SP- 150146
(New)

SPECIAL PROVISIONS
FOR
SHRINKAGE COMPENSATING STRUCTURAL CONCRETE

Pottawattamie County
IM-029-3(83)52--13-78

Effective Date
November 15, 2016

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.

150146.01 DESCRIPTION.

A. Provide a concrete mix with shrinkage compensating properties and a minimum compressive strength of 5000 psi, for use as shown in the contract documents. Shrinkage shall be mitigated through the use of a shrinkage reducing admixture (SRA) or through the use of an expansive cement additive.

B. The mix shall be based on Class C or Class HPC concrete. Section 2403 and Division 41 of the Standard Specifications shall apply with the following modifications.

150146.02 MATERIALS.

A. All material shall meet the quality requirements for the respective items in Division 41 of the Standard Specifications.

B. The concrete mix design shall mitigate shrinkage by using either an SRA or an expansive cement additive. The concrete mix design shall be designed to minimize total cementitious content. Cementitious content shall be limited to Type I, Type II or Type IP cement, fly ash and/or GGBFS. Where an expansive cement additive is elected to be used, said expansive cement additive shall be combined with the cementitious content.

C. The concrete mix design shall be shown by a minimum of two samples to evidence the following air void system when tested per ASTM C 457.

1. Maximum air-void spacing factor of 0.008 in.

2. Minimum specific surface of 600 in^2/in^3.

3. Minimum total air content of 5.5%.

D. Concrete mix designs using an SRA shall meet the following additional requirements:

1. The concrete mix design shall be shown by a minimum of two samples to evidence a maximum shrinkage of 0.02% at 28-days when tested per ASTM C 157 with the following modifications:
   a. Initial measurement shall be at 24 hours after casting.
   b. Moist curing shall be terminated after a maximum of 7 days after casting.

2. The SRA selected for use shall be shown to have a successful history of use in comparable highway bridge applications for not less than 5 years.

E. Concrete mix designs using an expansive cement additive shall meet the following additional requirements:

1. The resulting cementitious blend must meet the requirements of ASTM C 845 as a Type K cement and provide expansion from 0.04% to 0.10% at 7 days when tested in accordance with ASTM C 806. The resulting concrete mix incorporating said cementitious blend must provide expansion from 0.05% to 0.09% at 7 days when tested in accordance with ASTM C 878.

2. The expansive cement additive selected for use shall be shown to have a successful history of use in comparable applications for not less than 5 years.

F. Submit mix design to the District Materials Engineer for approval at least 60 calendar days prior to placement. Substantiate mix design with a trial batch and mix in the equipment used to batch production concrete.

G. For a new mix design without previous experience and for which the concrete production facility does not have field data for calculation of the standard deviation, the strength shall be an average of three cylinders and shall provide average compressive strength f'c = 5000 + 1200 = 6200 psi.

150146.03 CONSTRUCTION.

A. Trial Batch Concrete.

1. A trial batch will be required. Approval will be based on trial batch mix properties and submittal of a trial batch report.

2. The District Materials Engineer shall be given notice 7 calendar days prior to this event. The trial batch shall be made at least 30 calendar days prior to planned placement and shall be a minimum of 3 cubic yards in size. Establish batching sequence during trial batch. Transport the concrete a distance comparable to the distance from the ready mix plant to the placement site. Use concrete for testing representative of the entire batch while having a slump within 1 inch of the maximum slump allowed, an intended in place air content of 6% ± 1%, and a w/c ratio that will be typical in the placement. Perform the following tests by a certified laboratory for each trial batch:

Table 150146.03-1: Trial Batch Tests

Specific gravity of each individual aggregate	Materials I.M. 307
Gradation of each individual aggregate	Materials I.M. 302
Unit weight of plastic concrete	Materials I.M. 340
Slump of plastic concrete	Materials I.M. 317
Air content of plastic concrete	Materials I.M. 318
Air void system of hardened concrete	Per Materials section, above
Drying shrinkage (where SRA is proposed for use)	Per Materials section, above
Expansion (where expansive cement additive is proposed for use)	Per Materials section, above

3. Submit a trial batch mix design report and include the following:

Table 150146.03-2: Trial Batch Report

Cover page	Contractor and Producer Name Project Number Date and Location of Trial Batch Date Submitted Signature of Contractor/Producer Representative
Material source information	Brand, Type, and Source
Proportion Information	Specific Gravity Relative % of Each Individual Aggregate Design and As Mixed Batch Weights (SSD) Design and As Mixed w/c Ratios
Mix Properties	Unit Weight of Plastic Concrete Air Content of Plastic Concrete Individual Compressive Strength results at 7 and 28 Days Slump Air Void System of Hardened Concrete per ASTM C 457 as described in the Materials section, above Where an SRA is proposed for use: Drying shrinkage per ASTM C 157 as described in the Materials section, above Where an expansive cement additive is proposed for use: Cementitious Blend Expansion per ASTM C 806 at 7 days Concrete Expansion per ASTM C 878 at 7 days.

B. Production Concrete.

1. Prior to placing production concrete, develop a strength maturity curve in accordance with Materials I.M. 383 based on compressive strength. Monitor unit being placed with a minimum of two probes. Forms may be removed and concrete may be subjected to exterior loads other than post-tensioning once the maturity meets the required design strength for the unit being placed. The Engineer remains responsible for determining if sufficient strength has been achieved. Submit documentation to the Engineer prior to form removal, loading, and post-tensioning. Post-tensioning loads may not be applied until cylinders, cured under the same conditions as the portions of the structure that they represent evidence the required design strength for stressing operations.

2. Perform quality control testing of production concrete for strength to determine if production concrete meets the minimum required design strength. Cast, cure, and handle strength samples according to Materials I.M. 315 using a PCC level I Concrete Field Testing Technician. At the site ensure cylinders are cured properly with wet burlap and plastic. Do not move cylinders for 16 hours and ensure they remain at the site for a maximum of 1 calendar day before being transported to a certified laboratory for final curing and testing. Cast one random set of three strength samples in 4 inch by 8 inch cylinder molds for each pier, abutment or deck requiring shrinkage compensating concrete.

Further, for elements to be subjected to post-tensioning loads, cast and cure on-site, at a minimum, an additional set of three cylinders under the same conditions as the portions of the structure they represent.

Document slump, air content, and w/c ratio (adjusted for all water) of the concrete for the cylinders cast.

3. Test strength samples by a qualified lab in accordance with AASHTO T 22. Test three cylinders for strength at 28 days.

4. Perform quality control testing of production concrete to determine if production concrete meets the required concrete shrinkage mitigation. Cast a minimum of two samples for each placement, randomly selected from mix deliveries on the day of placement. Document slump, air content, cementitious blend content, and w/c ratio (adjusted for all water) of the concrete for the cylinders cast. Where the mix design uses an expansive cement additive, test for expansion at 7 days in accordance with ASTM C 878. Where the mix design uses an SRA, test for drying shrinkage in accordance with ASTM C 157 as described in the Materials section, above.

5. Perform quality control testing of production concrete to determine if production concrete meets the required air void system. Cast a minimum of two samples for each placement, randomly selected from mix deliveries on the day of placement. Document slump, air content, cementitious blend content, and w/c ratio (adjusted for all water) of the concrete for the cylinders cast. Test for air void system properties in accordance with ASTM C 457 as described in the Materials section, above.

6. Submit test results to the Engineer and the District Materials Engineer no later than 1 working day after testing is completed. Submittal shall clearly indicate the project number, location, contractor, producer, structural element constructed, slump, air content, w/c ratio (adjusted for all water), date sampled, date tested, break age, individual compressive strengths, average compressive strengths, and shrinkage mitigation (expansion or drying shrinkage). Attach plant report for the placement to the submittal.

C. Failure to Comply.

1. According to ACI 318, strength is acceptable if the average compressive strength of three cylinders meets the required compressive strength and no individual test falls below the required compressive strength by more than 500 psi. 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 for approval. Notify the Engineer 48 hours in advance of any sampling and testing and the Engineer will witness the sampling and testing of the in- place concrete. The Engineer will review the results with the Office of Bridges and Structures and determine corrective action required. The Contractor shall be responsible for the cost of evaluation and any corrective action required.

2. If the shrinkage mitigation (expansion or drying shrinkage) and/or air void system results fall outside of the acceptance range defined under Materials herein, the Engineer will review the results with the Office of Bridges and Structures and determine corrective action required. The Contractor shall be responsible for the cost of evaluation and any corrective action required.

D. Protection and Curing of Concrete.

1. **After Placement of Concrete.**
   - **a.** Continuous wet curing of non-formed surfaces using wetted burlap or cotton mats shall be conducted for a minimum of 7 days.
   - **b.** Where wooden soffit forms are used, the wood shall be continuous wetted for a minimum of 7 days.

2. **At the Completion of the Continuous Wetting Period,**
   - **a.** Burlap or cotton mats shall remain in place until the non-formed surfaces in their entirety are visibly dry.
   - **b.** Soffit forms shall be loosened sufficiently to allow the concrete to dry gradually until the surfaces are visibly dry upon trial form removal.

150146.04 METHOD OF MEASUREMENT.

The quantity of Shrinkage Compensating Structural Concrete in cubic yards, will be the quantity shown in the contract documents.

150146.05 BASIS OF PAYMENT.

The Contractor will be paid the contract unit price for Shrinkage Compensating Structural Concrete per cubic yard. The cost for testing the production concrete shall be included in the contract unit price for Shrinkage Compensating Structural Concrete.