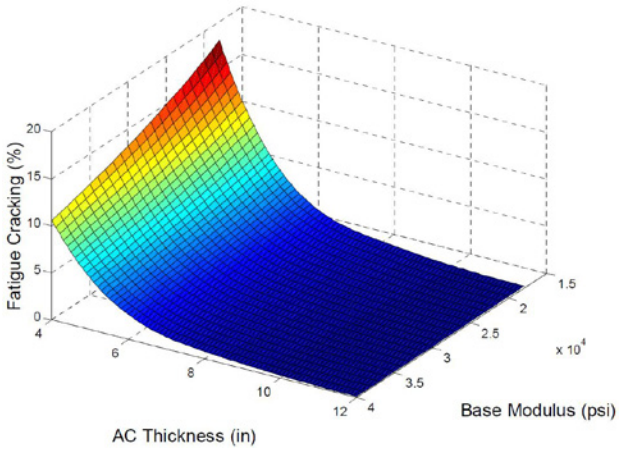
MDOT Research Spotlight

Michigan Department of Transportation | Office of Research & Best Practices

Implementing the Mechanistic-Empirical Pavement Design Guide in Michigan

One of the roles of Michigan DOT's Office of Research & Best Practices is to facilitate the implementation of effective and beneficial design methods. Toward this end, Michigan DOT began the initial phases of evaluating the new method of design for rigid and flexible pavements proposed by the American Association of State Highway and Transportation Officials (AASHTO). A rigorous analysis of predicted outcomes compared to real-world results will help with the decision on whether to adapt and implement this new pavement design procedure in Michigan.



Researchers validated the mechanistic-empirical approach to characterize fatigue cracking after 20 years in asphalt pavements with varying thicknesses and base moduli.

Problem

In the late 1950s, AASHO (now known as AASHTO) conducted a large-scale road test to determine how traffic and pavement structure contribute to the deterioration of highway pavements. The results were used to develop the first and subsequent versions of the AASHTO Guide for Design of Pavement Structures. Current road conditions, however, are significantly different from those that existed half a century ago, and applying these design approaches to present-day situations has become problematic.

Approach

A National Cooperative Highway Research Program project addressed these limitations by developing a new pavement design guide for AASHTO based on a mechanistic-empirical approach. Traditionally, engineers have taken a strictly empirical approach to highway design, which is based exclusively on the results of experimentation and the observation of those results (that is, empirical evidence). On the other end of the spectrum is the mechanistic design approach, which uses materials characterization and theories of mechanics to relate structural behavior and performance to traffic loading and environmental changes. As both of these models currently have their limitations, a mechanistic-empirical approach combines the best of both when applied to pavement design.

The resulting 2004 Mechanistic-Empirical Pavement Design Guide (MEPDG), which includes a written manual and software, uses mathematical engineering principles, laboratory test data and real-world pavement performance to help designers choose appropriate mix designs, materials, pavement thicknesses and other construction parameters based on expected traffic and climate for each highway project.

Research

The MEPDG software was made available to the states in 2004. Since that time, several state DOTs have explored various aspects of implementing this procedure, and researchers at Michigan State University began

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Project Information

Report Name: *Evaluation of the 1-37A Design Process for New and Rehabilitated JPCP and HMA Pavements*

Start Date: November 2005
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Research Report Number: RC-1516

Total Cost: $178,724
Cost Sharing: 20% MDOT, 80% FHWA through the SPR, Part II, Program

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Michigan DOT's investigation into the MEPDG by reviewing the efforts of other state transportation agencies. Researchers next addressed a number of technical, performance and calibration-related issues to consider whether to implement the MEPDG in Michigan. The objectives of this phase of the study were to:

- Evaluate the MEPDG methodology for Michigan conditions.
- Evaluate selected pavement sections in the state, on a limited basis, to compare the model's predictions to actual pavement performance.
- Identify possible future need to calibrate the performance models to local materials and construction practices.

Researchers performed sensitivity analysis to identify the MEPDG parameters that had the most impact on the software's predictions. Based on engineering judgment and agency practice, researchers identified seven key inputs for concrete pavement and 11 for asphalt pavement.

Next, using these selected parameters, researchers analyzed the performance of sample sections of jointed plain concrete and hot-mix asphalt pavements and compared them to the outputs predicted by the computer software. Five concrete and five asphalt projects, along with several sections of Michigan pavement included in the Federal Highway Administration's Long-Term Pavement Performance program, were chosen for comparison of actual versus predicted performance. As-constructed project information was used for the inputs, and distress information from the agency's Pavement Management System was compared to distresses predicted from the MEPDG.

Results

Based on the output of the software's predictions compared with actual performance, researchers concluded that the results did warrant calibrating performance models to reflect Michigan materials and practices. Researchers recommend a short-term, smaller-scale plan to help Michigan DOT designers gain more confidence in the new design procedures. The longer-term plan would involve calibrating the models for local Michigan conditions, construction practices and frequently observed distresses. After the models are validated and calibrated, researchers recommend that Michigan DOT more fully adopt the mechanistic-empirical design approach.

> *"This research was an important and necessary first step in evaluating the effectiveness of the MEPDG in Michigan."*
>
> *Michael Eacker, P.E.*
> *Pavement Design Engineer*

Value

Researchers agree that the MEPDG shows significant promise for improving pavement design. With proper calibration, it can predict how changes in material and design will affect pavement performance. Moreover, it can be a powerful analysis tool for addressing problems with existing roadways. Given the MEPDG's potential, researchers conclude that its continued evaluation for future implementation in Michigan will significantly improve the design process for the state's roadways. ■

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