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16. Abstract

This report is a part of the continuing post-construction evaluation of a sulphur extended asphalt field trial located on U.S. 69 near Lufkin, Texas.

It contains a discussion of the background methods of testing. In-situ test results and laboratory test results on cores are presented in tabular form with respect to pavement age.

No significant distress in any of the pavement subsections has been evident to date.

Other reports on this test section include: (1) a construction report, (2) "Post Construction Evaluation of Sulphur-Asphalt Pavement Test Sections", Interim Report No.1, January, 1976; (3) "Post Construction Evaluation of Sulphur-Asphalt Pavement Test Sections", Interim Report No. 2, October, 1976; (4) "Post Construction Evaluation of Sulphur-Asphalt Pavement Test Sections", Interim Report No. 3, May, 1977; (5) "Post Construction Evaluation of U.S. 69 Sulphur-Asphalt Pavement Test Sections in Lufkin, Texas", Interim Report No. 4, October, 1977; (6) "Post Construction Evaluation of U.S. 69 Sulphur-Asphalt Pavement Test Sections in Lufkin, Texas", Interim Report No. 5, September, 1978, (7) "Post Construction Evaluation of U.S. 69 Sulphur-Asphalt Pavement Test Sections in Lufkin, Texas", Interim Report No. 6.

Additionally, another report has been prepared and submitted, a final report on the first phase of the post construction evaluation covering the period September,1975 through April,1980.

17. Key Words	18. Distribution Statement
Sulphur, Asphalt, Sulphur Extended Asphalt, Marginal Aggregate	Unlimited

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Post Construction Evaluation

Of

U.S. 69 Sulphur-Asphalt Pavement Test Sections

In

Lufkin, Texas

Introduction and Background

During September 1975, a 3,650 foot (1,113 m) section of roadway being constructed on U.S. 69 in Angelina County, Texas under FCIP Study No. 1-10-75-512, Contract No. 199-4 was set aside for a demonstration test of hot-mixed sulphur-extended-asphalt (SEA) pavement sections. These sections were constructed with a sulphur-asphalt emulsion in accordance with a process developed by Societe Nationale des Petroles d'Aquitaine (SNPA).

After placement of the completed pavement, cores were taken by personnel of the State Department of Highways and Public Transportation (SDHPT) District 11 and testing was completed in accordance with the test matrix shown in Figure 1. This set of cores was designated as "Preliminary" in the identification scheme. Cores have been taken at approximately 6 month intervals after the initial testing period.

In November 1978, a sixth shipment of cores was obtained from District 11. These cores were taken from the road about 24 months after the road was opened to traffic (36 months after completion of construction).

In March and April of 1981 data collection began and this information forms the base of this interim report, the ninth in the series.

Purpose

To comparatively evaluate post-construction performance of pavement test sections composed of sulphur-extended-asphalt (SEA) mixture and asphaltic concrete (AC) mixtures.

Test Procedures

Laboratory testing of cores followed the methods listed below.

ASTM D 2041-71	Test for Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures (Density)
ASTM D 1559-73	Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 1560-65	Tests for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus

	PRELIMINARY	INITIAL	6 Mo.	12 Mo.	18 Mo.	24 Mo.	36 Mo.	48 Mo.	67 Mo
1. Traffic analysis									
a. Average daily traffic count						CONTINUOUS			
b. Truck and axle weight distribution									
2. Visual inspection	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
3. Mays Meter (psi)	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
4. Benkelman Beam deflections	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Deleted	
5. Dynaflect deflections	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
6. Core samples*									
a. Field density and Rice specific gravity	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
b. Stability, Marshall	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
c. Stability, Hveem	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
d. Resilient Modulus	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
e. Indirect Tension	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
f. Thermal expansion	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ

Loadmeter survey, 1 week duration
Evaluations on both sulphur-asphalt and conventional asphaltic concrete
*Set of 6 cores (minimum) at each test section per sampling period

Figure 1. Test matrix for US 69, Lufkin, Texas, sulphur-asphalt trial.

As per Schmidt	(1) Resilient Modulus
ASTM C 496-71	Test for Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM D 2041-71	Test for Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures (Rice Specific Gravity)

Table 1 is a summary of all field core test results up to April 1981.

In-Situ Testing

A variety of condition and performance on-site testing was conducted by District 11. This testing included Dynaflect deflection and Mays Ride Meter. These data are reported according to the lane in which the tests were run. Lane A is the inside (passing) lane and lane B is the outside (travelling) lane.

Table 2 presents a summary of the stiffness coefficients of the subgrade and pavement for the various test sections. These were calculated by the STIF 2 computer program from Dynaflect deflections. Table 3 shows the maximum Dynaflect deflections and surface curvature indexes computed by STIF 2. The Dynaflect measurements were taken in accordance to the procedure set forth by Scrivner and Moore (2).

Table 4 is a presentation of the visual inspection and traffic analysis for the entire field trial. The traffic analysis was prepared by the SDHPT Planning Office in Austin, Texas. The pavement rating score (PRS) was determined by the method suggested by Epps, et al (3).

Table 5 shows the serviceability index of each section as taken from Mays Ride Meter readings collected up to the present time. The operation of the Mays Ride Meter is discussed in Reference 5. As of 1981 the ride quality of all test sections is excellent.

Discussion of the Results

From Table 1 it may be noted that the density of all the materials under consideration has increased with time. The most notable of the materials is the SEA mixture with the 5.65 percent binder content which has increased about 10 pcf (160 kg/m^3). This occurrence was due to the compaction of traffic for the past six years. Of the hot sand mixtures the most notable density increase, 9 pcf (144 kg/m^3), was in the SEA mixture with 6.35 percent binder. Most of the increase in density took place in the early life of the pavement.

The Hveem stabilities values for all hot-mix asphaltic concrete (HMAC) materials are comparable and average about 27 percent. Likewise, Hveem stabilities for all hot sand mixtures are about 21. The Marshall stabilities of the HMAC mixture generally show comparable values between the AC mixture and the SEA mixtures with 5.65 percent binder

Table 1. Field Core Test Results According to Binder Type and Content for All Test Periods.

Mixture Type	Binder Content Percent	Density pcf	Air Voids, Percent	Hveem Stability, Percent	Marshall Stability, lbf	Marshall Flow, 0.01 in.	Splitting Tensile, psi	Resilient Modulus, 10^6	Date	Rice Max. Specific Gravity
HMAC (AC)	4.8	138	9	21	390	16	50	0.24	9/75(0)*	2.43
		140	8	27	610	14	155	0.07	8/76(11)	
		143	6	31	1200	13	120	0.55	3/77(18)	
		139	8	27	1140	13	180	0.63	9/77(24)	
		144	5	28	1200	14	150	0.60	3/78(30)	
		144	5	28	1140	14	200	1.13	9/78(36)	
		145	5	26	900	13	180	0.78	9/79(48)	
		144	4	27	1130	13	198	0.68	4/81(67)	
HMAC (SEA)	4.8	138	10	22	430	15	35	0.29	9/75(0)	2.45
		140	8	26	50	16	95	1.11	8/76(11)	
		142	7	27	1230	13	115	0.51	3/77(18)	
		139	9	26	490	13	125	0.70	9/77(24)	
		143	6	29	970	14	115	0.74	3/78(30)	
		142	7	27	690	14	145	1.12	9/78(36)	
		146	5	30	840	14	150	0.98	9/79(48)	
		144	6	30	1210	11	142	0.87	4/81(67)	
HMAC (SEA)	5.65	136	11	19	210	14	35	0.24	9/75(0)	2.44
		142	7	28	690	13	135	0.66	8/76(11)	
		144	5	30	1260	14	105	0.69	3/77(18)	
		144	5	31	660	14	170	0.82	9/77(24)	
		144	5	27	1410	13	134	0.61	3/78(30)	
		146	4	30	1000	13	185	1.02	9/78(36)	
		143	6	30	920	13	165	1.21	9/79(48)	
		147	2	33	1210	11	177	0.79	4/81(67)	

Table 1. (Continued).

Mixture Type	Binder Content Percent	Density pcf	Air Voids, Percent	Hveem Stability, Percent	Marshall Stability, lbf	Marshall Flow, 0.01 in.	Splitting Tensile, psi	Resilient Modulus, 10^6	Date	Rice Max. Specific Gravity
Hot Sand AC	5.4	116	23	15	210	15	30	0.14	9/75(0)*	2.43
		120	21	19	970	17	90	0.26	8/76(11)	
		122	20	22	1110	14	95	0.29	3/77(18)	
		124	18	27	900	17	115	0.33	9/77(24)	
		122	20	23	1310	15	110	0.32	3/78(30)	
		121	20	19	1090	13	135	0.43	9/78(36)	
		126	17	24	1370	13	135	0.51	9/79(48)	
		125	17	27	2000	14	139	0.58	4/81(69)	
Hot Sand (SEA)	6.0	113	26	21	170	13	30	0.13	9/75(0)	2.45
		119	22	26	730	14	75	0.31	8/76(11)	
		120	22	21	910	13	70	0.26	3/77(18)	
		121	21	23	460	15	90	0.36	9/77(24)	
		122	20	19	1080	16	90	0.27	3/78(30)	
		121	21	20	580	11	135	0.33	9/78(36)	
		124	19	22	550	11	95	0.41	9/79(48)	
		124	18	24	790	13	86	0.46	4/81(67)	
Hot Sand (SEA)	6.35	115	24	20	20	15	30	0.14	9/75(0)	2.42
		122	19	24	980	13	95	0.30	8/76(11)	
		122	19	20	840	13	85	0.23	3/77(12)	
		129	15	22	500	10	110	0.24	9/77(24)	
		123	19	21	680	13	90	0.25	3/78(30)	
		124	18	23	470	11	89	0.31	9/78(36)	
		123	18	22	460	9	90	0.37	9/79(48)	
		124	19	24	880	12	99	0.45	4/81(67)	

Table 1. (Continued).

Mixture Type	Binder Content Percent	Density pcf	Air Voids, Percent	Hveem Stability, Percent	Marshall Stability, lbf	Marshall Flow, 0.01 in.	Splitting Tensile, psi	Resilient Modulus, 10^6	Date	Rice Max. Specific Gravity
		117	23	24	140	18	30	0.20	9/75(0)*	2.42
		122	19	22	510	14	20	0.29	8/76(11)	
Hot Sand (SEA)	7.1	125	17	25	850	13	75	0.26	3/77(18)	
		126	17	22	540	12	115	0.27	9/77(24)	
		124	18	21	570	13	85	0.24	3/78(30)	
		124	18	19	440	11	100	0.32	9/78(36)	
		125	17	21	480	11	90	0.36	9/79(48)	
		125	18	21	820	14	89	0.44	4/81(67)	

1 pcf = 16.01 kg/m^3
1 lbf = 4.45 N

1 in. = 25.4 mm
1 psi = 6.89 kPa

*Pavement age in months from date of construction

Table 2. Stiffness Coefficients of Subgrade and Pavement as Computed by STIF 2.

Station	Total Pavement Depth (in)	Material	Thickness (in)	Stiffness Coefficient of Subgrade		Stiffness Coefficient of Pavement		Date
				Lane A**	Lane B	Lane A	Lane B	
Sec. 10				0.24	0.25	1.26	1.16	9/75(0)*
				0.24	0.26	1.35	1.13	3/76(6)
167+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	0.26	0.26	0.86	0.98	9/76(12)
to		4.8 A.C. HMAC	7.00	0.25	0.25	1.19	1.02	3/77(18)
170+50				0.22	0.21	1.36	1.54	9/77(24)
				0.24	0.24	1.20	1.18	4/78(31)
				0.26	0.27	0.91	0.89	9/78(36)
				0.23	0.23	1.07	1.14	4/81(67)
Secs. 8 and 9				0.25	0.24	1.15	1.20	9/75(0)
				0.24	0.24	1.33	1.28	3/76(6)
170+50	8.00	8% A.C. Lt. Wt. HMAC	1.00	0.25	0.25	0.74	0.86	9/76(12)
to		5.65% SEA HMAC	3.00	0.25	0.25	1.12	0.96	3/77(18)
177+50		4.8% SEA HMAC	4.00	0.25	0.23	1.02	1.21	9/77(24)
				0.25	0.25	1.03	1.17	4/78(31)
				0.28	0.28	0.84	0.79	9/78(36)
				0.24	0.24	1.00	1.08	4/81(67)
Sec. 7				0.26	0.27	1.50	1.31	9/75(0)
				0.26	0.26	1.50	1.52	3/76(6)
177+50	6.0	8% A.C. Lt. Wt. HMAC	1.00	0.28	0.28	0.89	0.85	9/76(12)
to		5.4% A.C. Hot Sand	5.00	0.26	0.28	1.19	0.91	3/77(18)
181+00				0.26	0.27	1.12	1.04	9/77(24)
				0.26	0.27	1.16	1.14	4/78(31)
				0.28	0.29	0.94	0.91	9/78(36)
				0.25	0.26	1.10	1.05	4/81(67)

**Lane A (inside) = Lane S
Lane B (outside) = Lane R

Table 2. (Continued)

Station	Total Pavement Depth (in)	Material	Thickness (in)	Stiffness Coefficient of Subgrade		Stiffness Coefficient of Pavement		Date
				Lane A	Lane B	Lane A	Lane B	
Sec. 6				0.26	0.27	1.54	1.29	9/75(0)*
				0.26	0.27	1.42	1.39	3/76(6)
181+00	6.0	8% A.C. Lt. Wt. HMAC	1.00	0.28	0.29	0.85	0.88	9/76(12)
to		6% SEA Hot Sand	5.00	0.27	0.29	1.06	0.87	3/77(18)
184+00				0.27	0.27	1.03	1.19	9/77(24)
				0.28	0.28	0.97	1.14	4/78(31)
				0.29	0.30	0.87	0.90	9/78(36)
				0.26	0.26	0.85	0.93	4/81(67)
Sec. 5				0.26	0.25	1.26	1.16	9/75(0)
				0.26	0.26	1.41	1.50	3/76(6)
184+00	6.00	8% A.C. Lt. Wt. HMAC	1.00	0.28	0.28	0.88	0.82	9/76(12)
to		6.35% SEA Hot Sand	5.00	0.27	0.29	1.07	0.79	3/77(18)
188+00				0.28	0.28	1.02	0.95	9/77(24)
				0.27	0.28	1.04	1.05	4/78(31)
				0.30	0.30	0.81	0.84	9/78(30)
				0.27	0.28	0.82	0.93	4/81(67)
Sec. 4				0.26	0.27	1.15	1.07	9/75(0)
				0.30	0.29	0.80	0.87	3/76(6)
188+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	0.29	0.29	0.67	0.71	9/76(12)
to		7.1% SEA Hot Sand	7.00	0.28	0.30	0.84	0.73	3/77(18)
193+00				0.28	0.28	0.86	0.98	9/77(24)
				0.28	0.27	0.89	1.01	4/78(31)
				0.30	0.30	0.68	0.70	9/78(34)
				0.27	0.28	0.78	0.70	4/81(67)

Table 2. (Continued).

Station	Total Pavement Depth (in)	Material	Thickness (in)	Stiffness Coefficient of Subgrade		Stiffness Coefficient of Pavement		Date
				Lane A	Lane B	Lane A	Lane B	
Secs. 2 and 3				0.27	0.28	0.96	0.93	9/75(6)*
				0.29	0.29	0.78	0.85	3/76(6)
193+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	0.29	0.29	0.63	0.68	9/76(12)
to		5.65% SEA HMAC	3.00	0.27	0.29	0.85	0.71	3/77(18)
200+00		6% SEA Hot Sand	4.00	0.29	0.29	0.73	0.80	9/77(24)
				0.27	0.28	0.91	0.91	4/78(31)
				0.30	0.30	0.73	0.72	9/78(36)
				0.27	0.28	0.85	0.78	4/81(67)
Sec. 1				0.26	0.28	1.06	0.89	9/75(0)
				0.25	0.28	1.06	0.89	3/76(6)
200+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	0.29	0.28	0.63	0.68	9/76(12)
to		4.8% A.C. HMAC	3.00	0.27	0.28	0.84	0.74	3/77(18)
203+50		5.4% A.C. Hot Sand	4.00	0.27	0.26	0.97	0.91	9/77(24)
				0.27	0.27	0.92	0.90	4/78(31)
				0.29	0.30	0.77	0.74	9/78(36)
				0.26	0.26	0.90	0.85	4/81(67)

1 in. = 25.4 mm

*Pavement age in months from date of construction.

Table 3. Maximum Dynaflect Deflections and Surface Curvature Index as Computed by STIF 2.

Station	Total Pavement Depth (in)	Material	Thickness (in)	Maximum Dynaflect Deflection (10^{-3} in)		Surface Curvature Index		Date
				Lane A**	Lane B	Lane A	Lane B	
Sec 10				0.900	0.900	0.175	0.195	9/75(0)*
				0.780	0.810	0.135	0.180	3/76(6)
167+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	1.020	1.008	0.268	0.226	9/76(12)
to		4.8% A.C. HMAC	7.00	0.753	0.880	0.130	0.188	3/77(18)
170+50				0.963	0.900	0.163	0.108	9/77(24)
				0.797	0.817	0.135	0.145	4/78(31)
				0.780	0.793	0.178	0.208	9/78(36)
				0.790	0.750	-	-	3/80(54)
				1.150	1.140	0.230	0.210	4/81(67)
Secs. 8 and 9				0.978	0.942	0.212	0.192	9/75(0)
				0.816	0.852	0.144	0.156	3/76(6)
170+50	8.00	8% A.C. Lt. Wt. HMAC	1.00	1.130	1.160	0.353	0.307	9/76(12)
to		5.65% SEA HMAC	3.00	0.785	0.975	0.148	0.227	3/77(18)
177+50		4.8% SEA HMAC	4.00	0.900	0.920	0.195	0.160	9/77(34)
				0.825	0.752	0.177	0.133	4/78(31)
				0.765	0.808	0.310	0.253	9/78(36)
				0.860	0.850	-	-	3/80(54)
				1.055	1.040	0.232	0.207	4/81(67)

**Lane A (inside) = Lane S
Lane B (outside) = Lane R

Table 3. (Continued).

Station	Total Pavement Depth (in)	Material	Thickness (in)	Maximum Dynaflect Deflection (10^{-3}in)		Surface Curvature Index		Date
				Lane A	Lane B	Lane A	Lane B	
Sec. 7				0.850	0.885	0.205	0.250	9/75(0)*
				0.885	0.840	0.210	0.195	3/76(6)
177+50 to 181+00	6.00	8% A.C. Lt. Wt. HMAC	1.00	1.075	0.165	0.368	0.375	9/76(12)
		5.4% A.C. Hot Sand	5.00	0.895	1.000	0.223	0.332	3/77(18)
				1.020	0.915	0.283	0.268	9/77(24)
				1.030	0.823	0.273	0.223	4/78(31)
				0.873	0.803	0.282	0.267	9/78(36)
				1.030	0.950	-	-	3/80(54)
				1.135	1.180	0.310	0.340	4/81(67)
Sec. 6				0.840	0.825	0.190	0.230	9/75(0)
				0.840	0.810	0.210	0.210	3/76(6)
181+00 to 184+00	6.00	8% A.C. Lt. Wt. HMAC	1.00	1.000	0.910	0.352	0.310	9/76(12)
		6% SEA Hot Sand	5.00	0.862	0.865	0.245	0.248	3/77(18)
				0.895	0.825	0.267	0.207	9/77(31)
				0.906	0.717	0.282	0.188	4/78(31)
				0.852	0.747	0.296	0.252	9/78(36)
				1.090	0.930	-	-	3/80(54)
				1.405	1.300	0.495	0.418	4/81(67)

Table 3. (Continued).

Station	Total Pavement Depth (in)	Material	Thickness (in)	Maximum Dynaflect Deflection (10^{-3}in)		Surface Curvature Index		Date
				Lane A	Lane B	Lane A	Lane B	
Sec. 5				0.990	0.885	0.265	0.240	9/75(0)*
				0.885	0.885	0.225	0.210	3/76(6)
184+00	6.00	8% A.C. Lt. Wt. HMAC	1.00	1.020	1.015	0.347	0.367	9/76(12)
to		6.35% SEA Hot Sand	5.00	0.847	0.935	0.240	0.352	3/77(18)
188+00				0.890	0.950	0.272	0.308	9/77(24)
				0.900	0.803	0.268	0.237	4/78(31)
				0.870	0.805	0.320	0.288	9/78(36)
				1.070	0.850	-	-	3/80(54)
				1.305	1.115	0.470	0.405	4/81(67)
Sec. 4				0.695	0.680	0.150	0.162	9/75(0)
				0.680	0.712	0.223	0.215	3/76(6)
188+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	0.840	0.778	0.295	0.260	9/76(12)
to		7.1% SEA Hot Sand	7.00	0.692	0.695	0.190	0.227	3/77(18)
193+00				0.722	0.632	0.198	0.148	9/77(24)
				0.723	0.625	0.185	0.147	4/78(31)
				0.752	0.673	0.262	0.230	9/78(36)
				0.770	0.700	-	-	3/80(54)
				1.012	0.910	0.298	0.307	4/81(67)

Table 3. (Continued)

Station	Total Pavement Depth (in)	Material	Thickness (in)	Maximum Dynaflect Deflection (10^{-3} in)		Surface Curvature Index		Date
				Lane A	Lane B	Lane A	Lane B	
Sec. 2 and 3								
				0.788	0.768	0.215	0.217	9/75(6)*
				0.780	0.765	0.262	0.237	3/76(6)
193+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	0.955	0.847	0.353	0.292	9/76(12)
to		5.65% SEA HMAC	3.00	0.782	0.798	0.212	0.263	3/77(18)
200+00		6% SEA Hot Sand	4.00	0.793	0.762	0.273	0.263	9/77(24)
				0.722	0.693	0.180	0.173	4/78(31)
				0.662	0.645	0.215	0.212	9/78(36)
				0.760	0.740	-	-	3/80(54)
				0.820	0.873	0.225	0.260	4/81(67)
Sec. 1				0.810	0.885	0.195	0.250	9/75(0)
				0.810	0.795	0.165	0.220	3/76(6)
200+00	8.00	8% A C. Lt. Wt. HMAC	1.00	1.005	1.000	0.368	0.343	9/76(12)
to		4.8% A.C. HMAC	3.00	0.845	0.950	0.232	0.300	3/77(18)
203+50		5.4% A.C. Hot Sand	4.00	0.742	0.855	0.173	0.217	9/77(24)
				0.783	0.783	0.193	0.202	4/78(31)
				0.680	0.673	0.208	0.213	9/78(36)
				0.720	0.800	-	-	3/80(54)
				0.885	0.980	0.223	0.263	4/81(67)

1 in = 25.4 mm

*Pavement age in months from date of construction.

content. The SEA mixture with 4.8 percent binder content shows a lower Marshall stability but yet well exceeds the recommended 500 lb (2225 N) minimum value (6). The hot sand AC mixture shows a history of Marshall stabilities higher than those of the hot sand SEA mixture. The Marshall stabilities between the SEA mixtures themselves are fairly consistent. It may be noted that the Marshall stabilities for all hot sand mixtures also exceed the recommended minimum.

For the HMAC mixture, the splitting tensile strength of the AC mixture is slightly higher than values for the SEA mixtures. Of the SEA mixtures, the one with 5.65 percent binder content has the highest value for splitting tensile strength. In the hot sand category, the highest splitting tensile strengths are observed to be in the AC mixture with the SEA mixture with 6.35 percent binder content having the next highest values. For all practical purposes this property has been stable for the last about three years.

The SEA mixtures possess higher resilient moduli than do the AC mixtures for the HMAC types. In the hot sand types the highest resilient moduli are observed in the AC mixture. The hot sand SEA mixtures all have about the same resilient modulus values but these values are lower than comparison sections made with pure asphalt.

From Table 2 it may be noted that the lowest pavement stiffness coefficients were computed for the section with 3 inches (76 mm) of SEA HMAC over 4 inches (10 mm) of SEA hot sand. This result was not expected and is subject to question since the subgrade stiffness which was assigned by STIF 2 is consistently higher here than in the other test sections. Conversely, it may be noted that some of the higher pavement stiffness coefficients were lowered by STIF 2. The stiffness coefficients presented in Table 2 should be considered with caution.

In Table 3 the lowest maximum Dynaflect deflections may be observed in Section 4 which has the 7-inch (178 mm) base of 7.1 percent SEA hot sand mixture. This result is somewhat surprising since it was expected that one of the HMAC bases would have the lower maximum Dynaflect deflections. The greatest deflections noted occurred in Section 7 with the 5 inch (127 mm) of 5.4 percent AC hot sand mixture.

In Table 4 it may be noted that the pavement rating scores of both the SEA sections and the AC sections are still quite high. In these ratings it was noted that there was only limited cracking and only a minor amount of rutting.

Generally, rutting in the SEA sections is 1/8 inch or less and that in the pure asphalt sections is a little over 1/4 inch

Table 4. Visual inspection and traffic analysis for highway design, U. S. 69, Lufkin

FROM: The Cherokee County Line

TO: SH 7

	1975	1977	1978	1979	1981
ADT:		4950	5200	5450	5500
Directional distribution factor:			60-40%	60-40%	60-40%
Design hourly volume:			11.5%	11.5%	10.5%
Percent trucks					
1) ADT:			20.3	20.3	17.0
2) DHT:			14.0	14.0	14.0
Anticipated annual growth rate:			5.1%	5.1%	3.8%
Average ten heaviest wheel loads (ATHWLD), lbs.			11,300 (5,136kg)	11,300 (5,136kg)	13,100 (5,955kg)
Percent tandem axles in ATHWLD			60%	60%	60%
Total number of equivalent 18K single					
Axle load applications, one direction:					
1) Flexible pavement (1 year)			142,000	203,000	193,000
2) Rigid pavement (2 years)			291,000	416,000	566,000
Pavement rating scores					
1) SEA	100%	97%	99%	96%	91%
2) AC	100%	97%	98%	93%	86%

There are no significant differences in the serviceability indexes of the various test sections as may be seen in Table 5. For the last testing period they range from about 3.7 to 4.4. As might be expected, the higher values occur on the inside lane (lane A). The overall ride quality as of 1981 is about 4 as measured by the MRM.

Tentative Conclusions

To date there is very little evidence to indicate that the test sections in this field trial are undergoing any major distress. Even the test sections which were designed for early failure exhibit relatively good pavement characteristics some 67 months after construction. The most cracks are in Section 10, the 7-inch HMAC section. Sections 2, 3, 4 and 5 have minor cracking but some of this is due to coring. Extensive coring in limited areas of each section has reduced the structural integrity of the pavement at each coring location. Details are presented in Appendix A.

Table 5. Mays Ride Meter Results Expressed As Serviceability

Station	Total Pavement depth	Material	Thickness (in)	Serviceability index Lane A	Lane B	Date
Sec. 10				4.0	4.9	4/5/75(7)*
				3.9	4.5	9/17/76(12)
167+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	4.4	4.3	4/14/77(19)
to		4.8% A.C. HMAC	7.00	4.4	4.1	8/25/77(23)
170+50				4.1	3.9	4/14/78(31)
				4.2	4.3	7/31/78(35)
				3.9	3.9	11/3/78(39)
				4.7	4.6	8/7/79(48)
				4.3	4.2	3/25/81(66)
Sec. 8 and 9				4.7	4.7	4/5/76(7)
				4.7	4.4	9/17/76(12)
170+50	8.00	8% A.C. Lt. Wt. HMAC	1.00	4.5	4.6	4/14/77(19)
to		5.65% SEA HMAC	3.00	4.5	4.2	8/25/77(23)
177+50		4.8% SEA HMAC	4.00	4.0	3.7	4/14/78(31)
				4.4	4.2	7/31/78(35)
				4.4	3.7	11/3/78(39)
				4.6	4.5	8/7/79(48)
				4.2	4.9	3/25/81(66)
Sec. 7				3.7	4.4	4/5/76(7)
				3.7	4.8	9/17/76(12)
177+50	6.00	8% A.C. Lt. Wt. HMAC	1.00	3.4	4.2	4/14/77(19)
to		5.4% A.C. Hot Sand	5.00	4.2	4.0	8/25/77(23)
181+00				3.7	4.0	4/14/78(31)
				4.2	4.2	7/31/78(35)
				4.2	3.9	11/3/78(39)
				4.4	4.3	8/7/79(48)
				4.1	4.0	3/25/81(66)

*Pavement age in months from date of construction.

1 in = 25.4 mm

Table 5. (continued)

Station	Total pavement depth	Material	Thickness (in)	Serviceability index Lane A	Lane B	Date
Sec. 6				3.9	4.5	4/5/77(7)*
				4.1	4.6	9/17/76(12)
181+00	6.00	8% A.C. Lt. Wt. HMAC	1.00	3.8	4.4	4/14/77(19)
to		6% A.C. HMAC	5.00	3.9	4.0	8/25/77(23)
184+00				4.0	3.9	4/14/78(31)
				4.1	4.0	7/31/78(35)
				3.9	3.7	11/3/78(39)
				4.2	4.5	8/7/79(48)
				4.3	3.9	3/25/81(66)
Sec. 5				4.1	4.3	4/5/76(7)*
				4.1	4.5	9/17/76(12)
184+00	6.00	8% A.C. Lt. Wt. HMAC	1.00	3.5	4.3	4/14/77(19)
to		6.35% SEA Hot Sand	5.00	4.0	3.7	8/25/77(23)
188+00				3.6	3.8	4/14/78(35)
				3.9	4.0	11/3/78(39)
				3.9	3.8	
				4.2	4.2	8/7/79(48)
				3.9	4.1	3/27/81(66)
Sec. 4				4.4	4.6	4/5/76(7)
				4.4	3.9	9/17/76(12)
188+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	3.9	4.2	4/14/77(19)
to		7.1% SEA Hot Sand	7.00	3.7	4.1	8/25/77(23)
193+00				3.7	3.8	4/14/78(31)
				3.8	4.0	7/31/78(35)
				4.1	3.7	11/3/78(39)
				4.4	4.1	8/7/79(48)
				4.0	4.5	3/27/81(66)

*Pavement age in months from date of construction

1 in = 25.4 mm

Table 5. (continued)

Station	Total pavement depth	Material	Thickness (in)	Serviceability Index Lane A	Lane B	Date
Secs. 2 and 3						
				4.4	4.4	4/5/76(7)*
				4.5	4.5	9/17/76(12)
193+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	4.0	4.2	4/14/77(19)
to		5.65% SEA MHAC	4.00	4.2	4.2	8/25/77/(23)
200+00		6% SEA Hot Sand		3.7	3.8	4/14/78(31)
				4.3	4.1	7/31/78(35)
				4.0	3.9	11/3/78(39)
				4.3	4.4	8/7/79(48)
				4.3	4.0	3/27/81(66)
Sec. 1				4.4	4.5	4/5/76(7)
				4.9	4.7	9/17/76(2)
200+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	4.1	4.2	4/14/76(19)
to		4.8% A.C. HMAC	3.00	4.2	4.2	8/25/77(23)
203+50		5.4% A.C. Hot Sand	4.00	3.4	4.4	4/14/78(31)
				4.3	4.0	7/31/78(35)
				4.1	3.9	11/3/78(39)
				4.6	4.3	3/7/79(48)
				4.4	4.3	3/27/81(66)

*Pavement age in months from date of construction

1 in = 25.4 mm

Table 5. (continued)

Station	Total pavement depth	Material	Thickness (in)	Serviceability Index Lane A	Lane B	Date
Secs. 2 and 3				4.4	4.4	4/5/76(7)*
				4.5	4.5	9/17/76(12)
193+00 to 200+00	8.00	8% A.C. Lt. Wt. HMAC	1.00	4.0	4.2	4/14/77(19)
		5.65% SEA MHAC	4.00	4.2	4.2	8/25/77/(23)
		6% SEA Hot Sand		3.7	3.8	4/14/78(31)
				4.3	4.1	7/31/78(35)
				4.0	3.9	11/3/78(39)
				4.3	4.4	8/7/79(48)
				4.3	4.0	3/27/81(66)
Sec. 1				4.4	4.5	4/5/76(7)
				4.9	4.7	9/17/76(2)
200+00 to 203+50	8.00	8% A.C. Lt. Wt. HMAC	1.00	4.1	4.2	4/14/76(19)
		4.8% A.C. HMAC	3.00	4.2	4.2	8/25/77(23)
		5.4% A.C. Hot Sand	4.00	3.4	4.4	4/14/78(31)
				4.3	4.0	7/31/78(35)
				4.1	3.9	11/3/78(39)
				4.6	4.3	3/7/79(48)
				4.4	4.3	3/27/81(66)

*Pavement age in months from date of construction

1 in = 25.4 mm

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Appendix A

[redacted]

Table 1A.

SYSTEM - ID & CARD - ID: MMS E1

DISTRICT NO.: 11

RATERS:

DENNY T K

LYONS D

DATE: MONTH 04 DAY 07 YEAR 1981

PAVEMENT CONDITIONS

COMMENTS / NOTES

NOTE:
ZERO SHOULD BE INSERTED IN APPROPRIATE PAVEMENT CONDITION COLUMN IF NO VISUAL DEFECT IS NOTED

LOCATION

SYSTEM ID	CARD - ID	COUNTY NO	FOREMAN NO	HIGHWAY NO	FROM MILEPOST	FROM DISPLACEMENT ±	TO MILEPOST	TO DISPLACEMENT ±	LANE	RUTTING (1/2"–1" =1, >1" =2; % AREA: 1-25, 26-50, >50)	RAVELING (% AREA: 1-25, 26-50, >50)	FLUSHING (% AREA: 1-25, 26-50, >50)	FAILURES (NO. PER LN. MI.: 1-5, 6-10, >10)	ALLIGATOR CRACKING (% AREA: 1-10, 11-50, >50)	LONGITUDINAL CRACKING (LIN FT PER STA/LN: 10-99, 100-200, >200)	TRANSVERSE CRACKING (NO. PER STA: 1-4, 5-10, >10)	COMMENT CODE	SPEED LIMIT	Pavement Type	COMMENTS / NOTES
MMS	E2	3	06	45 61[illegible]		.		.	R	0	0	0	0	1	1	1		55		167+00 - 170+50 Sec 10
MMS	E2					.		.	S	0	0	0	0	1	0	0		55		
MMS	E2					.		.	R	0	0	0	0	0	1	0		55		170+50 - 177+50 Sec 8 & 9
MMS	E2					.		.	S	1	0	[illegible]	1	0	0	0		55		
MMS	E2					.		.	R	[illegible]	0	0		0	0	1		55		177+50 - 181+00 Sec 7
MMS	E2					.		.	S	1	0	0	0	0	0	0		55		
MMS	E2					.		.	R	[illegible]	0	0	0	0	0	0		55		181+00 - 184+50 Sec 6
MMS	E2					.		.	S	0	0	0	[illegible]	0	0	[illegible]		55		
MMS	E2					.		.	R	[illegible]	0	1	[illegible]	1	1			55		184+50 - 189+00 Sec 5
MMS	E2					.		.	S	[illegible]	0	[illegible]		0	0			55		
MMS	E2					.		.	R	[illegible]	0			1	1			55		189+00 - 193+00 Sec 4
MMS	E2					.		.	S	[illegible]	[illegible]			0	0			55		
MMS	E2					.		.	R		[illegible]			1	1			55		193+00 - 200+00 Sec 3 & 2
MMS	E2					.		.	[illegible]	[illegible]	1			0	1	[illegible]		55		
MMS	E2					.		.												

Table 1A. Continued

SYSTEM - ID & CARD - ID: MMS E1   DISTRICT NO.: 11

RATERS: DE[illegible] K
LYONS D

DATE: MONTH 04 DAY 07 YEAR 1981

LOCATION: SYSTEM ID	CARD - ID	COUNTY NO	FOREMAN NO	HIGHWAY NO	FROM: MILEPOST	FROM: ± DISPLACEMENT	TO: MILEPOST	TO: ± DISPLACEMENT	LANE	RUTTING (1/2"–1" = 1, 1" = 2; % AREA: 1 - 25, 26 - 50, >50)	RAVELING (% AREA: 1 - 25, 26 - 50, >50)	FLUSHING (% AREA: 1 - 25, 26 - 50, >50)	FAILURES (NO. PER LN. MI.: 1 - 5, 6 - 10, >10)	ALLIGATOR CRACKING (% AREA: 1 - 10, 11 - 50, >50)	LONGITUDINAL CRACKING (LIN FT PER STA/LN: 10 - 99, 100 - 200, >200)	TRANSVERSE CRACKING (NO PER STA: 1 - 4, 5 - 10, >10)	COMMENT CODE	SPEED LIMIT	Pavement Type	COMMENTS / NOTES
MMS	E2			US 69	Hot Mix AC				R	1	0	0	0	1	1	1		55		200+00 - 203+50 Sec 1
MMS	E2								S	0	0	0	0	0	1	1		55		
MMS	E2																			
MMS	E2																			
MMS	E2																			
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NOTE: ZERO SHOULD BE INSERTED IN APPROPRIATE PAVEMENT CONDITION COLUMN IF NO VISUAL DEFECT IS NOTED