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Sponsor

Michigan Department of
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Project Title

Development of Specifica-
tions for the SuperPave
Simple Performance Tests

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Project Summary

Technology Transfer Outreach Publication

Building Tomorrow's Pavement Using Today's Materials

Asphalt mixtures are used as the surface of over 94% of all pavements in the U.S., and annually account for 45 billion dollars of national transportation spending (FHWA, 2001). The current mixture design and pavement design methodologies are not well correlated; therefore the design typically follows an empirical approach. A mechanistic-empirical design procedure is under consideration for implementation in design codes (AASHTO, 2002). This research project will bridge the material properties and pavement response, which is expected to result in a more mechanics-based design method, improving the design quality. The potential economic impact is significant, since a one-percent decrease in asphalt concrete life-cycle cost would amount to approximately \$500 million in annual savings in the U.S. alone.

Many state Department of Transportation (DOT) organizations have successfully implemented the Superpave volumetric mixture design procedure. However, the Superpave volumetric mixture design method alone is insufficient to ensure reliable mixture performance over a wide range of traffic and climatic conditions. Current methodologies lack simple performance test (SPT) criteria to evaluate pavement rutting, fatigue cracking, and low temperature cracking of flexible pavements. In this research project, the proposed Superpave SPT will be evaluated and draft specifications will be produced to test mixture resistance to pavement rutting, fatigue cracking, and low temperature cracking.

The measurement and prediction of dynamic modulus (E^*) of asphalt mixtures is a critically important parameter, as a result of the following:

- The new AASHTO Mechanistic-Empirical Design Guide (M-EPDG) is poised to become the standard for roadway design in the US and overseas (<http://www.trb.org/mepdg/>). The M-EPDG relies heavily on the E^* of asphalt concrete for nearly all predictions of pavement deterioration.
- Many users will opt to design pavements on predicted E^* values, rather than measured values.
- The currently available methods for predicting E^* from mixture properties are highly empirical and as a result have limited accuracy.
- While improved models are emerging, their use and further development will be limited unless an innovative approach is undertaken to make them easy-to-use and easily accessible to practitioners.

Research Objectives

- Using the SPT, conduct a laboratory study to measure the five parameters including the dynamic modulus terms ($E^*/\sin\delta$ and E^*) and the flow number (Fn) for typical Michigan HMA mixtures
- Correlate the results of the laboratory study to field performance as they relate to flexible pavement performance (rutting, fatigue, and low temperature cracking)
- Make recommendations for the SPT criteria at specific traffic levels (e.g. E3, E10, E30), including recommendations for a draft test specification for use in Michigan

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University Facts

Total Enrollment	6,550
Graduate Enrollment	916
Number of Faculty	417
Placement Rate	95%

Michigan Tech is located in Houghton, MI on the south shore of Lake Superior. This rural area is known for natural beauty, pleasant summers, abundant snowfall, and numerous all-season outdoor activities. In addition, the University maintains its own downhill and cross-country ski facilities and golf course. There are numerous cultural activities and opportunities on campus and in the community. Michigan Tech has also been rated as one of the safest college campuses in the United States, and the local community provides excellent resources conducive to an outstanding quality of life.

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Methodology

The research team will conduct an experimental program to measure the dynamic modulus of asphalt concrete mixtures at various loading rates and temperatures. In addition, the predictive models will be developed to simplify the measurement work.

Research Findings

The anticipated research findings will include the following deliverables:

- Development of a database of asphalt mixture's dynamic modulus and flow number for the State of Michigan
- Development of a trial specification of asphalt mixture's dynamic modulus to control the different distresses
- Broader understanding of material behavior under low and high temperatures

Future Work

The micromechanical models of the simple performance tests will be investigated in the future. The multi-scale model of pavement structures will be studied based upon the material's simple performance test results and the M-EPDG will be implemented based upon the results received.

Anticipated Implementation

The application of this research will assist the government, engineers, and contractors in bridging the link between design and paving of high quality pavements. The greatest advantage of the dynamic modulus (E^*) is that it can be used in developing a series of prediction models through M-EPDG.

Related Studies

- *Using Imaging Technology to Improve the Laboratory and Field Compaction of HMA*, funded by Texas Department of Transportation through Texas Transportation Institute, PI: Dr. Zhanping You
- *A Microstructure-Based Modeling Approach to Characterize Asphalt Materials*, funded by the National Science Foundation, PI: Dr. Zhanping You

Publications

You, Z., Adhikari, S., Goh, S., and Dai, Q., Dynamic Modulus Test For Mechanistic - Empirical Design For Asphalt Pavements, Proceeding of the 7th International Conference of Chinese Transportation Professionals, May 21-21, 2007 in Shanghai, China. China Com-munization Press, pp. 69-78

You, Z., Buttlar, W.G. and Dai, Q. Aggregate Effect on Asphalt Mixture Properties by Modeling Particle-to-Particle Interaction. Geotechnical Special Publication, American Society of Civil Engineers (ASCE), (2007)

Dai, Q. and You, Z (2007), Prediction of Creep Stiffness of Asphalt Mixture with Micro-mechanical Finite Element and Discrete Element Models, Journal of Engineering Mechanics, American Society of Civil Engineers (ASCE), Volume 133, Issue 2, pp. 163-173

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