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LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

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LRRB PROJECT COST:
$68,000

The Florida Bond Test measures the force needed to shear an asphalt sample perpendicular to the roadway surface.

MINNESOTA DEPARTMENT OF TRANSPORTATION

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Using the Florida Bond Test to Improve HMA Bond Strength and Durability

Researchers tested the bond strength of HMA layers of new and existing pavements in Minnesota to determine appropriate bond strength levels that will prevent de-bonding and premature deterioration. They recommend that HMA mixes achieve average shear strength of at least 100 psi.

What Was the Need?

Tack coat—an asphalt emulsion sprayed between layers of asphalt during construction—is an important factor in whether a pavement will perform according to its design. The tack coat binds the layers of asphalt together so the pavement acts as a monolithic structure much stronger than the sum of the individual layers, similarly to how a sheet of plywood is stronger than its individual layers.

While it is difficult to quantify, many asphalt roads in Minnesota have poor bond strength and suffer premature deterioration as a result. Some estimates suggest that up to half of Minnesota's hot mix asphalt pavements could suffer de-bonding of HMA layers, which could reduce service life by up to 25 percent. Many variables can affect the bond strength of a tack coat, including application rates and methods, paving techniques and the presence of dirt on the pavement surface when the tack coat is applied.

Before this project, there were no methods for testing bond strength of HMA layers in use in Minnesota.

What Was Our Goal?

The goal of this project was to determine an appropriate target range for the bond strength of a tacked HMA as a step toward broader implementation of tack coat strength testing to improve asphalt pavement performance.

What Did We Do?

Researchers took two steps in their effort to define an appropriate target HMA bond strength. First, they conducted a literature search to determine the shear strength levels in HMA that are generally considered to be poor, acceptable or exceptional. Then they tested the bond strengths of existing pavements and new construction in Minnesota as well as gyratory compactor mix design specimens of these pavements when possible.

MnDOT and county engineers tested nine pavements from around the state using the Florida Bond Test (with minor modifications) in a Marshall HMA load frame. The test uses a guillotine-type device to apply and measure the force necessary to shear a 6-inch-diameter asphalt core sample. The force is applied perpendicular to the roadway surface, typically in the direction of traffic, to measure the strength of the bond between asphalt layers. The tests included pavements of a variety of ages, tack application rates and current conditions, which researchers observed to compare their impacts on shear strength.

Researchers also constructed and tested an experimental unmilled HMA overlay at MnROAD. The overlay was constructed with three levels of tack coat application: no tack, 0.03 gallon per square yard (representing Minnesota's standard practice) and 0.1 gallon per square yard. Researchers also applied sand to half of each test section to evaluate the impact of contamination.

continued

"Minnesota didn't have a method for testing tack bond strength before this project. The Florida Bond Test is an effective and user-friendly test protocol for measuring asphalt bond strength."

—Thomas Wood,
Research Project Engineer,
MnDOT Office of Materials
and Road Research

"The project has made us familiar with different degrees of bonding that we might expect and has given us a reasonable starting point for evaluating the degree of bonding achieved during construction."

—Eddie Johnson,
Research Project Engineer,
MnDOT Office of Materials
and Road Research

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Applying a tack coat during paving helps to bind layers of asphalt together. Inadequate binding can lead to premature pavement distress, potentially reducing service life of some Minnesota pavements by up to 25 percent.

What Did We Learn?

The literature review found a National Center for Asphalt Technology study that recommended a minimum shear strength of 100 psi. An NCHRP report indicated that shear strengths between 35 and 80 psi could be used to effectively screen pavements likely to perform poorly.

Bond strengths of new pavements tested in this project generally ranged from 37 to 200 psi. However, when the tack coats were contaminated by dust or fine aggregate, the specimens either did not survive the coring process or produced very weak bonds.

At the MnROAD site, the first round of coring (conducted two days after construction) produced no cores with bonded interfaces, possibly because the tack coat had not cured sufficiently. A second round of coring conducted six months and one winter season after construction found that cores taken from clean, tacked surfaces were 90 percent likely to be bonded, while cores from contaminated surfaces were only 40 percent likely to be bonded.

MnDOT's modification of the Florida Bond Test procedure requires the test to be run at least three times per site. Based on the tested samples, researchers recommend that mixes in Minnesota achieve an average shear stress of at least 100 psi, with a standard deviation of 25 psi or less to ensure consistency across the site.

What's Next?

Researchers recommend that MnDOT create a tack bond strength testing pilot program using the testing procedures and criteria described in this project. The pilot project would help to more precisely define appropriate shear strength targets for Minnesota asphalt pavements. The MnDOT Pavement office would ultimately define specifications.

Researchers are seeking opportunities to present the project and demonstrate the value of tack bond testing to local agencies. The information will also be incorporated into appropriate Minnesota Local Technical Assistance Program classes.

This Technical Summary pertains to the LRRB-produced Report 2015-25, "Tack Coat Testing—Measuring Field Bond Strength," published May 2015. The full report can be accessed at mndot.gov/research/TS/2015/201525.pdf.