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Demonstration Projects Division
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Telephone: 703-557-0522
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 emulsified asphalt seal coat was placed in Texas. The material selected for the chip seal was a CRS-2 emulsified asphalt with a design rate of emulsion at .35 - .40 gal./yd². The aggregate was Type B, Grade 4A, at a coverage rate of 1 yd.³/110-120 yd. of surface. This report describes the construction procedures, material costs, energy consumption and savings, and performance of the section to date.
Placement and Evaluation of a Seal Coat Using Emulsified Asphalt - 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 ¼/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.

2
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:

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<td>Retained on No. 4 sieve</td>
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<td>Retained on No. 10 sieve</td>
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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
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.

Results:

This experimental emulsified seal coat is performing excellently and further results will be reported annually in order to further assess its performance.
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-- CTR Library Digitization Team
DAILY ROAD REPORT—ASPHALT

FM 2157 1-2D-80-543

Erath County

Demo Study

Type CRS-2 SEAL Coat

Control No. 1990 Sec. 1 Job F. A. P. No.

Contractor Dept. Hwy. & Pub. Trans. Date 7-30-80

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ASPHALT APPLICATION

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INSTRUCTIONS: MAKE TWO COPIES, ONE FOR DISTRICT OFFICE AND ONE OR RESIDENT ENGINEER. TO BE PREPARED DAILY AND SUBMITTED AT LEAST ONCE EACH WEEK.
DAILY ROAD REPORT—ASPHALT

Erath County

Type CRS-2 Seal Coat


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SUMMARY OF DAYS WORK 213

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NOTES:

- Marks: 104° surface temp at 10:00 AM
- 122° surface temp at 3:00 PM
- Sta 508+00 to 750+00 Rt side only, Not time asph, to brake.

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Inspector Report No. 12

Page 2 of 2
## ASPHALT APPLICATION

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### SUMMARY OF DAYS WORK

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## INSTRUCTIONS

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**DAILY ROAD REPORT—ASPHALT**

**FM 2157**

**Erath County**

**State**

**Control No.** 1990 Sec. 1

**Job** Demo Study

**F. A. P. No.** 1-2D-80-543

**Date** 7-29-80

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### ASPHALT APPLICATION

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#### AGGREGATE

Ty B Gr 4A

Source of Aggregate 1st Course: Zack Burkett

Source of Aggregate 2nd Course: Graham, Tex.

Source of Aggregate 3rd Course: 

Rate Aggregate Applied 1st Course:

Rate Aggregate Applied 2nd Course:

Rate Aggregate Applied 3rd Course:

### SUMMARY OF DAYS WORK

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| 2ND COURSE | PREV. REPORT | THIS REPORT | TO DATE | AVG. RATE | kals. per S. Y. |
| 3RD COURSE | PREV. REPORT | THIS REPORT | TO DATE | AVG. RATE | kals. per S. Y. |

**TOTALS** 28,990 77,095 18.0

### INSTRUCTIONS:

Make two copies, one for district office and one for resident engineer. To be prepared daily and submitted at least once each week.

**Remarks:**

- 100° Surface at 9:00 AM
- 120° Surface at 2:00 PM

---

**Inspector**

**Report No.** 1

**Page 2 of 2**
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-- CTR Library Digitization Team
Energy Requirements for Emulsion Seal

Energy Required to Produce Asphalt:

\[ 54,300 \text{ gal.} \times 0.67 \times 2550 \text{ btu/gal.} = 9.0953 \times 10^7 \text{ btu} \]

Energy Required to Produce Emulsion:

\[ 54,300 \text{ gal.} \times 2715 \text{ btu/gal.} = 1.4742 \times 10^8 \text{ btu} \]

Fuel Used on Job:

- 700 gal. gasoline \( \times 125,000 \text{ btu/gal.} = 8.75 \times 10^7 \text{ btu} \)
- 30 gal. diesel \( \times 139,000 \text{ btu/gal.} = 4.17 \times 10^6 \text{ btu} \)
- 320 gal. kerosene \( \times 135,000 \text{ btu/gal.} = 4.32 \times 10^7 \text{ btu} \)

Total Energy requirement for Emulsion Seal:

\[ 3.7324 \times 10^8 \text{ btu} \]

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:

\[ 54,300 \text{ gal.} \times 58,800 \text{ btu/gal.} = 3.1928 \times 10^9 \text{ btu} \]

Fuel usage assumed to be the same:

- gasoline \( = 8.75 \times 10^7 \text{ btu} \)
- diesel \( = 4.17 \times 10^6 \text{ btu} \)
- kerosene \( = 4.32 \times 10^7 \text{ btu} \)

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

\[ 300 \text{ btu/gal.} \times 54,300 \text{ gal.} = 1.629 \times 10^7 \text{ btu} \]
***Energy required to dry aggregate:

- to operate dryer
  
  \[
  1722 \text{ ton} \times 4780 \text{ btu/ton} = 8.2312 \times 10^6 \text{ btu}
  \]

- aggregate drying assuming 5% water
  
  \[
  1722 \text{ ton} \times 1.4 \times 10^5 \text{ btu/ton} = 2.4108 \times 10^8 \text{ btu}
  \]

Total Energy requirement for cutback seal:

\[
3.5933 \times 10^9 \text{ btu}
\]

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

Total energy requirement for cutback seal if aggregate drying not included =

\[
3.344 \times 10^9 \text{ btu}
\]

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:

\[
3.5933 \times 10^9 \text{ btu}
\]

Total energy requirement for emulsion seal:

\[
3.7324 \times 10^8 \text{ btu}
\]

Energy saved

\[
3.2201 \times 10^9 \text{ btu}
\]

Equivalent gallons of gasoline

25,760

Total energy requirements for cutback seal as normally done in Texas:

\[
3.344 \times 10^9 \text{ btu}
\]
Total energy requirement
for emulsion seal: $3.7324 \times 10^8$ btu
Energy saved $2.9708 \times 10^9$ btu
Equivalent gallons of gasoline 23,766

Gallons of petroleum distillates required:
   Emulsion - 0
   Cutback - 16,290
Gallon of petroleum distillates saved:
   16,290
Energy saved by elimination of aggregate drying operation:
   $2.4931 \times 10^8$ btu
Equivalent gallons of gasoline:
   1994.5