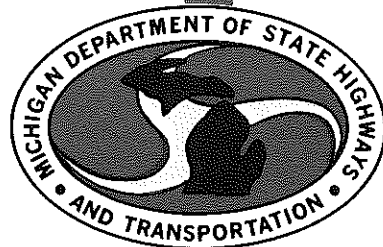


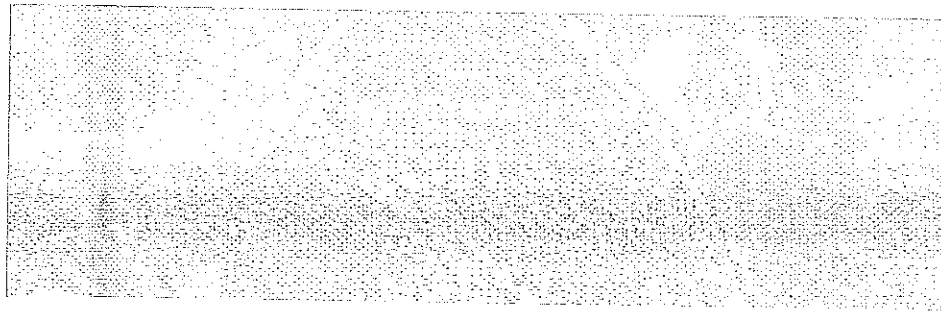
PERFORMANCE EVALUATION OF 'MIRAFI 140'
FABRIC AS OVERLAY REINFORCEMENT TO
CONTROL REFLECTION CRACKING



**TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION**



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TE270 .Z363 1979 c. 2
Performance evaluation of
"MIRAFI 140" fabric as
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C. A. Zapata

A Category 2 Project Conducted in Cooperation
With the U. S. Department of Transportation,
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Research Laboratory Section
Testing and Research Division
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Michigan Transportation Commission
Hannes Meyers, Jr., Chairman; Carl V. Pellonpaa,
Vice-Chairman; Weston E. Vivian, Rodger D. Young,
Lawrence C. Patrick, Jr., William C. Marshall
John P. Woodford, Director
Lansing, July 1979

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Introduction

Reflection cracking of asphalt overlays continues to be a major highway problem. This phenomenon, related to daily temperature changes, results from continuous opening and closing of joints and cracks existing in the original pavement. Such continuous thermal movements are 'reflected' through asphaltic concrete overlays placed over the existing pavement (1, 2).

Many highway agencies are presently experimenting with crack preventive features such as fabrics and wire-mesh reinforcements, stress relief courses, duplication of existing joint patterns in overlays, plant mix seals, heater-scarifiers, seal coats, and various crack-resistant materials. Results from some of these experiments have indicated intermittent success in achieving the intended purpose, but comprehensive information describing construction methods, cost, and remedial practices for each treatment is lacking (3, 4).

In studying fabric performance as asphalt overlay reinforcement, it is generally assumed that the reinforcing fiber improves the fatigue strength of the top pavement layer to help resist surface cracking (Appendix A).

A test recently conducted in North Carolina has suggested that 'Mirafi 140,' a plastic fabric made by Celanese Fibers Marketing Co., installed between an existing concrete pavement and an asphalt overlay, controls reflection cracking (5). Mirafi fabric properties and installation guidelines for pavement overlays are given in Appendix B.

A performance evaluation of this plastic fabric is the main purpose of the experiment described in this report. This research project, by incorporating a material unique to present construction methods and practices, is defined by the Federal Highway Administration as "Experimental Highway Construction, Category 2."

Objectives

Specifically, this study is designed to evaluate Mirafi 140 fabric performance in terms of reflection cracking reduction, laydown and bonding practices, labor, equipment and inspection required, maintenance, and construction costs, compared with conventional asphaltic concrete overlay.

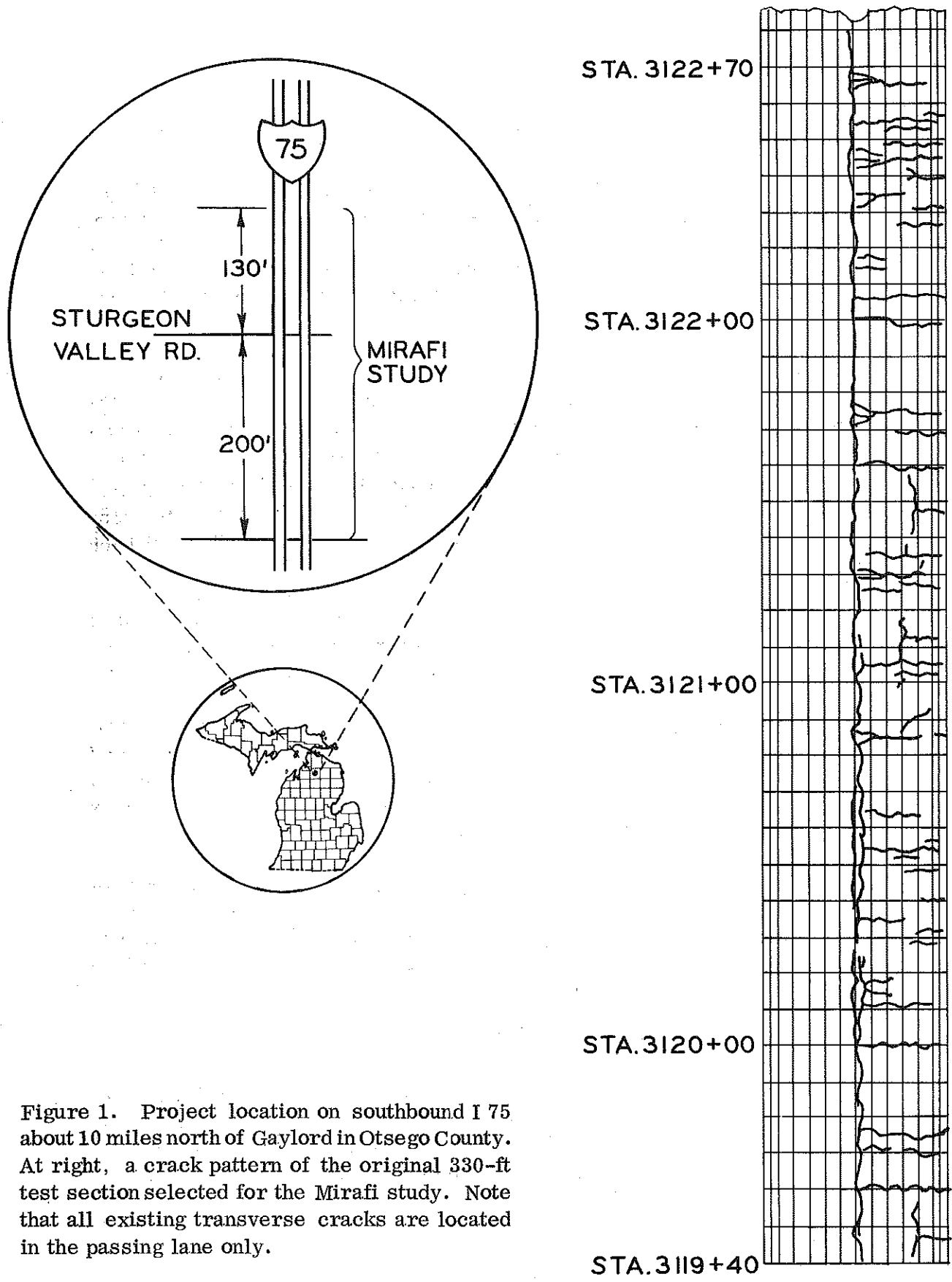


Figure 1. Project location on southbound I 75 about 10 miles north of Gaylord in Otsego County. At right, a crack pattern of the original 330-ft test section selected for the Mirafi study. Note that all existing transverse cracks are located in the passing lane only.

Project Location

The test site is located on southbound I 75 of Project I 69014-09240A, from Sta. 3119+40 south to Sta. 3122+70 north of Sturgeon Valley Rd about 10 miles north of Gaylord in Otsego County (Fig. 1). The 15-year old test area, which carried an average daily traffic of 7,000 vehicles in 1977 was originally built as a three-course asphaltic concrete pavement. This area has not been resurfaced over a 15-year service period since construction.

Since a major objective of this study is to evaluate the crack-resistant property of the Mirafi fabric, condition surveys of the test area were conducted before the experimental resurfacing was applied. Existing surface cracks were counted and mapped in September 1977. Figure 1 shows the crack patterns of the original 330-ft test section selected for the Mirafi study. Figure 2 shows typical distress conditions of the original 15-year old flexible pavement. Note that this 330-ft test section of two-lane pavement developed both transverse and longitudinal cracks. All existing transverse cracks, visible from each side of the roadway, were located in the passing lane of the southbound roadway. Also, a longitudinal crack over 1/4 in. wide and over 400 ft long developed along the pavement centerline.

Installation Procedure

Lake Construction Co. began the Mirafi installation on September 7, 1977 in cloudy, partly humid weather with temperatures ranging from 50 to 65 F and wind velocities over 10 mph. Eisenhour Construction Co. furnished, at no cost to the Department, over 1,000 sq yd of the Mirafi fabric to cover 330 ft of the 24-ft wide roadway.

The Mirafi test section was constructed by placing a tack-coat of emulsified asphalt (SS-1h) over the original cracked asphaltic concrete pavement and then placing the fabric directly on the tack-coat. In turn, the Mirafi fabric was covered with bituminous concrete (Standard Specification 4:12) at a rate of about 250 lb/sq yd. Adjacent to the Mirafi test section, the existing pavement without Mirafi fabric was first overlaid with a lean bituminous mix about 2 in. thick and then resurfaced with a (4:12) bituminous concrete placed at the rate of 250 lb/sq yd. Pavement sections of this 10-mile conventional overlay will be compared in field performance with the Mirafi test section. Other areas of similar pavement located south of this experimental project and which were conventionally resurfaced a few years ago will also be used for comparison purposes.



◀ Sta. 3121 looking west from the inside shoulder.

◀ Sta. 3121 looking south from the inside shoulder.

Figure 2. Typical distress conditions of the original 15-year old flexible pavement, construction Project I 69014-09240A on southbound I 75 about 10 miles north of Gaylord in Otsego County.



With extra care, the contractor's crew of five men spent more than an hour manually unrolling, laying down and bonding the first 330 ft of fabric, 14-3/4 ft wide. Installation problems such as tearing, wrinkling, and bubbling of the fabric were reasonably controlled during the project. Traffic continued to move along the open lane while the work was in progress. Figures 3 through 6 show field operations during the installation project.

Reflection Cracking

Crack surveys were made in May 1978 and March 1979 and showed about 18 percent reflection cracking over the Mirafi section. This rate of crack formation is similar to that of conventional bituminous concrete overlays after two winters of pavement service.

Conclusions and Recommendations

In general, the experimental Mirafi 140 fabric, used as reinforcement of asphaltic concrete overlays to control reflection cracking, was installed without any major field problem. Also the resurfacing work including paving operations, control practice, and workmanship was satisfactory throughout the experimental project. Although the Mirafi section, over a two-year period since construction, has shown little or no resistance to reflection cracking, it is recommended that seasonal crack surveys and field inspections should continue for at least two more winters to complete the evaluation.

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Figure 3. Spraying asphalt emulsion, SS-1h, over the 330-ft traffic lane of the test section. The emulsified asphalt was applied at temperatures over 300 F and at the rate of 0.15 to 0.20 gal/sq yd.



Figure 4. Unrolling, laying down and bonding the first 330-ft roll, 14-3/4 ft width, of Mirafi fabric, required five men and took more than an hour to place the fabric over the asphalt emulsion.

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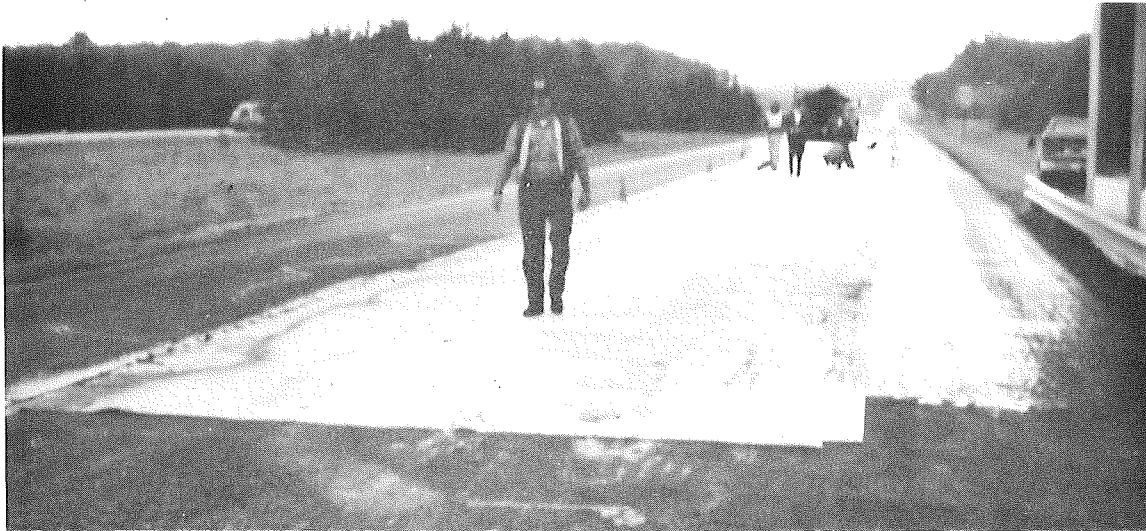


Figure 5. The uncovered Mirafi fabric was properly aligned, bonded and compacted along the straight 330-ft traffic lane of the test section. During the fabric laydown, the passing lane was opened to regular traffic.



Figure 6. Applying asphaltic concrete overlay to the fabric at a rate of 250 lb/sq yd. The rolling sequence behind the paver required first a 2-ton steel-wheeled roller operating at 3 mph and then another 8 to 12-ton steel-wheeled roller operating also at 3 mph to complete the resurfacing job. Once this lane was compacted and finished, the other lane was ready for the fabric laydown. The two lanes were completed the same day according to plan.

APPENDIX A

Reflection cracking through asphaltic concrete overlays is the most prevalent form of fatigue distress of asphalt resurfacing projects. It grows under the combined influence of traffic loading and thermal stresses according to the following crack propagation law (6, 7)

$$\frac{dc}{dN} = A(AK)^n$$

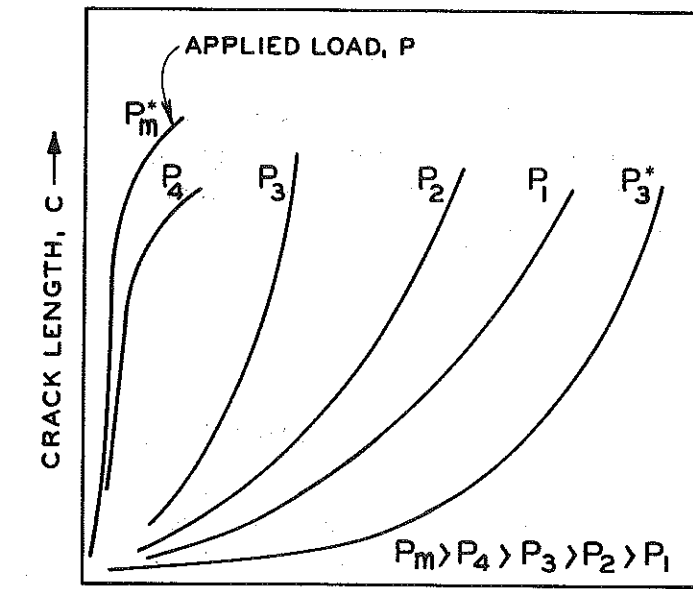
where the rate of crack growth $\frac{dc}{dN}$ is a function of the material property A, a major factor influenced by changes of temperature and moisture; the change in the stress-intensity factor K, a controlling parameter which describes the magnitude of the stress field near the crack location; and the exponent n which ranges from 2 to 100 depending on traffic loading, material properties, and environmental conditions. Assuming that only tension stresses contribute to the crack opening and propagation, experimental work has shown that the fourth-power relation:

$$\frac{dc}{dN} = A(AK)^4$$

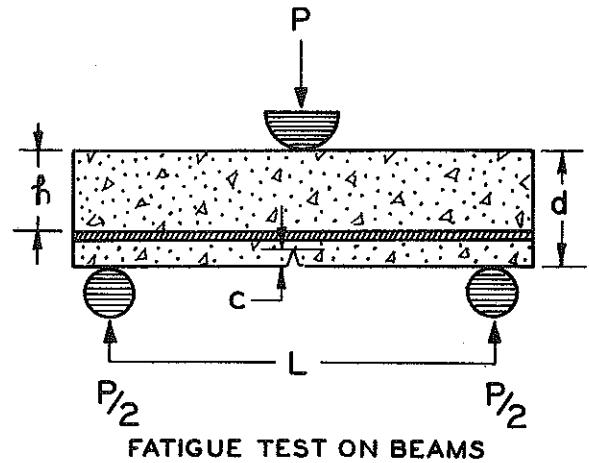
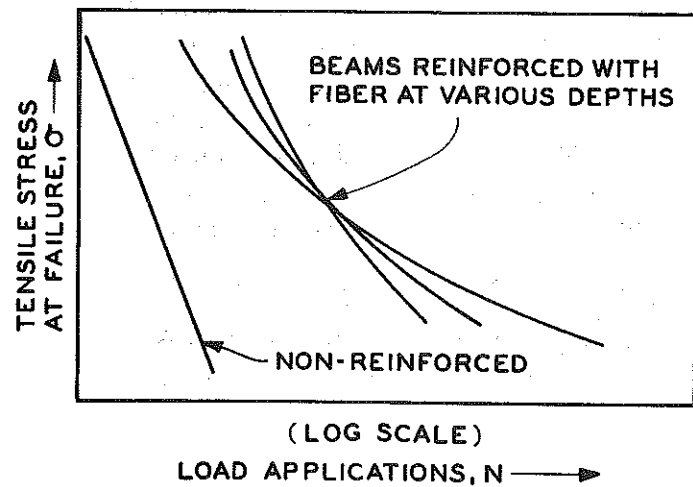
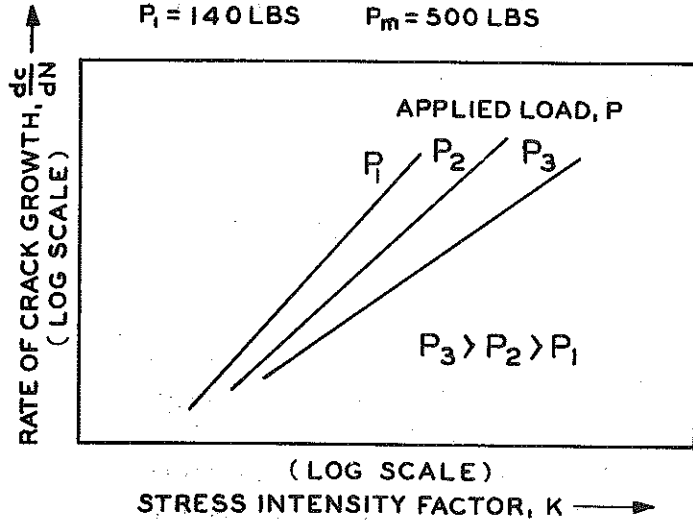
best fits fatigue laboratory data with asphaltic concrete mixtures (7).

Fabric-Reinforced Overlay

In an attempt to determine the effect of plastic fabric reinforcement on the fatigue strength of asphalt overlays, a simplified laboratory model (Fig. 1A) was tested in a recent study (8). Fracture and fatigue tests to simulate pavement response under actual field conditions were conducted using fabric-reinforced and non-reinforced asphaltic beams. The test loading ranged from 140 to 500 lb simulating field conditions under low and high stresses, respectively. Figure 1A includes three charts summarizing the laboratory results of this study. Figure 1Aa shows crack-growth trends associated with increased load applications N for fatigue loadings P ranging from 150 to 500 lb. It appears that fabric-reinforced as well as non-reinforced beams under high loadings ($P > 300$ lb) failed to stop or retard crack growth. However, fabric-reinforced beams under low stresses ($P < 200$ lb) showed better fatigue strength. Figure 1Ab seems to indicate that as the rate of fatigue cracking $\frac{dc}{dN}$ increases under various dynamic loadings P, the stress-intensity factor K also increases. Figure 1Ac shows the effect of fabric-reinforcement compared with non-reinforcement on



LOAD APPLICATIONS, N →
 *FABRIC-REINFORCED BEAMS
 $P_1 = 140 \text{ LBS}$ $P_m = 500 \text{ LBS}$



FATIGUE TEST ON BEAMS
 P = APPLIED LOAD
 d = BEAM DEPTH
 h = FABRIC-REINFORCED DEPTH
 L = BEAM SPAN
 C = CRACK DEPTH

Figure 1A. Laboratory fatigue results from recent study using fabric-reinforced and non-reinforced asphaltic concrete beams (8).

tensile stresses at the bottom of test beams. This indicates that as the applied tensile stress decreases, the number of loading cycles N increases and also that fabric-reinforcement seems to increase the fatigue strength of the test beams.

Concluding Remarks

The usefulness of the crack growth equation to predict the fatigue life of asphalt overlays is limited by several difficulties. First is the uncertainty in fatigue life associated with cumulative damage and the combined effects of cracking, rutting, and aging (7, 9, 10). Second, this uncertainty is further complicated by the mechanics of cracking associated with the stress-intensity factor K , which describes the magnitude of the stress field near the crack location (7). Third is the lack of fatigue data correlating random loadings, material properties, construction variations, and environmental factors with pavement performance (9, 10, 11). All these variables affect the exponent n which varies within a very wide range for many pavement conditions (7).

Furthermore, the fatigue data reported recently (8) were developed just for a single asphalt mix design without taking into account variations in aggregate type and gradation, filler type and content, asphalt content and penetration, mixing and curing temperatures, compaction and aging, all these affect fatigue behavior of asphaltic concrete mixes (9, 10, 11). Also, variations in asphalt mixes, materials properties, construction procedures, and environmental factors are actually involved in pavement construction (12, 13). Until some of these variations are taken into account in experimental work, the benefits from laboratory fatigue data are questionable, though it may be useful at least qualitatively for showing general trends and for planning further investigations. Finally, the general consensus indicates that the fatigue strength of asphaltic surfacings may be the controlling property in the mechanism of surface cracking (6, 7, 8, 9, 10, 14).

APPENDIX B

MIRAFI 140 FABRIC
SPECIFICATIONS AND PROPERTIES

A typical Mirafi 140 fabric mat, over 20-mil thick, is a white, thermo-plastic material consisting of a polypropylene core covered with a nylon sheath, made by the Celanese Fibers Marketing Co. and weighs about 4 oz/sq yd. The fabric is reported to have an average tensile strength of 52.5 lb/in. in either direction and elongates over 100 percent before breaking. The fabric is currently produced in 100 yd rolls, 14-3/4 ft wide and costs about \$0.72/sq yd delivered at job site.

Installation Procedure

In brief, the successive steps in the construction procedure are:

1. Clean and dry the existing pavement; seal and patch joints and cracks.
2. Apply the asphalt tack-coat or cationic emulsion over the old surface as recommended by the fabric manufacturer.
3. Place and unroll the fabric over the prepared road surface as recommended by the fabric manufacturer.
4. Place and compact 2-in. bituminous concrete wearing course over the fabric.

The manufacturer claims that the fabric installed between an existing pavement and an asphalt overlay improves fatigue life of the overlay by reducing reflection cracking.

INSTALLATION GUIDELINES FOR PAVEMENT
OVERLAYS USING MIRAFL 140 FABRIC

1. Pavement surface should be free of dirt, grease and loose material. Small cracks should be filled with crack sealer. Larger cracks should be filled with patching or hot mix.

2. Asphalt cement or emulsified asphalts are recommended for tack-coat. Approximately 0.15 to 0.20 gal/sq yd (based on residual asphalt content) is most optimum tack-coat quantity for Mirafi 140. Additional tack thickness acts as a film or lubricant between the old surface and the fabric, causing the resurfaced layer to "crawl" when compacted with a 1-1/2-ton sealing roller or an 8-ton pneumatic roller.

3. It is necessary to keep the roll of Mirafi 140 straight when applying on top of the tack-coat—preferably by using some sort of tensioning device with a slip clutch—to prevent wrinkles from developing in the fabric.

4. The fabric should be brushed immediately after being laid down to remove minor wrinkles, air pockets, and to insure intimate contact with the old surface. It is not necessary to roll Mirafi 140 with a pneumatic roller.

If wrinkles develop, they should be removed by slitting the fabric with a pocket knife and overlapping the pieces.

5. Fabric sections should be overlapped six (6) inches. All joints or slits in the fabric must be covered by hand placing several shovels full of asphalt over the joint and tamping to insure that the pavement machine does not pull the fabric up.

6. A very light layer of sand or asphalt mix is advisable over the fabric to "break" the tackiness so as to prevent the fabric from being lifted off the surface by sticking to the wheels of the paving machines or trucks.

7. Sufficient time should be allowed for the setting of the tack-coat prior to the spreading of the asphalt.

8. Precautions should be taken if the paving machine has to push the asphalt truck to prevent the torque on the paving machine wheels from wrinkling the fabric. If possible, the paving machine should not push asphalt trucks. Truck drivers should be cautioned not to "hot rod" their trucks over the fabric.

9. A light roller (1 to 2-ton seal roller) should be used on the layer directly over the fabric (i. e., the first one-inch layer) followed by normal rolling operations. Caution should be taken not to roll the first layer too much. Excessive rolling of a thin one-inch layer will induce cracking.