

**STATE**

**OF**

**TENNESSEE**

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**SPECIAL PROVISION  
 REGARDING  
 HIGH FRICTION SURFACE TREATMENTS (HFST)**

**SCOPE OF WORK**

This work shall consist of the application of High Friction Surface Treatments (HFST) for use on asphalt and concrete pavements in accordance with these specifications. The HFST is comprised of a single layer of a Binder Resin System and surface applied aggregate for asphalt and concrete pavements and a double layer of a Binder Resin System and surface applied aggregate for concrete above grade surfaces.

**MATERIAL**

**High Friction Surface Treatments**

All HFST systems used shall be from the Departments Qualified Products List, 31: High Friction Surface Treatments.

**Aggregate**

**High Friction Aggregate shall consist of Calcined Bauxite Only**

- Aggregate shall be angular, having less than 0.2% moisture and free of dirt, clay, asphalt and foreign or organic materials.
- Aggregate shall meet the requirements listed in Table 1.

<b>Table 1— Physical and Chemical Requirements of the Aggregate</b>		
<b>Property</b>	<b>Test Method</b>	<b>Requirement</b>
Micro Deval Resistance to Degradation	ASTM D7428	5% Max
Aggregate Grading No. 4 Sieve No. 6 Sieve No. 16 Sieve	AASHTO T27	Percent Passing 100% min 95% min 5% max
Moisture Content	AASHTO T255	0.2% max
Aluminum Oxide	ASTM C25	87% min



**PACKAGING**

**Binder Resin System Packaging:**

- Binder Resin System components shall be packaged in suitable, well-sealed containers clearly labeled as to the type material and the ratio of the components to be mixed by volume.
- Any special instructions regarding mixing shall be included.
- The label shall show Binder Resin System components, brand name, name of manufacturer, lot or batch number, temperature range for storage, expiration date and the quantity contained therein.
- The container shall be labeled with a Material Safety Data Sheet (MSDS) and caution warnings regarding contact of the binder with skin and eyes.

**Aggregate Packaging:**

- All aggregates shall be furnished in appropriate packaging that is clearly labeled and protects the aggregate from any contaminants on the jobsite and exposure to rain or other moisture.
- The label shall show the name of the manufacturer and location of processing.

**MATERIALS CERTIFICATION**

The manufacturers of the Binder Resin System and Aggregate shall certify that the materials meet the requirements of this specification. Such certification shall consist of either a copy of the manufacturer's test report or a statement by the manufacturer including a copy of the current test results that the Binder Resin System and Aggregate have been sampled and tested. All certifications must be signed by the manufacturer and include the date of testing. The manufacturer shall maintain and provide upon request complete records of sampling, testing, actions taken to correct problems and quality control inspection results.

**QUALIFICATION OF INSTALLER**

- The installer shall submit a minimum of 3 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.
- The installer shall submit a Quality Control (QC) Plan at least 30 days prior to placement.
- The QC Plan shall be project specific detailing installer's key personnel, equipment, materials, proposed methods of installation, materials blending procedures (mixing), and proposed methods of curing, clean up and traffic marking operations.
- Any deviation from the approved QC Plan shall be cause for immediate suspension of operations.

**Key Personnel**

- Provide contact information for key personnel.
- Designate a Project Superintendent who shall have full authority to institute any action necessary for the successful operation of the QC plan.

- Designate a lead technician who shall be present at the job site and be responsible for the required field quality control sampling and testing in conformance with the approved QC plan and contract documents.

**Equipment**

QC plan shall show equipment calibration records for all metering and application monitoring devices. Provide cleaning and maintenance schedules for application equipment.

**CONSTRUCTION PRACTICES****General**

- Ensure that a Binder Resin System 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.
- Do not apply high friction surface treatment on open graded friction course.
- Monitor and record general weather conditions (sunny, cloudy, ambient air temperature, surface temperature, relative humidity, ect.).
- Record quantities of materials installed.
- At no time shall the aggregate be exposed to rain or moisture.

**INSTALLATION OF HFST:****Test Section**

- The installer shall construct a test section of 250 square yards.
- This test section shall be used to demonstrate the Mechanically Automated Application or Mechanically Assisted Application machine has been properly calibrated and will verify application rates and cure time.
- The test section shall be part of the HFST quantity of the project and approved by the project engineer.

**PREPARATION OF SURFACES****General**

Prepare all pavement surfaces immediately prior to the installation of HFST.

- Pavement surfaces contaminated with oils, greases, or other deleterious materials not removed by the surface preparation shall be washed with a mild detergent solution, rinsed with clean potable water, and dried using a hot compressed air lance.
- Utilities, drainage structures, curbs and any other structure within or adjacent to treatment location shall be protected from the surface preparation and installation of the HFST.
- Pavement markings that exist within the HFST installation shall be removed by methods acceptable to the Engineer.

- Cover or tape the raised pavement markers, within the HFST installation prior to applying binder resin.
- Replace all removed pavement markings in kind after full cure and sweeping of HFST.
- 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 1/4" with a crack sealant approved by the polymeric resin manufacturer.

**Asphalt Roadway Surfaces**

- Receiving surfaces shall be clean, free of all dust, oil, debris and any other material that might interfere with the bond between the Binder Resin System and existing surfaces using vacuum sweep or air wash, with a minimum of 180 cfm of clean and dry compressed air. Clean asphalt surfaces by use of mechanical vacuum sweepers, high pressure air or other methods outlined in the installers QC plan.
- Maintain air lance perpendicular to the surface and the tip of the air lance within 12 inches of the surface.
- 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 and the Engineer.
- For applications on new asphalt pavements, ensure the installation of HFST occurs at a minimum of 45 days after placement of underlying and adjacent pavement.

**Concrete Roadway Surfaces, Concrete above Grade Surfaces (Bridges, Ramps, Overpasses, Directional Flyovers, Stacked Interchanges, Viaducts)**

- 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 as directed by the Engineer.
- The contractor will verify that the prepared surface complies with the International Concrete Repair Institute (ICRI) standard for surface roughness CSP 5 to CSP 6. After shot blasting, 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.
- On new concrete surfaces, all curing compounds shall be completely removed prior to installation.
- On new concrete surfaces and full or partial depth concrete repairs, the surface must cure for a minimum of 30 days prior to HFST placement. Magnesium phosphate based patching materials will not be allowed.

**APPLICATION****General**

- Apply the HFST material on a clean and dry surface, when the ambient and surface temperatures are above 55°F.

- Do not apply the HFST material if the anticipated weather or pavement surface conditions would prevent the proper application of the surface treatment as determined by the Binder Resin System manufacturer.
- Ensure the HFST components are capable of being mixed at lower than ambient temperatures in the event that the components are stored outdoors.
- Pre-treat with the mixed Binder Resin System specified joints and cracks less than 1/4 inches in width and depth.
- Once the Binder Resin System in the pre-treated areas has gelled, the installation may proceed.
- Use the High Friction Surface Treatment systems in a **single lift application** (Binder Resin System and aggregate) for **Asphalt and Concrete roadway surfaces**.
- The HFST shall be applied to the full width of pavement excluding shoulders.
- Use the High Friction Surface Treatment systems in a **double lift application** (Binder Resin System and aggregate) for **above Grade Concrete Surfaces** (Bridges, Ramps, Overpasses, Directional Flyovers, Stacked Interchanges, Viaducts).
  - Both lifts shall be applied to the full width of the structure.
  - On bridges with continuous concrete barrier rails apply the Binder Resin System to a minimum height of 6 inches above the deck.
  - Apply Binder Resin System to the barrier as each of the overlay applications are performed.
- Walking, standing or any form of contact or contamination with the wet uncured Binder Resin System prior to application of the aggregate without the use of spiked shoes to minimize the disturbance to the binder layer will result in that section of Binder Resin System being removed and replaced at the installer's expense.
- Contractor equipment and traffic is not permitted on the HFST during curing period.

**Application Methods**

Apply the High Friction Surface Treatment, in accordance with manufacturer's recommendations. The application methods allowed are shown below. —

**Mechanically Automated Application**

Mechanically apply the HFST by a continuous self-contained application vehicle. The application vehicle shall provide continuous pumping and portioning devices. These devices shall blend the Binder Resin System within a controlled system and must mechanically mix,

meter, monitor and apply the high friction Binder Resin System and aggregate in one continuous pass onto the pavement.

- Ensure the Binder Resin System manufacturer has approved the installers application equipment for spreading their material as stated in the installer's QC Plan.
- Heated pumps may be necessary if required by the Binder Resin System manufacturer to ensure proper installation.
- The system shall mechanically mix, meter, monitor and apply the HFST (Binder Resin System and Aggregate) in one continuous pass.
- Hand application of aggregate is allowed to assist in completely covering the Binder Resin System to achieve a uniform surface.
- Apply the HFST 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 Binder Resin System 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.
- Printouts from the contractor's equipment shall be obtained by the Engineer 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

#### **Mechanically Assisted Application**

- Use a Mechanically Assisted application vehicle that heats, mixes, meters, pumps, blends and applies the Binder Resin System. The Mechanically Assisted application machine shall have positive displacement volumetric metering pumps controlled by a hydraulic power unit. Use motionless, in-line mixing so as to not overly shear the material or entrap air in the mix. Maximize material working time by mixing it immediately before dispensing.
- After manually dispensing, spread the Binder Resin System with a serrated squeegee on to the prepared pavement surface at a uniform application thickness.
- Immediately mechanically apply the aggregate onto the Binder Resin System by means of Blower, Spreader Bucket or suitable device.
- Hand spreading the aggregate is not allowed as a primary method to spread the

aggregate. Hand application of aggregate is allowed to assist in completely covering the Binder Resin System to achieve a uniform surface.

### **Binder Application**

- Proportion and mix the Binder Resin System to the correct ratio as determined by the Binder Resin System 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.
- When placing in multiple lifts, ensure that the aggregate used is the same calcined bauxite material as the final riding surface. The aggregate material must be properly embedded into the Binder Resin System.
- The Binder Resin System is applied onto a prepared pavement surface with a uniform thickness of 50-60 mils (2.8 to 3.6 square yards per gallon).
- Coverage rate is based upon expected variances in the surface profile of the existing pavement.
- TDOT and the Contractor will measure and monitor placement using a contractor supplied depth gauge. A minimum rate of one per 100 square yards will be placed to ensure proper application thickness.
- Operations should proceed in a manner that will not allow the Binder Resin System to separate, cure, dry, be exposed, or otherwise harden in such a way as to impair retention and bonding of the aggregate.

### **Aggregate Application**

- After placing the Binder Resin System; the aggregate is applied at a minimum rate of 12-15 pounds per square yard.
- The placement of this material does not require any compaction. Aggregate shall completely cover the "wet" Binder Resin System to achieve a uniform surface.
- During the placement of the aggregate, by mechanical means, the aggregate will be dropped in a manner to not violently disturb the wet Binder Resin System.
- It is the responsibility of the installers to ensure full embedment of the bauxite aggregate, immediately cover any wet spots of excess polymer with aggregate prior to the gelling of the Binder Resin System to assure proper skid resistance and macro texture depth.
- Remove the excess aggregate by vacuum sweeping before opening to traffic.
- Excess aggregate shall not be reused.
- All applications will require final vacuum sweeping 36 hours after initial installation is completed. Applications on roadways with posted speeds greater than 45 mph will require additional sweeping three to seven days after the initial installation is completed.
- Additional vacuum sweeping may be necessary as deemed by the Engineer.

**Verification Testing**

The verification of the HFST quantities used shall be based on data collected for each day’s production.

Verification Testing shown in Table 3 will be performed as determined by the Engineer.

<b>Table 3— Verification Testing</b>		
<b>Property</b>	<b>Test Method</b>	<b>Requirement</b>
Skid Resistance (FN40R)	AASHTO T242	70 min
Macro Texture Depth (Sand Patch)	ASTM E965	1.0 mm min

- The Engineer will inspect the roadway and determine adequacy of the work performed before finalization is completed. The Engineer may direct full removal and replacement if the work is not acceptable.
- Any ordered repairs or removal and replacement of material will be at no additional expense to the Department.
- A repair procedure shall be submitted to the Engineer within 30 days of receiving notice that repairs are needed to a particular section. The repair procedure shall be acceptable to the Engineer and shall be done within 60 days of receiving notice of repairs.

**Corrective Action:**

Any unsatisfactory installations shall be remediated by the contractor with corrective actions as dictated by the engineer at the contractor’s expense.

**METHOD OF MEASUREMENT**

High Friction Surface Treatment (Single Lift) will be measured by the square yard of roadway covered, in place and complete.

High Friction Surface Treatment (Double Lift) will be measured by the square yard of above grade concrete surface covered, in place and complete with two lifts.

**Basis of Payment**

The accepted quantities of High Friction Surface Treatment (Single Lift) and High Friction Surface Treatment (Double Lift) will be paid at the contract unit price under the following pay item numbers:

- 406-04.03 HIGH FRICTION SURFACE TREATMENT (SINGLE LIFT) per S.Y.
- 406-04.04 HIGH FRICTION SURFACE TREATMENT (DOUBLE LIFT) per S.Y.

Such payment is full compensation for all Materials, Equipment, Tools, Labor, Removal and Replacement of Pavement Markings, and Incidentals to complete all work included here in.