

Special Specification 4154

Ultra-High Performance Concrete (UHPC) for Steel Girder End Encasement



1. DESCRIPTION

Furnish and place ultra-high performance concrete (UHPC) where shown on the plans.

2. MATERIALS

- 2.1. **UHPC.** Provide a proprietary UHPC product with independent test data showing the proposed UHPC product meets the requirements of Table 1.

Table 1
UHPC Requirements

Property	Test Method	Requirement
28-Day Compressive Strength ¹ , Min (psi)	ASTM C 1856	21,000
4-Day Compressive Strength ¹ , Min (psi)	ASTM C 1856	14,000
28-Day Shrinkage, microstrain	ASTM C 157	≤ 800
Permeability ² , coulombs	ASTM C 1202	≤ 250
Scaling Resistance	ASTM C 672	y < 3
Freeze-Thaw Resistance, 300 cycles, % RDM	ASTM C 666A	> 96
Alkali Silica Reactivity, % Max expansion at 14 days	ASTM C 1260	< 0.1

1. Use 3 in. x 6 in. cylindrical specimens
2. After 7 days of standard curing and 21 days of water curing at 100°F

- 2.2. **Water.** Furnish water meeting the requirements of Item 421, "Hydraulic Cement Concrete."
- 2.3. **Chemical Admixtures.** Furnish chemical admixtures meeting the requirements of DMS-4640.
- 2.4. **Steel Fibers.** Furnish steel fibers with a tensile strength greater than 290 ksi and with the size 0.008 in. diameter x 0.5 in. length. Use a minimum 2% of fiber content by volume.

3. EQUIPMENT

Provide equipment to batch, mix, transport, and place UHPC as recommended by the UHPC manufacturer. Provide equipment necessary to test fresh and hardened UHPC properties.

4. CONSTRUCTION

- 4.1. **Storage.** Properly store UHPC materials as required by the manufacturer to protect materials against loss of physical and mechanical properties.
- 4.2. **Working Drawings.** At least 2 mo. before placing UHPC, submit a construction package, which includes, but is not limited to the following:

- Proposed formwork for UHPC beam end encasement. Methods for formworks to accommodate the encased steel while maintaining water tightness.
- Falsework.
- UHPC mix design and equipment.

4.3. **Trial Batches and Prototype Casting.** Perform trial batches using approved UHPC materials and equipment to demonstrate UHPC can be mixed and placed properly. Perform prototype casting to demonstrate that the used UHPC can fill the small spaces between existing steel elements without voids, and forms and temporary supports can maintain their integrity during the pouring and curing process to meet the requirements on safety and deformation. The prototype model should be representative of the size, shape, geometric complexity, and placement restrictions of the designed encasements shown on the plan. Conduct the necessary testing to ensure the proposed UHPC meets the workability and compressive strength requirements. Develop contingency plans for form leak and other potential construction issues identified. Refer to FHWA-HIF-18-030 “Example Construction Checklist: UHPC Connection for Prefabricated Bridge Elements” as a guide for prototype casting and related information.

4.4. **Pre-Pour Meeting.** Before initial placement of the UHPC, arrange for an onsite pre-pour meeting with the UHPC material representative, and the Engineer. The objective of the meeting will be to clearly outline the procedures for mixing, transporting, finishing, and curing the UHPC material. Refer to FHWA-HIF-18-030 “Example Construction Checklist: UHPC Connection for Prefabricated Bridge Elements” as a guide for the pre-pour meeting discussion.

Ensure the representative of the UHPC material is on site during the placement. The representative must be knowledgeable in the supply, mixing, delivery, placement, and curing of the UHPC material.

4.5. **Forms.** Provide non-absorbent formwork in contact with the UHPC. Properly seal forms to contain the fluidity of UHPC. Top forms are required when pouring on a sloping grade. Properly secure forms to resist the hydrostatic pressure of UHPC. Provide a slight pressure head after the UHPC is placed. Perform a watertight test unless it is waived by the Engineer. Before pouring, properly clean the inside of the formwork so that no debris or water will be present. Do not remove forms until UHPC has reached a compressive strength of 14 ksi.

4.6. **Mixing and Placing UHPC.** Mix and place UHPC in accordance with the manufacturer’s recommendations. Use mixing equipment that is recommended by the UHPC manufacturer.

Place UHPC following the manufacturer’s recommendations. Do not vibrate UHPC.

4.7. **Quality Control.** Perform the testing listed in Table 2. The flow for each batch must be between 8 in. and 10 in.

**Table 2
UHPC Testing Requirements**

Property	Test Method	Frequency
Flow	ASTM C 1856	Every Batch
Temperature	Tex-422-A	Every Batch
3 in. x 6 in. Cylinder for Compressive Strength	ASTM C 1856	Minimum 3 sets per production day ^{1,2}

1. Each set consists of three cylinders.
2. Make sets of cylinders intermittently throughout the UHPC pour.

In addition, the Engineer will also test sets of cylinders from each production day at 4 days, 14 days, and at 28 days after casting. Testing of the 14 day and 28 day compression cylinders will be performed by Materials and Tests Division’s (MTD), Rigid Pavement and Concrete Materials Section. Deliver the cylinders to MTD 7 days before test date.

5. **MEASUREMENT**

Measurement will be by the cubic yard of UHPC measured in place. The volume of encased steel will be deducted (neglecting adjustment for corrosive section loss). There will be no deduction for the welded studs and rebar reinforcement.

6. **PAYMENT**

The work performed, and the materials furnished in accordance with this Item and measured as specified under "Measurement" will be paid for at the unit price bid for "UHPC for Girder Encasement." This price is full compensation for materials furnished, trial batches and prototype casting, equipment, labor, tools, and incidentals.