

**High Friction Surface Treatment**

**1. Description**

This work consists of installing a High Friction Surface Treatment (HFST) in accordance with the plans and specifications. The HFST is comprised of a minimum of a single layer using a polymeric resin binder and surface applied high friction aggregate utilized to increase the coefficient of friction of an asphalt or concrete pavement.

**2. HFST Materials**

**2.1 Polymeric Resin Binder**

**2.1.1 Specification of Binder Resin System**

Use a multi-component, cold-applied, modified polymeric resin treatment covered with natural or pigmented aggregates. Ensure that the binder consists of a thermosetting polymeric resin compound that holds the aggregate firmly in position and meets the following requirements:

<b>Two-Part Modified Resin System</b>		
<b>Property</b>	<b>Test Method*</b>	<b>Specification Limits</b>
Viscosity	ASTM D2556	7-30 P
Durometer Hardness	ASTM D2240	60-80
Cure Rate (Dry through time)	ASTM D1640	3 hours max.
Adhesive Strength	ASTM C1583	250 psi min. or 100% substrate failure
Ultimate Tensile Strength	ASTM D638	2000-5000 psi
Elongation at break point	ASTM D638	30% min.
Compressive Strength	ASTM C579	1000 psi @ 3 hours 5000 psi @ 7 days
Gel Time	ASTM C881	10 minutes min.
Water Absorption	ASTM D570	1% max
Mixing Ratio		Per Manufacturer's Recommendations (refer to Section 4.2)

Additional testing notes for laboratory: Prepare all samples per manufacturer's recommendation\*

- Viscosity – prepare one pint sample and mix for 2 to 3 minutes before testing. Refer to the section on Procedure in the test method for spindle selection and test at a temperature of 73 ± 2°F.
- Gel Time – Prepare a 60 g sample per manufacturer's recommendation. Perform testing at a temperature of 73 ± 2°F.
- Cure Rate – Prepare specimens of 50-55 wet mil thickness.

Cure the following test specimens for 7 days at 73 ± 2°F, and test immediately without delay.

- Durometer Hardness – Use the type 1 precision type D method.
- Compressive Strength – Prepare specimen according to Method "B", 2" x 2" cube, using 2.75 parts of sand to one part mix polymer resin by volume. Sand must conform to ASTM C778, 20-30 sand.
- Ultimate Tensile Strength - Prepare Type 1 specimens in accordance to ASTM D638.
- Elongation at break point - Prepare Type 1 specimens in accordance to ASTM D638.

### 2.1.2 Polymer Resin Packaging

Exothermic polymer resin binder must be packaged in suitable well sealed containers as to the type of material and the ratio of components to be mixed by volume. Any special instructions regarding mixing must be included. Label the components including brand name, name of manufacturer, lot or batch number, temperature range for storage, expiration date and the quantity contained therein. Caution warnings regarding the handling, and contact with skin and eyes must be included on the labels. The volumes of the pails or containers must be labeled in US gallons to assist in proper mixing dosage and application rates. Ensure that samples are obtained and tested in accordance with section 5 of this specification.

### 2.1.3 Polymer Resin Material Certification

Ensure the manufacturer certifies the polymer resin used will meet the requirements of this specification. The manufacturer will be required to provide a signed letter stating the material meets the specification and also provide a test report from a certified, independent lab including test report dates for the material provided to the project. Any QC samples taken by the contractor or the manufacturers during construction must be readily available to the Department once test results are obtained. Ensure a copy of the MSDS for the components of the polymer resin is given to the RCE.

## 2.2 Aggregate

### 2.2.1 Specification for HFST Aggregate

Ensure that the aggregate is a calcined bauxite material that is clean, dry and free from deleterious matter and meets the following requirements:

<b>Aggregate Properties</b>		
<b>Property</b>	<b>Test Methods *</b>	<b>Specification Limits</b>
Polish Stone Value	AASHTO T279	38.0 min.
Resistance to Degradation	AASHTO T96	20.0% max.
Aggregate Grading	AASHTO T27	100.0 % Passing No. 4 95.0-100.0% Passing No. 6 0.0 – 5.0% Passing No. 16
Moisture Content	AASHTO T255	0.2% max.
Aluminum Oxide	ASTM C25	87% min.

\*Additional testing notes for laboratory:

Resistance to aggregate degradation – Use grading “D” from table 1 of ASTM C131.

Aluminum Oxide Content – Use section 15.

### 2.2.2 Packaging

Bauxite aggregates must be supplied to the construction site in clearly labeled super-sacks or bins weighing a minimum of 2000 lbs. Small bags of aggregate material may be substituted when hand applications are necessary. Ensure that samples are obtained and tested in accordance with section 4 of this specification.

### 2.2.3 Material Certification

Ensure that the manufacturer provides certification that the bauxite aggregate used meets the requirements of this specification. Additionally, ensure that the manufacturer provides a signed letter stating the material meets this specification and provides a test report from a certified, independent lab including test dates for the material provided to the project. Any QC samples taken by the contractor or the manufacturers must be readily available to the Department once test results are obtained. Ensure a copy of the MSDS for the aggregate is given to the RCE.

### **3. Construction Requirements**

#### **3.1 Qualification of Installer**

Before submitting a bid for work, make a thorough inspection of the site and determine existing conditions so that the work can be expeditiously performed after a contract is awarded. Any additional lifts required to obtain final lift thickness of the HFST should be considered during the site inspection. The Department will consider submission of a bid to be evidence of this inspection being made. The Department will not honor any claims for cost or time extension resulting from site conditions.

The installer must submit a minimum of 3 completed projects with the owner's contact information on which a cumulative minimum of 5,000 square yards of HFST have been placed within the past three years demonstrating acceptable friction readings of 65 in accordance with ASTM E274 after installation.

The installer must submit a Quality Control (QC) Plan that is project specific detailing the installers key personnel (including contact information), equipment to be used, materials, proposed methods prior to installation including preparation of the pavement surface (including crack sealing, cleaning, sweeping, drying), material blending procedures, procedures for installation, and proposed methods of curing, clean up, and traffic marking operations. Ensure the QC Plan is submitted to the RCE a minimum of 7 days prior to placement of HFST. Ensure that all placement personnel are trained and are familiar with the products being placed and work diligently in order to obtain long lasting bond of the HFST to the existing pavement surface and high friction aggregate retention within the finished product.

### **4. Installation**

#### **4.1 Preparation**

Ensure that a polymer resin manufacturer's representative is on site to provide technical assistance during the startup operations and as necessary during the surface preparation, material placement and during any necessary remedial work. If required by the manufacturer, place a prime coat prior to the installation of the HFST. Clean and fill all inadequately sealed joints and cracks greater than ¼" with a crack sealant approved by the polymer resin manufacturer. Clean asphalt existing surfaces by use of mechanical vacuum sweepers, high pressure air or other methods outlined in the installers QC plan. Receiving surfaces must be clean, free of all dust, oil, debris and any other material that might interfere with the bond between the polymer binder material and existing surfaces. Surfaces may need to be washed with a mild detergent, and then rinsed and dried using a hot compressed air lance. Ensure that the pavement surface is clean and completely dry prior to the installation of the HFST to the satisfaction of the manufacturer's representative. Cover and protect all existing pavement markings (if left in place) and utilities prior to placement.

Clean concrete pavement surfaces by shot blasting and vacuum sweeping. Shot blast all concrete surfaces to remove all curing compounds, loosely bonded mortar, surface carbonation, and deleterious material. The prepared surface shall comply with the International Concrete Repair Institute (ICRI) standard for surface roughness CSP 5. After shot blasting, vacuum sweep or air wash, with a minimum of 180 cfm of clean and dry compressed air, all surfaces to remove all dust, debris, and deleterious material. Maintain air lance perpendicular to the surface and the tip of the air lance within 12 inches of the surface. Magnesium phosphate based materials will not be allowed.

Ensure for applications on new asphalt pavements, that the installation of the polymer binder and high friction aggregate topping is a minimum of 30 days after placement of underlying and adjacent pavement. On new concrete surfaces, all curing compounds must be completely removed prior to installation. Any full or partial depth repairs on concrete surfaces must cure a minimum of 28 days before the HFST can be placed.

## 4.2 Binder Application

Apply the polymer resin binder material on a dry surface, when the ambient temperature and surface temperature is above 55°F, unless the polymer resin binder can demonstrate a “dry to touch” cure rate at the installation ambient temperature within 3 hours, or when the anticipated weather conditions or pavement surface temperature would prevent the proper application of the surface treatment as determined by the polymer resin manufacturer. Ensure the polymer components are capable of being mixed at lower than ambient temperatures in the event that the components are stored outdoors.

Proportion the multi-component polymer binder to the correct ratio and mix the polymer binder to the correct ratio as determined by the polymer resin manufacturer (+/- 2% by weight). Ensure that any blushing (waxy surface coating on the epoxy) caused by a reaction of the moisture with the hardening agent does not occur during the application process. Remove any areas that show signs of blushing that typically cause adhesion issues to occur. Note that certain porous asphalt surfaces such as an open graded friction course or grooved concrete surfaces may require two layers of high friction surface treatment (HFST) to achieve the required mil thickness for adequate bonding to the existing surface. Ensure when placing in multiple lifts, that the aggregate used is the same bauxite material as the final riding surface and the aggregate material is properly embedded into the polymer. The mixed components are hand applied onto a prepared pavement surface with a minimum coverage rate of uniform thickness of 50-65 mils (25-32 square feet per gallon) onto the pavement. Coverage rate is based upon expected variances in the surface profile of the existing pavement. SCDOT and Contractor will measure and monitor placement using a contractor supplied depth gauge a minimum rate of 1 per 100 square yards placed to ensure proper application thickness. Operations should proceed in a manner that will not allow the mixed polymer resin to separate, cure, dry, be exposed or otherwise harden in such a way as to impair retention and bonding of the aggregate. Walking, standing or any form of contact or contamination with the wet uncured polymer resin prior to the application of the aggregate without the use of spiked shoes to minimize the disturbance of the binder layer will result in that section of the HFST being removed and replaced at the installer's expense.

### 4.2.1 Hand Application of the multi-component polymer base binder

***(This application may be used when installing low volume areas (less than 300 square yards total for the contract).*** Mix polymer components using a low speed high torque drill fitted with a helical stirrer. Hand applied base binder will be uniformly spread onto the substrate surface by means of a serrated edged squeegee capable of spreading at a rate of 50-65 mils (25-32 square feet per gallon). Mix only the quantity that can be used within its gel time.

### 4.2.2 Mechanical Application of the multi-component polymer binder

***This application must be used when installing high application volume areas (greater than 300 square yards total for contract). A test section (minimum of 100 SY) will be required to demonstrate equipment has been properly calibrated a minimum of 3 hours prior to beginning the project. In the event that the test section is not completely cured within 3 hours, additional time may be deemed necessary by the RCE before application can begin.***

Apply the multi-component polymer binder by a truck or trailer mounted application machine onto the pavement section in varying widths of up to 12 feet wide at a uniform application thickness. Ensure the polymer resin manufacturer has approved the installer's application equipment for spreading the material as stated in the installer's QC Plan. Automation of the installer's equipment will provide continuous pumping and portioning devices that blend the polymer resin within a controlled system. Heated pumps may be necessary if required by the polymer manufacturer to ensure proper installation. The system must mechanically mix, meter, monitor and apply the high friction polymer and aggregate in one continuous pass. Apply the polymer so no seams are visible in the middle of the traffic lanes of the finished work after application of the surface aggregate. Operations will proceed in such a manner that will not allow the polymer base binder material to separate in the mixing lines, cure, dry, or otherwise impair retention bonding of the high friction surfacing aggregate. The application machine shall be equipped with flushing systems such that blockages of lines will not occur, and installation operations are not delayed, stopped or otherwise compromised. The mixed

components are mechanically applied onto a prepared pavement surface with a uniform thickness of 50-65 mils onto the pavement. Computer printouts from the contractor's equipment must be obtained by the SCDOT Inspector to compare manual depth checks for mil thickness to ensure equipment is properly calibrated. Calibration can also be done by measuring the total gallons used divided by the number of square yards applied. Existing porous surfaces may cause the application rate to be adjusted in order to achieve overall desired mil thickness of finished product. Ensure that mechanical applications are capable of applying binder uniformly in one pass to obtain the desired mil thickness with varying placement widths and will automatically adjust based on application vehicle speed. Ensure that operations proceed in a manner that does not allow the polymer to separate, chill, or set up in a way that would impair the retention of the aggregate.

### **4.3 Aggregate Application**

Ensure that immediately after placing the polymer binder; the aggregate is applied at a rate of 12-15 pounds per square yard. The placement of this material does not require any compaction. Complete coverage of the "wet" polymer binder with aggregate is necessary to achieve a uniform surface. No exposed wet spots will be visible once the aggregate is placed. During the placement of the aggregate, by either manual or mechanical means, the aggregate will be dropped in a manner to not violently disturb the wet polymer film. It is the responsibility of the installers to ensure full embedment of the bauxite aggregate and immediately cover any wet spots of excess polymer with aggregate prior to the gelling of the polymer resin. Remove the excess aggregate by vacuum sweeping before opening to traffic. Excess aggregate can be reused on the following day's installation provided the reclaimed aggregate is clean, uncontaminated and dry. Application on high speed ramps or horizontal curves will require final vacuum sweeping 24-48 hours after initial installation has been completed. In the event the road is not swept within 48 hours of the initial installation, a penalty of 10% of the cost of the HFST section will be assessed by the RCE per day. Maintain "Loose Stone" signs between the initial application and the final vacuum sweeping operations. Additional vacuum sweeping may be necessary as deemed by the RCE. Ensure that the coverage rate of the retained aggregate is 12-15 pounds per square yard. Do not allow any of installation equipment, construction vehicles, or traffic onto the HFST during the curing period. The curing period of the finished HFST product must not exceed 3 hours.

#### **4.3.1 Hand Application**

Hand application in areas less than 300 square yards, or where equipment cannot be mobilized, is acceptable. Ensure that the aggregate is applied onto the prepared polymer resin surface within 5 minutes maximum.

#### **4.3.2 Mechanical Application**

Application in areas of more than 300 square yards will be applied using an aggregate spreader that evenly distributes the aggregate over the polymer resin at a uniform rate. Ensure that the mechanical aggregate spreader is capable of applying up to a continuous 12 foot width application, with an adjustable height (typically 12" above) from spreader to pavement surface to ensure proper spread of aggregate. Uniformly spread aggregate immediately without causing excessive overlap of aggregate outside of coverage area. Mechanical application typically occurs immediately after polymer resin application. Minimal hand application is permitted in difficult to reach areas or with corrective work.

### **5. Method of Measurement**

The RCE will obtain samples of the multi-component polymer binder components (individually) and aggregate at a minimum sample frequency of 1 set per 2000 square yards. In addition to this frequency, ensure that each batch of material is represented by a minimum of 1 sample. Ensure that all material sampling and labeling is performed under the direct observation of the RCE's inspector. Aggregate samples should be collected in cloth bags and weigh a minimum of 10 pounds. Aggregate samples are submitted to SCDOT Office of Materials and Research (OMR) for testing. Ensure the polymer is collected in plastic ½-1 gallon jugs with screw on lids. These samples are sent for third party testing by the RCE and testing expenses are billed directly back to the installer of the HFST. Third party testing must be performed by a randomly selected independent laboratory listed on SCDOT QPL 87. The selected lab must be other than

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**SUPPLEMENTAL SPECIFICATION**

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that used for the manufacturer's original certification. Send certified test results for each sample to the RCE prior to initial acceptance.

The quantity for the pay item High Friction Surface Treatment is the surface area of the road with surface treatment and is measured by the square yard (SY), complete in-place, and accepted. Material placed outside of the designated treatment area is disregarded in computing the quantity.

**6. Payment**

Initial acceptance of the High Friction Surface Treatment must be made on the project once it is completed to ensure that friction values are within guidelines listed below:

<b>Test Data</b>	<b>Tested After</b>	<b>Average Friction Value</b>
Acceptance	90 days of completion of project	≥ 70

The SCDOT Office of Materials and Research (OMR) will test the frictional characteristics of the finished roadway in accordance with ASTM E274 using standard ribbed tires meeting the requirements of ASTM E501. Testing will only be performed in application areas where speed limits equal or exceed 40 mph and there are safe traffic and geometric conditions as determined by the OMR. If the average friction values fail to meet guidelines in the table above, the entire High Friction Surface Treatment must be removed and replaced by the contractor, at no additional expense to the SCDOT. If the surfaced area is unable to be tested due to speed, traffic or geometric conditions as determined above, then the RCE will inspect the roadway and will either accept the work or direct repairs needed, up to and including removal and replacement, before the work will be accepted. Any ordered repairs or removal and replacement of material will be at no additional expense to the SCDOT. A repair procedure must be submitted to the RCE within 30 days of receiving notice that repairs are needed to a particular section. The repair procedure must be acceptable to the RCE and the DCE, and must be done within 60 days of receiving notice of repairs.

The contractor shall provide warranty for the surface treatment such that the following conditions are met. The RCE will re-inspect the treatment between 360-390 days after the completion of the project (once final vacuum sweeping has been completed by the contractor) to ensure that the High Friction Surface Treatment is not showing signs of severe delamination or experiencing aggregate retention issues. The visual inspection must show at least 90% (particularly in the wheel paths) of the HFST aggregate retained per any given SY. Also the RCE will ensure the HFST shows no evidence of severe delamination and/or softening of the placed HFST material, and the final product is still firmly attached to the underlying pavement surface. In the event that the product is unsatisfactory to the RCE, the contractor will be required to repair or remove the existing HFST and replace with new HFST at their expense over the entire pavement section if deemed necessary. A repair procedure must be submitted to the RCE within 30 days of receiving notice that repairs are needed to a particular section. The repair procedure must be acceptable to the RCE and the DCE, and must be done within 60 days of receiving notice of repairs.

Payment for the accepted quantity for High Friction Surface Treatment, measured in accordance with Section 4, is paid for at the contract unit bid price for the pay item. Payment for this item is full compensation for constructing the High Friction Surface Treatment as specified or directed and includes furnishing, hauling, surface preparation, applying, spreading, and sweeping the surface treatment, and incidentals necessary to fulfill the requirements of this pay item in accordance with the Plans, the Specifications and other terms of the Contract. Payment for the HFST will not be made until the HFST material certifications and results of field samples (epoxy and aggregate) have been obtained by the RCE and reviewed and accepted by the OMR.

<b>Item No.</b>	<b>Pay Item</b>	<b>Unit</b>
4079901	High Friction Surface Treatment	SY
6319505	Removal of Pavement Markings	Linear Foot