

Section 00558 – High Early Strength Concrete Overlay

Description

00558.00 Scope - This Work consists of constructing high early strength concrete (HESC) overlays.

00558.03 Submittals - 21 Calendar Days before the pre-placement conference, provide the following information and samples to the Engineer for approval:

- Personnel qualifications according to 00558.30 and 00558.31.
- The HESC mixture design.
- Air content achieved to meet the specified content in 02001 and air entraining admixture dosage rate
- A detailed work plan, by the hour, for the HESC preparation, resurfacing, and cleanup.
- Equipment specifications for all Work.

00558.04 Preplacement Conferences:

(a) Supervisory Personnel - Hold a pre-placement conference with all supervisory personnel, Subcontractors, Suppliers, the quality control technician, the concrete control technician, and all other personnel who will be involved in the resurfacing Work. Meet at a mutually agreed time approximately at least 14 Calendar Days in advance of the Work. Present and discuss all phases of the resurfacing Work.

(b) Placement Crew - Hold a second pre-placement conference with the Engineer and the entire resurfacing work crew and the QCT, at the job site 1/2 hour before resurfacing Work begins to discuss placement duties and procedures. Hold additional pre-placement conferences for additional shifts or changes in personnel. Do not begin the resurfacing Work until this meeting is held.

(c) Trial Overlay – Conduct one or more trial overlays on a concrete base to demonstrate the effectiveness of deck preparation, mixing, placing, finishing equipment, curing approach and methods proposed. Demonstrate the effectiveness of methods proposed for Section 00558.42(f)(3) including scrub coat application. Demonstrate the effectiveness and timing of final tined surface. Construct trial overlay meeting the acceptance criteria of this specification. Construct trial overlay when weather conditions are similar to those expected during the construction of the overlay. Use the same equipment and personnel, including deck preparation equipment that will be used for the overlay.

Materials

00558.10 Materials - Furnish materials meeting the following requirements:

Concrete.....	02001
Hydraulic Cement.....	02011
Curing Materials	02050
Portland Cement Concrete Repair Material.....	02015
Preformed Joint Fillers for Concrete.....	02440.10
Synthetic Macro Fiber Reinforcing	02045.20
Chemical Admixtures.....	0XXXX.XX

00558.11 Classes of Concrete - Furnish Class HESC4000 — 3/4" concrete designed to attain high early strength, according to Section 02001 except as modified. Alternatively, furnish Class XYZ000 (*HESC4000B*) – 3/4" concrete designed to attain high early strength (at 6 hours), according to Section 0XXXX except as modified. The class of concrete required will be determined by the Agency.

00558.13 Mixture Designs - Prepare and submit new or current mixture designs according to Section 02001 and the following:

HESC mixture designs shall contain fiber reinforcement according to 02045.20. Introduce and mix the fibers in a way that will achieve uniform distribution.

HESC mixture designs may have a Strength-Maturity Relationship established per AASHTO T 276 and AASHTO T 325 during the mixture design phase for the purpose of opening to traffic. A minimum of seven early age readings will be taken at 1, 2, 3, 4, 5, 6, and 24 hours. Each reading requires averaging the two maturity cylinders and breaking two compressive strength specimens. Submit the required concrete maturity data outlined in the "Reports" sections 11.1.1 through 11.1.10 of AASHTO T 276 and 11.1.1 through 11.1.5 of AASHTO T 325 for approval by the Engineer.

HESC mixture designs may use Type III Cement from the QPL or Cement that complies with the definition of hydraulic cement or blended hydraulic cement according to ASTM C219.

00558.15 Quality Control - Provide quality control according to Section 00165 and the following:

- Sample and test according to the MFTP
- For all HESC, provide personnel according to 02001.50 to sample and test the mixture for temperature, air content, water-cementitious materials ratio, density, and yield when:
 - The first load of each placement is made.
 - There is a visible change in the slump of the concrete.
 - A set of cylinders is obtained.

- Sample and cast maturity cylinders from the last truck of the shift.

If the results of any test are outside of the specification limits, stop placement of the load. Correct the load or, if the load cannot be corrected, do not incorporate it into the Work. Test subsequent loads before any further concrete placement. Correct subsequent loads if any of the tests are still outside the specification limits. Return to the specified test frequency when the test results from two consecutive loads are shown to meet the specification limits.

00558.17 Acceptance of Concrete - Acceptance of concrete will be according to Section 00165 and the following:

(a) Aggregate - Acceptance of aggregate will be according to 02690.12.

(b) Plastic Concrete - Acceptance of the plastic concrete will be based on the tests performed by the Contractor's QCT, according to the tolerances and limits for water/cementitious ratio, air entrainment, and temperature of Section 02001.

(c) Hardened Concrete - Acceptance of hardened concrete will be based on one set of three cylinders cast from each 50 cubic yards of concrete placed. Cast a minimum of one set per production shift. Cast and cure the test specimens according to AASHTO T 23 in 4 x 8 inch single-use plastic molds and test at 28 days according to AASHTO T 22.

(1) General - For all HESC, acceptance of hardened concrete will be based on an analysis of compressive strength tests of cylinders cast by the QCT. Test the cylinders at an Agency certified laboratory.

(2) Actual Strength Test Value (ASTV) - The ASTV at 28 Days is the average compressive strength of the three cylinders tested. Discard all specimens that show definite evidence, other than low strength, of improper sampling, molding, handling, curing, or testing. The average strength of the remaining cylinders shall then be considered the test result. A minimum of three cylinders shall be tested.

(3) Acceptance - Hardened concrete with an ASTV meeting or exceeding the specified design strength, f'_c will be accepted for strength. If the ASTV is less than f'_c but at least 85 percent of f'_c , the Engineer may review the results to determine if the concrete represented by the cylinders is suitable for the intended purpose. Remove concrete that has an ASTV less than 85 percent of f'_c unless otherwise authorized in writing by the Engineer. If the concrete is removed, the cost of removal, replacement and all related Work shall be the Contractor's responsibility. If the Engineer determines that the concrete is suitable for the intended purpose, the concrete may be allowed to remain in place, subject to a price adjustment according to 00150.25.

If an ASTV falls below f'_c , the Contractor may submit a written plan outlining a proposed alternate method of evaluating compressive strength. Submit the plan for review by the Engineer within 3 days of the test. Provide evidence that a reasonable

f'_{cr} (over-design) was maintained and that there is credible evidence (besides low strength) which warrants consideration of this option. The Engineer may allow an alternate method of acceptance if the compressive strength test results are determined to be suspect from definable external factors.

(d) Surface Tolerance - The finished surface, when tested with a 12-foot straightedge, shall not vary by more than 1/8 inch. Furnish the straightedge and operate it under the direction of the Engineer.

If the concrete surface does not meet the surface tolerance, stop the operation until revised methods, changes in Equipment, or correction of procedures are proposed and approved.

Correct all non-specification surface tolerance after curing and before texturing with a self-propelled diamond grinder. Correct the surface tolerances before opening the Roadway to traffic at no additional cost to the Agency.

(e) Bond Strength - Perform two bond tests for each placement in the presence of and at locations designated by the Engineer within 28 Calendar Days of overlay placement. Cut 3 inch diameter cores and conduct bond tests on the cores.

The bond tests consist of:

- Coring through the overlay and approximately 1 inch into the existing concrete. Locate reinforcement prior to coring, do not core through reinforcement.
- Attaching a device to the top of the core.
- Exerting a tensile load to the core sufficient to cause failure or achieve 300 psi, whichever occurs first.

A successful test is the failure of the concrete substrate or bond failure at or above 175 psi.

After coring and testing, restore the area voided by the cores by blowing with compressed air and filling with an approved PCC repair material.

Equipment

00558.20 Equipment - Remove all Equipment that leaks oil or other contaminants from the work area until they are repaired.

00558.21 Mobile Mixer for HESC - Furnish self-contained, mobile, continuous mixing Equipment for proportioning, mixing and placing HESC that:

- The mixer is self-propelled and carries sufficient unmixed dry bulk cement, sand, coarse aggregate, admixtures, and water to produce a minimum of 6 cubic yards of concrete on site.
- The mixer provides positive measurement of cement being introduced into the mix by meter or counter.
- The mixer provides positive control of the flow of water into the mixing chamber. Water flow is readily adjustable to provide for minor variations in aggregate moisture.
- Each mixer is calibrated to automatically proportion and blend all components according to the mix design on a continuous or intermittent basis as required by the placing operation.

Perform a calibration and yield test on each mixer prior to the first placement to accurately proportion the specified mix. Use a written calibration procedure from the mixer manufacturer, a procedure provided by the agency or other written procedure acceptable to the Agency. The calibration process may be witnessed by the Engineer. Provide the Engineer with information about the scheduled date, time and place for the calibration. Perform a new calibration when the source of Materials changes, when the mixer undergoes a major repair, or when requested by the Engineer.

00558.22 Finishing Equipment - Furnish a concrete finishing machine for all new surfaces that is:

- Self-propelled with positive control in both forward and reverse direction.
- Capable of mechanically raising the screed, pan, and any other parts of the finishing mechanical operation to clear the screeded surface, and capable of automatically returning to the specified grade.
- Equipped with augers, followed by oscillating, vibrating screed, vibrating roller tamper, or a vibrating pan, followed by a finish roller or rollers.
- Capable of transmitting vibration at frequencies between 3,500 and 4,500 impulses per minute.

Provide continuous supporting rails for the finishing machine that are adequately supported and sufficiently rigid so there is no visible deflection under the weight of the fully loaded machine. Provide anchorage for the supporting rails to ensure horizontal and vertical stability.

Set the finishing machine so it is capable of finishing to the edge of previously placed concrete.

Set the screed rails on the completed lane surface when placing concrete in a lane abutting a previously completed lane.

Alternative finishing equipment, including roller screeds, may be allowed by the Engineer if the use of self-propelled finishing equipment is impractical.

00558.23 Miscellaneous Equipment:

(a) Hand Tools - Furnish hand tools for placing and finishing concrete. Use manual type screeds with approved vibrators attached to consolidate and finish smaller areas where it is impracticable to use a finishing machine. Use spud vibrators when depths exceed 2 1/2 inches. Use supplemental vibration along the meet lines where adjacent pours come together at bulkheads, and along curb lines, unless it can be shown that vibration reaches the meet lines.

(b) Straightedge - Furnish a 12 foot metal straightedge.

(c) Recording Thermometer - Furnish a 24-hour recording thermometer accurate to $\pm 1^{\circ}\text{F}$.

(d) Coring Equipment - Furnish core cutting Equipment that can produce a core at least 3 inches in diameter.

(e) Bond Testing Equipment - Furnish bond testing Equipment that:

- Is compatible with the core tested.
- Can exert a tensile load to the core sufficient to exceed 300 psi.
- Is equipped with a measuring device capable of reading tensile force exerted within 1 percent accuracy.

(f) Wet-dry Vacuum Equipment - Furnish vacuum Equipment that can remove puddled water ahead of the concrete placement.

(g) Strength-Maturity Relationship Testing Equipment – Provide temperature sensors that meet the requirements of AASTHO T 276 and AASHTO T 325.

Labor

00558.30 Quality Control Personnel - Provide certified technicians according to 02001.50.

00558.31 HESC Personnel Qualifications - Demonstrate the company's qualifications and experience and the qualifications of personnel scheduled to perform the HESC overlay work by providing the Engineer the following:

- The name of the company that will be performing the surface preparation operations.
- The name of the company that will be providing the HESC material and mobile mixers.
- A project reference list of at least three structural overlay projects, successfully completed within the last five years. Include the following information for each qualifying project:
 - A brief description of each project.
 - Each project's name.

- The owner's contact person's name, title, and current phone number for each project.
- Alternate owner's contact person's name, title, and current phone number for each project.
- The amount of HESC, PCC, or HPC (high performance concrete) overlay material used on each project.
- Identify the mobile mixer operators and the finishing machine operators that will perform the HESC pavement overlay work. Include documentation that they have relevant experience with HESC or structural overlay work and that they have completed at least one structural overlay project within the last three years.
- A brief description of experience using slip-form screeds for PCC or HPC roadway wearing surfaces.

The Engineer may suspend the HESC overlay work if the Contractor substitutes unapproved personnel during construction. Submit requests for substitution of mixer operators and finishing machine operators to the Engineer.

Construction

00558.41 Surface Preparation - Perform surface preparation in accordance with Section 00504.

00558.42 Placing:

(a) Mixing and Delivering HESC - Mix HESC according to mobile mix supplier's recommendations.

(b) Placement Conditions - Place structural concrete overlays according to 00540.49 and the following:

The surface temperature of the prepared deck is 40 °F or greater and less than 80 °F. The surface temperature is rising if it is between 40 °F and 45 °F. In the presence of the Engineer, measure the surface temperature with an infra-red thermometer at a minimum of three locations on the deck.

(d) Thickness - Place HESC with a minimum thickness of 2 inches, as shown.

(e) Construction Limitations - Place HESC against a firmly fixed bulkhead. Control sagging or running of freshly placed HESC in areas of steep gradient by one or both of the following methods:

- Modifying direction or method of placement
- Modifying slump

Slow traffic in the adjacent lane by flagging for at least 4 hours after completion of the pour. The Engineer may adjust the time limits due to weather or traffic conditions.

(f) Placement Procedures - Furnish at least two transverse work Bridges as feasible based on horizontal clearances and traffic control, not counting the finishing machine for HESC overlay.

(1) Preceding Placement - Each Day before placing concrete operate the finishing machine, in the presence of the Engineer, over the deck to check that the required thickness of concrete overlay will be achieved. Place concrete working up-grade, unless otherwise approved.

(2) Joints - At transverse and longitudinal joints, saw cut the section previously placed to form a straight, vertical edge before placing any adjacent sections. Saw cutting joints may be omitted if the bulkhead produces a straight, smooth, vertical surface. On both saw cut and formed joints remove all loose material by sand blasting or water blasting the face of the joints.

a. Longitudinal Joint - A longitudinal construction joint will be allowed only at the centerline of the Roadway or at lane lines unless otherwise shown or directed.

b. Transverse Joint - When placement operation is delayed by 1/2 hour or more, form a construction joint by removing all material not up to finish grade, in a straight line.

(3) Placing HESC Overlay - After the deck surface has been cleaned and immediately before resurfacing, broom a thin coat of grout onto the prepared deck. Ensure that all parts of the prepared deck receive a vigorous brooming that scrubs the grout into the deck surface and results in an even coat with no excess grout collecting in pockets. Broom the grout at a rate to prevent drying and remove excess aggregate from the deck before being covered by the HESC. If the grout does dry, stop the overlay, remove the dried grout, clean and prepare the affected area of the deck, and reapply grout according to this subsection.

(4) Roadway Finish - After the deck has been struck off with a finishing machine, mist the surface horizontally with water and float it, if necessary, to produce a smooth, uniform, sealed surface. Tine the surface as demonstrated in the trial overlay to provide 1/8" to 1/4" texturing. Hand finishing may be required along edges of concrete placement. Use a 12-foot straightedge during placement to verify deck grades and to correct defects in hand finished areas.

(5) Curing – Cure the HESC overlay according to the information below based on the cementitious material used. Monitor the condition of the HESC overlay for 72 hours after placement to determine if any impacts (e.g. cracking) are evident. The equipment, materials, and method of curing must be approved by the Engineer.

- For HESC CSA, immediate application of a curing compound after final finishing/tining shall be used.
- For HESC CSA-OPC blends, either a 3-hour sealed cure (e.g. plastic sheeting) or immediate application of a curing compound after final finishing/tining shall be used.

(6) Saw Cut Texturing – Texture the concrete according to 00540.50(c) as early as feasible after duration of cure and 2,500 psi strength is met.

00558.43 Delamination and Crack Inspection:

(a) Delamination Inspection and Repair - The surface will be inspected by the Engineer for delamination, bond failure, or other damage by use of a chain drag, coring, or other devices.

Repair all delaminated areas of 1 square foot or greater as directed by the Engineer. Delaminated areas of less than 1 square foot will not require repair. Core samples will be at no additional cost to the Agency.

(b) Crack Inspection and Sealing- The surface will be inspected by the Engineer for cracks.

After correcting non-specification surface tolerances and after texturing the deck surface, seal all visible cracks as follows:

- In areas where cracks are 10 feet or more apart, seal each crack separately.
- In areas where the cracks are numerous or are less than 10 feet apart, seal the entire area where the cracks occur.

Seal with a low modulus concrete and crack sealer from the QPL.

Perform all repair and sealing Work at no additional cost to the Agency. Complete all repair and sealing Work as soon as feasible. If the Bridge is opened to traffic before completing repair Work, all additional traffic control to complete the repair Work will be at no additional cost to the Agency.

00558.44 Use of New Surface:

(a) Vehicles and Traffic - Do not open sections to traffic or allow vehicles or construction Equipment on the new concrete surface until curing is complete and the concrete has met a minimum average compressive strength of 2,500 psi.

Measurement

00558.80 Measurement - The quantities of Work performed under this Section will be measured according to the following:

- **Furnish HESC Overlay** - Furnishing concrete Material will be measured on the volume basis. The quantities will be determined from the delivery vehicle batch tickets and checked using the yield factor according to AASHTO T 121 (ASTM C138).

A deduction will be made for Material placed and removed beyond saw cuts or formed construction joints.

- **Constructing HESC Overlay** - Constructing overlay concrete will be measured on the area basis. The area will be determined by measuring the actual surface area of the resurfaced bridge deck.
- **Saw Cut Texturing** - The quantities of surface texturing will be measured on the area basis and will be the area of each bridge deck or end panel shown less 16 inches along each curb and 6 inches from joint blockouts and bridge ends. Field measurement of surface texturing will not be made.

Payment

00558.90 Payment - The accepted quantities of Work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Furnish Structural Overlay Concrete.....	Cubic Yard
(b) Construct Overlay Resurfacing	Square Yard
(c) Saw Cut Texturing.....	Square Yard

Payment will be payment in full for furnishing and placing all Materials, and for furnishing all Equipment, labor, and Incidentals necessary to complete the Work as specified.