAL**

### **2.1 GENERAL**

- A. All bearing and anchorage devices shall be designed in accordance with applicable AREMA recommendations.
- B. Bearing stresses in concrete shall not exceed applicable AREMA recommendations.

### **2.2 HANDLING AND STORING MATERIALS**

- A. All materials shall be handled and stored according to manufacturer's recommendation.
- B. Any bearing / anchorage device that has been damaged, according to the ENGINEER, shall be replaced at the expense of the CONTRACTOR.

## **PART 3 EXECUTION**

### **3.1 EXECUTION**

- A. Construction and installation of bearings and anchorage devices shall be in accordance with all applicable AREMA recommendations.

**END OF SECTION 000195**



## **PART 1 – GENERAL**

### **1.1 DESCRIPTION**

- A. CONTRACTOR: The CONTRACTOR shall furnish all labor, tools, equipment and material necessary for the design and installation of HANDRAIL in accordance with the plans and as specified herein.
- B. Provisions: Design of handrails and railings shall, at minimum, comply with OSHA 1910.23(e).

### **1.2 SUBMITTALS**

- A. Submittals: The CONTRACTOR shall prepare and deliver technical submittals for review and approval of the ENGINEER. All submittals must be approved before related work may begin. Listed below are submittals required for this item of work, additional submittals may be required due to site conditions or the nature of the work. In order to maintain correspondence records each submittal shall be assigned a submittal number and transmittal number for use by the CONTRACTOR and the ENGINEER. For additional information regarding each submittal refer to the appropriate section of this specification.
  - 1. Product data;
  - 2. Product specifications;
  - 3. Material Certifications;
  - 4. Plans showing location of handrail required with all necessary dimensions, and detail drawings showing standard handrail elevations, typical connections, anchoring systems, and expansion joints.
- B. Shop Drawings: CONTRACTOR shall furnish one (1) complete electronic copy of detailed shop drawings for approval prior to starting fabrication. By approving and submitting shop drawings, the CONTRACTOR thereby represents that they have determined and verified all field measurements, field construction criteria, materials, catalog numbers and similar data, or will do so, and that they have checked and coordinated the shop drawings with the requirements of the work and of the contract documents. After approval of shop drawings, the CONTRACTOR shall supply the SCDOT with one (1) set of reproducible approved drawings.
- C. Submittal Review: Approval by the ENGINEER is only for the purpose of confirming compliance with the contract plan and specifications. Approval shall not relieve the CONTRACTOR from responsibility for correctness, quantity and quality, nor for completeness of Work in accordance with the plans and specifications.

### **1.3 MEASUREMENT AND PAYMENT**

- A. Measurement of Payment, HANDRAIL, as shown on the drawings, as specified in this Section and as accepted in the final work, shall be on a LINEAR FOOT basis.
- B. Payment for HANDRAIL, measured as stated above, will be at the contract unit price per LINEAR FOOT bid. Said unit price shall be full compensation for furnishing all labor, materials, tools, equipment, forms, supplies, accessories, supervision, engineering and all other items of expense to design and install HANDRAIL.

| Item Number | Description | Unit |
|-------------|-------------|------|
| 000205      | Handrail    | LF   |

## **PART 2 - MATERIAL**

### **2.1 GENERAL**

- A. Rails: 1-1/2" diameter, Schedule 40, ASTM B429 or b221, 6061-T6, 6105-T5, or 6063-T6 aluminum alloy, extruded pipe.
- B. Posts: 1-1/2" diameter, Schedule 80 or Schedule 40 with solid aluminum inserts (minimum 18" long), ASTM B241, 6061-T6 aluminum alloy, extruded pipe.
- C. Fittings: Elbows, T-shapes, wall brackets, escutcheons shall be machined aluminum.
- D. Splice connectors: concealed spigot; cast or machined aluminum.

- E. Mounting: cast or extruded aluminum brackets, base flanges for horizontal surfaces, and angled base flanges for stair stringers and ramps.
- F. Hardware: mechanically connect pipe and fittings together with stainless steel hardware. No pop rivets, sheet metal screws, or self-tapping screws permitted. No glued or welded connections permitted.
- G. Aluminum surfaces: two-step anodized to clear color, Architectural Class I, minimum 0.7 mil thickness.

## **2.2 HANDLING AND STORING MATERIALS**

- A. Handling: All material shall be handled in a manner which will prevent members from being distorted or damaged. Stored material shall be piled securely, and no material shall be placed closer than 25 feet to the centerline of the nearest tracks. Material shall be placed on level platforms, skids, or other supports above the ground and shall be kept clean and properly drained.
- B. Shipping: All materials shall be carefully loaded so as to avoid damage in transit. Members weighing more than 3 tons shall have the weight marked thereon. All small parts such as bolts, pins, washers, and small connection plates shall be packed in containers of adequate strength. The contents of each unit shall be plainly marked on the top of each container.

## **PART 3 - EXECUTION**

### **3.1 EXECUTION**

#### **A. Design Requirements:**

1. Railing assembly, handrails, and attachments shall be designed for a single load of 200 pounds, applied either laterally or vertically, and at any point in the span. Posts shall be designed for a single load of 200 pound acting either laterally or vertically, applied at point of attachment of top railing.
2. Posts shall be a single unspliced length and maximum spacing is 5'-0" center-to-center.
3. Rails: Top rail shall be continuous wherever possible and shall be attached to a minimum of three posts. Lower rails shall be single unspliced length between posts.
4. Make provisions for expansion and contraction of top rails and toe plates. Expansion joints shall be placed at maximum 25 feet intervals and at all concrete expansion joints.
5. Top of handrail shall be not less than 3'-6" above surface of walkways. An intermediate rail, or rails, shall be provided, with center to center space between rails, or between rail and top of walkways, not to exceed 1'-9".

#### **B. Fabrication:**

1. Fit and shop assemble components in largest practical sizes for delivery to site.
2. Fabricate components with joints tightly fitted and secured. Provide mechanical fittings to accommodate site assembly and installation.
3. Provide anchors, brackets, and base flanges required for mounting and anchoring railings.
4. Exterior components: drill condensate drainage holes at bottom and low point of members at locations that will not encourage water intrusion.
5. Make exposed joints butt-tight, flush, and hairline. Ease exposed edges to small uniform radius.
6. Accommodate for expansion and contraction of members without damage to connections or members.
7. Wrap pipe in plastic wrap to protect finish. Maintain during fabrication, transportation, and erection.

#### **C. Installation:**

1. Install in accordance with manufacturer's instructions.
2. Install components plumb and level, straight and true, accurately fitted, free from distortion or defects.
3. Assemble with mechanical fittings to accommodate tight joints and secure installation.
4. At time approved by ENGINEER, remove protective wrap. Clean handrail with mild soap and water. Do not use solutions, steel wool, or abrasives.

**END OF SECTION 000205**

## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A. CONTRACTOR shall furnish and place crushed stone or crushed gravel as shown on Project Drawings.

### **1.2 MEASUREMENT AND PAYMENT**

- A. Measurement for the item SUBBALLAST will be the number of square yards measured along the surface of the subballast and authorized by the ENGINEER. Subballast installed in excess of the design area shall not be included in the measurement unless authorized by the ENGINEER in writing. Permanent access roads on the plans or as directed by the ENGINEER will be included in the measure. Temporary access roads for the benefit of the CONTRACTOR and construction will not be measured. Note that the CONTRACTOR is to coordinate tolerances of earthwork activities and subballast to obtain a six inch thick layer of subballast. Thicknesses in excess of six inches will not result in increasing the area measurement this item is based on. Obtaining the proper thickness of subballast is a part of this item and critical.
- B. Payment at the unit price bid shall be full compensation for all labor, material, equipment, tools, supplies, and all else necessary to supply, transport, unload, haul, properly place and compact the subballast. The cost of supplying and applying water to obtain the specified density shall be included in the Bid price.

| Item No. | Description | Unit |
|----------|-------------|------|
| 000250   | Subballast  | SY   |

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Subballast shall be composed of crusher run granite or limestone in conformance with the following gradation requirements:

| Screen Size | Percent Passing Graded Aggregate | Weight passing Crusher Run |
|-------------|----------------------------------|----------------------------|
| 1 1/2"      | 100%                             | 100%                       |
| 3/4"        | 60%-100%                         |                            |
| No. 10      | 30%-55%                          | 15%-45%                    |
| No. 60      | 8%-35%                           |                            |
| No. 200     | 5%-20%                           | 5%-12%                     |

- B. CONTRACTOR may substitute the governing DOT material for subbase with similar qualities to the MWI 301 Specification. Material shall be in conformance with DOT specifications in effect at the time of the project bid.
- C. Subballast materials shall be submitted to ENGINEER for approval prior to placing and transporting.

## **PART 3 - EXECUTION**

### **3.1 EXECUTION**

- A.** All rutting or displacement of the subgrade shall be smoothed and re-compacted by CONTRACTOR before the placement of any subballast. If the subballast is subject to construction equipment traffic causing displacement or excess compaction, CONTRACTOR shall, at no extra cost to OWNER, bring the sub ballast back to the designated density and grade.
- B.** CONTRACTOR shall not place subballast on a wet, snow covered or icy roadbed.
- C.** Subballast shall be placed in loose lifts of 3 inches and compacted to not less than 95% of its dry weight density as determined by the Modified Proctor Density Test ASTM D 1557. If additional moisture is required to obtain adequate density, then CONTRACTOR shall use water along with approved mixing, shaping and compaction equipment.
- D.** The thickness of the finished subballast shall have a tolerance of plus or minus 0.05 ft to the design thickness. Thickness of subballast shall be monitored throughout construction. Thickness found to be less than tolerance must be corrected by adding additional subballast material. Thicknesses found to be greater than the tolerance can be removed by the CONTRACTOR or left in place.
- E.** The subballast shall be placed with a descending grade of 2% away from the adjacent track in double track territory or away from the centerline in single track territory.

**END OF SECTION 000250**

## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A. The CONTRACTOR shall furnish all labor, tools, equipment and material necessary to monitor existing structures, track and temporary works during construction. The CONTRACTOR shall establish monuments prior to construction, maintain monuments throughout construction and collect measurements at regular established intervals. For additional requirements, see Specification No. 21, Exhibit 5 of the RFP.
- B. Site specific guidelines including allowable deflections, settlements, monitoring and reporting frequency, and any other pertinent data will be provided by CSXT authorized representative during or immediately after the Preconstruction Conference.

### **1.2 SUBMITTALS**

- A. The CONTRACTOR shall submit a plan for monitoring all existing structures during the installation or removal of temporary shoring, as well as during dewatering operations. The CONTRACTOR shall submit a plan for the monitoring of temporary shoring throughout the use of the temporary shoring. Submitted plans shall be subject to the review and approval of CSXT or their authorized representative.
- B. Excessive settlement or vibrations detected shall be immediately reported to CSXT representatives and SCDOT. All work activities shall be stopped immediately and corrective measures shall be taken to ensure the stability of the structure and track is restored. Work shall not resume until approval is given by CSXT.

### **1.3 DAMAGES**

- A. The Contractor shall be responsible for and shall repair without cost to the Department any damage to existing structures, temporary works, equipment, roadways or equipment

### **1.4 MEASUREMENT AND PAYMENT**

- A. No measurement or payment will be made with regard to monitoring the existing structures. The costs associated with all items above shall be included in pay items for Item Number 7120006 - Drilled Shaft Set-Up, Item Number 2047000 - Temporary Shoring and Item Number 2041010 - Dewatering.

## **PART 2 - MATERIAL (NOT USED, SEE PART 1)**

## **PART 3 - EXECUTION (NOT USED, SEE PART 1)**

**END OF SECTION 000260**

## **PART 1 - GENERAL**

### **1.1 DESCRIPTION**

- A. Due to the potential for encountering groundwater during construction, dewatering systems shall be implemented as required. The Contractor shall implement an avoidance strategy with respect to dewatering. Localized dewatering to the extent required for construction shall be performed and shall be minimized. The Contractor shall account for the effects of dewatering on nearby structures within the vicinity of the dewatering operations including an appropriate monitoring program to measure movement of the existing bridge foundations. The monitoring program and acceptable movement thresholds shall be determined in accordance with CSX requirements. See Special Provision 000260 Monitoring Structures.

### **1.2 GENERAL**

- A. The Contractor shall be responsible for identifying, treating, and disposing of any groundwater deemed as hazardous in accordance with the contract documents.
- B. The Contractor, or subcontractor, shall be experienced in construction dewatering on projects of similar size and complexity, in geology similar to that present at this site. The Contractor shall be responsible for collecting subsurface data to facilitate dewatering design, if needed.
- C. The Contractor shall control, by acceptable means, all water regardless of source and shall be responsible for disposal of the water in accordance with the contract documents. The Contractor shall confine all discharge piping and/or ditches to the available easement or to easement obtained by the Contractor. The discharge shall be arranged to facilitate collection of samples by the Department.
- D. Control of groundwater shall be accomplished in a manner that will preserve the strength of the foundation soils, will not cause instability of the excavation slopes or temporary shoring, and will not result in damage to existing structures. The Contractor shall implement an avoidance strategy with respect to dewatering. Where necessary, localized dewatering to the extent required for construction shall be performed but shall be minimized. Deep wells or well points that would generate global dewatering of the site are not allowed. The water level within the excavation is to be maintained at an elevation adequate for construction of the proposed element.
- E. Open pumping with sumps and ditches, if it results in boils, loss of fines, softening of the ground, or instability of slopes, will not be permitted.

### **1.3 SUBMITTALS**

- A. The Contractor shall provide a detailed plan for dewatering excavations and shall submit a Dewatering Plan to the Department for review and approval. The Dewatering Plan shall be signed and sealed by a licensed Professional Engineer in the state of South Carolina. The Dewatering Plan shall include, but not be limited to, the following:
1. The qualifications and experience of the Contractor or Subcontractor for equivalent systems (minimum of 5 years of proven experience in the design of equivalent systems required);
  2. Drawings showing the soil conditions, stratification, and characteristics; location and size of dewatering equipment; sumps and discharge lines, ditches, or other conveyance measures; monitoring instrumentation and structures potentially impacted; water and sediment discharge sampling details;
  3. Catalog cuts showing capacities of pumps, prime movers, and standby equipment;
  4. Design calculations including design parameters and basis of parameters, characteristics of pumping equipment, manifold or piping layout, and radius of influence of the water table drawdown;
  5. Detailed description of procedures and data forms for installing, maintaining, and

- monitoring performance of the system and movement of adjacent structures; and
6. Permits, permit revisions, and design of Best Management Practices for discharge points.
- B.** Submit seven copies of the Dewatering Plan to the Preconstruction Support Engineer a minimum of 21 days prior to installation of the system. Send a copy of the transmittal letter to the RCE. Drawings shall be Plan Size A or B (see Section 725 of the Standard Specifications).
- C.** Notice to Proceed issued by the Department or receipt of the Dewatering Plan and data submitted by the Contractor shall not in any way be considered to relieve the Contractor from full responsibility for errors therein or from the responsibility for complete and adequate design and performance of the system in controlling the groundwater in the excavated areas.

**1.4 DAMAGES**

- A.** The Contractor shall be responsible for and shall repair without cost to the Department any damage to work in place, other Contractor's equipment, utilities, residences, businesses, highways, roads, railroads, private and municipal well systems, and the excavation, that may result from his negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system.

**1.5 SYSTEM REMOVAL**

- A.** The Contractor shall remove all dewatering facilities from the site.

**1.6 MEASUREMENT AND PAYMENT**

- A.** Payment for the accepted dewatering system, as specified herein, measured in accordance with this specification, is determined using the contract unit bid price for the applicable pay item. Payment is full compensation for the Department's acceptance of the Dewatering Plan, installation and successful operation of the dewatering system, operation of the dewatering system during excavation and backfilling operations, and removal of the dewatering system as required in the Plans and Project Specifications.

The Department will pay for the accepted quantities at the contract prices as follows:

| Item    | Description        | Unit |
|---------|--------------------|------|
| 2041010 | DEWATERING SYSTEMS | LS   |

**PART 2 - MATERIAL (NOT USED, SEE PART 1)**

**PART 3 - EXECUTION (NOT USED, SEE PART 1)**

**END OF SECTION 000240**

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