S T A T E **O F** **T E N N E S S E E**

November 9, 2020 January 1, 2021

SPECIAL PROVISION

REGARDING

AUTOMATED HIGH FRICTION SURFACE TREATMENTS (HFST)

Description

This work shall consist of the automated continuous 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

Provide materials for all HFST systems that are on the Departments Qualified Products List (QPL), 31: High Friction Surface Treatments.

A. Aggregate

1. High friction aggregate shall consist of refractory grade Calcined Bauxite only
2. Aggregate shall be angular, having less than 0.2% moisture and free of dirt, clay, asphalt and foreign or organic materials.
3. Aggregate shall meet the requirements listed in Table 1.

Table 1— Physical and Chemical Requirements of the Aggregate

Property	Test Method	Requirement
Micro Deval Resistance to Degradation	ASTM D7428	5% Max
Aggregate Grading No. 4 Sieve No. 6 Sieve No. 16 Sieve	AASHTO T 27	Percent Passing 100% min 95% min 5% max
Moisture Content	AASHTO T 255	0.2% max
Aluminum Oxide	ASTM C25	87% min

B. Binder Resin System Packaging

1. 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.
2. Any special instructions regarding mixing shall be included.
3. 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.
4. The container shall be labeled with a Material Safety Data Sheet (MSDS) and caution warnings regarding contact of the binder with skin and eyes.

C. Aggregate Packaging

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

Materials Certification

Manufacturers of the Binder Resin System and Aggregate shall certify that the materials meet the requirements of this specification.

1. 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.
2. All certifications must be signed by the manufacturer and include the date of testing.
3. The manufacturer shall maintain and provide upon request complete records of sampling, testing, actions taken to correct problems and quality control inspection results.

Quality Control (QC) Plan

Submit a Quality Control (QC) Plan to the Engineer for approval prior to placement. The quality control plan shall include:

1. Equipment calibration records for all metering and application monitoring devices,
2. Cleaning and maintenance schedules for application equipment,
3. Contact information for key personnel,
4. A Project Superintendent who shall have full authority to institute any action necessary for the successful operation,
5. 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,
6. Procedures for storage and protection of materials both stockpiled and onsite, mixing and placement and monitoring of materials,
7. Procedures for recording quantities of materials installed and proposed curing table by temperature,
8. Proposed corrective actions to address unsatisfactory installations, such as failure to cure, failure to meet friction values, spills and job site hazards.

Equipment

Automated continuous application must be performed by an approved certified self-propelled application truck and shall include:

1. Capable of continuously and thoroughly blending the resin binder components to the ratio recommended by the manufacturer (± 2 percent by volume),
2. An aggregate drop spreader capable of mechanically and continuously dropping calcined bauxite aggregate from a maximum height of 12 inches into the uncured resin binder,
3. Fixed storage tanks that contain 600 gallons of the part A resin binder component and 600 gallons of the part B resin binder component,
4. An independent recirculating heating system capable of heating the resin binder storage tanks to precondition the resin binder components to a maximum heat of 110 °F,
5. Equipped with a bauxite aggregate hopper that is capable of holding up to 40,000 lbs. of bauxite, the hopper must be equipped with a dry screen system to keep the aggregate completely dry,
6. Install HFST at a minimum application rate of 26 ft./minute,
7. Equipped with a built-in data management unit which is capable of producing real time data flow showing:
    a. volume of resin,
    b. mil thickness on average throughout the application width,
    c. volume of aggregate applied throughout the application width,
8. Resin binder shall be continuously applied once blended,
9. Capable of applying the minimum binder spread rate,
10. Applies high friction aggregate and resin binder to the pavement section, capable of applying up to a continuous 14 foot width application.

Construction

A. General

1. Materials shall be stored in accordance to the manufacturer's recommendations.
2. At no time shall the aggregate be exposed to rain, or moisture.
3. 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.
4. Do not apply HFST on a wet surface or when the surface temperature is outside the manufacturer's recommendation.
5. Do not apply when anticipated weather conditions would prevent proper application and curing of the HFST.

B. Preparing Designated Surfaces

1. Prepare all pavement surfaces immediately prior to the installation of HFST.
2. 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.
3. Pavement markings that exist within the HFST installation shall be removed by methods acceptable to the Engineer.
4. Cover and protect all existing pavement markings that are adjacent to the treatment location for Asphalt and Concrete roadway surfaces as directed by the Engineer prior to performing surface preparation.
5. Cover or tape the pavement markers, within the HFST installation prior to applying binder resin.

6. Replace all removed pavement markings in kind after full cure and sweeping of HFST.
7. Clean and fill all inadequately sealed joints and cracks greater than 1/4" with a crack sealant approved by the polymeric resin manufacturer.

C. Asphalt Roadway Surfaces

1. Clean asphalt surfaces by use of mechanical vacuum sweepers, high pressure air or other methods outlined in the installers QC plan.
2. The asphalt 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, mechanical sweeper and or air wash, with a minimum of 180 cfm of clean and dry compressed air.
3. Maintain air lance perpendicular to the surface and the tip of the air lance within 12 inches of the surface.
4. 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.
5. Ensure for applications on new asphalt pavements, that the installation of HFST is a minimum of 45 days after placement of underlying and adjacent pavement.

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

1. Clean concrete pavement surfaces by shot blasting and air wash.
2. Shot blast all surfaces to remove all curing compounds, loosely bonded mortar, surface carbonation, and deleterious material.
3. The prepared concrete surface shall comply with the International Concrete Repair Institute (ICRI) standard for surface roughness CSP 5.
4. 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.
5. Maintain the tip of the air lance within 12 inches of the surface.
6. 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.

E. Application

1. Use the High Friction Surface Treatment systems in a single lift application (Binder Resin System and aggregate) for Asphalt and Concrete roadway surfaces.
2. The HFST shall be applied to the full width of pavement excluding shoulders.
3. 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).
4. Both lifts shall be applied to the full width of the structure.
5. On bridges with continuous concrete barrier rails apply the Binder Resin System to a minimum height of 6 inches above the deck.
6. Apply Binder Resin System to the barrier as each of the overlay applications are performed.

F. Automated Continuous Application

1. Apply the HFST by a continuous self-contained truck application machine onto the pavement section in varying widths of up to full width of the lane at a uniform application thickness.
2. 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.
3. 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.
4. 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.
5. Existing porous surfaces may cause the application rate to be adjusted in order to achieve overall desired mil thickness of finished product.
6. When placing double lifts, ensure that the aggregate used is the same calcined bauxite material as the final riding surface and the aggregate material is properly embedded into the Binder Resin System.
7. 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.
8. Ensure 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.
9. The aggregate shall be applied within 5 seconds (+/- 2 sec's) after placing the Binder Resin System; the aggregate is applied at a minimum rate of 12-15 pounds per square yard.
10. The placement of this material does not require any compaction. Aggregate shall completely cover the "wet" Binder Resin System to achieve a uniform surface.
11. During the placement of the aggregate, by continuous automated application means, the aggregate will be dropped from at a maximum height of 12 inches in a manner to not violently disturb the wet Binder Resin System.
12. 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.
13. Remove the excess aggregate by vacuum sweeping before opening to traffic.
14. Excess aggregate shall not be reused.
15. All applications will require final vacuum sweeping 36 hours after initial installation has been completed.
16. Additional vacuum sweeping may be necessary as deemed by the Engineer.
17. The Binder Resin System shall be applied at a uniform thickness of 50-60 mils, .28 to .36 gallons per square yard, for the double lift application both lifts shall be applied to a uniform thickness of 50-60 mils, .28 to .36 gallons per square yard.
18. Contractor equipment and traffic is not permitted on the HFST during curing period.
19. Clean the mix head and delivery lines if application of the blended resin binder is stopped for more than 15 minutes.
20. Live Data streaming to verify specification compliancy may be permitted.
    The live data will consist of the resin binder depth over the entire surface area being treated, the volume of the Binder Resin System being installed, the weight and volume of bauxite aggregate being installed per square yard, the ambient and pavement temperatures during the installation, and a 3D landscape graph of the embedded bauxite aggregate and resin binder on the pavement surface.

Acceptance Testing

Initial acceptance of the HFST shall be made on the project once it is completed. The Department will inspect and ensure that friction values meet requirements:

Table 2— Acceptance Testing

Property	Average Friction Value	Test Method
Skid Resistance (FN40R) (after 90 days of completion of project)	70 min.	ASTM E274 or AASHTO T242
Texture (sand patch)	1.0 mm min.	ASTM E965

1. 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 Engineer.
2. If the average friction values fail to meet guidelines in the table above, the entire High Friction Surface Treatment shall be removed and replaced by the contractor, at no additional expense to the Department.
3. If the surfaced area is unable to be tested due to speed, traffic or geometric conditions as determined above, then the Engineer 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.
4. Any ordered repairs or removal and replacement of material will be at no additional expense to the Department.
5. A repair procedure shall be submitted to the Engineer within 30 days of receiving notice that repairs are needed to a particular section.
6. The repair procedure shall be acceptable to the Engineer and shall be done within 60 days of receiving notice of repairs.

Method of Measurement

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

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

Basis of Payment

The Department will pay for the accepted quantities, complete in place, at the contract unit prices as follows**.**

Item No.	Description	Unit
406-04.03	HIGH FRICTION SURFACE TREATMENT (SINGLE LIFT)	Square Yard
406-04.04	HIGH FRICTION SURFACE TREATMENT (DOUBLE LIFT)	Square Yard

Such payment shall be full compensation for all materials, equipment, tools, labor, removal of pavement markings, and incidentals to complete all work.