

ULTRA-HIGH PERFORMANCE CONCRETE

**\*\*From Waitsfield BRF 013-4(39)**

- xx. DESCRIPTION. The Contractor shall furnish all materials, tools and labor necessary for the performance of all work to form, cast, cure & finish Ultra High Performance Concrete (UHPC) where required per plan. Before casting UHPC for actual construction, the Contractor will cast mockups per the requirements of 900.645 Special Provision (Precast Mockup) for a trial batch to understand the properties and placement of UHPC prior to the bridge closure.

All UHPC shall be produced using "DUCTAL" concrete materials manufactured by Lafarge North America.

The work under this section shall be performed in accordance with these provisions, the Plans, and the following sections of Section 501 of the Standard Specifications:

Forms.....501.09  
Finishing Concrete.....501.16

- xx. MATERIALS. Use the UHPC mixture JS1000 produced by Lafarge Corp supplied by Lafarge North America. Material supplier for DUCTAL concrete:

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UHPC components shall meet the following Ductal component recommendations:

- (a) Premix: Silica fume, ground quartz, sand, & cement
  - (b) High Tensile Steel Fibers: 0.2mm (0.008 in) diameter x 14mm (0.5 in) long (>2000MPa/290 psi)
  - (c) Admixture: High range water reducer/3<sup>rd</sup> generation
  - (d) Water: Conforming to Section 745.01 of the Standard Specifications. Lafarge North America may require potable ice to be used in the batching process in lieu of liquid water.
- xx. SUBMITTALS. A minimum of fourteen (14) calendar days prior to placement of the trial batch the Contractor shall submit the mix design for approval. The mix design shall be submitted to the Agency's Materials and Research Laboratory, attention Structural Concrete Engineer. Concrete under this provision shall not be placed until the mix design has been approved. The mixing sequence shall include the order and time of introduction of the materials, mixing time and QA/QC procedure for verification of the mix uniformity.

The Contractor shall submit for review and approval a UHPC placement plan, including methodology for batching and casting, equipment used for final placement, starting location of UHPC pours, and anticipated cold joints in UHPC joints to the Engineer.

- xx. PRE-POUR MEETING. Prior to the trial batch placement of the UHPC for the mockup, the Contractor shall arrange for an onsite meeting with the Lafarge Representative, Engineer and VTrans Structural Concrete Engineer. The

Contractor shall attend the site meeting. The objective of the meeting will be to clearly outline the procedures for mixing, transporting, finishing, curing and final grinding of the UHPC material. The Contractor shall arrange for a representative of Lafarge to be in site during placement of the UHPC. The Lafarge representative shall be knowledgeable in the supply, mixing, delivery, placement, curing and final grinding of the Ductal Material. The Engineer may request a second Pre-pour meeting after the placement of the trial batch.

- xx. TRIAL BATCH. The Contractor shall produce and place a trial batch in a precast mockup at a location agreed upon by the Contractor and the Engineer. The Engineer shall be given a minimum of seven (7) days notice prior to the trial batch pour. The trial batch shall be produced, poured, and cured in the same manner that will occur during construction. The trial batch is intended to test the handling and flowability during UHPC placement. Cylinders shall be cast to determine whether the concrete meets the strength requirement of 14.5 ksi required for the project.
- xx. STORAGE. The Contractor shall assure the proper storage of DUCTAL premix including powder, fibers and other additives, obtained by Lafarge North America, as required by the Lafarge specifications in order to protect materials against loss of physical and mechanical properties.
- xx. FORMING, BATCHING, PLACEMENT, CURING AND GRINDING. Forming, batching placing, curing and grinding shall be in accordance with the procedures by Lafarge and as submitted and accepted by the Structural Concrete Engineer.

Placement of the UHPC shall be in accordance with the procedures recommended by Lafarge to ensure the elimination of air pockets in the closure pours. A minimum 1/8" overpour above final elevation is required for all UHPC joints.

Grinding of the UHPC surface shall be performed when a strength of 10 ksi has been achieved and per the manufacturers recommendations. If significant fiber pullout is observed during grinding operations, grinding shall be suspended and not resumed until approved by the Engineer.

Construction loads applied to the bridge during UHPC placement, curing and grinding are the responsibility of the Contractor. The Contractor shall submit the weight and placement of concrete buggies, grinding equipment and of the significant construction loads to the Engineer for review prior to the pre-pour meeting described above.

The design and fabrication of forms shall follow approved installation drawings and shall follow the recommendations of Lafarge.

Two portable batching units will be supplied by Lafarge to the Contractor for mixing of the UHPC. The contractor shall follow the batching sequence as specified by Lafarge and approved by the Structural Concrete Engineer.

The Contractor shall supply insulated containers for ice used in the batching operations.

The bridge can be opened to traffic when a strength of 14.5 ksi has been achieved.

The concrete in the form shall be cured according to Lafarge's recommendations to attain design strength.

- xx. TESTING. The following tests shall be performed following casting of the mockup and for each day of UHPC placement:

- (a) Compressive Strength: Concrete compressive strength tests shall be performed according to ASTM C39. AASHTO T22/ASTM 39 shall be modified to allow a specimen loading rate of 150 psi/sec for each UHPC casting day. A

minimum of 12 specimens 3 inch diameter by 6 inches shall be provided for each UHPC casting day. Prior to grinding UHPC, three specimens from each casting day shall be tested to validate achievement of 10 ksi compressive strength two (2) days after casting. Three specimens from each casting day shall be tested four (4) days after casting to validate the achievement of 14.5 ksi compressive strength and final acceptance of each UHPC casting prior to opening the bridge to traffic. Three specimens from each casting day shall be tested to verify final 20 ksi strength for informational purposes only. The Contractor shall coordinate with representatives of Lafarge to determine the day of final testing. The remaining three specimens from each casting day shall be treated as reserves.

All specimens shall be tested at the VTrans Material and Research (M&R) Central Laboratory in Berlin, VT, or a VTrans approved alternate location.

- xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Ultra High Performance Concrete) to be measured for payment will be the number of cubic meters (cubic yards) of concrete placed with the complete and accepted work, as determined by the prismatic method using dimensions shown on the Plans or as directed by the Engineer. No deductions will be made for the volume of concrete displaced by steel reinforcement, structural steel and expansion joint material.
  
- xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Ultra High Performance Concrete) will be paid for at the Contract unit price per cubic meter (cubic yard). Payment will be full compensation for performing the work specified, including constructing forms and mockups for the trial batch, designing the mix, satisfactory finishing and curing, and for furnishing all forms, materials, including joint filler and bond breaker, labor, tools, admixtures, equipment, including automatic temperature recording units, trial batches, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
900.608 Special Provision (Ultra High Performance Concrete)	(Cubic Yard)