SECTION 614 – ULTRA HIGH-PERFORMANCE CONCRETE

614.1 Description

This work consists of providing, mixing, transporting, placing, finishing, curing, and grinding Ultra High-Performance Concrete (UHPC).

614.2 Materials

A.	Ultra-High Performance Concrete	Section 1025
B.	Water and Ice	Section 1021
C.	Liquid Membrane-Forming Compounds	Section 1045.7

614.3 Construction

614.3.1 Submittals

A. Submit a Quality Control Plan to verify that all materials, equipment, and workmanship meet the contract requirements. Provide detailed personnel, equipment, methods, sequence, and procedures to ensure the specified quality of all applicable materials and related field operations. Follow the submittal procedures outlined in Section 105.4. Provide the following information in the plan, as applicable:

1. Batch proportions, production sequence, and production rates.
2. Allowable ambient temperature and weather conditions for mixing and placement.
3. Construction loads with locations applied to the bridge during UHPC placement.
4. Surface preparation procedures, including cleaning and pre-wetting.
5. When performing closure pours, provide:
   a. Formwork information, including materials and removal.
   b. Locations of construction joints.
   c. Placement procedures.
   d. Procedures for supplemental heating of surrounding prefabricated elements.
6. Method of curing, including means and materials.

C. Temperature Control Plan. When temperature ranges fall outside of the manufacturer's recommended placement temperatures, submit a Temperature Control Plan in accordance with Section 610.3.1 and the manufacturer's recommendations.

D. Prior to the start of UHPC placement, schedule an on-site meeting with the UHPC manufacturer's representative, the Contractor, and the Engineer to review the approved Quality Control Plan and clearly outline the procedures for mixing, transporting, finishing, and curing of the UHPC.

614.3.2 Surface Preparation

A. Prior to placing UHPC, pre-wet surfaces to a saturated surface dry (SSD) condition, in accordance with the UHPC manufacturer's recommendations. An SSD condition is defined as a concrete surface that has absorbed the maximum amount of water without ponding on the surface.

B. For UHPC closure pours, create an exposed aggregate, 1/4-inch amplitude finish on all concrete surfaces that will be in contact with UHPC.

   1. Achieve SSD by placing wet burlap on the surface for a minimum of 24-hours or by other means submitted for approval by the engineer.

   2. Use compressed air, free of oil, to blow out any standing water.

614.3.3 Formwork

A. Design and fabricate formwork in accordance with Section 604.3.2 and the recommendations of the UHPC manufacturer.

   1. Construct forms from a nonabsorbent homogeneous material that is properly sealed and capable of resisting the hydrostatic pressures from UHPC in the unhardened state.

   2. Cover all UHPC closure pours with a top form with a moisture barrier.

   3. Do not remove formwork until a compressive strength of 10-ksi is achieved.

614.3.4 Mixing

A. Mix UHPC batches in accordance with the manufacturer's requirements.

B. Provide a minimum of two 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.

C. A representative from the UHPC manufacturer must be present during mixing, transporting, placing, finishing, and curing of the UHPC.

614.3.5 Sampling and Testing

A. Sample and make test specimens in accordance with ASTM C1856 as directed by the engineer.

B. Perform slump flow test in accordance with ASTM C1437, as modified by ASTM C1856, at a minimum rate of 1 test per batch.

C. Additional quality control tests may be performed at the discretion of the engineer, the contractor and the UHPC manufacturer.

614.3.6 Placing and Curing

A. Place and cure the UHPC in accordance with the manufacturer's recommendations, the Quality Control Plan, and the Temperature Control Plan.

B. Place UHPC flush with adjacent precast elements to within a tolerance of plus 1/4-inch and minus 0-inches.

C. Use in-place temperature monitors to monitor curing temperatures.

D. When placing UHPC closure pours:

1. Do not internally vibrate the UHPC. Rodding may be used to achieve a suitable blended connection where two successive pours meet.
2. Supplemental heat may be provided to the UHPC and surrounding prefabricated elements to reduce initial set times and accelerate strength gain.

614.3.7 Surface Profile and Finish

A. After curing, grind the UHPC surface smooth with adjacent concrete elements after the UHPC has achieved a minimum compressive strength of 10-ksi.

B. During grinding operations, if steel fiber pullout is observed, suspend the grinding, and do not resume until approved by the engineer.

C. Perform a watertight integrity test on 10-percent of the joints after grinding has been completed.

1. Continuously apply running water at a rate of 300-gallons per hour along the length of the joints to be tested, for a duration of 30-minutes.
2. The Engineer will inspect the underside of the joint for water leakage at 30-minutes and at 1-hour.
3. The joint is considered watertight if no dripping water or water droplets are visible underneath precast concrete element areas along the full length of the joint. If the results of the watertight integrity test are not satisfactory, the engineer will determine the required corrective action.

D. Traffic is not permitted on the bridge until the UHPC has achieved a minimum compressive strength of 14-ksi.

614.3.8 Reporting

A. Submit all quality control test results and a report in accordance with ASTM C1856.

614.4 Method of Measurement

A. The Department will measure the quantity of UHPC Closure Pour as the number of cubic feet of UHPC placed and accepted.

614.5 Basis of Payment

A. The Department will pay for UHPC Closure Pour at the contract unit price per cubic foot. Price and payment constitute full compensation for:

1. Quality Control Plan;
2. formwork;
3. providing and placing all materials;
4. mixing and transporting; and
5. finishing, curing, and grinding.

ITEM	DESCRIPTION	UNIT
614000	UHPC CLOSURE POUR	CF

SECTION 1025 – ULTRA HIGH-PERFORMANCE CONCRETE

1025.1 Material Requirements

A. Fine Aggregate

1. ASTM C33 or ASTM C144, except that the grading requirements need not apply.

B. Cement and Pozzolanic Materials — Section 1020 and ASTM C1797

C. Steel Fibers — ASTM A820

1. Closure Pours — 2 percent by volume

D. Non-Steel Fibers

1. Alkali Resistant Glass Fibers — ASTM C1666
2. Polyolefin Fibers — ASTM D7508
3. Cellulose Fibers — ASTM C7357

E. Water and Ice — Section 1021

F. Admixtures — AASHTO M194 and as required by manufacturer

1025.2 Mix Requirements

A. Steel fibers shall be used as the primary reinforcement.

1. Non-steel fibers may be used in the mix but shall not be the primary reinforcement.

B. UHPC mixed on-site.

1. Premix and proportion fine aggregate and cementitious materials in bags or supersacks. Supply dry components of the UHPC mixtures from a single UHPC material manufacturer. All materials must come from the same batch or lot.

C. UHPC mixed at a location other than on-site.

1. Produce UHPC in accordance with Section 1022.

1025.3 Material Properties

A. UHPC Closure Pours:

Table 1025.3-1. UHPC Closure Pour Material Properties

Description	Test Method	Acceptance Criteria
Compressive Strength	ASTM C1856	≥ 17 ksi @ 28 days ≥ 14 ksi @ 4 days
Shrinkage	AASHTO T160 (ASTM C157)	≤ 800 micro-strain
Fiber Segregation	ASTM C1712[1]	Material must be “resistant”
Rapid Chloride Ion Penetrability or Surface Resistivity Testing (without fibers)	AASHTO T277 (ASTM C1202)	≤ 350 coulombs
Chloride Ion Penetrability	AASHTO T259	< 0.1183 lbs/yd^3

	(½" depth)	
Freeze-Thaw Resistance	AASHTO T161 (Procedure A) (ASTM C666 (Procedure A)) 300 cycles	Relative Dynamic Modulus of Elasticity > 95%
Slump Flow	ASTM C1437	8 inches (Minimum) 10 inches (Maximum)
Effective Crack Strength	AASHTO T397	≥ 0.75 ksi
Crack Localization Strength	AASHTO T397	≥ $f_{t,cr}$

[1] Modify ASTM C1712 as follows: use of inverted slump mold is not required and minimum mold dimensions are a cylinder with a 4-inch diameter and an 8-inch height.

1025.4 Alkali Aggregate Reactivity and ASR Mitigation

A. Evaluate the aggregate for alkali aggregate reactivity and determine necessary mitigation in accordance with Section 1022.1025.5 Acceptance Testing

A. Notify the Materials and Research Section a minimum of 48-hours prior to the anticipated UHPC placement.

B. Cure field-fabricated specimens in accordance with ASTM C1856 prior to collection by the Materials and Research section.

C. The Materials and Research section will test for compressive strength in accordance with Table 1025.5-1

Table 1025.5-1. UHPC Acceptance Testing

Description	Test Method	Criteria
Compressive Strength	ASTM C1856	≥ 17 ksi @ 28 days ≥ 14 ksi @ 4 days