Overlay Construction and Performance Using Geotextiles

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Geotextiles (engineering fabrics) were installed at four locations in Texas to evaluate their potential as cost-effective measures to reduce or delay reflection cracking in asphalt concrete overlays. Test pavements were 0.25 mi long with the fabric installed edge to edge. Nine different types of commercially available geotextiles made of nonwoven polypropylene or polyester were tested. One woven experimental product composed of polypropylene and polyester was also tested. Resistance to reflective cracking has been evaluated for up to 9 years. Results, based solely on these test pavements, indicate that geotextiles are not cost-effective methods in addressing reflective cracking. However, limited evidence indicates that geotextiles will reduce pumping after cracking occurs. Additional data are presented showing that a fabric can be effective in reducing reflective cracking. Recommendations are made to maximize the probability of success when geotextiles are installed to reduce or delay reflective cracking.

Fabrics or geotextiles have been placed in asphalt concrete overlay systems since the 1960s for the purpose of reducing or delaying the occurrence of reflection cracking, or for both purposes. Results of field trials around the nation are available but often inconclusive in many respects. A field and laboratory research program (*1*) was initiated by the Texas Transportation Institute under sponsorship of the Texas State Department of Highways and Public Transportation (SDHPT) and FHWA. The primary objectives of this study were to develop the information necessary to evaluate the performance of geotextiles in asphalt overlay applications in order to

1. Determine the types of distress, if any, that fabrics can economically be used to correct,
2. Ascertain fabric properties that will optimize field performance,
3. Define satisfactory field installation procedures for utilizing fabrics, and
4. Establish realistic specification limits.

Field installations were constructed consisting of eight to thirteen 0.25-mi test sections in four different areas of the state. 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 asphalt concrete (HMAC) overlay. Ten different geotextiles were compared with control sections consisting of either a conventional HMAC overlay with no interlayer or one with a chip seal as an interlayer. All test pavements were installed over cracked asphalt concrete or portland cement concrete pavements 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 9 years. Although not reported in this paper, laboratory tests were also conducted on all paving materials.

The purpose of this paper is to describe the construction of the field installation, identify the properties of the construction materials, and evaluate performance to date of the test pavements.

SUMMARY OF FIELD PROJECTS

Four projects were installed in different geographic and climatic regions of Texas (Figure 1). Within each geographical location, the only variable was the type of geotextile. Ten different fabrics, applied to cover the complete pavement width, were evaluated. Fabric weights ranged from 3 to 8 oz/yd^2. Typical tack coats to accommodate these fabric weights ranged from 20 to 40 gal/yd^2, respectively. Specific information about each project is furnished in Table 1. Engineering fabrics installed at each of the four research projects are listed in Table 1 and described in Tables 2 and 3.

FINDINGS

The four field trials are described in detail in the following paragraphs. They are presented in chronological order according to installation.

Ozona

An 8.75-mi section of Interstate Highway 10 east of Ozona, Texas, was overlaid with HMAC in the fall of 1979. Thirteen 0.25-mi (1,320-ft) test pavements were designed and installed to evaluate the comparative ability of fabric interlayers to reduce or delay reflection cracking in an overlay. Geotextiles evaluated included Bidim C-22, Bidim C-34, Old Petromat, New Petromat, and 8 oz Petromat. The control section contained a conventional seal coat interlayer made of AC-5 and precoated grade 3 crushed limestone.

Preconstruction

The existing asphalt concrete pavement structure before the overlay is described briefly in Table 1. Transverse, longitudinal, and alligator cracking were prevalent in the travel lane for the entire length of this project. The most severe cracking

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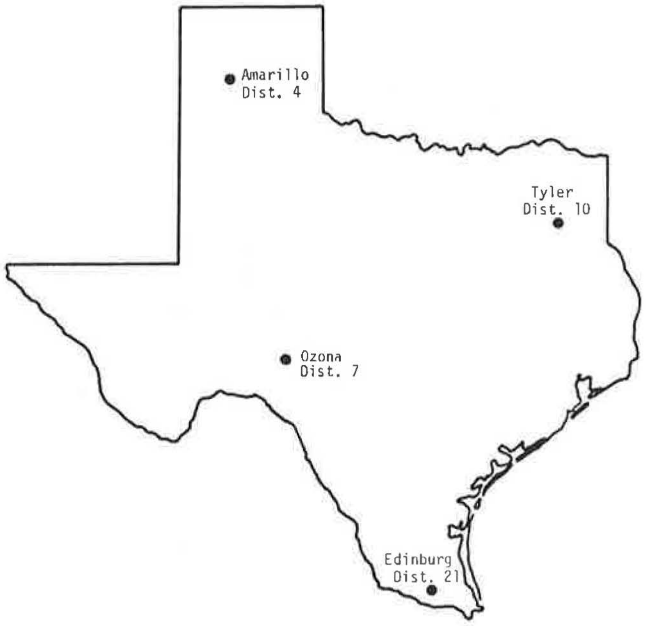

FIGURE 1 Location of trial field sections.

was in the right wheelpath of the westbound (WB) travel lane, which was also displaced downward in certain areas. This displacement was apparently due to severe pumping, which removed a significant volume of base material. Very little cracking was evident in the westbound passing lane. There was significantly less cracking in the eastbound (EB) lanes than in the westbound lanes. Although total traffic volume on this roadway is rather low, the percentage of trucks is quite high (Table 1).

Construction

After the existing pavement was patched to repair localized failures, a predetermined quantity of asphalt tack (AC-20) was applied to the pavement surface. A small tractor with special attachments was used to apply the fabric to the tacked pavement within 2 to 20 min after the asphalt tack was applied. A pneumatic roller was employed to strengthen the bond between the fabric and the old pavement surface. Transverse fabric joints were typically overlapped 6 in. and tacked with emulsified asphalt. Following a light application of sand, the test sections were opened to traffic for a period of 1 to 3 weeks. An HMAC overlay was placed on each test section

TABLE 1 SUMMARY FIELD PROJECTS INVOLVING GEOTEXTILES

	Location					
Item	West of Ozona	West of Amarillo	Edinburg		East of Tyler	
Highway Designation	IH-10	IH-40	US 281 and SH 107		IH 20	
No. of Lanes each Direction	2	2	2		2	
Existing Pavement						
Layer 1 (top)	3″ HMAC[1]	1″ HMAC (Type D)[2]	1″ HMAC[1]		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	
Materials Evaluated	Chipseal (Control) Bidim C-22 Bidim C-34 Old Petromat New Petromat Petromat 8 oz	Control Bidim C-22 Bidim C-34 Old Petromat New Petromat Petromat 8 oz	Control Bidim C-22 Bidim C-34 Old Petromat New Petromat Petromat 8 oz Bidim C-28		Control Old Petromat New Petromat Reepav—3 oz Reepav—4 oz Crown-Zellerbach Mirafi 900×	
HMAC Overlay	Type D	Type D	Type D		Type B[3]	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		TexEmuls M-200	Pavebond AP
Thickness	1 ¾-inch	1 ¼-inch	1.6-inch		2-inch	1 ½-inch
Traffic Data (1980)			(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	

[1] HMAC—Hot-mix asphalt concrete.

[2] Type D—Dense-graded surface course HMAC containing a maximum aggregate size of ½ in.

[3] Type B—Dense-graded base or level-up course HMAC containing a maximum aggregate size of 1 in.

TABLE 2 PHYSICAL DESCRIPTION OF FABRICS INSTALLED IN TEST SECTIONS

Fabric I. D.	Nominal Weight, oz/yd^2	Nominal Thickness, mils	Material	Type Construction	Type Filament	Fiber Bonding
Bidim C-22	4	60	Polyester	Nonwoven	Continuous	Needle-punched
Bidim C-34	8	90	Polyester	Nonwoven	Continuous	Needle-punched
Old Petromat	4	--	Polypropylene	Nonwoven	Staple	Needle-punched and heat bonded on both sides
New Petromat	4	--	Polypropylene	Nonwoven	Staple	Needle-punched and heat bonded on one side
Petromat - 8 oz.	8	--	Polypropylene	Nonwoven	Staple	Needle-punched and heat bonded on one side
Bidim C-28	6	75	Polyester	Nonwoven	Continuous	Needle-punched
Reepav - 3 oz.	3	15	Polyester	Nonwoven	Continuous	Spunbonded and heat bonded
Reepav - 4 oz.	4	17	Polyester	Nonwoven	Continuous	Spunbounded and heat bonded
Crown-Zellerbach	5	60	Polypropylene	Nonwoven	Continuous	Spunbounded and needle-punched
Mirafi 900 X	5	--	Polyester and Polypropylene	Woven	Continuous	Woven

TABLE 3 PROPERTIES OF FABRICS

Test Pavement Location	Fabric I. D.	Average Fabric Weight oz/yd^2	Machine Direction [4]		Cross Machine [4]		Asphalt Rentention,[2] oz/ft^2	Change in Area,[3] Percent
			Elongation, percent	Break, pounds	Elongation, percent	Break, pounds		
Ozona	Bidim C-22[1]	4.4	85	148	84	128	4.2	0
	Bidim C-34[1]	7.1	91	215	108	211	5.2	0
	Old Petromat[1]	4.2	103	75	65	92	2.2	-2
	New Petromat[1]	4.2	76	121	67	154	3.6	-5
	Petromat - 8 oz.	8.6	78	300+	97	300+	4.9	0
Amarillo	Bidim C-22	--	--	--	--	--	--	--
	Bidim C-34	--	--	--	--	--	--	--
	Old Petromat	4.3	84	91	71	112	2.2	-2.0
	New Petromat	4.3	69	115	82.9	133	3.6	-4.8
	Petromat - 8 oz.[1]	8.4	71	300+	71	300+	4.2	0
Edinburg	Bidim C-22	4.9	95	113	99.8	116	3.6	-2.3
	Bidim C-34	--	--	--	--	--	--	--
	Old Petromat	--	--	--	--	--	--	--
	New Petromat	4.6	104	124	91	186	4.0	-9.0
	Petromat - 8 oz.	--	--	--	--	--	--	--
	Bidim C-28	6.5	83	162	91	113	3.8	0
Tyler	Old Petromat	4.6	90	154	79	110	3.4[1]	0[1]
	New Petromat	4.5	94	81	76	118	2.3[1]	0[1]
	Reepav - 3 oz.	3.0	50	89	59	73	--	--
	Reepave - 4 oz.	4.1	52	116	57	96	1.6	0
	Crown-Zellerbach	5.1	140	117	161	112	3.9[1]	0[1]
	Mirafi 900 X	4.9	58	102	47	76	--	--

NOTE: Properties were measured by SDHPT in accordance with specifications in Item 3099.

[1] Only one sample tested.

[2] Asphalt required to saturate fabric.

[3] Change in area (shrinkage upon exposure to asphalt at 275°F for 60 minutes).

[4] Grab tensile test, ASTM D1682.

at a rate of approximately 180 lb/yd^2 (about 1 ¾-in. compacted thickness).

Soon after Bidim C22 and C34 were applied, they were observed to "fluff up" due to the action of traffic. It appeared that the tires became sticky due to tracking in asphalt sprayed outside the edge of the fabric or asphalt that bled through the fabric. The sticky tires subsequently pulled up the fibers near the surface of the fabric, which gave the surface the fluffed appearance. The Bidim products were most susceptible to this phenomenon, but a notable quantity of fibers was completely removed from all the fabrics and deposited alongside the roadway. After a few hours and a light application of sand, the fabric was once again pressed flat onto the pavement by traffic.

Visual inspection during construction showed that New Petromat did not slip as much under the wheels of the pneumatic roller as did Old Petromat. This was particularly noticeable when the pneumatic roller was used on a grade. Old Petromat was manufactured with a thermally bonded "glaze" on both sides of the fabric, whereas New Petromat has the glaze on one side and is fuzzy on the other side. The fuzzy side, which provides a greater effective surface area for better adhesive and shear strength, is designated to be placed next to the asphalt tack on the old pavement surface to provide reinforcement at the interface. This is in agreement with results observed in the laboratory by Button et al. (*2*).

In one fabric, blisters up to approximately 6 in. in diameter were observed in one area (not in a test section). This segment of fabric was installed on a surface-dry pavement shortly after a shower. It is postulated that moisture in small crevices in the pavement was sealed in by the fabric-asphalt membrane; the trapped moisture was later vaporized by the sun's heat on the dark fabric surface, thus forming the blisters. The blisters were slit to allow the vapors to escape and pressed down before the overlay was placed.

Postconstruction

By February of 1980, after a severe winter, a few transverse cracks had appeared in the shoulder along certain sections of the EB travel lane, but they did not continue into the travel lane. No fabric was installed on the shoulders. It is therefore reasonable to assume that the fabrics delayed reflection cracking. Cracks began to appear in the travelway about 3.5 years after construction.

Figures 2 through 4 show transverse, longitudinal and total reflection cracking as a function of time in three representative 100-ft segments of pavement in the WB lanes. In the WB lanes the Petromat products most often exhibited the best resistance to reflective cracking; however, their performance is not a notable improvement over that of the seal-coat interlayer. Figure 5 shows total cracking in the EB test pavements. Although little cracking has occurred to date in the EB lanes, the seal coat is outperforming the fabrics. Observations after rainfall indicate that the fabrics may be reducing pumping well after cracks appear at the pavement surface.

Amarillo

A 13.2-mi section of Interstate Highway 40 near Vega, about 25 mi west of Amarillo, Texas, was overlaid with HMAC in

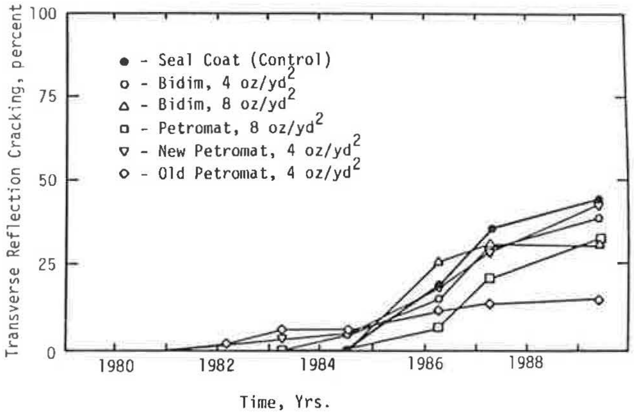

FIGURE 2 Percent transverse reflection cracking as a function of time for westbound test pavements on IH 10 near Ozona, Texas.

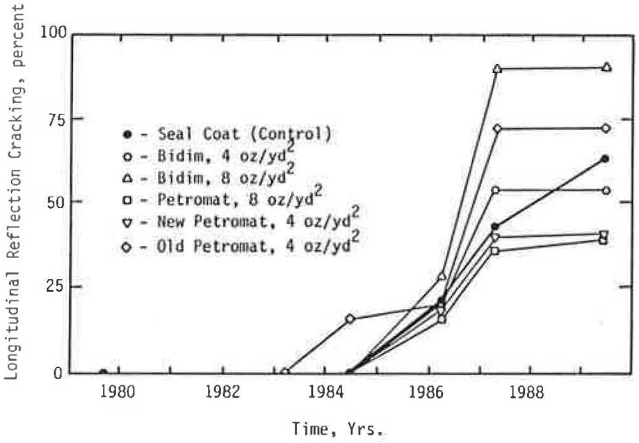

FIGURE 3 Percent longitudinal reflection cracking as a function of time for westbound test pavements on IH 10 near Ozona, Texas.

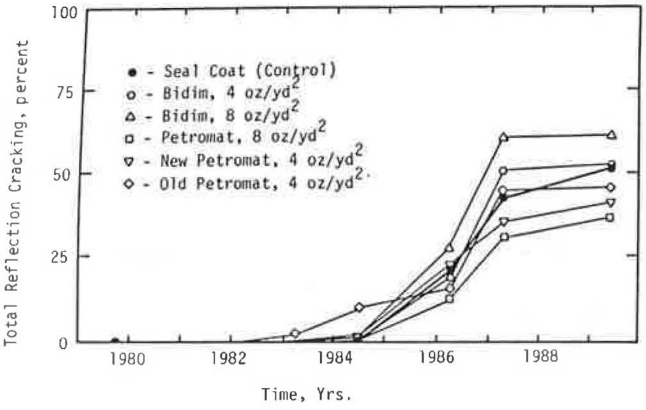

FIGURE 4 Percent total reflection cracking as a function of time for westbound test pavement on IH 10 near Ozona, Texas.

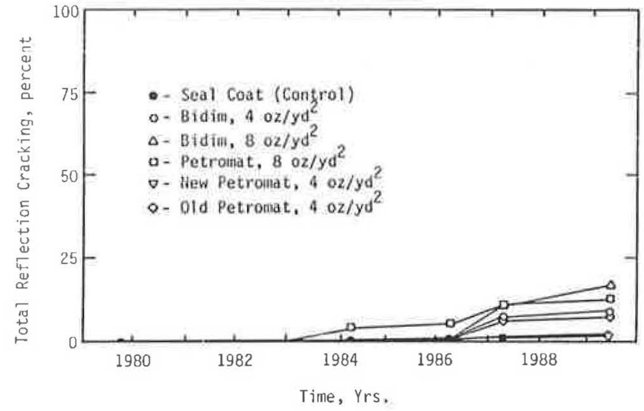

FIGURE 5 Percent total reflection cracking as a function of time for eastbound test pavements on IH 10 near Ozona, Texas.

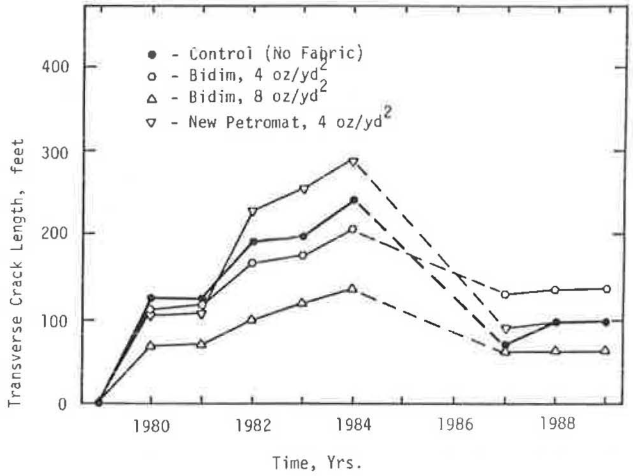

FIGURE 6 Length of transverse cracks in eastbound lanes as a function of time on IH 40 near Amarillo, Texas (600 lane ft).

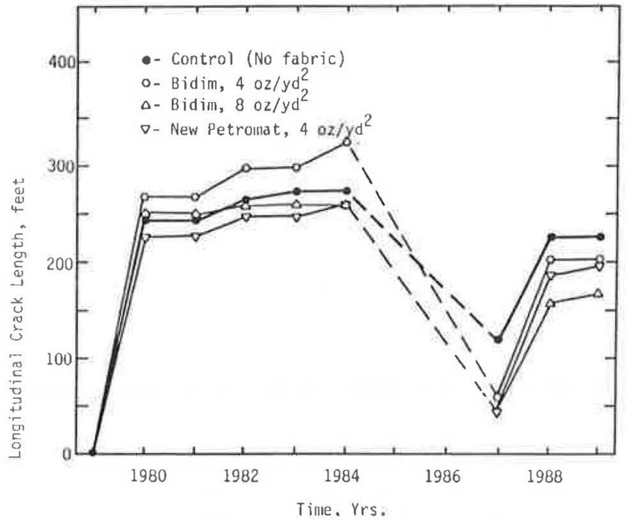

FIGURE 7 Length of longitudinal cracks in eastbound lanes as a function of time on IH 40 near Amarillo, Texas (600 lane ft).

the summer and fall of 1979. An area containing eight ¼-mi test sections was designated for a field trial to evaluate five different geotextiles (Table 1). The existing pavement was asphalt concrete. Different fabric combinations were used in the EB and WB lanes.

Preconstruction

In the summer of 1978, a seal coat was applied using Grade 3 precoated crushed stone. There was concern about placing the fabrics directly on this abrasive surface, because the action of traffic in conjunction with the highly textured surface might damage the fabric. Therefore, a level-up course of HMAC was placed in May 1979.

This construction project was not designated as a field trial for this study until after the seal coat was placed. Consequently, the researcher was unable to record the cracks in the existing pavement. However, verbal communication with the District Construction Engineer and an exhaustive series of photographs prepared by SDHPT personnel revealed that there was considerable fatigue cracking in the travel lane originally, with some thermal (transverse) cracking and moderate rutting throughout the project.

Construction

The fabric and HMAC overlay were placed in September 1979, about 4 months after the level-up course. Fabric was applied to both traveled lanes following application of an appropriate quantity of asphalt tack (AC-10). The fabric was rolled using a pneumatic roller. It was noted during construction that the thick fabrics (8 oz/yd²) were installed with significantly fewer wrinkles than similar thinner fabrics (4 oz/yd²). Fabric construction joints were tacked using a slow-setting anionic emulsion. After sand was applied to the fabric surface to aid in absorbing excess asphalt tack, the roadway was opened to traffic. Soon after the areas containing Bidim C22 and C34 were opened to traffic, the fabrics were observed to fluff up, as previously reported. The fabrics were exposed to traffic for 2 to 7 days before the overlay was placed. An HMAC overlay was placed on each section at 125 lb/yd² (about 1.25 in.). Control sections contained only a light tack between the level-up and the final overlay.

Post-Construction

Three 100-ft segments of pavement in each test section have been monitored periodically to evaluate the ability of the fabrics to reduce cracking. After 7 months in service, following the severe winter of 1979–1980, a visual evaluation revealed a considerable quantity of cracks. Figures 6 through 11 show that the cracks have continued to grow, but at a slower rate. Because the original crack patterns were not recorded, only crack length is shown in the figures and not the percentage of reflection cracking. In 1985 the pavements were heater-scarified to a depth of 0.75 in., an asphalt rubber seal con-

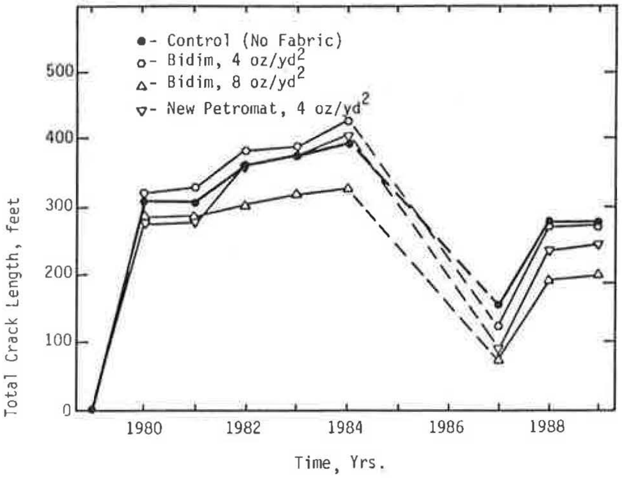

FIGURE 8 Total crack length in eastbound lanes as a function of time on IH 40 near Amarillo, Texas (600 lane ft).

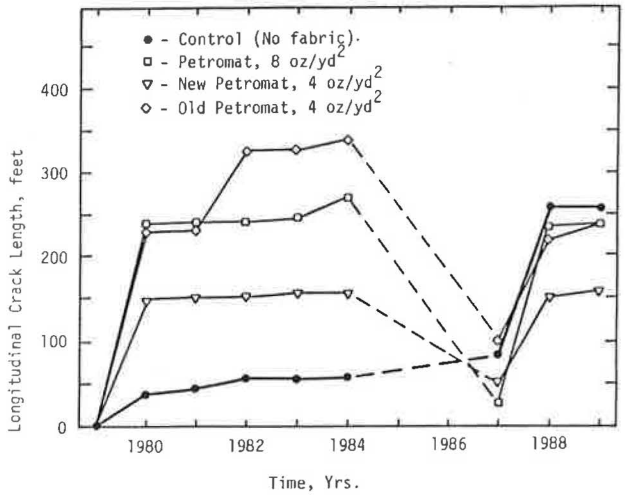

FIGURE 10 Length of longitudinal cracks in westbound lanes as a function of time on IH 40 near Amarillo, Texas (600 lane ft).

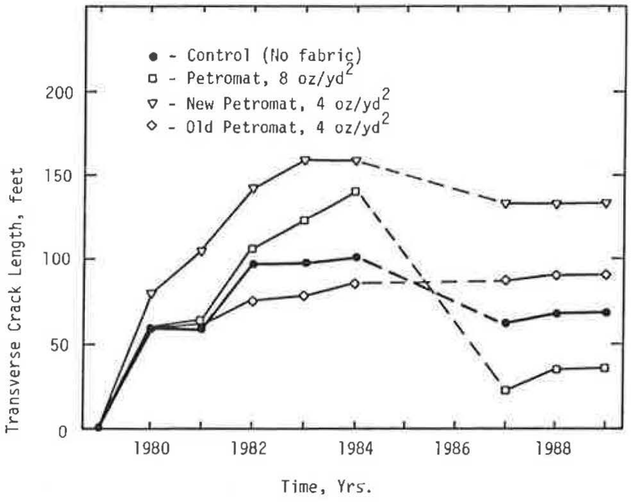

FIGURE 9 Length of transverse cracks in westbound lanes as a function of time on IH 40 near Amarillo, Texas (600 lane ft).

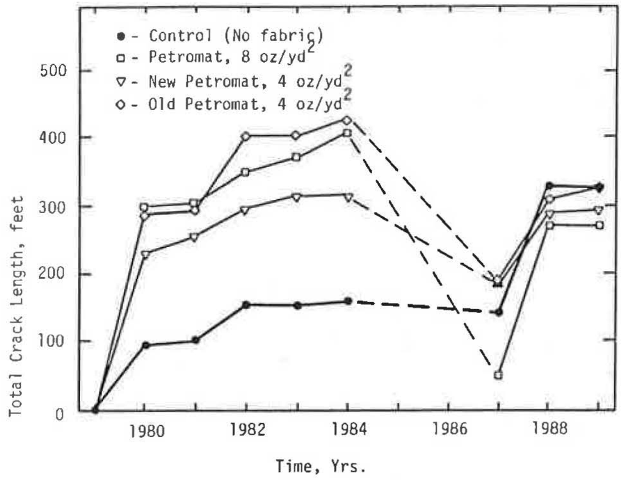

FIGURE 11 Total crack length in westbound lanes as a function of time on IH 40 near Amarillo, Texas (600 lane ft).

sisting of 0.65 gal/yd^2 of binder and 1 yd^3 of grade 3 precoated aggregate per 75 yd^2 of surface was applied, and the pavements were then overlaid with 2 in. of Type D HMAC.

Prior to the maintenance activity in 1985, the control pavements exhibited about the same or less cracking than the sections containing a fabric. After the maintenance activity in 1985, the control pavements, on average, exhibited more cracks in the new surface than the pavement sections containing a fabric. However, in most cases, the differences in crack lengths between the different sections are not considered to be significant. (These data, by their nature, did not lend themselves to a formal statistical analysis.) In these tests, the 8-oz/yd^2 products exhibited the best resistance to cracking in the overlay applied in 1985 but not in the original overlay. No single type of fabric consistently improved resistance to cracking throughout the 10-year evaluation period.

Observations shortly after rainfall indicate that the fabrics reduce pumping, which implies that even after cracks appear, the asphalt-impregnated fabric is acting as a moisture barrier. Admittedly, these observations of pumping have been sporadic and are probably biased.

Edinburg

In February, 1980, seven geotextile test pavements and a control section were installed on US 281 and SH 107 in Edinburg, Texas.

Preconstruction

Before construction, 1¾ to 3 in. of the existing asphalt concrete was removed by cold milling to preserve the curb line. The resulting surface texture was quite rough. Cracking patterns visible at the pavement surface before milling were mostly of the fatigue variety, with some transverse cracks in isolated areas. Cracking patterns were quite variable from one location to another and ranged in intensity from almost none in a 100-ft length to continuous, severe alligator cracking in one or both wheelpaths. There was evidence of rutting and pumping in isolated areas. Cracking patterns were no longer visible after the milling operation.

Construction

Because the test sections are located in an urban area, they are exposed to a considerable quantity of shear forces produced by acceleration, deceleration, and turning movements of traffic. The fabrics were applied curb to curb directly onto the highly textured milled surface after application of predetermined quantities of an asphalt tack coat (AC-10). The fabrics were exposed to traffic for periods ranging from 1 day to 2 weeks. Fluffing of the fabrics due to traffic was again observed.

An HMAC overlay was placed on each test section at a rate of 160 lb/yd² (about 1 ⅝ in. thick after compaction). Seven 1,500-ft test sections containing a fabric and one 385-ft control section containing no fabric were built.

Because of heavy, prolonged rainfall immediately after application of certain fabrics, it became necessary to replace the fabric in a few areas.

Post-Construction

Minor cracking began within 3 months after construction. Initially, pavement distress appeared as longitudinal cracks and block or alligator cracking in or near the wheelpaths, thus indicating their association with traffic loadings and insufficient base stiffness. The nature of the cracking patterns caused difficulty in quantifying and plotting the data. On the basis of a subjective evaluation of patterns, quantities, and severity of cracking, there were no noteworthy differences in reflective cracking between pavements with and without fabrics.

Low stability of the river gravel overlay mixture led to plastic deformation such that the overlay was milled off and replaced in 1985, terminating the experiment.

Tyler

Continuously reinforced portland cement concrete (CRCP) was repaired and a geotextile interlayer and two lifts of HMAC (2-inch Type D over 1½-in Type B) were placed in a project on IH 20 near Tyler, Texas. Seven 0.25-mi geotextile test pavements were installed on a portion of this project in July 1981.

Preconstruction

The original CRCP was constructed in 1965. Transverse cracks spaced about 3.3 ft apart, on the average, were prevalent throughout this project. In the most severely cracked areas, particularly those exhibiting substantial vertical movement upon loading, the concrete was completely removed and replaced with new reinforced concrete.

Construction

A specified quantity of asphalt tack (AC-20) was applied to the pavement surface. Fabrics were installed in the usual manner using a small tractor with special attachments. Both the traveled roadway and the shoulders were covered. Fabric construction joints were tacked at the overlap using hot AC-20. The fabrics were typically overlapped about 6 to 8 in. Two passes of a pneumatic roller ensured good adhesion of the fabric to the pavement surface. The fabrics were not exposed to traffic.

Postconstruction

Annual observations for 6 years revealed only a few isolated transverse reflection cracks (about one per 500 ft) dispersed uniformly throughout the test pavements without regard to type or presence of fabric. The overlay system performed to reasonable satisfaction in arresting reflection cracking, but apparently the fabrics were unnecessary in this instance. In the summer of 1987, major maintenance activities were needed to address rutting, including milling 0 to 1 in. from the pavement surface in the travel (outside) lane and overlaying with about 1 in. of HMAC.

PROJECT COST DATA

Cost information supplied by district personnel and based on 1980 contractor bid prices is presented in Table 4. From these data (*1*), an overall average cost for furnishing and placing a 4-oz/yd² fabric interlayer is about $1.10/yd², including asphalt tack. At this writing the costs of fabric and asphalt cement were down from the 1980 values, but the cost of labor was somewhat greater.

Solely on the basis of the data obtained from the aforementioned test pavements, it appears that fabrics are not a cost-effective measure for reducing or delaying reflection cracking in asphalt concrete overlays. Fabrics may, however, have other advantages that were not evaluated in this study, such as service as a moisture barrier even after pavement cracking occurs.

OTHER EXPERIENCE IN TEXAS

Numerous pavement rehabilitation projects in Texas have involved the use of fabric interlayers or underseals. Most of these have been successful; a few have been disastrous. Two common elements appear in many of the "disasters"—thin overlays and high traffic volume.

Overlays less than 1 ½ in. thick placed over a fabric interlayer on high-volume facilities have exhibited premature distress in several locations (Table 5). Similar problems have been reported in other states (*3*; H. Tyner and W. Gulden, Georgia Department of Transportation, unpublished data). Distress typically occurs during the first year after construction and appears as alligator cracking or slippage at the fabric interface. Alligator cracking is most likely to appear in the wheelpaths on straight sections, whereas slippage is more probable in urban areas at intersections or in curves where

TABLE 4 APPROXIMATE COSTS ASSOCIATED WITH FABRIC INTERLAYS AND COMPARATIVE COSTS OF ADDITIONAL 1-IN. OVERLAY AND CONVENTIONAL SEAL COAT

Item	Ozona	Amarillo	Edinburg	Tyler
Fabric & Placement	0.84	1.10	1.09	0.50
Tack Coat @ \$0.25 gal/yd^2	0.19	0.24	0.19	0.25
Fabric Placement Only (Labor)	--	--	0.39	--
Total Fabric Installation	1.03	1.34	1.28	0.75
Additional 1" of Overlay	1.69	2.00	1.20	1.73
Conventional Seal Coat	0.77	0.65	0.39	0.85

NOTE: Based on 1980 contractor bid prices and a hypothetical average tack coat of 0.25 gal/yd^2.

TABLE 5 SUMMARY OF SELECTED FIELD PROJECTS CONTAINING GEOTEXTILES: PROBLEMS EXPERIENCED

Location in Texas	Thickness of Overlay, in.	Date of Installation	Date of Distress	Type(s) of Distress	Comments
Parmer Co. US 60	1 1/4	July-Sept 80	Spring 81	Extensive slippage and shoving with cracking.	Similar mix performing well on adjacent sections with no fabric.
Lubbock Loop 289N	1 1/4	May 80	Winter 80/81	Extensive cracking	Drum mix plant, low quality HMAC.
Smith Co. IH-20	1 1/2	July 81	Jan 82	Alligator cracking wheelpath.	First occurred after snow, ice and severe cold weather.
McAllen 10th St.	1	Aug 79	Sept 79	Rutting and shoving.	Most likely due to low stability of overlay mixture.
Donna Silver St.	1	Spring 79	Summer 79	Slippage near intersections.	Slippage at fabric-pavement interface.
El Paso Alameda Ave.	1 1/2	Sept 78	Aug 80	Slippage at curves and intersections.	Occurred during period of abnormally high temperatures.
City of Wichita Falls Hempstead and 9th Streets	1 1/2	May 81	July 81	Slippage at intersections and curves with cracking	No problems with similar construction and no fabric. Low tack likely contributed to problem.

shear forces (from braking or turning movements) are maximal.

Thin overlays are difficult to compact adequately, which of course results in comparatively high air voids. Water can penetrate this permeable layer until it reaches the asphalt-impregnated fabric interlayer. The water may remain near the bottom of the new overlay for extended periods depending on the weather. This moisture in combination with traffic can weaken the overlay by freeze-thaw cycling or possibly by stripping near the bottom of the layer. Distress develops first in the wheelpaths from repetitive loading of traffic on the weakened pavement layer.

Shear forces of considerable magnitude develop at the base of thin pavement sections simply by the passage of heavy wheel loads. According to laboratory tests (*2*), under normal conditions, the shear strength at a fabric interface is more than adequate to sustain these stresses. However, if the overlay has been weakened, particularly in the vicinity of the fabric interface (say, by moisture), excessive lateral movement at, or just above, the fabric interface is likely to occur with the passage of each heavy wheel load. This, of course, will result in premature fatigue failure of the new overlay.

In areas where high shear forces are developed, the distress may appear as slippage. Slippage cracks are typically crescent-shaped, with the arched side of the crack pattern pointing in the direction opposite that of vehicle travel. Shear strength at the fabric interface as well as compressive and tensile strength of the asphalt concrete (all of which must be exceeded for localized slippage to occur) are lowest at high ambient temperatures. Therefore, slippage problems are most likely to occur in urban areas during hot weather.

Slippage should not be confused with problems resulting from unstable overlay pavement mixtures. Distress due to low stability will appear as plastic deformation within the mixture such as rutting, shoving, corrugations, and so on. Fabrics should not be blamed for these types of distress.

Moisture, which can migrate upward through cracks and pores in the old pavement, can be trapped below an undersealed and overlaid pavement. Evidence indicates that moisture can accumulate at the underside of the fabric interlayer and, after a period of time, seriously reduce the bond strength between the fabric and the old pavement. Horizontal components of stresses imparted by repetitive vertical wheel loads and other shear forces can eventually result in fatigue-related overlay distress or slippage.

Test sections containing various combinations of fabric, seal coat, and HMAC overlays were installed on IH 20 near Midland, Texas, in 1973 and 1974 (R. S. Neal, unpublished data). Chronological progression of reflection cracking for selected test sections is shown in Figure 12. This plot illustrates the rapid progression of reflection cracks during the first 2 years for the seal coat plus fabric and the conventional thin (1 ¼-in.) overlay. In contrast, the thicker (2 ½-in.) overlay and those overlays with a fabric or a seal coat, or both, exhibited a delay of 2 to 3 years before significant reflection cracking was visible.

CONCLUSIONS

On the basis of the four field trials studied, the following conclusions may be drawn:

1. After up to 10 years in service, no fabric type consistently showed significant improvements in resistance to reflective cracking over another fabric, a seal coat, or no fabric at all. However, other data show that fabrics delay reflective cracking for 2 to 3 years.
2. Thin overlays (less than 1 ½ in.) placed over fabric on high-volume roadways can, under certain conditions, result in premature failure of the overlay.
3. Traffic allowed on fabrics before placement of HMAC can delaminate or remove fibers from fabrics, or both. The needle-punched continuous-filament, non-heat bonded fabrics are more susceptible to this phenomenon than others.
4. Fabrics can be successfully employed on very highly textured surfaces such as freshly milled pavement; in fact, a highly textured surface at the fabric interface may decrease the probability of overlay slippage.
5. Pneumatic rolling of the fabric immediately after application maximizes adhesive strength and shear resistance and minimizes its disruption by traffic, construction equipment, or wind.
6. Pneumatic rolling of fabric on a slope sometimes results in slippage (downhill) of the fabric at the hot asphalt tack interface. Fabrics with a somewhat fuzzy surface next to the asphalt tack offer more resistance to slippage (and thus to wrinkling) under tires of construction equipment than the smoother-surfaced fabrics.
7. Additional tack (emulsified asphalt or hot asphalt cement) applied between overlapped layers of fabric at construction joints minimizes disruption of fabric by wind or construction equipment.
8. Some wrinkling of fabrics during installation is unavoidable. Heavier or thicker fabrics (8 oz/yd^2) resist wrinkling during installation better than thinner fabrics (4 oz/yd^2). Certain fabrics are noticeably stiffer than others of equal weight; they also seem to offer resistance to wrinkling.
9. Bulges or blisters 2 to 6 in. in diameter may appear in

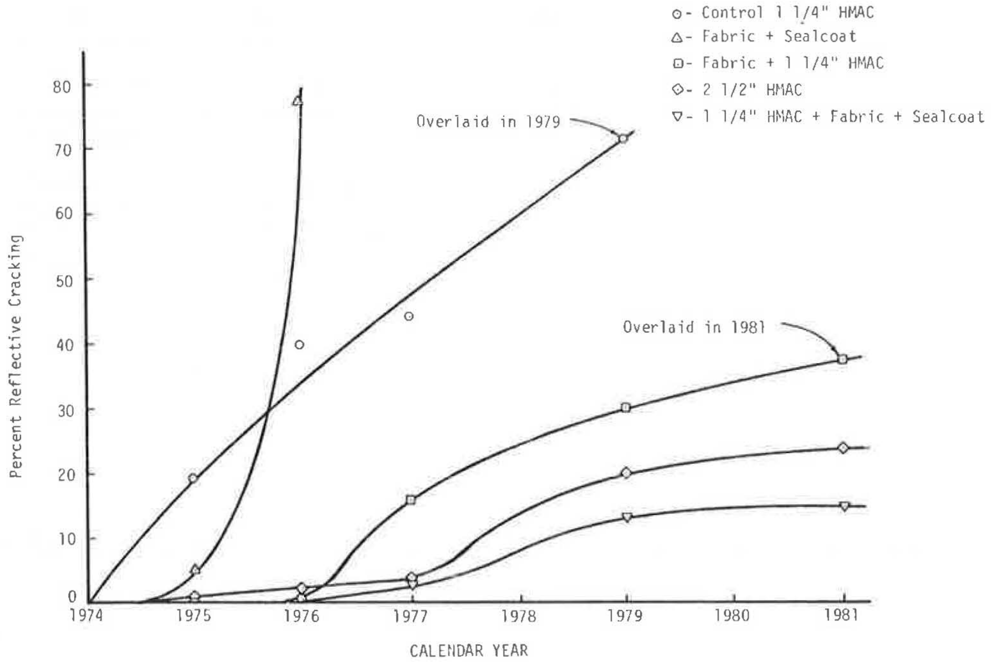

FIGURE 12 Reflection cracking progression for selected rehabilitative treatments (R. S. Neal, unpublished data).

a fabric that is placed shortly after a summer shower and left exposed for several days. Even though the pavement surface appears dry, small voids in the pavement contain water for fairly long periods. Moisture in the small openings is effectively sealed in by the fabric-asphalt membrane and later vaporized by solar heating, thus causing blisters to form. This situation should be avoided whenever possible, but, if blisters do form, they should be eliminated by being slit and rolled with a pneumatic roller before overlaying.

10. Exposure of fabric to prolonged rainfall and traffic action immediately after installation can adversely affect the fabric-to-pavement bond. In severe cases, isolated areas of fabric may become completely separated from the pavement. A highly textured pavement surface, in which there are significant voids between the fabric and the pavement surface, would most likely be detrimental in this situation.

11. Insufficient asphalt tack applied for fabric adhesion can result in failures due to slippage at the fabric interface, especially in areas of high shear forces during periods of hot weather. Excessive tack can migrate to the pavement surface and appear as flushing in the wheelpaths.

RECOMMENDATIONS

From the results of the study at this stage, the following recommendations are given as guides to minimize problems during construction and early service life and to maximize performance of geotextiles installed to reduce reflection cracking.

1. Potholes should be patched, cracks larger than ⅛ in. should be filled, and faulting should be eliminated prior to application of fabric or overlay, or both.

2. "Cure time" for the asphalt cement tack coat before placement of the overlay is not necessary. Only an insignificant quantity of volatiles will evaporate from asphalt cement at normal pavement service temperatures even after several months. Exposure to traffic and the elements of fabrics installed to reduce reflection cracking should be minimized. Exposure can only serve to damage the fabric and thus reduce its effectiveness, even though the fabric may not appear to be damaged. Traffic will abrade fibrous materials to varying degrees, depending upon the type of fabric. Tires will pinch or wear holes in the fabric at the peaks of the larger aggregate in the old surface. Fabric will be damaged predominantly where it is needed most—in the wheelpaths. Furthermore, from a skid-resistance standpoint, a dangerous situation could develop on exposed fabric, particularly during periods of wet weather.

3. Large wrinkles should be cut and overlapped to reduce the localized bulkiness of the fabric. Wrinkles can be a source of premature cracking in the overlay from compaction without firm support or possibly from fabric shrinkage (*4,5*).

4. The use of thin, high-void overlays with fabric should be avoided, particularly on high-traffic-volume facilities. An overlay thickness of 1 ½ in. should be considered a minimum for use over fabrics. Only dense-graded mixtures with low permeability should be installed over a fabric.

5. Asphalt saturation content of a fabric is dependent upon thickness and absorbency of the fabric and should be quantified before a pavement containing fabric is designed. Two methods of estimating asphalt retention of a fabric are reported in the literature (*6,7*). The proper quantity of asphalt tack is dependent not only on fabric properties but also on the condition of the old pavement surface.

6. Asphalt-impregnated fabrics usually remain intact even after moderate cracking and may therefore aid in reducing the flow of surface water into the base and thereby reduce pumping. Further investigation is needed.

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