

DIVISION V SURFACINGS AND PAVEMENTS

AA

37 BITUMINOUS SEALS

Replace 37-7 RESERVED of the RSS with:
37-7 HIGH FRICTION SURFACE TREATMENT

37-7.01 GENERAL

37-7.01A Summary

Section 37-7 includes specifications for applying high friction surface treatment (HFST).

Applying HFST consists of spreading resin binder and calcined bauxite aggregate on asphalt concrete, polyester concrete, or concrete surfaces.

Apply HFST by a truck mounted machine or by hand on areas less than 200 square yards. The Department is aware of at least one automated continuous application method and equipment that is allegedly covered by United States Patents 9,109,332 and 9,115,473.

37-7.01B Definitions

batch: A specific quantity of material of homogenous composition that can be unambiguously identified, manufactured in a single operation or a series of operations according to a well-defined process.

resin binder: A modified epoxy or polyester resin binder used to bond a surface applied aggregate to an asphalt or concrete surface.

prime coat: A resin that is used to fill cracks and voids in existing surface that is compatible with resin binder.

37-7.01C Submittals

37-7.01C(1) General

Submit the names of your proposed independent laboratories that will perform QC testing.

Submit a certificate of compliance and certified test results for the resin binder and calcined bauxite aggregate. Test results must be from tests performed within 90 days from the date of submittal and must have been performed by an independent laboratory.

Submit a SDS for the resin binder and its components.

37-7.01C(2) Quality Control Plan

Submit a QC plan that must be project specific and includes:

1. Surface preparation methods for areas where HFST is to be placed
2. Method of protecting areas and exposed facilities not to receive HFST
3. Method of protecting and reestablishing existing longitudinal and transverse joints and working cracks in concrete pavements and structures
4. Type of resin binder to be used
5. Resin binder manufacturer’s recommended mixing and placement instructions, including mixing ratios and temperatures
6. Resin binder manufacturer’s estimated cure times for resin binder to be used
7. Method for safe storage and handling of HFST components
8. Disposal methods for excess HFST and containers for HFST components
9. Contingency plan that describes corrective actions you will take in the event of equipment failure or material issues during HFST placement

Submit QC test results for the quality characteristics within the reporting time allowance, after sampling, shown in the following table:

Quality Control Test Result Reporting

Quality characteristic	Test Method	Maximum reporting time allowance
Los Angeles rattler loss at 100 revolutions	California Test 211	2 business Days
Aggregate moisture content	California Test 226	2 business Days
Aggregate magnesium soundness	ASTM C88	7 Days
Aluminum oxide content	ASTM C25	5 Days
Gradation	California Test 202	1 business Day
Polish stone value	ASTM D3319	7 Days
Aggregate acid insolubility	ASTM D3042	7 Days
Resin binder spread rate	Calculated based on amount of materials used	1 business Day
Viscosity	ASTM D2196	2 business Days
Elongation at break point	ASTM D638	2 business Days
Ultimate tensile strength	ASTM D638	2 business Days
Cure rate	ASTM D1640	1 business Day
Gel time	ASTM C881	1 business Day
Adhesive strength at 24 hours	ASTM C1583	2 business Days
Coefficient of friction before opening to traffic	ASTM E1911	Same day of testing and before opening to traffic
Coefficient of friction 7-15 days after opening to traffic	ASTM E1911	1 business Day after testing

37-7.01D Quality Assurance

37-7.01D(1) General

Not Used

37-7.01D(2) Preconstruction Meeting

Schedule a preconstruction meeting with the engineer at a mutually agreed time and place. Make the arrangements for the meeting facility. Before the start of the trial HFST, hold the meeting with the Engineer and your (or applicable personnel):

1. Project Manager
2. QC Manager
3. Project Superintendent
4. Project Foreman
5. Traffic Control Foreman
6. Subcontractors' Foreman
7. Resin Supplier Technical Representative

Meeting attendees must sign an attendance sheet provided by the Engineer. The Engineer retains the attendance sheet.

Discuss the project specifications and the processes for producing materials and constructing each item of work, including:

1. Quality assurance QC plan
 - 1.1 Quality control
 - 1.2 Acceptance criteria
2. Placement of materials:
 - 2.1 Trial HFST requirements
 - 2.2 Application rates
 - 2.3 Binder resin mixing methods and equipment
 - 2.4 HFST application methods and equipment
3. Contingency plan
4. Issues specific to the project, including:
 - 4.1 Weather
 - 4.2 Alignment and geometrics
 - 4.3 Traffic control issues

Do not place trial HFST, or start production work until the listed personnel have attended the meeting,

37-7.01D(3) Quality Control

37-7.01D(3)(a) General

Perform QC testing for trial HFST and production work. QC testing except coefficient of friction testing must be performed by independent laboratories.

37-7.01D(3)(b) HFST

Perform sampling and testing at the specified frequency and sampling location for the following quality characteristics:

Calcined Bauxite Quality Control Requirements

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of Sampling
Los Angeles rattler loss at 100 revolutions	California Test 211	1st day of production	Point of application or stockpile
Aggregate moisture content	California Test 226	1 per shift	Point of application or stockpile
Aluminum oxide content	ASTM C25	1st day of production	Point of application or stockpile
Gradation	California Test 202	1st day of production	Point of application or stockpile

Resin Binder Quality Control Requirements

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of Sampling
Viscosity	ASTM D2196	1 per batch	Point of application
Elongation at break point	ASTM D638	1 per batch	Point of application
Ultimate tensile strength	ASTM D638	1 per batch	Point of application
Cure rate	ASTM D1640	1 per batch	Point of application
Gel time	ASTM C881	1 per batch	Point of application
Adhesive strength at 24 hours	ASTM C1583	1 per batch	Point of application

HFST Quality Control Requirements

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of Sampling
Resin binder spread rate	Calculated based on amount of materials used	1 per Day	Point of application
Coefficient of friction before opening to traffic	ASTM E1911	Minimum of 1 every 500 ft ^a	Alternate between wheel paths
Coefficient of friction 7-15 days after opening to traffic	ASTM E1911	Minimum of 1 every 500 ft ^a	Alternate between wheel paths

^aFor application lengths <500 ft, test at every 200 ft interval

37-7.01D(4) Department Acceptance

The Department accepts HFST based on:

1. Visual inspection for the following:
 - 1.1. Uniform surface texture
 - 1.2. Raveling, which consists of the separation of the aggregate from the resin binder
 - 1.3. Streaking, which consists of alternating longitudinal bands of resin binder without uniform calcined bauxite aggregate retention, approximately parallel with the lane line
 - 1.4. Flushing, which consists of resin binder without or fully embedded calcined bauxite aggregate
2. The Department's sampling and testing of calcined bauxite aggregate for compliance with the requirements shown in the following table:

Calcined Bauxite Aggregate Acceptance Criteria

Quality characteristic	Test method	Requirement
Los Angeles rattler loss at 100 revolutions ^a (max, %)	California Test 211	10
Aggregate moisture content (max, %)	California Test 226	0.2
Sand equivalent (min)	California Test 217	95
Gradation (% passing by weight) Sieve size: No. 4(min) No. 6(min) No. 16(max)	California Test 202	100 95 5

^aUse grading D from Table 1.

3. The Department's sampling and testing of resin binder for compliance with the requirements shown in the following table:

Resin Binder Acceptance Criteria

Quality characteristic	Test method	Requirement
Viscosity (centipoise) no. 2 spindle, 10 RPM	ASTM D2196	1,000 - 3,000
Cure rate (max, hrs) Specimen, 0.05 inch thick, Method A, Dry-Through Time	ASTM D1640	3
Gel time (minutes)	ASTM C881	10-30
Elongation at break point (min, %) Type I specimen,	ASTM D638	30
Ultimate tensile strength (min, psi) Type I specimen,	ASTM D638	2,650
Adhesive strength (psi)	ASTM C1583	250 or 100% substrate failure

4. The Department's sampling and testing for HFST for compliance with the requirements shown in the following table:

HFST Acceptance Criteria

Quality Characteristic	Test Method	Requirement
Coefficient of friction at 60 km/h before opening to traffic	ASTM E1911	0.75 ^a
Coefficient of friction at 60 km/h 7-15 days after opening to traffic	ASTM E1911	0.75 ^a

^a Report coefficient of friction values at 20 km/h, 40 km/h, 80 km/h.

Areas of raveling, streaking and flushing that are greater than 0.25 sq ft are considered defective and must be repaired at your own cost. These must be removed and replaced, and must conform to the maximum lateral dimensions of the defective area.

Perform coefficient of friction calibration and testing in the presence of the Engineer. Notify the Engineer at least 48 hours before coefficient of friction testing.

37-7.01D(5) Trial HFST Application

Do not begin trial HFST until authorized.

Complete a trial of HFST application at an authorized location before starting production work. Resin binder manufacturer's representative must be present during the trial application.

Remove pavement markers and delineation within the area to receive HFST, for the lane and length involved, before placing the resin binder.

The trial HFST application must:

1. Be at least 12 feet wide and 20 feet long.
2. Be constructed using the same method and equipment as the production work. Construct an additional trial for each method proposed for the production work.
3. Replicate field conditions, including ambient and surface temperatures, anticipated for production work.
4. Demonstrate surface preparation requirements as outlined in the QC plan.
5. Document the area of application, quantities of resin binder and aggregate with a data management system capable of reporting coverage rates and thickness of the resin binder system after applying the HFST. Calculate and report HFST application rate.
6. Determine the initial set time for the resin binder.
7. Test the coefficient of friction using ASTM E1911 at 20 km/h, 40km/h, 60 km/h and 80 km/h on the HFST. If the coefficient of friction at 60 km/h speed is below 0.75, correct or replace the HFST until the coefficient of friction is greater than or equal to 0.75.

37-7.02 MATERIALS

37-7.02A General

Not Used

37-7.02B Prime Coat

Prime coat must be high-molecular-weight methacrylate resin complying with section 60-3.03B(2) except:

1. Methacrylate resin must be free of wax
2. Tack-free time requirements do not apply

Friction testing is not required for the resin prime coat

37-7.02C Resin Binder

Resin binder must meet the requirements shown in the following table:

Resin Binder Requirements

Quality characteristic	Test method	Requirement
Viscosity (centipoises) no. 2 spindle, 10 RPM ^b	ASTM D2196	1,000 - 3,000
Cure rate (max, hrs) Specimen, 0.05 inch thick, Method A, Dry-Through Time	ASTM D1640	3
Gel time (minutes)	ASTM C881	10-30
Elongation at break point (min, %) Type I specimen,	ASTM D638	30
Ultimate tensile strength (min, psi) Type I specimen,	ASTM D638	2,650
Compressive strength (min, psi at 3 hours)	ASTM C579	1,000
Water absorption (max, %)	ASTM D570	1.0
Durometer hardness (Shore D)	ASTM D2240	65-75
Styrene content ^a (% by weight)	ASTM D2369	30-40

^aFor polyester resin binder only. Perform test before adding initiator.

37-7.02D Calcined Bauxite Aggregate

Calcined bauxite aggregate must be clean, dry, and free from clay and any other deleterious matter and meet the requirements shown in the following table:

Calcined Bauxite Aggregate Requirements

Quality characteristic	Test method	Requirement
Los Angeles rattler loss at 100 revolutions ^a (max, %)	California Test 211	10
Aggregate moisture content (max, %)	California Test 226	0.2
Sand equivalent (min)	California Test 217	95
Polish stone value (min)	ASTM D3319	38
Aluminum oxide content (min, %)	ASTM C25	87
Gradation (% passing by weight) Sieve size: No. 4 No. 6 No. 16	California Test 202	100 95 5

^aUse grading D from Table 1.

37-7.03 CONSTRUCTION

37-7.03A General

Do not begin HFST production work until authorized after successful completion of the trial HFST.

37-7.03B Surface Preparation

37-7.03B(1) General

Protect utilities, utility covers, drainage structures, curbs and other structures within or adjacent to treatment location from HFST materials using methods outlined in the QC plan.

Protect existing transverse and longitudinal joints, and working cracks in concrete pavement and structures by taping or other approved method to prevent intrusion of HFST resin and aggregate into the joints and working cracks.

Surfaces must be clean, dry, and free of any dust, oil, debris, organic matter, or any material that may interfere with the bond between resin binder and existing surfaces.

37-7.03B(2) Asphalt Pavement Surfaces

Perform the following before applying resin binder:

1. Remove pavement markers and delineation to a maximum depth of 0.01 foot from the area receiving HFST
2. Sweep the pavement surface
3. Blow the surface clean with pressurized air using a minimum 150 cfm compressor fitted with an air lance
4. Clean cracks greater than 0.25 inch wide with pressurized air and pretreat with mixed resin binder.

37-7.03B(3) Concrete Structures Surfaces

Perform the following activities in the order listed before applying resin binder:

1. Abrasive blast the surface with steel shot
2. Sweep the surface clean
3. Blow the surface clean with pressurized air
4. Pretreat and seal cracks under section 41-3

Steel shot used for abrasive blast must comply with SSPC-AB3 and recycled steel shot must comply with SSPC-AB2. The surface must be dry when abrasive blasting is performed. All laitance, contaminants, paint, markers, foreign material, etc., must be removed from the surface.

If the concrete structures surface becomes contaminated before placing the HFST treatment, abrasive blast clean the contaminated area, sweep and blow the surface clean.

37-7.03C HFST Application

37-7.03C(1) General

Utilize one of the following methods to apply the resin binder and aggregate wearing course, under manufacturer's recommendations:

1. Automated continuous application
2. Hand mixing and application

Hand mixing must not be used on areas greater than 200 square yards.

Apply mixed resin binder under resin binder manufacturer's recommendations.

Do not apply resin binder on wet or damp surfaces. Asphalt concrete pavement surface must be greater than 30 days old before applying HFST.

For concrete structures surfaces, if polyester resin binder is the resin binder being used, comply with section 60-3.04 for the application of a prime coat of methacrylate resin before placing polyester resin binder. Aggregate requirements in section 60-3.04 for polyester concrete overlay do not apply.

Do not apply HFST when the ambient temperature is below 50 degrees F for epoxy type resin binders and 45 degrees F for other resin binders. Do not apply HFST when the ambient temperature is above 100 degrees F.

Spread resin binder at a minimum rate of 0.32 gal/sq yd to one lane width at a time. Narrower application widths are allowed as determined by the engineer.

Do not allow the mixed resin binder to do any of the following that may impair retention and bonding of aggregate:

1. Separate
2. Cure
3. Dry
4. Be exposed
5. Harden

Do not contaminate the exposed uncured mixed resin binder.

Replace contaminated areas of resin binder.

Spread aggregate until refusal within 3 minutes of resin binder application.

Cure HFST for a minimum period recommended by the resin binder supplier. During curing period do not allow vehicles, construction equipment, or foot traffic on the HFST.

HFST that has not completely cured is considered nonperforming and must be removed and replaced before opening to traffic.

Re-establish existing transverse and longitudinal joints, and working cracks in concrete pavement and structures by sawing or isolating the full depth of HFST, without damaging the joint or crack seal below, before opening to traffic. Match the width and location of the existing joints and working cracks in the concrete pavement within a tolerance of $\pm 1/4$ of an inch.

37-7.03C(2) Automated Continuous Application

Automated continuous application must be performed by an approved self-propelled truck-mounted application machine capable of continuously and thoroughly mixing resin binder components to the ratio recommended by the manufacturer (+/- 2 percent by volume). The machine will include an aggregate drop spreader capable of mechanically and continuously spreading calcined bauxite aggregate.

The applicator vehicle must be equipped with a built-in data management unit which is capable of producing real time data flow showing:

1. The volume of resin
2. The resin mil thickness on average throughout the application width
3. The volume of aggregate applied throughout the application width

The binder must be continuously applied once blended. The application vehicle must be capable of applying the minimum binder spread rate. Clean the mix head and delivery lines if application of the mixed resin is stopped for more than 30 minutes.

The high friction aggregate must be applied by the same automated continuous application vehicle that applies the resin binder to the pavement section. The automatic aggregate spreader must be capable of applying up to a continuous 12-foot width application.

Exposed uncured mixed resin binder must not be visible after the aggregate topping is applied. If exposed uncured mixed resin binder is visible after applying the aggregate topping, apply aggregate topping to the exposed areas using an approved application method.

37-7.03C(3) Hand Mixing and Application

For approved low volume areas and areas less than 200 square yards, hand-mix the resin binder under manufacturer's recommendations. Uniformly spread the resin binder onto the surface using a serrated edge squeegee. Immediately broadcast the high friction surfacing aggregates until refusal.

37-7.03D Excess Aggregate Removal and Reuse

Excess calcined bauxite aggregate must be recovered by a mechanical sweeper and may be reused for HFST. Before reuse of recovered calcined bauxite aggregate, blend with new calcined bauxite aggregate at a rate of 2 to 1 by volume. The recovered calcined bauxite must be clean, dry, and free from clay and any other deleterious material. Provide a record of all recovered calcined bauxite aggregate used and test results. Super sacks or stockpile containing the blended recovered calcined bauxite aggregate must be clearly marked "Recovered Calcined Bauxite Aggregate" and the contract number.

Before opening to public traffic, remove excess and loose aggregate from the traveled way and shoulders by sweeping. HFST must be completely cured before sweeping and there must be no damage or dislodging of aggregate from HFST surface. Perform additional sweeping before placement of pavement markers and delineation.

37-7.04 PAYMENT

Not Used