

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 Refractory Grade 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**

- At the request of the purchaser, the manufacturer of the binder resin system shall certify that the binder resin system meets 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, accompanied by a copy of the current test results, that the binder resin system has been sampled and tested.
- Such certification shall indicate the date of testing and shall be signed by the manufacturer.
- At the request of the purchaser, the manufacturer of the aggregate shall certify that the aggregate meets the requirements of this specification. Such certification shall consist of either a copy of the manufacturers' test report or a statement by the manufacturer, accompanied by a copy of the current test results, that the aggregate has been sampled and tested.
- Such certification shall indicate the date of testing and shall be signed by the manufacturer.
- The manufacturer shall maintain and make available 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 5 projects with the owner's contact information on which a cumulative minimum of 25,000 square yards of HFST have been placed within the past

three years demonstrating a friction reading of 70 FN40R when tested in accordance to AASHTO T 242 or 0.75 per ASTM E 1911.

- Quality Control (QC) Plan: The QC Plan shall be project specific detailing installer's key personnel, equipment, materials, proposed methods of installation for Binder and aggregate, materials blending procedures, and proposed curing table by temperature.
- 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**

- Equipment calibration records of metering devices and application monitoring devices to ensure specification compliance.
- Cleaning and maintenance schedule for application equipment.

**MATERIALS**

- Provide procedures for storage and protection of materials both stockpiled and onsite.

Installation of HFST:

- Provide procedures for mixing and placement of materials for HFST.
- Provide procedures for Monitoring, recording and submittal of ambient conditions (air temperature, surface temperature, relative humidity).
- Provide procedures for Recording of quantities of materials installed.

Corrective Action:

- The quality control plan shall include corrective actions to address unsatisfactory installation, such as failure to cure, failure to meet friction values, spills and job site hazards.
- Submit the QC Plan to the Engineer for approval at least 30 days prior to the placement.
- Any deviation from the approved QC Plan shall be cause for immediate suspension of operations until corrective action is complete and approved by the owner agency.

**RECOMMENDED CONSTRUCTION PRACTICES****Storage of Materials**

- Materials shall be stored in accordance to the manufacturer's recommendations.
- At no time shall the aggregate be exposed to rain, or moisture.
- Safety Data Sheet (SDS), Product Data Sheet, and other information pertaining to the safe practices for the storage, handling, and disposal of the materials, and to their health hazards shall be obtained from the manufacturer and posted at storage areas.
- A copy of such information shall be provided to the Engineer.

**Application Conditions**

- Do not apply HFST on a wet surface or when the surface temperature is outside the manufacturer's recommendation.
- Do not apply when anticipated weather conditions would prevent proper application and curing of the HFST.

**Preparation of surfaces**

- 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.
- Cover or protect all existing pavement markings that are to remain as directed by the plans prior to performing surface preparation and installation.
- Pavement markings that conflict with the HFST installation shall be removed by methods acceptable to the Engineer.
- 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 prepared according to the manufacturer's recommendation.

**Asphalt Surfaces**

- Clean asphalt pavement surfaces exhibiting excessive dirt, loose aggregate, debris, and deleterious material using a mechanical sweeper.
- Air wash using a minimum of 180 cfm of clean and dry compressed air, all surfaces to remove all dust, debris, and deleterious material.
- Maintain the tip of the air lance within 12 inches of the surface.
- For applications on new asphalt pavements a mandatory 45 day cure period shall take place prior to the installation of the HFST.

**Concrete Surfaces**

- Clean concrete pavement surfaces by shot blasting and air wash.
- Shot blast all 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, 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 the tip of the air lance within 12 inches of the surface.

**APPLICATION**

- Apply the High Friction Surface Treatment, in accordance with project specifications.
- Apply the HFST material on a prepared surface, when the surface temperatures are above 50°F and within manufacturer's recommendation.
- 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 HFST installer.
- Pre-treat with the mixed Binder Resin System specified joints and cracks greater than 1/4 inch and less than 1/2 inches in width.
- Cracks greater than 1/2 inch in width shall be repaired by the owner prior to HFST installation with a material compatible with the Binder Resin System.
- 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.
- Pavement surfaces such as open-graded and porous pavement may require a second lift of HFST to be paid as an additional pay item.
- The HFST shall be applied to the full width of pavement per project plans.

**Binder Application**

- Proportion and mix the Binder Resin System to the correct ratio as determined by the Binder Resin System manufacturer (+/- 2% by volume).
- The Binder Resin System shall be applied at a uniform thickness of 65+/-5 mils (2.96 to 2.54 square yards per gallon) onto a prepared pavement surface.
- Coverage rate is based upon expected variances in the surface profile of the existing pavement.
- 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.
- Evaluate and remedy as needed any areas that show signs of blushing that typically

cause adhesion issues to occur.

- 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.
- 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.

### **Aggregate Application**

- The aggregate material must be properly embedded into the Binder Resin System.
- 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 displace the wet Binder Resin System.
- When placing in multiple lifts, ensure that the aggregate used is the same calcined bauxite material as the final riding surface.
- It is the responsibility of the installers to ensure proper embedment of the bauxite aggregate.
- Immediately cover any wet spots of excess binder resin 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 sweeping before opening to traffic.
- Excess aggregate can be reused if it is clean, dry, free from foreign matter, and meets gradation requirements.
- It must be blended prior to reuse at a ratio of a minimum of 3 parts virgin material to 1 part recycled material.
- All applications will require additional sweeping 3-7 days after installation is completed.

### **Application Methods**

- Utilize one of the following methods to apply the binder resin and aggregate wearing course.

### **Fully-Automated Application**

- Mechanically apply the HFST by a continuous self-contained application vehicle.
- The application vehicle shall provide continuous pumping and proportioning devices.
- The system shall mechanically mix, meter, monitor and apply the HFST (Binder Resin System and Aggregate) in one continuous pass without the use of squeegees or other

tools to spread the binder.

- Ensure the Binder Resin System manufacturer has approved the installers application equipment for spreading their material as stated in the installer's QC Plan.
- Heating system may be necessary if required by the Binder Resin System manufacturer to ensure proper installation.
- Limited touch-up of the resin with hand tools is permitted for areas less than 2 square feet.
- Within 5 seconds after placing the Binder Resin System; the aggregate is applied at a minimum rate of 14-16 pounds per square yard.
- Hand application of aggregate is allowed only 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.
- Data shall be provided to the Engineer for each individual pass (start to stop) to compare manual depth checks for mil thickness to ensure equipment is properly calibrated.
- In case of equipment malfunction, calibration can also be done by measuring the total gallons used divided by the number of square yards applied.
- Coarse textured surfaces may cause the application rate to be adjusted in order to achieve overall desired mil thickness of finished product.
- Ensure that application equipment is capable of applying binder uniformly in one pass to obtain the desired mil thickness.
- Ensure that operations proceed in a manner that does not allow the Binder Resin System to separate, gel, or set up in a way that would impair the retention of the aggregate
- The Binder Resin System manufacturer shall approve the use of their material with said automated continuous application device.

### **Semi-Automated Application**

- Use a Semi-Automated Application machine that mixes, meters, pumps, blends and applies the Binder Resin System.
- A heating system may be necessary if required by the Binder Resin System manufacturer to ensure proper installation.
- The Semi-Automated Application machine shall have positive displacement volumetric metering pumps.
- 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 to meet the required uniform application thickness.
- Data shall be provided to the Engineer for each individual pass (start to stop) to compare manual depth checks for mil thickness to ensure equipment is properly calibrated.
  - Maintain a “wet line” of resin without aggregate 2 feet wide ahead of the aggregate placement operation, then follow the resin manufacturer recommendations for dwell time for placement of aggregate on the wet line based on ambient and surface temperatures
  - Mechanically apply the aggregate at a minimum rate of 14-16 pounds per square yard onto the Binder Resin System by means of Blower, Spreader Bucket or suitable device in such a manner as to not displace the resin binder.
  - Hand application of aggregate is allowed only to assist in completely covering the Binder Resin System to achieve a uniform surface.

## **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 Semi-Automated or Fully-Automated Application machine has been properly calibrated and to 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.

### **Verification Testing**

- The verification of the HFST quantities used shall be based on data collected for each day’s production and for each individual pass (start to stop).
- Verification Testing shown in Table 1 may be performed by the installer or Owner Agency, as indicated in the project plans.

Table 1— Verification Testing

Property	Test Method	Requirement
Skid Resistance	AASHTO T242	70 min (FN40R)
	ASTM E 1911	0.75 min (60 kph)
Macro Texture Depth (Sand Patch)	ASTM E965	1.0 mm min



- The Owner Agency will inspect the roadway and determine compliance of the work to this specification before finalization is completed.
- Any ordered repairs or removal and replacement of material will be at no additional expense to the Owner Agency.
- A repair procedure shall be submitted to the Owner Agency within 10 days of receiving notice that repairs are needed to a particular section.

The repair procedure shall be acceptable to the Owner Agency and shall be completed within 30 working days of receiving approval of repair procedure.