Nevada Department of Transportation

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Developing a Lower Modulus Polymer Resin Binder Systems Specifications for High Friction Surface Treatment (HFST) on Asphalt Pavements in Nevada

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16. Abstract

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DRAFT FINAL REPORT

Prepared for

Nevada Department of Transportation

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Abstract

A variety of physical property measurements were performed including Dynamic Scanning Calorimetry (DSC), Dynamic Mechanical Analysis (DMA), compression testing, tensile testing, heat deflection temperature (HDT) testing, and Coefficient of Thermal Expansion (CTE) testing. Results showed a wide range of properties of the resins. Lab scale application of the HFST resins onto asphalt with subsequent thermal cycling from -30°C to +55°C performed to determine the cracking or delamination propensity and correlate it to material properties. Unfortunately, no HFST failure was observed. Overall, while material properties could be obtained, the lack of any laboratory test with sufficient resolution to controllably fail HFST on asphalt prevents correlation to properties and, thus, no determination of "optimal" formations for HFST resin could be determined. Wheel polishing on slabs was also performed, with little difference between most resins. There seemed to be a weak inverse correlation between Dynamic Friction Test (DFT) values and modulus with low modulus binders having the highest DFT values at 300,000 wheel passes. Further, one anomalous material had a rapidly decaying DFT value and it was determined that this was the only material tested above its HDT, indicating that HDT may be a metric in determining upper usage temperature.

Summary

It was found that there was a wide spread in the thermal and mechanical properties of the HFST resins. With such large ranges of properties, it is highly likely that they are playing a role in failure of HFST resins in the field. In an attempt to correlate these properties to failure, HFST was coated onto asphalt samples and thermally cycled. However, none failed after many cycles. In an attempt to weaken the interface and replicate coating on aged roads, thermal aging as well as UV-based aging were performed, with still no HFST failure. This showed that the experiment currently does not have the requisite sensitivity to material properties to distinguish between the HFST resins tested. A key result of this work is that we have identified that to improve HFST resins and understand their failure, it is necessary to develop a standard laboratory test capable of failing HFST as it does in the field that is capable of distinguishing between resins. This will likely necessitate using aged asphalt samples (either field or artificially), larger slabs and possibly aged HFST. Without this, improvement in HFST is likely to be slow.

HFST overlay with high friction aggregate was applied to the test slabs and subjected to wheel polishing at 46°C. The polisher was stopped at predetermined intervals to take surface texture and friction measurements. Only two out of the ten products tested showed poor fractional properties under wheel load application. The performance of the remaining 8 overlays were closely clustered indicating that these tests too were not sensitive to material properties and cannot be used to delineate good from bad products from HFST application.

CHAPTER 1 - BACKGROUND

1.1 Problem Description

High friction surface treatments (HFSTs) are thin applications of high quality, polish-resistant aggregates bonded to a pavement surface with a polymer resin of some type. Because of their high cost, they are typically used as spot safety treatments in locations with high accident rates related to possible friction deficiencies, such as tight curves and ramps. HFSTs are relatively new in the USA but are similar in many ways to polymer bridge deck overlays that have been used for years to waterproof the deck and enhance friction. In fact, most HFST systems on the market today have high modulus binders like those used for bridge decks, which are more suited for use on concrete pavements than on asphalt surfaces.

High modulus resins are typically used to resist traffic-induced stresses, which can be severe in high accident locations. The high stiffness of the binders tends to make them less flexible and more susceptible to reflective cracking. As the pavement temperature rises above the glass transition temperature (T_g) of the resin, the resin will become less stiff, which can lead to debonding from the substrate or loss of aggregate. Thermal incompatibility between the resins and the asphalt surface can also contribute to performance problems in the HFSTs. The coefficient of thermal expansion (CTE) of the resin may be several times greater than that of the underlying asphalt, which can result in the HFST “popping off” or delaminating from the pavement surface.

While the Nevada Department of Transportation (NDOT) has used thin bonded multilayer overlays on bridge decks routinely, the use of single layer HFSTs on asphalt surfaces is a relatively new technique in the state. Premature cracking has been observed. The high service temperatures and temperature differentials experienced in the state may also cause aggregate loss and delamination to occur. One possible way to improve the performance of HFSTs on asphalt pavements is to use a lower modulus resin, as long as other properties are not negatively affected. For example, the Indiana DOT (INDOT) has reduced the required resin modulus for HFSTs to 90,000 psi (at 77°F and 7 days) to reduce incompatibilities between the resin and asphalt pavement. So far it appears there is no increase in aggregate loss or delamination. Conditions in Nevada, however, are more severe than in Indiana, so research is needed to establish whether a lower modulus binder will perform under those conditions. This research is aimed at identifying a polymer resin that can perform better in HFSTs under the conditions experienced in Nevada.

1.2 Background Summary

NDOT currently uses essentially the same specifications for HFSTs as for thin bonded multilayer overlays. The same epoxy-based resins are specified for both applications. HFSTs are placed in single lifts and use 100% calcined bauxite, while thin bonded overlays require multiple lifts. The use of up to 50% steel slag in lieu of part of the calcined bauxite is allowed with the bonded overlays to reduce costs while still waterproofing bridge decks. Given the different moduli, CTEs and deflections of asphalt and concrete, use of the same types of resins may not be optimal and may contribute to a shorter service life for HFSTs on asphalt.

Current practice for HFST is to use thermoset polymers, such as epoxy, to bind the aggregate together and to bond the HFST to the pavement. However, epoxy is known to be a brittle material lacking ductility and low elongation-to-failure upon being stressed, which results in epoxy being, in general, a low toughness material. While epoxy can be toughened by the addition of rubber particles, this does not greatly impact ductility. However, epoxy benefits from having excellent adhesion to many inorganic substrates, such as those in typical aggregates, which is why it is commonly used in high strength glue. Unfortunately, epoxy can be limited in its adhesion properties to organic materials. As an example, very specific and expensive methods are required to bond epoxy to petroleum-derived organic polymers such as polypropylene, including the use of organic solvents, such as xylene, to partially dissolve the polymer and allow the epoxy to better penetrate the material. A further issue with epoxy, as well as many glassy thermosets, is that the glass transition temperature is determined by the temperature of cure (commonly 30°C above) and can be in a range such that the epoxy can soften appreciably during normal use, thus weakening the material. There are other polymer binders, but many also suffer from similar drawbacks. What is needed is a different polymeric resin binder that satisfactorily binds to the aggregate, adheres well to the asphalt pavement, has increased ductility or rubbery elasticity to prevent cracking during stress, and consistent (good) properties over the temperature range of use.

A preliminary literature search on possible resins revealed that epoxy, polyurethane, thermoset polyester and vinyl ester resins are likely to be the dominant materials classes (1) based on their history of use and relatively low-cost. The properties of importance include strength, elongation-to-failure, modulus, toughness, Heat Deflection Temperature (HDT), and UV/environmental stability. Strength is important as these materials see load both in compression and shear due to vehicular weight and momentum and, therefore, to prevent breakage and cracking a high strength is ideal. However, as an adhesive system, strength may not be determinant in this system. Elongation-to-failure (the amount a material can stretch before cracking) and stiffness (modulus) are very important as it determines how well the material can "conform" to cracks, breaks and other defects in the pavement surface (2). As well, CTE mismatches can induce cracking in materials (3), but these can be minimized by having high elongation-to-failure as the material can better accommodate any thermally induced strains. Toughness is in general how much damage a material can accommodate before failure and in polymers is generally described by work-of-failure, or the integration of the stress-strain curve, which amounts to an energy that is necessary to fail a material (4). This factor is important as materials with higher toughness can withstand more damage, defects and impact before cracking/failing and affects usage lifetime. HDT is an engineering property that describes the temperature that a material undergoes a specified small amount of deflection under a small specified small load (5) and is related to properties such as the glass transition temperature (T_g) and temperature dependent modulus of a material. It is determinant of the maximum usage temperature of the material. Generally, an HDT higher than the maximum temperature seen in use for the roads is ideal. However, more important than HDT is the temperature stability of the modulus, which can be estimated by the storage modulus (E') in dynamic mechanical analysis (6). Some soft material shows very low HDTs but have relatively flat E' (7). If the overall modulus is sufficient, then what is more important is for it to be stable over a wide temperature range. This point is highlighted as high HDT materials can have high T_g and thus be very brittle at low temperatures, being prone to fracture. Lastly, UV-stability is needed so that sun exposure does not damage the material.

1.3 Layout of the report

The contents of this report are laid out in the following manner. Chapter 1 discusses the background and description of the problem which lead to this study. The research approach and properties of HFST products evaluated are presented in Chapter 2. Chapter 3 summarizes the findings from this research and suggested applications. Suggested future research topics from lessons learnt in this study and overall conclusions are covered in Chapter 4.

CHAPTER 2 - RESEARCH APPROACH

A two-pronged approach to the test methodology was taken in this study to achieve the project goals. In the first part, the mechanical properties of the HFST resins were evaluated. In the second part of the study, the HFST products were applied to hot-mix asphalt (HMA) specimens and evaluated under different temperature regimes to simulate aging and followed by polishing to simulate vehicular traffic.

2.1 Surface treatments used

A total of 11 different types of materials were tested, 9 of which were epoxy resins and one was a polyester resin. Additionally, a thermoset polyester comparison (HCSC) use in synthetic concrete was also tested as it was not a "low modulus" type of material and provided a high modulus control material. The full name, acronyms, and resin types are listed below. For epoxies, part A and part B of each one was mixed at 50:50 mass ratio. For PE resins, the initiator (MEKP): accelerator(Z-cure): monomer: = 2: 0.4: 100 (mass ratio).

Full name of the product	**Brand**	**Name used in this report**	**Type**
Hybrid Composite Synthetic Concrete	Kwik Bond Polymers	HCSC	PE
PPC™ - HFST	Kwik Bond Polymers	PPC	PE
KBP Epoxy LM	Kwik Bond Polymers	KBP-LM	Epoxy
E-bond 526	Transpo Industries, Inc.	E-bond 526	Epoxy
HFP 1:1	e-chem, LLC.	e-chem HFP	Epoxy
EPX50-OVERLAY FAST	e-chem, LLC.	EPX50	Epoxy
Pro-Poxy™ Type III D.O.T.	Unitex	ProPoxy-III	Epoxy
Sikadur®-22 Lo-Mod FS	Sika USA	Sika lo-mod	Epoxy
FLEXOLITH	Euclid Chemical	Flexolith	Epoxy
FasTrac CE330 Epoxy Binder	FasTrac	FasTrac	Epoxy
Planiseal Traffic Coat	MAPEI®	Planiseal	Epoxy

2.2 Methodology

Unless otherwise specified, all samples were tested after they were fully cured.

The mechanical tests were performed at room temperature. For mechanical tests, the modulus for tension and compression, ultimate tensile strength (UTS), and strain at break were collected using an MTS load frame. For uniaxial tensile tests, the epoxies samples were mixed and cast according to ASTM D638-10 (Type IV) (8). The test speed was set at 10 mm/min. The modulus was calculated as the slope of the early elastic deformation region, the ultimate tensile strength is the highest stress the samples can endure without breaking. For uniaxial compression tests, the epoxies samples were mixed and cast into cylinders with a diameter of 18 mm and a height of 10 mm. The test speed was set at 1 mm/min, and the test stopped at 60% strain in the axial direction.

For thermal properties, the glass transition temperature (T_g) was collected using a TA instrument D2000 Differential Scanning Calorimeter (DSC) using a heat-cool-heat cycling method with a ramp rate of 10°C/min, and the values of T_g were collected during the second heating cycle and reported as the midpoint of the transition. The heat deflection temperature (HDT) and coefficient of thermal expansion (CTE) were collected using a TA Instrument Dynamic Mechanical Analyzer Q850 (DMA). The HDT values were measured using the three-point bending method on DMA, and the detailed method to calculate HDT values can be found at this reference (9) with modification of sample dimensions to fit the fixture. The samples were cast into 62 mm × 13 mm × 2 mm cuboids. The distance between two supporting points of the 3-point bending fixture was 10 mm. The CTE values were measured using compression mode on DMA with a fixed amount of force of 0.01N and a temperature sweep from -40°C to 80°C at a ramp rate of 10°C/min. The samples were cast into cylinders with a diameter of 10 mm and a height of 5 mm. Strain was measured as a function of temperature, and calculated CTE values in the axial direction from the slope of the resulting curves.

2.3 Properties of surface treatment products used

HFST resins and PE control (HCSC) were tested for mechanical properties and presented in Table 1. As expected, the HCSC PE comparison had the highest modulus, strength and lowest strain at failure by a large degree. As hoped, the HFST resins had a large range of moduli (3.6 MPa to 834 MPa), strength (2.7 MPa to 19 MPa) and strain at break (0.26 to 0.82). Compression modulus tracked tensile modulus. It is commonly thought that a lower modulus “stretches” more, although this is not always the case. Modulus simply refers to the slope of the elastic linear part of the stress strain curve, whereas strain at break is a different property dictating how much a material can stretch before failure. A related property, ultimate tensile strength, dictates how much force a resin can achieve before cracking. In adhesion science, modulus is known to correlate strongly with pull-off force of rigid body, with lower pull-off forces correlated to lower moduli of the substrate. Hence, lower moduli HFST resins may lead to higher aggregate loss in wheel polishing. Similarly, modulus and strength tend to be correlated with wear with lower values leading to higher wear.

Table 1 Mechanical properties of resins**Product**	**Type**	**Tensile strength (MPa)**	**Strain at tensile failure**	**Modulus (MPa)**	
				In tension	**In compression**
HCSC	PE	43	0.12	2055	2062
e-chem HFP	Epoxy	13	0.38	385	111
ProPoxy-III	Epoxy	17	0.29	834	647
PPC	PE	19	0.47	175	259
Flexolith	Epoxy	15	0.26	488	394
FasTrac	Epoxy	13	0.57	214	148
Sika lo-mod	Epoxy	7.8	0.51	97	134

KBP-LM	Epoxy	2.7	0.82	37.2	18.7
E-bond 526	Epoxy	2.2	0.78	3.6	10.9
EPX50	Epoxy	19	0.36	460	214.3
Planiseal	Epoxy	6.6	0.67	36	24.3

Thermal properties were tested as well to understand how these may play a role in failure and wear. Thermal and thermophysical properties are given in Table 2. DSC was used to determine the glass transition temperatures (T_g), the temperature at which a material turns from a more rigid brittle glassy state to a more plastic rubbery state. As expected, due to the low modulus modifiers of the resins (e.g. rubber modifiers, low Tg monomers, etc), T_g's of the resins were low relative to epoxies and polyesters used in other applications, with a range of ~7 °C to ~36 °C for the HFST resins. Additionally, the T_g was exceptionally weak for all materials, again due to the additive loading. This places the T_g well within the usage temperature which can cause plastic flow as well as other issues. It must be noted that other glass transition measures, such as via DMA, would likely result in different numbers. However, for highly crosslinked materials with low modulus modifiers such as these, the $T_{g,}$ in general, is not a good measure of thermal performance as this low modulus lowers the T_g, but even above the T_g it is difficult for the material to undergo deformation due to the crosslinking. Thus, HDT was measured, which is a more practical measure for usage temperature. The HDT is the temperature at which the material undergoes appreciable flow under a small load. It was determined that all materials, except Planiseal had HDT above the "typical" usage temperature. However, many had HDTs in the upper 40s and lower 50s (°C), so conceivably on a hot day with plentiful sunshine, they could be above this temperature. Planiseal had an anomalously low HDT at 34 °C, which is well within the usage temperature, as well as the wheel polishing temperature, which likely led to strange effects as detailed in a later section.

Coefficient of Thermal Expansion (CTE) was measured as this is a component of thermal strain, as discussed below. However, the fact that the materials had a low T_g complicated measurement as CTE is different above and below the glassy point. Hence, they were calculated separately above and below T_g. As expected, due to the modulus differences, there was a large discrepancy between CTEs. Overall, it is known that CTE and modulus are highly inversely correlated with high CTE resulting from low modulus materials. However, CTE is also correlated with crosslink density with high CTE resulting from low crosslinking. Hence, behavior is expected to be complicated depending on the system.

Table 2 Thermal properties of the resins

Product	**HDT (midpoint) (°C)**	**T_g (DSC) (°C)**	**CTE (ppm/K)**	
			Before T_g	**After T_g**
HCSC	80	41.1	33.3	114.1
e-chem HFP	53	25.1	95	110.3
ProPoxy-III	63	30.8	39.9	69.7
PPC	63	22.8	67.9	87.1

Flexolith	56	29.7	21.7	76.3
FasTrac	53	17.3	48.4	61.2
Sika lo-mod	47	17.2	51.3	96.1
KBP-LM	52	12.1	70.2	113.5
E-bond 526	44	7.1	77.7	99
EPX50	50	36.4	4.96	136.4
Planiseal	34	20.8	9	175.1

One issue that was desired to be explored was the concept of “thermal stress and strain” with regards to the failure of these materials. If the substrate and the overlaid/coated material have vastly different CTEs, as the temperature changes from the coating temperature, the differing CTE will lead to stress in the coating. If this stress is larger than the ultimate failure stress (UTS) of the coating, then it will crack. This stress is dependent upon the difference in CTE and the modulus difference between the materials. For sufficiently thin coatings and thick substrates, the modulus that matters is that of the coating alone. In other words, for thin coatings, the CTE mismatch can simply be related to the strain to failure. A figure of merit (FOM) for thermal stress was calculated from the CTE difference between the resin and hot-mix asphalt concrete (assumed at 20 ppm/K or 2 x 10^{-5} /degree C taken as the midpoint from an online source) and modulus assuming 13% or 26% resin HFST coating and a ceramic, such as alumina, CTE at 8 ppm/ K) both above and below $T_{g.}$ The FOM should not be seen as a rigorous thermal stress value as actual stress is dependent on geometry, creep, etc., but the thermal stress scales with the FOM based on known physics of modulus and CTE mismatch. Thus, the FOM should be seen as scaling with the amount of stress that develops in the film per degree for comparative purposes rather than definitive values, where a Finite Element Model (FEM) would be needed. It should be noted that the values of the asphalt and HFST aggregate are not important as they are all constant, so relative comparison can still be made. Regardless of if the asphalt, HFST or adhesion is weakest, the HFST with highest thermal stress (and therefore FOM) would approach failure stress the fastest and would therefore be expected to be worst. Overall, all values are rather small with a spread of results. HCSC achieved a figure of merit 3X higher than any other material. Results are in Table 3.

Table 3 Thermal stress figure of merit of the resins

Product	**13% resin $<T_g$**	**26% resin $<T_g$**	**13% resin $>T_g$**	**26% resin $>T_g$**
HCSC	-0.0179	-0.0111	0.0037	0.0320
e-chem HFP	-0.0003	0.0041	0.0005	0.0056
ProPoxy-III	-0.0065	-0.0031	-0.0033	0.0034
PPC	-0.0007	0.0006	-0.0003	0.0015
Flexolith	-0.0050	-0.0041	-0.0015	0.0028
FasTrac	-0.0014	-0.0003	-0.0011	0.0004

Sika lo-mod	-0.0006	-0.0001	-0.0001	0.0010
KBP-LM	-0.0001	0.0002	0.0001	0.0006
E-bond 526	< -0.0001	< 0.0001	< -0.0001	< 0.0001
EPX50	-0.0057	-0.0059	0.0022	0.0098
Planiseal	-0.0004	-0.0004	0.0004	0.0011

2.4 Initial attempts with epoxy-resin overlay on HMA slabs

Plant-mix samples obtained from a local contractor were used to prepare 20” x 20” x 1.5” test slabs which served as the base for HFST application. The plant-mix used was a 9.5 NMAS with PG70-22 binder, compacted to approximately 7% air voids.

As mentioned earlier, one of the main issues with the use of HFST on HMA pavements is the mismatch between the coefficient of thermal expansion (CTE) of the pavement and that of the epoxy- resin treatment overlay, which results in delamination of the treatment layer or the appearance of cracks at the interface. To simulate these conditions in the laboratory, preliminary testing was conducted using two epoxy-resins, ProPoxy-III and E-Bond 526. These two epoxy-resins were chosen as they represented the whole range on moduli observed in the products studied here. ProPoxy-III had the highest Young’s modulus (834 MPa) and E-Bond 526 had the lowest modulus (3.6 MPa).

The compacted test specimens (unaged plant mix) were trimmed down to 15” x 15” x 1.5”, as their size was limited by the size of the test chamber used for thermal cycling. Adhesive aluminum tape was attached to the sides of the trimmed slab to create an enclosure for containing the resin treatment applied on the surface. The recommended proportions of resin and hardener were mixed at low speeds using a paddle mixer for a period of three minutes until it was homogenous. Following the mixing period, the mixture was allowed to rest for about 10 - 15 minutes, at which time the temperature of the epoxy mixture started to rise with an increase in its viscosity. At this point the epoxy treatments was applied (poured) over the HMA test slab and allowed to harden. The resulting film thickness was about 6 mm. Figure 1 shows an example of a test specimen with the hardened epoxy-resin treatment, before being subjected to conditioning. Pure HFST epoxy-resin instead of epoxy-resin + aggregate was used to create a more severe condition for thermal incompatibility between the overlay treatment and HMA layer.

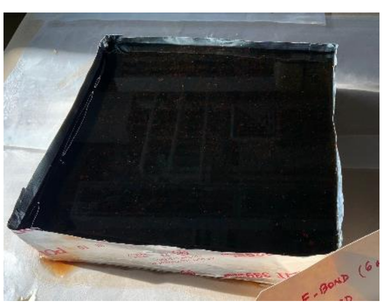

Figure 1 Test specimen with HFST layer

The temperature cycles proposed in ASTM C884, Thermal Compatibility Between Concrete and Epoxy-Resin Overlay (10), was loosely adopted for these initial trials. Accordingly, the test specimens were kept in a temperature-controlled chamber for 24 hours at 23°C and then transferred to a freezer for 24 hours, held at -21°C. This cycle was repeated 5 times, while the test specimen was examined for delamination and cracks at the end of each 24-hour period. Lastly, this temperature cycling using the same two epoxy-resins was repeated using thinner (¾”) HMA slabs to induce damage due to CTE mismatch between the two layers.

In a variation to the above procedure, loose plant-mix was subjected to long-term aging for 5 days at 85°C, in accordance with AASHTO R30 (11), prior to slab compaction. It was envisioned that this aging process would result in HMA akin to pavement material subjected to ~ 8 years of in-situ aging and make it more susceptible to cracking under heating and cooling cycles.

Successive iterations of this test were conducted with changes to test conditions, such as, changing the temperature range to more extreme conditions (55°C to -30°C), changing sample size, and subjecting the test specimens to UV-A aging. In case of UV-aging the test specimens, the specimens were subjected to 4 h of UV-A (365 nm), which was estimated to simulate 10 years for field exposure. The test specimens were further cut to 6” x 6” x 1.5” for UV aging, which was the maximum size that could fit into the UV-aging chamber. Table 4 summarizes test conditions and changes attempted prior to subjecting the test specimens to heating-cooling cycles. In addition to ProPoxy-III and E-Bond 526, a third product, HCSC was also tested in these initial trials. HCSC is primarily used as a patching material in concrete pavements. Summary of these test results will be presented later in the test data/analysis section.

Table 4 Aging condition, test temperatures and other test parameters

Products	**Plant-mix Aging**	**Size**	**Temperature cycle**
E-Bond 526	Unaged	15” x 15” x 1.5” 10” x 10” x 1.5”	+23°C to -20°C
ProPoxy-III			
E-Bond 526	Long-term aged (5 days at 85°C)	10” x 10” x 1.5”	+55°C to -30°C
ProPoxy-III			
HCSC			
E-Bond 526	Long-term aged + UV-aged (4 h of UV-A)	6” x 6” x 1.5”	+55°C to -30°C
ProPoxy-III			
HCSC			

2.5 Tests on HMA slabs with epoxy-resin overlay – post-conditioning

The test specimens prepared and conditioned in Section 2.4 were examined for damage and observations were recorded. These test specimens here then used to determine the pull-off strength, in accordance with ASTM C1583, Tensile Strength of Concrete Surfaces and Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method) (12).

In preparation for the pull-off test, three 2” or 50-mm dia. grooves, approximately 0.5” of 13-mm deep, were drilled in the test slabs. Steel pucks were epoxied to the surface of the treatment layer and allowed to set overnight. Pull-off testing was conducted using the Proceq dy-215, with a stress rate of 35 ± 15 kPa at room temperature and at -10°C. In the case of tests conducted at low temperature, the specimens were conditioned overnight in a freezer set to -10°C after the epoxy setting period. Figure 2 shows a test specimen before and after the test was conducted. Results from these tests will be presented later in this chapter.

Figure 2 Test specimen before (left) and after (right) Pull-off strength test

2.6 Tests on HMA Field Cores

In addition to lab prepared test specimens, two sets of field cores (8” dia.) were obtained from the state of Nevada. The ages of these two sets were approximately 6 and 20 years. Since HFST overlay is typically applied as a rehabilitation or maintenance option to extend the life of old pavement surfaces with low friction numbers, it was envisioned that testing these field cores would allow for a comparison between the lab prepared test specimens and the field aged specimens. Accordingly, limited testing was conducted on these cores and observations recorded.

2.7 Friction and Texture Testing of HMA slabs with HFST Overlay

In a study (13) conducted by the World Road Association (PIARC), standard categories for defining pavement texture based on wavelength were established. These are megatexture, macrotexture and microtexture with wavelengths in the range of 50 to 500 mm, 0.5 to 50 mm and ≤ 0.5 mm, respectively. Roughness was defined by wavelengths > 500 mm. Different aspects of pavement surface are governed or influenced by one or a combination of these categories. For example, skid resistance is mainly influenced by microtexture, and to a smaller extent by megatexture and macrotexture. On the other hand, tire-pavement noise is largely governed by megatexture and macrotexture. Megatexture also influences the pavement smoothness.

In a typical pavement, macrotexture is essentially the texture between and around the aggregates at the surface, while microtexture generally refers to the “roughness” of the aggregate particles themselves or the irregularities on the aggregate surface. The macrotexture is generally determined by the size and gradation of the aggregate blend used. The microtexture is a function of the type of aggregate, crystal size and structure (if crystalline), as well as other factors on the surfaces of the aggregates themselves.

Under the action of traffic, macrotexture can be lost as aggregate particles are abraded away or if traffic densification causes the matrix or binder to fill the “valleys” between aggregate particles. On the other hand, macrotexture can increase if aggregates are dislodged from the surface, creating small “craters” on the surface. Microtexture can change as the action of tires on the exposed aggregates polishes the surfaces; different types of aggregates can be more or less resistant to polishing.

To study the impact of vehicular traffic on the wear of HFST overlay at high temperature (46°C) using the products in this study, 20” x 20” x 1.5” test slabs were prepared with plant-mix obtained from a local Indiana contractor. The mixture used was classified as a 9.5 NMAS with PG64-22 binder. After the compacted slab was cooled for 24 hours, the surface treatment consisting of the epoxy-resin product and steel slag was applied in a 3” wide x 11” c-c diameter circle around the center of the slab. The dimensions of the HFST overlay are governed by the test apparatus used in this section, i.e., the wheel-path of the polishing wheel, the diameter of the circular track traced by the texture measuring device and the friction measure device. A brief discussion of the test apparatus used to measure pavement surface texture and coefficient of friction (wet) and to simulate vehicular traffic in the lab are given below.

2.7.1 Circular Track Polishing Machine (CTPM) – The CTPM consists of rotating set of three small tires that move in a circular track at 50 r.p.m., approximately 284 mm (11”) in diameter, center to center distance and a track width of ~50 mm (2”). Figure 3 shows the setup of the polishing device and a close-up of the water spray directed at the tires. Three water heaters were installed in the water tank to yield hot water at 46°C (115°F). This choice of water temperature was determined by the maximum operating temperature of the circulating pump (max. 120°F). The hot water is sprayed at tires from three sides to wash away any loose grit or worn rubber particles from the polishing surface. The total self-weight of the polisher along with the four added plates amounts to approximately 99 kg (~217 lb) which is applied on the slab surface.

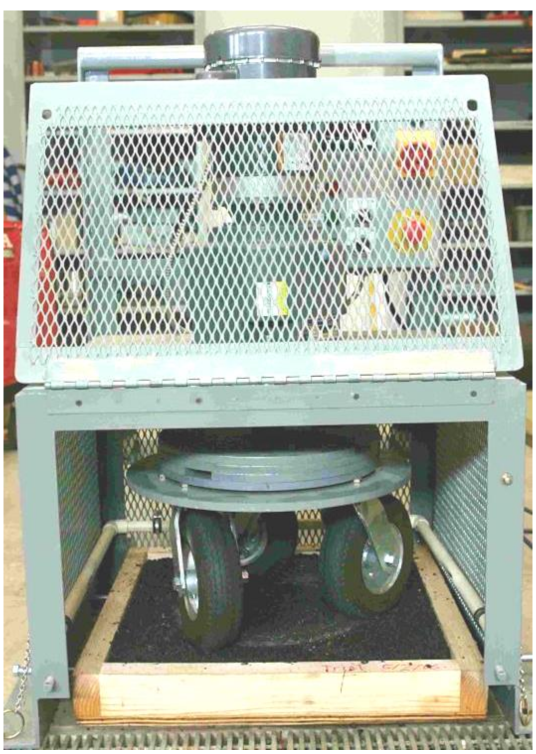

Figure 3 Overview of the CTPM and water sprayed at the tires

2.7.2 Surface Texture Measurements -- The surface texture and friction of each specimen was measured periodically before and during polishing at different intervals until 300k wheel-passes were completed. The surface texture was measured using a laser-based Circular Track Meter (CTM) with a vertical resolution of 3 µm. The diameter of the circle scanned by the CTM is also 284 mm (11”), which assures that the measurements are taken in the path worn by the CTPM. The CTM reading is a measure of pavement macrotexture discussed above. The procedure for determining the surface macrotexture using the CTM is given in ASTM E2157 (14). The texture is reported here in terms of the Mean Profile Depth (MPD) in millimeters, which is automatically calculated by the manufacturer’s software as defined in ASTM E 1845 (15). Figure 4 shows the CTM device and the rotating laser arm underneath. The MPD has been shown to correlate very well to the Mean Texture Depth (MTD) measured with the sand patch test.

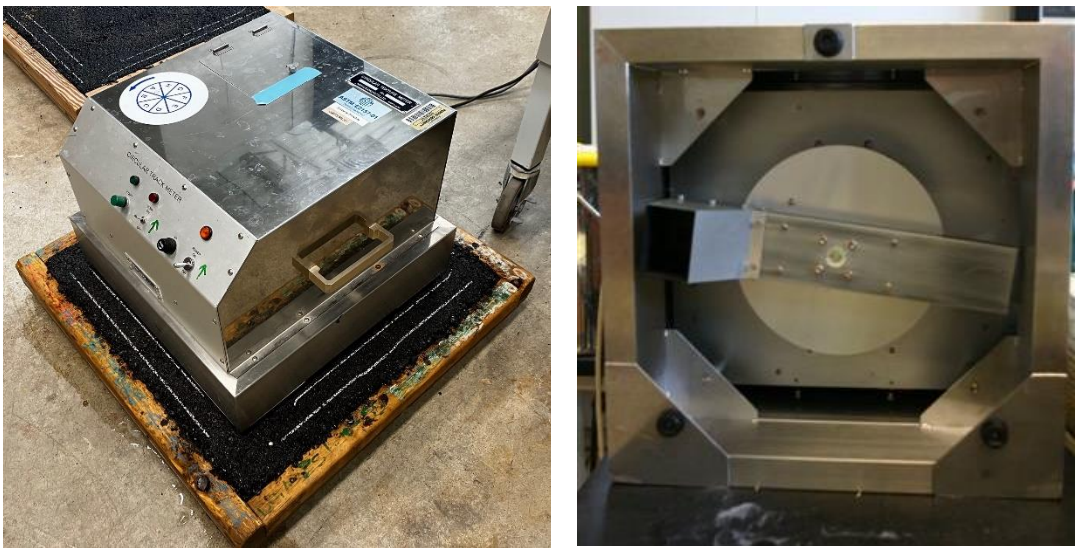

Figure 4 Circular Track Meter and the laser arm (underside)

2.7.3 Surface Friction Measurements -- The coefficient of wet surface friction of each compacted HMA slab was measured using a Dynamic Friction Tester (DFT) according to ASTM E1911 (16). In the DFT, a disk with three rubber sliders attached rotates at tangential velocities up to a maximum of 100 km/h (60 mph), then drops onto the surface. Figure 5 shows the DFT setup on a pavement surface and the rotating disc will rubber sliders underneath. A starting point of 80 km/h is used here. The torque generated as the disk slows provides an indication of the friction at various speeds. The output from the DFT is reported as unitless DFT numbers at various speeds (typically 20, 40, 60 and 80 km/h (12, 24, 36 and 48 mph)). The DFT value at 20 km/h (12 mph), DF_{20}, is used with the MPD to calculate the International Friction Index (IFI) according to ASTM E1960 (6). The F60 and Sp values are calculated as follows:

IFI (F60, Sp)

$$\begin{cases} F60 = 0.081 + 0.732 DF_{20} e^{\frac{-40}{Sp}} \\ S_p = 14.2 + 89.7 MPD \end{cases}$$

where MPD is measured by the CTM and DF_{20} is measured by the DFT. The DFT reading is a measure of the pavement microtexture and has a larger influence on the calculated IFI value, than the MPD obtained from the CTM.

Figure 5 Dynamic Friction Tester and rubber sliders on the underside

The observation and results obtained from this chapter are presented and analyzed in the next chapter.

CHAPTER 3 – FINDINGS AND APPLICATIONS

3.1 Results from temperature cycling of HMA slabs and field cores

Initial attempts to induce interfacial cracking or delamination of the HFST overlay focused on two products, namely, ProPoxy-III and E-Bond 526, on the 15” x 15” square, unaged, plant-mix test specimens. Subjecting the test specimens to temperature swings from room temperature to -20°C proved to be unsuccessful, as neither delamination nor any cracking was observed in the test samples. This was attributed to the relatively flexible nature of the “fresh”, unaged, plant-mix used to prepare the base layer.

In a follow-up attempt, the plant-mix was subjected to thermal aging prior to preparation of test specimens. This long-term aging was designed to simulate oxidative aging that occurs naturally in a pavement during its service life. Test specimens were then compacted and trimmed down to 10” x 10” square. In addition, the temperature range for the 24-h cycling regime was increased from +23°C to -20°C to a more extreme range from +55°C to -30°C. No damage was observed in the two overlay products in this scenario either. A third product, HCSC, was also tested with this combination of specimen size and temperature range for thermal cycling. In this case, both delamination and cracking within the HMA was observed in the test specimen at the end of the first heating cycle. This was expected since this compound has no additives to reduce modulus so that it is very stiff, producing a large thermal strain (3x higher than any other HFST resin as reported above), but also brittle with a propensity to crack.

In a further attempt to induce delamination and/or cracking under lab conditions, thermally-aged test specimens were subjected to 10-year field equivalent of UV-aging. However, these test conditions were not sufficient to induce adequate differential stresses in the two layers which would have led to delamination of the two overlay products. As in the previous case, the test specimen with HCSC overlay cracked at the end of the first heating cycle.

Lastly, the field cores were also tested in a similar manner. These cores were not subjected to any further thermal or UV-aging prior to testing as they were aged in-situ during their service life. The surface of two field cores were overlaid with ProPoxy-III and E-Bond 526 and subjected to heating and freezing cycles. No damage was observed in the underlying HMA layer nor the epoxy-resin overlay.

Upon the recommendation of the Study Advisory Committee (SAC), further testing of the remaining products using this method was discontinued. It may be concluded that the test conditions (specimen size, temperature cycles, aging condition, etc.) applied in the lab were not adequate to cause differential expansion and contraction in the two layers, hence no damage (in form or delamination and cracking) was observed in these test specimens.

3.2 Results from Pull-off Tests on post-conditioned HMA slabs

Since the test specimens at the end of the heating-freezing cycles were undamaged, they were used for Pull-off tests in Direct Tension mode. Initial pull-off testing was conducted at room temperature; three replicates each for the two epoxy-resin products used in the initial trials. Due to the viscoelastic nature of HMA, no clean break was observed at peak load. When the test was conducted on specimens frozen to -10°C, brittle failure was observed within the HMA layer (see Figure 2). Table 5 presents the bond strength for the two products at the two test temperatures.

Table 5 Pull-off strength of ProPoxy-III and E-bond 526

Aging condition (Test temperature)	**Pull-Off Strength (Direct Tension Mode)**	
	E-Bond 526, MPa (psi)	**ProPoxy-III, MPa (psi)**
Unaged (+23°C)	1.94 (282)	1.28 (186)
Long-term aged (+23°C)	1.12 (163)	1.53 (222)
Long-term aged (-10°C)	1.55 (225)	1.58 (229)
Long-term aged + UV (-10°C)	1.47 (213)	1.54 (223)

In general, UV-aging appears to result in a slight decrease in the pull-off strength for both products, when tested at low temperature. The percent decrease was 5.1 and 2.5, respectively for E-Bond 526 and ProPoxy-III. E-Bond 526 showed marginally lower strength than Pro-Poxy-III at both aging conditions (-2.0% for thermally-aged, -4.9% for thermal+UV-aged at low temperature.

Comparison of strengths for the long-term aged specimens tested at 23°C versus -10°C, indicates that lower test temperature increased the strength for E-Bond 526 by 27.4%, but only marginally for ProPoxy-III (2.9%). Unaged E-Bond 526 specimen was 42% stronger than the long-term aged specimen tested at 23°C. But, unaged ProPoxy-II was 19% weaker than its long-term aged counterpart tested at 23°C.

The impact of test temperature, thermal and UV aging on the pull-off strength of the products appear to be mixed and vary with product. However, no further pull-off testing was pursued on the remaining epoxy-resin products, upon the recommendation of the SAC.

3.3 Results from friction and texture measurements of HFST overlay on HMA slabs

Due to the unsuccessful attempts in inducing delamination by controlling aging conditions, temperature cycles and specimen size of the lab-prepared test slabs and field cores, with the SAC's recommendation the remainder of the study was focused on friction and texture measurements on test slabs subjected to wheel polishing at high temperature.

It should be noted that PIARC Model for IFI is based on two components, namely, the speed constant, S_p and F60 (friction at 60 kph). The speed constant is computed from texture measurements, i.e.,mean profile depth (MPD, mm) data using the CTM, in this case. Whereas, the F60 is computed using the coefficient of friction (μ) at 20 kph (12 mph) obtained with the DFT. This latter value, the DF_{20}, gave the highest degree of correlation (R = 0.96) with microtexture, while, DF_{60} gave a slightly lower correlation of 0.90. However, NDOT uses the DF_{60} (37 mph) in their pavement quality management program. Accordingly, these datapoints are presented in this section and were also used in IFI calculations.

Prior to polishing, MPD and DF_{60} data was obtained from the unpolished test slabs for all 10 overlay products evaluated in this study. Surface texture and friction measurements were taken at the end of the following wheel passes; 0k, 1.5k, 4.5k, 15k, 30k, 60k, 150k, 225k and 300k. The complete dataset for each test product is given in Appendix B, and presented here in a graphical format. Figure 6 to 7 show the trends in MPD, DF_{60} and IFI for the HFST overlays tested at 46°C.

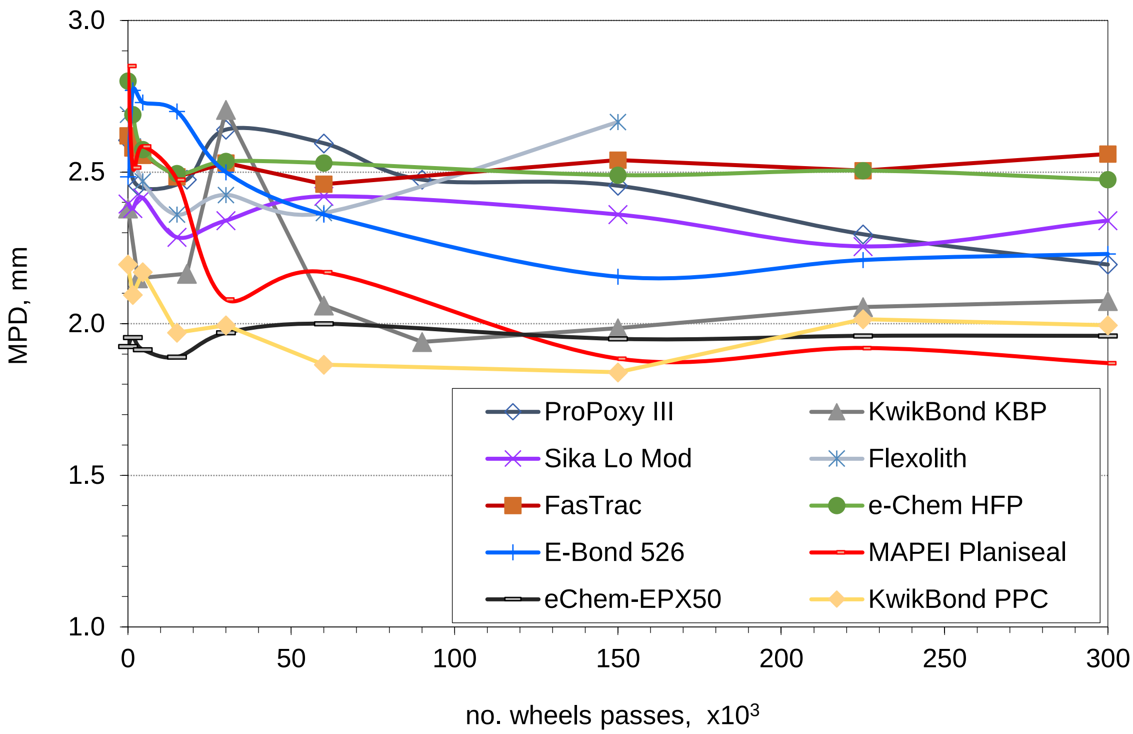

Figure 6 Changes in MPD with increasing wheel passes

ASTM E1960 specifies the range of profile depths and friction values for “normal”, untreated pavements. For MPD obtained from CTM measurements, 0.25 < MPD < 1.5 mm is recommended. For DF_{20} obtained from DFT measurements, the recommended range is 0.30 < DF_{20} < 0.90. Using these limits, the range of IFI or F60 may be calculated to yield a span from 0.15 < IFI < 0.58. Since these relationships were developed for untreated pavements, they are not applicable to HFST surfaces. However, it may be worthwhile to note that by their very nature, these high-friction surfaces satisfy the lower limit of recommended coefficient of friction value.

In general, MPD values tend to stabilize with increasing number of wheel passes. There were two notable exceptions, as can be seen in Figure 6. Testing of Flexolith was stopped at the end of 150k due to excessive wear of the aggregate leading to exposure of underlying HMA base, in a couple of spots along the wheel track. This may be indicative of poor bond between this product and HMA at the elevated test temperature. ProPoxy-III overlay showed a sharp decrease in texture due to loss of aggregate beyond the 150k mark, although no exposed base HMA was visible in this case. It is feasible that with more polishing before 300k, the degradation would increase and the base HMA would eventually be exposed. Among the remaining 8 products, FasTrac and e-Chem HFP maintained high MPD all through the testing phase, with Planiseal having the lowest value. In most cases, wearing off of aggregate particle due to polishing appears to have stabilized beyond the 150k point.

Examination of the DF_{60} data presented in Figure 7 Changes in coefficient of friction at 60 kph with increasing wheel passesFigure 7 show the readings stabilize with increasing wheel passes in most cases, except for Flexolith and Planiseal. As mentioned earlier, testing of Flexolith was stopped early when the HMA layer was exposed. Its terminal friction value was reasonably good, but for its poor bonding ability with the HMA surface. Planiseal overlay, however, showed rapid loss of friction early on and fell below 0.20 by 60k wheel passes. The terminal friction coefficients of the remaining products were grouped between 0.5 and 0.6. Sika Lo Mod had the highest friction coefficient, while ProPoxy-III overlay had the lowest friction coefficient; recall that the MPD of this product started to drop after 150k. In general, eChem EPX50 exhibited lower surface friction and lower surface texture.

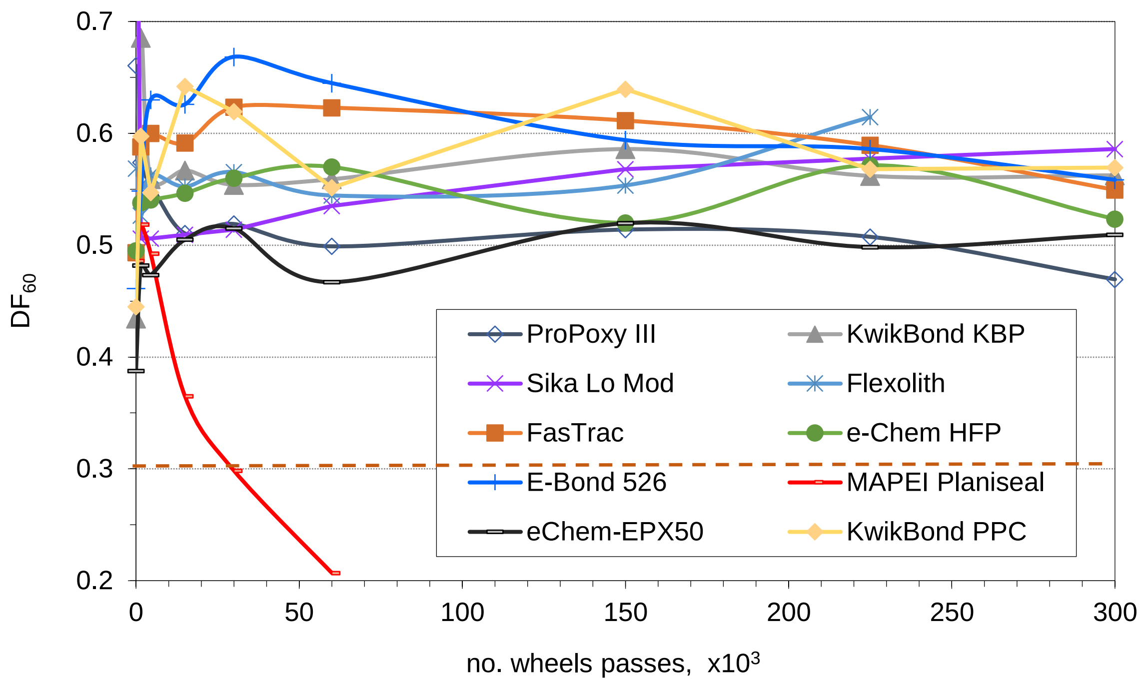

Figure 7 Changes in coefficient of friction at 60 kph with increasing wheel passes

The CTM and DFT data was used to calculate IFI using the equation giving in section 2.5.3. These trends were plotted in Figure 8. The IFI values were tightly grouped and fell in a narrow band between 0.4 and 0.5 initially, and dropped slightly to 0.35 to 0.45 at the end of 300k wheel passes. Based on the data presented in these three plots, it may be summarized that most of the products tested performed well, except for Planiseal and Flexolith. However, these tests do not appear to differentiate between good performers and worst performers and cannot be used to rank or delineate their performance in the field.

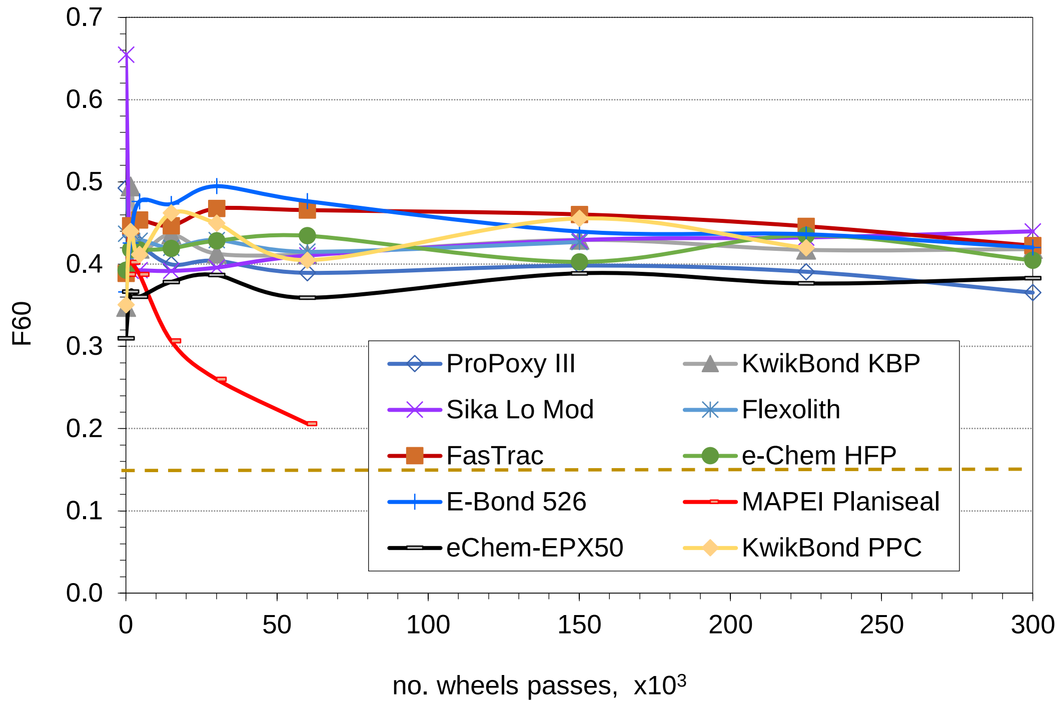

Figure 8 Changes in IFI with increasing wheel passes

3.4 Correlations between material properties and failure tests

It was found that there was a widespread range in the thermal and mechanical properties of the HFST resins: ranges of 200-fold for modulus, 10-fold for UTS, 3-fold strain to failure, 2-fold for HDT and CTE, and glass transition temperatures ranging from ~7°Cto ~30°C. With such a large ranges of properties, considering that thermal stresses scale with CTE and modulus, and are >10x different between materials and that field use will routinely subject some materials to use both above and below the glass transition, it is highly likely that they are playing a role in failure of HFST resins in the field. In an attempt to correlate these properties to failure, HFST was coated onto asphalt samples and thermally cycled. However, none failed after many cycles. In an attempt to weaken the interface and replicate coating on aged roads, thermal aging as well as UV-based aging were performed, with still no HFST failure. As a control, non-HFST PE resin, which is much stiffer, was used, which did crack. This showed that the experiment as performed could work, but currently does not have the requisite sensitivity to material properties to distinguish between the HFST resins tested (i.e., they all had material properties in a range to prevent failure). This is likely due to the relatively small size of the specimens (6” x 6” for aged, 15” x 15” for unaged) limiting thermal stresses at the temperatures studied. A key result of this work is that we have identified that to improve HFST resins and understand their failure, it is necessary to develop a standard laboratory test capable of failing HFST as it does in the field that is capable of distinguishing between resins. This will likely necessitate using much larger slabs in combination with aging asphalt samples (either field or artificially) and possibly aged HFST coatings (as changes may be due to thermophysical changes in the HFST). Without this, improvement in HFST is likely to be slow.

3.5 Correlations between material properties and slab polishing data

At 300,000 wheel passes, due to an overall general lack of differences between materials for IFI, with all passing minimum requirements and the majority coming in at 0.42, there are few trends that could be discerned. However, ignoring Planiseal due to the aforementioned issue, the lowest values of 0.37 and 0.38 were obtained by ProPoxy-III and E-chem HFP, respectively. They were generally on the higher end of modulus for the materials, with ProPoxy-III at 834 MPa tensile and 647 MPa compressive and E-chem HFP at 385 MPa tensile and 111 MPa compressive against an average/median of 252 MPa/195 MPa tensile and 194 MPa/141 MPa compressive. However, while ProPoxy-III was the highest modulus tested, E-chem HFP was third, but the second highest tensile modulus, Flexolith had the second highest IFI at 0.43. Overall, relatively flat non-correlative plots were obtained. Mean profile depth (MPD) similarly had very little correlation when plotted versus material properties. All graphs had a correlation value (R^2) of 0.27 or less and no discernable trend. Example graphs are shown below in Figure 9.

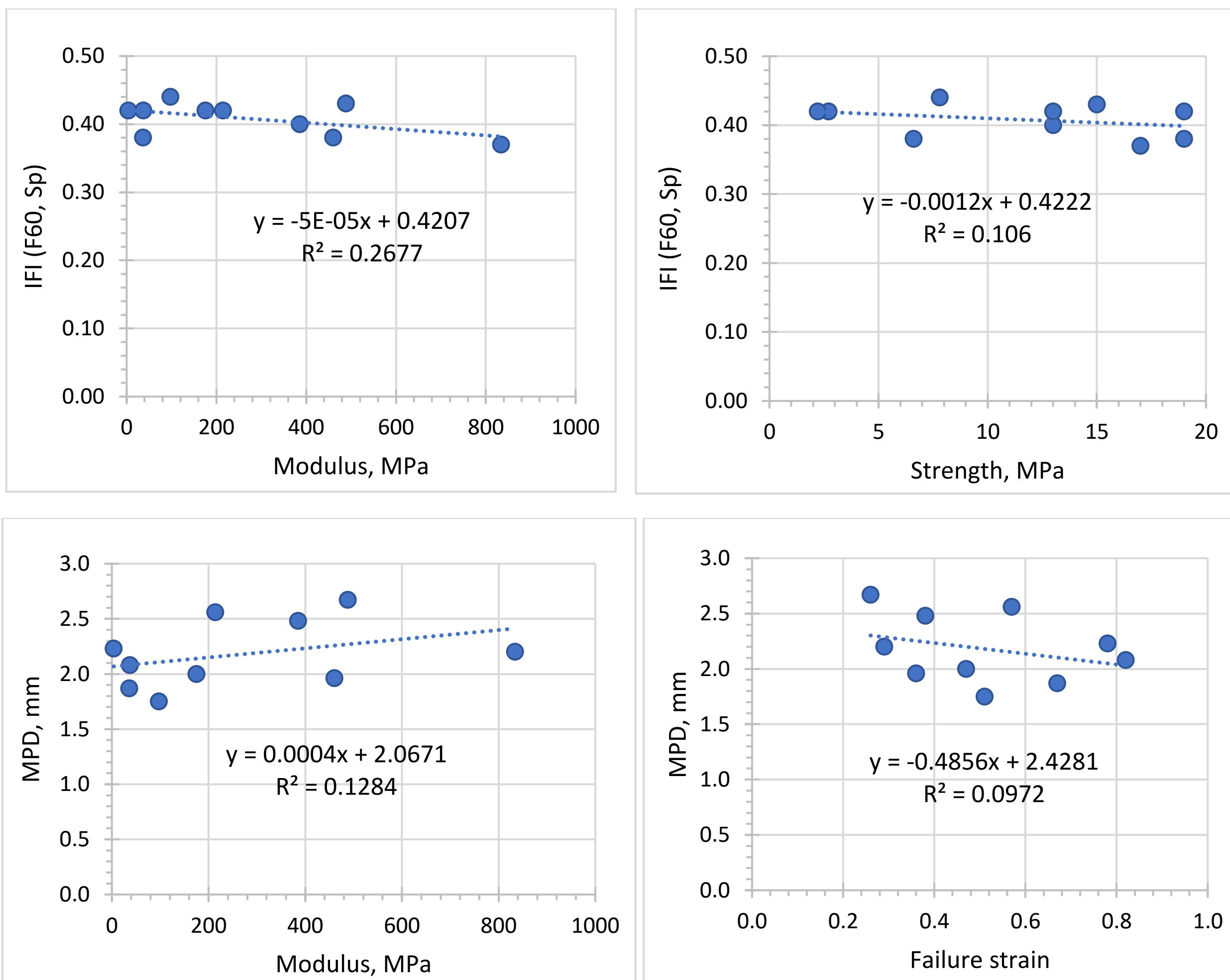

Figure 9 Graphs of IFI vs. modulus (upper left), IFI vs. strength (upper right), MPD vs. modulus (lower left) and MPD vs. failure strain (lower right)

However, there may be a weak correlation with modulus with higher coefficient of friction at 60 kph (DF_{60}) being correlated with lower modulus values (inverse correlation), although the correlation value (R^2) (0.81) indicates an overall flatness of the trend indicating a "weak" correlation, but one that is relatively statistically significant. Interestingly, as stated above, No significant correlation was found between IFI and modulus, although this is probably due to the spread in MPD values and increased statistical spread. DF_{60} versus tensile modulus is shown in Figure 10. No other trend was found, other than compressive modulus, which is highly correlated to tensile modulus. The dependence upon modulus is odd as in adhesion, low modulus is typically correlated with weak bonding, which would lead to aggregate loss. However, it may be that the material also smooths out significantly more or undergoes brittle or fatigue failure at high cycle rates. Regardless, the correlation is weak so may not be real and the differences small.

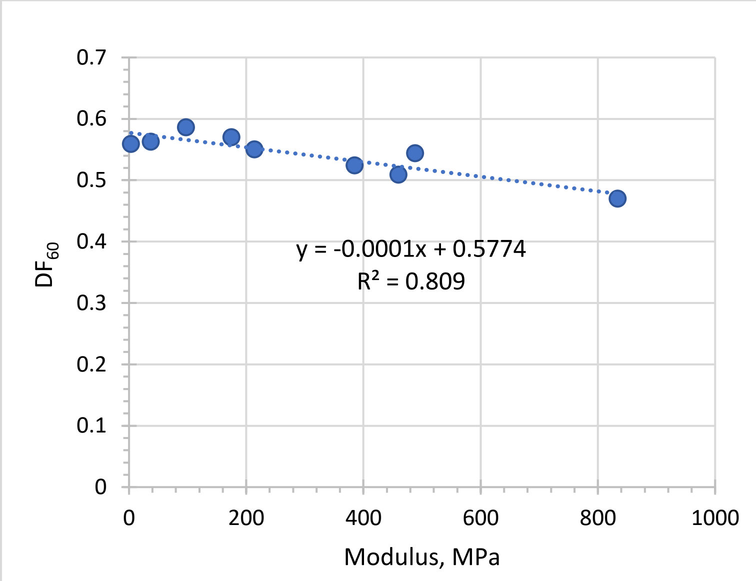

Figure 10 Correlation between DF_{60} and modulus

One factor affecting the DF_{60} versus modulus correlation is that moduli were determined at room temperature while wheel polishing was performed at higher temperature. Moduli likely do not change at similar rates for these materials. As example, Planiseal decayed rapidly in DF_{60} as the number of polishing cycles rose. While this may be improper application/formulation, this material also has a Heat Deflection Temperature (HDT) of 34°C, by far the lowest of the material tested and the only one below the testing temperature. HDT measures the temperature of a polymeric material to deform under a (specified) load. In most practical situations, this is a better value to utilize than glass transition temperature (T_g), although they are related. HDT is why a Styrofoam coffee cup "bows" in with hot coffee even though the material is below its T_g. As the wheel is acting on the material above the HDT, it will be significantly softer than the modulus indicates and will likely lose aggregate and smooth out much faster, leading to low DF_{60} values. Figure 11 shows the plots of DF_{60}, MPD and IFI as a function of HDT. No strong correlations were observed between these properties.

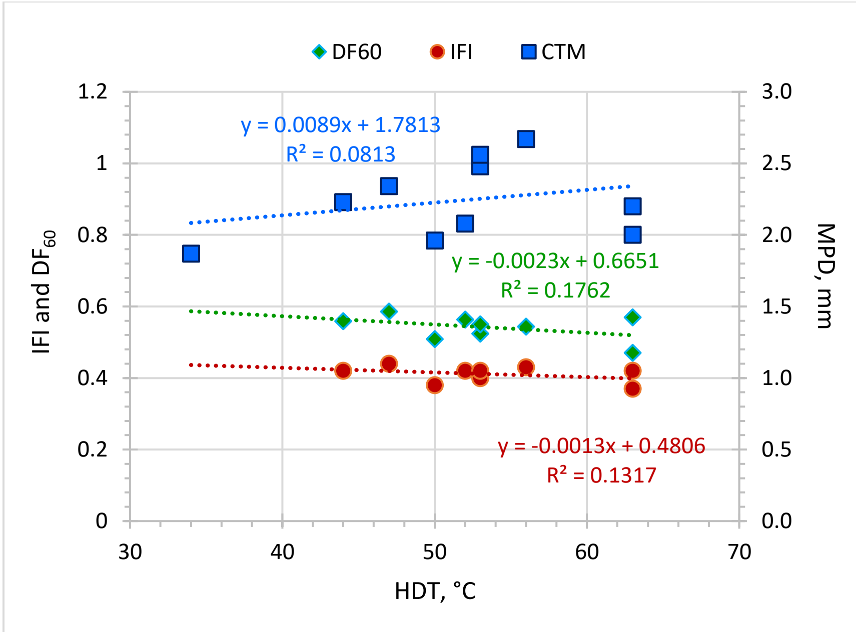

Figure 11 Correlation between DF_{60}, MPD and IFI and HDT

Another interesting observation, is that Flexolith wore away faster than other materials and the surface was exposed after 300,000 cycles. As it is only one specimen, little can be gleaned as to why, although it is noted that Flexolith had relatively high modulus (2nd highest), and was the most brittle material with the lowest strain-at-break of only 0.26. This may play a role, although ProPoxy-III was higher in modulus and similar in strain tolerance at 0.29, but did not wear through.

There were no correlations that could be found at with data obtained at other wheel passes numbers, other than the terminal readings taken at 300k wheel passes.

CHAPTER 4 – CONCLUSION AND SUGGESTED RESEARCH

4.1 Conclusions/Lessons learnt

We conclude that due to the large differences in materials properties in HFST resins that are relevant to thermal stresses, that it is likely that there are performance differences between them. However, these differences could not be ascertained due to limitations in current laboratory test methods. Current thermal cycling failure tests do not have sufficient resolution to discriminate between HFST resins, but can between HFST and higher modulus PE resins.

We conclude that lower modulus HFST resins may be superior in wheel polishing experiments as it may lead to higher DFT results. However, overall, a relatively small difference is noted.

We conclude that there may be an importance of heat deflection temperature (HDT) in terms of wheel polishing as DFT decays rapidly if above HDT.

Thus a low modulus, but high HDT may be optimal.

4.2 Suggested future research

Our principle suggestion and result of this research is that before significant resources are devoted by DOTs to improving HFST, a standard laboratory test for HFST thermal cycling failure be developed that replicates field-level observations. Without this, it is doubtful significant progress will be made.

It is also suggested that the influence of HDT on usage temperature be investigated as it is a more practical value than simple T_g in thermoset resins. This may be a simple method to screen for resins in hot climates.

Lastly, based on DFT and modulus we suggest prioritizing Kwikbond KBP Epoxy LM and Sikadur®-22 Lo-Mod FS for testing as these performed slightly better in DFT after 300,000 cycles and were in the highest group for IFI after 300,000 cycles. Both have relatively low modulus and have reasonably high HDT and strain to failure. As to which to prioritize, we must note that Sika started both DFT and IFI low and increased over time having started to plateau only after 300,000 cycles, while Kwikbond LM was relatively constant throughout the test, although both ended at similar values. Thus, we suggest the Kwikbond KBP LM simply due to the higher HDT and constant DFT and IFI, although Sika as an alternate is a fine choice as well as they are very similar.

APPENDIX

A1. Coefficient of wet friction, μ, at 60 kph (DF60) from DFT testing

Product ↓ / Wheel-passes →	**Initial**	**500**	**1500**	**5k**	**300 k**
Flexolith (Euclid Chemical)	0.569	0.527	0.563	0.553	0.554 @150k (exposed)
Pro-Poxy Type III DOT (Unitex)	0.661	0.574	0.555	0.511	0.470
KBP Epoxy LM (KwikBond)	0.435	0.686	0.559	0.567	0.563
PPC™ HFST (KwikBond)	0.445	0.598	0.547	0.624	0.570
Sikadur® -22 Lo Mod FS (Sika)	0.934	0.506	0.506	0.510	0.586
E-Bond 526 (Transpo Industries)	0.462	0.549	0.630	0.626	0.559
HFP 1:1 (E-Chem)	0.495	0.538	0.541	0.547	0.524
CE330 Epoxy Binder (FasTrac)	0.494	0.588	0.600	0.592	0.550
Planiseal (MAPEI)	0.486	0.519	0.493	0.365	
e-Chem EPX50	0.388	0.482	0.474	0.505	0.509

A2. Mean profile depth (MPD, in mm) from CTM testing

Product ↓ / Wheel-passes →	**Initial**	**500**	**1500**	**5k**	**300 k**
Flexolith (Euclid Chemical)	2.69	2.59	2.47	2.36	2.67 @ 150k (exposed)
Pro-Poxy Type III DOT (Unitex)	2.61	2.46	2.48	2.64	2.20
KBP Epoxy LM (KwikBond)	2.38	2.15	2.17	2.71	2.08
PPC™ HFST (KwikBond)	2.20	2.10	2.17	1.97	2.00
Sikadur® -22 Lo Mod FS (Sika)	2.40	2.38	2.42	2.29	2.34
E-Bond 526 (Transpo Industries)	2.49	2.77	2.73	2.70	2.23
HFP 1:1 (E-Chem)	2.80	2.69	2.58	2.50	2.48
CE330 Epoxy Binder (FasTrac)	2.62	2.58	2.56	2.49	2.56
Planiseal (MAPEI)	2.85	2.52	2.59	2.48	1.87
e-Chem EPX50	1.93	1.96	1.92	1.89	1.96

A3. Computed International Friction Index, IFI (F60, S_p)

Product ↓ / Wheel-passes →	**Initial**	**500**	**1500**	**5k**	**300 k**
Flexolith (Euclid Chemical)	0.44	0.41	0.43	0.42	0.43 @ 150k (exposed)
Pro-Poxy Type III DOT (Unitex)	0.49	0.44	0.42	0.40	0.37
KBP Epoxy LM (KwikBond)	0.35	0.49	0.42	0.44	0.42
PPC™ HFST (KwikBond)	0.35	0.44	0.41	0.46	0.42
Sikadur® -22 Lo Mod FS (Sika)	0.65	0.39	0.39	0.39	0.44
E-Bond 526 (Transpo Industries)	0.37	0.43	0.48	0.47	0.42
HFP 1:1 (E-Chem)	0.39	0.42	0.42	0.42	0.40
CE330 Epoxy Binder (FasTrac)	0.39	0.45	0.45	0.45	0.42
Planiseal (MAPEI)	0.39	0.40	0.39	0.31	
e-Chem EPX50	0.31	0.37	0.36	0.38	0.38

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PRODUCT DATA SHEET: Hybrid Composite Synthetic Concrete (HCSC)

Hybrid Composite Synthetic Concrete (HCSC) is structural, basalt fiber reinforced polymer concrete material with hybrid co-polymer resin binder, graded aggregates and pre-blended basalt fibers with a High Molecular Weight Methacrylate (HMWM) primer that develops true composite action at the bond line of abrasive blasted concrete and steel substrates. HCSC is designed for structural deck elements like closure pours, shear keyways, link slabs and structural overlays for bridge deck strengthening.

SPECIAL FEATURES

- 4-hour traffic return from 40-100 °F
- 6 d_b rebar development length
- Exceptional adhesion at the bond line eliminates slip for true composite action
- Failure in the concrete substrate
- Extremely abrasion resistant

HCSC Composite Properties		
Compressive Strength	ASTM C39	10,000 psi
Tensile Strength	ASTM C1583	1,500 psi
Flexural Strength	ASTM C78	2,500 psi
Modulus of Elasticity	ASTM C469	2,500 ksi
Coefficient of Thermal Expansion	ASTM T336	<11 x 10^{-6} in/in/°F
Abrasion Resistance	ASTM C944	< 0.03% weight loss
Rebar Development Length	NY 701-14E Pull-out test for UHPC	6 d_b, rebar yielded
Permeability	ASTM C1202	0 coulombs
28-day Linear Shrinkage	ASTM C157 (4-hr initial)	< 500 με

APPLICATION

SURFACE PREPARATION:

HCSC is applied to concrete or steel substrates that are sound, strong, clean, visibly dry, and abrasively blasted.

Identify unsound concrete by chain-drag or hammer sounding. Remove unsound areas to sound concrete. Rebar exposure is not required for composite action between HCSC and substrate material.

Complete removal of existing overlay materials to below the existing bond line is recommended. Existing concrete overlays that are both structurally sound and also placed below the top mat of rebar may remain in place.

Abrasive blasting is required for all substrate surfaces, including new CIP concrete, new precast concrete, existing concrete, milled concrete, diamond ground concrete and all steel. Abrasively clean concrete substrate surfaces by shot blasting to remove all visible contaminants and excess cement paste, yield an open pore structure and expose some aggregate within the concrete. Sand blasting is acceptable for patches and headers as well as vertical surfaces and boundaries of overlay areas inaccessible to the shot blasting machine.

Abrasively clean steel surfaces by shot or sand blasting to remove all visible contaminants and flash rust leaving a clean steel finish.

PATCHING:

Complete substrate patches with HCSC for optimal performance and material compatibility with both substrate deck and HCSC overlay. A minimum rebound hammer reading of 4,000 psi is required prior to overlay when placed separately.

Patches made with most cementitious materials must reach both 80% expected ultimate strength AND a minimum of 3-days open air cure after wet-curing prior to overlay.

UHPC closure pours must reach 14 ksi compressive strength prior to HCSC overlay. It is recommended that UHPC surface is ground to remove air pockets, laitance and weak cement paste prior to surface preparation for overlay by abrasive blasting.

Avoid placing HCSC on patches with high expected shrinkage. Do not use patching materials with CTE >15x10^{-6} in/in/°F.

SUGGESTED FORMING:

Suggested materials to form expansion joint gaps include rigid foam board wrapped in polyethene sheeting or closed cell backer rod. Closed cell spray foam used for small gaps and holes must form a hard shell prior to HCSC installation. Do not use open cell spray foam.

Overlays placed with a vibratory screed can be formed with wood strips or steel set to finished grade.

Line bottom formwork for full depth HCSC elements such as patches, joints and closure pours with polyethylene sheeting.

TOOLS & EQUIPMENT:
KBP 204 ProPrime is mixed in buckets and placed with rollers, brooms and brushes.

HCSC is mixed in batches using ≥ 9 CF paddle or drum mixers or continuously using volumetric mixing trucks specifically designed for production of HCSC or PPC 1121 material. Mix in single, double or partial batches as needed. A single batch is 2.5 CF.

HCSC is placed to grade using a vibratory screed or automated slip form paver specifically designed for HCSC or PPC 1121. Do not use a roller screed. Finish with standard concrete finishing tools such as hand floats, bull floats and fresno trowels.

HMWM PRIMER INSTALLATION:
KBP ProPrime is a pre-promoted version of KBP 204 with the cobalt promotor pre-mixed into the HMWM resin prior to shipment. For applications that require delivery of un-promoted KBP 204 primer instead of KBP ProPrime, follow KBP 204 mixing directions.

KBP ProPrime Components:
- ProPrime HMWM Resin
- Cumene Hydro Peroxide (CHP) Initiator (3 oz per gal of ProPrime)
- ZCure Accelerator (varies based on temperature 0 to 3oz/gal)

Ensure substrate temperature is within the specified range using an infrared temperature gun. Premix the entire container of KBP 204 ProPrime to ensure that contents are well mixed before portioning out material to be used. Combine up to 4 gal KBP ProPrime HMWM resin, CHP and ZCure in a clean, dry bucket and mix for 30 seconds with a drill mixer. Follow mix ratios given by KBP technical service representative for exact mix proportions.

Within 5 minutes of mixing, empty contents onto the substrate surface. Evenly spread primer to refusal using brooms or rollers and brushes. Reapply to dry areas and redistribute excess puddling as necessary leaving a deeply saturated substrate. Application rates range from 70-120 sf/gal depending on porosity and surface texture of the deck. Place HCSC within 15-120 minutes after priming.

HCSC MIXING:
HCSC Components:
- HCSC Polymer Resin Binder
- HCSC Aggregate Blend (with Basalt fibers)
- Methyl Ethyl Ketone Peroxide (MEKP) Initiator ZCure Accelerator

To mix a single 2.5 CF batch of HCSC, combine 4 gallons of HCSC Polymer Binder Resin, (7 to 15 oz) MEKP and (0 to 4 oz) ZCure in a clean, dry bucket and mix for 30 seconds with a drill mixer. Exact levels to be used are dependent on placement conditions, temperature, application, and dimensions. Follow KBP technical support guidance for specific mix design.

While clean mortar mixer is turning, add catalyzed HCSC Polymer Binder Resin and 6 each bags HCSC Aggregate blend with Basalt fibers. Mix for 1-2 minutes and until all aggregate appears wetted.

Dump catalyzed material into a wheelbarrow, buggy, or other transfer device. Immediately recharge mixer with proper volume of catalyzed HCSC Polymer Resin Binder and continue mixing.

Adjust catalyst levels as needed to account for changes in temperature, application type, environmental conditions, and proper strength gain requirements. Temperature and application timing impact working time and strength development of HCSC.

Continuous volumetric mixers specifically designed for mixing HCSC or PPC 1121 may also be used for high output applications. Volumetric mixers must be properly calibrated and equipped with appropriate resin/catalyst/accelerator pumping systems as well as computer tracking system capable of meeting specifications for output tracking and calibration.

FINISHING
Place HCSC mixture to grade using a vibratory screed, a slip form paving machine, or standard hand finishing tools for smaller areas. Strike off and fill to finished grade using concrete finishing tools as needed. Properly finished HCSC should yield a well-compacted material and surface with a slight glossy sheen without excessive bleed resin. Immediately hand broadcast top sand leaving an evenly covered finished surface free of mirroring or glossing. If specified, texture by mechanical saw-cut grooving or diamond grinding a minimum of 48 hours after installation.

HCSC can be placed at temperatures between 40-100℉ with a 2-4 hour traffic return. Trial batches can be used to determine working time and set time based on anticipated application temperatures, conditions, and strength gain requirements.

CLEANUP
Clean tools, screed and mixer with acetone, or other suitable solvent prior to initial set. Cured material may have to be chipped off. Mixers in continuous operation do not need to be cleaned between batches.

STANDARD PACKAGING
- HCSC Binder Resin: 4 gal pail, 55 gal drum, 40,000 lb tanker
- Mix Aggregates: 50 lb bags, 2 ton super sacks
- Top Sand: 50 lb bags
- KBP 204 ProPrime: 4 gal pails, 50 gal drums, 250 gal totes
- MEKP & CHP: 12 oz, 1 gal bottles
- Z Cure: 12 oz, 1 gal bottles and 5 gal pails

SAFETY & STORAGE
Follow all OSHA, and other guidelines as well as all applicable fire codes. Refer to SDS for storage, handling, and use. Gloves, eye protection, and other protective clothing should be worn while working with HCSC and KBP ProPrime. Respirator with Organic Vapor cartridges may be desired while working with HCSC Binder Resin. Dust protection must be worn while working with neat aggregates. If liquid components come in direct contact with skin, wash off with soap and water. If any component gets in eyes, flush immediately with eye wash. If customer requests to have Cobalt promoter supplied separately from HMWM resin, extra care must be taken to avoid contact between Cobalt promoter and peroxide catalysts as a violent exothermic reaction will occur.

Store all components in a cool, dry location out of direct sunlight and in their original containers. Always protect components from moisture. Minimum shelf life is 12 months when properly stored.

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KWIK BOND POLYMERS

BRIDGE DECK & ROADWAY REHABILITATION SYSTEMS

PRODUCT DATA SHEET: PPC™-HFST

PRODUCT DESCRIPTION

PPC™- HFST is Kwik Bond Polymers' unique hybrid polymer-based resin binder system for High Friction Surface Treatments. This technology is designed specifically to wick into high friction aggregates and bond to various pavement substrates. PPC™-HFST is easily mixed and applied with serrated squeegees, or with current automated installation equipment. Because this hybrid polymer-based system gains strength so quickly, it can be applied rapidly and returned to traffic within a normal production shift. PPC™-HFST has the following performance advantages:

- PPC™-HFST is tough enough to meet the most stringent demands in the retention of durable aggregates through extreme thermal cycles and exposure to snow plows.
- PPC™-HFST has high strength characteristics in both compression and tensile properties.
- PPC™-HFST when properly used with Calcined Bauxite aggregate will maintain the high friction values required for High Friction Surface Treatment (HFST).
- PPC™-HFST hybrid polymer binder resin technology has a long history of performance (In use since 1983)
- PPC™-HFST when mixed and applied properly, can be returned to traffic safely within 2 hours at temperatures below 50˚ F (10˚C).
- PPC™-HFST has superior adhesion to Portland cement concrete and Asphalt pavements and has demonstrated superior UV stability relative to other polymer based systems.

PPC™-HFST is designed to provide exceptional adhesion to concrete and asphalt pavements while retaining aggregates under extreme, highly abrasive impact, and variable climatic conditions. The designed intent of the PPC™-HFST system is to improve coefficient of friction and reduce crashes in horizontal curves, ramps, roundabouts, steep grades and intersections. PPC™- HFST is also designed to work as a resin binder for colored glass and other aggregates used for bus and bike lane demarcation, or other safety demarcations.

PHYSICAL PROPERTIES - KBP PPC HFST	
Weight per gallon	9.5 lbs
Viscosity	1000-2000 cps
Tensile Strength (ASTM D-638)	2650-3900 psi
Tensile Elongation at Break (ASTM D-638)	>30% min
Meets California Air Resource Board Regulations	

TYPICAL APPLICATIONS

As a polymer resin binder for use as a part of a High Friction Surface Treatment (HFST) designed to reduce roadway departure crashes in areas where friction demand is higher than the roadway surface can provide. PPC™ -HFST is also used for colored lane demarcation.

- High Friction Surface Treatment for Horizontal Curves and Intersections, Ramps, Roundabouts and Steep Grades
- Colored Bus Lanes, Bike Lanes, Toll Lanes and other forms of Lane Demarcation
- Safety Crossings and other Pedestrian Demarcation

Aggregates must be cleaned, kiln- dried with a maximum moisture content of 1.2%. Calcined Bauxite, or other approved aggregates.

SURFACE PREPARATION

Surface Prep:
Prior to any installation, it is important to ensure that the pavement condition has been properly assessed for this application. Asphalt pavements shall be free of any dirt, dust, or debris that could potentially inhibit the bond of the polymer HFST system. Remove any marking paints and striping by grinding, milling or sand-blasting that will be covered by the HFST system to insure good adhesion. Follow with a high pressure air blast of the area with clean, oil-free, compressed air until all contaminants are removed.
Portland Cement Concrete substrates: Shot-blasting is required to remove surface contaminants from Portland cement concrete prior to applying polymer surface treatments. The final surface should be clean, free of oils, dirt, curing compounds, and other materials that may affect the adhesion of the polymer system. Follow by a high pressure air blast of the area with clean, oil-free, compressed air until all surface contaminants are removed and the clean, open pore structure of the concrete is clearly visible.

Patching Steps (if required for PCC): Saw cut (dry blade) a minimum ¾" depth shoulder around the edge of the prepared area

1. Chip out the delaminated, unsound PCC areas
2. Blow off dust from saw cutting operations and chipping operations
3. Patch unsound areas with PPC™ "EASY" Patch
4. Fill the prepared area to rough grade; strike-off to final grade

HFST APPLICATION

PPC™-HFST Hand Mixing: Mix at a ratio of 4 gallons of PPC™-HFST Binder Resin with 7-12 fluid ounces of MEKP-DDM9. When installing in temperatures below 70˚F(21°C), store, or pre-condition the PPC™-HFST Binder Resin to 70°F(21˚C) prior to installation. For faster strength gain requirements, see chart below for Z-cure recommendations. When mixing by hand use a drill motor mixer and a JIFFY® mixer blade, or similar bladed mixer for mixing to minimize the entrainment of air. Mix for 30 seconds. Dispense the material on the work area. Apply evenly using the proper serrated squeegees at a rate of 25-32 sf. /gal., or 50-65 wet mils in thickness. Without delay and prior to the gelling of the resin binder, evenly broadcast the graded aggregate until refusal at a minimum rate of 11-15 lbs. per square yard.

PPC™-HFST Automated Equipment: A pump system and automated application equipment must be designed in accordance to the manufacturer's recommendations. This automated equipment shall be designed specifically to mix, spread and proportion the KPB PPC™ HFST system.

When the final coat has achieved sufficient strength to hold the aggregate, sweep or vacuum up any excess remaining on the surface. Traffic can safely be returned within 45 minutes to an hour and half after final sweeping. It is recommended to sweep again after 24 hours to remove any additional loose aggregate.

A minimum gel time of 25 minutes is required for maximum aggregate adhesion and bond strength.

Mix Guidance for KBP PPC HFST to Achieve 30 minute Thin Film Gel Time				
Substrate Temperature		Zcure Addition Level		
Fahrenheit	Celsius	Zcure (%Wt)	Zcure (oz/gal)	Zcure (ml/gal)
41	5	2	2.8	83
50	10	1.25	1.7	50
60	15	0.75	1	30
68	20	0.4	0.6	18
77	25	0.175	0.25	7
86	30	0.15	0.2	6
95	35	0.075	0.1	3
104	40	0.05	0.03	1
113	45	0	0	0

STANDARD PACKAGING

PPC™-HFST Components

- PPC™ HFST Binder resin-available in 4 gallon, 55 gallon drums, 250 gallon totes, tankers
- MEKP-DDM9- available in 1 gallon containers
- Z Cure- available in pre-packaged bottles, 1 gal cans, 5 gal pails

PPC™ "EASY" Patch

- .43 cf Pre-Packaged Patch Kit
- Larger kits available upon request

STORAGE

Aggregates, PPC™-HFST Resin, and catalyst components should be stored in a cool, dry location and in their original containers. The shelf life for these materials, properly stored at temperatures 80˚F(27˚C) and below, greater than 12 months. At elevated temperature, storage shelf life is reduced. Store all bagged aggregates in a clean, dry location away from moisture.

SAFETY

PPC™-HFST and PPC™ Patch systems consist of polymer materials that have been used safely for over 20 years. However, there are certain safety issues that need to be readily understood. PPC™-HFST Resin and "EASY" patch Binder Resin are FLAMMABLE! Safety equipment and protective gear should be available for those unexpected emergency situations. Emergency equipment includes clean water for accidental contact in the eyes, fire extinguishers, and emergency center addresses, phone numbers, protective clothing, eye protection, and chemical resistant gloves. Organic vapor respirators are not normally required. For individuals highly sensitive to chemical vapors, organic vapor respirators are suggested.

Follow the mixing instructions outlined in this product data sheet and safety will be maintained.

KWIK BOND POLYMERS
BRIDGE DECK & ROADWAY REHABILITATION SYSTEMS

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PRODUCT DATA SHEET: KBP Epoxy LM

PRODUCT DESCRIPTION

KBP Epoxy LM is Kwik Bond Polymer's low modulus, epoxy resin binder system designed primarily for use as a protective wearing course for concrete bridge decks and a binder system for High Friction Surface Treatments (HFST). KBP Epoxy LM is easily mixed with a drill motor mixer and applied with serrated squeegees, or with current automated installation equipment. KBP Epoxy LM has the following performance advantages:

Bridges:

- Meets or exceeds most State DOT standards for Thin Polymer Bridge Deck Overlay.
- Is designed to provide a durable wearing course that will extend the life of a steel-reinforced, concrete bridge deck.
- Minimize the intrusion of moisture, de-icing chemicals, carbonation and other potential sources of premature degradation of concrete bridge decks.
- KBP Epoxy LM is best suited as part of a bridge deck preservation strategy for increased life expectancy.

High Friction Surface Treatment (HFST):

- Superior adhesion to asphalt and concrete pavements as specified for High Friction Surface Treatments (HFST)
- Bonds well with durable high friction aggregates
- Designed to work with rigid and flexible pavement surfaces

*TYPICAL PHYSICAL PROPERTIES - KBP Epoxy LM	
Mix Ratio	1:1
Weight per gallon	9-9.2 lbs.
Viscosity	1400-1800 cps
Tensile Strength (ASTM D-638)	2800- 3,200 psi
Tensile Elongation (ASTM D-638)	50-60%
Compressive Strength (ASTM C-579)	>5000psi
Durometer Hardness (ASTM D-2240)	70
Bond Strength (ASTM C-1583)	>250psi
Thermal Compatibility (ASTM C884)	Pass
Chloride Ion Permeability (AASHTO T277)	0 coulombs
Shelf Life	2 years
* material property values noted are typical and subject to slight variation	

CURE CHART - KBP Epoxy LM		
Temperature (F)	**Sweep (Hours after placement)**	**Open to Traffic (Hours after placement)**
50	6	6
75	2	3.5
100	1.25	1.75

TYPICAL APPLICATIONS

- Thin-Polymer Bridge Deck Overlay
- High Friction Surface Treatment
- Pedestrian Bridges
- Sidewalks

Broadcast aggregates must be cleaned, washed, kiln- dried with a maximum moisture content of 1.2%. Follow the specifying agencies requirements for durability properties of aggregates that have been tested and approved for use, or recommended by the manufacturer.

SURFACE PREPARATION

Surface Prep:
Shot-blasting, or other approved mechanical methods are recommended to remove surface contaminants from Portland cement concrete decks prior to applying polymeric overlay systems. The final surface should be clean, free of oils, dirt, curing compounds, and other materials that may affect the adhesion of the polymer system. Unsound concrete areas should be located by using a chain-drag or hammer. The unsound areas must be removed and repaired until a sound concrete base is established. For asphalt pavement air-wash with oil-free, compressed air; a high pressure air compressor fitted with an oil trap and air lance is recommended. Remove all trapped dust, dirt and debris from the pavement surface. Pavement markings within the application area should be removed by grinding or other approved method. Remove any oil, grease, or other contaminants prior to installation.

Patching Steps (Concrete): Saw cut (dry blade) a minimum 3/8" depth shoulder around the edge of the prepared area

1. Chip out the delaminated, unsound PCC areas
2. Blow off dust from saw cutting operations and chipping operations
3. Patch unsound areas with PPC™ "EASY" Patch
4. Fill the prepared area to rough grade; strike-off to final grade

KBP Epoxy LM APPLICATION

Prior to use, pre-condition material to 65°-85°F (18°-29°C) as a best practice for mixing and proportioning. Pre-mix components (A) and (B) individually prior to mixing together. In conformance with many State agency specifications for the Thin-Polymer Overlay of bridge decks and High Friction Surface Treatment when the following steps are followed:

Bridge Deck Overlay Application:

KBP Epoxy LM Layer 1: Mix the KBP Epoxy LM resin binder at a 1:1 ratio of component (A) to component (B). Use a drill motor with a "jiffy" style mixer and mix for a minimum of 3 minutes at 300-600 rpm's. Keep the mixer below the surface of the resin binder to minimize any entrainment of air during the mixing process. Pour material on prepared area. Spread material using a notched squeegee (or automated mixing equipment) at an approximate rate of 40ft^2/gal. (1m^2/L). As soon as possible and prior to gelling, broadcast the graded aggregate at a rate of approximately 10-12 lbs. per square yard, or until refusal. As soon as Layer 1 gains sufficient strength to retain the aggregate, the excess can be removed by power brooming and/or vacuuming.

KBP Epoxy LM Layer 2: For mixing follow the same mixing procedures as the first step. Spread the mixed material using a notched squeegee (or automated mixing equipment) at an approximate rate of at a coverage rate of 20ft^2/gal. (0.5 m^2/L). Broadcast aggregate at the rate of 14-15 lbs. per square yard. When the final coat has achieved sufficient strength to hold the aggregate, sweep or vacuum up any excess remaining on the surface. Traffic can typically be safely returned within 45 to 90 minutes after final sweeping.

High Friction Surface treatment Application:

KBP Epoxy LM: For hand mixing application, mix the KBP Epoxy LM epoxy resin binder at a 1:1 ratio of component (A) to component (B). Use a drill motor with a "jiffy" style mixer and mix for a minimum of 3 minutes at 300-600 rpm's. Keep the mixer below the surface of the resin binder to minimize and entrainment of air during the mixing process. Dispense all the mixed material on the work area; material left in the mixing vessel will gel faster than it will in a thin film. It is considered best practice to get the material on the pavement and broadcast the aggregate into the resin expediently. Apply evenly using the proper serrated squeegees at a rate of 25-32 sf. /gal., or 50-65 wet mils in thickness. Without delay and prior to the gelling of the resin binder, evenly broadcast the graded aggregate until refusal at a minimum rate of 11-15 lbs. per square yard. For automated or machine-applied applications, a pump system and automated application equipment must be calibrated and tested prior to installation. Testing and calibration are recommended to ensure proper coverage rates of the resin binder and aggregate. Apply materials at recommended coverage rates, or as specified by the governing agency.
Once the system has achieved sufficient strength to hold the aggregate, sweep or vacuum up any loose or remaining aggregate on the surface. Traffic can safely be returned within 45 to 90 minutes after final sweeping. It is recommended to sweep again after 24 hours to remove any additional loose aggregate.

STANDARD PACKAGING

KBP Epoxy LM Components

- KBP Epoxy LM Binder resin-available in 8 gallon kits and 110 gallon kits, 500 gallon kits and tankers.

PPC™ "EASY" Patch

- .43 cf Pre-Packaged Patch Kit
- Larger kits available upon request

STORAGE

Aggregates, KBP Epoxy LM Resin and hardener, PPC™ "EASY" Patch and catalyst components should be stored in a cool, dry location and in their original containers. Store all bagged aggregates in a clean, dry location away from moisture.

LIMITATIONS

New concrete must be a minimum of 28 days old. New asphalt pavements must be a minimum of 30 days old. Surface and ambient temperature must be a minimum of 50°F (10°C). Do not dilute KBP Epoxy LM with solvents, or other additives. Do not apply KBP Epoxy LM on unsound concrete, or incompatible patching materials. Contact a KBP technical representative with any concerns regarding the compatibility of underlying patching materials. Do not apply if moisture is present on the surface of the concrete at the time of application.

SAFETY

READ KBP Epoxy LM SDS PRIOR TO USING. Safety equipment and protective gear should be available for those unexpected emergency situations. Emergency equipment includes clean water for accidental contact in the eyes, and emergency center addresses, phone numbers, protective clothing, eye protection, and chemical resistant gloves. Organic vapor respirators are not normally required. For individuals highly sensitive to chemical vapors, organic vapor respirators are suggested.

Properly dispose any unused materials in accordance with the requirements of state, local and federal agencies.

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EPX50-OVERLAY FAST

FAST-SETTING, LOW-MODULUS, EPOXY URETHANE CO-POLYMER

DESCRIPTION
EPX50-OVERLAY FAST is a fast-setting, solvent-free, 100% solids, moisture-insensitive, low-modulus epoxy urethane co-polymer overlay resin.

APPLICATIONS
EPX50-OVERLAY FAST is designed primarily for bonding skid-resistant overlays to bridges, elevated slabs and PCCP, including High Friction Surface Treatments.

ADVANTAGES
- Epoxy urethane technology
- Excellent bond strength
- Moisture-insensitive
- Nonflammable
- Easy to mix - 1:1 ratio, color coded
- Retains tensile elongation at low temperatures
- No primer required
- Designed for automated pump
- Non-regulated, hazmat certification or placards not required for transport.

COMPLIANCES
- ASTM C881 (Type III. Grade 1. Class B & C.)
- AASHTO
- VOC compliant, 0 g/L
- Transportation within the United States is non-regulated by the DOT

PACKAGING
10-gallon unit
- Component A: (1) 5-gallon pail
- Component B: (1) 5-gallon pail

110-gallon unit
- Component A: (1) 55-gallon drum
- Component B: (1) 55-gallon drum

500-gallon unit
- Component A: (1) 250-gallon tote
- Component B: (1) 250-gallon tote

Appearance of Components: A - Blue, B - Yellow
Shelf Life: 2 years in original unopened container
Storage: 50°F to 95°F in dry and dark conditions
Temperature Considerations: IMPORTANT! Epoxy Resins are temperature sensitive and care should be taken to condition all components to between 65°F to 95°F for a minimum of 24 hrs. prior to mixing and placement. Temperatures colder than stated range increase viscosity of resins and inhibit mixing and flow of materials. Temperatures warmer than stated range decrease viscosity of resins, hasten the cure and reduce the working time. Mixing and curing at less than ideal temperatures, <60°F or >95°F, will require special considerations.

COVERAGE
Minimum Coverage Rates (3/8" overlay):

	Epoxy	Aggregate
Course 1	1 gallon/40 sq. ft.	10 lbs./sq. yd.
Course 2	1 gallon/20 sq. ft.	14 lbs./sq. yd.

CURE TIME
Use the table below to determine minimum cure times based on the temperature of the overlay materials and substrate.

	Average Temperature of Materials & Substrate (°F)							
Cure Temp	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Course 1	4 hrs	3.5 hrs	3 hrs	2.5 hrs	2 hrs	1.5 hrs	1 hr	1 hr
Course 2	6 hrs	5.5 hrs	5 hrs	4.5 hrs	3 hrs	2 hrs	1.5 hrs	1 hr

*Set times are merely averages. Site conditions will dictate actual cure response for sweeping of 1st & 2nd layers, as well as open to traffic time.

INSTALLATION
Bonding Skid-Resistant Overlays

Surface Preparation: Repair delamination, potholes and cracks with EP-Patch. Clean surface by shot-blasting to remove all contaminants, ICRI Level 5 minimum. Remove dust and debris by blowing off with oil-free compressed air.

Mixing: Mechanically mix Component A with Component B 1:1 by volume with Jiffy type mixer and low-speed variable drill at 300 rpm for a minimum of 3 minutes. Mix only the quantity that can be used within its gel time. BULK: For bulk mixing, a positive displacement pump, incorporating a static mixing wand and meter, is recommended.

Placement: Apply neat EPX50-OVERLAY FAST by 3/16" to 1/4" notched squeegee at the specified rate. Broadcast select aggregate to refusal. The aggregate should be angular grain or fractured Flint, Basalt or Bauxite having less than 0.2% moisture and free of dirt, clay, etc. The aggregate should have a minimum MOHS scale hardness of 7 unless otherwise approved. After initial cure of first course, remove excess aggregate. Do not open to traffic. Apply second course of epoxy and aggregate at specified rate. Remove excess aggregate. Allow to cure following the table herein. Open to traffic.

LIMITATIONS
- For professional use only
- Do not thin with solvents
- Minimum age of concrete must be 28 days before applying as an overlay, unless otherwise approved by E-Chem.
- Consult with E-Chem representative when used on exterior slabs on grade subject to freezing.
- Consult with E-Chem representative for project specific directions when using as Binder for Epoxy Mortar.
- EPX50-OVERLAY FAST is a vapor barrier after curing.
- Substrate temperatures must be 50°F and rising prior to installation; 50°F must be maintained minimum of 8 hours post installation or meet curing guidelines stated above for proper cure.

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www.e-chem.net

- Consult E-Chem representative when mixing or placing outside of the temperature recommendations listed.

CLEAN UP

EQUIPMENT: Uncured material can be removed with C-Clean100 or approved solvent. Cured material can only be removed mechanically.

MATERIAL: Collect with absorbent material. Flush area with water. Dispose of in accordance with local, state and federal disposal regulations.

CAUTIONS

READ SDS PRIOR TO USING PRODUCT!

- Component A: Irritant
- Component B: Irritant
- Product is a strong sensitizer. Use of safety goggles and chemical resistant gloves are recommended.
- Use in a well-ventilated area and avoid breathing vapors
- Use of a NIOSH/MSHA organic vapor respirator is recommended if ventilation is inadequate.
- Avoid skin contact

FIRST AID

EYE CONTACT: Flush immediately with water for at least 15 minutes. Contact physician immediately.

RESPIRATORY CONTACT: Remove person to fresh air.

SKIN CONTACT: Remove any contaminated clothing.

Remove epoxy immediately with a dry cloth or paper towel. Solvents should not be used as they carry the irritant into the skin. Wash skin thoroughly with soap and water.

IF INGESTED: Do not induce vomiting. If swallowed give water to drink. Seek medical treatment immediately.

GENERAL: Remove contaminated soaked clothing immediately. In the event of persistent symptoms receive medical treatment.

CURED EPOXY RESINS ARE INNOCUOUS.

WARRANTY

This product is warranted and guaranteed to be of good quality. Manufacturer, as its sole and exclusive liability hereunder, will replace material if proved defective. This warranty and guarantee are expressly in lieu of all others, express or implied, including any implied warranty of merchantability or fitness for a particular purpose and may not be extended by representatives or any persons, written sales information, or drawing in any manner whatsoever. While the manufacturer recommends uses for the product based on tests believed reliable, no warranties, express or implied, or guarantees can be given as to particular methods of use or application, nor can performance be warranted, expressly or impliedly, or guaranteed under special conditions. Distributors, salespersons or company representatives are not authorized to extend or vary any warranties or guarantees beyond those outlined herein, nor may the manufacturer's or seller's limitation of liability be waived or altered in any manner whatsoever.

E-Chem, LLC | 4102 El Rey Rd. SE | Albuquerque, NM 87105 | Phone: 505-217-2121 | Fax: 505-217-3721

www.e-chem.net

HFP 1:1

LOW-MODULUS, 1:1 RATIO, HIGH FRICTION SURFACE POLYMER

DESCRIPTION
HFP 1:1 is a moisture-insensitive, low-modulus, two-component high friction surface polymer.

APPLICATIONS
HFP 1:1 is designed for binding High Friction Surfacing Aggregates to asphalt and concrete on grade and elevated surfaces. Specific applications include:

- Asphalt roadways
- Bridge decks
- Roadway departure areas
- Horizontal curves
- Stop zones / Intersections
- High grade roadways
- Parking structures

ADVANTAGES
- Excellent bond strength
- Moisture insensitive to minimize contaminants
- High early strength
- High tensile elongation allows for non-linear expansion and contraction (move with the roadway)
- High tensile strength for superior retention of aggregates
- High range of flexibility
- Easy to mix - 1:1 ratio
- Fast set time for quick return to traffic
- Designed for automated pump or hand mix application
- Non-regulated, hazmat certification or placards not required for transport.

COMPLIANCES
- Tested to AASHTO PP79 standards [Title: *High Friction Surface Treatment for Asphalt and Concrete Pavements*]
- Transportation within the United States is non-regulated by the DOT

PACKAGING
10-gallon unit

- Component A: (1) 5-gallon pail
- Component B: (1) 5-gallon pail

110-gallon unit

- Component A: (1) 55-gallon drum
- Component B: (1) 55-gallon drum

500-gallon unit

- Component A: (1) 250-gallon tote
- Component B: (1) 250-gallon tote

Appearance of Components: A - Clear, B - Amber
Shelf Life: 2 years in original unopened container
Storage: 50°F to 95°F in dry and dark conditions
Temperature Considerations: IMPORTANT! Epoxy resins are temperature sensitive and care should be taken to condition all components to between 65°F to 95°F for a minimum of 24 hrs. prior to mixing and placement. Temperatures colder than stated range increase viscosity of resins and inhibit mixing and flow of materials. Temperatures warmer than stated range decrease viscosity of resins, hasten the cure and reduce the working time. Mixing and curing at less than ideal temperatures, <60°F or >95°F, will require special considerations.

COVERAGE
Minimum Coverage Rates:

	Epoxy	Aggregate
Asphalt Road	1 gallon/26-32 sq. ft.	14-20 lbs./sq. yd.

CURE TIME
Use the table below to determine minimum cure times based on the temperature of the materials and substrate.

	Average Temperature of Materials & Substrate (°F)					
Cure Temp	60-64	65-69	70-74	75-79	80-84	85+
Cure Time	3 hrs	2.5 hrs	2 hrs	1.5 hrs	1 hr	1 hr

*Set times are merely averages, site conditions will dictate actual cure response for sweeping as well as open to traffic time.

INSTALLATION
Surface Preparation: Remove all traffic control markings from roadway, if required. CONCRETE: For concrete surfaces, clean surface by shot-blasting to remove all contaminants. Concrete surface should be at a minimum ICRI CSP 5 for surface roughness. Remove dust and debris by blowing off with oil-free compressed air. Prefill cracks larger than 1/4” with premixed resin, add aggregate to larger voids. ASPHALT: For asphalt surfaces, clean pavement using mechanical sweepers and blow down with oil-free compressed air to remove all dirt, debris and surface contaminants. Prefill cracks larger than 1/4” with premixed resin, add aggregate to larger voids. Asphalt surfaces should be at least 45 days old prior to applying HFP 1:1.

Mixing: Mechanically mix Component A with Component B 1:1 by volume with Jiffy type mixer and low-speed variable drill at 300 rpm for a minimum of 3 minutes. Mix only the quantity that can be used within its gel time. BULK: For bulk mixing, a positive displacement pump, incorporating a static mixing wand and meter, is recommended.

Placement: Apply neat HFP 1:1 by pouring the material on the surface. Distribute material evenly with a ¼” notched squeegee or other approved placement method. Epoxy resin should be uniform in coverage, no puddles, sags or rippled areas. Broadcast select aggregate to properly cover liquid resin to refusal. The aggregate should be moisture free and free of dirt, clay, etc., and manufactured for HFST applications. After cure, remove excess aggregate prior to opening to traffic. Please consult with E-Chem for Project Specification Guidance.

LIMITATIONS
- For professional use only
- Do not thin with solvents
- Compressed air equipment must have an oil/air separator.
- Minimum age of concrete must be 28 days before applying as a HFST.
- HFP 1:1 is a vapor barrier after curing.

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LOW-MODULUS, 1:1 RATIO, HIGH FRICTION SURFACE POLYMER

- Substrate temperatures must be 50°F and rising prior to installation: 50°F minimum must be maintained during stated cure period.
- Consult E-Chem representative when mixing or placing outside of the temperature recommendations listed.

CLEAN UP

EQUIPMENT: Uncured material can be removed with C-Clean 100 or approved solvent. Cured material can only be removed mechanically.

MATERIAL: Collect with absorbent material. Flush area with water. Dispose of in accordance with local, state and federal disposal regulations.

CAUTIONS

READ SDS PRIOR TO USING PRODUCT!

- Component A: Irritant
- Component B: Irritant
- Product is a strong sensitizer. Use of safety goggles and chemical resistant gloves are recommended.
- Use in a well-ventilated area and avoid breathing vapors
- Use of a NIOSH/MSHA organic vapor respirator is recommended if ventilation is inadequate.
- Avoid skin contact

FIRST AID

EYE CONTACT: Flush immediately with water for at least 15 minutes. Contact physician immediately.

RESPIRATORY CONTACT: Remove person to fresh air.

SKIN CONTACT: Remove any contaminated clothing.

Remove epoxy immediately with a dry cloth or paper towel. Solvents should not be used as they carry the irritant into the skin. Wash skin thoroughly with soap and water.

IF INGESTED: Do not induce vomiting. If swallowed give water to drink. Seek medical treatment immediately.

GENERAL: Remove contaminated soaked clothing immediately. In the event of persistent symptoms receive medical treatment.

CURED EPOXY RESINS ARE INNOCUOUS.

WARRANTY

This product is warranted and guaranteed to be of good quality. Manufacturer, as its sole and exclusive liability hereunder, will replace material if proved defective. This warranty and guarantee are expressly in lieu of all others, express or implied, including any implied warranty of merchantability or fitness for a particular purpose and may not be extended by representatives or any persons, written sales information, or drawing in any manner whatsoever. While the manufacturer recommends uses for the product based on tests believed reliable, no warranties, express or implied, or guarantees can be given as to particular methods of use or application, nor can performance be warranted, expressly or impliedly, or guaranteed under special conditions. Distributors, salespersons or company representatives are not authorized to extend or vary any warranties or guarantees beyond those outlined herein, nor may the manufacturer's or seller's limitation of liability be waived or altered in any manner whatsoever.

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BUILDING TRUST

PRODUCT DATA SHEET

Sikadur®-22 Lo-Mod FS

LOW-MODULUS, FAST SETTING, MEDIUM-VISCOSITY, EPOXY RESIN BINDER

PRODUCT DESCRIPTION

Sikadur®-22 Lo-Mod FS is a 2-component, 100% solids, moisture-tolerant, fast setting epoxy resin binder. It conforms to the current ASTM C-881, Type III, Grade 1, Class C and AASHTO M-235 specifications.

USES

Sikadur®-22 Lo-Mod FS may only be used by experienced professionals.

Use neat as the binder resin for a skid-resistant broadcast overlay. Use also as the binder resin for epoxy mortar and concrete for patching and overlays.

CHARACTERISTICS / ADVANTAGES

- Fast Setting for quick turn around
- Meets 3 h/1000 psi requirement when mixed as an epoxy mortar
- Tolerant to moisture both before and after cure
- Convenient easy mix ratio A:B = 1:1 by volume
- Excellent strength development
- Leveling viscosity for easy, efficient application of a broadcast overlay
- Successfully used in HFST applications. Refer to local DOT specifications for product acceptance

PRODUCT INFORMATION

Chemical Base	Epoxy Resin
Packaging	4 gallon (15 L) units / 110 gallon (416 L) unit / 660 (2498 L) gallon totes. **Note: Part A of the Sikadur® 22 Lo-Mod, Sikadur®-22 Lo-Mod FS and Sikadur® 21 Lo-Mod LV is a universal component of these three products.**
Color	Clear to light amber
Shelf Life	24 months in original, unopened containers
Storage Conditions	Store dry at 40–95 °F (4–35 °C) Condition material at 65–85 °F (18–29 °C) before using.
Volatile organic compound (VOC) content	<20 g/L
Viscosity	Approximately 2,000 cps

TECHNICAL INFORMATION

Shore D Hardness	72	(ASTM D-2240) 73 °F (23 °C) 50 % R.H.

Compressive Strength (ASTM C-579)

	40 °F(4 °C)	73 °F (23 °C)	90 °F (32 °C)
3 hours	-	1750 psi	3600 psi
8 hours	2000 psi	4400 psi	6400 psi
1 day	4500 psi	6500 psi	8000 psi
3 days	5500 psi	7500 psi	8500 psi
7 days	8500 psi	8500 psi	9000 psi
14 days	9000 psi	9000 psi	9000 psi
28 days	9000 psi	9000 psi	9000 psi

Material cured and tested at the temperatures indicated and 50 % R.H.

Modulus of Elasticity in Compression (ASTM C-579) 73 °F (23 °C) 50 % R.H.

7 days	40,000 psi
28 days	40,000 psi

Tensile Strength (ASTM D-638) 73 °F (23 °C) 50 % R.H.

	Mortar 1:3	Neat
7 day	1200 psi	2650 psi

Elongation at Break (ASTM D-638) 73 °F (23 °C) 50 % R.H.

	Mortar 1:3	Neat
7 day	40 %	55 %

Tensile Adhesion Strength (ASTM C-1583; ACI 503R) 73 °F (23 °C) 50 % R.H.

	Mortar 1:3	Neat
1 day	-	> 550 psi (concrete failure)
7 days	-	> 570 psi (concrete failure)

Shear Strength (ASTM D-732) 73 °F (23 °C) 50 % R.H.

	Mortar 1:3	Neat
7 day	2600 psi	3430 psi

Thermal Compatibility	Pass	(ASTM C-884)

Abrasion Resistance (Taber Abrader) 73 °F (23 °C) 50 % R.H.

	Mortar 1:3	Neat
14 day, Weight loss, 1,000 cycles*	2.0 grams	0.030 grams

* (H-22 wheel; 1,000 gm weight for mortar/ C-17 wheel, 1,000 gm wt for neat)

Water Absorption (ASTM D-570) 73 °F (23 °C) 50 % R.H.

	Mortar 1:3	Neat
7 day (24 hour immersion)	-	< 0.20 %

Rapid Chloride Permeability	0 coulombs	(AASHTO T-277)

APPLICATION INFORMATION

Mixing Ratio

Component 'A': Component 'B' = 1:1 by volume.

Coverage

1 gal. yields 231 in^3

Mortar Binder - 1 gal. of mixed Sikadur® 22 Lo-Mod FS with the addition of 5

	gal. by loose volume of an oven dried sand, yields approximately 808 cu. in. of epoxy mortar
Pot Life	Approximately 15–20 minutes (60 gram mass; ASTM C-881)

Waiting / Recoat Times

	60–64 °F (16-18 °C)	**65–69 °F (19-21 °C)**	**70–74 °F (21-23 °C)**
Coat 1	4–4 ½ h	2 ½–3 h	2–2 ½ h
Coat 2	5 ½–6 h	4 ½–5 h	4 h
	75–79 °F (24-26 °C)	**80–84 °F (27-29 °C)**	**85+ °F (29+ °C)**
Coat 1	2 h	1.5 h	1 h
Coat 2	3 h	3 h	2 ½–3 h

Average Substrate and Material Temperature. These set times were determined under laboratory conditions, actual set times may vary based on on-site conditions

APPLICATION INSTRUCTIONS

SUBSTRATE PREPARATION

Surface must be clean and sound. It may be dry or damp, but free of standing water. Remove dust, laitance, grease, curing compounds, impregnations, waxes and any other contaminants.

Preparation Work: Concrete - Should be cleaned and prepared to achieve a laitance and contaminant free, open textured surface by blast cleaning or equivalent mechanical means.

Steel - Should be cleaned and prepared thoroughly by blast cleaning to white metal finish.

MIXING

Mixing Pre-mix each component. Proportion equal parts by volume of Component 'A' and 'B' into clean pail. Mix thoroughly for 3 min. with Sika paddle on low-speed (400–600 rpm) drill until uniformly blended. Mix only that quantity that can be used within pot life.

To prepare epoxy mortar - Slowly add 5 parts by loose volume of oven-dried sand to 1 part mixed resin.

APPLICATION METHOD / TOOLS

Broadcast Overlay - Prime the prepared substrate with Sikadur®-22 Lo-Mod FS. While primer is still tacky, spread mixed Sikadur®-22 Lo-Mod FS with a 3/16 in. (4.7 mm) notched squeegee. When material levels, broadcast the oven-dried aggregate slowly allowing it to settle in the epoxy binder.
Ultimately the broadcast aggregate should be applied to excess at a rate of 2 lb./ft^2 (0.9 kg/m^2) Remove excess broadcast aggregate after epoxy has set. Priming is an optional step in the broadcast overlay applications.

Epoxy Mortar - Prime prepared substrate with mixed Sikadur®-22 Lo-Mod FS. While primer is still tacky, apply epoxy mortar by trowel or vibrating screed. Finish with finishing trowel. Priming is mandatory when using the Sikadur®-22 Lo-Mod FS as an epoxy mortar.

LIMITATIONS

- Minimum substrate and ambient temperature 40 °F (4 °C).
- Minimum age of concrete before application is 21–28 days depending upon curing and drying conditions.
- For on grade, split-slab and unvented metal pan deck, please consult Sika Technical Service regarding moisture limitations.
- Maximum thickness 1/2 in. (13 mm) exterior exposed to thermal change.
- Do not dilute. Addition of solvents will prevent proper cure.
- Use oven-dried aggregates only.
- Material is a vapor barrier after cure.
- Not an aesthetic product. Color may alter due to variations in lighting and/or UV exposure.
- For HFST applications, system and application details are governed by local DOT & AASHTO specification.

BASIS OF PRODUCT DATA

Results may differ based upon statistical variations depending upon mixing methods and equipment, temperature, application methods, test methods, actual site conditions and curing conditions.

OTHER RESTRICTIONS

See Legal Disclaimer.

ENVIRONMENTAL, HEALTH AND SAFETY

For further information and advice regarding transportation, handling, storage and disposal of chemical products, user should refer to the actual Safety Data Sheets containing physical, environmental, toxicological and other safety related data. User must read the current actual Safety Data Sheets before using any products. In case of an emergency, call CHEMTREC at 1-800-424-9300, International 703-527-3887.

LEGAL DISCLAIMER

• KEEP CONTAINER TIGHTLY CLOSED
• KEEP OUT OF REACH OF CHILDREN
• NOT FOR INTERNAL CONSUMPTION
• FOR INDUSTRIAL USE ONLY
• FOR PROFESSIONAL USE ONLY

Prior to each use of any product of Sika Corporation, its subsidiaries or affiliates ("SIKA"), the user must always read and follow the warnings and instructions on the product's most current product label, Product Data Sheet and Safety Data Sheet which are available at usa.sika.com or by calling SIKA's Technical Service Department at 1-800-933-7452. Nothing contained in any SIKA literature or materials relieves the user of the obligation to read and follow the warnings and instructions for each SIKA product as set forth in the current product label, Product Data Sheet and Safety Data Sheet prior to use of the SIKA product.

SIKA warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Product Data Sheet if used as directed within the product's shelf life. User determines suitability of product for intended use and assumes all risks. User's and/or buyer's sole remedy shall be limited to the purchase price or replacement of this product exclusive of any labor costs. **NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. SIKA SHALL NOT BE RESPONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS.**

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FLEXOLITH

Low-Modulus Epoxy Coating and Broadcast Overlay System

EUCLID CHEMICAL

Description

FLEXOLITH is a two-component, 100% solids, low-modulus, moisture-insensitive epoxy binder with properties that make it suitable for use in applications where stress relief and resistance to mechanical and thermal movements are required. FLEXOLITH is formulated for low temperature applications, or where rapid cure is required. FLEXOLITH SUMMER GRADE is formulated for high temperature applications.

Primary Applications

- Parking decks
- Bridges
- Factories
- Warehouses
- Loading docks
- Nosing repair applications

Features/Benefits

- Rapid cure, minimizes down time
- Easy to use
- Can be used as a mortar or broadcast system

Technical Information

The following are typical values obtained under laboratory conditions. Expect reasonable variation under field conditions.

Mixing Ratio, by volume (Part A:B)...............................1:1

Mixed Viscosity, cp
ASTM D2556.................................700 to 2,500

Gel Time, ASTM C881, Class B, min...................14 to 45

Tensile Strength, ASTM D638, psi (MPa)
Final...>2,000 (13.8)

Tensile Elongation, ASTM D638, %.................30 to 70

Compressive Strength, ASTM C579, psi (MPa)
@ 3 hours..>2,000 (13.8)
@ 7 days..>6,000 (41.4)

Compressive Modulus, psi (MPa).........120,000 (827)

Flexural Strength, ASTM D790, psi (MPa)
Final...4,500 (34.5)

Bond Strength, psi (MPa)
ASTM C1583...>250 (1.7)

Chloride Permeability, ASTM C1202, AASHTO T 77
Final..0 coulombs

Hardness Shore D, ASTM D2240, min................70±5

Water Absorption, ASTM D570, 24 hr. %..............<0.50

Thermal Compatibility, ASTM C884.................passes

Effective Shrinkage, ASTM C883......................passes

Appearance: FLEXOLITH is available in clear, light gray, dark gray, and tile red. Custom colors are available, but are subject to minimum order quantities.

Packaging

FLEXOLITH is available in 4 gal (15 L) cases, 10 gal (38 L) units, 100 gal (378 L) units, and 500 gal (1,892 L) totes

Shelf Life

2 years in original, unopened, properly stored containers

Specifications/Compliances

ASTM C881, Type III, Grade 1 Classes B and C

AASHTO M 235, Type III, Grade 1

Coverage

Bridge Deck Overlay	1st Coat	2nd Coat	3rd Coat (Optional)
Flexolith (ft^2/gal (m^2/L))	40 (.98)	20 to 22 (.49 to .54)	20 to 22 (.49 to .54)
#8 Flint Rock or Basalt (lbs/ft^2 (kg/m^2))	1.25 to 1.50 (6.1 to 7.3)	1.50 to 2.00 (7.3 to 9.8)	1.50 to 2.00 (7.3 to 9.8)

Parking Deck Coating	1st Coat	2nd Coat	Seal Coat (Optional)
Flexolith (ft^2/gal (m^2/L))	60 to 80 (1.5 to 2.0)	40 to 60 (.98 to 1.5)	80 to 100 (2.0 to 2.5)
#4 Flint Rock or Basalt (lbs/ft^2 (kg/m^2))	1.00 to 1.50 (4.9 to 7.3)	1.25 to 1.50 (6.1 to 7.3)	----------------

Trowel Down Coating	1st Coat	2nd Coat	Seal Coat (Optional)
Flexolith (ft^2/gal (m^2/L))	200 (4.9)	----------------	150 to 250 (3.7 to 6.1)
Flexolith mortar* at 1/4" (6.4 mm) thick	----------------	16 to 20 ft^2 (1.5 to 1.9 m^2)	----------------

*Flexolith mortar consists of 1 gal (3.8 L) of mixed FLEXOLITH combined with 2 to 3 gal (7.6 to 11.4 L) 20/40 mesh, clean, dry silica sand

Note: Coverage rates are approximate. Actual coverage depends on temperature, texture, and substrate porosity.

Directions for Use

Surface Preparation: The surface must be structurally sound, clean and free of grease, oil, curing compounds, soil, dust and other contaminants that may interfere with bond. New concrete and masonry must be at least 28 days old. Surface laitance must be removed. Concrete surfaces must be roughened and made absorptive, preferably by mechanical means, and then thoroughly cleaned of all dust and debris. If the surface was prepared by chemical means (acid etching), a water/baking soda or water/ammonia mixture, followed by a clean water rinse, must be used for cleaning, in order to neutralize the substrate. The Concrete Surface Profile (CSP) should be equal to CSP 4-6 in accordance with Guideline 310.2R-2013, published by the International Concrete Repair Institute (ICRI). Allow substrate to dry before coating application. Following surface preparation, the strength of the surface can be tested if quantitative results are required by project specifications. An elcometer or similar tensile pull tester may be used in accordance with ASTM C1583, and the tensile pull-off strength should be at least 250 psi (1.7 MPa).

Do not apply epoxy or urethane coatings if there is excessive moisture in the concrete or if the moisture vapor transmission rate is high. Before application of FLEXOLITH, perform the "Visqueen test" (ASTM D 4263, modified to a test duration of 2 hours). Do not apply FLEXOLITH when the Visqueen test indicates the presence of moisture vapor transmission through the concrete. After surface preparation, a test section application of FLEXOLITH is recommended to confirm good adhesion and compatibility of the coating with the surface, and also to confirm appearance and aesthetics.

When coating steel, all contamination should be removed and the steel surface prepared to a "near white" finish (SSPC SP10) using clean, dry blasting media.

Mixing: Mix FLEXOLITH using a low-speed drill and a mixing paddle. Pre-mix Part A and Part B separately for approximately 1 minute each. Combine Part A and Part B in a 1 to 1 ratio by volume, then mix thoroughly for 3 minutes.

To make FLEXOLITH mortar, gradually add clean, dry aggregate to previously mixed FLEXOLITH epoxy and mix thoroughly for 3 minutes. Aggregate types and quantites for mixing are listed in the "Coverage" section above. A low-speed drill and a mixing paddle may be used for small quantities, and a horizontal shaft mortar mixer may be used for large quantities.

Scrape the bottom and sides of the containers at least once during mixing. Do not scrape bottom or sides of the container once mixing operations have ceased; doing so may result in unmixed resin or hardener being applied to the substrate. Unmixed resin or hardener will not cure properly. Do not aerate the material during mixing. To keep aeration to a minimum, the recommended mixing paddles are #P1 or #P2 as found in ICRI Guideline 320.5R-2014.

Application: See the "Epoxy & Urethane Coatings Application Guide" for installation means and methods. Note that any coverage rates or mixing ratios for epoxy or epoxy-aggregate combinations found in the "Epoxy & Urethane Coatings Application Guide" are approximations, and are for general reference only. For product-specific coverage rates and mixing ratios, refer to this technical data sheet.

The recommended aggregate for heavy duty applications/skid-resistant overlays (high traffic bridge decks, parking deck turn lanes, etc.) is #8 or #4 basalt, #8 or #4 flint rock, or another similarly graded non-slip aggregate. For other applications, or where specified, silica sand aggregate may be used.

Clean-Up

Clean tools and application equipment immediately with acetone, xylene, or MEK. Clean spills or drips with the same solvents while still wet. Hardened FLEXOLITH will require mechanical abrasion for removal.

Precautions/Limitations

- Store FLEXOLITH indoors, protected from moisture, at temperatures between 40°F and 90°F (4°C and 32°C)
- Surface and ambient temperature during coating applications should be between 40°F and 90°F (4°C and 32°C)
- Material temperatures should be at least 40°F (4°C) and rising
- Do not apply FLEXOLITH if surface temperature is within 5°F (3°C) of the dew point in the work area
- Working time and cure time will decrease as the temperature increases, and will increase as the temperature decreases
- Do not thin FLEXOLITH
- Do not apply FLEXOLITH to slabs on grade
- Do not apply FLEXOLITH if the substrate is subject to excessive moisture vapor transmission or hydrostatic pressure
- Although FLEXOLITH is chemically resistant, surface staining of the coating may occur after contact with some chemicals. Consider the use of a urethane topcoat such as EUCOTHANE for improved stain resistance.
- FLEXOLITH will discolor upon prolonged exposure to ultraviolet light and high-intensity artificial lighting. An aliphatic urethane topcoat such as EUCOTHANE can minimize these effects.
- Depending on the condition of the substrate, minor surface defects can appear in the coating when applied. Proper surface prep, patching of substrate imperfections, and priming will ensure a better overall finish.
- Application of a test area is recommended to confirm final appearance and texture of the system with the end user
- If FLEXOLITH is to be exposed to chemicals, contact Euclid Chemical Technical Service for a top coat recommendation
- In cold weather applications, it is recommended that all materials used in the overlay be conditioned to at least 75°F (24°C) for at least 24 hours prior to use. Heating of the epoxy components and aggregates will enhance cure times and improve material handling characteristics.
- In all cases, consult the product Safety Data Sheet before use

Rev. 05.19

CE330 EPOXY BINDER

LOW MODULUS EPOXY POLYMER BINDER

DESCRIPTION

FasTrac CE330 Epoxy Binder is a two-component, 100% solids, moisture-tolerant, high strength, low modulus, multi-purpose epoxy adhesive. It meets ASTM C881 and AASHTO M235, Type III, Classes B & C specifications.

USE

Used as a binder for High Friction Surface Treatment (HFST) on portland cement concrete, asphalt pavements and other approved substrates. CE330 is also used for bonding thin overlays on bridge and parking decks, as well as for bike and bus lane demarcation with colored aggregate.

FEATURES

- High strength, low modulus epoxy binder
- Rapid cure return to traffic formula
- Technical support from experienced technicians
- Independent testing lab certification
- Convenient 1:1 mix ratio by volume
- Mends cracks on HFST or bridge deck overlay applications
- Protects concrete from water and deicing salts
- Made in the USA

PACKAGING AND YIELD

- 600 ml cartridge
- 2 gal / 7.6 L unit
- 10 gal / 38 L unit
- 500 gal / 1,893 L unit

PHYSICAL PROPERTIES

Shelf Life: 2 years in original unopened containers
Storage Conditions: 40ºF-95ºF (5ºC-35ºC)
Conditioning: 65ºF-85ºF (18ºC-29ºC) before using
Mix Ratio: 1:1 by volume
Viscosity: 1,500 cP
Gel Time (60g): 15 minutes
Shore D Hardness: 70
Tack Free Time: (75ºF/24ºC): <3 hours
Tensile Strength (ASTM D638): 2,800 psi (19.3 MPa)
Tensile Elongation (ASTM D638): 40%
Bond Strength (ASTM C882): 2 day cure 2,000 psi (13.8 MPa) 14 day cure 2,800 psi (19.3 MPa)
Compressive Strength (ASTM C579): 3 hour cure 1,500 psi (10.3 MPa) 24 hour cure 5,000 psi (34.5 MPa)
Bond Strength (ASTM C1583/ACI 503R): 300 psi (2.0 MPa)
Shrinkage (ASTM D2566): 0.2%
Thermal Compatibility (ASTM C884): Pass
Heat Deflection Temperature (ASTM D648): 120ºF (49ºC)
Absorption (ASTM D570): 0.2% (24 hr)
Chloride Ion Permeability (AASHTO T277): 0.0 coulombs

CURING TIME (HRS.)

Temperature (°F):	40	45	50	55	60	65	70	75	80	90	100
CE330 Regular:	16	12	10	8	6	5	4	3	2.5	2	1
CE330 with Acc.:	12	10	8	6	4						
CE330 Low Temp.:	8	6	5	4	3						

APPLICATION

SURFACE PREPARATION:

General Guidance Recommendation
Surface must be must be clean and sound. Surface should be visibly dry. No standing water. Concrete moisture levels must be less than 5 % when measured using a multi-pin moisture meter.

Remove dust, laitance, grease, curing compounds, impregnations and other contaminants. Concrete surfaces should be shot blasted to a CSP 3-5 per ICRI.

Condition material to 65°F - 85°F (18-29°C) for optimum application. Minimum age of concrete 21- 28 days, depending on mix design.* Minimum age of asphalt is 30 days and 75 % aggregate exposure.*
**Consult Cornerstone Construction Material Technical Services for applications outside these parameters.*

General Guidance Recommendation
Utilize the following method to apply the resin binder under manufacturer's recommendations: Manual applications are allowable for locations of less than 500 square yards, please refer to your local technical sales representative 816-380-1082.

Automated Continuous Application
Automated continuous application must be performed by an applicator vehicle with a minimum of 1100 gallons of the polymer resin binder. The applicator vehicle must continuously mix, heat, meter, monitor and apply the polymer resin binder in a continuous pass as one layer.

General Application / High Friction Surface Treatment

The bauxite high friction aggregate and polymer resin binder shall be dispensed equally across the entire application surface in a manner that covers the surface area to be treated at the mil thickness of 65±5 mils without any breaks, swirls, ridge lines or differential thickness of the polymer resin binder over the area being treated, the bauxite high friction aggregate shall simultaneously cover the polymer resin binder at a rate of 15±2 lbs per square yard within 15±5 seconds of the polymer resin binder application.

Do not place the high friction surface treatment if the material can't be applied and cured within 2.5 hours of placement and opened to traffic.
The rate of application coverage for the polymer resin binder and bauxite high friction aggregate equally applied shall be 1500 square yards to 2000 square yards per hour.

LIMITATIONS

Minimum substrate and ambient temperature is 50ºF (10ºC) for all applications. Maximum substrate and ambient temperature is 95ºF (35ºC) for hand mix or semi-automated installations. Do not thin. Solvents will prevent proper cure. Use oven-dried aggregate. Material is a vapor barrier after cure.

CLEAN UP

Collect with absorbent material. Flush area with water. Dispose of in accordance with local, state and federal disposal regulations. Uncured material can be removed with Natural Clean or other approved solvent. Cured material can only be removed mechanically.

LIMITED WARRANTY

All information provided by Cornerstone Construction Material LLC (CCM) concerning CCM products, including but not limited to, any recommendations and advice relating to the application and use of CCM products, is given in good faith based on CCM's current experience and knowledge of its products when properly stored, handled and applied under normal conditions in accordance with CCM's instructions. In practice, the differences in materials, substrates, storage and handling conditions, actual site conditions and other factors outside of CCM's control are such that CCM assumes no liability for the provision of such information, advice, recommendations or instructions related to its products, nor shall any legal relationship be created by or arise from the provision of such information, advice, recommendations or instructions related to its products. The user of the CCM product(s) must test the product(s) for suitability for the intended application and purpose before proceeding the full application of the product(s). CCM reserves the right to change the properties of its products without notice. All sales of CCM product(s) are subject to its current terms and conditions of sale.

Prior to each use of any CCM product, the user must always read and follow the warnings and instructions on the product's most current Technical Data Sheet, product label and Safety Data Sheet which are available at www.ccmaterial.com. Nothing contained in any CCM materials relieves the user of the obligation to read and follow the warnings and instructions for each CCM product as set forth in the current Technical Data Sheet, product label and Safety Data Sheet prior to product use.

CCM warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current Technical Data Sheet when used in accordance with the written instructions. User determines suitability of product for intended use and assumes all risks. Buyer's sole remedy shall be limited to the purchase price or replacement of product exclusive of labor or cost of labor.

NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CCM SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. CCM SHALL NOT BE REPSONSIBLE FOR THE USE OF THIS PRODUCT IN A MANNER TO INFRINGE ON ANY PATENT OR ANY OTHER INTELLECTUAL PROPERTY RIGHTS HELD BY OTHERS.

MANUFACTURER

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Version: June 26, 2019

MAPEI®

Planiseal® Traffic Coat

Epoxy Overlay for Vehicular and Pedestrian Traffic

DESCRIPTION

Planiseal Traffic Coat is a moisture-tolerant, 100%-solids, low-modulus, two-part, epoxy binder engineered for providing a skid-resistant overlay on elevated concrete decks.

FEATURES AND BENEFITS

- Offers an exceptionally durable decorative or skid-resistant overlay
- Provides a tenacious bond between aggregate and properly prepared concrete surfaces
- Moisture-insensitive
- Fast-curing with early film strength
- Easy to mix: 1-to-1 ratio by volume
- Low-modulus characteristic ensures superior compatibility with thermal movement in concrete

INDUSTRY STANDARDS AND APPROVALS

- ASTM C881-10: Type III; Classes A, B and C
- ACI 548.8M-07 for Type EM (epoxy multi-layer) polymer overlay for bridge and parking decks
- ACI 548.9M-08 for Type ES (epoxy slurry) polymer overlay for bridge and parking decks
- Meets AASHTO-AGC-ARTBA Task Force 34, October 1995
- USDA-compliant

WHERE TO USE

- Use on interior/exterior, horizontal concrete surfaces.
- Use on elevated concrete bridges and decks subject to frequent freeze/thaw cycles, de-icing chemicals, and stresses produced by severe humidity and temperature changes.
- Use to provide a durable, attractive and trafficable water-resistant coating system on balconies, parking garages and plaza decks.
- Use to provide a durable, protective skid-resistant overlay.
- Use to extend the life of concrete decks subject to abrasion and chloride attack.

SUITABLE SUBSTRATES

- Concrete at least 28 days old, stable and free of standing water
- Elevated concrete decks or slabs
- Slabs on grade with no rising moisture vapor. Before application on slabs on grade, perform a moisture test with a transparent plastic sheet for 6 to 24 hours (per ASTM D4263). If rising vapor is present for slabs on grade, alternate overlay systems or treatments are recommended.

SURFACE PREPARATION

Reference ACI 548.8M-07, Specification for Type EM (Epoxy Multi-Layer) Polymer Overlay for Bridge and Parking Garage Decks.

- Surfaces must be concrete at least 28 days old, sound, stable and dry.
- Repair spalls, potholes and cracks before the application of *Planiseal Traffic Coat. Planiseal Traffic Coat* can be used as an epoxy mortar and

become an effective repair material, when 2 parts of dry sand are added per 1 part of mixed *Planiseal Traffic Coat*.

- Prepare surfaces by shotblasting or alternate mechanical means to achieve an International Concrete Repair Institute (ICR) concrete surface profile (CSP) of #5. Remove all contaminants, dust and debris.

MIXING

Before product use, take appropriate safety precautions. Refer to the Safety Data Sheet for details.

1. Precondition the material to between 65°F and 85°F (18°C and 29°C) before use.
2. Mix both Part A and Part B individually to ensure that all solids are evenly dispersed throughout each component.
3. Mechanically mix Part A with Part B at a ratio of 1 to 1 by volume with a Jiffy-type mixer and low-speed variable drill at 300 rpm for 3 minutes. Mix only the quantity that can be used within its gel time.
4. Metered mix ratio pumps can also be used.

PRODUCT APPLICATION*

Read all installation instructions thoroughly before installation.

1. Apply the first coat of *Planiseal Traffic Coat* neat with a 3/16" (4.5 mm) notched squeegee at 1 U.S. gal. per 40 sq. ft. (3.79 L per 3.72 m^2).
2. Broadcast select aggregate to refusal at about 11 lbs. per 10 sq. ft. (4.99 kg per 0.93 m^2).

   Aggregate specification: Select angular aggregate, grain quartz silica sand, Oklahoma flint rock or basalt having less than 0.2% moisture and that is free of dirt, clay, etc. The aggregate must have a minimum Mohs hardness of 7, unless otherwise approved in writing by MAPEI's Technical Services for Concrete Restoration Systems.
3. Allow the first coat to cure, in accordance with the "Curing Times" table below, and then remove excess aggregate. Do not open to traffic.
4. Apply a second coat of epoxy at 1 U.S. gal. per 20 sq. ft. (3.79 L per 1.86 m^2).
5. Broadcast select aggregate into the second coat of epoxy at about 16 lbs. per 10 sq. ft. (7.26 kg per 0.93 m^2).
6. Allow to cure according to the "Curing Times" table.
7. Remove excess aggregate by power-blowing, sweeping or vacuuming.
8. Open to traffic.

** Application rates are theoretical and are for estimating purposes only. Actual spread rates depend on field conditions, as well as concrete profile and quality. Contact MAPEI's Technical Services Department for applications not listed.*

LIMITATIONS

- Use only between the temperatures of 55°F and 95°F (13°C and 35°C).
- For temperature above 85°F (29°C), take appropriate precautions to keep material cool.
- No additional ingredients are required; do not thin with solvents.
- Do not use across moving joints, or for sealing joints or cracks subject to hydrostatic pressure.

Consult MAPEI's Technical Services Department for installation recommendations regarding substrates and conditions not listed.

Product Performance Properties

Laboratory Tests	Results	ASTM C881 Specifications	ACI 548.8M/548.9M Specifications
VOCs (Rule #1168 of California's SCAQMD)	< 50 g per L	N/A	N/A
Compressive strength – ASTM C579, Method B			
At 3 hours	> 1,030 psi (7.10 MPa)	N/A	> 1,000 psi (6.90 MPa)
At 24 hours	> 5,000 psi (34.5 MPa)	N/A	> 5,000 psi (34.5 MPa)
Compressive modulus – ASTM D695	< 125,000 psi (862 MPa)	130,000 psi (897 MPa) maximum	N/A
Tensile strength – ASTM D638	> 2,250 psi (15.5 MPa)	None	2,000 to 5,000 psi (13.8 to 34.5 MPa)
Tensile elongation – ASTM D638	≥ 30%	30% minimum	30% to 70%
Modulus of elasticity – ASTM D638	< 12,000 psi (82.8 MPa)	None	13,050 psi (90 MPa) maximum
Bond strength, 14-day cure – ASTM C882	≥ 1,500 psi (10.3 MPa)	1,500 psi (10.3 MPa) minimum	None
Absorption – ASTM D570	< 0.50%	1.0% maximum	None
Gel time – ASTM C881	30 minutes	30 minutes (minimum)	15 to 45 minutes
Brookfield viscosity RVT No. 3 at 20 rpm – ASTM D2393	1,000 to 2,000 cps	2,000 cps maximum	700 to 2,500 cps
Shore "D" hardness – ASTM D2240	> 60	None	None
Linear coefficient of shrinkage – ASTM D2566	< 0.003 in./in. (0.003 mm/mm)	0.005 in./in. (0.005 mm/mm) (maximum)	None
Thermal compatibility – ASTM C884	Pass	Pass	Pass
Chloride ion permeability – AASHTO T277	< 100 coulombs	None	None
Flexural strength at 7 days – ASTM C348	> 3,000 psi (20.7 MPa)	None	None
Bond strength at 7 days – ASTM C1583	> 300 psi (2.07 MPa)	None	> 250 psi (1.72 MPa)

Curing Times

Average Temperatures of Overlay Component and Substrate				
Minimum Curing Time		**60°F to 64°F (16°C to 18°C)**	**65°F to 69°F (19°C to 21°C)**	**70°F to 74°F (21°C to 23°C)**
	Coat 1	4 hours	3 hours	2.5 hours
	Coat 2	5 to 6 hours	5 hours	4 hours
		75°F to 79°F (24°C to 26°C)	**80°F to 84°F (27°C to 28°C)**	**+85°F (+29°C)**
	Coat 1	2 hours	1.5 hours	1 hour
	Coat 2	3 hours	3 hours	3 hours

CSI Division Classification

Traffic Coatings	07 18 00

Shelf Life and Product Characteristics

Shelf life	2 years in original, unopened container. Store at 40°F to 90°F (4°C to 32°C).
Color (before mixing)	Part A: Yellow or clear Part B: Amber
Mixing ratio (Part A to Part B)	1 to 1 by volume
Gel time	> 30 minutes

Planiseal® Traffic Coat

Approximate Coverage*

Type of Coverage	For a Skid-Resistant Coating
Epoxy only	1st coat at 40 sq. ft. (3.72 m²) per U.S. gal. (3.79 L) 2nd coat at 20 sq. ft. (1.86 m²) per U.S. gal. (3.79 L)
With aggregate	1st coat at 11 lbs. (4.99 kg) 2nd coat at 16 lbs. (7.26 kg)

** Coverage will depend on surface profile, particularly on the aggregate used.*

Packaging

Size
Part A epoxy resin Pail, 5 U.S. gals. (18.9 L) Drum, 55 U.S. gals. (208 L) Tote: 275 U.S. gals. (1 041 L)
Part B curing agent Pail, 5 U.S. gals. (18.9 L) Drum, 55 U.S. gals. (208 L) Tote: 275 U.S. gals. (1 041 L)

Refer to the SDS for specific data related to health and safety as well as product handling.

For information on MAPEI's commitment to sustainability and transparency, as well as how MAPEI meets the health and well-being requirements of product certification programs, contact the MAPEI Sustainability Team at 1-800-992-6273.

We proudly support the following industry organizations:

ICRI TTMAC ACTTM American Concrete Institute® ASC CTDA SWR INSTITUTE MARBLE INSTITUTE of America

MAPEI®

MAPEI Headquarters of North America
1144 East Newport Center Drive
Deerfield Beach, Florida 33442
1-888-US-MAPEI (1-888-876-2734) /
(954) 246-8888

Technical Services
1-888-365-0614 (U.S. and Puerto Rico)
1-800-361-9309 (Canada)

Customer Service
1-800-42-MAPEI (1-800-426-2734)

Services in Mexico
0-1-800-MX-MAPEI (0-1-800-696-2734)

Edition Date: June 25, 2019
MK 3000168 (19-1824)

Pro-Poxy™ Type III DOT

Low modulus, low viscosity, epoxy/urethane binder and adhesive

TECHNICAL DATA SHEET

DESCRIPTION
Pro-Poxy™ Type III D.O.T. is a 100% solids, low modulus, moisture tolerant, low viscosity epoxy urethane binder and adhesive meeting the requirements of ASTM C-881, Type III, Grade I, Classes B & C.

USE
Pro-Poxy™ Type III D.O.T. Is used primary for bonding skid-resistant overlays and high friction surfaces to bridges and elevated slabs and as a low modulus binder for epoxy mortars where thermal change is a consideration. Material can also be used to seal interior and exterior above grade slabs and as low modulus crack filler

FEATURES
- Low modulus, high strength adhesive meeting ASTM C-881 Type III Requirements
- Moisture tolerant
- Can be used as a High Friction Surface Treatment
- V.O.C. compliant
- Shock absorbing ability
- Easy blending of aggregates for mortar repairs
- Can be use on parking garages and parking decks

PROPERTIES
Meets Specification:

ASTM C-881, Type III, Grade 1, Classes B & C

Mix ratio – 1:1, by volume

Gel time – ASTM C881
60 gm sample @ 73°F (23°C): minimum 15 min.

Viscosity minimum 1,500 cps
(1.5 Pascal-second) at 77° F (25° C)

Hardness ASTM 2240 (Shore -D)73

Tensile Strength - ASTM D-638:
>3,000 psi (20.7 MPa) 3 days

Compressive Strength - ASTM C109:
minimum 5,000 psi (34.4 MPa) in 24 hours

Bond Strength - ASTM C1583: >250 PSI, 100% failure in concrete

Elongation at Break – ASTM D-638: minimum 30.0%

Water Absorption – ASTM D-570: 0.20%

Thermal Compatibility – Passes Test

AASHTO T277 and ASTM C1202 0 coulombs (two coats)

Note:
Pro-Poxy D.O.T. is not intended to provide resistance to reflective cracking.

High temperatures will accelerate the setting time. As a general rule, the gel time of the epoxy will be cut in half for each 10° to 15° increase in temperature above 75°F (24°C).

VOC
Pro-Poxy™ Type III D.O.T. has a VOC content of 0 g/L and is compliant with all Canadian and U.S. VOC

regulations including Federal EPA, OTC, LADCO, SCAQMD & CARB.

Estimating Guide
Broadcast Overlays:
Course #1: Epoxy rate: 40 ft²/gal. (1 L/m²)
Aggregate rate: 1-1.5 lb/ft², (4.88-7.32 kg/m²).
Course #2: Epoxy rate: 20 ft²/gal. (2 L/m²)
Aggregate rate: 1-1.5 lb/ft², (4.88-7.32 kg/m²).

Epoxy Mortar: 2 gal/ (7.6 L) epoxy mixed with 10 gal (37.8 L) of dry sand yields approximately 0.94ft³

Packaging

PRODUCT CODE	PACKAGE	SIZE	
		Gallons	Liters
140302	Unit	1	3.79
140304	Unit	2	7.57
140313	Unit	10	37.85
140324	Unit	110	416.40
140333	Unit	500	1892.71

Accelerator
Bridge Seal Accelerator

PRODUCT CODE	PACKAGE	SIZE	
		Gallons	Liters
144977	Pail	5	18.93

Note:
When faster turn around is required, the use of Bridge Seal Accelerator can reduce the set time of Pro-Poxy Type III DOT between 30-60% based on ambient conditions, material temperatures, and substrate conditions.

STORAGE
The material should be stored between 40°-95°F (5°-35°C). Shelf life of properly stored, unopened containers is 24 months

Surface Preparation:
Surface to be bonded must be clean and sound. Remove oil, dirt, grease, laitance, curing compounds and other foreign matter that may cause a problem with bond. Abrasive blast cleaning and mechanical removal methods are recommended. Remove all standing water and dust with clean, oil free, compressed air prior to installation.

Surface should be a concrete surface profile (CSP) of 5-9 according to ICRI Technical Guideline no 310.2R-2013, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and concrete Repair". Surface and ambient temperature must be a minimum of 50°F (10°C).

Mixing:

Condition material to 65°-85°F (18°-29°C) for ease of mixing and optimum flow prior to using. Premix each component then place 1 part by volume of Component A and 1 part by volume of component B into a clean pail and mix for three minutes with a low speed drill using a Jiffy mixer or paddle until uniformly blended. Mix only what can be used within the pot life

Test before placement:

There shall be no visible moisture present on the surface of the concrete at the time of application of the polymer concrete overlay. Concrete surface must be less than 5% moisture content when tested with a moisture pin meter.

When applying Pro Poxy Type III D.O.T. over cementitious patches less than 28 days contact Dayton Superior Technical service for recommendations.

Placement:

Epoxy/Urethane Overlays: Repair all delaminations, potholes and cracks using the Pro-Poxy™ Type III D.O.T. or the Pro-Poxy™ 2500. Mix the epoxy as previously directed and apply course #1, spreading the neat Pro-Poxy™ Type III D.O.T. at a coverage rate of 40 ft²/gal. (1 m²/L) using a 3/16 notched squeegee;

Immediately broadcast select aggregate to refusal (typically 1-1.5 lb/ft², 4.88-7.32 kg/m²). The aggregate should have a hardness of six or higher on the Mohs hardness scale (unless otherwise approved). Aggregate shall be angular, (free of dirt, clay and all impurities) shall consist of natural silica sand, basalt, or other nonfriable aggregate, and shall contain less than 0.2% moisture when tested in accordance with ASTM C566.

After the initial cure of the first course, remove all excess aggregate and apply course #2, spreading the neat Pro-Poxy™ Type III D.O.T. at a coverage rate of 20 ft²/gal. (0.5 m²/L), once again broadcasting the select aggregate to the point of rejection.
After allowing the system to cure and after all the aggregate has been removed it can be opened up to traffic. Colder temperatures will slow the setting time while warmer temperatures will accelerate the set time.

High Friction Surface Application

High Friction Surface Application:
Surface Preparation: 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 binder material and existing surfaces.

Pavement markings that conflict with the surface application shall be removed by grinding and the surface shall be swept clean prior to the application of the Pro-Poxy™ Type III D.O.T.

Surface and ambient temperature must be a minimum of 50°F (10°C). Utilize one of the following methods for the application of the Pro-Poxy™ Type III D.O.T. and aggregate wearing course, as applicable.

1) Hand mixing and application: The Pro-Poxy™ Type III D.O.T. components, Part A and Part B, shall be premixed and proportioned to the correct ratio, as stated on the TDS. Mix material using a low speed, high torque drill fitted with a helical stirrer. This method shall be used where truck mounted application machines are not applicable to the specified locations because of logistics and restrictions. The mixed components shall be hand applied onto a prepared pavement surface at an application coverage rate of 20-30 sf/gal. Hand applied base binder shall be uniformly spread onto the substrate surface by means of a (1/4) notched squeegee. Immediately, spread the high friction surfacing aggregate onto the epoxy at a minimum rate of 13 lbs/sy.

2) Mechanical mixing and application: The Pro-Poxy™ Type III D.O.T. shall be applied by a truck mounted application machine onto the pavement section to be treated in varying widths at a uniform application thickness. Operations shall proceed in such a manner that will not allow the Pro-Poxy™ Type III D.O.T. to separate in the mixing lines, cure, dry, or otherwise impair retention bonding of the high friction surfacing aggregate. The mixed components shall be applied mechanically onto the prepared pavement surface at a minimum coverage rate of 20-30 sf/gal. Immediately, spread the high friction surfacing aggregate onto the installed two part modified epoxy base binder, at a minimum rate of 1-1.5 lb/ft², (4.88-7.32 kg/m)

Cure Time

Temperature	Set Time
50-55°F (10-12.7°C)	5-6 hours
60°-65°F (16-18°C)	3-4 hours
70 - 74°F (22-23°C)	2-2 1/2 hours
75 - 79°F (24-26°C)	1 1/2-2 hours

The data shown is typical for controlled laboratory conditions. Reasonable variation from these results can be expected due to Inter-laboratory precision and bias. Material, surface and ambient temperatures will affect set times.

CLEAN UP

Tools and Equipment: Clean before the epoxy sets up using Xylene or Unitex Citrus Cleaner.

LIMITATIONS

FOR PROFESSIONAL USE ONLY

Minimum age of concrete must be 21-28 days from date of placement depending on curing and drying conditions.
Concrete surface must be less than 5% moisture content when tested with a moisture pin meter. On wood and other surfaces contact Technical Service for more information.

Surface and ambient temperature must be a minimum of 50°F (10°C)
Do not thin with any solvents.
Do not place Pro-Poxy™ Type III D.O.T. on magnesium phosphate cement concrete

PRECAUTIONS

READ SDS PRIOR TO USING PRODUCT

- Component A – Irritant
- Component B – Corrosive Product is a strong sensitizer
- Use with adequate ventilation
- Wear protective clothing, gloves and eye protection (Goggles, Safety Glasses and/or Face Shield)
- Keep out of the reach of children
- Do not take internally
- In case of ingestion, seek medical help immediately
- May cause skin irritation upon contact, especially prolonged or repeated.
- If skin contact occurs, wash immediately with soap and water and seek medical help as needed
- If eye contact occurs, flush immediately with clean water and seek medical help as needed
- Dispose of waste material in accordance with federal, state and local requirements
- Cured Epoxy Resins are Innocuous

MANUFACTURER

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Website: www.daytonsuperior.com

WARRANTY

Dayton Superior Corporation ("Dayton") warrants for 12 months from the date of manufacture or for the duration of the published product shelf life, whichever is less, that at the time of shipment by Dayton, the product is free of manufacturing defects and conforms to Dayton's product properties in force on the date of acceptance by Dayton of the order. Dayton shall only be liable under this warranty if the product has been applied, used, and stored in accordance with Dayton's instructions, especially surface preparation and installation, in force on the date of acceptance by Dayton of the order. The purchaser must examine the product when received and promptly notify Dayton in writing of any non-conformity before the product is used and no later than 30 days after such non-conformity is first discovered. If Dayton, in its sole discretion, determines that the product breached the above warranty, it will, in its sole discretion, replace the non-conforming product, refund the purchase price or issue a credit in the amount of the purchase price. This is the sole and exclusive remedy for breach of this warranty. Only a Dayton officer is authorized to modify this warranty. The information in this data sheet supersedes all other sales information received by the customer during the sales process. THE FOREGOING WARRANTY SHALL BE EXCLUSIVE AND IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND ALL OTHER WARRANTIES OTHERWISE ARISING BY OPERATION OF LAW, COURSE OF DEALING, CUSTOM, TRADE OR OTHERWISE.

Dayton shall not be liable in contract or in tort (including, without limitation, negligence, strict liability or otherwise) for loss of sales, revenues or profits; cost of capital or funds; business interruption or cost of downtime, loss of use, damage to or loss of use of other property (real or personal); failure to realize expected savings; frustration of economic or business expectations; claims by third parties (other than for bodily injury), or economic losses of any kind; or for any special, incidental, indirect, consequential, punitive or exemplary damages arising in any way out of the performance of, or failure to perform, its obligations under any contract for sale of product, even if Dayton could foresee or has been advised of the possibility of such damages. The Parties expressly agree that these limitations on damages are allocations of risk constituting, in part, the consideration for this contract, and also that such limitations shall survive the determination of any court of competent jurisdiction that any remedy provided in these terms or available at law fails of its essential purpose.

Nevada Department of Transportation

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