REINFORCEMENT OF ASPHALTIC CONCRETE OVERLAYS WITH PETROMAT FABRIC

MICHIGAN
RESEARCH LABORATORY SECTION

MICHIGAN DEPARTMENT OF
STATE HIGHWAYS AND TRANSPORTATION

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C. A. Zapata
L. M. Bateman

Research Laboratory Section
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"Petromat" fabric is a black, non-woven polypropylene plastic manufactured by the Phillips Petroleum Co. (Appendix A). The Company claims that the fabric, when used as reinforcement, can substantially extend the maintenance-free service of asphaltic concrete overlays by eliminating or reducing reflection cracking, and preventing water infiltration into lower pavement layers (Appendix B). The purpose of this study is to determine how well the Petromat fabric is succeeding by evaluating its performance characteristics and to recommend appropriate action for future evaluation, if warranted, under local conditions. For this general approach, two specific tasks were assigned: 1) to observe installation procedures of a Petromat project at Ann Arbor, Michigan and conduct informal seasonal surveys of this overlay project; and, 2) to study reported findings about Petromat fabric being tested by other highway agencies as reinforcement of asphalt overlays.

Ann Arbor Petromat Project

In August 1975, the City of Ann Arbor installed 34,000 sq yd of Petromat fabric reinforcement as part of its street maintenance program (Fig. 1). Their primary objective was to assess Petromat's performance as a moisture barrier. The project consisted of bonding the fabric between asphaltic concrete layers and then overlaying it with an asphaltic wearing course mixture. Figure 2 summarizes the installation data. The existing four-lane concrete pavement, located on Stadium Blvd between Pauline St and Main St, was badly distressed, with bituminous patches covering most of the transverse joints and cracks. The traffic on this heavily traveled street has increased to the point where it now carries up to 20,000 vehicles per day.

Installation Procedure

On August 11, 1975, the Phillips Petroleum Co., the fabric manufacturer and contractor, began the Petromat installation. In brief, the successive steps in the construction procedure were: 1) cleaning and sweeping the old pavement to remove dirt, water, and any vegetation; 2) overlaying the old surface with a 1-in. bituminous concrete leveling course 25A; 3) spraying asphalt cement, 85/100 grade, at 320 F and at a rate of 0.25 to 0.30 gal/sq yd (Fig. 3); 4) unrolling and placing the Petromat fabric at a rate of 15 to 25 ft/minute (Figs. 4 and 5); 5) overlaying the fabric with 1-1/4-in. bituminous concrete binding course 25A (Figs. 6 through 8); and 6) resurfacing with a 1-1/2-in. bituminous concrete wearing course 31A. The first two asphalt overlays were applied as specified in current MDSHT Standard Specifications, Section 4.12. The third overlay (also 4.12) was applied two weeks later.

Installation Problems

1) Careful overlapping of two adjacent fabric mats to minimize pick-up by paving equipment was a time-consuming task (Fig. 9). This application required at least five minutes and three men at each 300-ft interval (project total; 80 times) to apply additional binder, brooming and flattening the 12-ft transverse joint.

2) Large wrinkles and bubbles were frequently associated with the fabric laydown (Figs. 10 and 11).

3) Bonded fabric, subjected accidentally to braking by a paving truck, was severely damaged (Fig. 12).

4) Asphalt flushing and rich asphalt mix caused a slippage problem (Fig. 13).

5) Frequently, paving trucks riding over the fabric caused large wrinkles (Fig. 14).

Although the Ann Arbor project was not installed for controlled experimentation, seasonal condition surveys will be conducted to assess the Petromat performance as a reinforcement to prevent cracking.

Results From Other Agencies

Petromat fabric as reinforcement of asphalt overlays is also being tested in other states for various performance characteristics: resistance to reflection cracking, moisture barrier, breaking and bond strength, resistance to wrinkling and weathering, ease of installation, and economy.

Although these experiments are still inconclusive, early results reveal that Petromat as a reinforcement to prevent cracking is far from satisfactory. Table 1 summarizes the limited results received so far from various agencies.

Conclusions

1) Usually, large wrinkles and bubbling of the fabric were the main installation problems of Petromat laydown at the Ann Arbor project. With extra care, tearing of the fabric, flushing, and slippage were reasonably controlled during the project.

2) Overlapping adjacent fabric mats at 300-ft intervals was a time-consuming task. Each Petromat transverse joint and lap required three men and at least five-minutes of hand application.

3) Unrolling each 300-ft roll, 12-ft wide, took 15 to 25 minutes; and application rate of about 1,700 sq yd/hr required a special laydown device, five trained men and a five-minute reloading time for a new roll. 34,000 sq yd of Petromat at $1.20/sq yd were laid in two and a half days.

4) Results from other agencies seem to indicate that Petromat performance in controlling reflection cracking is far from satisfactory. However, additional time is needed to draw definite conclusions.

Recommendations

Since the test projects using Petromat fabric as overlay reinforcement are still under study by other agencies, two steps are recommended:

1) Continue informal condition surveys of the Ann Arbor project with emphasis on cracking development and other pavement distresses.

2) Continue seeking additional information from agencies testing Petromat, for at least two more years, until sufficient results are obtained to estimate the fabric performance as overlay reinforcement.

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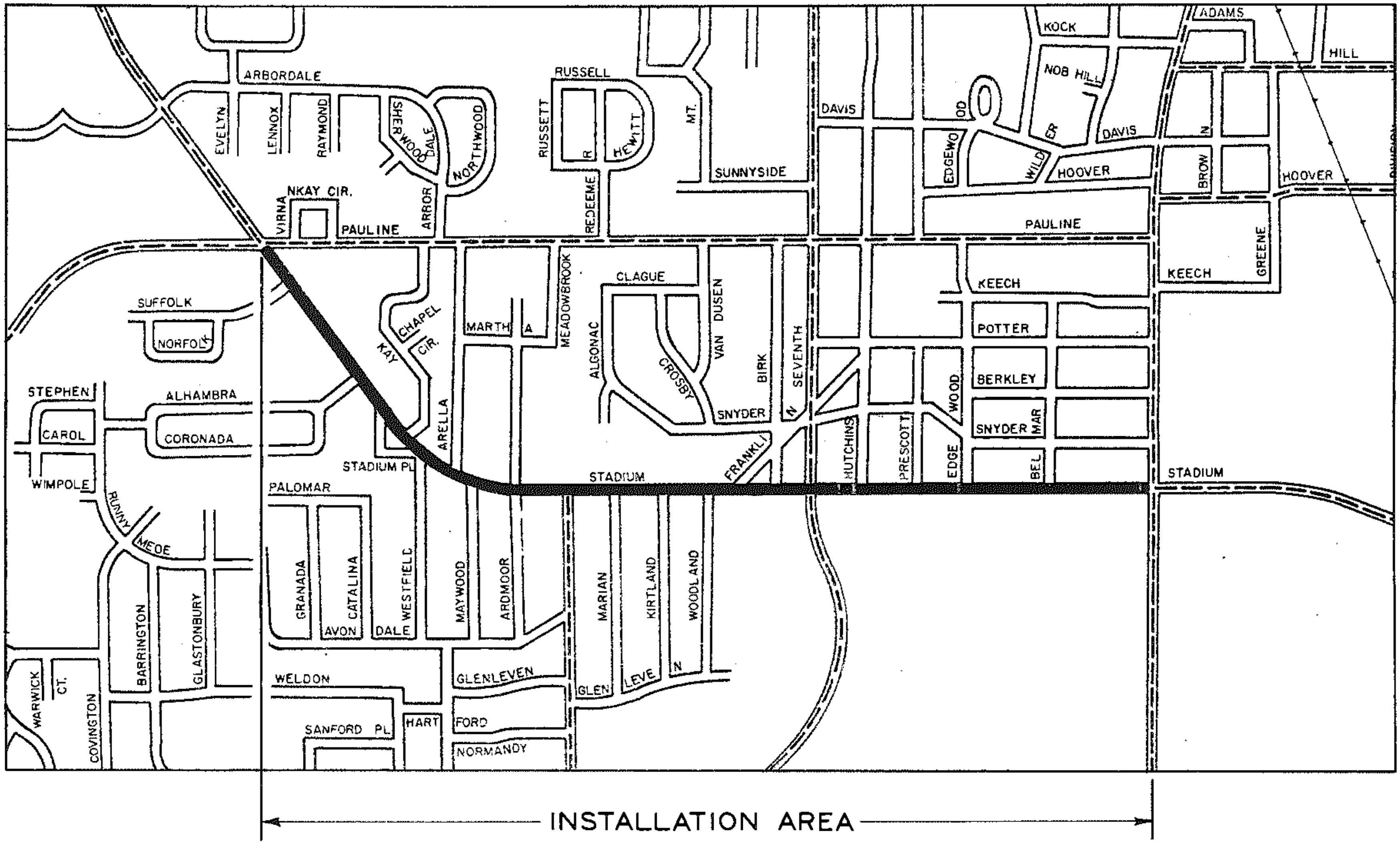


Figure 1. Petromat installation on Stadium Blvd between Pauline St and Main St; Ann Arbor.

Location: Stadium Boulevard between Pauline and Main Sts, Ann Arbor, Mich.

Section: 1.2 miles, 4-lane pavement

ADT: 20,000 vehicles

Speed Limit: 35 mph

Installation Data: Petromat fabric installed, August 20, 1975
Contractor: Phillips Petroleum Company
Roll Size: 20-mil mat, 12 ft by 300 ft
Area Covered: 34,000 sq yd
Cost Installed: $1.20/sq yd
Fabric Binder: Asphalt Cement 85/100

1st Overlay: 1-in. Bituminous Concrete
Leveling Course 25A (4.12)

2nd Overlay: 1-1/4-in. Bituminous Concrete
Binding Course 25A (4.12)

3rd Overlay: 1-1/2-in. Bituminous Concrete
Wearing Course 31A (4.12)

Weather: Sunny to cloudy, 70 to 90 F, wind 5 to 15 mph, partly humid.

Old Pavement: 7-in. concrete, 22 ft wide, built 1923, widened, resurfaced 1957 (1-1/2-in. overlay), joints repaired, 1962, 1968; found badly distressed, sealed cracks, drainage problems.

Subgrade: Moderate to poor soils; subject to frost heaving and cracking.

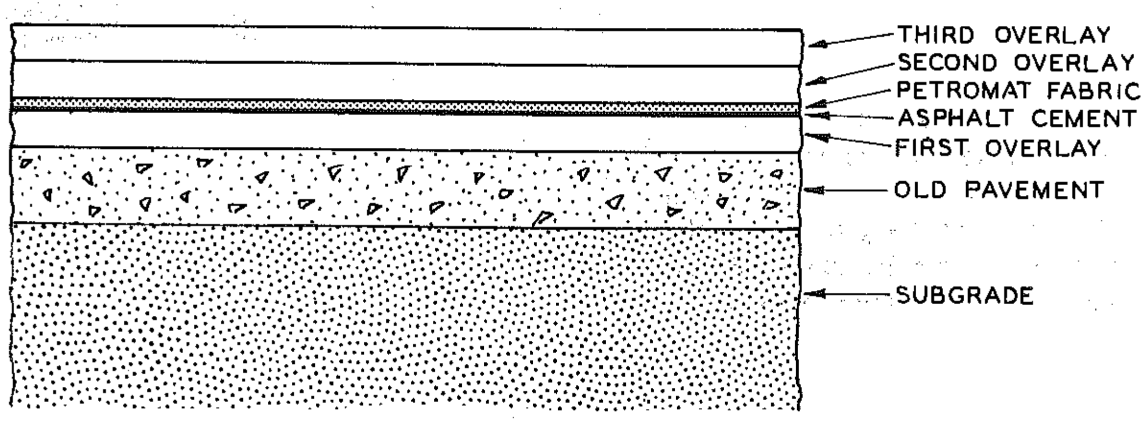


Figure 2. Petromat installation project, Ann Arbor, Michigan.

Figure 3. Spraying asphalt cement, 85/100 grade over 1-in. leveling course 25A. Application temperature 320 F and rate of 0.25 to 0.30 gal/sq yd.

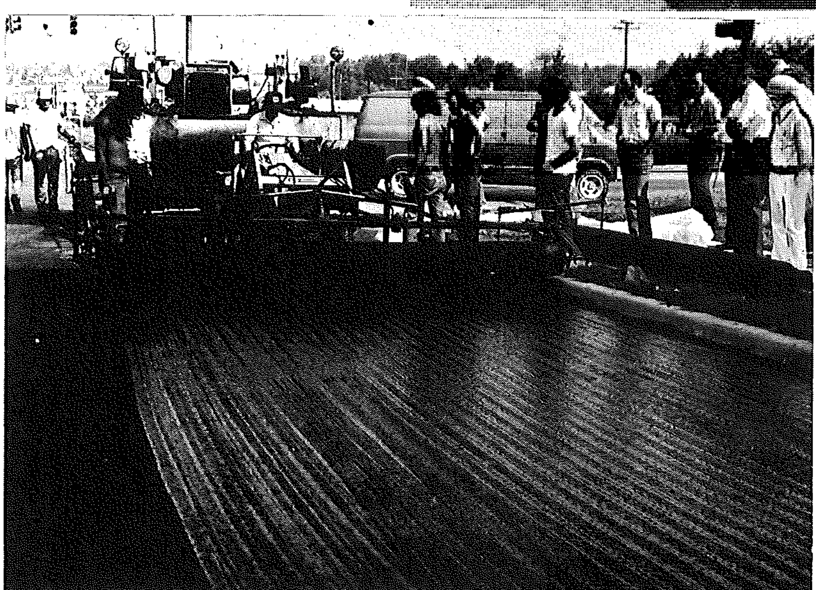


Figure 4. Placing Petromat fabric with roller mounted on the front of an Allis-Chalmers tractor and stiff bristle attempting to smooth it behind roller. Unrolling each 300-ft roll, 12-ft wide, took 15 to 25 minutes.

Figure 5. Rolling out the fabric at the application rate of about 1,700 sq yd/hr required five trained men and five minutes delay to reload the tractor with new roll. Note bubbles and wrinkles after fabric placement.

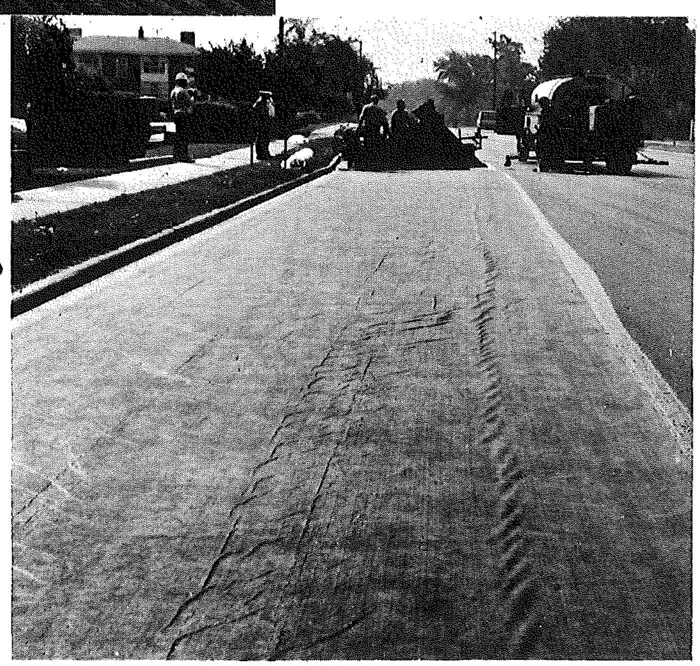
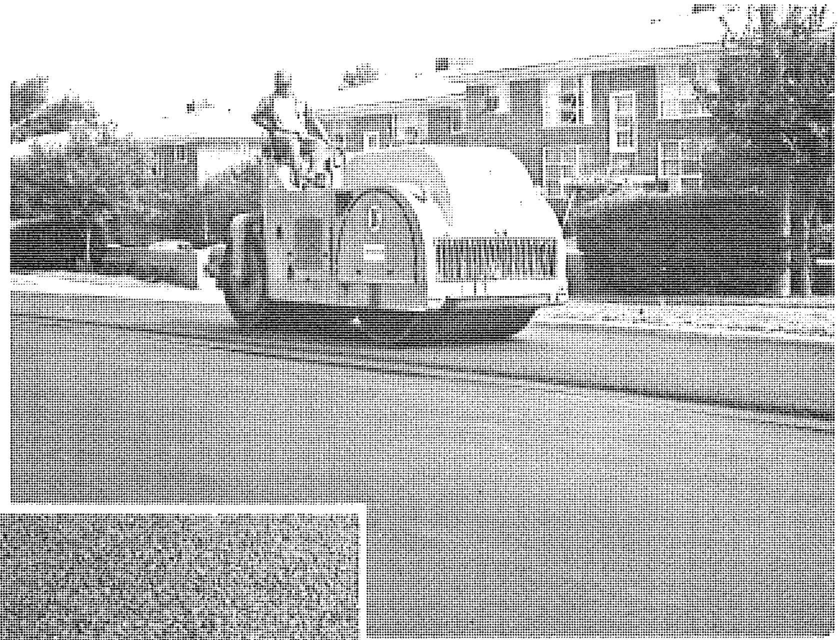


Figure 6. Applying 1-1/4-in. asphalt concrete overlay to the fabric. The overlaying sequence immediately behind the fabric laydown included a standard paver and two steel wheeled rollers each weighing 8 to 12 tons.



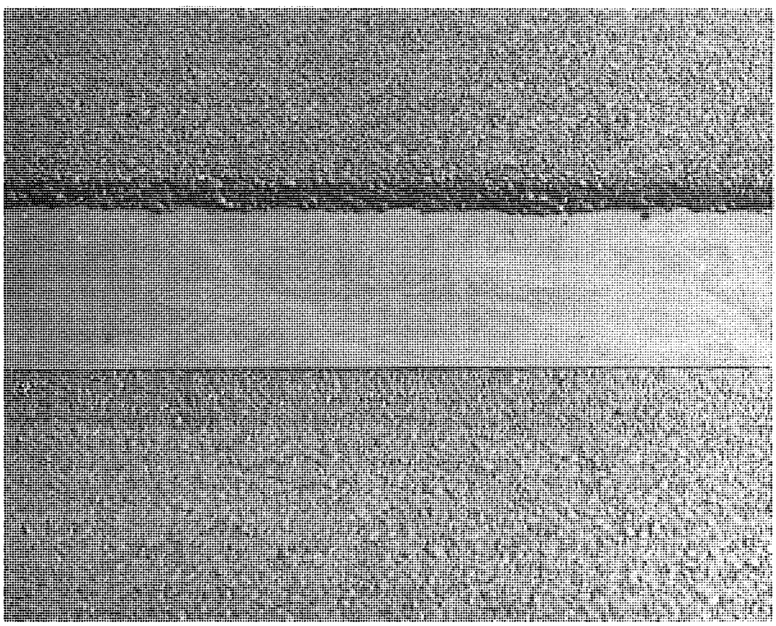
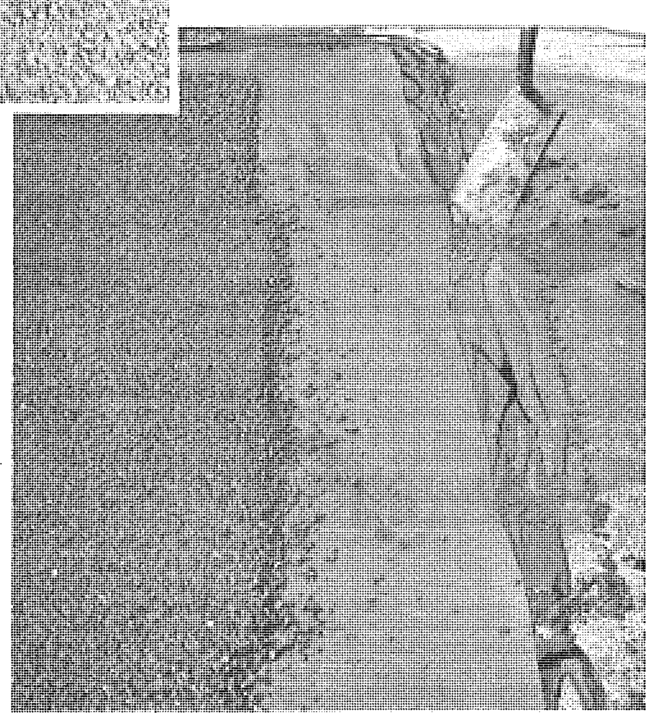


Figure 7. The uncovered fabric, 6 to 8 in. wide, was aligned properly along straight pavement lanes with the adjacent fabric laydown to follow.

Figure 8. Residual asphalt being removed at outside edge of the fabric. Two asphaltic concrete overlays above the fabric complete the resurfacing job.



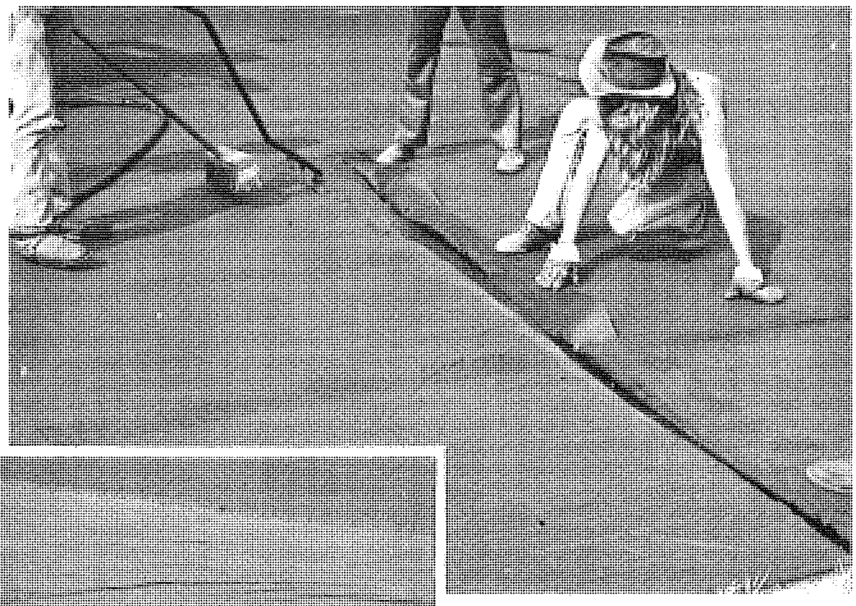


Figure 9. Overlapping two adjacent fabric mats in the direction of laydown; additional binder and brooming was applied manually to minimize pick-up by paving trucks.

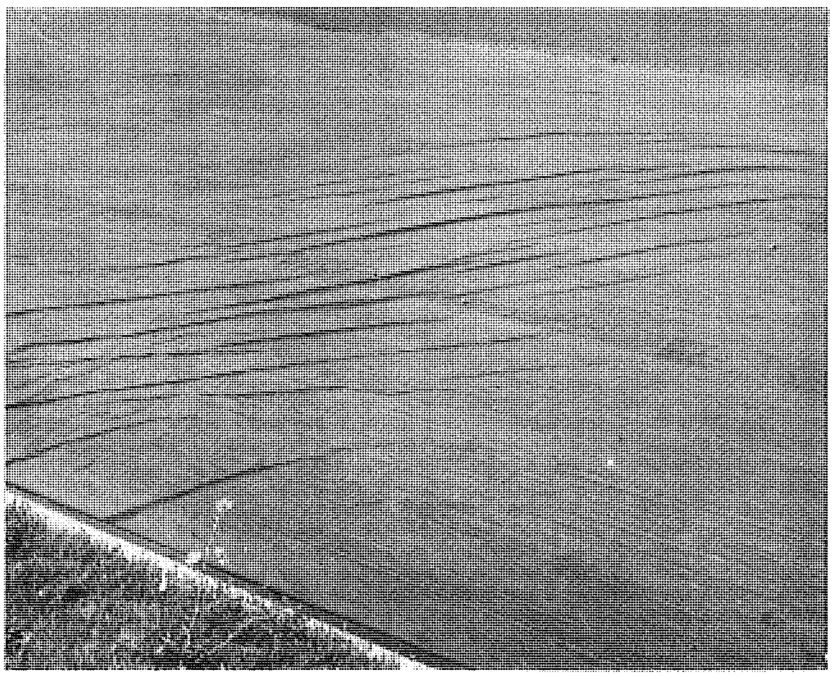


Figure 10. On some straight sections, the bonded fabric showed large wrinkles.

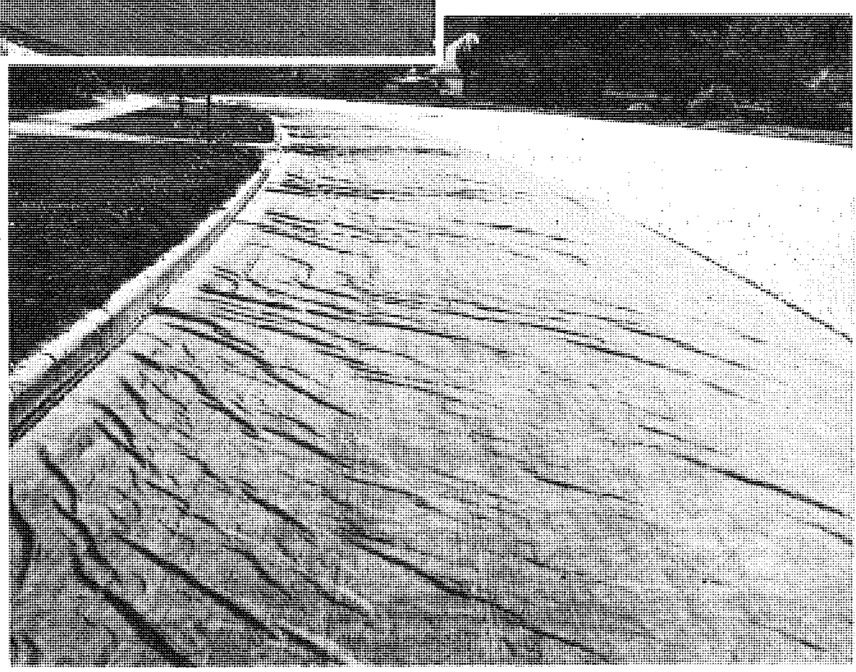


Figure 11. On moderate curves, the fabric was not aligned properly along the pavement lane. Cutting with scissors and overlapping was required. Note large bubbles and severe wrinkling.

Figure 12. A paving-truck driver inadvertently hit brakes and tore up outside edge of fabric. The damaged section (20-ft long) was cleaned and resurfaced.

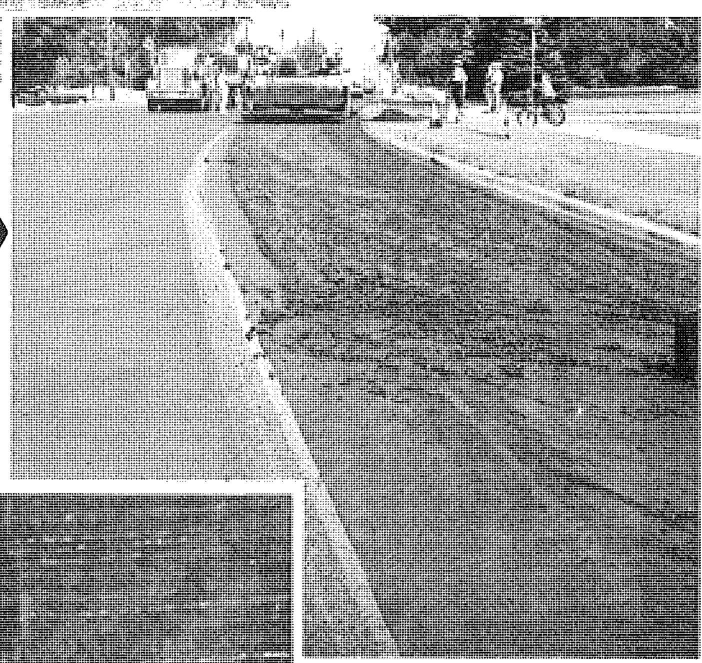


Figure 13. Asphalt flushing and rich asphalt mix probably caused this problem; a slippage plane. The disturbed section (100-ft long) was cleaned and resurfaced.

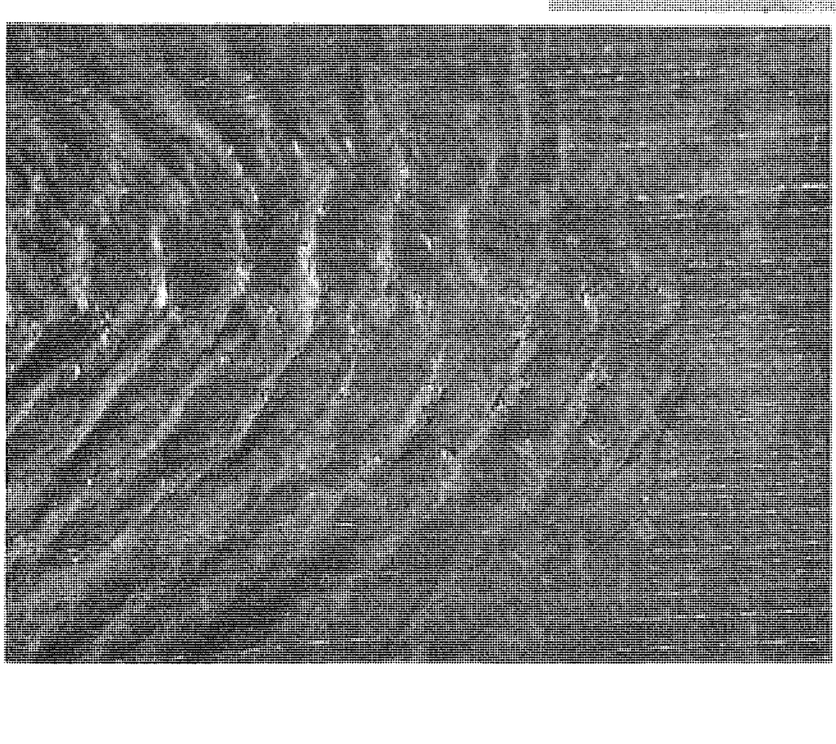


Figure 14. Although regular traffic was not allowed over the bonded fabric, large wrinkles resulted from the paving trucks.

TABLE 1
SUMMARY OF PETROMAT PERFORMANCE AS A REINFORCEMENT OF ASPHALT CONCRETE OVERLAYS

State	Date Installed	Design Type	Cost, dollars/sq yd	Field Performance
Arizona	4/72	Two overlays (1.75 in.)		Good bonded layers; some cracks reflected.
California	3/73	Two overlays over 7,272 sq yd	0.92	Some cracks reflected.
Colorado	9/71	Two overlays (3 in.)	1.40	Some cracks reflected.
Florida	4/71	Two overlays (2 in.)		Large wrinkles; no cracks reported.
North Carolina	9/73	Two overlays (2 in.)	1.20	Progressive cracking reflecting continuously.
North Dakota	9/71	2-in. overlay over 56,713 sq yd, 1-1/2-in. leveling		235 cracks reflected at 62 ft intervals.
Oklahoma	7/74	2-in. overlay		Control and test sections; no cracks.
Oregon	7/70	2-in. overlay over 165 sq yd		Control and test sections; no cracks.
Virginia	8/71	1-1/2-in. overlay		Control and test sections; 100 percent joints and cracks reflected.
Iowa	9/71	3-in. overlay over 1,600 sq yd		29.6 percent cracks reflected after 18 months.
Wyoming	4/72	4-in. overlay		Final report states: "The benefits derived from Petromat are not sufficient to warrant the additional cost involved."

APPENDIX A

PETROMAT FABRIC

A typical Petromat fabric mat, 20-mil thick, is a black, non-woven polypropylene, plastic fabric made by the Phillips Petroleum Company and weighs between 3 to 5 oz/sq yd. A Petromat sample is attached below. The fabric is currently produced in 100-yd rolls, 75 and 150 in. wide. Installation costs vary according to geographical location from $0.90 to 1.40/sq yd. The fabric is reported to have a tensile strength of about 5,000 psi and elongates between 80 to 110 percent before breaking. The manufacturer claims that the fabric, asphalt saturated and bonded to adjoining pavement layers, provides improved pavement durability as follows:

> "As a stress relieving membrane beneath new road surfaces, and as a waterproofing membrane for pavements, bridge decks, or wherever a moisture barrier is needed:
>
> 1. Controls reflection cracking.
> 2. Permits reduced overlay thickness for equivalent road performance.
> 3. Protects pavement structures by minimizing asphalt aging and freeze-thaw damage (reduces air and water intrusion into old roadbed).
> 4. Reduces cost of pavement patching where dig-out of highly fatigued pavement can be avoided.
> 5. Protects bridge decks from corrosive salts."

APPENDIX B

MOISTURE-TEMPERATURE EFFECTS

Low and Lowell (1) and Yang (2) discuss moisture conditions under pavements, and how these conditions may change with time. They acknowledge the following moisture sources:

1) Water percolation
2) From the sides
3) Seepage from higher adjacent ground
4) From the water table
5) Vapor from subsoil
6) From shoulder areas.

Based on these considerations, Figure 1B, illustrates a potential problem that Petromat fabric might develop, at the Ann Arbor project, especially between Woodland and Seventh Streets as a moisture barrier. First,

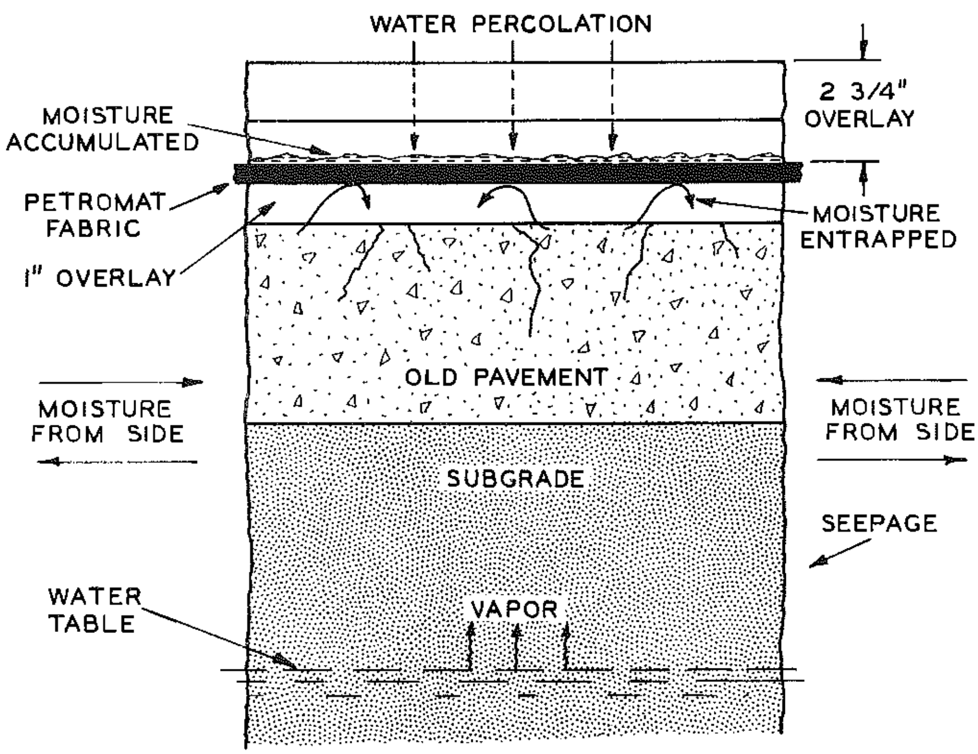


Figure 1B. Moisture movement above and under Petromat fabric.

during spring time, rapid cycles of freezing and thawing in surface layers could accumulate excessive surface water on the upper side of the fabric. At freezing temperatures this excessive moisture, because of differential expansion, might create cracks and bumps sooner on the south lane than on the other lanes. Second, moisture entrapped under the waterproofing fabric might contribute to drastic pavement upheaval during severe cold weather.

Reflection Cracking

This cracking problem developed in overlays is caused mainly by daily and seasonal temperature changes (3, 4). Because of these thermal changes, vertical and horizontal movements of joints and cracks in existing pavements are transferred directly into concrete and bituminous overlays. Although several methods for controlling reflection cracking are available, an economical and effective technique of crack control has yet to be developed. Some of the methods to control reflection cracking in asphaltic concrete overlays include intermediate layer as stress relief course, reinforcement, increased thickness, bond breaker plates, rubber additives, and softer asphalts (3, 4). As overlay reinforcement a Petromat fabric, asphalt saturated, is directly bonded to adjoining pavement layers, (Fig. 2). The bonded fabric, to prevent reflection cracking, must serve as a stress relieving membrane beneath the 2-3/4-in. overlay. This means that the fabric must absorb mainly the effects of horizontal movements of joints and cracks in the distressed pavement. Presently, laboratory data supporting this alleged property are nonexistent and field results are limited, variable, and often argumentative.

Petromat-Treated Projects

Assuming that the two alleged properties (crack resistance and moisture barrier) hold true for the Petromat fabric, those projects treated with Petromat and showing reflection cracking (Table 1) demand some reasonable explanations for their failure. Some possible explanations are:

1) The Petromat fabric being tested might vary significantly in overall quality and in individual strengths and weaknesses. In such cases, acceptance sampling and testing procedures are needed to select the experimental fabric for field evaluation. The sample fabric tested in the laboratory must be representative of the mat to be investigated in the field.

2) Special directions for surface preparation and fabric reinforcement might be required for specific distressed areas. Here, carefully controlled experiments are mandatory to obtain meaningful results.

3) In areas undergoing freeze-thaw cycles, the moisture barrier property of the fabric might become detrimental rather than beneficial; the excessive moisture accumulated on top of the fabric would greatly increase cracking development in overlays.

4) Failure to keep under reasonable control those known factors (asphalt, aggregates, temperature, void content, viscosity) affecting fatigue and durability of asphaltic mixes (5).

5) The fabric, as cracking resistance and moisture barrier, is not performing as expected over the cracking conditions being investigated. Such experimental work should be terminated as recommended by highway engineers (6).