Abridgment

Interlayers on Flexible Pavements

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A study was initiated to evaluate the effectiveness of stress-relieving interlayers in reducing reflective cracking on asphalt overlays over existing flexible pavements. Six lane-wide interlayers were installed on three construction projects under New York's two standard overlay thicknesses (1 and 2½ in.). Strip interlayers 1 ft wide were also placed on two additional construction projects to cover individual transverse cracks. The strip applications failed within 1 year and were considered inappropriate for future use. Performance of full-lane sections was monitored for 7 years. From statistical analysis it is concluded that overlays with interlayers have lower average crack returns than those without them. Coring showed that half the interlayers at cracked areas did not remain intact. Results of a simplified life cycle cost analysis indicated that interlayer treatments were not cost-effective compared with normal overlays. However, a 1-in. overlay with interlayer was shown to be more economical than a 2½-in. overlay without one. Interlayer products should continue to be considered as experimental features.

The purpose of an overlay is to extend the service life of an existing pavement by restoring its riding quality and correcting its structural deficiencies. Reflective cracking caused by propagation of existing cracks or joints in the original pavement up through the new surface, however, is a problem that has long troubled highway engineers. New York conducted a study (*1*) to address reflective cracking in asphalt overlays on rigid pavements. Methods investigated included bond breakers, membrane reinforcement, sawing and sealing, breaking and seating, and thicker overlays. The sawing-and-sealing method [sawing joints in the new surface directly over those in the original pavement and sealing them, expecting cracks to reflect through the sawed joints (*2*, p. 47)] was found to be the most effective. For severely deteriorated pavements where slabs were not intact, breaking-and-seating or "rubblizing" methods were recommended.

The reflective cracking problem, however, is not unique to rigid pavements, but occurs over flexible pavements as well. Reflected cracks lead to premature failure of overlays by allowing water to enter the subbase and cause loss of support.

In the early 1970s manufacturers promoted use of geotextiles as stress-relieving interlayers. Proprietary stress-relief systems using rubberized asphalt made from waste tires were also developed. These various materials received extensive national attention, and it was decided to initiate a study to determine whether they could be cost-effective in reducing reflective cracking in overlaid asphalt pavements in New York State.

The benefits claimed for interlayers were (*a*) increased overlay service life and (*b*) cost savings because thinner overlays could be used. This paper summarizes 7 years of evaluating performance of interlayers between asphalt pavements and overlays. Construction details were reported in the study's interim report (*3*).

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INVESTIGATION

Materials

Materials selected for this study may be classified into two general categories: applied full-lane width and applied in strips over single cracks (Table 1). They were designed to provide stress-relieving overlay reinforcement and an impervious membrane to prevent water intrusion. Strip materials to cover individual transverse cracks were supplied in 1-ft-wide rolls. Full-width materials to cover an entire lane were used over more extensively cracked pavements.

Test Sites and Construction

Three sites were selected for full-lane applications and two for strips. The two strip applications were on Routes 156 and 9, both near Albany. Route 156 and most of Route 9 were conventional flexible pavements, but portions of Route 9 were composite (i.e., asphalt over concrete). Full-lane interlayers were installed on I-481 in Syracuse, Route 10 in Schoharie County, and Route 12 in Jefferson County. All were flexible pavements. Figure 1 shows a Route 12 cross section and its structural components. New York's two standard overlay thicknesses (1 and 2½ in.) were both placed on Routes 10 and 12; only the 1-in. overlay was placed on I-481. Figure 2 shows layouts of the test sites. In all, there were 28 control sections and 22 treated sections. I-481 had both temperature and load-associated cracking. On Route 10, wheelpath alligator cracking was the predominant distress, plus some areas of edge cracking. Block cracking was extensive on Route 12. All test sites were overlaid in 1980 and 1981. Several problems were encountered, including improper application rate, wrinkling during placement, and insufficient overlay thickness. I-481 was given another 1-in. overlay course in 1982, when the 1980 overlay was found to be only ⅜ to ½ in. thick. In some areas on Route 10, severe rutting and edge cracking resulted in truing-and-leveling courses of up to 5 in. being placed before overlay.

Performance Evaluation

Cracks were sketched on survey sheets by surveyors walking along shoulders. Individual cracks were measured in linear

TABLE 1 Summary of Materials Tested

Brand Name	Manufacturer	Description
FULL-WIDTH APPLICATION		
Petromat	Phillips Fibers Corp.	Non-woven polypropylene fabric
Mirafi	Celanese Fibers Marketing Co.	Heat-stable polyester and polypropylene woven fabric[a]
Typar/ReePav[b]	E.I. duPont de Nemours & Co.	Spun-bonded polyester fabric[a]
Bidim[c]	Monsanto Textile Co.	Non-woven polyester fabric (Style C-22)
Propex	Amoco Fabrics Co.	Non-woven polypropylene (Style CEF4545)
Arm-R-Shield	Arizona Refining Co.	Blend of reclaimed rubber and modified asphalt cement applied as a binder coat with a subsequent layer of stone chips
STRIP APPLICATION		
Bituthene	W.R. Grace and Co.	Polypropylene woven mesh laminated to a layer of self-adhesive rubberized-asphalt
Roadglas	Owens-Corning Fiberglas Corp.	Composite system of high-strength fiber glass woven roving and a proprietary hot asphalt binder (Roadbond)
Polyguard	Polyguard Products Inc.	Rubberized asphalt waterproofing element with a polypropylene mesh laminated to the outer surface

[a] 1980 and 1981 fabric weights differed.
[b] Introduced experimentally in 1980 as Style T-323 under the brand name "Typar"; reintroduced at a different weight in 1981 as Style T-376 under the brand name "ReePav."
[c] Manufacturer discontinued production of this engineering fabric in 1981.

feet and alligator cracks in square feet. They were summed for each test section and reported in linear feet. All sections were surveyed before overlay and annually through 1987. A measure of performance called crack return percentage was obtained by dividing the amount of cracking in 1987 by the amount existing before overlay. Crack density was also calculated, defined as linear feet of cracking per 100 lane-ft, providing the extent of cracking in each section regardless of its length.

Benkelman beam deflections were measured to examine structural adequacy and uniformity among sections at each site. Several cores were taken in 1987 from Route 12 to check the manufacturer's claim of the fabric's ability to remain intact and keep water from entering the subbase.

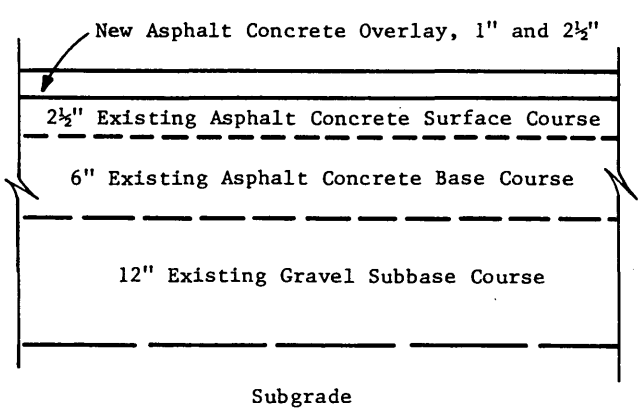

FIGURE 1 Pavement cross section on Route 12.

RESULTS AND DISCUSSION

Strip Applications

Cracks in all treated and control sections reflected through the overlay in the first winter. Cracks over the fabrics required more maintenance than those without fabrics. Overlays with interlayers raveled and delaminated, thus requiring patching. Cracks in control sections only needed sealing.

Full-Lane Applications

After 7 years average crack return was about 20 to 30 percent. Crack returns were generally lower on interlayered sections

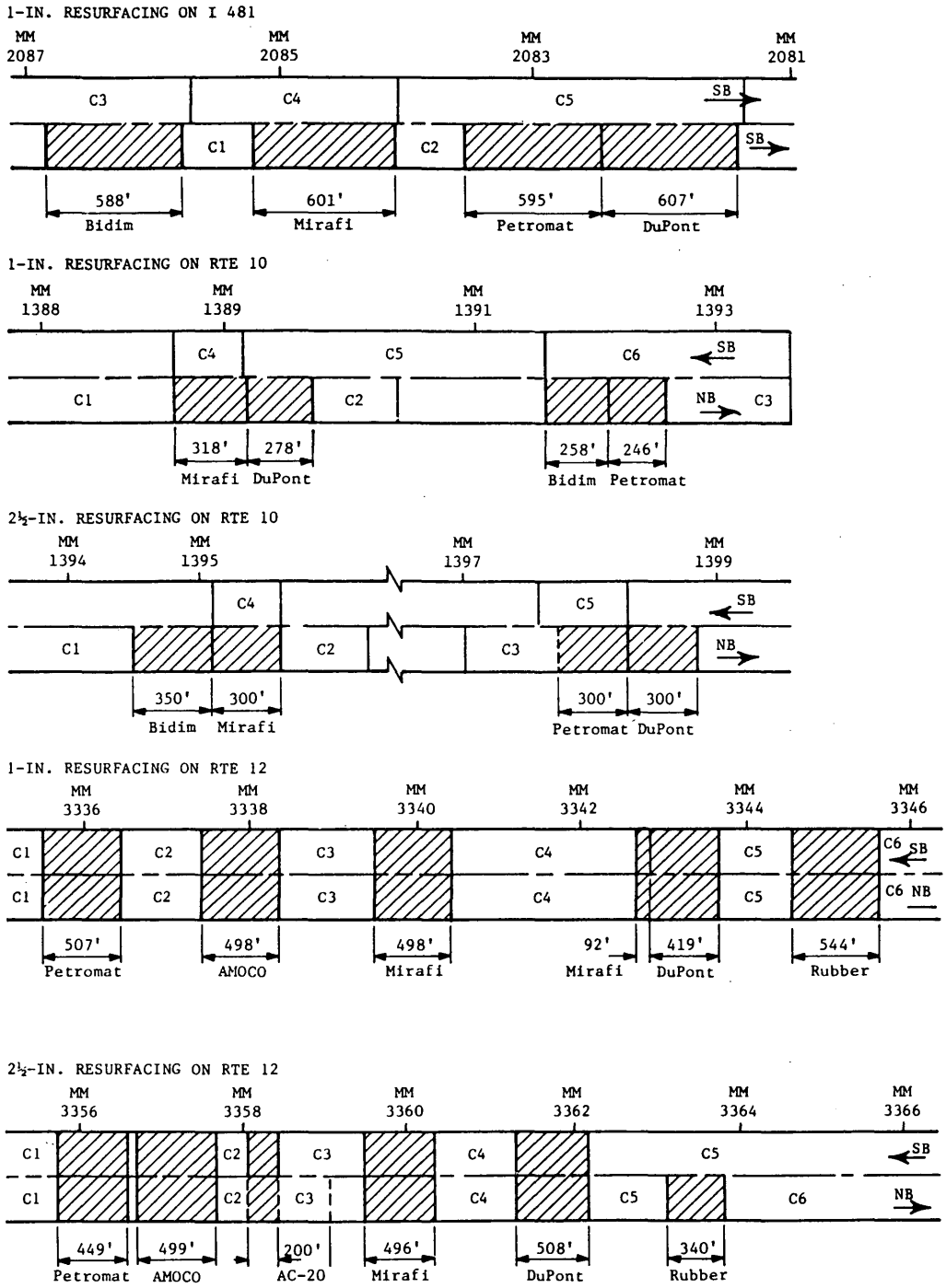

FIGURE 2 Test section layouts.

than on the controls. Crack-return ratios of interlayered to control sections, after eliminating some extreme cases, ranged from 40 to 70 percent. Route 10 had a nonuniform condition due to the previously mentioned localized distress and edge failures. Deflection measurements also showed this nonuniformity among sections. Route 10 data thus were discarded from the analysis. Condition on Route 12 was relatively uniform and hence offered consistent results. Because of the added 1-in overlay on I-481, the overlay (with an actual thickness of about 1½ in.) had a performance between that of 1- and 2½-in. overlays. Average crack returns of control sections on Route 12 for 1- and 2½-in. overlays were 52 and 14 percent, respectively. The average for I-481, after eliminating one extreme section, was 26 percent.

A *t*-test was used to assess effectiveness of interlayers in reducing reflective cracking. The test sections are assumed to represent typical conditions and are random samples. Testing was performed separately for 1- and 2½-in. overlay sections. Detailed testing [given in this study's final report (*4*)] shows that for 1-in. overlay sections on I-481 and Route 12, the null

hypothesis of mean percentage of crack return on treated sections equaling or exceeding that on control sections is rejected at the 0.025 significance level. On sections with 2½-in. overlays on Route 12, the null hypothesis can be rejected at a significance level of 0.05 and the alternative hypothesis favored. This supports the conclusion that interlayers are effective in reducing crack return. Using the same testing procedure on Route 12 for percentage of crack return on sections with 2½-in. versus 1-in. overlay, crack return for 2½-in. cover is significantly less than with 1-in. cover, justifying the conventional approach of using thicker overlays.

A comparison of average crack return between this study and two previous New York State studies (*5,6*) shows that crack return on 1-in. overlays in this study is similar to those of the two other studies, but those on 2½-in. overlays have lower return percentages.

Besides overlay thickness and interlayer treatment, a third factor—crack density of the pavement before overlay—was found to affect return of cracking. An "increase-decrease" relationship was found between these two variables for control sections with 1-in. overlays. This could probably explain the lower crack return percentages in 2½-in. sections just discussed because both Routes 10 and 12 had very high initial crack densities—202 and 484, respectively. Possible explanations for this phenomenon were found and are discussed in the final report (*4*).

Results of coring on Route 12 pavements showed that about half the interlayers did not remain intact when cracks reflected through them. The benefit of keeping water from entering the original pavement is under discussion. If water enters cracks in the overlay and is retained by an interlayer, it may cause pumping, stripping, or huge pressure buildups. Whether this is an advantage or disadvantage was not examined.

Economic Analysis

Route 12 was chosen for economic analysis to represent the whole study. Overlay lives of the four alternatives were determined by defining a failure criterion and extrapolating the reflective crack progressing trend (*4*). The resulting lives are as follows:

Sections	*Years in Service*
1-in. control	8
1-in. treated	11
2½-in. control	12
2½-in. treated	15

On the basis of these overlay lives, 1987–1988 bid prices on interlayers and asphalt concrete, and a discount rate of 4 percent assumed by New York State Department of Transportation, simplified life cycle costs were analyzed to see whether interlayers were cost-effective alternatives (*4*). Three analyses were conducted: (*a*) 1-in. overlay with and without interlayer, (*b*) 2½-in. overlay with and without interlayer, and (*c*) 1-in. overlay with interlayer versus 2½-in overlay. Results of the first two analyses showed that interlayers offered no cost benefits for either 1- or 2½-in. overlays, given the relative life of each alternative. The third analysis examined substitution of 2½-in. overlay for 1-in. interlayered overlay. Costs of overlaying shoulders were included. Results indicated that the 1-in. interlayer option is cheaper.

This simplified analysis could be viewed as only an approximate assessment of relative benefits among treatments. For interlayer treatments on pavements receiving both overlay thicknesses, the 3-year extended life does not warrant the expense. Interlayers are more cost-effective for 2½-in. overlays than for 1-in. overlays. Because the shoulder is involved in the cost, the 1-in. interlayer alternative is more economical than the conventional 2½-in. overlay. The complexity and difficulty involved in determining the lives preclude general conclusions as to benefits of interlayers. Engineers should continue to consider this option on an experimental basis.

Other Considerations

Factors other than performance and economy should be considered for overlay projects. If distresses other than cracking are present—for example, rutting, edge cracking, or local depressions—they may call for a truing-and-leveling course before overlay. This additional asphalt thickness would also reduce reflective cracking. Other construction procedures are also available for cracked pavements, such as milling before overlay and cold in-place recycling. These procedures may be more cost-effective than interlayers.

CONCLUSIONS

1. Test sections treated with strips all failed. These applications consequently should not be considered for further use.
2. Statistical analysis indicated that overlays with full-lane interlayers had lower average crack return percentages than those without them. Testing also confirmed that 2½-in. overlays had significantly less cracks reflected than 1-in. overlays.
3. An increase-decrease relationship was found between crack densities on overlaid pavements and crack return percentages on overlays. Possible explanations were also found.
4. Coring results indicated that some fabrics did not remain intact. The benefit of keeping water from infiltrating into the subbase is questionable.
5. Simplified life cycle cost analyses performed for the four alternatives on Route 12 showed that interlayers were not cost-effective compared with normal overlays for both overlay thicknesses. The 1-in. interlayer option was cheaper than the normal 2½-in. option, but this analysis was limited in scope and based on many assumptions that may be subject to discussion.

In summary, there is no question regarding abilities of stress-relieving interlayers, if installed properly, to reduce or delay reflective cracking on overlays over flexible pavements. Their cost-effectiveness, however, depends on how long they can delay cracks from occurring. For heavily cracked Route 12, interlayers were more effective for 2½-in. than for 1-in. overlays. Because mixed results were obtained, engineers should continue to consider using various interlayer products primarily on an experimental basis. Other techniques should also

be considered when a flexible pavement overlay is being designed.

ACKNOWLEDGMENTS

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