TEC Services
Testing • Engineering • Consulting

September 25, 2019

Mr. James High
E-Chem, LLC
4102 El Rey Rd SE
Albuquerque, NM 87105

Email: James@e-chem.net
Phone: 505-554-0659

Subject: **Report of Product Testing – AASHTO PP79**
Product: HFP 1:1
TEC Project No: 16-1306
TEC Laboratory No: 18-1407-1

Dear Mr. High:

Testing Engineering & Consulting Services, Inc. (TEC Services) is an AASHTO R18, ANS/IEC/ISO 17025:2005, and Army Corps of Engineers accredited laboratory. TEC Services is pleased to present this report of testing on the subject product submitted to our laboratory on December 10, 2018. Testing was performed in accordance with the terms and conditions of our Service Agreement (TEC-PRO-16-1306). These test results pertain only to the sample tested. The purpose of the testing was to evaluate the submitted product in accordance with the below referenced standards. Mix proportions are reported in Table 1. Summary test results are reported in Table 2. Complete test results are reported in Tables 3-6.

- ASTM D570-10 *Standard Test Method for Water Absorption of Plastics*
- ASTM D638-10 *Standard Specification for Tensile Properties of Plastics*
- ASTM D2240-10 *Standard Test Method for Rubber Property—Durometer Hardness*
- AASHTO M235 *Standard Specification for Epoxy-Resin Bonding Systems for Concrete*
- ASTM C579-12 *Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes*
- ASTM E1252-13 *Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis*
- ASTM D4541-17 *Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers*
- ASTM D1640-14 *Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings*
- AASTHO PP79 *Standard Practice for High-Friction Surface Treatment for Asphalt and Concrete Pavements*
- ASTM C881-15 *Standard Specification for Epoxy-Resin Bonding Systems for Concrete*
- ASTM C1583-13 *Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)*
- ASTM D2556-14 *Standard Test Method for Apparent Viscosity of Adhesives Having Shear-Rate-Dependent Flow Properties Using Rotational Viscometry*
- ASTM D1084-16 *Standard Test Methods for Viscosity of Adhesives*
- ASTM D2196-18 *Standard Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational Viscountess*
- ASTM D695-15 *Standard Test Method for Compressive Properties of Rigid Plastics*

AASHTO M235/ASTM C881 – Gel Time - Neat

The components and equipment were conditioned to 75 °F prior to and during testing. Gel time was measured by placing approximately 60g of the mixed epoxy into an 8oz paper cup at the referenced temperature. The material was probed with a wooden tongue depressor every two minutes until a soft gelatinous mass formed in the center of the sample.

ASTM D2196/ D2556/ D1084 – Viscosity - Neat

The Brookfield DV-E Viscometer was leveled prior to testing, and the subject product was transferred to a 350 mL plastic cup capable of accommodating the viscometer spindle. The spindle was submerged in the material up to the reference mark and adjusted to the highest spindle speed capable of achieving a reading between 20% and 80% of torque. Viscosity was recorded in centipoise and is reported with spindle size, motor speed, and percent torque in Table 2.

ASTM D638 - Tensile Properties - Neat

Tensile strength and elongation were performed in accordance with ASTM D638 using Type I specimens. Five test specimens were cast and cured at 75°F until the time of testing at an age of 7 days. The rate of testing was 0.2 in./min of crosshead displacement. Elongation was determined using a 2.00 inch gage length.

ASTM D570 – Water Absorption - Neat

Water absorption was determined in accordance with ASTM D570. Three test specimens were prepared and cured at laboratory temperature until the date of testing. After curing for 7 days the disks were submerged in water for 24 hours. The initial and final weights were used to calculate the percent absorption.

ASTM D4541/C1583 – Bond Strength to Concrete - Neat

The subject material was applied to a 18” x 18” x 1.75” concrete substrate with an ICRI CSP-3 finish at a wet film thickness of 55-60 mils applied in a single coat. The specimen was allowed to cure at ambient laboratory conditions for 24 hrs. The specimen was wet cored in three areas to a depth of 0.5” and bond test fixtures were adhered to the cored areas and allowed to cure prior to testing. Testing was performed using a Prosec DY-216 pull off tester at a loading rate of 5 psi/sec until failure.

ASTM C579 – Method B – Loading Rate II - Compressive Strength – Extended

Compressive properties were determined in accordance with C579 Method B – Loading Rate II. The epoxy was mixed and extended with ASTM C778 20-30 sand using the proportions shown in Table 1. The mold was filled approximately 1/2 full with the extended mixture. The layer was then rodded to ensure sufficient distribution. This was repeated to obtain a single specimen. Nine extended 2” x 2” cubes were prepared and cured at laboratory temperature until the time of testing at ages of 3 hrs, 24 hrs, and 7 days. The specimens were loaded at a rate of 0.25 in./min of crosshead displacement until failure.

ASTM E1252 – FTIR of Components

Infrared spectra of the two components were collected with a PerkinElmer Spectrum 2 FT-IR spectrometer, fitted with a UATR (Single Reflection Diamond) Accessory; spectra were recorded over the range 4000-450 cm-1, with a resolution of 4 cm-1 and 16 accumulations and the sample positioned parallel at a nominal origin of 0˚ to the ATR crystal. Information pertaining to the product is reported in Table 1. The scans for each component and identified peaks are attached to this report.

Table 1 – Product Information & Mix Proportions

Product Name	**HFP 1:1**
Lot #	A - 2.181010 | B – 2.180810
Lot Size	Unknown
Conditioning Temperature	75 °F
Curing Temperature	75 °F
Test Temperature	75 °F
Components	2 Component
Mix Proportions A:B	1.000 | 0.835 by weight
Extended Mix Proportions	2.75 Sand | 1.00 Combined Epoxy by volume
Part A	218 g
Part B	182 g
Part C (C778 20-30 Sand)*	1877g
Mixing Time	3 minutes
Mixer Type	Drill Paddle – Extended | Hand Mix - Neat

*Extended specimens only

Table 2 – Summary Test Results

ASTM	**Test Property**	**Age**	**Average Test Result**	**AASHTO PP79 Polymeric Requirements**
D2196/D2556/D1084	Viscosity (Ps)	Plastic	**15.5**	7 - 30
AASHTO M235/ ASTM C881	Gel Time – 60g (min.)	Plastic	**18**	10 minutes (min.)
D1640	Drying Time – 50-55 wet mils (min.)	Plastic	**92**	180 minutes (max.)
D570	Water Absorption 24 hr Immersion (%)	7 days	**0.15**	1% (max)
D2240	Shore D Hardness	7 days	**74**	60 - 80
D4541/C1583 (Neat)	Tensile Bond Strength to Concrete (psi)	24 hrs	**480 100 % Substrate Failure**	250 psi or 100% Substrate Failure
C579 (Extended)	Compressive Strength (psi)	3 hrs	**1,630**	1,000 (min.)
		24 hrs	**5,095**	NA
		7 days	**6,780**	5,000 (min.)
D638 (Neat)	Tensile Strength (psi)	7 days	**4,100**	2,500 – 5,000
	% Elongation		**33.6**	30 - 70

Table 3 – ASTM D638 – Tensile Properties – Neat – Type I Specimens - 7 days

ID	Width (in.)	Thickness (in.)	Area (in^2)	Peak Load (lbf.)	Tensile Strength (psi)	% Elongation
1	0.499	0.148	0.0735	333	4,530	34.2
2	0.498	0.164	0.0817	308	3,770	32.6
3	0.502	0.121	0.0607	241	3,970	29.5
4	0.501	0.112	0.0559	242	4,330	35.6
5	0.500	0.170	0.0847	332	3,920	36.0
				Average	**4,100**	**33.6**

Table 4 – ASTM C579 – Compressive Properties - Extended

Age	ID	Width (in.)	Length (in.)	Area (in^2)	Peak Load (lbf.)	Peak Stress (psi)
3 hrs	1	2.00	2.00	4.00	6,555	1,640
	2	2.00	2.00	4.00	6,556	1,640
	3	2.00	2.00	4.00	6,432	1,610
	Average					**1,630**
24 hrs	1	2.00	2.00	4.00	20,350	5,090
	2	2.00	2.00	4.00	20,279	5,070
	3	2.00	2.00	4.00	20,500	5,125
	Average					**5,095**
7 days	1	2.00	2.00	4.00	27,181	6,800
	2	2.00	2.00	4.00	28,243	7,060
	3	2.00	2.00	4.00	25,952	6,480
	Average					**6,780**

Table 5 – ASTM D570 – Absorption - Neat

Specimen #	Diameter (in.)	Thickness (in.)	Initial Weight (g)	Weight After 24hr Soak (g)	Difference (g)	% Absorption
1	2.00	0.1640	8.3509	8.3638	0.0129	0.15
2	2.00	0.1500	7.5185	7.5289	0.0104	0.14
3	2.00	0.1520	7.9513	7.9639	0.0126	0.16
					Average	**0.15**

Table 6 - ASTM D4541/C1583 – Direct Tensile Bond Strength to Concrete – Neat – 24 hrs

Specimen	Sample Diameter (in.)	Bond Area (in^2)	Peak Pull Off Load (lbf)	Bond Strength (psi)	Material Where Failure Occurred	Avg Bond Strength (psi)
1	2.00	3.14	1,550	494	Concrete Substrate	**480**
2	2.00	3.14	1,478	471	Concrete Substrate	
3	2.00	3.14	1,496	476	Concrete Substrate	

Summary

Based on results to date the submitted product meets the requirements of AASTHO PP79 Standard *Practice for High-Friction Surface Treatment for Asphalt and Concrete Pavements* for a Polymeric Resin.

We appreciate the opportunity to provide our services to you on this project. Please do not hesitate to contact us at your convenience if you have any questions about this report or if we may be of further assistance.

Sincerely,

TESTING, ENGINEERING & CONSULTING SERVICES, INC.

James G. McCants III
Laboratory Manager, Chemist

Shawn P. McCormick
Laboratory Principal

Attachments: ASTM E1252 – FTIR Scans of Component A & B

Figure 1 – Component A – FTIR

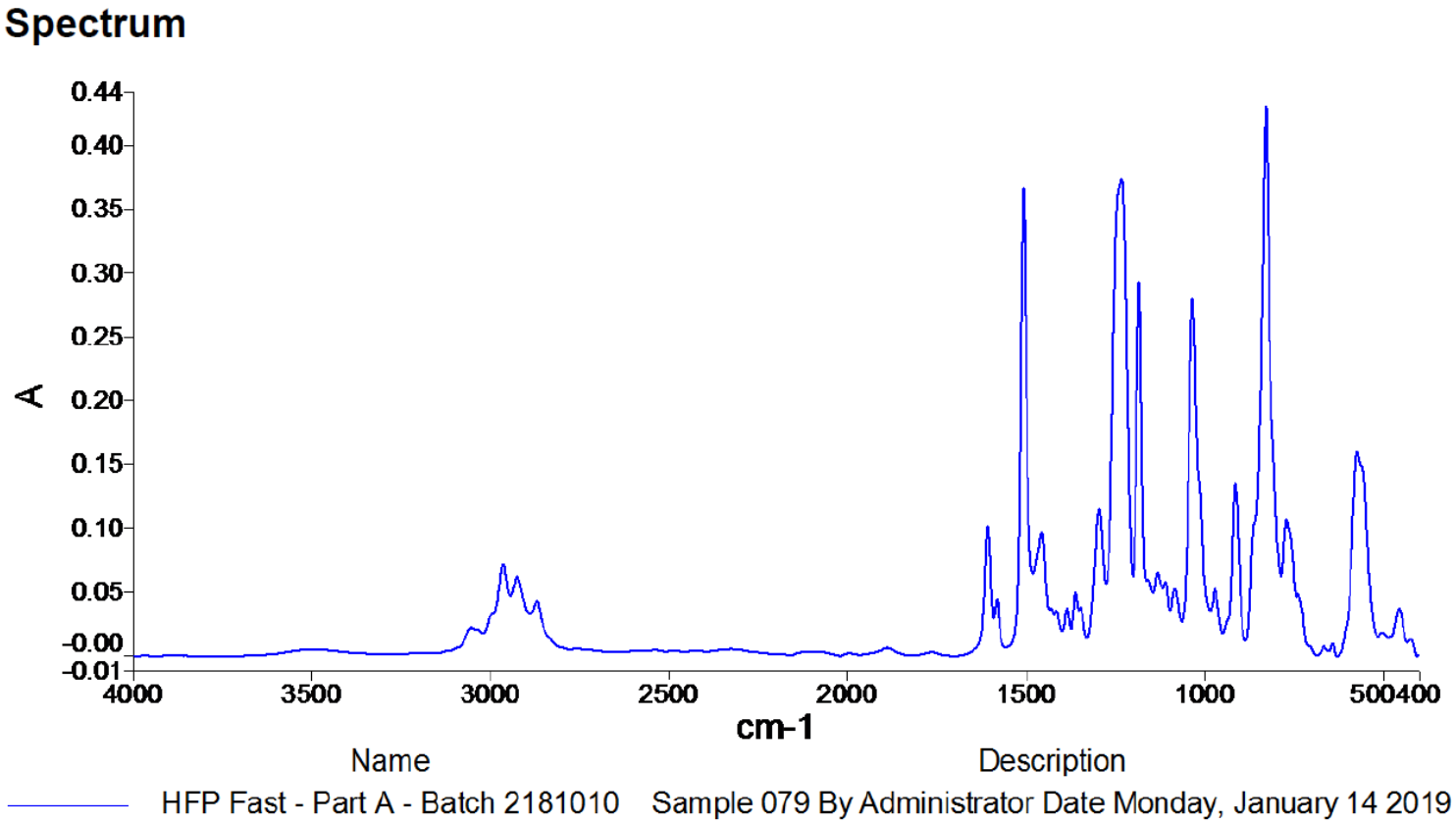

Figure 2 – Component A – Relative Peaks

Peak Number	Height (A)	Start	End	X (cm-1)	Y (A)
1	0.0711	4000	2946.32	2965.62	0.0711
2	0.0619	2946.32	2890.76	2926.45	0.0619
3	0.0423	2890.76	2019.62	2871.89	0.0423
4	0.1014	2019.62	1590.67	1606.88	0.1014
5	0.0438	1590.67	1554.93	1581.71	0.0438
6	0.3674	1554.93	1479.32	1507.22	0.3674
7	0.0962	1479.32	1397.92	1456.02	0.0962
8	0.0364	1397.92	1373.74	1384.5	0.0364
9	0.0489	1373.74	1328.37	1361.67	0.0489
10	0.1147	1328.37	1275.93	1295.55	0.1147

Peak Number	Height (A)	Start	End	X (cm-1)	Y (A)
11	0.375	1275.93	1200.53	1231.93	0.375
12	0.2935	1200.53	1144.45	1182.6	0.2935
13	0.0649	1144.45	1095.22	1131.74	0.0649
14	0.0517	1095.22	1063.67	1082.78	0.0517
15	0.28	1063.67	983.6	1032.69	0.28
16	0.0518	983.6	947.77	969.95	0.0518
17	0.1345	947.77	883.86	913.31	0.1345
18	0.4315	883.86	784.42	827.56	0.4315
19	0.1066	784.42	685.66	769.89	0.1066
20	0.1603	627.22	483.74	571.03	0.1603

Figure 3 - Component B – FTIR

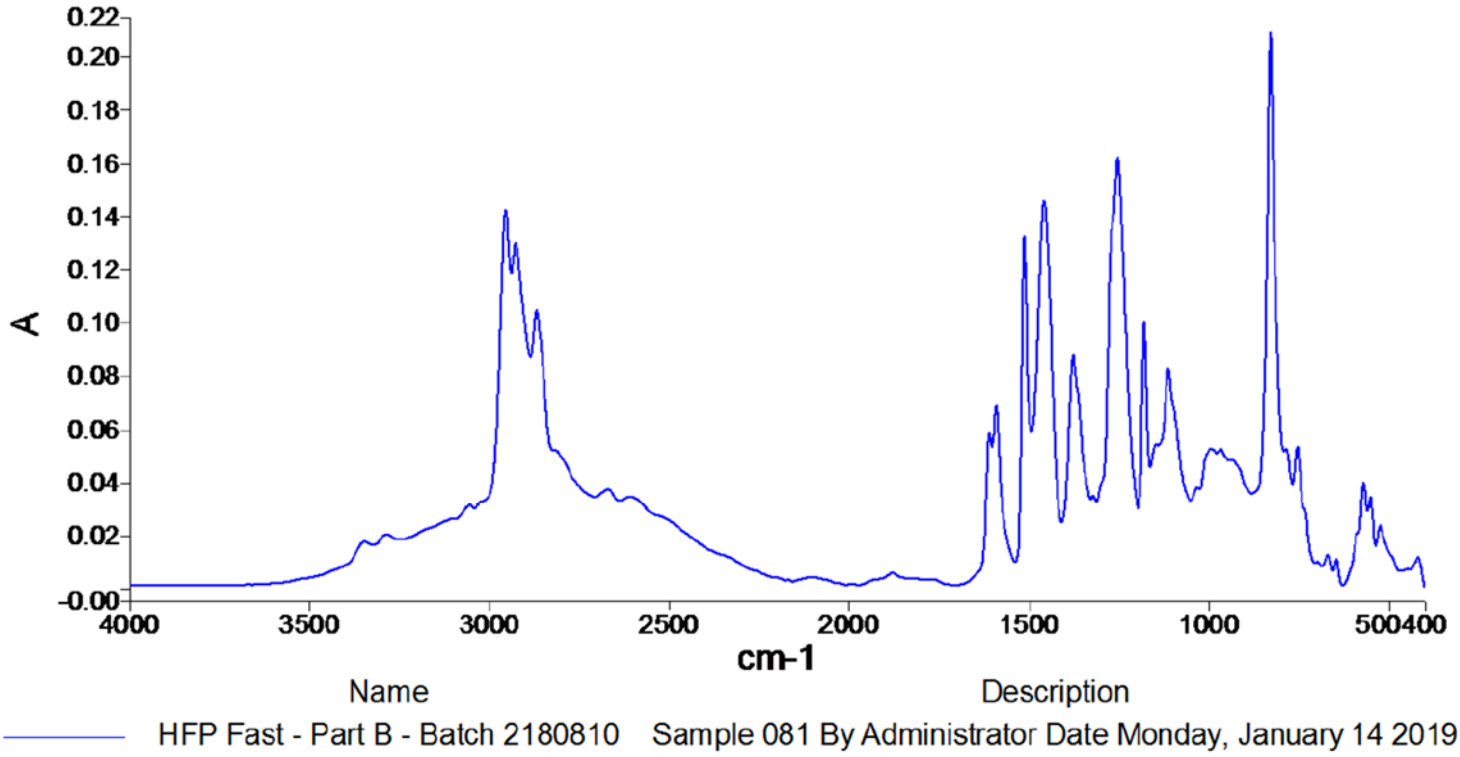

Figure 4 - Component B – Relative Peaks

Peak Number	Height (A)	Start	End	X (cm-1)	Y (A)
1	0.1432	4000	2941.66	2956.81	0.1432
2	0.1306	2941.66	2887.68	2928.68	0.1306
3	0.105	2887.68	1971.35	2870.95	0.105
4	0.0691	1971.35	1537.51	1591.18	0.0691
5	0.1333	1537.51	1492.88	1513.21	0.1333
6	0.1465	1492.88	1408.93	1457.7	0.1465
7	0.088	1408.93	1312.4	1377.17	0.088
8	0.163	1312.4	1195.67	1252.67	0.163
9	0.1006	1195.67	1162.61	1179.07	0.1006
10	0.0831	1162.61	1050.86	1112.18	0.0831

Peak Number	Height (A)	Start	End	X (cm-1)	Y (A)
11	0.0529	1050.86	879.89	993.64	0.0529
12	0.2098	879.89	766.83	827.93	0.2098
13	0.0538	766.83	626.89	752.74	0.0538
14	0.0404	626.89	400	568.56	0.0404