M.E.'s ME Report

Newsletter on mechanistic-empirical pavement design implementation at the Michigan DOT May 2012

Welcome!

Welcome to the first update on Michigan's efforts toward implementation of the mechanistic-empirical pavement design methodology (ME). The intent is to provide these updates to pavement design stakeholders on a quarterly basis.

Content

What can be expected in these updates? You can expect news and information on tasks laying the groundwork toward implementation of the ME software (DARWin-ME), updates on ongoing or future research projects, background information on the ME design methodology, and insight into the DARWin-ME software.

The implementation plan calls for a multitude of tasks to be completed in order for MDOT to be positioned to take advantage of the state of the art in pavement design. Construction Field Services Division is in the process of designing a Web page that will provide MDOT ME-related information. The Web address for the Web page will appear in a future edition of this newsletter.

Stakeholder Feedback

As a stakeholder in this process, your thoughts and opinions are important. Please let me know of any questions or ideas you may have on ME. Also, any feedback you may wish to provide on the format of this newsletter is greatly appreciated.

Mike Eacker

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Calibration and Validation Project

On October 1, 2011, a 30-month research project to do calibration and validation of the ME software began. A team from Michigan State University will be conducting the research that will consist of three parts and is scheduled for completion on March 31, 2014.

HMA Lab Testing

Part 1 of the project involves laboratory testing of various HMA mixes from around the state. ME has several new material inputs that MDOT has not tested in the past. These inputs include dynamic modulus and indirect tensile strength of the mix and complex modulus of the asphalt binder. The dynamic modulus, commonly referred to as E* ("E-star"), is the modulus of the mix at different temperatures and different loading frequencies. E* is important for predicting cracking and rutting. Indirect Tensile Strength is used in the equation predicting thermal cracking. The complex modulus of the binder, commonly referred to as G* ("G-star"), is a measure of the binder stiffness. It is used in conjunction with E* for cracking and rutting prediction.

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What is ME?

Mechanistic-empirical pavement design (ME) is not a recent development. The idea of ME was put in print as far back as the 1970's. It wasn't until 1998 that a National Cooperative Highway Research Program (NCHRP) research project was initiated to finally pull together all the information and research on ME into one design method. That project delivered its results in 2004, and in 2007, the first version of the ME software was released for evaluation. After several rounds of refinements, AASHTO released the commercial version of the software in 2011 as DARWin-ME.

ME is based on the theory of mechanics of materials to predict the pavement's response (stress and strain) to loading from traffic. This is the mechanistic part of the name. These stresses and strains are converted to damage and this damage has to be transferred into an accumulation of distress. To do this, observed distresses from in-service pavements are used to help transfer the response terms into distress terms. This would be the empirical part of the name.

In addition to mechanistic principles, climatic considerations are a large part of the ME methodology. Climate data from weather stations are integrated into the software. The properties of the materials in the pavement cross section are varied throughout the design life based on this weather data. The data includes information such as monthly temperatures, monthly precipitation, freeze-thaw days, amount of solar radiation, etc. It is well known that weather can affect pavement performance, but this is the first time it has been integrated in a design method to this degree.

ME departs from previous design methodologies that only output a pavement thickness. A cross section is one of the inputs and predicted distresses (performance) are the output. Thus, ME will be an iterative design process. The benefit of predicting performance is that the design process can be linked with how we measure the health of our pavements–distresses. This allows for a full loop of feedback into ME to improve its predictive capability. Existing methods do not have this level of feedback capability. (See page 3 for a simplified diagram of the ME design principles.)

While the ME idea may have been around for a while, DARWin-ME represents a big leap forward in the art of pavement design. ❖

MDOT to Join Prep ME Pooled Fund

MDOT is committing to be a part of a national pooled fund project that will further develop the Prep ME software. Prep ME is a software tool that allows DARWin-ME users to put their materials and traffic data into the correct format. It began as a tool to do quality control checks on weigh in motion data and then put that data into the correct inputs required by ME. It has since expanded to include materials databases. The project is scheduled for completion in August 2014. ❖

"The benefit of predicting performance is that the design process can be linked with how we measure the health of our pavements–distresses."

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MSU is expecting to test a minimum of 60 mixes collected from around the state. In 2011, 50 mixes were collected and delivered to MSU. Sample preparation and testing began in October. This part of the project is expected to be complete by September 30, 2012.

Evaluation of Rehabilitation Fixes

Part 2 of the project consists of evaluating rehab fixes that can be designed in ME. A previous project, also conducted by MSU, evaluated the applicability of using ME to design new and reconstruction projects. A sensitivity analysis of the various inputs will be conducted first to learn what inputs affect the results the most. Next, a selection of pavements currently in-service will be designed in ME. The performance predicted by ME will be compared to actual observed performance to see if ME is producing reasonable results.

This portion of the project (also started in October) is scheduled to be completed by March 31, 2013.

Calibration and Validation

Part 3 of the project will calibrate and validate the software to Michigan conditions. The predictive models in ME were calibrated using the Long Term Pavement Performance (LTPP) database. The LTPP database contains data on hundreds of test sections from around the country. While this is impressive compared to the test sections that were used for the previous AASHTO design method (one location in Ottawa, Illinois), for the best results, the models should be calibrated to Michigan's performance information. ME will be used to predict performance for a number of in-service pavements. Similar to Part 2, the predicted distresses of ME will be compared to observed distresses. The coefficients in the software will then be adjusted to bring ME more in line with observed performance. ME, with the new coefficients, will be tested on a separate set of projects to validate the changes made.

Part 3 is scheduled to begin in February 2013 and will be completed by March 31, 2014. ❖

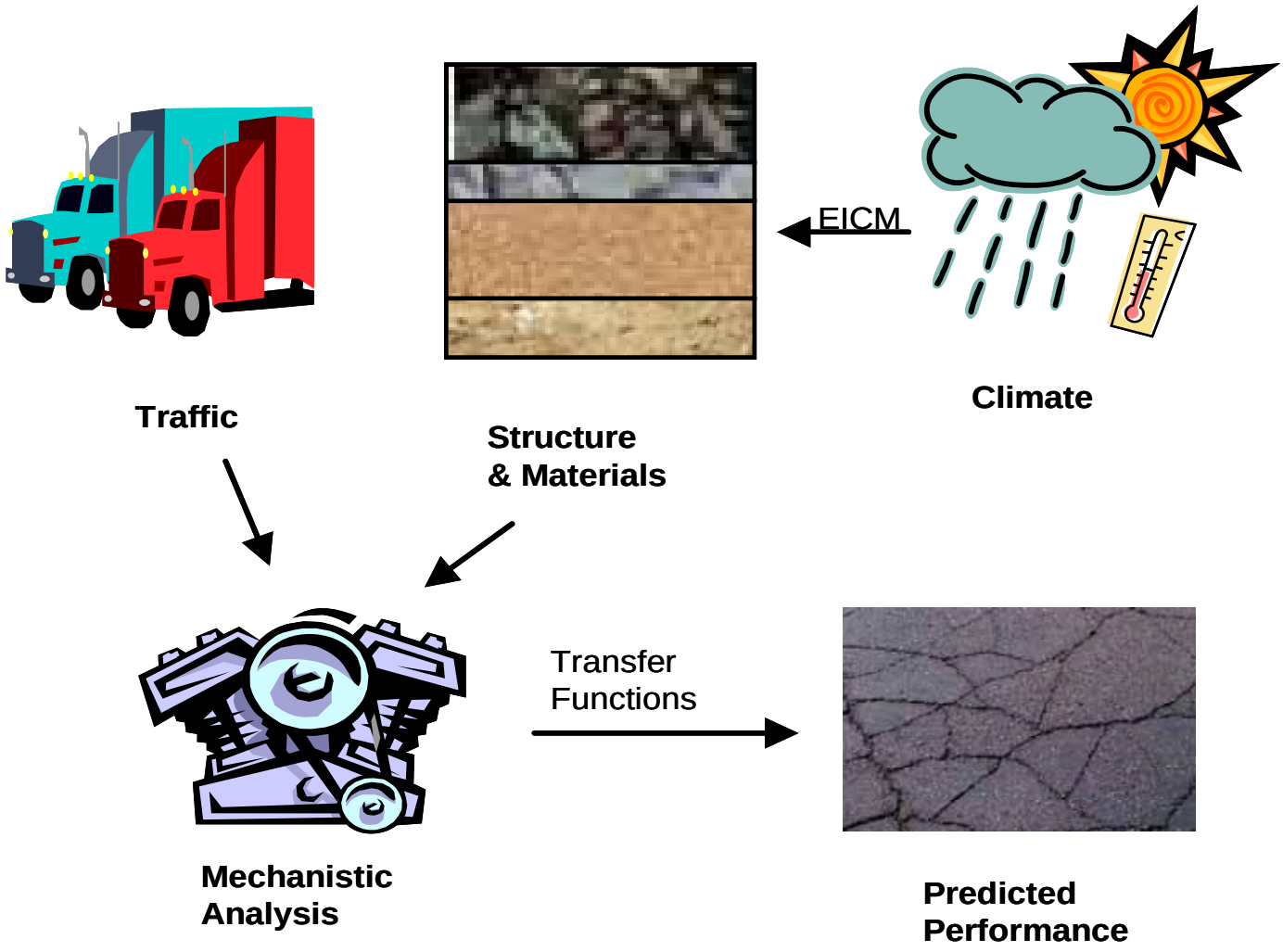
AASHTO Dropping Support of DARWin 3.1

With the release of DARWin-ME, AASHTO decided to end support for their previous design software, DARWin 3.1. Support will end June 30, 2012. Michigan has an unlocked, unlimited license, so the software will still function; however, it will no longer be updated to ensure functionality with new computer operating systems. Loss of support also means that bugs or problems with functionality will no longer be handled by AASHTO's software vendor.

AASHTO has offered to provide the software code to agencies with unlimited licenses. MDOT is looking into taking ownership of the software to provide self-support if issues arise. ❖

Mechanistic-Empirical Pavement Design Principle

(EICM = Enhanced Integrated Climatic Model)



For questions about information in this newsletter, further details on mechanistic-empirical pavement design implementation in Michigan, or to submit an idea for an article in a future newsletter, please contact:

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