Separator

536-8

Sulphur Extended Asphalt Field Trials On MH 153, Brazos County, Texas

Progress Report No. 8

TTI Project 2536

FCIP Study No. 1-10-78-536-8

by

F. C. Benson

B. M. Gallaway

D. Saylak

Prepared for

The Texas State Department of Highways and Public Transportation

and

The Sulphur Institute

May, 1983

Sulphur Extended Asphalt Field Trials On MH 153, Brazos County, Texas

Purpose

The major purpose of this project was to conduct construction and post-construction testing and evaluation of a sulphur extended asphalt (SEA) experimental test section located on MH 153 (Wellborn Road in the cities of Bryan and College Station) in Brazos County, Texas. This section of roadway was in District 17 of the Texas State Department of Highways and Public Transportation (SDHPT) during planning and construction.

Background

During June, 1978, a 2700-foot (824-m) 2-lane section of a four-lane, undivided roadway being constructed as MH 153 (Municipal Highway) in Brazos County, Texas was selected for a demonstration of sulphur extended asphalt paving mixtures. A schematic layout of this demonstration section with trial test sections is shown in Figure 1. The construction of the experimental demonstration was made possible by a "Field Change" in the MH 153 contract between the SDHPT and Young Brothers, Inc., Contractors, with District 17 of the SDHPT providing the engineering construction inspection and supervision.

Separate from the agreement between the State (SDHPT) and Young Brothers was an agreement between the Sulphur Institute and Young Brothers whereby the Sulphur Institute would reimburse the contractor for costs required for handling and utilization of the sulphur above the payments (bid price) received from the State for the placement of the conventional

Estimated Tons of Paving Mix Required:

Pavement: Finished width 26 ft (7.9 m); length 2,700 ft (824 m); area 7,800 sq yds (6522 m^2)
Mix: Quantity of mix/sq yd estimated at 660 lbs (299 kg); total tons 2, 574 (2335 Mkg)

Layout:

Southbound Lanes

2700 ft (824 m) Total Length
(Direction of Travel ⟶)

40/60 SEA Job Mix Formula	40/60 SEA 75:25 Bank Run Gravel: Field Sand	30/70 SEA 75:25 Bank Run Gravel: Field Sand	30/70 SEA 75:25 Bank Run Gravel: Field Sand	40/60 SEA 50:50 Conc. Sand:Field Sand	30/70 SEA 50:50 Conc. Sand:Field Sand
Section 2 450 ft (137 m)	Section 3 450 ft (137 m)	Section 4 450 ft (137 m)	Section 5 450 ft (137 m)	Section 6 450 ft (137 m)	Section 7 450 ft (137 m)
Section 1 (Control)					Section 8 (Control)

Stations: 48+00, 52+50, 57+00, 61+50, 66+00, 70+50, 75+00

Notes: 1) Sulphur-asphalt binder was optimized on a volume substitution basis
2) Sulphur-asphalt binder for Section 5 was prepared by bypassing emulsion mill

Nomenclature:

Job Mix Formula: 55:30:15 Bank Run Gravel:Pea Gravel:Field Sand with 5 pct wt pure asphalt (Mix used for conventional asphalt concrete in Section 1 etc.)

SEA: Sulphur-extended-asphalt - 30/70 and 40/60 are ratios of sulphur to asphalt by weight

Figure 1 General layout of field test sections, MH 153, Brazos County, Texas (South Bound Lanes) asphalt cement binder pavement which the trial sections replaced.

The two principal objectives of these field trials were (1) to compare mixtures with sulphur-asphalt emulsion binders prepared in a colloid mill with one mixture prepared by comingling the molten sulphur and hot asphalt in a bypass line leading directly to the weigh batch plant pugmill, and (2) to investigate the upgrading of local marginal siliceous aggregates through the addition of sulphur to the mixtures containing these materials.

Two major reports are available concerning these field trials on MH 153. Report FHWA-TS-80-214 by Izatt and Gallaway (1) describes the construction details of the project. This description includes details of materials, mixture designs, equipment used, materials handling, quality control and evolved gas emissions data. Report FHWA/TX-82/36 + 536 - 7 (2) describes the testing and evaluation that has been accomplished on MH 153 from July 1978 through November 1981.

Following construction, Texas Transportation Institute (TTI) personnel have collected cores and conducted testing on MH 153 according to the periods specified in the testing matrix shown in Figure 2. The series of tests conducted for each period is as outlined in Figure 2.

This present report, Progress Report No. 8, provides an updating based on testing conducted on MH 153 from December 1981 to December 1982. Testing conducted during this period included pavement visual evaluation to determine a pavement rating score, PRS; total traffic and truck counts; the taking of slide pictures and an unscheduled checking of Mays Ride Meter, MRM, values for MH 153 in April, 1982. A discussion of the results of the above testing is given below.

Test Description	Evaluation Within One Week After Open to Traffic (T_o)	November 1978 T_o + 6 mo.	June 1979 T_o + 12 mo.	June 1980 T_o + 24 mo.	November 1981 T_o + 41 mo.	March 1982 T_o + 45 mo.
1. Traffic Analysis						
a. Average Daily Traffic Count						
b. Truck and Axle Weight Distribution				continuous		
(Loadmeter survey for one week)	x				x	
2. Visual Evaluation	x	x	x	x	x	
3. Mays Meter	x	x	x	x	x	
4. Dynaflect Deflections	x	x	x	x	x	
5. Cored Samples						
a. Density	x	x	x	x	x	
b. Stability, Marshall	x	x	x	x	x	
c. Stability, Hveem	x	x	x	x	x	
d. Resilient Modulus	x	x	x	x	x	
e. Indirect Tension	x	x	x	x	x	
f. Rice Specific Gravity	x					
6. Progress Reports	x	x	x	x	x	
7. Interim Report		x				
8. Final Report						x

Figure 2. Testing matrix for MH 153.

Test Description	December 1982 To + 54 mo.	June 1983 To + 60 mo.
1. Traffic Analysis		
a. Average Daily Traffic Count	x	
b. Truck and Axle Weight Distribution (Loadmeter survey for one week)	x	
2. Visual Evaluation (*Including slide pictures)	x*	x*
3. Mays Meter		x
4. Dynaflect Deflections		x
5. Cored Samples		x
a. Density		x
b. Marshall Stability		x
c. Hveem Stability		x
d. Resilient Modulus, M_R		x
e. Indirect Tension		x
f. Rice Specific Gravity		x
6. Progress Reports	x	x
7. Interim Reports		
8. Final Reports		

Figure 2. (Continued) Testing matrix for MH 153.

Test Results

Table 1 provides an analysis of the traffic data obtained for MH 153 from 1977 through 1982. Analysis results shown through 1981 are based upon estimates and projections provided by D-10 (Division 10) of the SDHPT. The results for 1982 are based upon actual counts obtained by TTI personnel on the MH 153 roadway and, for the weight data, upon SDHPT computer estimates using TTI data of observed numbers of trucks of different axle configurations.

Table 2 provides a summary of pavement rating score, PRS, values for five visual pavement evaluations that have been made on MH 153 from December 1978 through December 1982. These pavement evaluations have been made in the travelled or outside lane of the MH 153 southbound lanes.

Table 3 is included in this report because the TTI Mays Ride Meter was employed on April 12, 1982 to verify serviceability index results, SI's, previously obtained on December 8, 1981.

Discussion of Results

As Table 1 indicates, an average daily traffic, ADT, of 14,180 was determined by actual traffic counts by TTI personnel, from the average of two consective 24-hour counts. This traffic count is much higher than the value for the 1981 traffic increased by a factor of 0.086 and thus indicates that the estimates of total traffic used from 1977 to 1981 were not high enough to reflect the actual growth.

Directional distribution factor and design hourly volume, DHV, figures determined from TTI actual traffic counts are very close to those

Table 1. Traffic analysis for MH 153.

	Year of Study						
	1977	1978	1979	1980	1981	1982	1983
1. Average Daily Traffic (ADT)	7680	8340	9060	9840	10,690	14,180	
2. Directional Distribution Factor, percent	60-40	60-40	60-40	60-40	60-40	64-36	
3. Design Hourly Volume (DHV), percent	11.7	11.7	11.7	11.7	11.7	11.8	
4. Percent Trucks							
a. ADT	6.1	6.1	6.1	6.1	6.7	2.2	
b. DHV	4.1	4.1	4.1	4.1	4.1	1.1	
5. Anticipated Annual Growth Rate, percent	8.6	8.6	8.6	8.6	8.6	13.0*	
6. Average of Ten Heaviest Wheel Loads Daily (ATH WLD)	10,800 lb (4903 kg)	10,800 lb (4903 kg)	10,800 lb (4903 kg)	10,800 lb (4903 kg)	12,600 lb (5720 kg)	9,100 lb (4123 kg)	
7. Tandem Axles in ATHWLD, percent	60	60	60	60	60	50	

* See discussion on page 10.

Table 2. Pavement rating scores, PRS, for MH 153.

	PRS Values				
Dates of Evaluations	12/18/78	6/29/79	12/12/80	12/1/81	12/20/82
Section, Binder and <u>Aggregate Type</u>					
Section 2: 40/60 SEA, Job Mix Formula	100	100	83	83	85
Section 3: 40/60 SEA, 75:25 Bank Run Gravel: Field Sand	100	98	88	85	83
Section 4: 30/70 SEA, 75:25 Bank Run Gravel:Field Sand	100	97	93	85	85
Section 5: 30/70 SEA 75:25*, Bank Run Gravel:Field Sand	100	98	93	85	85
Section 6: 40/60 SEA, 50:50 Concrete Sand:Field Sand	100	100	93	88	87
Section 7: 30/70 SEA, 50:50 Concrete Sand:Field Sand	100	100	88	80	80
Section 8: 0/100 AC Control	100	100	93	85	83

*Sulphur-asphalt binder was prepared by bypassing the colloid mill.

Table 3. Results of Mays Ride Meter at intervals of 0.05 and 0.20 miles for MH 153**. Readings are interms of serviceability index, SI.

Section No.											
Station No.	48+00		52+50	57+00	61+50		66+00	70+50		75+00	Date of Test
Ride Meter Readings											
At 0.05 mile	4.2	3.9	4.0	4.1	4.5	4.4	4.1	3.9	1.8	3.2	12/18/78
At 0.20 mile				4.1				4.2			
At 0.05 mile	3.6	3.9	3.7	3.9	3.8	4.4	4.5	3.9	2.1	3.2	5/18/79
At 0.20 mile				3.8				3.7			
At 0.05 mile	---	---	---	---	---	---	---	---	---	---	9/8/80*
At 0.20 mile				---				---			
At 0.05 mile	3.2	3.3	3.1	3.1	3.3	3.0	2.7	2.8	2.9	3.7	12/8/81
At 0.20 mile				3.3				3.0			
At 0.05 mile	2.5	2.9	2.8	3.4	3.4	2.9	2.6	2.5	2.7	3.1	4/12/82
				2.8				2.7			

*SI readings taken this date were incorrect due most likely to the Mays Meter being out of calibration and are therefore omitted.

**Results shown are for tests in traveled lane (outside) only.

Metric Conversion: 1 mile = 1.609 km.

estimated previously by D-10 of the SDHPT.

Two of the more significant differences between TTI observed traffic data and the SDHPT estimates are the values for percent trucks of ADT and DHV. As seen in Table 1, the TTI percent trucks of ADT is only 2.2 percent and of DHV only 1.1 percent, as compared to SDHPT estimated percentages of 6.7 and 4.1 respectively for 1981. The TTI figures are based on one 12-hour count of trucks on a Monday from 7:00 a.m. to 7:00 p.m. It is highly probable that the TTI percentages would have risen somewhat from a 24-hour count, but the type of trucks seen using MH 153 would seem to indicate a very small increase for nighttime usage.

During the 12-hour count, a total of 308 trucks heavier than the panel and light pickup category was observed. Of this total, 164 or 53 percent consisted of 2-axle trucks with dual rear wheels, and 60 or 19 percent consisted 3-axle trucks of which 59 were transit mix concrete trucks. The 2-axle trucks were primarily involved in service or construction related activities. Approximately one-half, or 30 of the concrete trucks were using the SEA binder trial lanes loaded, and they returned to their batch plants unloaded via the northbound lanes of MH 153. The SDHPT "Traffic Classification and Density Report" showing the axle configurations of the trucks observed is attached to this report.

Based on the 1977 traffic estimate of 7,680 and the average count of 14,180 for 1982, an estimated annual growth rate of 13.0 percent is calculated and presented in Table 1. This figure is very high for a growth rate probably for the reason that estimated and observed traffic are being correlated. When actual traffic counts are taken again in 1983, a more realistic percentage for growth rate will probably be obtained.

Table 2 shows that the PRS values from visual evaluations of Sections 2 through 8 have not changed appreciably from December 1981 to December 1982. This is another way of saying that the condition or situation of the pavement surface for each of the trial sections has apparently changed very little during 1982.

In one situation, the PRS value went up from the 1981 to the 1982 evaluation. This occurred for the SEA section 2. There are two probable reasons for this: (1) although the rater has been the same since 1980, his estimation concerning the severity of longitudinal cracking has possibly changed over the three rating periods and (2) the trial sections are long enough to yield different PRS values if the evaluation is made in only one or possibly two small lengths in a section.

The main distress types that have occurred in the trial sections to date consist of largely longitudinal cracking and some alligator cracking that has become evident since 1980. Rutting as of December 1982 has been very acceptable, ranging from as little as three to eight millimeters maximum in the wheelpaths of the traveled lane. A copy of the December 1982 pavement evaluation form is attached to this report.

Table 3 shows that the TTI Mays Meter readings for SI taken in April 1982 are approximately the same as those taken in December 1981. Thus the April readings verify those taken in 1981, apparently.

Financial Statement for Project 2536

Total Fund Authorized 1982 - 1983	$7,184.00
Fund Expended to March 31, 1983	$ 121.08
Remaining Balance	$7,062.92

Conclusions

Perhaps the most surprising results of the 1982 data acquisition on MH 153 as shown in Table 1 concern the analysis of the traffic counts taken. The 1982 ADT of 14,180 vehicles per day shows a much larger traffic growth rate of approximately 13 percent since 1977 instead of the estimated 8.6 percent through 1981. The 1982 percentage of trucks shown using MH 153 by actual count is only one-third of that estimated for 1981. Also, the Average of Ten Heaviest Wheel Loads Daily (ATHWLD) based on actual observed trucks in 1982 is down considerably from the 1981 estimated values.

The low percentage of trucks for 1982 may be partly due to a depressed economy which has affected even the Bryan-College Station area. The day on which the trucks were counted, however, was a clear, sunny day that was suitable for construction activities.

Based on the results in Tables 2 and 3, there appear to be little change in the surface conditions, as shown by PRS values, of the seven trial sections on MH 153. The main types of distress noted are slight to moderate states of alligator and longitudinal cracking. The maximum rut depth observed in the right wheel path of the travelled lane was no more than 8 millimeters or less than three-eights of an inch.

Mays Ride Meter values have generally declined somewhat since 1981, but the declines are not severe. These readings have tended to stabilize in the last two years, for Sections 3 through 7, as shown from Station 57+00 through approximately 59+00 in Table 3.

References

1. Izatt, J. O. and Gallaway, B. M., "Sulphur Extended Asphalt Field Trials - MH 153 Brazos County, Texas, a detailed construction report", Report FHWA-TS-80-214, prepared by Texas Transportation Institute for the Federal Highway Administration, Offices of Research and Development, Implementation Division (HDV-22), Washington, D. C., 20590, December, 1979.

2. Benson, F. C. and Gallaway, B. M., "Sulphur-Extended-Asphalt Field Trials - MH 153 Brazos County, Texas", Report FHWA/TX-82/36 + 536-7, prepared by Texas Transportation Institute for the Federal Highway Administration, Office of Research, Development and Technology, Washington, D. C., 20590, November, 1982.

Selected References

1. Epps, J. A., Meyer, A. H., Larrimore, I. E., Jr., and Jones, H. L., "Roadway Maintenance Evaluation User's Manual", Research Report 151-2, Texas Transportation Institute, September, 1974.

2. Goss, C. L., Hankins, K. D., and Hubbard, A. B., "Equipment for Collecting Pavement Roughness Information", Department Research Report No. 2-1, Texas State Department of Highways and Public Transportation, December, 1976.

Form No T-15 B
File 10-32

Traffic Classification and Density Report

TEXAS HIGHWAY DEPARTMENT
PLANNING SURVEY DIVISION

IN COOPERATION WITH
U S DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

County BRAZOS

Station No WESTGATE SHOPPING CENTER Weather SUNNY, HAZY, P.C., BREEZY, WARM TO COOL Date FEBRUARY 14 19 83 Day MONDAY (BY FRED C. BENSON

Highway No MH153-WELLBORN ROAD To In Cities of Bryan and College Station Direction from Station SOUTHBOUND (SEA) Hours 7:00 A.M. to 7:00 P.M.

Hour	Passenger Cars: Standard and Compact: Local	Standard and Compact: Foreign	Small: Local	Small: Foreign	Trucks: Single Unit: Panel and Pickup	Single Unit: Other 2 Axle: Single Rear Tire	Other 2 Axle: Dual Rear Tire	Single Unit: 3 Axle	Combinations: Tractor-Truck: Semitrailer: 3 Axle	Semitrailer: 4 Axle: 2S2	Semitrailer: 4 Axle: 3S1	Semitrailer: 5 Axle	Semitrailer: 6 Axle or More	Semitrailer Trailer: 5 Axle	Semitrailer Trailer: 6 Axle or More	Truck & Trailer: 3 Axle	Truck & Trailer: 4 Axle	Truck & Trailer: 5 Axle	Truck & Trailer: 6 Axle or More	Buses: School	Buses: Other: 2 Axle	Buses: Other: 3 Axle	Motorcycles & Motorscooters	Totals	Light Trailers: 1 Axle: Pass	1 Axle: P-P	2 Axle: Pass	2 Axle: P-P	3 Axle: Pass	3 Axle: P-P	
Total SOUTHBOUND →						7	77	30	3	6		3								7	1							5			139
Highway No MH153-WELLBORN ROAD To Direction from Station NORTHBOUND																															
Total NORTHBOUND →						10	87	30	3	5		8								11	3							12			169
GRAND TOTAL						17	164	60*	6	11		11								18	4							17			308

*All but 1 of those trucks were concrete trucks. Concrete trucks were loaded on Southbound SEA lanes, and unloaded on Northbound lanes.

CARD NO. 1

DISTRICT NO.	17
RATERS	BENSON, FRED C.
	MARTINEZ, FRED
DATE	MONTH 12 DAY 20 YEAR 1982

PAVEMENT

Distress	Unit	Ratings
RUTTING	%AREA	① 1-15 ② 16-30 ③ >30
RAVELING	%AREA	① 1-15 ② 16-30 ③ >30
FLUSHING	%AREA	① 1-15 ② 16-30 ③ >30
CORRUGATIONS	%AREA	① 1-15 ② 16-30 ③ >30
ALLIGATOR CRACKING	%AREA	① 1-5 ② 6-25 ③ >25
LONGITUDINAL CRACKING	LIN FT PER STA/LN	① 10-99 ② 100-199 ③ >200
TRANSVERSE CRACKING	NO. PER STA	① 1-4 ② 5-9 ③ >10
CRACKS (1) SEALED (2) PARTIALLY SEALED (3) NOT SEALED		
PATCHING	%AREA	① 1-5 ② 6-15 ③ >16
FAILURES/MILE		① 1-5 ② 6-10 ③ >10
SHOULDER (1) YES (2) NO		

LOCATION

DISTRICT NO.	SECTION NO.	COUNTY NO.	HIGHWAY NO.	CONTROL	SECTION	FROM	TO	LANE (TRAVELED)	MAYS METER	RUTTING	RAVELING	FLUSHING	CORRUGATIONS	ALLIGATOR SLIGHT	ALLIGATOR MODERATE	ALLIGATOR SEVERE	LONGITUDINAL SLIGHT	LONGITUDINAL MODERATE	LONGITUDINAL SEVERE	TRANSVERSE	CRACKS	PATCHING GOOD/FAIR/POOR	FAILURES	SHOULDER	SN AVG/LOW/HIGH	SURFACE TEXTURE IWP/BWP/OWP	ADT LANE
17			MH153- WELLBORN		2			R						1			2										
			ROAD- SB LANES		3			R						0/1				2									
					4			R										2									
					5			R							1		1										
					6			R							0/1		1										
					7			R							1			1									
					8 (CONTROL)			R							0/1			1									

NOTES:

1. AVERAGE RUT DEPTHS, MILLIMETERS

SEC	LWP	RWP
2	7	6
3	6	7
4	8	8
5	5	6
6	4	7
7	3	6
8	4	5

1-INCH = 25.4 MM; 1/2" = 12.7 MM

2. TAKEN IN LANE R, THE TRAVELED LANE.