SECTION 03390

CONCRETE CURING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Concrete curing materials and methods.

1.2 REFERENCES

A. AASHTO M 148: Liquid Membrane-Forming Compounds for Curing Concrete

B. ASTM C 156: Water Retention by Concrete Curing Materials

C. ASTM C 309: Liquid Membrane-Forming Compounds for Curing Concrete

D. ASTM C 1315: Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

E. ASTM D 56: Test Method of Flash Point by Tag Closed Tester

F. ASTM D 2369: Test Method for Volatile Content of Coatings

G. ASTM D 2371: Test Method for Pigment Content of Solvent Reducible Paints

H. ASTM E 1347: Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry

1.3 SUBMITTALS

A. For Concrete Curing Compound:
   1. Provide a manufacturer's certificate of compliance as verification for all concrete work.
   2. Provide the Engineer with test results before placing concrete pavement.

PART 2 PRODUCTS

2.1 CURING COMPOUND FOR STRUCTURAL AND ARCHITECTURAL CONCRETE

A. Meet AASHTO M 148, Type I D, Class A.

B. Meet applicable VOC air-pollution control requirements.

2.2 CURING COMPOUND FOR PORTLAND CEMENT CONCRETE PAVEMENT

A. Select a curing compound from the Approved Products List (APL) maintained by the UDOT Research Division.
   1. Meet AASHTO M 148, Type 2, Class B.
   2. Conform to the criteria in Table 1.
   3. Resin type: Poly-alpha-methylstyrene (PAMS).
   4. Do not use compounds that show significant phase separation within 24 hours after thorough agitation.
   5. Meet applicable VOC air-pollution control requirements.

Table 1

Characteristics (Curing compound for PCC)	**Min.**	**Max.**	**ASTM**
Total Solids, percent by weight compound	35		D 2369 D 2371
$Ti0_2$ Pigment, percent reflectance	60		E 1347
Drying Time: Set to touch, min. Track Free, min		 60 120	C 309
Coverage rate, ft^2/gal		100	
Water Loss, lb/ft^2 in 72 hours		0.06	C 156
Flash point, degrees F	50		D 56

2.3 CURING COMPOUND FOR LEAN CONCRETE BASE COURSE

A. Select from the Qualified Products List maintained by UDOT Research Division.
   1. Use a curing compound with a wax base.
   2. Meet AASHTO M 148, Type 2
   3. Meet applicable VOC air-pollution control requirements.

2.4 CURING COMPOUND FOR CONCRETE BARRIER

A. Select from the Accepted Products Listing maintained by UDOT Research Division.
   1. Meet ASTM C 1315, Type 1, Class A.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify concrete surfaces are ready for curing. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

B. Follow product manufacturer's recommendations for preparing surfaces.

C. For newly placed concrete using membrane-curing compound method:
   1. Deliver the curing compound in a ready-mixed form with the pigment uniformly disbursed without diluting or altering the compound. If the compound is chilled and too viscous, warm it to a maximum of 100 degrees F.
   2. Keep surfaces moist until the curing compound is applied.
   3. Complete all patching or surface finishing before applying compound.

D. For lean concrete base course curing: Do not dilute or alter the compound.

3.2 CURING STRUCTURES

A. Bridge Decks, Approach Slabs, Curbs, and Parapets.
   1. Apply membrane-curing compound at the manufacturer's recommended rate so that no portion of the deck or approach slab is exposed to the atmosphere for more than 20 minutes after the tining or finishing operation.
   2. Apply membrane-curing compound at a uniform rate of 100 ft^2/gal.
   3. Work bridge to follow immediately after the finishing machine to allow application of the curing compound while the concrete is still plastic.

4. As soon as the concrete is sufficiently set to support the materials, cover bridge decks, approach slabs, curbs, and parapet walls with material that retains moisture and does not prevent evaporation, such as cotton or burlap mats.
    a. Restrain the cotton or burlap mats to prevent wind or other forces from removing them.
    b. Do not damage the finish.
5. Keep concrete moist continuously for seven days after placement. Keep the entire surface damp, but do not wash away or erode the surface.

B. Other newly placed concrete: Use membrane-curing compound method.
1. Keep surfaces wet and moist until the curing compound is applied.
2. Complete all patching or surface finishing before applying compound.
3. Warm chilled compound that is too viscous to a maximum of 90 degrees F.
4. Apply curing compound immediately after finishing operations are completed
5. Spray the entire surface of the concrete with a membrane curing compound at a uniform rate of 100 ft^2/gal.
6. Immediately re-spray any portion damaged before the seven-day curing expires.

3.3 CURING CURB, GUTTER, FLATWORK, SIDEWALK, DRIVEWAY, AND OTHER MISC CONCRETE ITEMS (CONCRETE SLOPE PROTECTION)

A. Refer to this Section, article 3.1, Preparation and article 3.2, Curing Structures, paragraph B, Other newly place concrete.

3.4 CURING PRE-STRESSED CONCRETE

A. Cure following this Section article 3.2, Curing Structures or article 3.10, Steam Curing, until concrete has reached a strength of 4,000 psi or as designated on the plans.

3.5 CURING PRE-CAST CONCRETE BARRIER

A. Cure exposed surfaces immediately after finishing operations are completed.
1. Apply the curing compound at a rate of 100 ft^2/gal.

B. After removing form, broom clean the surface of the barrier and apply two coats of curing compound.
1. Apply the first coat at a rate of 100 ft^2/gal.
2. Allow the first coat to dry thoroughly before applying the second coat.
3. Apply the second coat at a rate of 200 ft^2/gal.

3.6 CURING CAST-IN-PLACE CONCRETE BARRIER

A. Cure immediately after finishing operations are completed.

B. Apply two coats of curing compound as specified for Curing Pre-cast Concrete Barrier.

3.7 CURING PRE-CAST NOISE WALL

A. Cover surface of exposed aggregate noise wall panels with a moisture barrier or membrane immediately after initial finishing operations are completed.

B. Leave cover in place until final finishing operations (exposed aggregate) are performed.

C. Remove cover, complete final finishing operations, and immediately apply curing compound.
   1. Apply curing compound at a uniform rate of 100 ft^2/gal.
   2. After removing from forms, apply curing compound to all surfaces not previously covered.

D. Cure all other precast noise wall components.
   1. Apply curing compound to all exposed surfaces immediately after finishing or form removal operations are completed.
   2. Apply curing compound at a uniform rate of 100 ft^2/gal.

3.8 CURING LEAN CONCRETE BASE COURSE

A. After finishing operations are complete, apply curing compound.
   1. Spray entire exposed area (top and sides) at a rate of 200 ft^2/gal.
   2. Use fully atomizing mechanical sprayers that have a wind-protective hood.
   3. Hand spray on small areas and areas inaccessible to mechanical spraying equipment.
   4. Provide complete coverage with curing compound at edges, corners, sides, and rough spots.

B. Damage to the film of curing compound occurring within 72 hours of application must be repaired immediately at no additional cost to Department.

3.9 CURING PORTLAND CEMENT CONCRETE PAVEMENT

A. Pretest the liquid membrane curing compound using an infrared spectrometer to determine specification compliance.

B. Provide the Engineer with the test results before placing the concrete pavement.

C. Delay placing concrete pavement until an acceptable shipment of curing compound is received.

D. Warm viscous curing-sealing compound to a temperature not to exceed 100 degrees F if necessary.

E. Thoroughly mix the compound during use and uniformly disperse the pigment throughout the vehicle. Stir continuously mechanically during application and do not dilute or alter in any manner.

F. Apply compound to the entire pavement surface and exposed edges immediately after completing finishing operations:
   1. Apply the curing compound in two approximately equal applications.
   2. Apply the second application in the opposite longitudinal direction as the first at a combined application rate equal to 100 ft^2/gal.
   3. Allow at least 30 minutes between applications.
   4. Small and irregular areas and areas inaccessible to mechanical spraying equipment may be hand sprayed.

G. Stop paving operations if the application of the compound behind the paving machine is delayed until the problem is resolved.
   1. Keep the pavement moist with water until the compound application process is resumed.
   2. Apply the water in a fog-mist spray without damaging the pavement surface texture.

H. Immediately repair any damage to the compound film occurring until seven days after the initial application at no additional cost to Department.

3.10 STEAM CURING

A. Steam curing.
   1. Provide a complete steam curing system approved by the Engineer, including 24 hour temperature control and monitoring devices, and a suitable enclosure to contain live steam and minimize moisture and heat losses.

2. Do not apply steam until the concrete has set. Wait four to six hours if retarders are used. If no retarders are used, wait two to four hours.
3. Maintain 100 percent relative humidity in the steam curing enclosure.
4. Do not apply steam directly on the concrete.
5. When applying steam, increase the ambient air temperature at a rate not to exceed a 40 degrees F per hour until a temperature range of 140 degrees to 160 degrees F is reached.
6. Maintain the temperature range until the concrete has reached the specified strength.
7. When discontinuing the steam, decrease the ambient air temperature at a rate not to exceed a 40 degrees F per hour until reaching a temperature of not more than 20 degrees F above the air temperature to which the concrete will be exposed.

END OF SECTION