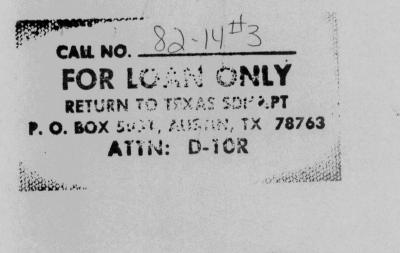
U.S. Department of Transportation

Federal Highway Administration

Demonstration Projects Program

Demonstration Project No. 55 Asphalt Emulsions for Highway Construction Erath County, Texas

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FHWA-DP-5

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Initial Report

January 1982

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Placement and Evaluation of a Seal Coat Using Emulsified Aspahlt -Initial Report

> FM 2157, Control 1990-1 Erath County, Texas

> > Report No. 543-1

by

Fred E. Atrip Senior Resident Engineer District 2

and

Jon Underwood Senior Research Engineer Transportation Planning Division

Texas State Department of Highways and Public Transportation

in cooperation with

Federal Highway Administration Region 15

Demonstration Study 1-2D-80-543 "Placement and Evaluation of a Seal Coat Using Emulsified Asphalt"

October, 1980

Introduction:

The use of asphalt emulsion in the highway industry is a technology that has been available to the highway engineer for many years. But because the price of asphalt was cheap, many engineers felt quality was improved using AC's, AC's and cutbacks could successfully be used in colder weather, and little or no concern was felt for the environment, asphalt emulsion has not gained widespread use.

Increased concern for the environment and spiraling prices for petroleum products have brought about increased interest in the use of emulsified asphalts in highway construction. This emphasis has been placed primarily in the construction of chip seals using emulsions.

In order to assess design and construction procedures, as well as roadway performance, an experimental section was placed in Texas. This section was placed by Texas State Department of Highways and Public Transportation maintenance personnel in conjunction with the Federal Highway Administration, Demonstration Projects Division, Region 15. This demonstration project was placed in Texas Highway District 2.

Preliminary Investigation:

This demonstration project is located on FM 2157 in the mid-eastern part of Erath County at a point from 2.09 miles east of US 281 to 0.4 miles west of the Erath-Hood County line, for a length of 12.29 miles. The average daily traffic on this experimental section, as of May 13, 1980, varies from 260 to 344 vehicles per day. This roadway has a very small percentage of trucks and a posted speed limit of 55 mph. This experimental section is a rural Farm to Market Highway with two 10-foot lanes, a maximum curvature of 6°00' and a maximum gradient of 5.98%.

The construction on this project consisted of three stages; the first stage was built in 1955 and consisted of 1.8 miles. The second stage was built in 1957 and had a length of 6.74 miles. The third stage was built in 1966 for a length of 3.75 miles. The base course is a pit-run caliche-type material, approximately 6 inches thick in good condition except for the failures indicated on the strip map in Appendix A.

The original surface was predominately free of excess asphalt and had a smooth texture. A number of level-ups had been applied to the surface at various locations as shown on the strip map in Appendix A.

The relatively low traffic volume on this roadway has helped keep accident statistics low. Accident information for the past year indicate two accidents occurred on this roadway with one of them occurring when the pavement was wet. The average skid number over this section of roadway prior to resurfacing was 35. This measurement was taken with a locked-wheel skid test trailer conforming to ASTM E-274.

The annual snowfall is 2.34 inches. The average relative humidity is 56%, and the annual rainfall is 28.9 inches averaged over the past 66 years. The average annual temperature is 64° F.

The drainage structures of concrete box construction are designed on a 5-year frequency and the pipe structures are designed on a 2-year frequency. The pavement has a design slope of $\frac{1}{4}$ "/ft. and a ditch depth of 1.5 ft. to 2.0 ft.

Design Criteria/Procedures:

The objective of this surface treatment or chip seal was to seal the existing surface and to provide improved skid resistance. The material selected for use was a CRS-2 emulsified asphalt.

The design rate of emulsion application was determined to be 0.35 to 0.40 gal./sq.yd. The Type B, Grade 4A aggregate was used at a coverage rate of one cubic yard of aggregate/110 to 120 square yards of surface area. The Type B, Grade 4A limestone aggregate met the following specification limits:

Percent by Weight

Retained on 5/8" sieve	0
Retained on 1/2" sieve	0-2
Retained on 3/8" sieve	20-45
Retained on No. 4 sieve	95-100
Retained on No. 10 sieve	99-100

The emulsified asphalt analyses revealed the following results: Average residual asphalt content 67.5% Viscosity at 122[®]F 274.5 sec.

 Demulsibility
 90%

 Penetration (5 sec. @ 77°F)
 152.5

 Percent solvent
 0.0

The source of the asphalt was Riffe Petroleum Co., Arlington, Texas. Since this job was done by State maintenance forces, there was no formal traffic control plan. Traffic was controlled by flagmen on each end. After each shot and the completion of each rolling operation, the flagman moved his operations to the beginning of the next shot. The lead flagman was stationed each time at the end of every emulsion shot.

The standard specifications of the Texas State Department of Highways and Public Transportation controlled the materials and construction of this experimental project with the exception of the modified aggregate gradation listed earlier.

Construction Criteria/Procedure:

Prior to the placement of the emulsified asphalt seal, an asphaltic concrete level-up was placed at all necessary locations as shown on the strip map in Appendix A. A rotary-power broom was used to sweep the surface of the entire job prior to application of the seal coat.

The construction of this experimental project began at 9:00 a.m. on July 29, 1980. The weather was hot with a light breeze. The pavement temperature at 9:00 a.m. was 100° F, and at 2:00 p.m., 120° F. The next day, July 30, the weather conditions were the same as the preceding day and the roadway temperature was 104° F at 10:00 a.m. and 122° F at 3:00 p.m. The emulsified asphalt was applied at an average temperature of 155° F and at an average rate of 0.359 gallons per square yard. The distributor used was a Rosco, Model No. RRE, Serial No. FD100418H, using No. 2 nozzles at a box height of ten inches. The emulsion was evenly applied across each lane.

The aggregate spreader was a Flaherty Model K, Serial No. 2271. The aggregate was spread at a rate of 1 c.y./115 square yards of surface area. Prior to spreading the aggregate, the stockpiles were moistened with water. For the entire project the emulsion was allowed to break prior to the application of the aggregate with the exception of approximately 25,000 ft. On this portion of the project, the aggregate was placed directly behind the distributor prior to the break of the emulsion. These two times of aggregate placement were to allow a side by side comparison of the two different times. See Appendix B.

The seal coat was applied to one half of the roadway for the entire length of the project then the remaining one half was sealed. Two 9-wheel SP-3000 pneumatic roll-o-pactors manufactured by Bros Division of American Hoist & Derrick were used on this project.

They were equipped with 10-ply tires at a pressure of 60 psi. Each had a maximum wheel load of 3,000 pounds which produces a ground contact area of 46 square inches and a ground contact pressure of 65 pounds per square inch. The rolling was continuous during the time the seal was applied.

All equipment used on this project was the property of the Texas State Department of Highways and Public Transportation and was in good operating condition.

Cost of Material:

As previously stated, the material used was a CRS-2 emulsified asphalt. A total of 54,300 gallons was used over an area of 151,385 square yards for an average rate of 0.359 gallons per square yard. The cost of the emulsion was \$147.32 per ton delivered to the project. This converts to approximately \$0.22 per square yard. The cost of an alternate material (asphalt cutbacks) was not available for this project.

If AC asphalt had been used for this project, a rate of 0.30 gallons/ sq. yd. as compared to 0.36 gallons/sq.yd. for the emulsion would have been sufficient for this type of seal.

Energy Consumption:

The total fuel used over the two-day period during construction was approximately 700 gallons of gasoline, 30 gallons of diesel and 320 gallons of kerosene.

The following equipment was used on the project:

- 7 aggregate haul trucks
- 1 aggregate spreader
- 1 aggregate loader
- 1 aggregate spot truck
- 1 paper joint truck

l rotary broom	2 pneumatic rollers
2 booster trucks	l water truck
l asphalt distributor	l equipment haul truck
l asphalt heater	6 pickups

1 asphalt pump

The energy calculations in Appendix C assume the same amount of fuel was used in the emulsion seal as would be used in a cut-back seal except for the additional fuel necessary to fuel the heaters for the elevated temperature of the cutback asphalt.

Environmental Considerations:

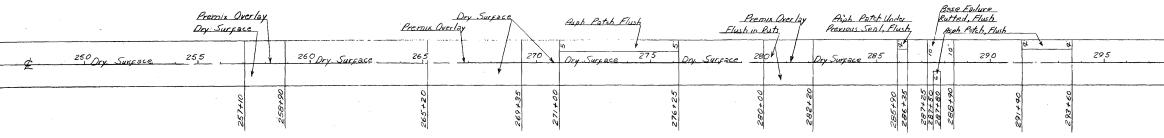
Since the location of this project is in a rural ranching area, there are no known environmental regulations for using asphalt emulsions or any other type of asphalt.

The air quality, as related to HC emission, was not considered applicable to this project. The effect of lower application temperatures for emulsion in relation to environmental considerations was found to be negligible. <u>Results:</u>

This experimental emulsified seal coat is performing excellently and further results will be reported annually in order to further assess its performance.

APPENDIX A

Begin of Project Flush in Ruts - Flush in Ruts Fresh Premix Overlay Premix Buildup Flush Fresh Premix Overlay Flush 150 Dry Surfoce. 125 135 Dry Surface 140 145 155 120 160 & Dry Surface 13 22+22 160+00 24+00 23+0 Old Aspb. Patch Under Previous Seal, Flush Aspb. Patch, Flush Flush in Ruts Old Asph Patch Under Previous Scal, Flush Old Asph Patch, Flush, Flush to Dry in Ruts Premix Overlay Premix Overlay Flush in Ruts Dry Surgace Premix Overlay Flush in Ruts Flush to Dry in Ruts Under Previous Seal Dry Surface Flush in Ruts Asph Seal Flush 200 225 Dry Surface 210 1215 Dry Surra 205 22 190 Dry Surface 180 Surgace 185 195 Dry Surgace 212+80 219+10 219+40 204+63 57+66, 208+00 203+15 213+13 188+75 01+621 Ð 96

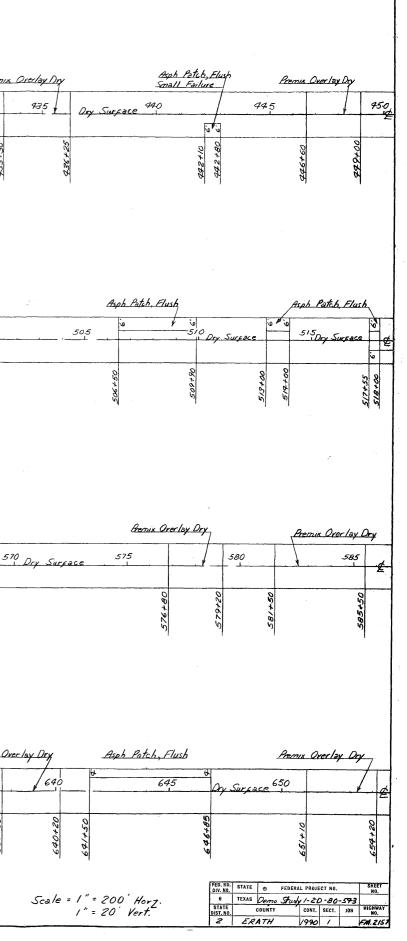


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APPENDIX B

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R. 1	R. CAR I	10.	MATERIAL	NET WT.	B. REP.	AMOUNT	R.	R. CAR NO.	MATER	AL NE	rwt.	LAB. RE	P. A	MOUNT
												· · · · · · · · · · · · · · · · · · ·		
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					ASP	HALT	APPLI	ATTON		1	1			
·			6	ENERAL	28.54	ALIXIJA				ASP	HALT			
F.	CRSE.	DIST.	p	NGTH	LENGTH	WIDTH	AREA	Aggr	Used	GALS.	GALS.	NET	TEMP	GALS /
2.	NO.	NO.	5TA.	to STA.	FT.	FT.	\$. Y.			START	END	NET GALS.	TEMP. • F.	GALS./ S. Y.
1	1	1	120+00	149+00	2900	11	3544	Rt	36	1550		1250	150	.35
8	1	1	149+00	178+00	2900	11	3544		32	1550		1500	150	. 42
8	1	1	178+00	207+00	2900	11	3544	19	32	1550	150	1400		1
4 	1	1	207+00	238+00	3100	+11	3789	**	36	1550		1500		a standing the second sec
3 		4	238+00	268+50	3050	11	3728		36	1550		1500		1
7	1	1	268+50 288+00	288+00	<u>1950</u> 2600		2383	19	<u>28</u> 30	1000	<u>100</u>	900		1
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	1	7	338+50	370+00	3150		3850	18	36	1550	100	1450		
)	1	1	370+00	402+00	3200	11	3911	11	42	1550		1470		
}	1	1	402+00	434+00	3200	11	3911	11	42	1550		1430		
3	1	1	434+00	466+00	3200	11	3911	**	42	1550	80			
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;		1	540+00	572+00	3200	11	3911	0¥ 	42	1550		1480		
	1	1	572+00	604+00	3200	11	3911	11	42	1600	180	1420		
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ource of Aggregate 1st Course							ASP	HALT		BLADING	ROLLING			
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ISTRUCTIONS: MAKE TWO COPIES, ONE FOR DISTRICT OFFICE AND ONE OR RESIDENT ENGINEER. TO BE PREPARED DAILY AND SUBMITTED T LEAST ONCE EACH WEEK.

marks:

Hand B Hampton Report No. 1 Inspector Page 1 of 4. Page 1 of 2

gals. per. S. Y.

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AV. RATE ;

13

TOTALS

Porms 187 Demo Study DAILY ROAD REPORT-ASPHALT FM 2157 1-2D-80-543 State Control No. 1990 Sec. 1 Job F. A. P. No. 7-29-80 Erath County. ype CRS-2 Seal Coat Contractor Dept, Hwys, & Pub, Trans. Date MATERIALS-RECEIVED R. R. CAR NO. MATERIAL NET WT. LAB. REP. AMOUNT R. R. CAR NO. MATERIAL NET WT. LAB. REP. AMOUNT ASPHALT APPLICATION ASPHALT GENERAL CRSE. DIST. LENGTH LENGTH WIDTH FT. AREA S. Y. R. R. CAR NO. CY GALS. GALS. END TEMP. 6ALS./ S. Y. NET GALS. STA. STA. 2933 30 1300 280 1020 155 . 348 632+00 656+00 2400 11 Rt 1 1 36 1520 200 1320 3200 3911 150 .338 1 688+00 11 1 656+00 88 718+00 3000 11 3667 36 1480 150 1330 150 .363 1 1 688+00 88 . 344 3280 11 4009 42 1400 20 1380 155 750+80 1 1 718+00 782 AGGREGATE SUMMARY OF DAYS WORK Ty B Gr 4A 213 urce of Aggregate 1st Course Zack Burkett ASPHALT BLADING ROLLING urce of Aggregate and Course Graham. Tex. IST COURSE GALLONS SQ. YDS. HOURS HOURS urce of Aggregate 3rd Course PREV. REPORT 0 0 0 ste Aggregate Applied 1st Course THIS REPORT 77,095 28,990 18.0 its Aggregate Applied ind Course TO DATE 28,990 77,095 18.0 tte Aggregate Applied \$rd Course AV. RATE .376 gals. per. S. Y. ASPHALT C.R.S. II 2ND COURSE urcs of Asphalt 1st Application Riffe Petrolsum Co PREV. REPORT urce of Asphalt and Application Arlington, Tex. THIS REPORT urce of Asphalt 3rd Application TO DATE me Work Began: 8:30 AM AV. RATE gals, per. S. Y. 5:00 PM me of Last Application: SRD COURSE me Work Finished: 5:30 PM PREV. REPORT sasons for Time Loss: THIS REPORT TO DATE AV. RATE / gals, per. S. Y. TOTALS 28,990 77,095 18.0 100° Surface at 9:00 AM marks: 120° Surface at 2:00 PM

NSTRUCTIONS: MAKE TWO COPIES, ONE FOR DISTRICT OFFICE AND ONE OR RESIDENT ENGINEER. TO BE PREFARED DAILY AND SUBMITTED T LEAST ONCE EACH WEEK.

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APPENDIX C

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Energy Requirements for Emulsion Seal

Energy Required to Produce Asphalt:

54,300 gal. x .67 x 2550 btu/gal. = 9.0953×10^7 btu Energy Required to Produce Emulsion:

54,300 gal. x 2715 btu/gal. = 1.4742 x 10⁸ btu Fuel Used on Job:

700 gal. gasoline x 125,000 btu/gal. = 8.75×10^7 btu 30 gal. diesel x 139,000 btu/gal. = 4.17×10^6 btu 320 gal. kerosene x 135,000 btu/gal. = 4.32×10^7 btu Total Energy requirement for Emulsion Seal: 3.7324 x 10⁸ btu

2985.9 equiv. gal. gasoline

Energy Requirements for Cutback Seal

*Assume cutback used to be RC-2, no other changes made from emulsion seal Energy required to produce cutback asphalt:

54,300 gal. x 58,800 btu/gal.** = 3.1928 x 10⁹ btu

Fuel usage assumed to be the same:

gasoline	8.75	х	10 ⁷	btu
diesel	4.17	х	10 ⁶	btu
kerosene	4.32	х	10 ⁷	btu

Additional btu's necessary to elevate heat of cutback to shoot temperatures:

300 btu/gal. x 54,300 gal. = 1.629×10^7 btu

***Energy required to dry aggregate:

to operate dryer

1722 ton x 4780 btu/ton = 8.2312×10^6 btu

aggregate drying assuming 5% water

 $1722 \text{ ton x } 1.4 \text{ x } 10^5 \text{ btu/ton} = 2.4108 \text{ x } 10^8 \text{ btu}$

Total Energy requirement for cutback seal:

 3.5933×10^9 btu

Equiv. gal. of gasoline = 28,746 gal.

Total energy requirement for cutback seal if aggregate drying not included = 3.344×10^9 btu

Equiv. gal. of gasoline = 26,752 gal.

**The 58,800 btu/gal. also includes the energy in the solvent.

***This procedure is not normally performed in Texas.

Theoretical net savings in energy reported in equivalent gallons of gasoline: Total energy requirement for

cutback seal:	3.5933 x 10 ⁹ btu
Total energy requirement for	
emulsion seal:	3.7324 x 10 ⁸ btu
Energy saved	<u>3.2201 x 10⁹ btu</u>
Equivalent gallons of gasoline	25,760

Total energy requirements for cutback seal as normally done in Texas: 3.344×10^9 btu

Total energy requirement

for emulsion seal:	3.7324 x 10 ⁸ btu
Energy saved	2.9708 x 10 ⁹ btu
Equivalent gallons of gasoline	23,766

Gallons of petroleum distillates required:

Emulsion - O

Cutback - 16,290

Gallon of petroleum distillates saved:

16,290

Energy saved by elimination of aggregate drying operation: \circ

2.4931 x 10⁸ btu

Equivalent gallons of gasoline:

1994.5