PUTTING RESEARCH TO WORK

BRIEF

New HMA Test Simplifies Mechanistic-Empirical Design

Asphalt pavement performance varies with temperature. Flexible pavement can be stiff in the winter but very soft in the summer. This variation may lead to low-temperature cracking or rutting under traffic loads. Pavement designers aim for mixture designs to resist such deformation from traffic and environmental stresses.

As WisDOT continues its adoption of the AASHTO Mechanistic-Empirical Pavement Design Guide and its sophisticated methods for designing pavement mixtures that suit specific locations and service, WisDOT pavement designers need to submit its most successful asphalt mixtures to MEPDG standards to determine appropriate mix design parameters for the new design method.

The Asphalt Mixture Performance Tester helps establish two key parameters for rutting performance: dynamic modulus (a measure of stiffness) and flow number (an indicator of rutting resistance). The AMPT data then helps establish MEPDG design specifications.

What's the Problem?

To best employ the MEPDG, WisDOT needed to know how the design guide would work with mixtures that historically perform well in this state. It is not clear how sensitive AMPT tests can be to key mix design factors. WisDOT does not know what dynamic modulus and flow numbers the AMPT produces for the best asphalt mixtures.

Research Objectives

This study aimed to evaluate the stiffness and deformation properties of typical WisDOT asphalt mixtures by using the AMPT and related test and analysis methods. This data would produce inputs for MEPDG design and enable WisDOT to evaluate the sensitivity of the AMPT.

Methodology

Investigators selected 12 successful asphaltic mixtures widely used in Wisconsin from four aggregate sources (Christian/Gade Pit, Cisler Quarry, Glenmore Quarry and Wimmie Pit); two traffic design levels (3 million equivalent single-axle loads and 10 million ESALs); and two asphalt binder grades (Performance Grade 70-28 and PG 58-28).

The AMPT was then used to test these mixtures, generating a dynamic modulus master curve and flow number for each. This data was analyzed statistically: Investigators compared AMPT measurements to those generated using predictive models and MEPDG pavement rutting models to determine AMPT sensitivity to design factors, including aggregate angularity and design voids in mineral aggregate, design traffic level and binder grade.

Results

This project validated current WisDOT design practices and produced an effective bridge to certain aspects of MEPDG design. Investigators produced dynamic modulus data for all aggregate sources at multiple traffic levels with two binders, data suitable for use with MEPDG. With the AMPT equipment procedures, WisDOT will be able to rapidly evaluate asphalt mixture properties pertinent to pavement design and rutting performance. Key findings included:

- **Mineral Aggregate.** Dynamic modulus from specific aggregate sources proved insensitive to key design factors except at the highest tested temperatures. Aggregates from the Christian/Gade and Glenmore sites provide greater stiffness at high temperatures than those from Cisler and Wimmie. Aggregate source impacted the flow number in terms of fine aggregate angularity, but not in a dramatic way.

Investigator

"The data that we collected here serves as a database WisDOT can use to compare the actual performance of many pavement sections in the state to what the [MEPDG] would predict."

–Ramon Bonaquist
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The Asphalt Mixture Performance Tester, also referred to as the Simple Performance Tester, was designed through NCHRP Project 9-29.

- **Design Traffic Level.** For a traffic level of 10 million ESALs, the predicted rutting was low and approximately the same for all mixtures for design traffic speeds of 40 mph and 20 mph. For a design traffic speed of 1 mph, the predicted rutting was higher, but still relatively insensitive to the mixture design traffic level and binder grade. The predicted rutting at 1 mph was affected most by the aggregate source. Traffic level had somewhat more, but similar, impact on flow number results than predicted in MEPDG methods. Measured flow numbers and traffic levels predicted by MEPDG methods correlated well.
- **Binder Grade.** PG 70-28 binder had little impact on rutting predictions at the higher traffic level, and at most traffic levels offers the same or lower stiffness as PG 58-28 at the same traffic level. Binder grade had more effect on flow number than other mix design parameters, increasing as the binder grade was increased at the high end range from PG 58 to PG 70.

Implementation

WHRP hosted a webinar for WisDOT pavement designers July 22, 2009, from the University of Wisconsin–Madison's Engineering Hall. The presentation shows how the AMPT may be used in MEPDG design by WisDOT. More information is available at www.whrp.org/research-areas/flex/workshop.html.

Further Research

The results of this project present a few paths for further study:

- WisDOT may further evaluate the MEPDG with the help of dynamic modulus master curves developed in this project.
- WisDOT may test additional asphalt mixes using the revised flow number test criteria from this project to validate these new criteria.
- WisDOT may also wish to further evaluate the Christian/Gade and Glenmore aggregates, which performed better than others in binders at high temperature. Determining why these modulus values were high at high temperatures may offer applications in other asphalt mixtures.

An FHWA-led, pooled fund effort, including Wisconsin, has been initiated to evaluate the nationwide implementation of the AMPT and provide states with training and support. More information about this effort is available at TPF-5(178): Implementation of the Asphalt Mixture Performance Tester (AMPT) for Superpave Validation.

This brief summarizes Project 0092-08-06, "Wisconsin Mixture Characterization Using the SPT on Historical Aggregate Structures," 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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Project Manager

"This project renews our enthusiasm for engineering new materials into HMA by improving our knowledge of impacts to ultimate pavement performance."

–Judie Ryan
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