PUTTING RESEARCH TO WORK

BRIEF

Creep and Recovery Test May Improve HMA Pavement Design

National efforts are under way to develop a simple performance test for the design and optimization of hot-mix asphalt mixtures. Current mix design and field tests measure volumetric properties, such as air voids and asphalt content, but these measurements are not recognizably correlated to mechanical properties, so they cannot be used to accurately predict performance for quality control and quality assurance.

Studies have identified several tests of mechanical properties, and promising correlations between these properties and pavement distresses, for use with the new AASHTO Mechanistic-Empirical Design Guide currently under WisDOT review. These tests include dynamic modulus compressive tests for laboratory use, and creep and recovery tests for certain field settings. Since dynamic modulus serves as a critical M-E design guide parameter, correlation or extrapolation of dynamic modulus from viable tests remains an important goal for HMA mixture testing.

What's the Problem?

No single test method or device has been found to be suitable for use in the laboratory, mixing plant, and field. A cost-effective, repeatable examination of materials in all settings would let designers more confidently predict the pavement performance of any selected mix. Before a simple, reliable test for lab, plant and field use can be developed, a suite of tests or procedures capable of accurate mechanical assessment and performance prediction in these settings must be identified and tested.

Research Objectives

Researchers sought to identify methods for testing hot-mix asphalt materials to predict performance through mechanistic properties. Specific goals included:

- Identifying a potentially viable laboratory method for determining dynamic modulus of design mixes.
- Identifying viable testing methods for use at mixing plants, and viable methods for field testing that do not require destructive sampling such as coring.
- Recommending the best test or combination of tests for lab, plant and field evaluation of the mechanical properties of a mixture for correlation to performance predictions.

Methodology

Following an extensive literature review of mechanistic parameters and their impact on performance, as well as a thorough review of methods and devices for testing mechanical behavior of mixes and pavement, investigators found the following tests most promising:

- Dynamic complex modulus test for laboratory use.
- Creep and recovery for mixing plant use.
- Indentation for field use.

Researchers examined the DCM test in laboratory settings, and creep and recovery and indentation tests in a pilot experimental program.

Results

Tests of the dynamic complex modulus test and creep and recovery were encouraging, while results of indentation testing were less so. Specific results include:

- The dynamic complex modulus test accurately captures mechanical responses of mixtures to

Investigator

"We found that the creep and recovery test gives us accurate data on the mechanical properties of an asphalt mix that we can correlate to pavement field performance."

–Yusuf Mehta
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With further development, the creep and recovery test (performed in this study with this MTS load machine) offers a promising method for measuring mechanical properties of asphalt mixtures at mixing plants. Engineers can use this test data to derive the dynamic modulus of a mixture, a critical factor in the new mechanistic-empirical design protocols.

dynamic, repeated loading, and correlates well to rutting and fatigue cracking. If successfully implemented, it could serve as an appropriate lab test for M-E design guide uses.

- Creep and recovery, both simpler and quicker than the DCM test, produces data that can be used at mixing plants to derive dynamic modulus values, and can therefore be indirectly correlated to pavement performance.
- Indentation proved insufficiently sensitive to asphalt content changes, and can be abandoned for QA/QC applications.

Researchers identified the creep and recovery test as the most promising technique for capturing the interaction between the complex mechanical behavior of mixtures and construction variability, as a method of projecting long-term pavement performance. Ultimately, they believe creep and recovery could be used in field settings to monitor asphalt mixtures during construction, allowing contractors to adjust mixtures in the field as necessary to optimize long-term pavement performance.

Further Research

While the DCM test can be used in laboratories now, creep and recovery requires further research before it can be implemented at mixing plants for QA/QC purposes. In lab tests of the creep and recovery method, researchers sawed the ends of the test specimens to create smooth, parallel surfaces, a step that would be impractical at mixing plants. More loading cycles may be necessary to obtain reliable, repeatable data using specimens with nonparallel ends; further refinement of devices and methods is needed before implementing creep and recovery at mixing plants.

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Flexible Pavements TOC Chair

"This study gives us a good start toward developing procedures that will work in Wisconsin with the new Mechanistic-Empirical Design Guide."

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