POST CONSTRUCTION EVALUATION

OF

SULPHUR-ASPHALT PAVEMENT TEST SECTIONS

Interim Report #2

FCIP Study No. 1-10-75-512

by

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Prepared For

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Purpose:

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

Background:

During the month of 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 sulphur-asphalt pavement sections. These sections were constructed with a sulphur-asphalt emulsion (SAE) binder in accordance with a process developed by Societe Nationale des Petroles d'Aquitaine (SNPA). A detailed report describing the design and construction of the test section was prepared and distributed during January 1976.

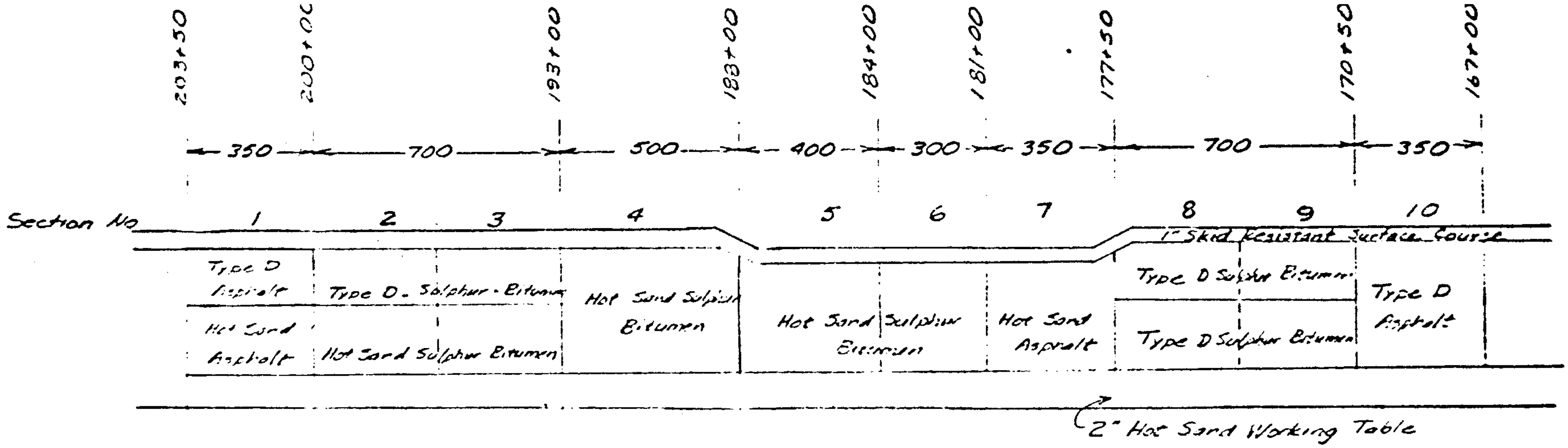
At the completion of the pavement placement, cores were obtained from District 11 and a series of tests run in accordance with the Test Matrix shown in Figure 1. This preliminary phase of testing was an attempt to determine the pavement material properties as soon as possible after placement but prior to any aging or traffic loading. A second set of cores was obtained from District 11 in early August 1976. These cores were taken one week after the facility was opened to traffic and approximately ten months after construction. This initial phase of testing, as shown in Figure 1, was intended to characterize the pavement material at the time it began its service life. Location of the cores along the roadway as well as aggregate type and binder content is shown in Figure 2.

FIGURE 1 - Testing Matrix

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

O Loadometer survey, 1-week duration
Δ 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 a site of test section.



Section	Material	Layer Thickness, in	Binder Content, percent
1	Type D Asphalt Base	3	4.8
	Hot Sand Asphalt Base	4	5.4
2,3	Type D Sulphur - Bitumen	3	5.65
	Hot Sand Sulphur-Bitumen	4	6.0
4	Hot Sand Sulphur-Bitumen	7	7.1
5	Hot Sand Sulphur - Bitumen	5	6.35
6	Hot Sand Sulphur Bitumen	5	6.0
7	Hot Sand Asphalt Base	5	5.4
8,9	Type D Sulphur Bitumen	3	5.65
	Type D Sulphur Bitumen	4	4.8
10	Type D Asphalt Base	7	4.8

Fig. 2. Layout of SNPA Sulphur Bitumen Binder Pavement Test
US Highway 69 Lufkin, Texas

Test Results

A comparison of test results from the preliminary (P) and initial (I) testing phases is presented in Tables 1 and 2. The initial material properties of each mix design at the time the roadway was opened to traffic are shown in Table 2. Test methods utilized include:

Density: ASTM D-2041-71

Marshall Stability and Flow: ASTM D-1559-73

Hveem Stability: D-1560-65

Resilient Modulus (As per Schmidt [1])

Indirect (Splitting Tension: ASTM C-496-71)

Rice Specific Gravity: ASTM D-2041-71

The data shown in Tables 1 and 2 indicate an increase in density between the time of preliminary testing and the time of initial testing for all mixture types in the test section. This increase ranged from 1 to 10 pounds per cubic foot. An increase in Hveem stability also occurred during this period for most mixes. The Marshall stability values displayed a significant increase and were accompanied by very little change in the Marshall flow values. Splitting tensile values of the test mixes indicated a remarkable increase in strength. The splitting tensile strnegths increased by a factor of 3 to 5.

Resilient modulus values exhibited a significant increase indicating that the test mixes were increasing in stiffness with time.

These data are consistent with that expected and indicate a normal trend to higher degrees of densification with service life. In order to show that these results are consistent with those obtained in the laboratory, a representative number of samples were remolded and compacted with 50 blows/side using a Marshall compactor. The results are

TABLE 1 - COMPARISON OF RESULTS FOR

PRELIMINARY AND INITIAL TESTING PHASES -

DENSITY, RICE SPECIFIC GRAVITY, AIR VOIDS, AND HVEEM STABILITY TESTS

le inder ontent (%)	Location Benchmark (ft.)		Density (lb/ft.^{3})		Test Rice Specific Gravity	Air Voids (%)		Hveem Stability (%)	
	P	I	P	I		P	I	P	I
4.8	202+58	202+26	138.3	139.3	2.426	7.6	8.6	21	28
4.8		201+26		140.2	2.435		8.0		26
4.8	169+59	169+56		141.1	2.404		4.8		27
4.8		168+56		141.0	2.420		6.3		26
4.8	172+59	172+56	137.6	139.7	2.438	7.7	10.8	22	27
4.8		175+56		139.9	2.463		10.4		25
5.65	175+60	175+56	134.3	142.1	2.435	11.0	8.4	19	22
5.65		172.56		143.2	2.438		6.8		28
5.65	197+10	198+26	137.3	139.5	2.436	8.3	10.8	18	31
5.65		195+26		142.5	2.455		7.1		31
5.4	202+59	202+56	118.9	119.3	2.428	20.9	22.0	15	21
5.4		201+26		119.6	2.431		20.8		21
5.4	179+60	179+56	112.8	123.8	2.438	22.4	20.5		19
5.4		178+56		117.3	2.390		20.1		16
6.0	183+59	183+42	113.0	121.3	2.423	23.3	20.8	21	24
6.0		182+56		118.1	2.456		24.7		24
6.0	195+60	195+26		118.3	2.441		22.3		32
6.0		198+26		117.7	2.464		24.0		22
6.35	186+59	186+26	115.2	121.1	2.400	20.8	20.5	20	23
6.35		185+26		122.5	2.447		18.8		24
7.1	189+59	189+26	117.1	121.8	2.399	19.8	19.6	24	22
7.1		191.26		121.2	2.438		22.0		22

TABLE 2 - COMPARISON OF RESULTS FOR PRELIMINARY AND INITIAL TESTING PHASES - MARSHALL STABILITY AND FLOW, SPLITTING TENSILE, AND RESILIENT MODULUS TESTS

Sample ype	Binder Content (%)	Location Benchmark (ft.)		Test Marshall Stability (lb)		Test Marshall Flow (0.01 in.)		Splitting Tensile Strength (psi)		Resilient Modulus x 10^6 (psi)	
		P	I	P	I	P	I	P	I	P	I
MAC	4.8	202+58	202+26	388	554	16	14		168	0.235	0.843
AC)	4.8		201+26		620		13		152		0.671
	4.8	169+59	169+56		500		15	48	164		0.779
	4.8		168+56		762		14		135		0.776
MAC	4.8	127+59	172+56	425	485	15	15	35	91	0.288	1.219
	4.8		175+56		607		16		95		0.997
	5.65	175+60	175+56	221	632	14	14	35	135	0.213	0.665
	5.65		172+56		711		12		138		0.889
	5.65	197+10	198+26	200	720	14	12		114	0.262	0.447
	5.65		195+26		713		12		143		0.660
ot and	5.4	202+59	202+26	352	645	14	14	31	92	0.159	0.311
AC)	5.4		201+26		718		14		91		0.240
	5.4	179+60	179+56	70	1480	15	16		88	0.113	0.345
	5.4		178+56		1023		23		95		0.154
ot and	6.0	183+59	183+42	169	340	13	12		76	0.127	0.277
SAE)	6.0		182+56		1400		13		82		0.320
	6.0	195+60	195+26		559		14	28	68		0.305
	6.0		198+26		627		16		74		0.345
	6.35	186+59	186+26	152	613	15	14		95	0.141	0.355
	6.35		185+26		1350		12		90		0.248
	7.1	189+59	189+26	137	512	18	13	27	136	0.189	0.369
	7.1		191.26		518		15		100		0.211

TABLE 3

Initial Test Results For Each Mix Design

Sample Type	Binder Content (%)	Density (lb/ft^3)	Rice Specific Gravity	Air Voids (%)	Hveem Stability (%)	Marshall Stability (lb)	Marshall Flow (0.01 in)	Splitting Tensile Strength (psi)	Resilient Modulus x 10^6 (psi)
HMAC (AC)	4.8	140.4	2.425	6.9	27	610	14	155	0.767
HMAC (SAE)	4.8	139.8	2.474	10.6	26	546	16	93	1.108
	5.65	141.8	2.453	8.3	28	694	13	133	0.665
Hot Sand (AC)	5.4	120.0	2.428	20.9	19	967	17	92	0.263
Hot Sand (SAE)	6.0	118.9	2.462	23.0	26	732	14	75	0.312
	6.35	121.8	2.459	19.7	24	982	13	93	0.302
	7.1	121.5	2.448	20.8	22	515	14	119	0.290

shown in Table 4 which indicate values more in line with laboratory data taken prior to and during construction.

Benkleman beam and Mays Meter data were not available at the time of this writing and will be transmitted under separate cover.

Conclusions to Date:

Nothing in the data generated to date would indicate any anomalies or adverse trends being incurred in either the conventional or sulphur-asphalt systems. Densification is expected to continue and reflect a decrease in Air Voids and increases in Density, Stiffness, Stability and Tensile Strength. The next series of sample cores are scheduled to be obtained during February 1977.

TABLE 4

Results of Remolded Lufkin Cores

Material	Type D HMAC 5.65% SAE[1]	Hot Sand (SAS) 7.1% SAE	Type D HMAC 4.8% AC	Hot Sand 5.4% AC
Unit Weight (pcf)	146.5	127.9	144.4	123.0
% Air Voids	3.6	15.1	4.4	18.2
Hveem Stability	37	25	42	31
Marshall Stability (lb)	2070	1410	2150	2610
Marshall Flow (1/100 in)	10	12	9	15

(1) SAE = 30/70 SAE