WISCONSIN DEPARTMENT OF TRANSPORTATION

PUTTING RESEARCH TO WORK BRIEF

Preventing Interlayer Bonding Failures in Asphalt Pavement

Though occasionally asphalt pavement may consist of a single thick layer of hot-mix asphalt, it typically entails several layers, or lifts. These may include asphalt over another layer of asphalt, over a layer of concrete pavement or over aggregate base. Asphalt layers must bond well with other layers to prevent delamination—separation between layers—that reduces the pavement's ability to effectively bear loads or accommodate environmental stress.

What's the Problem?

When an HMA surface bonds poorly to the layers below, the top pavement layer may slide as vehicles pass over it. Damage will inevitably follow. Tears or crescent-shaped cracks in the surface of asphalt pavement typically indicate slippage problems. Unable to effectively transfer loads through the entire depth of the pavement structure, slipping top layers must absorb most of the stress, leading to tears and cracking.

Problems with interlayer bonding can be difficult to diagnose and correct. WisDOT currently relies on the experience of its engineers to identify interlayer de-bonding. Lacking tools for identification or evaluation, experienced engineers draw on anecdotal evidence not just to identify slippage, but also to evaluate the seriousness of the delamination and to determine appropriate treatment of the poorly performing pavement. A standard approach is to simply mill through the sliding pavement down to an undamaged depth, then overlay it with new asphalt to the original thickness. However, this approach is not always effective. WisDOT needed design guidelines to minimize slippage cracking in both new and rehabilitated pavements.

Research Objectives

This research sought to identify and locate interlayer bonding failures in the field and recommend treatment and prevention strategies. Specifically, investigators sought to:

- Confirm that observed slippage damage was caused by failures at the interface of pavement layers.
- Provide guidelines to minimize slippage cracking in new pavements.
- Determine the additional thickness required in upper pavement layers to minimize slippage cracking in rehabilitated pavements.

Methodology

Investigators evaluated three Wisconsin highways for this study. WisDOT provided thickness data for two of the roadways, and thickness was estimated for the third.

Stiffness ratios, a comparison of the stiffness or stability of the top layer to that of the second layer, were determined with the help of a falling weight deflectometer. High deflection measurements should indicate stiff, well-bonded pavement structures.

Specific steps for developing design and treatment recommendations included:

- To verify interlayer bonding problems, investigators evaluated distress in terms of tensile strain at the bottom of the pavement structure and in terms of FWD-measured stiffness.
- For new pavement guidelines, stiffness was backcalculated for full slippage and no-slippage sections to develop recommended stiffness ratios.
- For rehabilitated pavement guidelines, investigators compared the deflection performance of low- and high-stiffness sections and determined the additional pavement thickness required to achieve acceptable stiffness ratios.

Investigator

"WisDOT can use FWD data to identify slippage areas in existing pavements. The effect of slippage can be minimized by ensuring that the surface layer is sufficiently thick and/or stiff."

–Yusuf Mehta
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A falling weight deflectometer can identify the extent of delamination, or de-bonding, between pavement layers.

Project Manager

"This project gave us a method for evaluating pavement slippage areas as well as a potential treatment for mitigating damage. It helped set the groundwork for future research."

–Tom Brokaw
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Results

Evaluation and deflection testing confirmed that the stiffness ratio of no-distress sections was much higher than that of high-distress sections. The probability of slippage, then, can be correlated to stiffness ratio. Other findings include:

- Slippage can be minimized with sufficiently thick or stiff surface layers.
- The bond between pavement layers cannot be improved once constructed, but increasing top-layer thickness will increase stiffness ratio and help pavement resist slippage and related distress.
- For rehabilitation, adding 2 inches of lift to a 2-inch layer, or 4 inches to a 3-inch layer, will impart high stiffness to a pavement structure.
- A stiffness ratio of 10 or higher will effectively resist slippage if the second layer has a stiffness of 20 ksi or greater.
- Construction quality is more important to slippage resistance than achieving optimal top-layer stiffness.

Benefits

As a result of this research, WisDOT can use FWD data to identify and locate potential and existing interlayer bonding failures. The forensic use of FWD may help WisDOT assess liability against the responsible party in case of premature failure due to slippage, and so help recover costs of rehabilitation. The study also suggests the rehabilitation potential of increasing top-layer thickness with an overlay for pavements where signs of slippage develop.

Further Research

This study offers a first step toward understanding and correcting slippage damage. The findings must be validated before conclusions can be adopted as conventional practice. Further research is needed to determine how to achieve adequate stiffness and bond in overlays of rough pavement. Causes of interlayer de-bonding will also need to be determined. Finally, tack-coat performance will be evaluated in a FFY2009 Wisconsin Highway Research Program project to identify the materials that are most effective at achieving and sustaining adequate bonds between HMA pavement layers.

This brief summarizes Project 0092-02-13, "Evaluation of Interlayer Bonding in HMA Pavements," produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research Program, 4802 Sheboygan Ave., Madison, WI 53707.

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