

**HIGH FRICTION SURFACE TREATMENT.****(REV 1-17-17)**

The following new Section is added after Section 330:

**SECTION 333  
HIGH FRICTION SURFACE TREATMENT**

**333-1 Description.**

This work consists of furnishing and applying a high friction surface treatment (HFST) in accordance with this Section and in conformity with the lines and details shown in the Plans.

The Contractor shall be responsible for providing a manufacturer's representative at the construction site in order to train Department, Construction, Engineering & Inspection (CEI), and Contractor personnel prior to surface treatment and shall require the manufacturer's representative to be available during application of the surface treatment as necessary.

**333-2 Materials.**

**333-2.1 General:** Use a two part polymer resin binder treatment capable of retaining a bauxite aggregate topping under vehicular traffic conditions.

**333-2.2 Polymer Binder:** The polymer resin binder shall consist of a thermosetting modified polymer compound and shall meet the following requirements:

Table 333-1 Polymer Resin Binder Requirements		
Property	Requirement	Test Method
Viscosity	7 – 30 poises	ASTM D-2556
Gel Time	10 minutes min.	ASTM C-881 (60 gram mass)
Ultimate Tensile Strength	2,000 – 5,000 psi	ASTM D-638 (Type 1 Specimen)
Elongation at break point	30 – 70%	ASTM D-638 (Type 1 Specimen)
Durometer Hardness (shore D)	60 - 80	ASTM D-2240
Compressive Strength	1,000 psi min 3 hours, 5,000 psi min at 7 days	ASTM C-579
Cure Rate (dry time)	3 hours max	ASTM D-1640
Water Absorption	1.0% max	ASTM D-570
Adhesive Strength at 24 hrs	250 psi min or 100% substrate failure	ASTM C-1583

**333-2.3 Aggregate:** The aggregate shall be a calcined bauxite consisting of a 1-3mm gradation. The aggregate shall be clean, dry, and free from foreign matter. The aggregate will be delivered to the construction site in packaging that is clearly labeled; which protects the aggregate from any contaminates on the jobsite and from exposure to rain or other moisture. The aggregate shall meet the following requirements:

Table 333-2 Aggregate Requirements		
Property	Requirement	Test Methods
Aggregate Abrasion Value	20% max	AASHTO T-96
Aggregate Grading	No. 4 Sieve Size	100% min Passing
	No. 6 Sieve Size	95% min Passing
	No. 16 Sieve Size	5% max Passing
Moisture Content	0.2% max	AASHTO T-255
Aluminum Oxide	86% min	ASTM C-25

**333-2.4 Certified Test Results:** Provide to the Engineer, certified copies of complete test results from the producers documenting that the polymer resin binder meets the requirements of Table 333-1 and that the aggregate meets the requirements of Table 333-2. The test results shall be within 12 months of project letting date and must be representative of the material used on the project and must document source of origin.

**333-3 Vendor Qualification.**

The HFST vendor shall provide a list of similar projects on which a minimum of 3,000 square yards of high friction surface treatment has been placed within the past three years from the date of the submittal of bid. Provide the owners contact information and project locations. Include documentation that indicates the in-place friction characteristics of these projects met a minimum FN40R of 65 when tested in accordance with AASHTO T-242.

**333-4 Quality Control Plan.**

The vendor shall submit an HFST Quality Control Plan (QCP) and provide a copy to the State Materials Office (SMO) for approval at least 30 days prior to placement of HFST. The QCP shall contain a minimum:

1. Schedule for the trial HFST work and the production HFST work.
2. Description of equipment for placing HFST.
3. Method of application for measuring, mixing, placing, and finishing HFST.
4. Method for protecting areas not to receive HFST.
5. Description of acceptable environmental conditions for placing HFST.
6. Cure time and time to bear traffic estimates for HFST.
7. Storage and handling of HFST components.
8. Disposal and recycling of excess HFST and containers.
9. Contingency plan for possible failure during the HFST application.
10. Name of the certified independent testing laboratory.
11. Key personnel and contact information.
12. All project certifications and test results.

The QCP shall designate a QC Manager who shall have full authority to institute any action necessary for the successful operation of the plan.

### **333-5 Application.**

**333-5.1 General:** Do not apply the two part polymer resin binder on a wet surface, when the ambient or surface temperature is below or above the manufacturer's recommendation, or when the anticipated weather conditions would prevent the proper application of the surface treatment as determined by the manufacturer's representative.

**333-5.2 Test Strip.** Complete a trial test strip prior to starting HFST production work. Surface preparation on the rest of the project may be completed prior to the test strip or during the cure time.

The trial HFST shall:

1. Be at least 20 feet long and equal to the production width.
2. Be constructed using the same equipment as the production work.
3. Replicate field conditions, including ambient and surface temperatures, anticipated for the production work.
4. Demonstrate surface preparation requirements.
5. Document the settings on the applicator equipment, initial quantities of resin and aggregate, and unused quantities of resin and aggregate remaining in the applicator equipment after applying the HFST.
6. On a small area, verify the polymer resin binder film thickness using a wet film thickness gauge prior to aggregate placement.
7. Determine the initial set time for polymer resin binder in HFST.
8. Have temporary or permanent pavement markers and delineation in place when lanes are open to public traffic.
9. Determine that work can be completed within allowable lane closure times.

Remove and dispose of the HFST test strip if quality is unacceptable. No payment will be made for disposed material. Do not begin HFST production until successful completion of the trial HFST and authorization is provided by the Engineer. The test strip requirement may be waived by the Engineer.

**333-5.3 Preparation:** Surfaces shall be clean, dry, and free of all dust, oil, debris and any other material that might interfere with the bond between the polymer resin binder material and existing surfaces. For applications on new pavements, install the HFST a minimum of 30 days after the placement of the underlying and adjacent asphalt pavement.

Clean asphalt pavement surfaces using a mechanical sweeper to remove dirt, loose aggregate, debris, and deleterious material.

Clean concrete pavement surfaces by shot blasting to remove all curing compounds, loosely bonded mortar, surface carbonation, and deleterious material. The final surface must have, at minimum, the texture of Concrete Surface Profile (CSP) 5 as specified by the International Concrete Repair Institute (ICRI). The texture should not go above CSP 7. After shot blasting, vacuum sweep or air wash, with a minimum of 180 cfm of clean and dry compressed air. Maintain the air lance perpendicular to the surface and the tip of the air lance within 12 inches of the surface.

Utilities, drainage structures, curbs and any other structure within or adjacent to the treatment location shall be protected against the application of the surface treatment materials. Cover and protect all existing pavements and pavement markings that are adjacent to the application surfaces as directed by the Engineer. Pavement markings that conflict with the

surface application shall be removed by grinding, or by other methods approved by the Engineer, and the surface shall be swept clean prior to the polymer binder application.

Pre-treat asphalt joints and cracks greater than 1/4 inch in width and depth with the mixed polymer specified herein. Once the polymer in the pre-treated areas has gelled, the high friction polymer binder and aggregate topping installation may proceed.

The top layer of flexible pavement should be milled and inlaid prior to HFST application in the following conditions: cracking covering 6% or more of the surface; widespread rutting of 0.25 inches or greater; raveling; or bleeding surface. On concrete, slab repair or replacement is required for any single slab with moderate or severe distress (specifically transverse cracking, longitudinal cracking, spalling, or corner cracking) or a shattered slab in more than three pieces.

**333-5.4 Automated Mixing and Application:** Apply HFST with a continuous automated method using an applicator vehicle. The applicator vehicle shall mechanically mix, meter, monitor, and apply the binder resin system and have the capability to spread the high friction aggregate a minimum of 12 feet wide in one uniform and continuous pass. If recommended by the manufacturer, metering pumps shall be heated.

The applicator vehicle must have continuous pumping and proportioning devices that blend the binder components within a controlled system and can blend and mix per the manufacturer's specification (plus or minus 2% by volume). The polymer resin binder must be continuously applied once blended. The applicator vehicle must be capable of applying the minimum polymer resin binder spread rate.

Dense-graded asphalt and rigid pavement surfaces will require one course layer of HFST following the application rates in Table 333-3. Open-graded asphalt surfaces are required to be milled and overlaid with dense grade asphalt prior to HFST application. All HFST layers must be constructed to a minimum of the drivable lane width or as directed by the Engineer. When the lane width exceeds the capability of the vendor's machine and the machine has to make two runs to cover the whole lane width, verifying the following for daily acceptance:

1. Joints appear neat and uniform without buildup, uncovered areas, or unsightly appearance.
2. For longitudinal joint construction, there will be no opening or gap between adjacent passes and should not be constructed within a vehicle wheel path.
3. Construction joints have no more than 1/4 inch (6 mm) difference in elevation across the joint as measured with a 6 foot (2 m) straightedge.

Table 333-3 Application Rate	
Polymer Resin Binder Application Rate	High Friction Aggregate Application Rate
50-65 mils (25 to 32 sf/gal)	12 to 15 lbs/sy

The aggregate shall be applied less than 30 seconds after the polymer resin binder application. Completely cover the "wet" polymer binder with aggregate until refusal. Recovered clean aggregate may only be reused once and must be blended with new aggregate at a rate of 2:1 (two parts new aggregate to one part recovered aggregate). Provide a written record of the recovered aggregate and clearly label storage containers with "Recovered HFST Aggregate" and the project number.

**333-5.5 Manual Mixing and Application:** Manual mixing and application are only allowed for areas that are less than 200 square yards or upon approval by the Engineer where truck mounted application machines are not applicable to the specified locations because of construction constraints. Hand-mix the polymer resin binder in accordance with the manufacturer's recommendations. Uniformly spread the binder using serrated edge squeegees, and within five minutes broadcast the aggregate until refusal. All other conditions apply.

**333-5.6 Curing:** Allow each course of the HFST to cure in accordance with manufacturer recommendations. Protect treated surfaces from traffic and environmental effects until the area has cured. After the initial cure, the inspector may perform a visual inspection to verify that the polymer resin binder has cured properly and that there are no uncured spots. HFST that does not cure properly is subject to removal at the Contractor's expense.

Before opening to traffic, remove the excess aggregate by mechanical sweeping or vacuum sweeping. Excess aggregate that can be reused shall be reclaimed by a vacuum sweeper. The recovered aggregate must be clean, uncontaminated, and dry, as approved by the Engineer.

Aggregate shedding after construction shall require additional sweeping or vacuuming on the shoulders as needed to remove excess aggregate, but not more than two weeks after final HFST placement.

Restripe the pavement surface and reinstall pavement markers as directed in the contract documents after the HFST has been completed and approved by the Engineer. Temporary striping may be necessary as described by the contract documents or as directed by the Engineer.

**333-6 Warranty and Friction Acceptance Testing.**

All HFST applications require a minimum one year warranty from latent surface defects. Threshold values and associated remedial work are specified in Table 333-4.

Within 90 days after construction of the HFST, the Department will measure the friction characteristics in accordance with AASHTO T242. The friction tests are needed prior to final acceptance. The minimum acceptable friction number (FN40R) is 65 or the Contractor must remove and replace all materials at no additional expense to the Department. The Department also reserves the right to measure the friction characteristics of the HFST at any time during the warranty period.

Type of Distress	Type of Survey	Threshold Values for HFST Application Area	Remedial Work
Surface Cracking <sup>(1)</sup>	Any Survey	≥ 10% of any given 100 square yard of HFST application area	Remove and replace the distressed areas HFST to the full distressed depth and to a minimum surface area of 150% of each distressed area, subject to performance at final survey <sup>(2)</sup>

Table 333-4 Warranty Criteria			
Type of Distress	Type of Survey	Threshold Values for HFST Application Area	Remedial Work
Raveling and/or Delamination <sup>(3)</sup>	Any Survey	≥ 10% of any given 100 square yard of HFST application area	Grind and replace the distressed area(s) with HFST to the full distressed depth and to a minimum surface area of 150% of each distressed area, subject to performance at final survey <sup>(4)</sup>
Soft Spots /Bleeding <sup>(5)</sup>	Any Survey	≥ 10% of any given 100 square yard of HFST application area	Grind and replace the distressed area(s) with HFST to the full distressed depth and to a minimum surface area of 150% of each distressed area, subject to performance at final survey <sup>(4)</sup>

(1) Severity of Cracking Class IB or greater.  
 (2) Remedial Work for surface cracking: The Contractor must perform all corrective work to the satisfaction of the Engineer.  
 (3) Raveling and/or Delamination: Loss of cover aggregate or lack of HFST mix on the surface.  
 (4) At the time of final survey, repaired areas must be performing to the satisfaction of the Engineer.  
 (5) Soft Spots is caused by uncured or polymer binder and bleeding is due to excess binder. The soft spots can be detected and verified by using a small scraper knife to shovel off the material.

**333-7 Method of Measurement.**

The quantities to be paid for will be the plan quantity, in square yards, completed and accepted. No deduction will be made for the areas occupied by manholes, inlets, drainage structures, pavement markings or by any public utility appurtenances within the area.

**333-8 Basis of Payment.**

Price and payment will be full compensation for all work specified in this Section. Payment will be made under:

Item No. 908-333-1 High Friction Surface Course – per square yard.