SP-150170
(New)

SPECIAL PROVISIONS
FOR
HIGH PERFORMANCE SELF CONSOLIDATING CONCRETE

Scott County
IM-NHS-074-1(197)5--03-82
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THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150170.01 DESCRIPTION.

A. Develop and provide high performance self consolidating concrete (HP-SCC) for cast in place structural concrete when called for in the contract documents. HP-SCC is defined as a concrete mix that provides the following:
- Filling ability to flow and fill completely spaces within formwork, under its own weight.
- Passing ability to flow through tight spaces between reinforcement without segregation or blocking.
- Ability to resist segregation by remaining homogenous during transport and placement.

B. Additional requirements of the HP-SCC concrete mix are as follows:
- Minimum average 28 day compressive strength of 5000 pounds per square inch, unless otherwise specified in contract documents.
- Target permeability of 2000 coulombs (or greater than 20 K ohm-cm surface resistivity by Wenner probe).
- HP-SCC mix shall also meet the requirements of the Developmental Specification for Mass Concrete-Control of Heat of Hydration .
- When HP-SCC is poured against conventional concrete it is intended that the HP-SCC color match the color of the conventional concrete as close as possible. The Contractor shall prepare a mockup to demonstrate the match of the color of the HP-SCC and the conventional concrete.

C. Apply Sections 2403, 2412, and Division 41 of the Standard Specifications with the following modifications.

150170.02 MATERIALS.

Provide a mix meeting the following requirements.

A. Materials.

- Use coarse aggregate meeting Class 3i durability
- Use maximum nominal aggregate size no larger than 0.75 times the minimum clear spacing between reinforcing steel or reinforcing steel and forms
- Maximum w/c ratio of 0.45
- Air content according to Article 2403.02, C, 3, of the Standard Specifications, except with a target of 6.5% and a maximum variation of plus 2.0% and minus 1.0%
- Use Type I, II, IP or IS cement
- Slag replacement shall not exceed 40% by weight of the cement
- Fly ash replacement shall not exceed 25% by weight of the cement
- Maximum total cement replacement shall not exceed 50% by weight of the cement
- Minimum cementitious content shall be 624 pounds per cubic yard
- Use a viscosity modifying admixture (VMA) compatible with the high range water reducer (HRWR)
- When required to maintain plasticity during a placement, use a retarding admixture or hydration stabilizer.

B. Mix Design.

- Slump flow in accordance with Materials I.M. 389. The target slump flow value is 27.0 inches. The allowable tolerance range of the slump flow is ±2 inches.
- Target Visual Stability Index (VSI) in accordance with Materials I.M. 389. The VSI Rating shall not exceed 1.0. Record the time to flow 20 inches, or T_{20}, for information only.
- Passing ability by J-Ring in accordance with ASTM C 1621. Calculate the difference between slump flow and J-Ring flow. The maximum allowable difference is 2 inches.
- Static segregation using column technique in accordance with ASTM C 1610. The maximum allowable static segregation limit is 15%.

150170.03 CONSTRUCTION.

A. Quality Control Plan.

1. Submit for approval a written Quality Control Plan describing the procedures to be used to control the production and placement of HP-SCC. 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 self consolidating concrete, as well as, the design of formwork for full static pressure. This engineer shall submit a list containing at least three self consolidating 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. 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. Develop mix design that meets the design criteria for strength, permeability, flowability, passing ability, and consistency.

b. 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.
c. Define concrete placement pattern and methods. Include maximum horizontal flow distance from point of discharge.
d. Describe the required qualification of personnel performing testing of self-consolidating concrete.
e. Describe additional quality control procedures at the plant to ensure consistent delivery of concrete.
f. Define field procedures to accept or reject concrete during production.
g. Describe procedures used when continuous placements are interrupted.
h. Provide stability analysis of proposed formwork for full static pressure and proposed methods used to prevent leakage.

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. 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 (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 the District Materials 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 20 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 5000 plus 1400 psi or 6400 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. Subsequent to the development of a satisfactory trial batch, perform a field demonstration by casting a mockup of the element as shown in the plans. Obtain approval for the mockup element from the Engineer. Ensure that a representative from the admixture manufacturer is present during the field demonstration.

2. Mockup should be in accordance with the details shown in the plans. It will represent a section of a unit, 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 piers is compatible with the contractor's means and methods.

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

4. After forms are removed, the Engineer will perform a post placement inspection to observe any signs of honeycombs, cracks, aggregate segregation, or other defects. The Engineer may require the mockup to be sawed or cored to observe a cross section.

5. 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.

6. Dispose of mockup specimen.

D. Production Concrete.

1. Notify the Engineer 48 hours prior to placement of production concrete. Use only approved HP-SCC 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 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 15 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 is critical to producing consistent batches of HP-SCC, 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. 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. 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.

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

3. 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.

4. 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.

5. Any deviation from the approved construction techniques shall require an additional pier mockup at the Contractor's expense.

I. Curing.
Leave forms in place and wet burlap covering for 96 hours after placement.

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.

150170.04 METHOD OF MEASUREMENT.
Measurement will be as follows:

A. High Performance Self Consolidating Concrete.
Cubic yards shown in the contract documents.

B. Trial Batch Concrete.
None.

C. Pier Mockup
None.

150170.05 BASIS OF PAYMENT.
Payment will be paid the contract unit price as follows:

A. High Performance Self Consolidating Concrete.

1. Per cubic yard.

2. The cost for testing the production concrete is included in the contract unit price for High Performance Self Consolidating Concrete.

B. Trial Batch Concrete.
Lump sum including cost of qualified laboratory.

C. Pier Mockup

1. Lump Sum

2. Payment is full compensation for one approved mockup. Payment 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.