



HIGH FRICTION SURFACE TREATMENT (HFST)

INSTALLATION GUIDELINES

This Installation Guideline describes the application of Dural HFS, a High Friction Surface Treatment (HFST) for use on asphalt and concrete pavements. The HFST is comprised of a minimum single layer of Dural HFS epoxy binder resin and surface applied aggregate. High Friction Surface Treatments are used primarily for restoring or enhancing the skid resistance of a pavement surface where high friction or anti-skidding properties are desired. The typically recommended locations for High Friction Surface Treatment installations include bridges, horizontal curves, intersections, exit-entrance ramps, steep grades, and other identified hazardous areas.

Related Work

1. Concrete Repair:
 - A. Horizontal: VersaSpeed
 - B. Form and Pour, Eucocrete
2. Crack Repair/Injection: Dural 452, Dural fast Set Epoxy
3. Architectural Coatings: Tammscoat
4. Penetrating Sealers: Baracade WB 244, Baracade 100C
5. Bonding Agents: Duralprep A.C., Dural 452 MV
6. Cathodic Protection: Sentinel Galvanic Anodes

Reference Documents

1. Refer to the specific Dural HFS product Data Sheet
2. Refer to applicable Safety Data Sheet
3. ASTM C597-01, "Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes".
4. ASTM C881, "Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete".
5. ASTM C882, "Standard Test Method for Thermal Compatibility between Concrete and an Epoxy Resin Overlay".
6. ASTM C1583-04, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)".
7. ASTM D638-03, "Standard Test Method for Tensile Properties of Plastics".
8. ASTM D2393, "Standard Test Method for Viscosity of Epoxy Resins and Related Components".
9. ASTM D2240, "Standard Test Method for Rubber Property – Durometer Hardness".
10. ASTM D4263-88, "Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method".
11. ASTM D570, Standard Test Method for Water Absorption of Plastics".
12. ASTM D 4259-88, "Standard Practice for Abrading Concrete".
13. ASTM D 1640, "Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature".



Submittals

1. Submit a certificate of compliance and quality control test reports verifying conformance to material specifications for each manufactured batch of epoxy and lot of aggregate. A lot or batch is a quantity of material manufactured at one time and placed into containers.
2. Submit material and product data sufficient for the Engineer to evaluate the system, including all installation instructions and quality control procedures required to assure an acceptable finished overlay.
3. Submit certified test results from a nationally recognized independent testing laboratory verifying properties of the cured system meet the requirements of this specification.

Delivery, labeling, storage, and handling of materials

1. Labeling – Mark product containers with the following information:
 - ◆ Name of manufacturer;
 - ◆ Manufacturer's product identification;
 - ◆ Material quantity;
 - ◆ Manufacturer's batch number;
 - ◆ Manufacturer's mixing instructions;
 - ◆ Warning for storage and handling; and
 - ◆ Hazard information.
2. Delivery and Storage – Deliver the epoxy resins and selected aggregate in original, unopened containers. Store epoxy resins and hardeners in an area that prevents them from getting wet. Store them away from open flames and other sources of ignition. Store epoxy resins and hardeners at temperatures between 50 and 120° F (10-49°C) unless otherwise recommended by the material manufacturer. Store aggregates in an area that prevents them from getting wet. Outdoor storage of all materials is permitted with manufacturer's approval.
3. Handling – Protective gloves, clothing, and safety glasses shall be provided to workers and inspectors directly exposed to the materials. Product safety data sheets shall be provided to all workers and inspectors as obtained from the manufacturer. Heed all warnings of the Safety Data Sheets and manufacturer's labels.

Project Conditions

1. Cold weather limits – Do not place the HFST when the temperature of the surface and epoxy polymer materials are below 45 °F. ~~Do not place the HFST when the temperature of the surface and epoxy polymer materials are below 45 °F unless otherwise recommended by the material manufacturer and accepted by the Engineer.~~
2. Hot weather limits – Do not place the HFST if the 6 oz mixed resins job site production samples have a gel time less than 10 minutes or if the broadcast aggregate will not penetrate the epoxy binder layer.



Section 2 - Products

Epoxy Binder

DURAL HFS, manufactured by The Euclid Chemical Company, 19218 Redwood Road, Cleveland, OH 44110, phone 800-321-7628, meets the requirements of this section. The epoxy binder resin used in the HFST system shall meet the requirements listed in Tables 2.1 and 2.2. All components used for physical testing shall be maintained at 73°F ($\pm 1^\circ$ F), (23°C) for a minimum of 24 hours before mixing, curing, or testing.

Table 2.1 - Properties of mixed, uncured epoxy binder

Property	Value	Test Method
Viscosity	1000 to 3,000 cps	ASTM D2393
Gel Time at 73° F	15 to 45 minutes	ASTM C881
Flash Point	>199° F	ASTM D3278
VOC	0	

Table 2.2 - Physical Properties of Cured Epoxy Binder at 7 days.

Property	Value	Test Method
Tensile Strength	>2,500 psi	ASTM D638
Tensile Elongation	30 to 70%	ASTM D638
Water Absorption	<0.50%	ASTM D570
Shore D Hardness	65 \pm 5	ASTM D2240
Cure Rate	3 hours max.	ASTM D1640
Chloride Permeability	< 100 Coulombs	ASTM C1202
Flexural Strength	>5,000 psi	ASTM D790

Aggregate

The surface applied aggregate used for the HFST application shall be Calcined Bauxite. The aggregate shall be clean, dry and free from foreign matter. The aggregate shall be angular and comply with the table below.

Table 2.3 - Requirements of Aggregate

Property	Value	Test Method
Aggregate Grading	No. 6 - Passing 95% min. No. 16 – Passing 5% max.	ASTM T27
Aggregate Abrasion Value – ‘C’ Grading	10% max	AASHTO T96
Moisture Content	0.2% max	AASHTO T-255

Other aggregate gradations are acceptable, if approved by the Engineer.



HFST OVERLAY

The epoxy polymer overlay (including resin and aggregate) shall meet the requirements of Table 2.4.

Table 2.4 – Properties of cured epoxy polymer overlay

Property	Value	Test Method
Compressive Strength, 3 hours	>1,000 psi	ASTM C579
Compressive Strength, 7 days	>5,000 psi	ASTM C579
Thermal Compatibility	Pass	ASTM C884
Bond Strength	>250 psi	ASTM C1583

Section 3 - Execution

Surface Preparation

1. Surfaces shall be clean, dry, and free of all dust, oil, debris and any other material that might interfere with the bond between the epoxy resin binder material and existing surfaces.
2. Prepare all pavement surfaces immediately prior to the installation of the 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.
3. Clean asphalt pavement surfaces using mechanical sweepers and high pressure air wash with sufficient oil traps. Mechanically sweep all surfaces to remove dirt, loose aggregate, debris, and deleterious material. Vacuum sweep or 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 air lance perpendicular to the surface and the tip of the air lance within 12 inches of the surface.
4. Clean concrete pavement surfaces by shot blasting and vacuum sweeping. Shot blast all surfaces to remove all curing compounds, loosely bonded mortar, surface carbonation, and deleterious material. The prepared surface shall comply with International Concrete Repair Institute (ICRI) standard for surface profile of CSP 4-5. After shot blasting, vacuum sweep or 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 air lance perpendicular to the surface and the tip of the air lance within 12 inches of the surface.
5. For applications on new asphalt pavements or resurfacings a minimum 30 day cure period shall take place prior to the installation of the HFST.
6. Only those surfaces that can be covered with the high friction surface treatment in one working day shall be cleaned in advance.



7. Utilities, drainage structures, curbs and any other structure within or adjacent to the treatment location shall be protected from the application of the surface treatment materials. Cover and protect all existing pavement markings that are adjacent to the application as directed by the Engineer. Pavement markings that conflict with the surface application shall be removed by grinding and the surface shall be swept clean prior to the epoxy binder application.
8. No traffic (other than HFST application equipment) shall be allowed on the accepted prepared surface until all layers of the high friction surface treatment have been applied. Should the surface be opened to traffic and/or contaminated in any way additional cleaning will be required.
9. The HFST application equipment is allowed to drive on the clean deck surface during application of the overlay provided precautions have been taken to insure that the deck surface will not become contaminated.
10. Immediately prior to the application of the HFST, the Contractor shall request and receive approval to proceed from the Engineer to assure that the surface is acceptable for the application of the system.

HFST APPLICATION

GENERAL

1. Pre-treat joints and cracks greater than 1/4 inch in width and depth with the mixed epoxy specified herein. Once the epoxy in the pre-treated areas has gelled, the epoxy binder and aggregate topping installation may proceed.
2. Premark a section of the surface to be treated to verify proper application rates of the epoxy binder as specified in this guideline.
3. Cease all epoxy binder operations if rain is imminent. Protect freshly applied surface treatment from sudden or unexpected rain by covering with plastic. Remove the plastic cover soon after the treated surface is tack-free. The Engineer may order the removal and replacement of any material damaged by rainfall. If removal is required, square off the damaged area by saw cutting to the top of the pavement surface and remove overlay using appropriate methods as approved by the Engineer.

MIXING EPOXY BINDER:

1. Hand Mixing:
Proportion the two-part epoxy binder components to the correct ratio and mix as recommended by the manufacturer.
2. Optionally, in lieu of hand mixing the epoxy binder utilized in the high friction surface treatment, automated continuous application equipment may be used. When continuous mixing is specified, use equipment that continually meters, mixes, and dispenses the epoxy binder. At the very least the application machine shall feature positive



displacement volumetric metering pumps. In colder weather temperature controlled reservoirs may be necessary. In line mixing of the resins shall be motionless (static mixer) so as to not excessively shear the material or entrap air in the mix. One proposed proportioning and mixing equipment is GRACO XP50 Plural Component unit with Quick Set Package and Data Recording. Similar equipment may be approved.

Placement of the High Friction Epoxy Aggregate Surface Treatment:

1. After mixing of the components, the liquid shall be evenly distributed on the clean, dry deck surface.
2. Application of the mixed epoxy binder to the surface shall be done by squeegee, or roller, or any combinations thereof as approved by the Engineer. The application method used shall apply the material smoothly, uniformly, and continuously. The contractor shall provide suitable coverings, such as heavy-duty drop cloths and the like, to protect all exposed areas where the application of the epoxy binder is not intended. These areas may include and are not limited to; curbs, sidewalks, railings, parapets, joints, etc.
3. The epoxy binder shall be applied to the prepared surface at an application rate of 30 ft²/gal (50 mils). While the epoxy is still wet, broadcast the aggregate such that the aggregate just covers the epoxy resin. Typically the application rate is 1.25 – 1.5 lb/ft² resulting in a surface where no wet spots from the epoxy binder can be seen. If wet spots develop, immediately broadcast additional aggregate until a dry surface is re-established. When broadcasting the aggregate it is required that it be dropped or sprinkled vertically in such a manner that it does not violently disturb the wet epoxy film. After the first coat of epoxy binder has cured to a point that will allow foot traffic, sweep, vacuum or blow off (using oil and water free compressed air) the excess aggregate completely from the surface of the epoxy/aggregate coat. The excess aggregate can be reused as long as it is clean, uncontaminated and dry.
4. If a second course is required for an open graded pavement surface, repeat the application of the subsequent layer by applying the epoxy binder at a coverage rate of 30 ft²/gal. The aggregate shall be broadcast into the still wet epoxy resin binder such that the aggregate just covers the epoxy resin. Typically the application rate is 1.5 – 2.0 lb/ft² resulting in a surface where no wet spots from the epoxy binder can be seen. After the second coat of epoxy binder has cured to a point that will allow foot traffic, remove the excess aggregate completely from the surface as described above.
5. The completed surface shall be free of any smooth or “glossy” areas such as those resulting from insufficient quantities of surface aggregate. The Contractor shall repair such surfaces at no additional cost.
6. Do not open to traffic until finished overlay is hard enough to not be damaged by the traffic.

CURING

1. Curing:
The HFST application shall be allowed to cure sufficiently before subjecting it to loads or traffic of any nature that may damage the overlay. Cure time depends upon the ambient



and surface temperatures during and after application. The following cure schedule is provided as a guide; however, actual degree of cure and suitability for traffic shall be determined by the Manufacturer and accepted by the Engineer on the actual HFST application.

HFST Application	
Temperature, °F (C)	Time, hrs.
40 (4.4)	7
45 (7.2)	6½
55 (12.8)	5½
60 (15.6)	5
75 (23.9)	3½
85 (29.4)	2½
95 (35.0)	2