SPECIAL PROVISIONS FOR ARCH RIB CONCRETE

Scott County
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April 25, 2017

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150200.01 DESCRIPTION.

A. The work consists of furnishing and installing the concrete for the arch rib and cross beam for Piers 12 and 13 as shown in the plans.

B. The Arch Rib Concrete shall be patched at areas of form ties, locations where cooling pipes enter or exit the pier or any abnormality such as opening in forms for the placement of the concrete. The final color of the patch concrete shall match the final color of the Arch Rib Concrete.

150200.02 MATERIALS.

A. If High Performance Self Consolidating Concrete (HP-SCC) is used, the Arch Rib Concrete shall meet the requirements of the Special Provisions for High Performance Self Consolidating Concrete (HP-SCC).

B. If High Performance Concrete for Structures (HPC) is used, the Arch Rib Concrete shall meet the combined requirements of the Developmental Specifications for High Performance Concrete for Structures (HPC) and the Developmental Specifications for Structural Concrete (4500 psi or Greater).

150200.03 CONSTRUCTION.

A. Quality Control Plan.

1. The Contractor shall submit for approval a written Quality Control Plan describing the procedures to be used to control the production and placement of Arch Rib Concrete. The Quality Control Plan shall be developed by a Professional Engineer licensed in the State of Iowa with experience in the design, quality control and placement of arch rib concrete or similar large and complex structural elements, as well as, the design of formwork for full static pressure. This Engineer shall submit a list containing at least three concrete projects, of

similar dimension and requirements to those shown on the plans, completed in the last three years. In the list of projects include names and phone numbers of owner's representatives who can verify the engineer's participation on those projects. This engineer shall also work in conjunction with the admixture supplier technical representative to develop the mix design. When the elements being placed meet mass concrete criteria, this engineer shall also follow the procedures outlined in the Developmental Specification for Mass Concrete - Control of Heat of Hydration.

2. The Contractor shall submit the Quality Control Plan at least 30 calendar days before the first intended structural concrete placement. No structural concrete shall be placed before receiving written approval from the engineer of the Quality Control Plan and having all equipment and materials necessary to facilitate the plan on site and ready for use.

3. The Quality Control Plan shall include, but not be limited to the following:
- **a.** Define concrete batching sequence, mixing time, and minimum revolutions to prevent cement balls and mix foaming. Include procedures for ensuring wash water is removed before batching.
- **b.** Define concrete placement pattern and methods. Include maximum horizontal flow distance from point of discharge.
- **c.** Describe the required qualification of personnel performing testing of arch rib concrete.
- **d.** Describe additional quality control procedures at the plant to ensure consistent delivery of concrete.
- **e.** Define field procedures to accept or reject concrete during production.
- **f.** Provide stability analysis of proposed formwork for full static pressure and proposed methods used to prevent leakage or the Contractor shall test the concrete to determine the rate of placing the concrete to meet the acceptable design formwork pressure.

B. Trial Batch Concrete.

1. All testing will be performed by a qualified testing laboratory. The District Materials Engineer may witness the trial batching. Provide the District Materials Engineer notice and mix proportions 7 calendar days prior to this event.

2. Mix the trial batch (a minimum of 3 cubic yards in size) at least 30 calendar days prior to planned placement. Establish the batching sequence of the materials during the trial batch.

3. Transport the concrete a distance comparable to the distance from the ready mix plant to the placement site.

4. Test concrete samples that are representative of the entire batch for air content, slump flow, visual stability index, J-Ring, density (unit weight), the static segregation using column technique and temperature. Cast specimens from each sample for compressive strength tests. Modify the consolidation method of all materials test procedures, including Materials I.M.’s 315, 316, 318, and 340, by placing the concrete in the molds in one layer without vibration or tamping.

5. Determine the workability of the concrete by performing a slump flow test every 15 minutes until the slump flow reaches the target slump flow less 5.0 inches. From the slump loss flow curve, determine the cut-off time at the lower tolerance range value.

6. Submit a trial batch report to the District Materials Engineer no later than 7 calendar days after trial batching. Include the following in the report:

Cover Page	Contractor and Producer Name Project Number Date and Location of HP-SCC Trial Batch Date Submitted Signature of Contractor/Producer Representative
Material Source Information	Brand, Type, and Source
Material Proportion Information	Specific Gravity Relative % of Each Individual Aggregate Target Combined Gradation (Materials I.M. 531) Target Combined Gradation Charts (Materials I.M. 532) Design and As Mixed Batch Weights (Mass) (SSD) Design and As Mixed w/c Ratios
Mix Properties	Air Content of Plastic Concrete Slump flow Visual Stability Index (VSI) Passing ability by J-Ring test Static segregation by column technique

7. The qualified testing laboratory will cast samples and transport them to their laboratory for testing. Trial batch concrete will be tested for permeability and strength. All samples will be cast, cured, and handled according to Materials I.M. 315. One permeability and six strength samples will be cast in 4 inch by 8 inch cylinder molds.

8. One cylinder will be sent to the Central Materials Laboratory for rapid chloride permeability testing in accordance with Materials Test Method 412-A or the District Materials Laboratory for resistivity meter testing. Samples for permeability will be delivered within 7 days from casting and will be left in molds and sealed in a plastic bag or placed in container with water. The target value of permeability is 2000 coulombs or less based on the average of two tests or 21 k·ohm-cm or higher when tested by the resistivity meter.

9. Strength samples will be stripped of their molds and wet cured until their break age. Strength samples will be tested according to AASHTO T 22. Three cylinders will be tested for strength at each age of 28 and 56 days. For a mix design without previous experience, the average 28 day compressive strength shall be equal to or greater than 7900 psi. A standard deviation may be established after 30 or more tests.

10. Approval will be based on trial batch mix properties and submittal of a trial batch report. The District Materials Engineer may waive the trial batch testing provided satisfactory mix properties have been achieved through testing of previous trial batches or production placements.

C. Field Demonstration.

1. If a proposed drop height of 6 feet is exceeded or there are proposed deviations from the requirements stated in Section H. Placing Concrete, herein; then the Contractor is required to fabricate a mockup of a portion of the arch rib, to demonstrate placing concrete. The Contractor shall submit shop drawings to the engineer, 30 days prior to fabricating the mockup. The shop drawings shall sealed by a Professional Engineer licensed in the State of Iowa.

2. The following are requirements field demonstration for the mockup:

a. Subsequent to the development of a satisfactory trial batch, perform a field demonstration by casting a mockup of the element as shown in the shop drawings. Obtain approval for the mockup element from the engineer. Ensure that a representative from the admixture manufacturer is present during the field demonstration.

b. Mockup should be in accordance with the shop drawings. It will represent a section of the arch rib, which is the worst case condition of reinforcing steel congestion. It will also be used to verify that the maximum drop height that is allowed for the arch rib is compatible with the contractor's means and methods. If excessive segregation is noted, the contractor must reduce the drop height to a distance that is acceptable.

c. Ensure that the arch rib concrete is mixed, delivered, placed, and consolidated in accordance with proposed methods. Ensure the concrete meets all plastic property requirements.

d. After forms are removed, the engineer will perform a post placement inspection to observe any signs of honeycombs, cracks, aggregate segregation, or other defects. A minimum of one saw cut and two cores will be required to inspect the mockup for any signs of honeycombs, cracks, aggregate segregation, or other defects.

e. If excessive segregation is noted, reduce the drop height to a distance that is acceptable; change the concrete mix, or a combination of both. Cast a new mockup demonstrating means and methods of placing the concrete for approval.

f. Dispose of mockup specimen.

D. Production Concrete.

1. Notify the Engineer 48 hours prior to placement of production concrete. Use only approved Arch Rib Concrete mixes for production concrete. Ensure mix has the same materials, proportions, and properties established in the trial batch.

2. Slump flow, visual stability index, and J-ring test shall be performed by the Contractor on the first truck of the day and every 50 cubic yards thereafter. Slump flow range shall be +/- 2 inches of the mix design target value and shall not exceed 29 inches. The visual stability index shall not exceed 1. The difference between slump flow and J-ring flow shall not exceed 2 inches. The engineer will witness the testing.

3. Test production concrete for strength. An Iowa DOT certified PCC Level I Concrete Field Testing Technician is to cast, cure, and handle strength samples according to Materials I.M. 315. At the site, properly cure the cylinders with wet burlap and plastic. Cast six strength samples in 4 inch by 8 inch cylinder molds for each day of placement greater than 100 cubic yards. Document the air content, slump flow, VSI, passing ability by J-ring test, and water cement ratio (adjusted for all water) of the concrete for the cylinders cast. The Engineer may reduce testing of cylinders to one set per week of production greater than 100 cubic yards after 15 or more sets of samples have been tested and design strength has been exceeded.

4. Strength samples are to be tested by a qualified lab according to AASHTO T 22. Test three cylinders for strength at each age of 28 and 56 days. After 30 or more sets of samples have been tested, testing of the cylinder at 56 days may be waived by the Engineer if the average 28 day strength exceeds the required strength.

5. Submit test results to the Engineer and the District Materials Engineer no later than one working day after testing is completed. In the submittal, clearly indicate (as a minimum) the project number, location, Contractor, producer, structural element constructed, slump flow, VSI, air content, w/c ratio (adjusted for all water), date sampled, date tested, break age, individual compressive strengths, and average compressive strengths. In addition, attach the plant report for the pour to the submittal.

6. The District Materials Engineer will obtain verification strength samples on a minimum of one random placement. Strength samples will be tested at the District Materials Laboratory according to AASHTO T 22. A set of four cylinders will be cast, cured, and handled according to Materials I.M. 315. Three cylinders will be tested for strength at 28 days. One cylinder will be tested for permeability on a random basis by the Central Materials Laboratory or Wenner probe testing performed by the District Materials Engineer.

7. The District Materials Engineer may randomly cast cylinders for static segregation of hardened cylinders in accordance with Material I.M. 390.

E. Quality Control Testing - Plant.
Since controlling water may be critical to producing consistent batches of Arch Rib Concrete, perform aggregate moisture content daily for production greater than 50 cubic yards per day. Increase testing rate to account for changes such as new material delivered, rain events, etc.

F. Falsework and Forms.
Design falsework and forms for full hydrostatic head pressure of the concrete or test the concrete to determine the rate of placing the concrete to meet the acceptable design formwork pressure. Forms shall be tight to prevent leakage of fluid concrete.

G. Non Complying Strength.
When the average 28 day compressive strength does not meet or exceed the specified strength, propose evaluation methods to determine the in place concrete strength. Submit the proposal to the Engineer. Notify the Engineer 48 hours in advance of sampling and testing. The Engineer will witness the sampling and testing of the in-place concrete. The Engineer will review the results and determine corrective action required. The Contractor is responsible for the cost of evaluation and any corrective action required.

H. Placing Concrete.

1. Placing concrete shall meet the requirements of Article 2403.03, C of the Standard Specifications unless stated herein.

2. If concrete is to be placed by pumping, use a pump line with a section reduction to reduce the exit velocity of the pumped concrete and minimize damage to epoxy coated reinforcement. Submit measures for reducing exit velocity of the concrete to the Engineer for approval prior to placement by pumping.

3. Protect epoxy coated reinforcement from damage caused by placing and handling equipment.

4. Open troughs and chutes shall extend as nearly as practicable to the point of deposit. The maximum drop distance for construction of production piers will be established by the concrete placement demonstrated and the subsequent testing of the mockup.

5. Continuous placement of concrete shall be maintained. Do not exceed 30 minutes between placement of successive batches unless engineer has reviewed placement conditions. If emergency delay occurs, concrete shall be rodded with a piece of lumber or conduit if the material has lost its fluidity prior to placement of additional concrete. Any other method for restoring the fluidity of the concrete shall be approved by the Engineer.

6. Any deviation from the construction techniques would require the Contractor to demonstrate the proposed deviations on an additional mockup. The additional arch rib mockup(s) will be at the Contractor's expense.

7. The Contractor has the option of High Performance Self-Consolidating Concrete (HP-SCC) or High Performance Concrete for Structures (HPC) or a combination of the two. If the Contractor elects to use HPC and HP-SCC, the Contractor must demonstrate that a cold joint does not form at the interface between the HPC and HP-SCC, unless noted on the plans. The color of the HPC must match the color of the HP-SCC as close as possible.

I. Curing.

1. Leave forms in place for 96 hours of curing.

2. Leave wet burlap covering in place for 96 hours.

J. Cold Weather Protection.

1. Monitor the surface temperature of the concrete continuously during the curing period using electronic recording type thermometers capable of recording a minimum of one reading per hour. Furnish the information to the Engineer in electronic format as required.

2. If supplemental housing and heating is used, locate temperature monitors in the concrete at the furthest and closest point from the heat source. Verify the maximum temperature at monitor point closest to heat source does not exceed 150ºF.

3. After the required curing period, gradually reduce the temperature of the air surrounding the concrete to outside air temperature according to Article 2403.03, F, of the Standard Specifications.

4. Ensure concrete and its surface temperature are maintained at a temperature of no less than 50ºF for the first 120 hours after placing. Curing time will not be counted if the concrete temperature falls below 50ºF.

150200.04 METHOD OF MEASUREMENT.

Measurement will be as follows:

A. Arch Rib Concrete.
Cubic yards shown in the contract documents. Any additional concrete resulting from the distortion of the formwork or falsework will not be measured.

B. Trial Batch Concrete.
None.

C. Arch Rib Mockup
None.

150200.05 BASIS OF PAYMENT.

Payment will be paid the contract unit price as follows:

A. Arch Rib Concrete.

1. Contract unit price per cubic yard.

2. The cost for testing the production concrete is included in the contract unit price for Arch Rib Concrete.

B. Trial Batch Concrete.
Lump sum.

C. Arch Rib Mockup.

1. Lump Sum.

2. Payment is full compensation for one approved mockup. Payment is for furnishing all materials, tools, and labor for the performance of all work necessary to design, cast, finish,

saw cut, core test and dispose of mockup as indicated. Any additional mockup(s) required to obtain approval for the concrete mix and the means and methods for placing concrete will be at the Contractor's expense.