TTI-2-9-79-261-2 (SUPPLEMENT NO. 1)

TEXAS
TRANSPORTATION
INSTITUTE

STATE DEPARTMENT
OF HIGHWAYS AND
PUBLIC TRANSPORTATION

COOPERATIVE
RESEARCH

EVALUATION OF FABRIC INTERLAYERS—A CONDITION SURVEY REPORT

in cooperation with the
Department of Transportation
Federal Highway Administration

RESEARCH REPORT 261-2 (SUPPLEMENT NO. 1)
STUDY 2-9-79-261
FABRIC UNDERSEALS

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16. Abstract
Field installations consisting of eight to thirteen 1/4-mile pavement test sections in Districts 4, 7, 10 and 21 were constructed in 1979-80. The purpose of these pavements was to evaluate fabric interlayers. Research Report 261-2, published in 1982, presented the initial field evaluation and properties of the construction materials. This supplement gives a field evaluation after up to five years in service. Based on the data collected, there is no evidence to indicate that one fabric performs better than another or that any fabric performs better than none at all in reducing reflection cracking.

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EVALUATION OF FABRIC INTERLAYERS--
A CONDITION SURVEY REPORT

by

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Research Report 261-2
Supplement No. 1

Research Study No. 2-9-79-261

Sponsored by the
Texas State Department of Highways and Public Transportation
U.S. Department of Transportation and
Federal Highway Administration

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843

August, 1984

PREFACE

This is the third in a series of reports dealing with the findings of research project number 2-9-79-261 which concerns the use of engineering fabrics to reduce reflection cracking in asphalt concrete overlays. This report is a condition survey of the field test sections installed as a part of the research study and is written as a supplement to Research Report 261-2.

DISCLAIMER

LIST OF REPORTS

Report No. 261-1, "Laboratory Evaluation of Selected Fabrics for Reinforcement of Asphaltic Concrete Overlays," by D. L. Pickett and R. L. Lytton, deals with the development of a computer program to analyze laboratory data using fracture mechanics and finite element theory and relate these data to field performance.

Report No. 261-2, "Evaluation of Fabric Interlayers," by J. W. Button and J. A. Epps, summarizes laboratory and field test results and gives recommendations to minimize problems during construction and early service-life and to maximize long-term performance of fabrics installed to arrest reflection cracking in asphalt concrete overlays.

IMPLEMENTATION STATEMENT

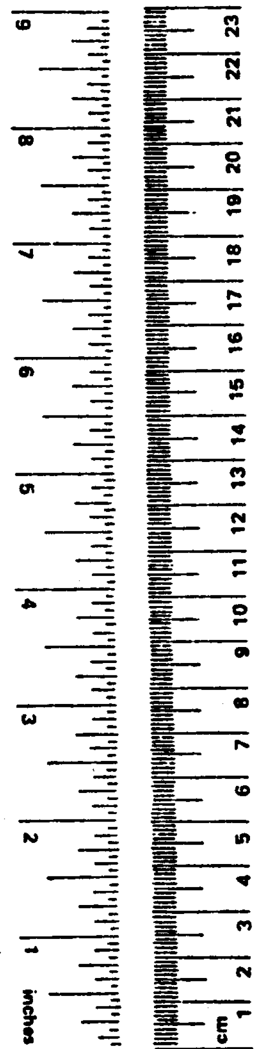
In general, the four primary field tests of fabrics installed to reduce reflective cracking in asphalt concrete overlays in Texas are presently inconclusive. That is, based on the test sections described in Research Report 261-2 and this supplement, no positive statements can be made regarding the ability of fabrics to reduce reflective cracking within five years in service. However, during the course of this study, certain design and construction procedures and fabric properties appeared to be more suitable than others. Recommendations pertaining to these construction procedures and fabric properties have been made in Research Report 261-2 and should be implemented.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

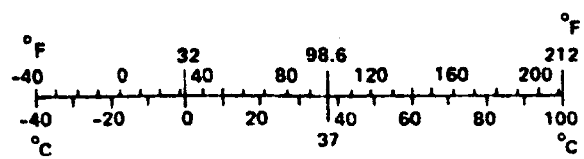
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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INTRODUCTION

Field installations consisting of eight to thirteen one-quarter mile test sections were constructed in four different areas of the state of Texas. Two projects were constructed in 1979, one in 1980 and one in 1981. The test sections involved placement of a fabric followed by a hot-mix asphaltic concrete (HMAC) overlay. Ten different fabrics were tested. They were compared to a control section consisting of either a conventional HMAC overlay with no interlayer or one with a chipseal as an interlayer. One location included an additional test section containing a chipseal using asphalt rubber as an interlayer (and underseal). Three test sections were installed over cracked asphalt concrete pavements and one over a portland cement concrete pavement to evaluate the relative ability of the interlayer to reduce reflection cracking. Field performance of these test pavements has been evaluated for periods up to five years.

The primary objectives of this study are to evaluate the performance of fabrics in order to 1) establish realistic specification limits, 2) determine the types of distress, if any, that fabrics may be used to correct, 3) quantify fabric properties that will optimize field performance, 4) define satisfactory field installation procedures for utilizing fabrics and 5) establish an economic cost-benefit relationship for fabric overlay systems. Objectives 1, 3, and 4 were at least partially met by the laboratory and field research conducted during this study. Objectives 2 and 5 have been difficult to fulfill from the four field studies considered, since the fabric test sections and the control sections are performing essentially the same. However, additional data collected from other fabric tests in Texas and other states have been used to partially fulfill these objectives.

The purpose of this report is to supplement Research Report 261-2 (1) by documenting two additional years of performance evaluation of the field experiments located in Districts 4, 7, 10, and 21.

SUMMARY OF FIELD PROJECTS

Test pavements were built at four locations as shown in Figure 1. The primary purpose of these test pavements was to determine the effectiveness of fabrics in arresting reflection cracking in asphalt concrete overlays. Original pavements in Districts 4, 7 and 21 consisted of asphalt concrete; whereas, the original pavement in District 10 consisted of continuously reinforced portland cement concrete. The control section in District 7 contains a standard chipseal as an interlayer; control sections in Districts 4, 10 and 21 do not contain an interlayer. Specific information about each test project is furnished in Table 1. Detailed information about the projects is given in Research Report 261-2 (1).

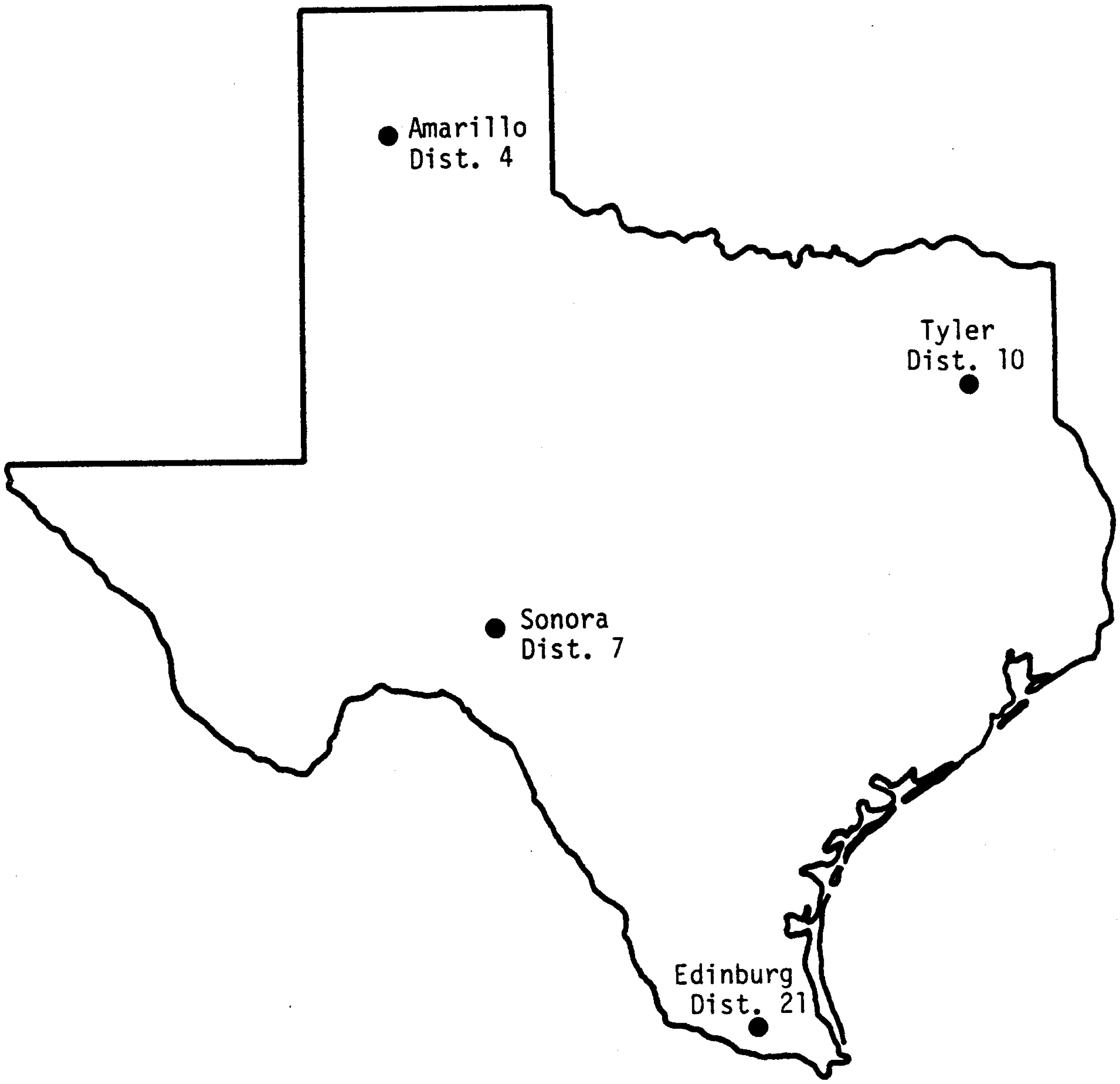

Figure 1. Location of Trial Field Sections

Table 1. Summary Field Projects where Fabrics were Installed

Item	Location			
	West of Sonora	West of Amarillo	Edinburg	East of Tyler
Highway Designation	IH-10	IH-40	US 281 and SH 107	IH 20
District Number	7	4	21	10
County and Number	Crockett (53)	Oldham (180)	Hidalgo (109)	Gregg (93)
Control-Section No.	141-1	90-4	255-7 & 8 and 342-1	495-6 & 7
No. of Lanes each Direction	2	2	2	2
Existing Pavement				
Layer 1 (Top)	3" HMAC	1" HMAC (Type D)	1" HMAC*	8" CRCP
Layer 2	15" Flex Base	3" HMAC (Type A)	12" Flex Base	RC-2 membrane
Layer 3	Subbase	12" Flex Base	Subgrade	6" Soil Cement
Layer 4	-	6" Lime Tr.Subgr.	-	Subgrade
Date of Overlay Construction	Aug-Sept 1979	Sept 1979	Feb 1980	July 1981
Fabrics Used				
1	Chipseal (Control)	Control	Control	Control
2	Fabric 1	Fabric 1	Fabric 1	Fabric 3
3	Fabric 2	Fabric 2	Fabric 2 (SH 107)	Fabric 4
4	Fabric 3	Fabric 3	Fabric 3	Fabric 7
5	Fabric 4	Fabric 4	Fabric 4	Fabric 8
6	Fabric 5	Fabric 5	Fabric 5	Fabric 9
7	Asp-Rub Chipseal			Fabric 10
HMAC Overlay	Type D	Type D	Type D	Type B / Type D
Asphalt Type & Grade	AC-10	AC-10	AC-10	AC-20 / AC-20
Asphalt Source	Refinery 4	Refinery 5	Refinery 15	Refinery 6 / Refinery 24
Aggregate Type	Crsh Limestone + Field Sand	Crsh Limestone + Field Sand + Blow Sand	River Gravel + Sand	Crsh Limestone + Field Sand / Lt wt + conc. Sand + fld sand
Asphalt Additives	None	None	None	Antistrip A / Antstrip B
Asphalt Tack Coat for Fabrics				
Type and Grade	AC-20	AC-10	AC-10	AC-20
Source	Refinery 4	Refinery 5	Refinery 15	Refinery 24
Traffic Data**			(US 281) / (SH 107)	
ADT	3,400	7,900	19,500 / 13,000	14,000
Percent trucks	24.1	23.8	3.4 / 18.2	22
Equivalent 18K axle loads	5,983	15,468	19,043 / 1,476	-
Percent Tandem Axles	90	20	90 / 40	40
Weather Data (1)				
Temperature				
Normal Max, °F	95	91	97	94
Normal Min, °F	33	22	49	35
Typical Max Drop, °F/hr	-	5	-	-
Typical Max 24 hr Drop, °F	-	60	-	-
Frost Penetration, in.	1	12 (max)	0	1
Freeze Index	0	0	0	0
Precipitation				
Annual Ave. Precip, in.	19	20	18	43
Annual Ave. Ice/Snow, in	1	15	Trace	2

*Approximately 2 inches of ACP had been removed by cold milling prior to placement of fabric.

**Traffic data as of 1980.

FINDINGS

Field performance evaluations of the four field trials as of the spring of 1984 are described in the following paragraphs. Updated weather data are given in Appendix A. Updated traffic data are included in Appendix B.

DISTRICT 7

After 57 months in service, which includes five winters, all of the test pavements and control sections on Interstate 10 in District 7 appear to be in good condition. Some new cracks appeared in the overlay during the unusually cold winter of 1983-84 but they are few and do not appear to be associated with the lack of fabric (control sections contain a standard chipseal interlayer) or any particular type of fabric. The spring of 1984 was the first time that a significant number of cracks had been observed on any of these test pavements.

More cracking occurred in the westbound lanes than the eastbound lanes. Most of the cracking occurred as a longitudinal crack near the centerline of the roadway. About two-thirds of these longitudinal cracks are located above cracks in the original pavement and hence may be considered reflection cracks. However, about one-third of these longitudinal cracks are not associated with cracks in the original pavement. Therefore, all of these cracks cannot be considered reflection cracks. Furthermore, the westbound control section exhibited a substantial amount of longitudinal cracks, some of which were above cracks in the original pavement and some of which were not. This indicates these cracks are not necessarily associated with longitudinal joints in the fabrics. Typical cracking patterns in the overlay are shown as dashed lines in Figure 2.

Most of the transverse cracks appeared to be reflective as they were located over cracks in the original pavement surface.

As in years past, slight flushing was observed in the travel lane and was about the same in all the fabric test sections and the control section. Moderate flushing was noted in the travel lanes of the

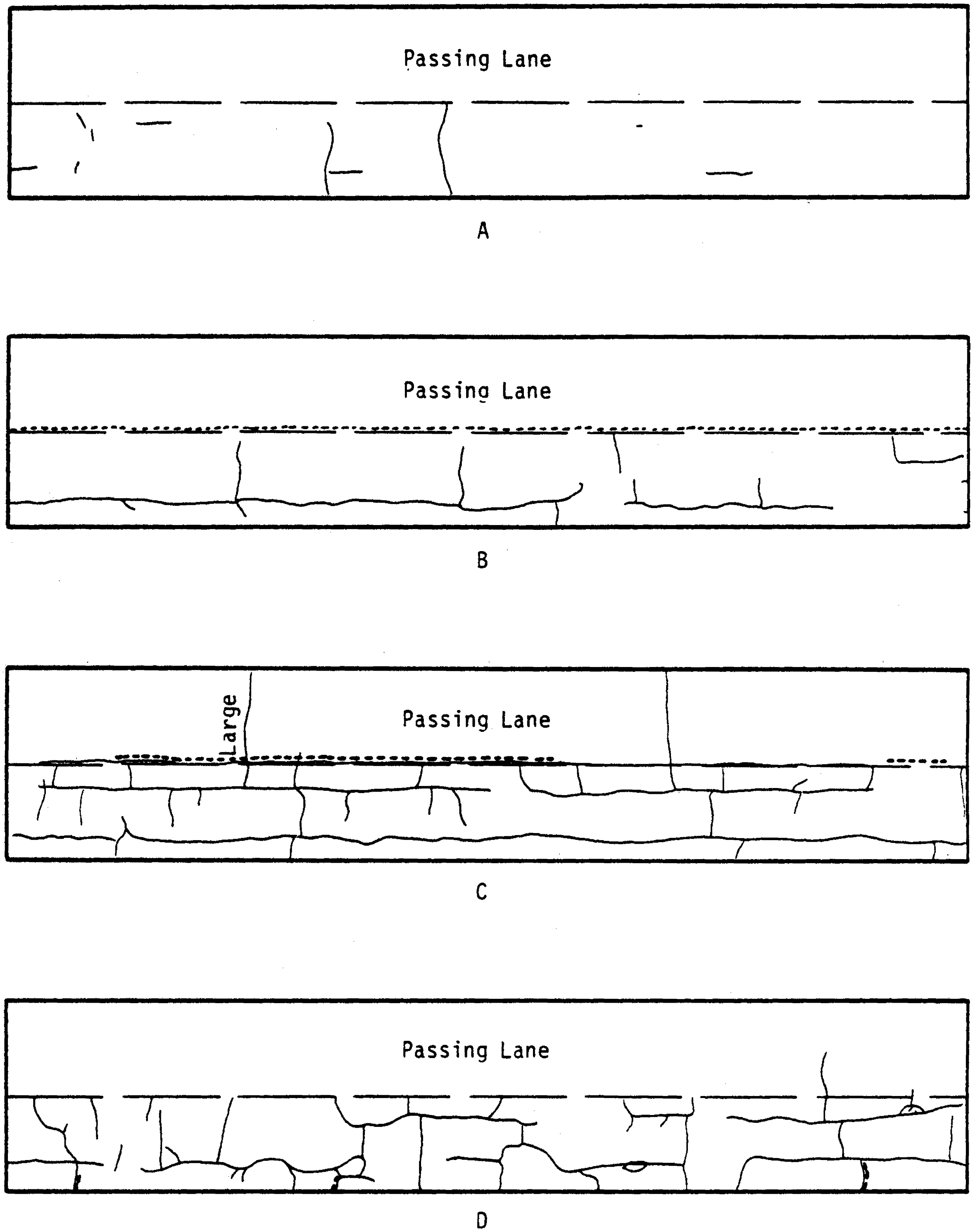

Figure 2. Original Cracking Patterns on IH 10 West of Sonora (District 7) Prior to Overlaying (Maps are typically 100 ft. x 24 ft.). (Cracks in overlay as of June 1984 are shown as dashed lines.)

asphalt rubber test sections. Flushing was not evident in the passing lanes of any of the sections. In fact, there were no signs of distress in the passing lane of any of these pavement sections.

Rutting in the travel lanes of all pavement sections ranged from one-eighth inch to one-quarter inch. The deeper rut was usually in the inside wheel path. Slightly more rutting (3/8-inch) was noted in the asphalt rubber test sections. A few areas, primarily in the westbound lane, exhibited a longitudinal crack along the inside edge of the outer edge-stripe. This is a minor crack and is possibly due to the difference in thermal expansion of the pavement caused by the reflectivity (thus cooling effect) of the white edge-stripe.

In summary, there is no evidence to indicate that one fabric performs different from another or that a chipseal interlayer performs different from a fabric interlayer. The asphalt rubber test sections exhibited slightly more rutting and flushing than any of the other sections possibly due to the use of more binder.

DISTRICT 4

In the fall of 1979, fifty-six months after construction, the test pavements on Interstate 40 in District 4 appear to be performing reasonably well in spite of moderate cracking which occurred during the first winter. Since that time, the cracks have grown a small amount during each winter but very few new cracks have appeared since the spring of 1980. Cracks have been filled twice since the overlay was placed. The second time they were filled (in 1984) with a material composed of asphalt and granulated rubber.

As mentioned in Report 261-2, (1), this construction project was not designated a field trial for this study until after a sealcoat had been placed in 1978. Consequently, the research team was unable to record the cracks in the original pavement prior to overlaying. However, verbal communication with the District Construction Engineer and an exhaustive series of photographs prepared by District 4 personnel revealed that, originally, there was considerable fatigue cracking in the travel lane with some thermal (transverse) cracking and moderate rutting throughout the project.

The first winter after construction of this pavement was long and cold and moderate cracking appeared as shown in Report 261-2 (1). These cracks were sealed immediately but they continued to grow during each winter in service. Crack growth, of course, appeared directly related to the severity of the weather. Considerable crack growth occurred during the very cold winter of 1983-84. However, there appears to be no significant differences in cracking patterns in the sections containing fabric and those containing no fabric. Figure 3 shows cracking patterns typical of those presently found in the test pavements on Interstate 40.

In the spring of 1984, cracks in the pavements were filled using an apshalt/granulated rubber crack filler. This material covered an area about 3 or 4-inches wide along the path of the cracks and often extended past the end of the cracks. This made it impossible to precisely locate the crack tip by visual inspection.

Rutting in the travel lane has not progressed a perceptible amount since 1983. It ranges from one-eighth to one-quarter inch in both the eastbound and westbound travel lanes. No rutting was observed in the passing lanes. There is no difference in rutting in the fabric test sections and the control sections.

Raveling is about the same as reported in years past (1). Moderate raveling in the passing lanes and only slight raveling in the travel lanes does not appear to be progressing significantly.

No appreciable flushing was noticed. There were no other signs of pavement distress.

In summary, there is no evidence to indicate that asphalt concrete pavements containing different fabrics perform different from one another or different from similar pavements containing no fabric.

DISTRICT 21

The distress observed in the original test pavements located on US 281 and SH 107 in Edinburg was relatively nonuniform. Some areas exhibited severe block cracking, while other areas exhibited severe alligator cracking and some areas exhibited almost no cracking at all. In addition, there was some very localized rutting usually associated

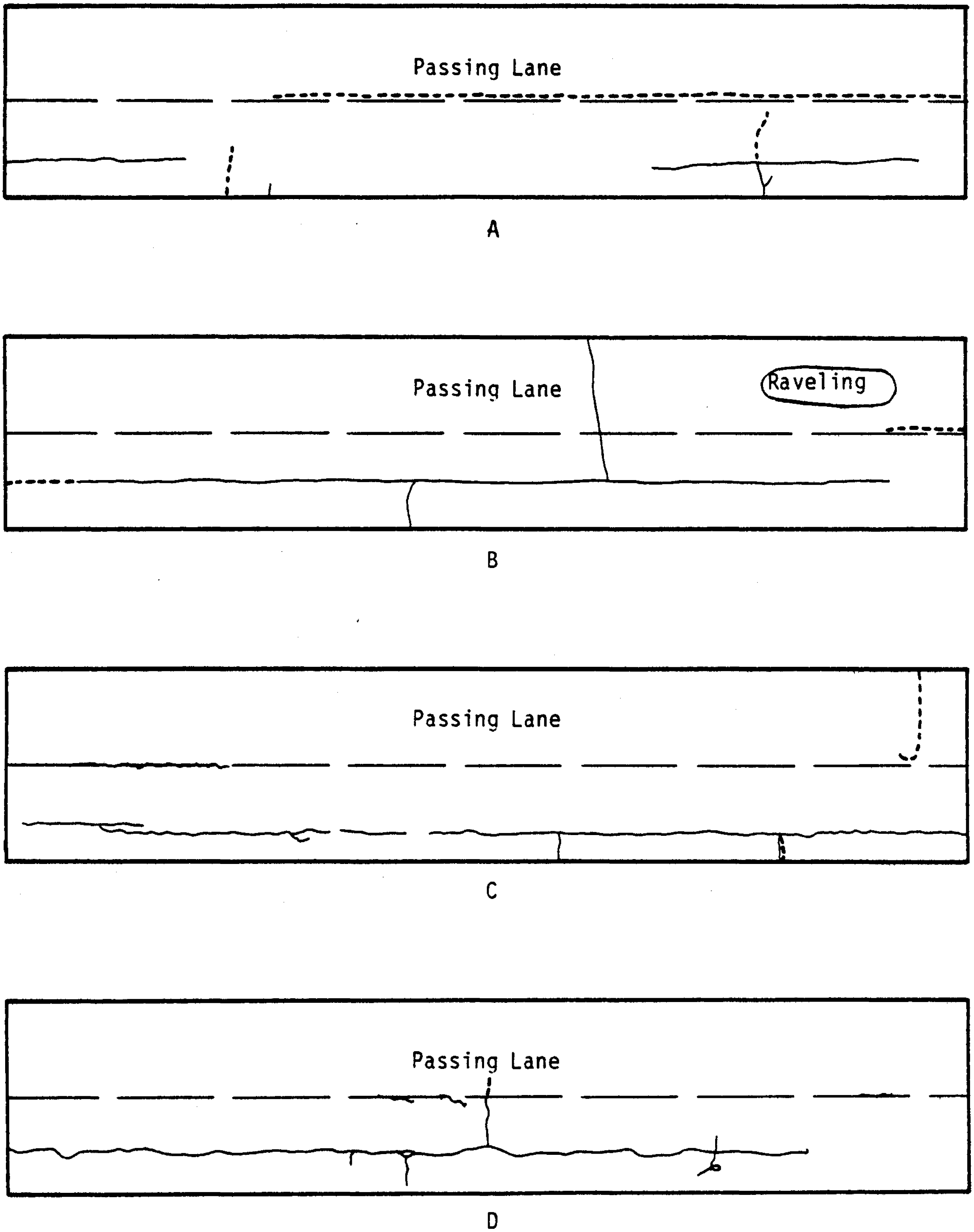

Figure 3. Typical Cracking Patterns on IH 40 West of Amarillo (District 4) These reflected through overlay during first winter. (Maps are typically 100 ft. x 24 ft.) (Further development of cracks in succeeding 4 years are shown as dashed lines.)

with alligator cracking. This nonuniformity in the original pavements is evident in the appearance of the overlay surface today.

After a 40-month performance period, the pavements appear to be serving quite well. A few new cracks have appeared in the last two years. Most of them appear to be reflective but some are not. The reader is reminded that prior to overlaying, much of the asphalt concrete surface course was removed by cold milling to maintain the curbline. Mapping of the cracks in the surface of the original pavement was accomplished prior to the milling operation.

A few new longitudinal cracks were observed in fabric test sections 21-US281-4, 21-US281-5 and 21-SH107-1. These new cracks do not appear to be associated with longitudinal joints or the outer edge of the fabrics. A few new fatigue cracks (alligator or T-shaped cracks) were observed in isolated areas of all pavement sections. However, cracking does not appear to be a serious problem. Typical cracking patterns in the overlays are shown as dashed lines in Figure 4. Existing cracks have not been sealed. There are no significant differences between the test pavements containing fabric and the control section. There is no evidence to indicate any of the fabrics are reducing the occurrance of cracking whether reflective or otherwise.

Generally, rutting throughout the pavement sections is less than one-eighth inch in depth. Although some very localized rutting was observed with depths up to one-half inch, this is not a serious problem. The localized rutting appears to be associated with weak spots in the base or subgrade and not the asphalt concrete pavement. Typically, the more deeply rutted areas are only 5 to 15 feet in length and, in most cases, were visible prior to overlaying.

No flushing, raveling, corrugations, or significant patching were observed.

DISTRICT 10

Thirty-three months after construction, the test pavements on Interstate 20 in District 10 appear to be in very good condition. Some rutting and minimal cracking were noted throughout all the test sections and the control section in Gregg County.

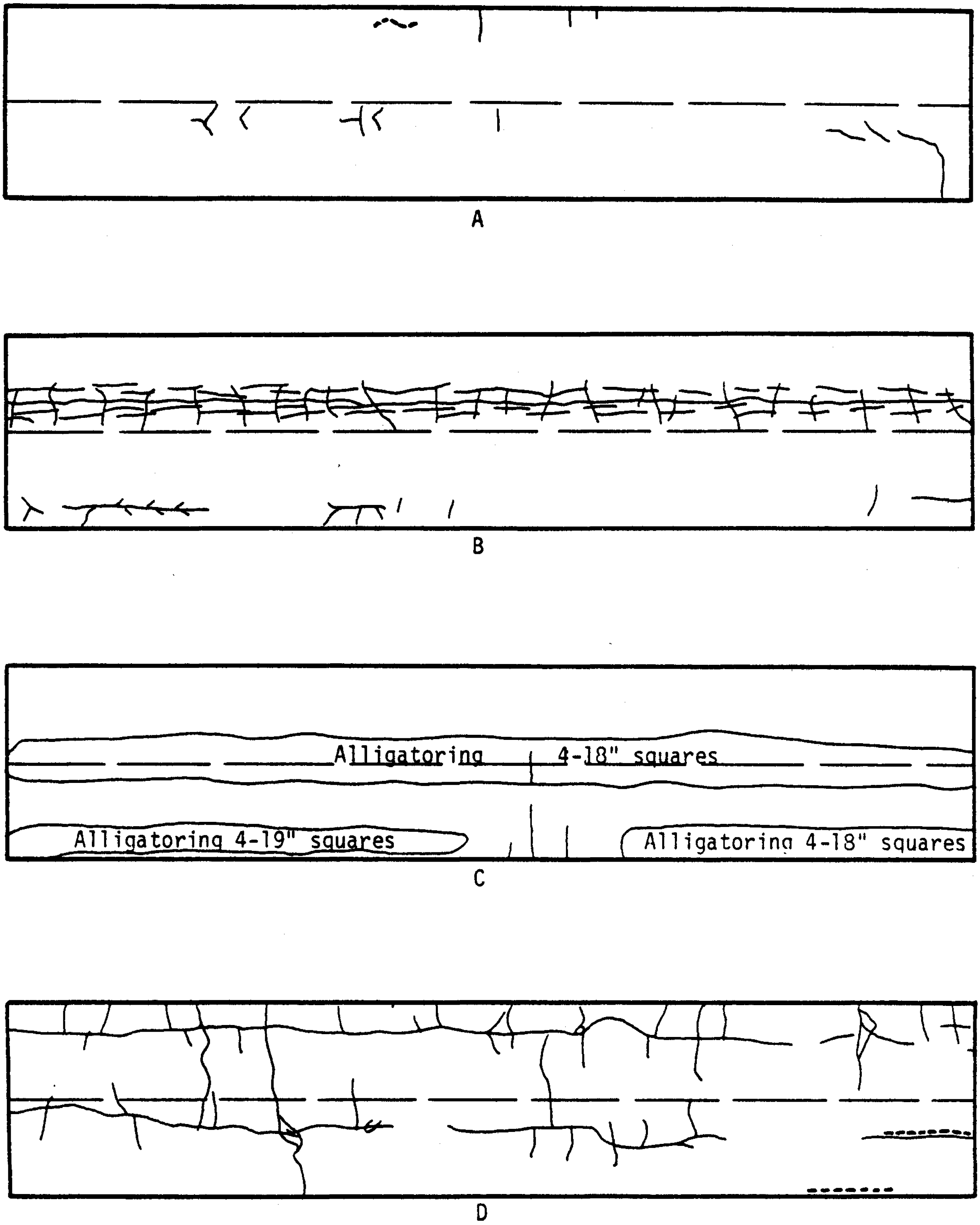

Figure 4. Original Cracking Patterns on US 281 in Edinburg (District 21) Prior to Overlaying. (Maps are typically 100 ft. x 24 ft.). (Cracks in overlay as of June 1984 are shown as dashed lines.)

Only one transverse crack was observed. It was located in test section 10-IH20-4E, which is probably not significant. The crack started at the right edge of the travel lane and proceeded about four feet toward the center of the roadway. No other transverse cracks were observed in the test pavements in Gregg County. Approximately 90 percent of the edge crack originating between the continuously reinforced concrete pavement and the soil cement shoulder has reflected through the asphalt concrete overlay. Prior to overlaying, this crack was sawed to give an opening at the surface of about 2-inches wide and 2-inches deep and filled with an asphalt rubber crack sealing material. Where fabrics were applied, this edge crack was covered with the fabric. In addition, two test sections in Smith County employed three foot fabric strips to cover these edge cracks. The fabric did not appear to aid in reducing reflection of this large edge crack.

Rutting in the travel lane ranged from 3/8-inch to 3/4-inch and appears to be independent of the type or presence of fabric. Hardly any rutting was noticed in the passing lanes.

Slight flushing was observed in the wheelpaths of the travel lane of all pavement sections. There were no other visible signs of distress. Generally, there were no observable differences in the pavement sections in Gregg County.

CONCLUSIONS AND RECOMMENDATIONS

Based on the information developed, after up to five years in service, the four primary fabric test projects show no significant differences between any of the test sections. Furthermore, from the data collected one cannot positively conclude that one fabric performs better than another or that any fabric performs better than none at all in reducing reflection cracking.

The test sections described in Research Report 261-2 and this supplement have been documented in considerable detail. A great deal of engineering design, research effort and funds have been invested in these field experiments. It often takes many years to fully evaluate the effectiveness of paving materials or techniques. It is, therefore, recommended that annual monitoring of these test pavements be continued for an unspecified period to evaluate the long-term effects of fabrics installed to reduce or delay reflection cracking. This will also facilitate realistic estimates of the benefits of the different types of fabrics or fabric properties and thus allow maximum achievement of the project objectives.

REFERENCES

1. Button, J. W. and J. A. Epps, "Evaluation of Fabric Interlayers", Research Report 261-2, Texas Transportation Institute, Texas A&M University, November, 1982.

Appendix A

Table A1. Temperature Data from Ozona (Sonora) District 7

Month	Average Monthly Temperatures, °F		Extreme Temperatures, °F		Maximum Drop in 24 hours, °F
	Maximum	Minimum	Highest	Lowest	
1979					
Sept	89	58	99	48	44
Oct	85	51	97	29	46
Nov	64	35	79	11	49
Dec	61	33	78	13	46
1980					
Jan	61	32	79	21	45
Feb	64	33	82	20	52
Mar	71	39	85	8	63
Apr	79	47	89	30	45
May	84	61	97	50	34
June	94	70	106	65	34
July	98	73	104	64	38
Aug	92	69	98	60	33
Sept	87	67	95	55	36
Oct	76	50	88	30	45
Nov	63	35	88	20	51
Dec	60	34	78	20	54
1981					
Jan	59	32	79	22	48
Feb	61	37	79	10	60
Mar	66	42	84	26	37
Apr	76	56	85	36	42
May	83	59	97	40	33
June	87	66	95	56	-
July	93	69	98	61	27
Aug	94	66	100	58	31
Sept	88	59	98	43	35
Oct	77	55	91	32	35
Nov	72	38	85	22	48
Dec	65	29	80	12	49

Table A1. Continued.

Month	Average Monthly Temperature, °F		Extreme Temperatures, °F		Maximum Drop in 24 hours, °F
	Maximum	Minimum	Highest	Lowest	
1982					
Jan	61	27	81	1	60
Feb	59	32	82	10	48
Mar	73	45	93	18	44
Apr	79	52	96	39	53
May	82	60	94	40	33
June	90	68	99	50	31
July	94	71	101	63	33
Aug	95	70	100	63	33
Sep	91	63	97	50	39
Oct	79	53	92	35	40
Nov	66	42	91	19	40
Dec	60	32	80	24	45
1983					
Jan	57	30	72	18	40
Feb	61	34	76	24	39
Mar	71	42	81	29	41
Apr	Data Unavailable				
May					
Jun	88	65	98	54	35
Jul	94	71	99	62	29
Aug	95	68	100	63	33
Sep	90	64	100	44	37
Oct	79	56	93	39	40
Nov	69	42	84	16	47
Dec	51	23	78	-2	43
1984					
Jan	51	29	76	15	52
Feb	65	31	79	18	56
Mar	72	41	86	23	49
Apr	82	46	98	30	49

Table A2. Temperature Data from Amarillo District 4.

Month	Average Monthly Temperatures, °F		Extreme Temperatures, °F		Maximum Drop in 24 hours, °F
	Maximum	Minimum	Highest	Lowest	
1979					
Sep	83	56	94	46	40
Oct	76	44	94	31	45
Nov	52	29	68	16	42
Dec	53	24	73	9	51
1980					
Jan	47	23	73	9	46
Feb	50	25	77	9	36
Mar	59	28	76	4	44
Apr	67	38	85	26	42
May	75	49	92	41	35
June	93	64	106	51	37
July	97	68	104	62	34
Aug	92	65	99	58	36
Sept	83	58	97	42	38
Oct	72	42	84	21	43
Nov	56	29	87	3	47
Dec	56	26	77	11	45
1981					
Jan	53	23	75	13	47
Feb	59	25	83	-7	51
Mar	62	36	83	22	44
Apr	79	52	89	37	49
May	80	52	93	37	42
June	93	64	107	48	-
July	95	68	105	58	35
Aug	86	63	95	56	28
Sept	81	57	91	47	35
Oct	69	44	85	28	42
Nov	63	35	80	23	44
Dec	55	25	76	13	40

Table A2. Continued

Month	Average Monthly Temperatures, °F		Extreme Temperatures, °F		Maximum Drop in 24 hours, °F
	Maximum	Minimum	Highest	Lowest	
1982					
Jan	54	21	73	2	63
Feb	50	22	82	-5	45
Mar	64	31	82	9	44
Apr	70	38	89	24	55
May	79	48	94	35	44
June	86	56	102	46	39
July	91	66	100	59	32
Aug	91	66	102	59	31
Sept	84	58	97	47	36
Oct	72	42	86	26	39
Nov	59	33	75	17	42
Dec	49	24	74	3	45
1983					
Jan	45	22	68	9	44
Feb	47	25	71	7	39
Mar	58	33	84	11	46
Apr	65	37	87	25	42
May	75	46	88	33	40
Jun	84	57	101	44	41
July	94	66	102	54	33
Aug	96	66	101	61	34
Sept	88	59	102	31	38
Oct	73	48	90	38	39
Nov	61	35	80	16	39
Dec	36	14	68	-7	43
1984					
Jan	44	19	71	-11	37
Feb	56	24	74	15	47
Mar	58	30	84	13	43
Apr	66	37	84	29	44

Table A3. Temperature Data from McAllen (Edinburg) District 21

Month	Average Monthly Temperatures, °F.		Extreme Temperatures, °F		Maximum Drop in 24 hours, °F
	Maximum	Minimum	Highest	Lowest	
1980					
Feb	72	51	90	33	35
Mar	83	60	93	31	35
Apr	87	62	99	43	39
May	90	71	95	60	28
June	97	76	104	72	24
July	100	76	101	72	31
Aug	95	77	100	73	28
Sept	96	74	100	68	27
Oct	85	64	97	31	30
Nov	72	51	88	36	33
Dec	70	50	83	38	35
1981					
Jan	68	48	82	36	37
Feb	73	53	90	34	33
Mar	78	57	90	43	35
Apr	85	69	93	56	23
May	90	70	98	58	25
June	94	75	99	71	-
July	97	75	101	73	26
Aug	98	77	103	74	28
Sept	92	71	99	54	25
Oct	90	65	95	44	36
Nov	82	57	89	44	35
Dec	76	49	90	35	35
1982					
Jan	74	48	90	27	48
Feb	70	49	92	31	38
Mar	80	58	90	37	33
Apr	85	65	100	52	35
May	86	70	92	60	25

Table A3. Continued.

Month	Average Monthly Temperatures, °F		Extreme Temperatures, °F		Maximum Drop in 24 hours, °F
	Maximum	Minimum	Highest	Lowest	
1982 (cont.)					
Jun	95	74	100	70	26
July	97	75	99	73	26
Aug	96	75	100	72	25
Sept	94	71	99	63	29
Oct	87	65	94	49	32
Nov	80	60	95	41	40
Dec	73	52	92	41	37
1983					
Jan	68	49	82	38	35
Feb	75	51	85	43	33
Mar	81	56	96	48	34
Apr	85	61	97	49	32
May	87	70	98	60	28
Jun	94	72	103	68	32
July	93	75	98	71	24
Aug	95	75	101	70	26
Sept	93	72	100	60	28
Oct	87	65	95	55	30
Nov	82	59	91	47	37
Dec	64	42	88	18	38
1984					
Jan	61	44	80	30	30
Feb	72	50	85	39	34
Mar	82	59	104	41	42
Apr	90	64	105	54	33

Table A4. Temperature Data from Tyler District 10

Month	Average Monthly Temperatures, °F		Extreme Temperatures, °F		Maximum Drop in 24 hours, °F
	Maximum	Minimum	Highest	Lowest	
1981					
July	93	71	99	67	28
Aug	94	68	102	59	34
Sept	86	60	94	41	35
Oct	76	53	94	31	34
Nov	69	42	80	26	36
Dec	58	33	79	16	37
1982					
Jan	57	30	78	1	49
Feb	55	34	87	16	40
Mar	70	50	87	26	33
Apr	73	51	86	32	46
May	82	62	93	42	33
June	88	66	93	54	31
July	93	71	100	65	31
Aug	95	71	100	65	30
Sept	90	60	99	43	36
Oct	77	50	93	29	43
Nov	64	44	84	27	32
Dec	60	39	81	19	35
1983					
Jan	53	32	71	21	37
Feb	58	36	74	28	37
Mar	67	42	82	28	34
Apr	72	47	83	32	37
May	81	57	92	41	39
Jun	86	64	94	52	31
July	91	70	97	56	29
Aug	94	71	100	67	28

Table A4. (Continued)

Month	Average Monthly Temperatures, °F		Extreme Temperatures, °F		Maximum Drop in 24 hours, °F
	Maximum	Minimum	Highest	Lowest	
1983 (cont.)					
Sept	89	61	100	36	21
Oct	79	52	93	39	34
Nov	67	44	83	23	42
Dec	46	26	75	2	40
1984					
Jan	50	26	73	8	37
Feb	Data Unavailable				
Mar	68	46	85	29	40
Apr	77	53	89	39	37

Appendix B

1983 Traffic Data

Table B1. Traffic Data as of 1983

Item	Location				
	West of Sonora	West of Amarillo	Edinburg		East of Tyler
Highway Designation	IH-10	IH-40	US 281 and SH 107		IH 20
District Number	7	4	21		10
County and Number	Crockett (53)	Oldham (180)	Hidalgo (109)		Gregg (93)
Control-Section No.	141-1	90-4	255-7 & 8 and 342-1		495-6 & 7
No. of Lanes each Direction	2	2	2		2
Traffic Data					
ADT	3,900	9,100	24,000	13,400	18,000
Percent trucks	32.8	33.5	8.5	5	23
Equivalent 18K axle loads*	6.8×10^6	17.3×10^6	10.8×10^6	2.02×10^6	28.5×10^6
Percent Tandem Axles**	90	80	80	80	100

*20 year design value (1983 to 2003)

**Percent in average ten heaviest wheel loads daily (ATHWLD)