1. HIGH FRICTION SURFACE TREATMENT (HFST) – ASPHALT SURFACES

A. Description. This work is the preparation of asphalt road surfaces and the furnishing and applying a single layer of a two-component polymer high friction surface treatment to the road segments shown on the plans.

B. Materials. Furnish materials specifically designed for use as a high friction surface treatment.

1) Polymer Resin. Use a polymer resin base and hardener composed of two-component, 100% solids, 100% reactive, thermosetting compound with the following properties:

Property	Requirements	Test Method
Gel Time [A]	10 - 45 minutes @ 73° to 75° F	ASTM C881
Viscosity [A]	7 - 70 poises	ASTM D2393, Brookfield RVT, Spindle No. 3, 20 rpm
Absorption [B]	1% maximum at 24 hr	ASTM D570
Tensile Elongation [B]	30% - 70% @ 7 days	ASTM D638
Tensile Strength [B]	>2000 psi @ 7 days	ASTM D638
Chloride Permeability [B]	<100 coulombs @ 28 days	AASHTO T277

[A] Uncured, mixed polymer binder
[B] Cured, mixed polymer binder

2) Aggregates. Furnish refractory grade calcined bauxite specifically manufactured for this application. Furnish aggregates that are non-polishing, clean, free of surface moisture, fractured or angular in shape; free from silt, clay, asphalt, or other organic materials; and meet the following properties and gradation requirements:

Aggregate Properties:

Property	Requirement	Test Method
Moisture Content	≤ 0.2%	AASHTO T255
Hardness	≥ 8.0	Mohs Scale
Fractured Faces	100% with at least 1 fractured face & 80% with at least 2 fractured faces of material retained on No.16	ASTM 5821
Absorption	≤ 1%	ASTM C128
Aggregate Gradation [A]	100% passing No. 4 15-30% passing No. 8 0-5% passing No. 16 0-1% passing No. 30	MT 202

[A] Or recommended gradation per manufacturer of polymer resin and approved by Project Manager.

3) Required Properties of Overlay System

The required properties of the overlay system are listed in the table below:

Property	Requirement [A]	Test Method
Minimum Compressive Strength at 8 Hrs. (psi)	1,000 psi @ 8 hrs 5,000 psi @ 24 hrs	ASTM C 579 Method B, Modified [B]
Thermal Compatibility	No Delaminations	ASTM C 884
Minimum Pull-off Strength	250 psi @ 24 hrs	ACI 503R, Appendix A

[A] Based on samples cured or aged and tested at 75°F
[B] Plastic inserts that will provide 2-inch by 2-inch cubes shall be placed in the oversized brass molds.

C. Construction Requirements.

1) Manufacturer's Representative. Provide a resin manufacturer's representative available for the duration of the work, to provide expert assistance on storage, mixing, surface preparation, application, clean-up, and disposal of materials.

2) Submittals. Submit two copies of the following to the Project Manager a minimum of 14 calendar days prior to beginning the polymer overlay. Do not begin work prior to receiving approval from the Project Manager.

a) Product data sheets and specifications from the manufacturer of the resin and aggregate, and certified test reports. The Project Manager may request samples of the polymer and/or aggregate, prior to application, for the purpose of acceptance testing by the department. Product data sheets and specifications from the manufacturer consists of literature from the manufacturer showing general instructions, application recommendations/methods, product properties, general instructions, or any other applicable information.

b) Product history/reference projects and a certified test report from an independent testing laboratory showing compliance with the requirements of the specification. The product history/reference projects consist of a minimum of 5 locations where the proposed overlay system has been applied in Montana or other locations with a similar climate. Include contact names for the facility owner, current phone number or e-mail address, and a brief description of the project.

3) Material Delivery and Storage. Store resin materials in their original containers in a dry area. Store and handle materials according to the manufacturer's recommendations. Store all aggregates in a dry environment and protect aggregates from contaminants on the job site.

a) Moisture Content. Prior to performing the work, provide an aggregate sample to the Project Manager for a moisture content determination, taken no more than 48 hours prior to placement. An MDT representative must be onsite to witness the sampling. Do not proceed with placement if the aggregate moisture is greater than 0.5%. Aggregates may be placed with moisture contents greater than 0.2% however in these cases the contractor must warranty the overlay, through a period ending March 1 following the placement, where the overlay must perform with no visual loss of aggregate or delamination. The Project Manager has sole authority to require warranty repairs for failures identified during the warranty period. Submit a traffic control plan and repair plan for affected areas within 14 days of written notice and perform traffic control and repairs within 120 calendar days of the notice at no cost to MDT. The contractor may reprocess (dry) aggregate to bring it into spec. Reprocessed aggregates must be retested for gradation and moisture. Additional aggregate moisture samples may be taken as determined by the Project Manager.

4) Pre-installation Conference. Conduct a pre-installation conference with the manufacturer's representative prior to construction to establish procedures for maintaining optimum working conditions and coordination of work. Furnish the Project Manager a copy of the recommended procedures and apply the overlay system according to the manufacturer's instructions. Ensure the manufacturer's representative familiar with the overlay system installation procedures is present at all times during surface preparation and overlay placement to provide quality assurance that the work is being performed properly.

5) Surface Preparation. Lightly shot blast (to point of discoloration) the asphalt surface. Do not damage the integrity of the asphalt. Repair any damage to the integrity of the asphalt prior to installation of the HFS at the contractor's expense. Ensure surface preparation removes any oil, dirt, rubber, debris, or any other potentially detrimental material which may prevent proper bonding to and curing of the material. Walk behind or hand grinders may be needed to remove larger contamination. Pressure washing (as an alternative to shot blasting) may be done 24 hours prior to application of the high friction surface treatment. Do not install the HFS on newly placed asphalt pavement until after a minimum of 30 days.

Prepare the entire surface using the final accepted adjustments to the shotblasting machine as determined above. Thoroughly blast-clean with hand-held equipment any areas inaccessible by the shotblasting equipment. Do not perform surface preparation more than 24 hours prior to the application of the high friction surface treatment.

Just prior to high friction surface treatment placement, clean all dust, debris, and fines from the prepared surfaces with compressed air. When using compressed air, the air stream must be free of oil. Completely remove any grease, oil, or other foreign matter that rests on or has absorbed into the asphalt. If any prepared surfaces (including the first layer of the polymer overlay) are exposed to rain or dew, lightly sandblast (breeze blast) the exposed surfaces.

Do not place the high friction surface treatment prior to Project Manager approval of the final surface profile and cleanliness.

6) High Friction Surface Treatment Application. Perform the handling and mixing of the polymer resin and hardening agent in a safe manner to achieve the desired results according to the manufacturer's instructions. Do not apply the overlay system if any of the following exists:

a) Ambient air temperature is below 50^{o}F;

b) Surface temperature is below 50^{o}F;

c) Moisture content in the surface exceeds 4.5% when measured by an electronic moisture meter or shows visible moisture after 2 hours when measured in accordance with ASTM D4263;

d) Rain is forecasted during the minimum curing periods listed under C.8 ;

e) Materials component temperatures below 50^{o}F or above 99^{o}F;

f) The surface temperature exceeds 100^{o}F.

g) If the gel time is less than 10 minutes at the predicted high air temperature for the day.

After the surface has been shotblasted and during the high friction surface treatment curing period, allow on the surface only that equipment which is necessary for surface preparation and high friction surface treatment application. Begin high friction surface treatment placement as soon as possible after surface preparation operations.

Use a polymer overlay consisting of a single course application of polymer and aggregate, consisting of a layer of polymer covered with a layer of aggregate in sufficient quantity to completely cover the polymer. Apply the polymer and aggregate according to the manufacturer's requirements. Apply the overlay using equipment designed for this purpose. Use an application machine that features positive displacement volumetric metering and is capable of storing and mixing the polymer resins at the proper mix ratio. Disperse the aggregate using a standard chip spreader or equivalent machine that can provide a uniform, consistent coverage of aggregate. If the Project manager determines that the course application does not receive enough aggregate before the polymer gels, remove and replace the course.

After completion of the course, cure the overlay according to the manufacturer's instructions. Remove the excess aggregate from the surface treatment by sweeping, blowing, or vacuuming without tearing or damaging the surface; the material may be re-used if approved by the Project Manager and manufacturer. Do not allow traffic on the treated area until directed by the Project Manager.

Prior to opening to traffic, clean surface of all debris and polymer. A minimum of 3 days following opening to traffic, remove loosened aggregates from the pavement.

7) Application Rates. Apply the polymer overlay in accordance with the manufacturer's instructions, but not less than the following rate of application:

Minimum Polymer Coverage Rate	Minimum Aggregate Coverage Rate [A]
1 gallon/32 square feet	12+ pounds/square yards

[A] Apply aggregate in sufficient quantity to completely cover the polymer.

8) Minimum Curing Period. As a minimum, cure the coating per the recommendation of the polymer manufacturer and as approved by the Project Manager.

9) Repair of Polymer Overlay. Repair all areas of unbonded, uncured, or damaged polymer overlay at no cost to the State. Submit repair procedures from the manufacturer to the Project Manager for approval. Absent a manufacturer's repair procedures and with the approval of the Project Manager, complete repairs according to the following: Remove the overlay by scarifying, grinding, or other approved methods; shot blast or sand blast and air blast the surface prior to placement of polymer overlay; and place the polymer overlay according to application procedures in this special provision.

D. Method of Measurement. High friction surface treatment is measured by the square yard of surface area treated.

E. Basis of Payment. Payment for the completed and accepted quantities is made under the following:

Pay Item	Pay Unit
High Friction Surface Treatment	Square Yard

Payment at the contract unit price is full compensation for all resources necessary to complete the items of work under the contract.