PUTTING RESEARCH TO WORK

BRIEF

Do Asphalt Anti-Stripping Additives Add Value?

Moisture damage in hot-mix asphalt pavement—specifically raveling, stripping, rutting and alligator cracking—occurs occasionally in Wisconsin as it does nationwide, and tests of a mixture's potential to suffer such damage is a standard element of highway construction specifications. In the early 1990s, the Wisconsin Department of Transportation adopted the Tensile Strength Ratio test, using the ASTM D4867 standard method, to predict mix susceptibility to moisture damage. WisDOT required that anti-stripping agents be added when the TSR of a mixture at optimal asphalt content fell below 70%. The enhanced mixture then had to obtain a TSR value of at least 75%.

What's the Problem?

Practice led to concerns that anti-stripping agents might not be beneficial or cost-effective. In 1999, Wisconsin Highway Research Program Project 0092-45-94, "Evaluation and Correlation of Lab and Field Tensile Strength Ratio (TSR) Procedures and Values in Assessing the Stripping Potential of Asphalt Mixes," concluded that TSR tests suffered repeatability problems. Furthermore, the study found no clear relationship between moisture damage on pavements in the field and the wide range of TSR values found for original and refabricated mixtures.

Hence, WisDOT could not substantiate a correlation between failing TSR values and poor pavement performance, and the effectiveness of anti-stripping additives in preventing or delaying moisture damage remained uncertain.

Research Objectives

This project had three goals:

- To determine whether TSR values are related to pavement performance.
- To evaluate the effects of anti-stripping additives on adhesion properties.
- To assess the cost-effectiveness of using anti-stripping additives, taking safety concerns, effects on pavement production, and construction costs into account.

Methodology

Researchers selected 21 pavement sections from WisDOT projects reflecting a range of locations and aggregate sources, all built before the state adopted the TSR requirement. Their work included:

- **TSR and pavement distress analysis.** Researchers analyzed TSR data and Pavement Distress Index data to determine the correlation between passing and failing TSR values and overall pavement condition.
- **Anti-stripping additives data analysis.** To determine the impact of anti-stripping additives, investigators compared PDIs for projects that employed mixtures with additive to PDIs for projects that used the same aggregates without additive.
- **Laboratory testing of anti-stripping additives.** Laboratory testing on Wisconsin's most commonly used anti-stripping agents measured binder properties with and without the agent, and adhesion and cohesion properties between aggregates and agent-enhanced binders. Researchers employed a new, inexpensive and easy-to-use testing device—the Pneumatic Adhesion Tensile Testing Instrument.
- **Life-cycle cost.** Researchers compared the life-cycle cost of construction and early maintenance of pavements constructed without anti-stripping additives to the cost of using the additives, the cost of TSR testing, and related safety costs.

Results

The central finding of the study was that while anti-stripping additives provide value, WisDOT's current method for determining when to use them—the Tensile Strength Ratio test—is not effective.

Investigator

"We knew anti-stripping additives were beneficial, but the relationship of the improvement to the cost of adding the agents was unclear."

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Not pictured:
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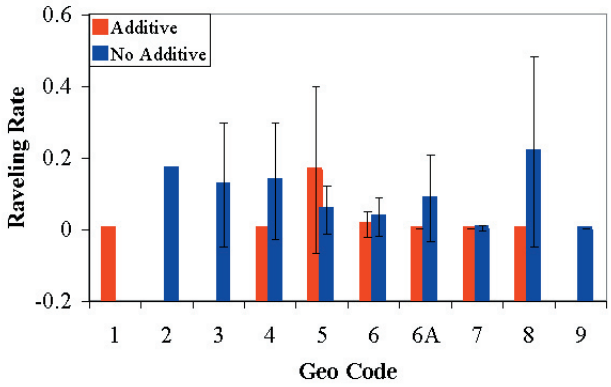

Investigators found that surface raveling was lessened in most pavements that were constructed with anti-stripping additives. Only one aggregate mineralogy, Niagara Dolomite in Geo Code 5, showed higher raveling with the additive (Fig. 3.2, page 35 of final report).

TSR fails as a quantifiable measure of moisture damage effects, and is expensive, time-consuming and highly variable. The best use of TSR is to index the compatibility of asphalts and aggregates. Detailed study findings included:

• **TSR and pavement distress analysis.** Database analysis found no clear relationship between PDI and TSR, or between TSR and the specific pavement distresses related to moisture damage (raveling, stripping, rutting and alligator cracking).
• **Anti-stripping additives data analysis.** Database analysis showed that PDI and pavement distresses related to moisture damage improve with the use of anti-stripping additives.
• **Laboratory testing of anti-stripping additives.** Laboratory analysis of binder properties could not explain the improvement shown in the database analysis, nor did it find improvements in rutting and fatigue behavior or rheological properties of binders enhanced by the additives. However, the additives were found to increase the adhesion properties of binders to certain aggregate surfaces, a relationship that was particularly prominent in binder bonds exposed to water. This may explain the improvements noted in the database analysis.
• **Life-cycle cost.** The 18-year life-cycle cost of a pavement constructed with anti-stripping additives was very similar to the cost of a pavement without the additives (including increased maintenance costs). Furthermore, an overlay enhanced with anti-stripping additives proved to be an excellent value.

Implementation and Benefits

By finding an alternative to TSR, WisDOT can save money by running faster and less expensive tests designed to index binder and aggregate compatibility. Researchers developed a modified use of the Pneumatic Adhesion Tensile Testing Instrument to evaluate the bonding of binders and aggregates. Improvement of this bonding under the wet conditions that prevail around Wisconsin should follow.

The study also confirmed the effectiveness of anti-stripping additives in providing a measurable improvement in those mixture performance properties associated with moisture damage. These cost-effective agents improve asphalt adhesion in wet conditions.

Further Research

Investigators recommend further research on the roles of binders and aggregates separately to better understand their physical interactions. Researchers also noted that the TSR testing protocol could potentially be improved to control the variability that currently weakens the test's value. Such improvements could lead to better correlation with pavement field performance.

This brief summarizes Project 0092-01-03, "Evaluation of the Extent of HMA Moisture Damage in Wisconsin as It Relates to Pavement Performance," produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research, Development & Technology Transfer Program, 4802 Sheboygan Ave., Madison, WI 53707.

Nina McLawhorn, Research Administrator

Project Manager

"Partway through our research on moisture damage we were discovering that there was no discernible evidence that the TSR test we were using had predictive value."

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