BENEFICIAL USE OF SULPHUR

IN

SULPHUR-ASPHALT PAVEMENTS

Quarterly Progress Report No. 1
Project RF 3644
Period 1 October, 1877, to 30 December, 1977

by
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Prepared for
The Sulphur Institute and The U.S. Bureau of Mines
February, 1978

INTRODUCTION

This report is written in two sections. Part A deals with the results the second sampling (designated I+6) of the experimental sulphur-asphalt test sections on U.S. 77 in Kenedy County, Texas. The initial sampling (designated I) was reported earlier (Ref. 3) and is also included in this submission for comparison purposes.

The second section, Part B, deals with the result of the support effort TTI is providing to the Bureau of Mines in the area of fatigue testing of sulphur recycled pavement material and freeze-thaw testing of sulphur concrete.

Part A

Post Construction Evaluation of Sand-Asphalt-Sulphur Test Section, Kenedy County, Texas

Purpose:

To conduct post-construction testing and evaluation of a sand-asphalt-sulphur (S-A-S) experimental test section located on U.S.77 in Kenedy County, Texas, in District 21 of the Texas State Department of Highways and Public Transportation (SDHPT).

Background:

During the month of April, 1977, a 3000 linear foot section of roadway being constructed on U.S. 77 in Kenedy County, Texas was set aside for a demonstration test of sand-asphalt-sulphur paving mixtures. The experimental sections were placed on the two N-S lanes in conjunction with Project TQF 913(13) under the jurisdiction of District 21, Texas State Department of Highways and Public Transportation. The pavement was constructed in accordance with technology developed and patented by Shell Canada, Ltd. and involves the use of sulphur as a structuring agent with poorly graded sands. Such sands are found in many areas of the United States and specifically along beaches and inland regions of the Gulf Coast States.

Through efforts initiated by the Sulphur Institute, and co-sponsored by the U.S. Bureau of Mines, the Texas Transportation Institute (TTI) has, during the past four years, conducted considerable laboratory verification studies of the sand-asphalt-sulphur pavement concept developed in Canada.

One of the prime objectives of this effort was to introduce to United States highway agencies the utilization of sulphur in asphalt concrete mixtures. The construction of this experimental section represents the culmination of this effort.

A construction report describing details of the design and placement of the test section has been prepared. The report includes details of materials, mix designs, equipment, materials handling, quality control, and evolved gas emissions analyses. Distribution is on an "As Requested" basis (see Reference 2).

Upon completion of the S-A-S pavement placement, cores were obtained by District 21 personnel and a series of tests was run (see Reference 1). At the end of the first six month period, following construction, TTI personnel collected cores and a series of tests was run in accordance with the Test Matrix shown in Figure 1-A. SDHPT personnel collected Mays Ride Meter (MRM), pavement cracking and Dynaflect data which appear in the Test Results. Location of the cores within the test sections was established by station numbers. A schematic of the test sections is given in Figure 2-A.

Test Results

The results of the initial (I) and initial plus six months (I+6) testing phases are given in Tables 1-A and 5-A.

The results of the I+6 testing phase are given in Table 2-A. Specific methods of testing were in accordance with the following:

Test Description	Initial I	6 mo.	12 mo.	18 mo.	36 mo.
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				2 ↓	
a. Density (set of 3 cores (min) at each test section per sampling period (each lane))				→	
b. Stability, Marshall	△	△	△	△	△
c. Stability, Hveem					
d. Resilient Modulus					
e. Indirect Tension	⊥				
f. Rice Specific Gravity	⊥				
7. Interim Reports	△	△	△	△	△

○ Loadometer survey, 1-week duration
△ Evaluations on both sulfur-asphalt-sand mixes and asphalt binder pavement sections
⊥ Initial evaluation of paving materials

Notes: 1. Initial testing will be performed one week after pavement is open to traffic.
2. Continous at 6 month intervals.

FIGURE 1-A. Testing Matrix

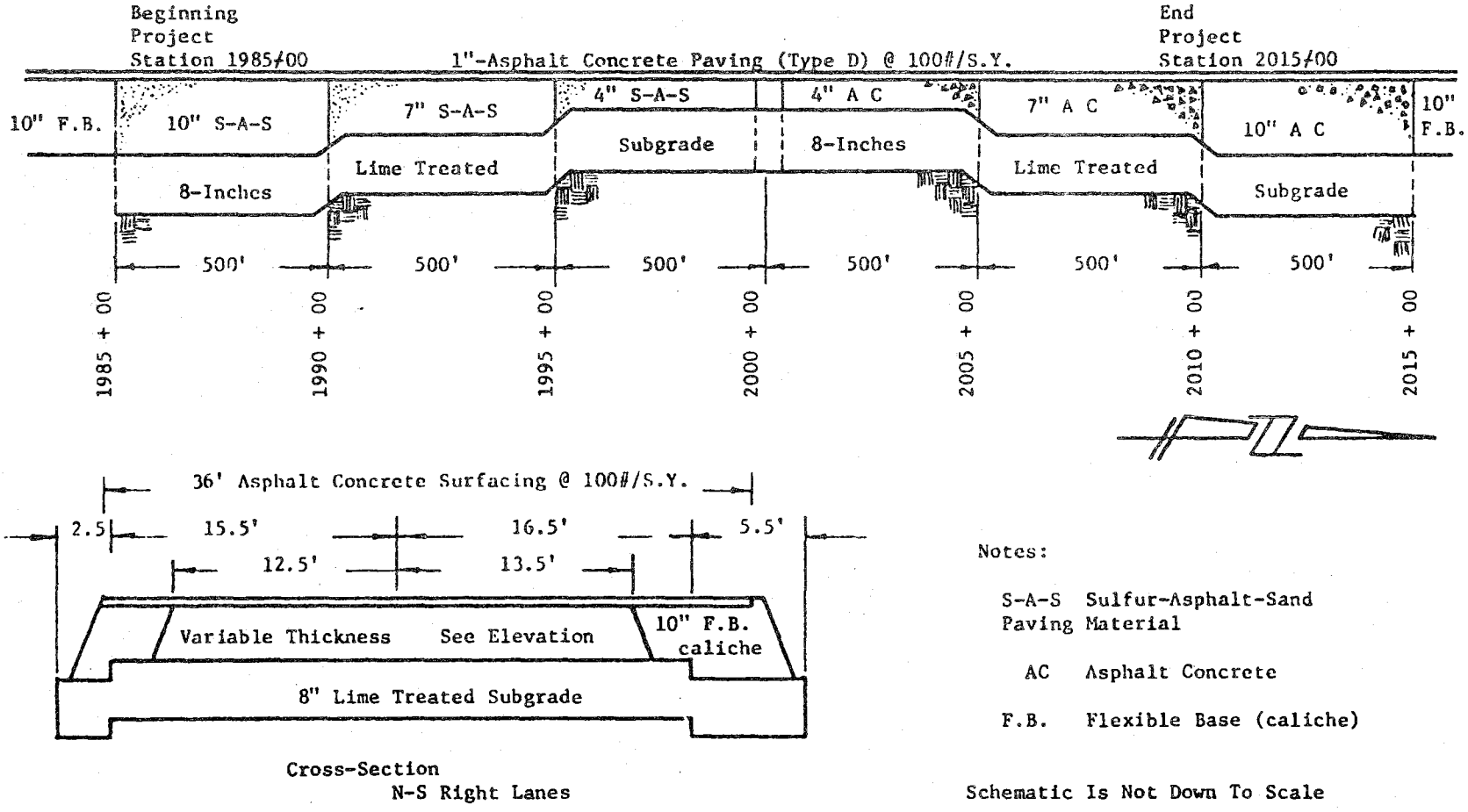

Figure 2-A. Schematic Showing Arrangement of Subsections and Construction of Mineral Aggregate-Asphalt-sulfur Experimental Project

Density:	ASTM D-2041-71
Marshall Stability and Flow:	ASTM D-1559-73
Hveem Stability:	ASTM D-1560-65
Resilient Modulus, M_R:	(as per Schmidt-Ref. 3)
Indirect (Splitting) Tension:	ASTM C0496-71
Rice Specific Gravity:	ASTM D02041-71

The Mays Ride Meter data has been reduced and is presented as Serviceability Index (SI) in Table 3-A. The MRM vehicle straddled the wheel paths in both lanes to obtain measurements.

A record of pavement cracking is given in Table 4-A for both the inside and outside lanes. These surveys begin at station 1980+00 and end at station 2018+00.

From the Dynaflect data gathered, the SDHPT ran a STIF2 computer program to obtain stiffness coefficients for the pavement and subgrade of all test sections. These are presented in Table 5-A. The complete Dynaflect print out is given in Appendix A of this report.

It would be premature to draw any hard conclusions from the data at this point in time because no definite trends have appeared as of yet. It may be observed from Table 1-A that the specific gravity and Resilient Modulus for both the S-A-S and AC sections have increased. This can be expected due to the compaction of the pavement from traffic.

Table 1-A. Test Results for Initial and I+6.

Sample		Location		Test											
Type	Binder Content (%) †	Benchmark (Ft)		Specific Gravity		Marshall Stability		Marshall Flow (1/100 in)		Hveem Stability		Resilient Modulus (68°F) (psi x 10^6)		Splitting Tensile Strength (psi)		Rice Specific Gravity	
		I	I+6	I	I+6	I	I+6	I	I+6	I	I+6	I	I+6	I	I+6	I	I+6
SAS	6.2	1978+50	1986+60	2.017	2.020	1350	1444	16.9	8.0	24.8	30.6	.459	.701	156	161	2.285	2.233
SAS	6.2	1992+50	1991+40	2.012	2.042	1886	1741	14.9	9.1	33.5	30.2	.444	.637	143	148	2.283	2.136
SAS	6.2	1997+50	1996+50	2.011	2.047	1889	1874	14.3	10.4	32.0	37.6	.446	.767	154	187	2.276	2.351
AC	6.2	2002+50	2001+60	2.133	2.251	340	582	10.8	12.6	35.8	26.0	.732	1.28	216	291	2.381	2.360
AC	6.2	2007+50	2006+80	2.258	2.261	676	663	17.5	11.3	No test	27.0	.813	1.23	242	254	2.374	2.388
AC	6.2	*	2011+80	*	2.242	*	704	*	11.6	*	29.0	*	1.12	*	257	*	2.397
AC	Outside of Test Section	*	1984+20	*	1.931	*	1665	*	8.3	*	36	*	.544	*	179	*	2.261

* No cores available for initial testing phase.

† The mix design established for these systems was 6.2 weight percent asphalt and 13 weight percent sulphur. However asphalt contents in the field ranged from 5.8 to 6.9 weight percent. (See Reference 1).

Table 2-A. Test Results for Initial+6 Testing Phase

Sample		Location	Test					
Type	Binder Content (Weight Percent)	Benchmark (Ft)	Specific Gravity	Marshall Stability (Lb)	Marshall Flow (1/100 in)	Hveem Stability (percent)	Resilient Modulus (68°F) (psi x 10^6)	Splitting Tensile Strength (psi)	Rice Specific Gravity
SAS	6.2	1986+60	2.020	1444	8.0	30.6	.701	161	2.233
SAS	6.2	1991+40	2.042	1741	9.1	30.2	.637	148	2.136
SAS	6.2	1996+50	2.047	1874	10.4	37.6	.767	187	2.351
AC	6.2	2001+60	2.251	582	12.6	26.0	1.28	291	2.360
AC	6.2	2006+80	2.261	663	11.3	27.0	1.23	254	2.388
AC	6.2	2011+80	2.242	704	11.6	29.0	1.12	257	2.397
AC	Outside of Test Section	1984+20	1.931	1665	8.3	36.0	.554	179	2.261

Table 3-A. Mays Meter Test Results for Road Serviceability Index

Serviceability Index (SI)

Station No.

N ⟶

	1988	1991	1994	1997	2000	2003	2006	2009	2012	2015
Wheel Path No. 1										
I	3.1	3.8	2.8	3.22	2.8	2.9	3.1	3.3	3.2	3.7	3.7
I+6	3.6	3.8	3.8	3.8	3.3	3.2	3.6	3.9	3.8	4.2	3.9
Wheel Path No. 2										
I	3.1	4.1	2.6	3.2	3.7	2.9	3.9	4.2	3.3	4.1	3.7
I+6	3.3	4.1	3.6	4.2	4.1	3.8	4.5	4.4	4.1	4.5	4.5
Wheel Path No. 3										
I	2.5	3.2	2.7	2.9	3.1	2.3	3.9	3.4	2.8	3.3	3.7
I+6	3.0	3.9	3.5	4.1	3.8	3.0	4.5	4.0	4.0	4.2	4.5
Wheel Path No. 4										
I	2.5	2.9	2.9	2.5	2.9	2.1	3.6	3.9	3.7	3.1	-
I+6	3.8	3.7	3.9	2.9	3.0	2.9	4.1	3.9	4.2	3.1	3.9

Table 4-A. Record of Pavement Cracking

Inside Lane

Transverse Cracks

1980+00 - Begin survey
1998+44 - 2 Ft. length Begin 1 Ft. from outside edge
2015+15 - Construction joint (no crack)
2015+40 - Construction joint (no crack)
2018+00 - End survey

Outside Lane

Transverse Cracks
1980+00 - Begin survey
1980+10 - Full lane width or 12 Ft.
1980+27 - 8 Ft. from outside edge toward interior
1980+52 - Full lane width or 12 Ft.
1980+70 - 3 Ft. from inside edge of lane toward outside
1980+77 - 6 Ft. from outside edge toward interior
1980+92 - 6 Ft. from outside edge toward interior
1981+06 - 4 Ft. from outside edge toward interior
1981+32 - 7 Ft. from outside from outside edge toward interior
1981+48 - 5 Ft. from outside edge toward interior
1981+65 - 7 Ft. from outside edge toward interior
1981+82 - 4 Ft. from outside edge toward interior
1982+00 - Construction joint (no cracks)
1982+37 - 4 Ft. from outside edge toward interior
2015+22 - Construction joint (no cracks)
2015+45 - Construction joint (no cracks)
2018+00 - End survey

* There are no cracks in the sand-asphalt-sulphur or asphaltic base sections. The only cracks noted were in the flexible base section.

Table 5-A. Stiffness Coefficients (*)
Determined by STIF2 Computer Program

Binder Type	Section	A Subgrade	Pavement
AC	1980+00-1985+00	0.26	0.65
SAS	1985+00-1990+00	0.23	0.85
SAS	1990+00-1995+00	0.24	0.76
SAS	1995+00-2000+00	0.24	0.76
AC	2000+00-2005+00	0.23	0.83
AC	2005+00-2010+00	0.21	0.85
AC	2010+00-2015+00	0.21	0.97

*See Appendix A for complete print out.

Part B

Supporting Research Activities for the Bureau of Mines

Testing of fatigue beams made from recycled materials continues. All of the beams made from the Boulder City Highway material and the Nellis A.F.B. material have been tested and the results are shown in Figures 1-B and 2-B.

It can be seen in Figure 1-B that the recycled mixture containing 1.0% virgin asphalt and 0.5% Paxole® maintains a consistently higher strain level than the other two designs in Boulder Highway. The recycled mixture containing only 1.25% sulphur has a curve which roughly parallels the curve of the asphalt and Paxole® mixture at a lower strain. The curve of the 1.25% sulphur and 0.25% asphalt mixture shows a fatigue curve similar to that of the typical asphaltic concrete which starts at a higher strain but becomes more susceptible to fatigue with time than the other two designs.

In Figure 2-B, once again it is the asphalt and Paxole® mixture which maintains a higher strain level than the other two designs at Nellis A.F.B. Again, the mixture recycled only with sulphur parallels that recycled with asphalt and Paxole® at a lower level of strain. It can also be observed that, as in Figure 1-B, the mixture containing sulphur and virgin asphalt posssesses about the same fatigue properties as typical asphaltic concrete.

Six sets of six sulphur concrete freeze thaw beams were sent to TTI during January, 1978, for testing. A catalogue of these samples is given in Table 1-B. Testing has begun on these samples and the results will be reported in the next Quarterly Progress Report. It should be noted that a number of samples were broken in shipment. Replacements for those samples have been requested.

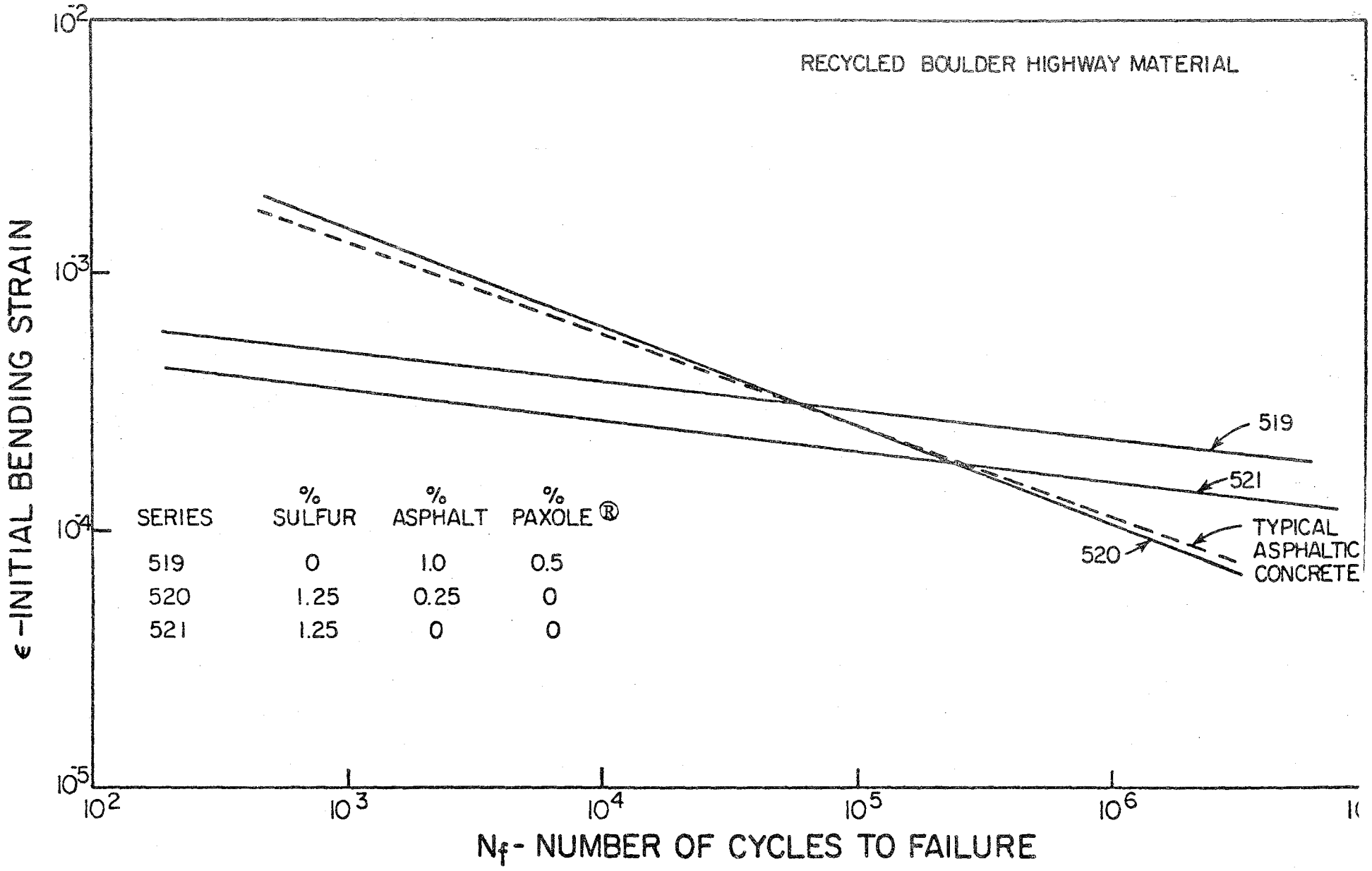

Figure 1-B. Fatigue Curves for Recycled Boulder Highway Material

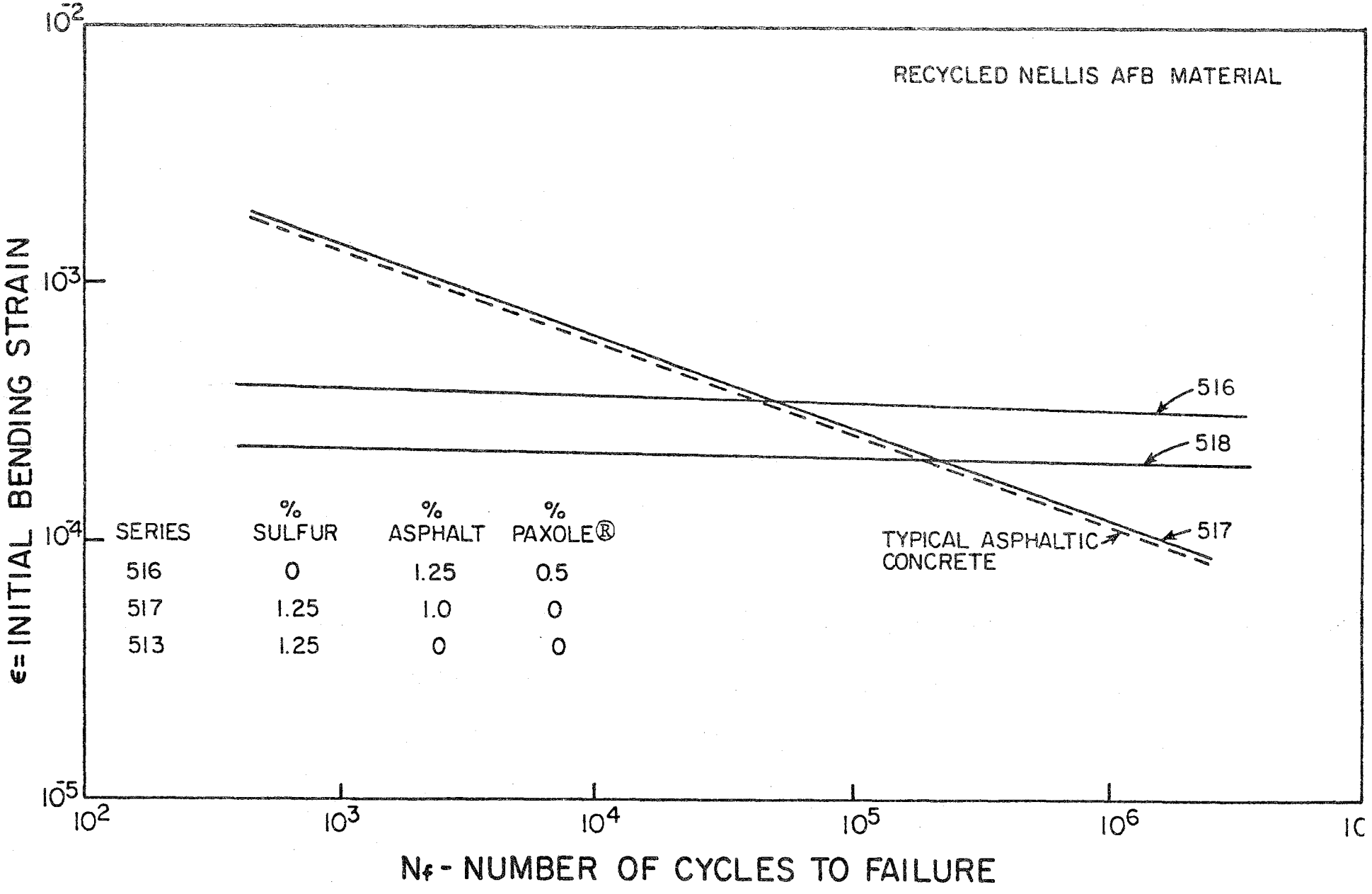

Figure 2-B. Fatigue Curves for Recycled Nellis A.F.B. Material

Table 1-B. Sulphur Concrete Freeze-Thaw Specimens

Sample Number	Composition (%) Sulphur	Aggregate	Aggregate Type	Binder Composition (%) Sulphur	Modifier	Remarks
582-A	23	77	Quartz	75	25	Broken in Shipment
B	23	77	Quartz	75	25	" " "
C	23	77	Quartz	75	25	" " "
D	23	77	Quartz	75	25	" " "
E	23	77	Quartz	75	25	" " "
F	23	77	Quartz	75	25	In test
583-A	23	77	Quartz	65	35	Broken in Shipment
B	23	77	Quartz	65	35	
C	23	77	Quartz	65	35	
D	23	77	Quartz	65	35	" " "
E	23	77	Quartz	65	35	In test
F	23	77	Quartz	65	35	Broken in Shipment
585-A	23	77	Quartz	50	50	In test
B	23	77	Quartz	50	50	" "
C	23	77	Quartz	50	50	" "
D	23	77	Quartz	50	50	
E	23	77	Quartz	50	50	
F	23	77	Quartz	50	50	
586-A	21	79	Limestone	75	25	In test
B	21	79	Limestone	75	25	" "
C	21	79	Limestone	75	25	" "
D	21	79	Limestone	75	25	
E	21	79	Limestone	75	25	
F	21	79	Limestone	75	25	
587-A		79	Limestone	65	35	In test
B	21	79	Limestone	65	35	" "
C	21	79	Limestone	65	35	" "
D	21	79	Limestone	65	35	" "
E	21	79	Limestone	65	35	
F	21	79	Limestone	65	35	
588-A	21	79	Limestone	50	50	In test
B	21	79	Limestone	50	50	" "
C	21	79	Limestone	50	50	" "
D	21	79	Limestone	50	50	" "
E	21	79	Limestone	50	50	
F	21	79	Limestone	50	50	

Part C

Activities Planned for Next Reporting Period

Fatigue testing will continue with the testing of Los Angeles Freeway recycled samples.

Freeze-thaw tests will continue on the sulphur concrete beams received from the Bureau of Mines in January, 1978.

REFERENCES

1. Saylak, D., Gallaway, B.M., "Post Construction Evaluation of U.S. 77 Kenedy County Sulphur-Asphalt-Sand Pavement Test Sections", Interim Report No. 1, October, 1977.

2. Izatt, J.O., Gallaway, B.M., Saylak, D., Sand-Asphalt-Sulphur Pavement Experimental Project Highway U.S. 77, Kenedy County, Texas, "A Construction Report", April, 1977.

Appendix A

TEXAS HIGHWAY DEPARTMENT

DISTRICT 21 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 12-19-77

****

PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

REASONS FOR MEASUREMENTS AND COMMENTS
SS -

TOTAL PAV DEPTH
19.00 INCHES

****

EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
ACP TY. D	1.00
FLEX BASE - CALICHE	10.00
LIME TR SUBGRADE	8.00

****

GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NORTH OPPOSITE MILEPOINTS
MEASUREMENTS ARE 3 FEET FROM THE RIGHT SIDE OF LANE B

DESCRIPTION OF LOCATION	ODOMETER READING	MILEPOINT
FROM-BEGIN CONTROL SECT	1980+00	
TO-	1985+00	

****

PLOTS WERE REQUESTED WITH THIS PROGRAM.

****

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
1980+25	0.400	0.340	0.290	0.171	0.129	0.060	0.25	0.70	
1980+75	0.400	0.340	0.280	0.126	0.120	0.060	0.25	0.70	
1981+25	0.430	0.360	0.290	0.174	0.153	0.070	0.25	0.67	
1981+75	0.400	0.320	0.260	0.153	0.138	0.080	0.27	0.63	
1982+25	0.400	0.350	0.290	0.180	0.165	0.050	0.24	0.75	
1982+75	0.470	0.380	0.310	0.240	0.180	0.090	0.26	0.63	
1983+25	0.500	0.300	0.250	0.156	0.150	0.200	0.31	0.47	
1983+75	0.420	0.340	0.290	0.189	0.171	0.080	0.26	0.64	
1984+25	0.470	0.380	0.310	0.240	0.210	0.090	0.26	0.63	
1984+75	0.500	0.410	0.330	0.260	0.230	0.090	0.25	0.63	
AVERAGES	0.439	0.352	0.290	0.189	0.165	0.087	0.26	0.65	
STANDARD DEVIATION						0.042	0.02	0.08	

NUMBER OF POINTS IN AVERAGE = 10

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 21 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 12-19-77

****

PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327.	02		US - 77	12-13-77	29

REASONS FOR MEASUREMENTS AND COMMENTS
SS -

TOTAL PAV DEPTH
19.00 INCHES

****

EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
ACP TY. D	1.00
SAND ASPH. SULPHUR	10.00
LIME TR SUBGRADE	8.00

****

GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NORTH OPPOSITE MILEPOINTS
MEASUREMENTS ARE 3 FEET FROM THE RIGHT SIDE OF LANE B

DESCRIPTION OF LOCATION	ODOMETER READING	MILEPOINT
FROM-BEGIN SECT A SA	1985+00	
TO-	1990+00	

****

PLOTS WERE REQUESTED WITH THIS PROGRAM.

****

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
1986+15	0.420	0.370	0.330	0.270	0.250	0.050	0.24	0.76	
1986+45	0.400	0.340	0.300	0.240	0.210	0.060	0.25	0.70	
1986+75	0.320	0.300	0.260	0.210	0.168	0.020	0.22	1.00	
1987+05	0.350	0.320	0.280	0.220	0.174	0.030	0.23	0.88	
1987+35	0.400	0.360	0.320	0.250	0.230	0.040	0.23	0.82	
1987+65	0.420	0.380	0.340	0.280	0.250	0.040	0.23	0.83	
1987+95	0.460	0.420	0.370	0.310	0.290	0.040	0.22	0.85	
1988+25	0.480	0.440	0.400	0.340	0.310	0.040	0.22	0.87	
1988+55	0.470	0.440	0.400	0.330	0.300	0.030	0.21	0.96	
1988+85	0.500	0.450	0.400	0.320	0.300	0.050	0.22	0.80	
AVERAGES	0.422	0.382	0.340	0.277	0.248	0.040	0.23	0.85	
STANDARD DEVIATION						0.012	0.01	0.09	

NUMBER OF POINTS IN AVERAGE = 10

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 21 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 12-19-77

****

PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

REASONS FOR MEASUREMENTS AND COMMENTS
SS -

TOTAL PAV DEPTH
16.00 INCHES

****

EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
ACP TY D	1.00
SAND ASPH. SULPHUR	7.00
LIME TR SUBGRADE	8.00

****

GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NORTH OPPOSITE MILEPOINTS
MEASUREMENTS ARE 3 FEET FROM THE RIGHT SIDE OF LANE B

	DESCRIPTION OF LOCATION	ODOMETER READING	MILEPOINT
FROM-	BEGIN SECT. B SA	1990+00	
TO-		1995+00	

****

PLOTS WERE REQUESTED WITH THIS PROGRAM.

****

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
1991+15	0.500	0.430	0.350	0.260	0.220	0.070	0.25	0.77	
1991+45	0.520	0.460	0.360	0.260	0.210	0.070	0.24	0.78	
1991+75	0.550	0.470	0.360	0.260	0.200	0.080	0.24	0.75	
1992+05	0.500	0.430	0.340	0.250	0.210	0.070	0.25	0.77	
1992+35	0.580	0.490	0.380	0.260	0.200	0.090	0.24	0.72	
1992+65	0.520	0.450	0.360	0.270	0.220	0.070	0.24	0.78	
1992+95	0.520	0.450	0.360	0.270	0.230	0.070	0.24	0.78	
1993+25	0.500	0.420	0.340	0.260	0.200	0.080	0.25	0.72	
1993+55	0.480	0.420	0.340	0.260	0.200	0.060	0.24	0.81	
1993+85	0.660	0.550	0.400	0.280	0.210	0.110	0.24	0.69	
AVERAGES	0.534	0.457	0.359	0.263	0.210	0.077	0.24	0.76	
STANDARD DEVIATION						0.014	0.00	0.04	

NUMBER OF POINTS IN AVERAGE = 10

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 21 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 12-19-77

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PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

REASONS FOR MEASUREMENTS AND COMMENTS
SS -

TOTAL PAV DEPTH
13.00 INCHES

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EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
ACP TY D	1.00
SAND ASPH. SULPHUR	4.00
LIME TR SUBGRADE	8.00

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GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NORTH OPPOSITE MILEPOINTS
MEASUREMENTS ARE 3 FEET FROM THE RIGHT SIDE OF LANE B

	DESCRIPTION OF LOCATION	ODOMETER READING	MILEPOINT
FROM-	BEGIN SECT. C SA	1995+00	
TO-		2000+00	

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PLOTS WERE REQUESTED WITH THIS PROGRAM.

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DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
1996+15	1.050	0.840	0.530	0.370	0.300	0.210	0.23	0.69	
1996+45	0.840	0.700	0.520	0.380	0.320	0.140	0.23	0.78	
1996+75	0.720	0.610	0.490	0.370	0.310	0.110	0.24	0.83	
1997+05	0.670	0.580	0.480	0.370	0.320	0.090	0.23	0.89	
1997+35	0.820	0.680	0.520	0.380	0.360	0.140	0.24	0.77	
1997+65	0.760	0.660	0.530	0.390	0.320	0.100	0.23	0.90	
1997+95	0.820	0.680	0.520	0.390	0.330	0.140	0.24	0.77	
1998+25	0.990	0.810	0.530	0.370	0.310	0.180	0.23	0.74	
1998+55	1.020	0.730	0.490	0.330	0.280	0.290	0.26	0.56	
1998+85	0.800	0.600	0.420	0.290	0.250	0.200	0.26	0.62	
AVERAGES	0.849	0.689	0.503	0.364	0.310	0.160	0.24	0.76	
STANDARD DEVIATION						0.061	0.01	0.11	

NUMBER OF POINTS IN AVERAGE = 10

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 21 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 12-19-77

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PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

REASONS FOR MEASUREMENTS AND COMMENTS
SS -

TOTAL PAV DEPTH
13.00 INCHES

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EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
ACP TY D	5.00
LIME TR SUBGRADE	8.00

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GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NORTH OPPOSITE MILEPOINTS
MEASUREMENTS ARE 3 FEET FROM THE RIGHT SIDE OF LANE 8

DESCRIPTION OF LOCATION	ODOMETER READING	MILEPOINT
FROM-BEGIN SECT. C ACP	2000+00	
TO-	2005+00	

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PLOTS WERE REQUESTED WITH THIS PROGRAM.

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DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
2001+15	0.800	0.660	0.500	0.370	0.300	0.140	0.24	0.76	
2001+45	0.900	0.750	0.560	0.400	0.330	0.150	0.23	0.78	
2001+75	0.850	0.710	0.530	0.390	0.310	0.140	0.23	0.79	
2002+05	0.760	0.650	0.520	0.380	0.320	0.110	0.23	0.85	
2002+35	0.800	0.680	0.520	0.390	0.320	0.120	0.23	0.83	
2002+65	0.800	0.680	0.520	0.380	0.310	0.120	0.23	0.83	
2002+95	0.770	0.660	0.510	0.380	0.310	0.110	0.23	0.86	
2003+25	0.780	0.670	0.520	0.390	0.320	0.110	0.23	0.86	
2003+55	0.770	0.660	0.520	0.390	0.330	0.110	0.23	0.86	
2003+85	0.730	0.630	0.510	0.390	0.320	0.100	0.23	0.88	
AVERAGES	0.796	0.675	0.521	0.386	0.317	0.121	0.23	0.83	
STANDARD DEVIATION						0.017	0.00	0.04	

NUMBER OF POINTS IN AVERAGE = 10

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 21 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 12-19-77

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PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

REASONS FOR MEASUREMENTS AND COMMENTS
SS -

TOTAL PAV DEPTH
16.00 INCHES

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EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
ACP TY D	8.00
LIME TR SUBGRADE	8.00

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GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NORTH OPPOSITE MILEPOINTS
MEASUREMENTS ARE 3 FEET FROM THE RIGHT SIDE OF LANE B

	DESCRIPTION OF LOCATION	ODOMETER READING	MILEPOINT
FROM-	BEGIN SECT. B ACP	2005+00	
TO-		2010+00	

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PLOTS WERE REQUESTED WITH THIS PROGRAM.

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DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
2006+15	0.740	0.660	0.540	0.420	0.350	0.080	0.22	0.84	
2006+45	0.740	0.660	0.540	0.420	0.340	0.080	0.22	0.84	
2006+75 ✓	0.740	0.660	0.540	0.420	0.340	0.080	0.22	0.84	
2007+05 ✓	0.740	0.660	0.540	0.420	0.350	0.080	0.22	0.84	
2007+35	0.780	0.700	0.580	0.450	0.380	0.080	0.21	0.86	
2007+65 ✓	0.760	0.690	0.570	0.440	0.360	0.070	0.21	0.91	
2007+95	0.820	0.730	0.590	0.450	0.360	0.090	0.21	0.83	
2008+25	0.790	0.700	0.560	0.430	0.350	0.090	0.21	0.82	
2008+55 ✓	0.740	0.670	0.560	0.440	0.370	0.070	0.21	0.90	
2008+85	0.740	0.660	0.550	0.430	0.360	0.080	0.22	0.84	
AVERAGES	0.759	0.679	0.557	0.432	0.356	0.080	0.21	0.85	
STANDARD DEVIATION						0.007	0.00	0.03	

NUMBER OF POINTS IN AVERAGE = 10

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT

TEXAS HIGHWAY DEPARTMENT

DISTRICT 21 -DESIGN SECTION

DYNAFLECT DEFLECTIONS AND CALCULATED STIFFNESS COEFFICIENTS

THIS PROGRAM WAS RUN - 12-19-77

****

PROJECT IDENTIFICATION

DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

REASONS FOR MEASUREMENTS AND COMMENTS
SS -

TOTAL PAV DEPTH
19.00 INCHES

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EXISTING PAVEMENT

MATERIAL TYPE	LAYER THICK.(IN)
ACP TY D	11.00
LIME TR. SUBGRADE	8.00

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GENERAL LOCATION INFORMATION

DIRECTION OF TRAVEL IS NORTH OPPOSITE MILEPOINTS
MEASUREMENTS ARE 3 FEET FROM THE RIGHT SIDE OF LANE B

DESCRIPTION OF LOCATION	ODOMETER READING MILEPOINT
FROM-BEGIN SECT. A ACP	2010+00
TO-	2015+00

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PLOTS WERE REQUESTED WITH THIS PROGRAM.

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DIST.	COUNTY	CONT.	SECT.	PPSN	HIGHWAY	DATE	DYNAFLECT
21	KENEDY	327	02		US - 77	12-13-77	29

DYNAFLECT DATA

STATION	W1	W2	W3	W4	W5	SCI	AS2	AP2	REMARKS
2011+15	0.480	0.450	0.410	0.350	0.320	0.030	0.21	0.97	
2011+45	0.460	0.430	0.400	0.340	0.310	0.030	0.21	0.96	
2011+75	0.450	0.430	0.390	0.330	0.300	0.020	0.20	1.10	
2012+05	0.470	0.440	0.400	0.330	0.300	0.030	0.21	0.96	
2012+35	0.480	0.440	0.400	0.330	0.300	0.040	0.22	0.87	
2012+65	0.460	0.430	0.390	0.330	0.300	0.030	0.21	0.96	
2012+95	0.480	0.450	0.410	0.340	0.310	0.030	0.21	0.97	
2013+25	0.520	0.490	0.440	0.370	0.330	0.030	0.20	1.00	
2013+55	0.530	0.490	0.440	0.370	0.340	0.040	0.21	0.89	
2013+85	0.530	0.500	0.440	0.380	0.340	0.030	0.20	1.00	
AVERAGES	0.486	0.455	0.412	0.347	0.315	0.031	0.21	0.97	
STANDARD DEVIATION						0.006	0.01	0.06	

NUMBER OF POINTS IN AVERAGE = 10

W1-5 DEFLECTIONS AT GEOPHONES 1,2,3,4,&5
SCI SURFACE CURVATURE INDEX (W1 MINUS W2)
AS2 STIFFNESS COEFFICIENT OF THE SUBGRADE
AP2 STIFFNESS COEFFICIENT OF THE PAVEMENT