TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM

Project Summary Report 0-1777-S

Project 0-1777: Field Synthesis of Geotextiles in Flexible and Rigid Pavement Rehabilitation Strategies Including Cost Considerations

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PROJECT SUMMARY REPORT

Using Geosynthetics in Overlays to Minimize Reflection Cracking

One of the more serious problems associated with the use of thin overlays is reflective cracking. This phenomenon is commonly defined as the propagation of cracks from the movement of the underlying pavement or base course into and through the new overlay as a result of load-induced and/or temperature-induced stresses.

Some of the latest techniques for reducing the severity and/or delaying the appearance of reflective cracking include incorporating geosynthetic products into the pavement structure. Geosynthetics are defined herein as grids, fabrics, or composites. This procedure is typically accomplished by attaching the geosynthetic to the existing pavement (flexible or rigid) with an asphalt tack coat and then overlaying with a specified thickness of hot mix asphalt (HMA) pavement. These materials have exhibited varying degrees of success, and their use within a particular agency has been based primarily on local experience or a willingness to try a product that appears to have merit.

TTI Overlay Tester.

Several geosynthetic products on the market claim to reduce the severity or delay the appearance of reflective cracking in HMA overlays due to stresses induced by the environment and traffic. The objective of this research was to investigate the state of the art and develop information that will aid in the evaluation of the relative effectiveness of commercially available geosynthetic materials. Specific objectives of this research include:

- Review published and unpublished information, and synthesize the findings.
- Obtain geosynthetic products representing the different categories of materials marketed for reducing reflection cracking in HMA overlays.
- Fabricate HMA beams reinforced with geosynthetic materials, and measure their relative resistance to thermally induced stresses.
- Identify and utilize the best available model to analyze the laboratory data, and

determine the material properties that have the greatest effect on overlay performance.

- Plan and construct test pavements to evaluate relative resistance to reflective cracking of various geosynthetics.
- Determine the relative effectiveness of each category of geosynthetic products in reducing reflective cracking.

What We Did…

An extensive review of publications was conducted, and pertinent information regarding geosynthetic selection, application, performance, and costs was synthesized.

Researchers selected six different geosynthetic products including two fiberglass grid composites, two polyester grid composites, one fiberglass grid, and one polypropylene nonwoven fabric. These products were incorporated into HMA beam specimens and evaluated in the laboratory by measuring relative resistance to thermal cracking. The Texas Transportation Institute (TTI) overlay tester, which accommodates 3x6x20-inch beam specimens, was used in this testing program. Researchers identified the best mathematical model and used fracture mechanics to study the effects of various geosynthetic products on HMA cracking.

Researchers developed a computer program as a design check with the FPS-19 pavement design process. The program permits evaluation of additional alternative overlay scenarios that incorporate geosynthetics for addressing reflective cracking.

Researchers identified test pavement locations in Pharr, Waco, and Amarillo Districts for evaluation of geosynthetic products. Due to unavoidable construction delays, only the Pharr District test pavements were constructed during the initial phase of the study. All three of the test pavements will be constructed, and relative performance, particularly related to reflective cracking, will be evaluated for several years.

Researchers prepared field guidelines for selection and use of geosynthetics with HMA overlays on flexible, rigid, and composite pavements to reduce reflection cracking. The Texas Department of Transportation's (TxDOT) geosynthetic-related specifications were studied, and modifications were recommended to improve them.

What We Found…

Based on the findings of this study, the following conclusions appear warranted:

- Performance of geosynthetics in addressing reflection cracking in HMA overlays has ranged from great successes to disastrous failures. Generally, the cost-effectiveness of geosynthetics in reducing reflection cracking is marginal.
- The geosynthetics tested in the laboratory consistently increased the number of cycles to failure in the overlay tester.
- Quality assurance tests were performed on selected beams and compared to the TxDOT job-mix formula (JMF). Extraction revealed asphalt contents between 4.1 percent and 4.6 percent as compared to the optimum asphalt content of 5 percent. Insufficient asphalt cement produces inadequate film thickness around aggregate particles and decreases the durability of the mixture. The mixture for this investigation was sampled at a production plant and stored in metal containers. Re-heating of the mixture for beam fabrication was necessary, which of course caused further oxidation of these thin films. These findings are considered the major causes for the relatively low number of cycles to failure recorded during this investigation. The remainder of the quality assurance tests were within acceptable ranges of the JMF.
- Control beams were fabricated with and without an asphalt tack coat (0.05 gal/yd^2) between the overlay and level-up course. Laboratory results indicate that a thin tack coat significantly increased the number of load cycles to failure. Therefore, in typical overlay construction, the simple addition of a thin asphalt cement tack coat appears to increase the cracking resistance of the overlay.
- Plots of measured load versus pseudo displacements were produced to determine the rate of change of dissipated pseudo strain energy (or pseudo work) per unit area of crack growth, defined as the pseudo J-Integral. By considering the effects of the geosynthetic products on the loading and unloading paths of the HMA specimens, a new geosynthetic rating factor, termed reinforcing factor, was developed.
- Limited laboratory testing indicated that the use of emulsified asphalt as a tack coat for geosynthetics produced a

plane of weak shear, which could promote slippage during overlay construction and service.

The Researchers Recommend...

The following recommendations are based on the information gained from this investigation:

- Guidelines for selection and use of geosynthetics with HMA overlays on flexible, rigid, and composite pavements to reduce reflection cracking have been prepared as part of this research project. Researchers recommend that these guidelines be printed as a separate document for use by pavement designers, inspectors, and contractor personnel.
- A computer program was developed as a design check for FPS-19. This design check should be used with alternative overlay scenarios when geosynthetics are being considered for addressing reflection cracking.
- Emulsified asphalt should not normally be used as tack for geosynthetics installed to address reflection cracking in HMA overlays. If emulsion is used, sufficient time should be allotted for breaking before application of geosynthetics and curing before application of the new overlay.
- When placing a self-adhesive fiberglass grid to address reflective cracking in an HMA overlay, a tack coat should be applied on top of the grid (i.e., after grid application). The appropriate quantity of tack is that normally used without a grid. Type of tack should be hot applied asphalt cement (not emulsion) of the same grade as that determined in the HMA overlay.
- When ordering geosynthetics, the contractor should specify the desired roll width and length to minimize construction joints and maximize efficiency. Longitudinal joints in a wheelpath should be avoided. The contractor should also consider the maximum roll weight that his application equipment can handle.
- Placing a ¾-inch to 1-inch level-up course on the existing pavement surface *before* the installation of the geosynthetic material will provide optimum reduction in reflection cracking. Both theory and practice indicate that a leveling course can significantly add to the performance of geosynthetics in delaying reflection cracking.
- Regarding DMS-6220, Fabric for Underseals, asphalt retention should be at least 0.2 to 0.3 gallons/yd^2; retention is directly related to the fabric weight and thickness. When used as a stress-relieving interlayer, the fabric should generally have a minimum weight of 4.1 ounces/yd^2. It is recommended that TxDOT follow AASHTO M 288 and specify a paving fabric with a 101-pound grab tensile strength and 4.1-ounce/yd^2 minimum unit weight. The small cost differential will probably not affect the bid price for installed paving fabric.
- Specific recommendations are given regarding Item 356, Fabric Underseal; Item 3203, Geogrid-Fabric Composite for Pavements; Item 3126, Reinforcement Mesh for Joint Repair; and Item 3031, Fabric Joint Underseal. These recommendations address: (1) requiring a geosynthetic manufacturer's representative on site during the first three days of construction, (2) filling cracks exceeding 1/8 inch in width, (3) repairing faulted joints/cracks, (4) proper storage of geosynthetic rolls, (5) suitable construction joint overlaps in geosynthetic products, (6) appropriate temperature of asphalt tack material, (7) ideal blotting material in the event of excessive bleeding of asphalt tack through the geosynthetic, (8) controlling of traffic on geosynthetic products, and (9) treatment of damaged areas of geosynthetics.

For More Details . . .

The research is documented in Report 1777-1, *Geosynthetics in Flexible and Rigid Pavement Overlay Systems to Reduce Reflection Cracking*.

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TxDOT Implementation Status—March 2004

Implementation of the findings of this project will be included in the TxDOT specifications once monitoring of the experimental sections is completed. The estimated date for the final report of this project is August 31, 2005.

For more information, contact Dr. German Claros, P.E., Research and Technology Implementation Office, (512) 465-7403, or e-mail gclaros@dot.state.tx.us.

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