

## **ITEM 557.6601NN16 - ULTRA-HIGH PERFORMANCE CONCRETE (UHPC)**

### **DESCRIPTION**

This work shall consist of furnishing and installing ULTRA-HIGH PERFORMANCE CONCRETE (UHPC) in accordance with the contract documents and as directed by the Engineer. Strength determination is permitted to be made through compressive testing or maturity testing. Ultra-High Performance Concrete (UHPC) includes, but is not limited to precast deck panel joints, closure pours, link slabs, and joint headers. It does not include bridge deck overlays.

### **MATERIALS**

UHPC shall be accepted based on the Manufacturer and product designation appearing on the Approved List under Bridge Joint Systems. Other materials can be accepted if they meet the requirements below:

**UHPC Acceptance Criteria:** UHPC which is not on the Approved List can be accepted by meeting the material requirements below. Contact DCES for testing and acceptance procedures. The preparation for the testing and the acquisition of results for the testing may take several months. No extension of time will be granted for completion of testing. All components of Ultra-High Performance Concrete shall be supplied by one Manufacturer. Materials commonly used in UHPC are:

- Fine aggregate
- Cementitious material
- Super plasticizer
- Accelerator
- Steel Fibers 2% minimum by volume

### **UHPC Material Properties**

UHPC material shall meet the following, at 28 days unless otherwise noted:

Minimum Compressive Strength (ASTM C39)	18 ksi
Minimum Compressive Strength (four days)	12 ksi
Flexural Tension Stress, (ASTM C1609, first crack, minimum)	1.5 ksi
Flexural Tension Stress (ASTM C1609), peak, minimum	2.0 ksi
Flexural Tension ratio, peak to first crack, minimum	1.25*
Long-Term Shrinkage (ASTM C157; initial reading after set)	≤ 766 microstrain
Scaling Resistance (ASTM C672)	$y < 3$
Abrasion Resistance (ASTM C944 2x weight; ground surface)	< 0.025 oz. lost
Freeze-Thaw Resistance (ASTM C666A; 600 cycles)	RDM > 96%
Alkali-Silica Reaction (ASTM C1260; tested for 28 days)	Innocuous

\*If the peak stress exceeds the first crack by at least 100 psi, the first crack stress need not be taken as greater than 1.8 ksi when computing this ratio.

Cast 6 additional cylinders 12 in. diameter and 7 ½ in. deep. Each cylinder shall have one grade 60 epoxy-coated reinforcing bar 32 inches long cast in the center of the circular face. The axis of the bar shall be perpendicular to the formed surface. 3 of the bars shall be #6 bars embedded 5 inches deep and 3 of the bars shall be #4 bars embedded 3 inches deep. These cylinders will be kept wet until delivered to the Materials Bureau for testing according to Test Method No. NY 701-14 E. Contact the Materials Bureau prior to casting for specific instructions on preparing the test specimens. The test will be performed as soon as practical after the corresponding samples reach 12 ksi.

This test is a pullout test. The samples pass if the stress in the bars reaches 60 ksi without the UHPC failing and without the bars pulling out of the UHPC.

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**High Weight Methyl Methacrylate (HMWM)** (used to seal leaks for pours which must be watertight)

The HMWM resin shall be low viscosity and non-fuming.

Acceptance is based on the Manufacturer certifying that it conforms to the following, and the contractor forwarding the certification to the DCES:

Viscosity Less than 25 cps when measured according to ASTM D2849

Density Greater than 8.4 lb/gal. @ 77° F.

Flash Point Greater than 200° F.

Vapor Pressure Less than 1.0 mm Hg @ 77° F. (ASTM D 323)

TG (DSC) Greater than 136° F (ASTM D3418)

Gel Time Greater than 40 minutes for a 100 gram mass

Percent Solids Greater than 90 % by weight

Bond Strength Greater than 1522.3 psi (ASTM C882)

Sand: The sand shall be commercial quality dry blast sand. 95% of the sand shall pass the #8 sieve, and 95% shall be retained on the #30 sieve.

The container shall include the following information: The name of the Manufacturer, the brand name of the product, the date of manufacture.

**CONSTRUCTION DETAILS**

**Installation Drawings:** Preparation, submittal to the DCES, approval, and time for review of Installation Drawings shall be per Section 2 of the PCCM. The proposed method of mixing, placing, and curing the UHPC shall be shown on the installation drawings. When using the maturity method, the Contractor shall use the maturity method data shown on the installation drawing to demonstrate that the proposed method of curing will achieve the required strength at the required time. The Contractor shall arrange for a representative of the UHPC supplier to be on site during the placement of the UHPC until the Contractor's own staff has become well-trained in the use of the material. The representative shall be knowledgeable in the supply, mixing, delivery, placement, and curing of the UHPC.

**Pre-Pour Meeting**

Prior to the initial placement of the UHPC, the contractor shall arrange for an onsite meeting with the UHPC representative. The Contractor's staff and the NYSDOT Engineer and Inspectors shall attend the site meeting. The objective of the meeting is to clearly outline the procedures for mixing, transporting, finishing, and curing of the UHPC material.

**Storage**

The Contractor shall assure the proper storage of premix, fibers, and additives as required by the supplier's specifications in order to protect materials against loss of physical and mechanical properties.

**Form Work, Batching, and Curing**

The design and fabrication of forms shall follow approved installation drawings and shall follow the recommendations of the Manufacturer. A top form is required. The forms shall be coated to prevent absorption of water.

New concrete surfaces which will bond with UHPC shall have an exposed aggregate finish unless otherwise prohibited. Existing concrete surfaces shall be roughened to an amplitude of 1/8". Thoroughly and continuously wet the existing concrete contact area for 24 hours prior to placing UHPC, keep the surface wet, and remove all surface water just prior to UHPC placement.

The Contractor shall follow the batching sequence as specified by the supplier. The Contractor shall measure the slump flow on each batch of UHPC. The slump flow shall be conducted using a mini-slump cone. The flow for each batch shall be between 7 and 10 inches.

All UHPC shall be placed within ten feet of its final position.

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UHPC shall be filled to a minimum of plus 1/4 inch above the intended elevation. The UHPC in the form shall be cured according to Manufacturer’s recommendations to attain the required strength. The excess UHPC shall then be ground flush to the required elevation.

**Estimation of In-Place Strength**

- 1) Two thermocouples shall be installed per each UHPC placement, one at each end, at half the depth of the placement, and no nearer to an edge than half the depth. The locations of these installations shall be shown on the installation drawings. These locations shall be revised if directed by the DCES. The thermocouple wiring may be connected to reinforcing steel, but probe endings shall not be in direct contact with the steel. Structural and exposure conditions shall be considered when placing thermocouples.
- 2) Listed actions are allowed when the maturity value of all the thermocouples reaches the corresponding strength values listed below.

<b>Action</b>	<b>Strength Requirement</b>
Removal of forms	10 ksi
Open Bridge deck to Traffic	12 ksi

3. Record and save the maturity data from the meter until the strength reaches 18 ksi. Disconnect the meter and clip all wires flush with the concrete surface.

A continuous read thermocouple or thermistor with a data logger can be used to estimate in place strength. The methodology outlined in ASTM C 1074-11 shall be used. The maturity function used to estimate strength shall be calculated with the same formula that is used by the maturity meter that established the initial strength maturity relationship. Copies of the calculations shall be provided to the DCES for record purposes.

**Validation of the Strength-Maturity Relationship**

For each day of placement, cast 7 – 3 inch x 6 inch cylinders to be used for validation testing. Equip one of the cylinders with a thermocouple. Test the other cylinders as close as possible to the maturity values corresponding to 8, 10, and 12 ksi. Record the maturity value immediately prior to testing. All testing shall be conducted by an AASHTO accredited testing lab. Report the results to the DCES for record purposes.

If the average value of compressive strength of each pair of cylinders is within 10% of the estimated value, the strength-maturity relationship will be validated. If the average cylinder value is more than 10% below the estimated value, the strength maturity relationship will need to be re-established. If the first four cylinders produce acceptable results, the remainder need not be tested.

The Department may perform additional testing for research purposes. Casting and testing in addition to that required in this spec will be performed by NYSDOT personnel.

In case of loss of required data, or non-verification of the strength-maturity relationship, use the cylinders cast above, one pair at a time, to verify the strength.

**Watertight Integrity Test**

After a placement has reached the required strength, a watertight integrity test shall be performed in accordance with §567-3.01.H. If leakage occurs the Contractor must seal the entire length of the placement using HMWM at no extra cost to the State.

**Sealing**

Abrasive blast-clean the area to be treated; removing all contaminants from the surface. Clean adjacent surfaces of the leaking areas using compressed air which is free of oil and moisture.

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Do not apply sealer if rain is expected within 12 hours of completion. Apply sealer to clean and dry surfaces when the surface temperature is at least 50° F and, if near 50° F, rising. The sealer shall be mixed and applied according to the Manufacturer’s instructions and no more than 5 gallons at a time. Pour the sealer over the leaks.

When the HMWM is placed on a driving surface, sand must be applied to provide friction. After the resin has been applied, at least 20 minutes shall elapse before applying the sand. The sand shall be broadcast at a rate of approximately two pounds per square yard, completely covering the sealer. Once the sealer is cured, any loose sand shall be removed from the surface.

The sealer must be tack-free before construction traffic is permitted to resume.

**METHOD OF MEASUREMENT**

This work will be measured as the number of cubic feet of ULTRA-HIGH PERFORMANCE CONCRETE (UHPC) satisfactorily furnished and installed.

**BASIS OF PAYMENT**

The unit price bid shall include the cost of furnishing all labor, materials, and equipment necessary to satisfactorily complete the work.

<u>Item Number</u>	<u>Description</u>	<u>Pay Unit</u>
557.6601NN16	Ultra-High Performance Concrete	Cubic Feet

NN – serialized by location or by type