

SECTION 353 CONCRETE PAVEMENT SLAB REPLACEMENT

353-1 Description.

Replace the existing defective area of concrete pavement with portland cement concrete free of any uncontrolled cracks. Repair the damaged area of adjacent slabs, caused by slab removal at no cost to the Department. Submit a strength-maturity relationship curve as determined by FM- 3-C1074 for opening to traffic during design mix verification.

353-2 Materials.

Meet the following requirements:

Portland Cement Concrete*	Section 346
Coarse Aggregate	Section 901
Fine Aggregate	Section 902
Portland Cement	Section 921
Water	Section 923
Admixtures	Section 924
Curing Materials	Section 925
<u>Epoxy Compounds</u>	<u>Section 926</u>
Post-Installed Anchor Systems F for Structural Applications i n Concrete Elements	Section 937
Pozzolans and Slags*	Section 929
Embedded Items <u>Dowel Bar Assembly</u>	Section 931
Calcium Chloride	AASHTO M-144, Type 1

*For concrete pavement slab replacement, the use of pozzolans and slag is

optional.

Concrete pavement containing only dowel bars will be considered non-reinforced concrete.

353-3 Composition of Concrete.

353-3.1 Mixture Proportions: Designate the actual proportions to be used to produce a concrete with a minimum ~~6 hour compressive strength of 2,200 psi and a minimum 24-hour~~28 day compressive strength of 3,000 psi.

Prior to producing concrete, submit the design mix for approval on a form acceptable to the Department. Ensure that the 24 hour acceptance strength has design mix proportions will produce a concrete with a minimum ~~over design of 400 psi. Indicate slump before and after~~compressive strength of 1,600 psi, designated for opening to traffic, at the time period specified in the Contract Documents. Perform the plastic property tests in accordance with Section 346, except when the mix design contains an accelerator, perform the plastic property tests prior to the addition of the accelerator. Use mixes approved by the Department and obtain concrete from a plant that is currently on the Department's Production Facility listing. Producers seeking inclusion on the list shall meet the requirements of Section 105.

~~When an accelerating admixture is used in solution, the amount of water in the solution is considered to be part of the mixing water. Make necessary adjustment to the concrete mix-water to account for the amount of water in the accelerating admixture solution. Test the concrete for consistency subject to the following values from the approved mix design values:~~

Slump Tolerance**plus or minus 1.5 inches

Entrained Air**1% to 6%

Temperature not to exceed 100°F

~~**For values as specified in the approved Design Mix prior to the addition of accelerating admixture.~~

353-3.2 Delivery Certification: ~~Provide~~Submit a delivery certification ticket in accordance with Section 346-6.3.

353-3.3 Demonstration Slab: Prior to batching production concrete, demonstrate the ability to furnish replacement slabs by constructing a demonstration slab ~~on site~~. Demonstrate production techniques for slab removal, dowel installation, concrete placement, finishing, slab curing, sample preparation and curing, and proper timing of joint sawing. Demonstrate the ability to achieve the required compressive strengths. ~~Use and demonstrate the ability of the slabs to achieve proficiency to the Engineer of~~ the maturity ~~method needed for~~to determine when the concrete has achieved a compressive strength of 1,600 psi in order to opening the pavement to traffic within the required time. Use cylinders to verify the concrete compressive strength at 28 days. Schedule construction of the demonstration slab during the same time period specified in the Contract Documents. If the Engineer determines that elements of the demonstration slab fail to meet requirements of the Contract Documents, propose adjustments to the construction processes and/or materials for the Engineer's approval.

The demonstration slab may be used in the final work with the approval of the Engineer. No slab replacements will be constructed until the demonstration slab is approved. The Engineer may require additional demonstration slabs until a demonstration slab conforms to the Contract Documents.

353-4 Batching and Mixing Concrete.

Obtain concrete that meets the requirements of Section 346-7 with the following additional requirements:

Add all the concrete ingredients, excluding the accelerator to the truck mixer at the plant. ~~Mix each batch at the plant at the mixing speed for 70-100 revolutions of the drum.~~

~~Agitate the concrete en route to the job site at a speed of no more than three revolutions per minute.~~ Add the accelerator to the ~~concrete~~load at the job site and record the amount on the delivery ticket. Mix the concrete for ~~430-~~additional revolutions at mixing speed after the accelerator is added to the mixer. Do not add accelerator to any concrete which has attained the age of 60 minutes, measured from the beginning of the initial mixing at the plant.

Incorporate the accelerator into the concrete design mix in accordance with the recommendations of the admixture ~~suppli~~manufacturer. Do not exceed the recommendations of the manufacturer's technical data sheet for the dosage rate of the accelerating admixture.

353-5 Test Requirements.

353-5.1 General: Perform concrete sampling and testing in accordance with Section 346-5. Unit weight testing is required. Perform the plastic property tests ~~in accordance with 346-8~~after all ingredients have been added to the load, except when the mix design contains an accelerator; perform the plastic property tests prior to the addition of the accelerator. ~~The requirements of 346-9 apply to this Section with the following modification: 28-day requirements will be replaced with 24-hours and if the design mix includes an accelerator, then the compressive strength cylinders will be fabricated after all ingredients, including the accelerator, are added.~~

~~Make a minimum of four test cylinders from the last slab for each day of placement to assess strength for protection and opening to traffic (protection set). Cure the protection set of cylinders by methods identical to those used in curing the concrete replacement slabs. Cure the acceptance set of cylinders identical to the protection set of cylinders for the first 6 hours, then by laboratory cured conditions thereafter until the 24-hour strength test. Provide a location and curing facility for initial curing of verification cylinders.~~

~~Test two cylinders from the protection set within 6 hours of sampling and consider the average compressive strength of these two tests to be the 6-hour compressive strength. If the compressive strength is below 2,200 psi, test the remaining 2 cylinders from the protection set no longer than 6 hours from sampling. The Maturity Method specified in 353-10.2 may be used as an alternate to the protection set of concrete cylinders.~~

~~Test the acceptance and verification cylinders at 24 hours from the time of sampling.~~

353-5.2 Field Delivered Mix Consistency: Test the concrete for consistency subject to the following tolerances from the approved mix design values:

Slump Toleranceplus or minus 1.5 inches

Unit Weight..... plus or minus 2.0 pounds

Temperature not to exceed 100°F

*For values as specified in the approved design mix prior to the addition of accelerating mixture.

Reject concrete with a slump or unit weight content that does not fall within the specified tolerances and immediately notify the concrete production facility that an adjustment of the concrete mixture is required. If a load does not fall within the tolerances, test each subsequent load and the first adjusted load. If concrete not within the specified tolerances is not rejected or adjustments are not implemented, the Engineer may reject the concrete and terminate further production until corrections are implemented.

353-5.3 Verification of Maturity Curve Data: A new maturity curve will be required should any of the plastic properties or the unit weight measure results exceed the tolerances specified in Table 1, for the initial sampling.

<u>Table 1</u>		
<u>Property</u>	<u>Tolerance</u>	<u>Test Method</u>
<u>Slump</u>	<u>± 1.0 in.</u>	<u>ASTM C143</u>
<u>Unit Weight</u>	<u>± 2.0 lbs.</u>	<u>ASTM C138</u>

Use the maturity method specified in this Section to determine if the concrete has achieved 1,600 psi and can be opened to traffic. Use the maturity value to verify the strength of the last slab of each day's placement. Additional maturity meters may be used to open other locations to traffic prior to the last slab of each day, as needed, provided each location has achieved the minimum strength.

353-5.3 Cylinder Fabrication and Testing: The requirements of Section 346 apply to this Section.

Fabricate three test cylinders for strength and maturity curve correlation testing. Fabricate the compressive strength cylinders after all ingredients, including the accelerator, are added.

-The compressive strength cylinders and maturity curve correlation testing will be performed for the first production day, when the mix design is changed to another mix design, at

the discretion of the Engineer for each remaining placement week, when a new maturity curve is required, or until terminated by the Engineer.

353-6 Concrete Slab Acceptance and Testing.

Reject any Concrete not meeting the plastic property requirements of ~~353-5~~this Section. Acceptance will be based on ~~plastic properties,~~ achieving ~~the 2,21,600~~ psi compressive strength prior to opening the slabs to traffic based on the maturity method, and ~~thea 24-hour~~28 day compressive strength of 3,000 psi.

Meet the requirements of 346-8 and 346-9. Perform Quality Control (QC) tests for temperature and unit weight and prepare compressive strength cylinders once per LOT. A LOT is defined as one day's production, Section 346-9.2 does not apply.

~~If the compressive strength of any set of test cylinders fails to meet the strength requirements, take immediate corrective measures to ensure that concrete placed in the future meets the specified strength requirements.~~ The Engineer will evaluate the particular circumstances in each instance where a strength deficiency occurs. ~~If the Engineer determines that there will be a significant effect on the service life of the replacement slab, replace the concrete at no expense to the Department~~Strength deficiencies will be addressed in accordance with Section 346.

For each quality control (QC) cylinder that is lost, missing, damaged or destroyed, payment for that LOT will be reduced by \$750.00 per 1,000 psi of the specified design strength [Example: loss of two QC cylinders that have no verification data will require the element to be cored and a pay reduction will be assessed (3,000 psi / 1,000 psi) x \$750 x 2 = \$4,500]. This reduction will be in addition to any pay adjustment for low strength.

Controlled cracks are cracks designed to occur at specific locations based on the pavement design. All other cracks in the pavement are uncontrolled cracks. If anyRepair uncontrolled cracked slabs, which appearoccur during the life of the contract, ~~remove and replace the cracked slab at no expense to the Department.~~ Repair by removing and replacing the pavement across the full width of all affected lanes or shoulders and to the nearest transverse joint in each direction. Investigate and implement immediate effective solutions to eliminate further cracks, in consultation with, and subject to the approval of, the Engineer.

353-7 Placing, Striking Off, Consolidating and Finishing Concrete.

~~Place concrete as specified in 350-8.~~

~~—~~The requirements of Section 350-9 and 350-10 are applicable to this Section.

Perform straight edging while the concrete is still in plastic state after floating is completed and the excess water removed. Furnish and operate a 10 foot straightedge meeting the requirements of Section 350-3.6. Hold the straightedge in successive positions parallel to the road centerline, in contact with the surface, testing until the replacement slab is straight edged from one side to the other. Advance along the road in successive stages of not more than one-half the length of the straightedge. Fill any depressions immediately with freshly mixed concrete, consolidate, strike-off, ~~consolidate~~ and refinish. Cut down and refinish any high areas. Continue straightedge testing and surface correction until the entire surface conforms to the required grade and cross section. Ensure that transverse slope deviations of the finished pavement do not exceed 1/8 inch with the straightedge laid in a direction perpendicular to the centerline. When portland cement concrete pavement abuts bridge approaches or pavement not under this Contract, ensure that the longitudinal slope deviations of the finished pavement do not exceed 1/8 inch in 10 foot length. Produce a uniform, gritty textured final finish longitudinally along the pavement by

dragging a broom or seamless strip of damp burlap, having at least 3 feet in contact with the pavement.

If the Engineer identifies a surface irregularity determined to be objectionable ~~in an area to be opened to traffic and the design speed is 55 mph or greater~~, straightedge with a 10 foot long straightedge and address all deficiencies in excess of ~~1/4~~1/8 inch ~~within 72 hours of placement~~ by grinding in accordance ~~with the requirements of~~ Section 352.

When required in the Contract Documents, produce a pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture by grinding in accordance with Section 352.

353-8 Curing.

Cure the slab as specified in ~~Section 350-11~~, except for time and temperature restrictions. Use a Type I (with dye) or Type ID (clear with dye) curing compounds as specified in 350-11.2 and apply within 1/2 hour after completing the finishing operations. After the curing compound has been applied, cover the surface and exposed edges with two layers of white burlap-polyethylene curing blanket conforming to Section 925 or insulating blankets approved by the Engineer. ~~Cover the slab with the curing materials as soon as the slab hardens enough to resist marring the concrete surface.~~ Continue curing the slab until the concrete achieves the required ~~6-hour~~1,600 psi compressive strength indicated by the maturity value.

353-9 Joints.

353-9.1 General: Construct transverse joints as specified in ~~Section 350-12~~ and as shown on the Design Standards, except that dowels bars are installed per ~~353-9.2~~this Section. Tie bars will not be placed along the longitudinal joints unless shown in the Contract Documents. Apply a ~~liquid~~ bond breaker ~~recommended by the manufacturer for the intended application~~ to all vertical faces of the adjacent slabs. Submit the proposed bond breaker to the Engineer for approval.

Clean and seal joints in accordance with Section 350.

353-9.2 Dowel Bars: Provide dowel bars in accordance with the details shown in the Contract Documents.

353-9.2.1 Dowel Bars at Transverse Joint Between two Replacement Slabs: Follow the requirements of 350-12 when providing dowel bars at a transverse joint between two freshly placed replacement slabs.

353-9.2.2 Dowel Bars at Transverse Joints Between Existing and Replacement Slabs: Follow the requirements of ~~Section 350-12~~, except drill holes and install dowel bars into the sawed face or end of the existing slab. Develop load transfer between existing and freshly placed replacement slab. The dowels shall be free to move inside the replacement slab and epoxy-bonded into the existing slab.

353-9.2.3 Dowel Bar Installation: Install dowel bars in accordance with Section 416 except as modified herein. ~~Use a gang drill (several drills mounted parallel in a rigid frame), when enough operating space is available. Drill parallel to the centerline of the concrete pavement~~Position each dowel such that its final deviation from parallel to the surface of the pavement and parallel to the longitudinal centerline of the pavement does not exceed 1/2 inch. Position each dowel such that its final deviation from centered on the joint does not exceed 2 inches. Position each dowel such that at no point in its length does it deviate from the surface of the pavement as shown in the Plans in excess of 1 inch. Confirm the position of dowel bars by means acceptable to the Engineer, which may include non-destructive testing methods.

Use epoxy compounds in accordance with Section 937. Dispense the epoxy from a cartridge or from metered equipment that indicates the amount of each component material being dispensed.

Inject epoxy into the hole after cleaning and prior to dowel insertion. Start injection at the back of the hole to force the epoxy to move forward during dowel insertion. Twist the dowel a minimum of one full turn during the insertion to ensure that the epoxy completely surrounds the dowel. The injection process and viscosity of the epoxy shall be adequate to insure that the space between the surface of the dowel and the inside of the hole is completely filled with epoxy.

Do not allow the epoxy to escape from the front of the hole after inserting the dowel in the hole. Use a grout retention disk 1/8 inch thick, fabricated from nylon or plastic, to hold epoxy in the hole during dowel insertion.

353-10 Protection and Opening to Traffic.

353-10.1 General: The requirements of Section 350-6 apply to this Section. Keep the placed slabs closed to traffic until the maturity value indicates that the compressive strength requirement of 2,200 psi is achieved. Verify the achievement of the required strength by cylinder testing as specified in 353-5 or the use of the Submit a maturity method value test as described in 353-10.2. Provided documentation that 6-hour record to the Engineer indicating that the required strength was achieved prior to opening to traffic. by either a cylinder test report or a printed maturity meter monitoring record The Engineer may allow opening to traffic should the maturity equipment fail to provide a reading. Opening to traffic due to equipment failure does not constitute acceptance of the concrete.

Protect the pavement from all traffic, including construction vehicles, until the specified 2,200 psi maturity value indicates that the required strength has been obtained. The protective measures shall be arranged so as not to interfere with traffic lanes being utilized for required maintenance of traffic.

353-10.2 Maturity Method Testing: Provide and perform, with the assistance of the Engineer, Maturity Method Testing as specified in ASTM C1074 using Maturity Meter apparatus specified therein Use a maturity curve to estimate the strength of the concrete for opening to traffic for each day of production. Embed temperature sensors at mid-depth in the slab, at 6- inches from the leading edge of the transverse joint and at 6 inches from the longitudinal joint or at locations designated by the Engineer.

Maturity Method Testing may be used to estimate the in-place strength of that days production of concrete slabs. Temperature sensors will be embedded at locations designated by the Engineer Submit a strength-maturity relationship curve using the Arrhenius maturity function with an activation energy of 33,500 J/mol as outlined in FM- 3-C1074, in a laboratory qualified to perform the method. Compressive strength tests, as specified in FM 3-C1074, will be performed to produce a five point curve with points before and after the anticipated time for opening to traffic. Submit the mix design supporting data and the maturity curve to the Engineer for his approval.

When this method is used, a strength-maturity relationship chart, as outlined in ASTM C1074, will be prepared and tested at the concrete producer's design mix trial batch laboratory, or at other approved laboratory facilities designated by the Engineer. Compressive strength tests, as specified in ASTM C1074, will be generated to produce a five point curve with points before and after the target and with prior approval by the Engineer.

~~—————The Engineer may require compressive strength testing as outlined in 353-5. Fabricate six test cylinders for protection strength and Maturity Meter correlation testing. The compressive strength cylinder and maturity meter correlation testing will be performed for the first production day and at the discretion of the Engineer for each remaining placement week, or until terminated by the Engineer.~~
Any changes of a material source or proportion in the concrete mixture will require a new maturity curve.

353-11 Method of Measurement.

The pay quantity for concrete pavement slab replacement, calculated using field-measured horizontal dimensions and thickness of the removed slab, will be the volume, in cubic yards, of calculated concrete volume placed and accepted.

The pay quantity for cleaning and sealing joints will be in accordance with Section 350.

353-12 Basis of Payment.

Price and payment for concrete pavement slab replacement, will be full compensation for all work specified in this Section and shall include demonstration slab construction, all joint construction, including tie bars and dowels, furnishing of test specimens, and all necessary incidentals.

Price and payment for cleaning and sealing joints will be made in accordance with Section 350.

Payment will be made under:

Item No. 353- 70- Concrete Pavement Slab Replacement - per cubic yard.