SP-150864
(New)

SPECIAL PROVISIONS
FOR
NON-PROPRIETARY ULTRA-HIGH PERFORMANCE CONCRETE

Webster County
MB-926-1(506)1--77-94

Effective Date
July 19, 2022

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.

150864.01 DESCRIPTION.

This work consists of using non-proprietary ultra-high performance concrete (UHPC) for the field repair of deteriorated pretensioned prestressed concrete beam (PPCB) ends. The concrete mixture described in this special provision shall be used at locations specified on the project plans. All work shall be in accordance with the Standard Specifications, except as modified herein.

150864.02 MATERIALS.

A. Mixture Ingredients.
The non-proprietary UHPC mixture shall be made in accordance with the following ratios, proportions, and material specifications:

Ingredient	Cement	Sand	Masonry Sand	Silica Fume	Water
Volume Ratio (for 1.0 ft^3)	0.425	0.226	0.200	0.060	0.089
Proportion (lb/yd^3)	1500	790	710	210	320

1. **Cement:** Type I/II portland cement meeting the requirements of Section 4101 of the Standard Specifications.

2. **Sand:** Meeting the requirements of Section 4110 of the Standard Specifications with a specific gravity of (at least) 2.65. The sand shall be sieved such that the portion with 100% passing the No. 30 sieve is obtained to be used as sand required for the UHPC mixture.

3. **Masonry Sand:** Meeting the requirements of Section 4110 of the Standard Specifications with 100% passing the No. 30 sieve.

4. **Silica Fume:** Meeting the requirements of AASHTO M307 with a high purity (i.e., silica content ≥ 94%).

5. **Water:** Meeting the requirements of Section 4102 of the Standard Specifications.

6. **High-Range Water Reducer (HRWR):** It shall be in accordance with Section 4103 of the Standard Specifications and Materials I.M. 403. The HRWR content shall be determined based on the trial batch to reach the desired flow, i.e., with a spread diameter of 8 to 12 inches. An HRWR-to-cement ratio of 0.05 (45.0 pounds per cubic yard) can be used as a starting point.

7. **Steel Fiber:** Straight 0.008 inch diameter by 0.5 inch long steel fibers with a smooth surface meeting the requirements of ASTM A820 shall be incorporated into the mixture design. The steel fibers shall have a minimum tensile strength of 285 ksi. The steel fiber dosage is 2.0% by volume (263 pounds per cubic yard).

B. Submittals.

Submit the following to the Engineer for review and approval, at least 15 calendar days before trial mixing and field casting can take place:

- Material certifications and ingredient specifications from their manufacturers.
- A Quality Control plan that shall include, but is not limited to, the following: (1) Mixing protocol; (2) Casting procedure; (3) Sampling and testing procedure; (4) Curing procedure; and (5) Finishing procedure after field placement.

C. Mix Design.

1. The mix shall meet desired placement, finishing, and curing characteristics. A trial batch and test placement will be conducted to ensure these qualities are met prior to field work.

2. The following mixing protocol shall be followed:
   - **a.** Dry mix silica fume and all sand together for a minimum of 6 minutes in a high-energy portable mixer.
   - **b.** Add cement and mix together for a minimum of 6 additional minutes. Do not allow materials to cake on the side of the mixer.
   - **c.** Based on the moisture content of sand, determine the amount of water to be mixed. Add water and HRWR to the mixture and mix for a minimum of 10 additional minutes until the mixture becomes fluid.
   - **d.** Conduct the flow test according to ASTM C1856. If the flow is between 8 and 12 inches, add the steel fibers into the mixture and mix for a minimum of 6 additional minutes.

150864.03 CONSTRUCTION.

A. Storage.

Assure the proper storage of all constituent materials, including but not limited to cement, aggregates, additives, and steel fibers, as required by the specifications provided by their suppliers/manufacturers in order to protect the integrity of the materials against the loss of physical, chemical, and mechanical properties.

B. Placement Plan and Pre-Pour Meeting.

1. Submit a Placement Plan (with a detailed field work schedule) to the Engineer for review and approval at least 15 calendar days prior to the scheduled UHPC placement pour. The following list is intended as a guide and may not address all the means and methods the Contractor may elect to use. The Contractor is expected to assemble a comprehensive list of all necessary items for executing the placement of UHPC.
   - Responsible personnel and hierarchy.

- Equipment – including but not limited to mixers, holding tanks, generators, wheelbarrows, scales, meters, thermometers, floats, screeds, burlap, plastic, heaters, blankets, etc.
- Quality Control of batch proportions – including dry ingredients, steel fibers, water, and admixtures.
- Quality Control of mixing.
- Batch procedure sequence.
- Formwork – including materials and removal.
- Placement procedure – including but not limited to the preparation of existing concrete surfaces (in terms of roughness and wetness) before UHPC placement, in addition to spreading, finishing, and curing details.
- Threshold limits for ambient temperature, ambient relative humidity, batch consistency, batch temperature, batch times, and related corrective actions as appropriate.

2. Arrange for an onsite meeting with the Engineer and the Research Personnel at least 7 calendar days prior to the UHPC placement. The objective of the meeting will be to outline the procedures for mixing, transporting, finishing, and curing of the UHPC.

C. Trial Batch and Test Placement.

1. Produce a trial batch and perform a test placement. Provide the Engineer and the Research Personnel notice and mix proportions at least 7 calendar days prior to this event. The trial placement will be witnessed by the Engineer.

2. Mix the trial batch at least 15 calendar days prior to the planned field placement. The trial batch shall be of sufficient quantity to complete the test placement. The trial batch shall be produced under the same ambient conditions (e.g. time of day, weather, etc.) as anticipated during the field work. Include documentation of ambient conditions at the time of trial batch and anticipated ambient conditions at the time of trial placement in the submittal to the Engineer.

3. For mockup test placement, prepare a full-scale trial batch mix and place in a full-scale mockup as shown in the project plans. Use at least the minimum mix capacity of the mixing equipment for the trial batch, including quantities for sampling and testing. Use the same equipment and the same forming, casting, and curing procedures that will be used during the field work for the trial placement.

4. Test the trial batch for workability according to ASTM C1856. Perform the compressive strength test on a set of 3 inch by 6 inch cylinders after 7, 14, and 28 days, in accordance with ASTM C1856. Each set shall contain at least three samples and all test sets shall be cured similar to that of the trial batch.

5. Submit the results of density (unit weight), flow, rapid chloride ion penetrability, 7 day compressive strength, 14 day compressive strength, and 28 day compressive strength to the Engineer for review and approval a minimum of 10 calendar days prior to the use of the UHPC in the field. To be considered a successful test placement, there shall be no segregation of the UHPC and no visible voids when the forms are removed.

D. Formwork, Casting, and Curing.

1. Forms shall be watertight and coated to prevent the absorption of water and leakage of the mix after placement. The formwork shall be resistant to the hydraulic pressure of the UHPC mix.

2. Use a portable pan-style mixer with orbital mixing action for the UHPC batches. The Mortarman 750 by IMER is an example that has been used to mix UHPC in past field

projects. Due to the energy required to turn over the wet mix, it is recommended to limit each batch's volume to a third of the mixer's capacity. Other portable mortar mixers may be submitted to the Engineer for consideration and based on the results of the trial batch mix, approved for use. Portable drum mixers are not permitted.

3. For casting, do not place UHPC at ambient air temperatures below 40°F, nor above 90°F. Also, pumping UHPC is not permitted.

4. Forms shall remain in place for 7 calendar days for curing. In addition, cover exposed surfaces with plastic within 10 minutes after final finishing. The moist curing period will be 7 days. This period can be reduced to 4 days if it can be proved that, due to early-age reactions, the target 28 day properties will be achieved.

5. In addition to Article 1105.11, D of the Standard Specifications, limit any loads or vibrations on the spans where the UHPC has been placed until the mix has completed its initial set.

E. Acceptance Testing.

1. The Engineer and the Research Personnel will be on site during the placement of UHPC. Coordination with the Engineer and the Research Personnel shall be made a minimum of 48 hours prior to the anticipated UHPC placement.

2. Provide an appropriate location to place acceptance specimens for initial curing prior to transport to the laboratory. Curing boxes shall be equipped with supplemental heat or cooling as necessary to cure the specimens in accordance with ASTM C1856.

3. Testing shall be performed by the Contractor and approved by the Engineer. The required testing is summarized in the following table. The table contains the test methods, minimum acceptance criteria, and expected frequencies. Tests may be performed at a more frequent intervals than described below, at the discretion of the Engineer.

Description	Test Method	Acceptance Criteria	Frequency
Flow and Visual Stability	ASTM C1856	8 inches (Minimum) 12 inches (Maximum); No bleed water; Consistent fiber distribution	One per batch
Compressive Strength*	ASTM C1856 (3×6 inch cylinders)	≥ 9 ksi (at 7 days) ≥ 11 ksi (at 14 days) ≥ 12.5 ksi (at 28 days) (150 psi/sec loading rate)	7 day, 14 day**, and 28 day
Rapid Chloride Ion Penetrability***	ASTM C1856 (4×8 inch cylinders)	≤ 300 coulombs	28 day (two per job)

* Each set shall contain at least three samples and all test sets shall be cured similar to that of the field work.
** 14 day compressive test shall be used for acceptance.
*** The samples shall be collected at the time of the flow test before the addition of steel fibers.

1050864.04 METHOD OF MEASUREMENT.

A. Measurement of Beam End Repair Non-Proprietary Ultra-High Performance Concrete (UHPC) will be plan-measured quantity per cubic foot.

B. The quantity for Non-Proprietary UHPC Trial Batch per each includes one trial batch. The Engineer may authorize up to two additional combined trial batches, to be measured and paid per each.

C. The quantity for Non-Proprietary UHPC Test Placement per each includes one test placement. The Engineer may authorize up to two additional combined test placements, to be measured and paid per each.

150864005 BASIS OF PAYMENT.

A. Payment will be for the contract unit price of Beam End Repair Non-Proprietary Ultra-High Performance Concrete (UHPC) per cubic foot. Payment is full compensation for furnishing all submittal, materials, labor, testing, results, formwork and incidental work for completion of the beam end repair as indicated in this special provision and the contract documents.

B. Payment will be for the contract unit price for Non-Proprietary UHPC Trial Batch per each trial batch. Payment is full compensation for furnishing all submittal, materials, labor, testing, results, and incidental work for completion of the trial mix as indicated in this special provision and the contract documents.

C. Payment will be for the contract unit price for Non-Proprietary UHPC Test Placement per each test placement. Payment is full compensation for furnishing all submittal, materials, forms, labor, and incidental work for completion of the trial placement as indicated in this special provision and the contract documents.