

POST CONSTRUCTION EVALUATION
OF
U.S. 69 SULPHUR-ASPHALT PAVEMENT TEST SECTIONS
IN
LUFKIN, TEXAS

Interim Report No. 4
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Purpose:

To conduct post-construction testing and evaluation of a sulfur-asphalt binder concrete pavement test section located on U.S. 69, 15 miles north of Lufkin, Texas.

Sampling Period:

Twelve (12) months after opening to traffic.

Background:

During September 1975, a 3,650 foot section of roadway being constructed on U.S. 69 in Angelina County, Texas under Project RF 353(18), Contract No. 199-4 was set aside for a demonstration test of hot-mixed sulfur-asphalt pavement sections. These sections were constructed with a sulfur-asphalt emulsion (SAE) binder in accordance with a process developed by Societe Nationale des Petroles d' Aquitaine (SNPA).

At the completion of the pavement placement, cores were obtained from District 11, State Department of Highways and Public Transportation (SDHPT) and testing was completed in accordance with the test Matrix shown in Figure 1. A second set of cores was received from District 11 in August 1976. A third set of cores was obtained in April 1977, six months after the facility was opened to traffic (12 months after the completion of construction). The results of tests performed on these cores appear in Interim Report Nos. 1, 2 and 3 published in January 1976, October 1976, and May 1977, respectively.

In September 1977, a fourth shipment of cores was obtained from District 11. These cores were taken from the road about twelve months after the facility was opened to traffic (18 months after completion

Figure 1 - Testing Matrix

Test Description	Preliminary	Initial	Time Intervals			
	P	I	I+6	I+12	I+18	I+24
1. Traffic Analysis						
a. Average Daily Traffic Count			← continuous →			
b. Truck and Axle Weight Distribution		○				○
2. Visual Evaluation	△	△	△	△	△	△
3. Mays Meter (PSI)	△	△	△	△	△	△
4. Benkelman Beam Deflections	△	△	△	△	△	△
5. Dynaflect Deflections	△	△	△	△	△	△
6. Cored Samples						
a. Density		set of 6				
b. Stability, Marshall		cores (min)				
c. Stability, Hveem	△	at each test	△	△	△	△
d. Resilient Modulus		section per				
e. Indirect Tension		sampling period				
f. Rice Specific Gravity	⊥					
g. Thermal Expansion	⊥					
7. Skid Resistance	△	△	△	△	△	△

○ Loadometer survey, 1-week duration

△ Evaluations on both sulfur-asphalt binder and asphalt binder pavement sections

⊥ Initial evaluation of paving materials

- NOTES:
1. Preliminary testing will be performed at completion of pavement placement.
 2. Initial testing will be performed one week after pavement is open to traffic.
 3. Skid tests will be made on surface with s/a binder on the project but not at site of test section.

of construction). The latest test series was designated I+12. Tables 1A and 1B show a composite of the current and previous data series (P, I, I+6, I+12), associated mix designs, and location along the highway. The engineering properties with respect to the various mixture designs for the I+12 test series are shown in Table 2. A comparison of the properties of each mix type at the initial testing phase I, the I+6 phase, and the I+12 phase is shown in Table 3.

Discussion of Results:

Up to this sampling all data had indicated either a stabilization or changes which would reflect those normally encountered with post-construction densification. For the first time; however, changes are being encountered which could indicate structural changes within the pavements are being experienced.

A comparison of the data shown in Table 1A shows that both the density and Hveem Stability appear to be remaining relatively constant in both the conventional and sulfur-asphalt systems. The air void content in the Hot Sand mixes also appears to be relatively unchanged whereas the HMAC mixes are showing significant increases in void content, an indication that damage might be taking place.

A similar comparison of that data in Table 1B shows slight increases in Marshall flow, stiffness and tensile strength for all four systems. However, Marshall Stability for the same systems are indicating reversals, with the most significant decreases reflected in the sulfur-asphalt systems. Some of these stability changes appear significant.

Tables 2 and 3 are a summary of the average values of the test results for the I-12 month sampling and the three samplings taken since

TABLE 1A. Test Results for Preliminary, Initial, I+6, and I+12 Samplings

Mixture Type	Binder Content %	Station				P	Density (PCF)			Air Voids, (%)				Rice Specific Gravity	Hveem Stability, %			
		P	I	I+6	I+12		P	I	I+6	I+12	P	I	I+6		I+12			
HMAC (AC)	4.8	202+58	202+26	202+23	202+20	138	139	143	182	8	9	5	16	2.43	21	28	31	26
	4.8		201+26	201+23	201+20		140	144	143		8	4	9	2.44		26	38	26
	4.8	169+59	169+56	169+53	168+50		141	142	140		5	5	9	2.41		27	28	31
	4.8		1.68+56	158+53	168+51		141	142	141		6	5	9	2.42		26	28	25
HMAC (SAE)	4.8	172+59	172+56	172+53	172+50	138	140	142	140	8	11	7	11	2.44	22	27	25	29
	4.8		175+56	175+53	175+50		140	142	137		10	5	13	2.46		25	29	23
	5.65	175+60	175+56	175+53	175+50	134	142	144	142	11	8	4	9	2.44	19	22	26	26
	5.65		172+56	172+53	172+50		143	144	143		7	4	8	2.44		28	30	36
	5.65	197+10	198+26	198+23	198+20	137	140	142	146	8	11	5	8	2.44	18	31	32	30
	5.65		195+26	195+23	195+20		143	143	143		7	6	8	2.46		31	33	30
Hot Sand (AC)	5.4	202+59	202+26	202+23	202+20	119	119	119	133	21	22	22	10	2.44	15	21	19	19
	5.4		201+26	201+23	201+20		119	122	121		21	19	18	2.43		21	22	43
	5.4	179+60	179+56	179+53	178+50	113	124	121	123	22	20	19	17	2.44		19	21	23
	5.4		178+56	178+53	178+51		117	125	118		20	17	20	2.39		16	24	24
Hot Sand (SAE)	6.0	183+59	183+42	183+39	182+50	113	121	121	121	23	21	20	19	2.42	21	24	22	25
	6.0		182+56	182+53	182+51		118	121	123		25	17	18	2.46		24	19	23
	6.0	195+60	195+26	195+23	195+20		118	119	120		22	22	20	2.44		32	20	25
	6.0		198+26	198+23	198+20		118	119	119		24	21	20	2.46		22	21	19
	6.35	186+59	186+26	186+23	185+20	115	121	121	130	21	20	22	7	2.40	20	23	20	20
	6.35		185+26	185+23	185+21		122	123	127		19	21	9	2.44		24	20	24
	7.1	189+59	189+26	189+23	189+21	116	122	125	125	20	20	16	16	2.40	24	22	23	24
	7.1		191+26	191+23	191+20		121	125	126		22	17	15	2.43		22	27	20

TABLE 1B. TEST RESULTS FOR PRELIMINARY, INITIAL, I+6, AND I+12 SAMPLINGS

Mixture Type	Binder Content (%)	Station				Marshall Stability (LBS.)				Marshall Flow (0.01 in)				Splitting Tensile Strength (psi)				Resilient Modulus x10 ⁶ (psi)			
		P	I	I+6	I+12	P	I	I+6	I+12	P	I	I+6	I+12	P	I	I+6	I+12	P	I	I+6	I+12
HMAC (AC)	4.8	202+58	202+26	202+23	202+20	390	550	1010	1300	16	14	12	12		170	120	220	0.24	0.84	0.59	.68
	4.8		201+26	201+23	201+20		620	1140	1520		13	12	14		150	125	185		0.67	0.59	.68
	4.8	169+59	169+56	169+53	168+50		500	1280	680		15	13	15	50	160	130	160		0.78	0.52	.65
	4.8		168+56	168+53	168+51		760	1370	1050		14	13	13		135	110	160		0.78	0.48	.52
HMAC (SAE)	4.8	172+59	172+56	172+53	172+50	430	490	1100	600	15	15	13	13	35	90	135	140	0.29	1.22	0.52	.64
	4.8		175+56	175+53	175+50		600	1350	380		16	13	16		95	95	110		1.00	0.50	.76
	5.65	175+60	175+56	175+53	175+50	220	630	1550	400	14	14	13	14	35	135	120	170	0.21	0.67	0.57	1.06
	5.65		172+56	172+53	172+50		710	1270	800		12	12	12		140	120	175		0.89	0.57	.73
	5.65	197+10	198+26	198+23	198+20	200	720	1190	620	14	12	14	15		115	90	150	0.26	0.45	0.60	.75
	5.65		195+26	195+23	195+20		710	1040	800		12	15	14		140	90	175		0.66	0.61	.74
Hot Sand (AC)	5.4	202+59	202+26	202+23	202+20	350	650	620	740	14	14	15	17	30	90	100	95	0.16	0.31	0.24	.26
	5.4		201+26	201+23	201+20		720	860	1190		14	14	20		90	90	105		0.24	0.30	.28
	5.4	179+60	179+56	179+53	178+50	70	1480	1480	770	15	16	13	17		90	90	150	0.11	0.35	0.28	.51
	5.4		178+56	178+53	178+51		1020	1480	910		23	14	13		95	105	110		0.15	0.36	.28
Hot Sand (SAE)	6.0	183+59	183+42	183+39	182+50	170	340	960	590	13	12	12	12		80	65	85	0.13	0.28	0.24	.58
	6.0		182+56	182+53	182+51		1400	850	380		13	13	13		80	75	105		0.32	0.22	.22
	6.0	195+60	195+26	195+23	195+20		560	960	500		14	13	17	30	70	60	80		0.31	0.29	.35
	6.0		198+26	198+23	198+20		630	860	380		16	14	17		70	75	90		0.35	0.28	.28
	6.35	186+59	186+26	186+23	185+20	20	610	730	400	15	14	13	10		95	85	115	0.14	0.36	0.18	.24
	6.35		185+26	185+23	185+21		1350	950	600		12	13	9		90	85	100		0.25	0.28	.24
	7.1	189+59	189+26	189+23	189+21	140	510	850	560	18	13	13	11	30	135	70	115	0.20	0.37	0.26	.28
	7.1		191+26	191+23	191+20		520	850	520		15	12	12		100	80	115		0.21	0.26	.25

TABLE 2. TEST RESULTS FOR EACH MIX DESIGN FOR THE INITIAL + 12 TESTING PHASE

Sample Type	Binder Content (%)	Density (PLF)	Air Void (%)	Hveem Stability (%)	Marshall Stability (Lbs.)	Marshall Flow (0.01 in)	Splitting Tensile (psi)	Resilient Modulus ($\times 10^6$ psi)
HMAC (AC)	4.8	139	11	27	1140	13	180	.63
HMAC (SAE)	4.8	139	12	26	490	13	125	.70
	5.65	144	8	31	660	14	170	.82
Hot Sand (AC)	5.4	124	16	27	900	17	115	.33
	6.0	121	19	23	460	15	90	.36
Hot Sand (SAE)	6.35	129	8	22	500	10	110	.24
	7.1	126	16	22	540	12	115	.27

TABLE 3. INITIAL, INITIAL + 6, AND INITIAL + 12 TEST RESULTS FOR EACH DESIGN

Sample Type	Binder Content (%)	Density (PCF)			Air Voids (%)			Hveem Stability (%)			Marshall Stability (lbs)			Marshall Flow (0.01 in)			Splitting Tensile Strength (psi)			Resilient Modulus (x10 ⁻⁶ psi)		
		I	I+6	I+12	I	I+6	I+12	I	I+6	I+12	I	I+6	I+12	I	I+6	I+12	I	I+6	I+12	I	I+6	I+12
HMAC (AC)	4.8	140	143	139	7	5	11	27	31	27	610	1200	1140	14	13	13	155	120	180	0.70	0.55	.63
HMAC (SAE)	4.8	140	142	139	11	6	12	26	27	26	50	1230	490	16	13	13	95	115	125	1.11	0.51	.70
	5.65	142	144	144	8	5	8	28	30	31	690	1260	660	13	14	14	135	105	170	0.66	0.59	.82
Hot Sand (AC)	5.4	120	122	124	21	19	16	19	22	27	970	1110	900	17	14	17	90	95	115	0.26	0.29	.33
Hot Sand (SAE)	6.0	119	120	121	23	20	19	26	21	23	730	910	460	14	13	15	75	70	90	0.31	0.26	.36
	6.35	122	122	129	20	22	8	24	20	22	980	840	500	13	13	10	95	85	110	0.30	0.23	.24
	7.1	122	125	126	21	17	16	22	25	22	510	850	540	14	13	12	20	75	115	0.29	0.26	.27

the test section was opened to traffic. Trends discussed above are also reflected in these tabulations, as well.

Conclusions:

After 12 months of service the test results are indicating that some structural changes may be occurring. These are showing up by increases in air void content and decreases in Marshall Stability. The most significant changes in the latter parameter were reflected in the sulfur-asphalt sections. However, the resilient moduli of the sulfur-asphalt sections show no significant change. On the average, modest increases in stiffness are evident. The next sampling is due during March 1978.