EVALUATION STUDY OF FIBERMAT® TYPEB INTERLAYER SYSTEM FOR ROADWAY PAVEMENT REHABILITATION

Original report prepared by
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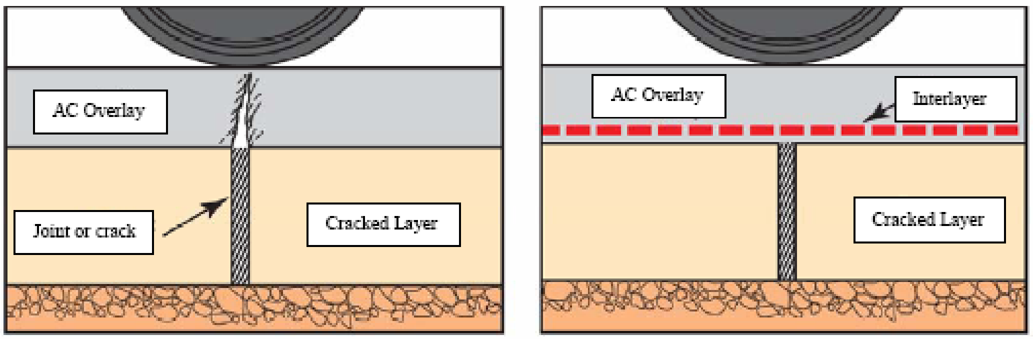
Background:

The majority of pavements nowadays in the U.S. are composed of asphalt concrete (AC) and Portland cement concrete (PCC). In the latter periods of their design service life, both types of pavements exhibit cracking distresses: fatigue and thermal cracking in AC pavements; faulting and mid-slab cracking in the case of PCC pavements. Interlayers, such as FiberMat Type B®, with high shear and tensile strength in addition to high ductility can act as a crack-inhibitor layer when placed between the old surface and the new overlay. Because of their strength, the crack propagation through such an interlayer would require high energy and stress concentrations, ultimately leading to a delay in the formation of reflective cracks.



a. b.

Figure 1: Schematic of a pavement structure: a) without an interlayer; b) with a reinforcement interlayer

The study conducted concentrated on the evaluation of FiberMat® Type B interlayer, a patented technique developed by Midland Asphalt Materials, Inc, as a superior performing Stress Absorbing Membrane Interlayer (SAMI) and also used within the gamut of pavement preservation techniques to maintain a road as an enhanced surface treatment although this is aspect is not covered in this report. The FiberMat® Type B reinforcing treatment when used as a SAMI, where two layers of polymer modified asphalt emulsion are spray applied and glass fiber is cut in-place sandwiched between the two emulsion layers. Over the emulsion-fiber-emulsion membrane, aggregate of nominally ¼" size aggregate is spread then compacted.

Figure 2: Truck with an emulsion tank and Fiber Storage Unit

Figure 3: Rows of nozzles spraying the emulsion and fibers

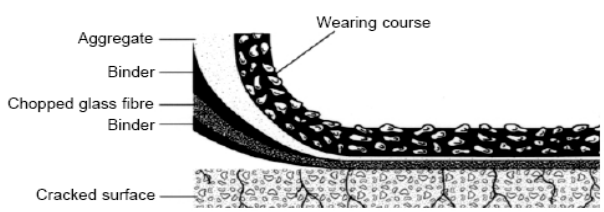


Figure 6: Schematic diagram showing FiberMat B® treatment.

Study Approach:

The study involved the comparison of a typical 1.5" HMA overlay, with and without the inclusion of a FiberMat® Type B interlayer, on test sections on Pennsylvania Transportation Institute's Test Track in addition to laboratory testing of the constituent materials of the interlayer.

The evaluation process of FiberMat® Type B consisted of the following tasks:

1. Literature review;
2. Bending Beam Rheometer test on the emulsion with and without fibers;
3. Comparative evaluation of the sections on the test track;
4. Accelerated pavement testing on the test sections using Mobile Model Load Simulator Scale 3 (MMLS3); and
5. Analysis of surface moduli using Portable Seismic Property Analyzer (PSPA) at the Pennsylvania Transportation Institute's Test Track.

Literature review:

Pavement performance is affected by rutting, bottom-up and top-down fatigue cracking, and reflective cracking caused by material deterioration of pavement layers. To minimize the re-appearance of distresses after the pavement is overlaid; i.e., reflective cracking, industry has developed techniques such as interlayers. An interlayer can be defined as a system for relieving material excess stress at the sub-surface levels. ***In this particular study, the interlayer evaluated is considered a remedy for reflective cracks***.

Types of Interlayers:

The use of interlayers is one of the methods developed to retard the propagation of reflective cracks. Conventionally, a thicker overlay is placed to reduce cracking. The common interlayer treatments given by Vanelstaraete A. and de Bondt A. E (1997) are as follows:

- Sand Asphalt:
- Stress Absorbing Membrane Interlayer (SAMI):
- Non-woven:
- Three dimensional steel honey comb grids: Geogrids
- Paving Fabric and Asphalt Rubber Interlayers:
- Steel Reinforcing nettings:
- Combined Products:

Different Modes Causing Reflective Cracking:

The types of interlayers above may not be appropriate to alleviate or retard all reflective cracking mechanisms. Reflective cracking typically occurs due to three fracture modes occurring in a new layer on top of existing cracks. The different types of crack edge movements are as follows (3):

Mode 1: Corresponding to opening of crack
Mode 2: Corresponding to Shearing
Mode 3: Corresponding to Tearing

The purpose of the interlayer is mainly aimed at resisting the fracture mechanisms of all three modes.

Bending Beam Rheometer

The Bending Beam Rheometer (BBR) test is devised to evaluate binder properties at low pavement temperatures. The test measures the creep in a beam shaped binder specimen under a constant load at a constant temperature.

The study intended to evaluate the effect on creep stiffness for an emulsion residual modified binder mixed with glass fibers, which is applied as an interlayer for asphalt pavements. The fiber mixed residual modified asphalt layer with aggregates act as an interlayer between the old layer and overlay. The stiffness and the elastic strength of the interlayer determine the measure of its effectiveness in reducing reflective cracking.

A definite increase in the stiffness of the residual modified binder was found due to the inclusion of the fibers. The fibers acted with the residual modified binder and reduced the deflection caused due to the load. Furthermore, it was seen that the stiffness of the specimens with fibers was greater than the case of samples without fibers and an increase in elastic behavior when the glass fibers are added.

Evaluation of Test Sections

For long term performance evaluation of the FiberMat® Type B**,** a section on the Pennsylvania Transportation Institute Test Track was laid with the interlayer under evaluation at the same time that a control section was laid without the interlayer. Both sections were constantly monitored from June, 2005, time when it was applied, until the end of December, 2006.

Original Pavement Grid and Distresses

A pre-construction distress survey was done for both sections. Observations over 18 months at periodical intervals had concluded that there is no crack development in the FiberMat® Type B section. Throughout the project, roughly 15,000 bus passes were applied on the sections, in addition to loading applied by the MMLS3 accelerated pavement tester. Maximum and minimum temperatures as well as maximum amount of monthly snow accumulated were recorded.

Accelerated pavement testing using Mobile Model Load Simulator Scale 3 (MMLS3)

Accelerated pavement testing was performed on top of sections where a wide crack was known to be present on the pre-existing pavement. One million cycles were applied on both the FiberMat Type B experimental and control sections. Conditions during testing included temperatures that yielded freeze and thaw cycles. After one million cycles of MMLS3 traffic load, no cracks were observed under the MMLS3 wheel path for the FiberMat Type B section.

Field Cores

Field cores were taken from the FiberMat B® experimental and control sections. Three cores were taken from locations that did not originally exhibit any cracks. From the cores it was possible to distinguish the different layers thicknesses of both FiberMat B® and the control section. An additional set of two cores were extracted on top of similar cracks in the pre-existing pavement. No reflective crack was visible on the core removed from FiberMat® Type B. For the control section, a preexisting crack could be seen propagating through the new overlay upwards to the surface, thus developing a reflective crack.

FiberMat® Type B Interlayer

Control Section

Portable Seismic Pavement Analyzer

After applying one million cycles on top of pre-existing cracks on both FiberMat® Type B and the control sections, no visible reflective cracks appeared. However, after closer scrutiny and taking the cores on top of the pre-existing pavement cracks, a crack was visible on the control section. Therefore, it was decided to further investigate that area using the Portable Seismic Pavement Analyzer (PSPA). The Portable Seismic Pavement Analyzer (PSPA) is an instrument designed to determine the variation in modulus with depth of exposed layer being concrete or asphalt.
The surface moduli of the overlay were evaluated using (PSPA) in the FiberMat® Type B and the control sections. The surface moduli were measured at -7ºC and at 7 ºC. The results at -7^{o}C suggest that for locations with pre-existing cracks, the modulus of the control section is higher than that of FiberMat® Type B interlayer system. The higher modulus of the control stems from the high modulus of ice entrapped in the reflected crack in the top 2" of the control section which implies more voids or the reflective crack is more prominent. Comparing crack and no crack sections, both crack sections were higher to the ones without cracks, because of the high modulus of ice. For the higher temperatures, $+7^{o}$C on top of the pre-existing crack, the FiberMat® Type B interlayer system section had a higher modulus than the control due to absence of the reflective crack. For the section on top of no pre-existing cracks, the FiberMat® Type B interlayer system section has a lower modulus, due to the inclusion of the FiberMat® Type B interlayer which has a lower modulus than regular HMA overlay. This fact makes the treated section less stiff and more ductile. Comparing sections with crack and no cracks the same observations as in the lower temperatures were observed.

Conclusions:

An overall improvement of performance for FiberMat® Type B section can be observed from the different evaluations conducted.

- BBR results suggest a higher ductility at lower temperature for the FiberMat® Type B interlayer which would delay cracks reflecting upwards.

- Cores removed from both sections having pre-existing cracks show that reflective cracks occur in the control section; whereas, reflective cracks are absent in the FiberMat® Type B sections.

- One million cycles of MMLS3 on top of pre-existing cracks did not induce any visible cracks in the FiberMat® Type B section. Cracks greater than nominally ¼" should be sealed prior to commencement of any works.

- Results from Portable Seismic Pavement Analyzer show that more voids and micro/macro cracks are present in the overlay surfaces in the control section as compared with the FiberMat® Type B section. Visual observations of both studied sections suggest that cracks are more likely to reflect in the control section than in the FiberMat® Type B section.

It can be concluded from this study that the FiberMat® Type B alleviates and/or delays propagation of reflective cracks.