Mechanistic-Empirical Pavement Design Implementation

Operations Executive Staff Meeting
Construction Field Services
October 18, 2012

Mike Eacker
Outline

- What Is ME?
- Why Adopt ME?
- Implementation Plan/Timeline
- Calibration Project
What Is ME?
What Is ME?

Mechanistic-Empirical pavement design (ME) is the latest generation of pavement design methodology

Not a new concept

Theory of mechanics – pavement response (stresses/strains) to applied load

Empirical observations (actual performance) used to calibrate the mechanistic models
What Is ME?

Traffic

Structure & Materials

Mechanistic Analysis

Climate

Transfer Functions

Predicted Performance

EICM* = Enhanced Integrated Climatic Model
What Is ME?

- Distresses (performance) predicted over time
  - HMA distresses: transverse cracking, longitudinal cracking, % fatigue cracking, rutting, IRI
  - Concrete distresses: % slabs cracked, faulting, IRI
- 29 states, 4 Canadian provinces, 3 local agencies, FHWA, 19 academic institutions, and 32 private companies are licensing DARWin-ME (as of Oct. 2, 2012)
Why Adopt ME?
Why Adopt ME?

Current design method, AASHTO 1993, based on AASHO Road Test from 1958-1960
### Why Adopt ME?

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<th>AASHTO 1993</th>
<th>Mechanistic-Empirical</th>
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<td><strong>Basis</strong></td>
<td>Empirical observation from the 1958-59 AASHO Road Test</td>
<td>Theories of mechanics</td>
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<td><strong>Original</strong></td>
<td>AASHO Road Test – Ottawa, Illinois</td>
<td>SHRP test sections from around the country</td>
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<td><strong>Calibration</strong></td>
<td>Equivalent Single Axle Load</td>
<td>Axle load spectra</td>
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<td><strong>Characterization</strong></td>
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<td><strong>Materials</strong></td>
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<td><strong>Inputs</strong></td>
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<td><strong>Climatic</strong></td>
<td>Limited – can change inputs based on season</td>
<td>Integral – weather data from 600+ US weather stations included</td>
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<td><strong>Effects</strong></td>
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<td><strong>Performance</strong></td>
<td>Present Serviceability Index</td>
<td>Various distresses, IRI</td>
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<td><strong>Output</strong></td>
<td>Thickness</td>
<td>Performance prediction (distress prediction)</td>
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Why Adopt ME?

Benefits

- Many more materials inputs that effect performance
- Effects of weather are integrated
- Can evaluate proposed design/material changes
- Material properties are changed with time (aging effects)
- Multiple levels for each input allow customization based on resources and importance
- Output matches how we monitor performance (distresses)
Why Adopt ME?

Michigan weather stations embedded in DARWin-ME
Why Adopt ME?

- Distress progression output over time
Implementation Plan

List of tasks:

- Review MDOT ME research reports
- Learn from states already implementing
- Literature review (anything ME related)

**ME oversight committee**

- Decide on reliability levels
- Decide on performance thresholds
- Develop acceptance protocol for designs
- Run designs, run designs, run designs
- Catalog all inputs

- preliminary levels only for ME evaluation, production design levels decided at later time
List of tasks (cont.):

- Decide which inputs are default and which are in-play as well as input level
- Review climatic data that came with the software
- Investigate rehab designs

Calibration and validation

- Where does the initial cross-section come from?
- What should be in the output file
- Organization of design files
- Transition plan
List of tasks (cont.):

- Overall design process
- Get the server version of DARWin-ME set up
- Develop user’s manual
- Conduct training class
- Develop research ideas
- Determine equipment needs
- Keep stakeholders updated
Goal of ME Oversight Committee:

Facilitate the implementation of ME as MDOT’s standard design method
Committee membership:

Supervisors of the following general areas:
- Pavement management
- HMA materials
- Concrete materials
- Aggregate materials
- Pavement evaluation
- Traffic monitoring

- Pavement Operations Engineer
- Pavement Design Engineer (chair)
- Region Soils Engineers (Region pavement designers)
- Concrete and HMA paving industries
Implementation Plan
ME Oversight Committee

- Facilitate business process changes for pavement design
  - Who provides the traffic data and how?
  - Which designs are central office and which are not?
  - etc.

- Decisions on equipment
  - CTE test
  - HMA dynamic modulus test
  - etc.
Help with decisions on design criteria
  - Distress thresholds
  - Reliability levels,
  - etc.

Help with decisions on input values
  - Time to 50% shrinkage (PCC)
  - 20 year/28 day PCC compressive strength ratio
  - HMA effective binder content
  - % air voids
  - etc.
Implementation Plan
ME Oversight Committee

- Expand department knowledge of the software and the impacts of different inputs and design decisions
- Explore research needs
- Facilitate industry participation
- Decide on and oversee subcommittees, including membership
Implementation Plan
ME Oversight Committee

Proposed Subcommittees
- Traffic
- HMA
- Concrete

Subcommittee goals
- Learn the materials/traffic inputs and their impacts in the software
- Recommend equipment
- Facilitate testing
- Make recommendations on input values
### Mechanistic-Empirical Pavement Design Implementation Timeline

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### Literature Review/Other States Experience

- L1: Contact other states
- L2: Review literature for a policy implementation
- L3: Review completed MDOT ME research
- L4: Review new literature as it becomes available

### Committees

- C1: Plan for an expert committee
- C2: Plan for traffic subcommittee
- C3: Conduct meetings

### Software Operation

- S1: Preliminary reliability levels
- S2: Preliminary distress threshold levels
- S3: Run designs on LCCA projects
- S4: Preliminary acceptable design criteria
- S5: List of inputs
- S6: Evaluate potential designs in ME
- S7: Final reliability analysis
- S8: Final distress threshold levels
- S9: Final acceptable design criteria
- S10: Database of inputs
- S11: Review climatic data
- S12: Pretrial calibration and validation
- S13: Needs for future calibration
- S14: How to choose initial cross-section
- S15: Control of summary document
- S16: Organization of design output files
- S17: Developing transition plan
- S18: Develop design process

### IT Needs

- I1: Resources for multi-user license
- I2: Explore obtaining DARWIN 3.1 code
- I3: Training
- I4: ME users - draft version
- I5: Training class for MDOT designers
- I6: ME users manual
- I7: ASIT training with designs
- I8: Review national/regional conferences

### Research

- R1: Immediate research needs
- R2: Research needs
- R3: Equipment/Resources
- R4: Equipment/personnel needs

### Communication

- X1: Report progress to management
- X2: Obtain industry feedback - implement plan
- X3: Obtain industry feedback - specific items
- X4: Obtain industry feedback - specific items
Implementation Timeline

- Calibration Project scheduled completion date is March 31, 2014
  - Calibration Project draft final report due December 31, 2013
  - Acceptance of final report by March 31, 2014
  - Includes a one-day training seminar as a deliverable

- Transition plan will be developed prior to this
Calibration Project
"Preparation for Implementation of the Mechanistic-Empirical Pavement Design Guide in Michigan" - research project with Michigan State University

- Part 1 – HMA Characterization
- Part 2 – Evaluate Rehab Designs
- Part 3 – Calibration and Validation

$400,000 total

Completion: March 31, 2014
Calibration Project

- Example of calibration factor adjustment – ME over predicting
Pooled Fund Project

PrepME pooled fund project

- PrepME is a software tool for preparing and housing inputs for ME
- Started as a tool for converting WIM data into applicable traffic inputs
- Expanded to include climatic and materials inputs, including a database structure for storage
- Louisiana is the lead state
- Oklahoma State University is the contractor
- Completion: August 31, 2014
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.

Inside This Issue

1. Welcome!
2. Calibration and Validation Project
3. MDOT to Join Prep ME Pooled Fund
4. AASHTO Dropping Support of DARWin 3.1

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
Pooled Fund Project

Newsletter sign-up web page:

http://www.michigan.gov/mdot/0,1607,7-151-9625_25885-141523--,00.html?list=MDOT_ME_PAVEMENT_DESIGN

Alternatively, select the following from the MDOT public web site:

1. Doing Business
2. Highway Field Services
3. Construction Field Services
4. “Mechanistic-Empirical Pavement Design List-Serv” (under Resources & Publications)
Questions?