



**DEVELOPMENTAL SPECIFICATIONS
FOR
ULTRA HIGH PERFORMANCE CONCRETE OVERLAY**

**Effective Date
October 17, 2023**

THE STANDARD SPECIFICATIONS, SERIES 2023, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

23030.01 DESCRIPTION.

This specification consists of supplying, mixing, transporting, placing, finishing, curing, and diamond grinding of Ultra High Performance Concrete (UHPC) for use as an overlay and riding surface in accordance with the Contract Documents and as directed by the Engineer.

23030.02 MATERIALS.

A. Material Properties.

Provide materials as follows. All materials in Items 1 and 2 below must be premixed and proportioned in bags or supersacks and come from the same batch or lot.

1. Fine Aggregate - Crushed Quartz with 100% passing the No. 30 sieve and a maximum of 3% passing the No. 200 sieve.
2. Cementitious Material - Meet all applicable ASTM specifications.
3. Steel Fibers - ASTM A 820, Type 1, cold drawn high-carbon steel with a minimum tensile strength of 300 ksi, length of 12 mm to 13 mm, and diameter of 0.220 mm to 0.225 mm. Minimum steel fiber content will be 3.25% of the mix's dry volume.
4. Water - Water for Mixing Portland Cement per Standard Specifications and as specified by the manufacturer for use in the UHPC mix.
5. Admixtures - Only as specified by the manufacturer.

B. UHPC Mix Design.

1. Submit UHPC mix design to the Engineer 60 days prior to first placement of UHPC. Results of all compressive tests, conducted by an AASHTO accredited testing lab, shall be submitted to the Engineer for review and approval with the mix design. The Engineer may waive the tests of

the UHPC mix if these tests have been previously performed for material supplied by the manufacturer.

2. A minimum of 16 cylinders 3 inches by 6 inches shall be cast for mix design compressive strength testing.
3. All compressive test cylinders shall be cured using the same method of curing proposed to be used in the field. The temperature during curing shall be within 18°F of the low end of the proposed temperature range for curing in the field. Testing times are at 12 hours, 18 hours, 24 hours, 48 hours, 72 hours, 96 hours, 7 days and 28 days. Two cylinders shall be tested for each testing day. The compressive strength shall be measured by ASTM C39 and shall meet 12 ksi minimum at 48 hours and 18 ksi minimum at 28 days. Only a UHPC mix design that passes these tests may be used.

C. Material Requirements

The UHPC mixture shall meet the material properties listed in Table DS-23030.02-1: UHPC Material Properties after 28 days, unless otherwise noted in the contract documents or as directed by the Engineer. Material properties listed below will be verified by the manufacturer and submitted for approval in the Placement Plan.

Table DS-23030.02-1: UHPC Material Properties after 28 days

Description	Test Method	Acceptance Criteria
Compressive Strength <i>Ends of cylinders must be ground flush prior to testing.</i> <i>Saw cutting, capping, and use of neoprene pads are not permitted.</i>	AASHTO T 22 (3"x6" cylinders and 2"x2" Cubes) * (150 psi/sec loading rate)	≥14 ksi at 28 days
Long-Term Shrinkage	AASHTO T160 (64 weeks)	≤ 800 micro-strain
Chloride Ion Penetrability	AASHTO T 259 (1/2" depth)	< 0.1183 lbs/yd ³
Scaling Resistance	ASTM C672	Y < 3
Freeze-Thaw Resistance	AASHTO T 161 / ASTM C666A (300 cycles)	Relative Dynamic Modulus of Elasticity > 95%
Alkali-Silica Reaction	ASTM C1260	Innocuous

* Additionally cast 2 inch by 2 inch cubes for 28 day acceptance testing by Construction and Materials Bureau, Ames, Iowa.

23030.03 CONSTRUCTION.

A. Surface Preparation

1. To prepare the bridge deck surface for UHPC overlay, use hydrodemolition in accordance with Developmental Specification for Partial Removal of Existing Bridge Deck Using Hydrodemolition.
2. When hydrodemolition and final cleaning are complete, the deck surface shall be thoroughly saturated to the point that the surface does not dry out, and any excess water shall be removed with compressed air.

3. Clean polyethylene sheeting shall be used to cover the deck completely until such time that the overlay is poured.

B. Storage.

Assure proper storage of all materials including but not limited to cement, aggregate, steel fibers and additives, as required by the supplier's recommendation to protect the integrity of the materials against the loss of physical and mechanical properties.

C. Placement Plan.

1. Submit a placement plan with a detailed construction work schedule to the Engineer for review and approval at least 30 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 time and batch times.
 - Batch procedure sequence.
 - Form work – including materials and removal.
 - Placement procedure – including but not limited to surface preparation of existing concrete surfaces and pre-wetting of the existing concrete interface to a saturated-surface-dry (SSD) condition before the placement of UHPC, spreading, finishing, and curing protection. Include provisions for acceptable ambient conditions and batch temperatures and corrective measures as appropriate.
 - Threshold limits for ambient temperature, ambient relative humidity, batch consistency, batch temperature, batch times and related corrective actions.
2. Pumping of UHPC is not allowed.
3. Addition of mix water or surface water to improve workability or aid in placement is not allowed. Do not allow water to pond on the surface of the prepared deck prior to placement.
4. Construction loads applied to the bridge during UHPC placement and curing are the responsibility of the Contractor. Submit the weight and placement of concrete buggies, grinding equipment or other significant construction loads for review as part of the proposed Placement Plan.

D. Pre-Pour Meeting.

Prior to the initial placement of UHPC, arrange for an onsite meeting with the UHPC representative and the Engineer. The Contractor's staff and the Contracting Authority's inspectors shall attend the site meeting. The objective of the meeting will be to clearly outline the procedures for mixing, transporting, finishing, and curing of the UHPC material. Arrange for a representative of the UHPC supplier to be on site during the placement of all UHPC. The UHPC representative shall be knowledgeable in the supply, mixing, delivery, placement, and curing of the UHPC material.

E. Forming, Mixing, Transporting, Placing and Curing.

1. If required in the contract documents and as directed by the Engineer, complete and cure all bridge deck repairs per the Standard Specification before placing UHPC.

2. Design and fabricate formwork if required to adhere to Standard Specifications and the recommendations of the UHPC manufacturer. Construct forms from nonabsorbent material that are properly sealed and capable of resisting the hydrostatic pressures from UHPC in the unhardened state. Do not remove formwork until the UHPC overlay achieves a minimum compressive strength of 11.0 ksi, except as required to prepare the surface at construction joints for placement of the following stage. Use of a concrete set retarder followed by high-pressure water wash is required at construction joints to achieve satisfactory bond.
3. A curing compound shall be applied to the UHPC overlay surface immediately after placement of the UHPC. Apply plastic sheeting to the surface following placement of curing compound for the duration of the minimum curing period.
4. Forming, batching, placing, and curing will be in accordance with the UHPC manufacturer's recommendations and as submitted and accepted by the Engineer.
5. Representatives of the UHPC manufacturer knowledgeable in supplying, mixing, transporting, placing, finishing, and curing of the UHPC material must be present during mixing, transporting, and placing of the UHPC. The Contractor will arrange for two manufacturer's representatives to be on site for the duration of the UHPC construction; one representative will remain with the mixing operations and the second representative will remain with the placement operations. Do not start mixing or placing UHPC until the manufacturer's representatives are on-site. Place UHPC in accordance with the approved Placement Plan using one continuous pour per each stage of construction. The use of bulkheads will not be permitted. Keep UHPC from freezing until it has achieved a minimum compressive strength of 11.0 ksi minimum.
6. Provide a minimum of three portable batching units for mixing of the UHPC. Mixing equipment, which is not supplied by the UHPC manufacturer, must be reviewed by the UHPC manufacturer for adequacy. During batching keep the temperature of the UHPC below 80°F; ice may be added to the mix as recommended by the UHPC manufacturer's representative.

F. Acceptance Testing.

1. The Construction and Materials Bureau will be on site during the placement of UHPC. To schedule a representative, contact Construction and Materials a minimum of 48 hours prior to the anticipated UHPC placement. Final acceptance will be based upon 28 day strength. Field coring of UHPC for dispute resolution will not be allowed.
2. The Contractor is responsible for providing an adequate location to place acceptance specimens for initial curing prior to transport to the lab. Curing boxes will be equipped with supplemental heat or cooling as necessary to cure specimens in accordance with ASTM C31. Testing shall be performed by the Contractor and approved by the Engineer. Testing is summarized in Table DS-23030.03-1: UHPC Acceptance Testing. Performance frequencies of each test listed in Table DS-23030.03-1 are minimum values and tests may be performed at more frequent intervals, at the discretion of the Engineer.
3. The Contractor has the option to use the Maturity Method for estimating the in-place UHPC strength in lieu of destructive testing. Use of this method requires the development of the strength-maturity relationship according to [Materials I.M. 383](#). If using the Maturity Method, one set of cylindrical specimens shall be cast, as described, for each day of UHPC placement. These shall be treated as reserves.
4. When test data shows specified strength requirements are not achieved, notify the Engineer. Wait until the next scheduled test for the material in question or perform a test at a time that has been approved by the Engineer.

Table DS-23030.03-1: UHPC Acceptance Testing

Description	Test Method	Acceptance Criteria	Frequency
Compressive Strength	AASHTO T 22 **	≥ 14 ksi (at 28 days) (3"x6" cylinders) (150 psi/sec loading rate)	12 tests in 1 st day at intervals specified by engineer, 2 day, 3 day, 4 day, 8 day, 14 day, & 28 day
Slump Flow and Visual Stability	ASTM C 1856	8 inches (Min.) 10 inches (Max.) No bleed water Consistent fiber distribution	1 per batch

** In lieu of AASHTO T 22, the Maturity Method in accordance with Materials I.M. 383 is allowed.

G. Surface Profile and Finish

1. The UHPC shall have a formulated rheology to be thixotropic so that the finished surface of the UHPC overlay will match the proposed roadway profile to within a tolerance specified in [Article 2413.03, E](#) of the Standard Specifications. After curing, the entire UHPC overlay will be grooved in accordance with [Article 2413.03, E](#) of the Standard Specifications. The extent of the required diamond grinding will be described in the contract documents or as directed by the Engineer. Grinding and Grooving of the UHPC surface can be performed after the UHPC overlay achieves a minimum compressive strength of 11.0 ksi, unless otherwise approved by the Engineer.
2. Traffic or other loading will not be permitted directly on the UHPC overlay until the UHPC undergoes the aforementioned curing process and achieves a minimum compressive strength of 11.0 ksi, unless otherwise approved by the Engineer.

23030.04 METHOD OF MEASUREMENT.

The quantity of Ultra High Performance Concrete will be measured as the number of square yards of UHPC placed and accepted. The volume will be computed using the dimensions shown on the plans. The quantity of grinding will not be measured.

23030.05 BASIS OF PAYMENT.

- A. The quantity of UHPC overlay will be paid at the Contract unit price per square yards. Price and payment will constitute full compensation for surface preparation, supplying, mixing, transporting, placing, finishing, curing, grinding, grooving, and for furnishing all equipment, tools, labor, and incidentals required to complete the work.
- B. Additional quantity of material used for areas where the removals went below the planned depth shall be paid for separately. The additional quantity shall be based on the volume computed from the dimensions shown on the plans deducted from the total volume placed during the overlay operation.
- C. Additional quantity of material used in the determination of material properties and for acceptance testing as described herein will be furnished at no additional cost to the Contracting Authority. No additional payment will be made for surface preparation or for grinding procedures.
- D. If the UHPC does not meet the minimal material properties as described herein, the UHPC will be removed and replaced or remediated to the satisfaction of the Engineer at the Contractor's expense. No additional payment will be made for remedial solutions to insufficient bonding between the UHPC and underlying bridge elements.