WisDOT MEPDG Implementation Peer Exchange

Wisconsin Department of Transportation

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16. Abstract

The Wisconsin Department of Transportation (WisDOT) Materials Management Section, with funding and organizational support provided by the WisDOT Research Program, hosted a peer exchange September 10-12, 2013 in Madison, Wisconsin.

The peer exchange participants represented the ten member states of the American Association of State Highway & Transportation Officials (AASHTO) Region 3 – Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio and Wisconsin. The Federal Highway Administration (FHWA) also participated as did a representative from Applied Research Associates (ARA) who developed software and guidance supporting MEPDG.

Participants shared their experiences related to implementation of the Mechanistic-Empirical Pavement Design Guide (MEPDG). The event centered on facilitated discussion for five key aspects of implementation: calibration, materials testing, traffic data, design acceptance, and deployment.

This report presents the key observations from the peer exchange discussions.

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Mechanistic-Empirical Pavement Design Peer Exchange

September 10-12, 2013

Madison, Wisconsin

EXECUTIVE SUMMARY

The Wisconsin Department of Transportation (WisDOT) hosted a peer exchange in September 2013 in Madison, Wisconsin to discuss implementation of the Mechanistic-Empirical Pavement Design Guide (MEPDG) by state DOTs. There were four key objectives for the peer exchange:

1. To determine what is working well for states in MEPDG implementation;
2. To identify successful steps state DOTs should emulate;
3. To discuss elements that create problems or concerns for state DOTs; and
4. To identify unresolved issues that could be addressed by other agencies.

<u>Background</u>

MEPDG was developed through the National Cooperative Highway Research Program (NCHRP) in the early 2000s as a more realistic characterization of in-service pavements with uniform guidelines for designing flexible, rigid, and composite pavements. The approach incorporates traffic analyses, calibration to local conditions and design reliability measures. It is used to analyze causes of pavement distress including fatigue, rutting, and thermal cracking in asphalt pavements, and cracking and faulting in concrete pavements. ME design is supported nationally by the *Mechanistic-Empirical Pavement Design Guide, a Manual of Practice* and the AASHTOWare Pavement ME Design software.

<u>Participants</u>

The peer exchange participants represented the ten member states of the American Association of State Highway & Transportation Officials (AASHTO) Region 3 – Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio and Wisconsin. The Federal Highway Administration (FHWA) also participated as did a representative from Applied Research Associates (ARA) who developed software and guidance supporting MEPDG.

The WisDOT Research Program funded and staffed the event. Gary Whited of the Construction & Materials Support Center (CMSC) at the University of Wisconsin – Madison facilitated the exchange.

Peer exchange format

The exchange involved two and one-half days of meetings. To introduce the event, participants were invited to complete and discuss their state DOT's timeline of MEPDG implementation. The bulk of the event centered on facilitated discussion for five key aspects of implementation:

1. Calibration
2. Materials testing
3. Traffic data
4. Design acceptance
5. Deployment

The peer exchange included a discussion of the current state of the ME Design software with the ARA consultant. To conclude the peer exchange, the participants collectively identified key findings and takeaways that resulted from the discussion.

Key findings

The peer exchange identified several findings that could aid states in further development and usage of MEPDG regardless of their current implementation status:

- Adoption – State DOTs are generally moving ahead with MEPDG, but there remains a wide range of progress towards full implementation. A few states have already adopted MEPDG and most others will adopt it fully by the end of 2015. One state (Illinois) has its own pavement design process that uses similar concepts as MEPDG. Kentucky and Minnesota have their own ME processes as well.

- Local calibration – Although the traditional term has been to "calibrate" MEPDG to local conditions, the peer exchange revealed that a more accurate process is "verification, validation, calibration and revalidation." Regardless of the terms, local calibration is essential to establish accuracy, knowledge and acceptance of MEPDG with state DOTs and the pavement industry. Future rounds of re-calibration will be useful after MEPDG-designed pavements have been in service for a few years. States would like more information on what DOTs are adopting for default vs. calibrated inputs and also more guidance on calibration needs following ME Design software updates.

- Materials testing – As with calibration, materials testing is a necessary step in MEPDG adoption but inputs and standards may be set as needed by each state's policy. These standards must then remain consistent throughout design and construction. There are some concerns that MEPDG-produced design may occur long before states have access to in situ property data. Some states are also just beginning to move to the updated AASHTO T-336 Standard Method of Test for Coefficient of Thermal Expansion of Hydraulic Cement Concrete.

- Traffic data – While the default traffic inputs for the ME software may apply to some situations, states are carefully developing local traffic data to feed the design process. Traffic inputs can be improved by availability of weigh-in-motion data and information on local traffic generators, or alternatively hindered by lack of data. There are concerns about suitability of current traffic data sources to MEPDG needs, and additional questions about growth rates, seasonal changes and verification of data. FHWA indicated that the LTPP Pavement Loading User Guide (PLUG) may provide some solutions to traffic-related issues for MEPDG.

- Design acceptance – States have found that a defined design acceptance process helps MEPDG provide a level tool for alternative bidding practices, assuming that the pavement industry has accepted reliability thresholds. This is an area with some variation amongst the states regarding what acceptances are appropriate or applicable and where to set thresholds. Participants noted the issue of design acceptance may lead to certain problems for design-build, public/private partnership or consultant design processes.

- Deployment – The participants generally noted good acceptance and direction from DOT management on MEPDG and interested involvement from the pavement industry. Training is essential for deployment, not just on the software but also on the overall concept. States should also carefully set policies regarding inputs, level of design and other variables. As with other factors, the participants could use more information about state-by-state deployment issues and need guidance on how future software upgrades would affect usage.

<u>Conclusions</u>

The MEPDG peer exchange proved to be a productive exchange of ideas, experiences, tips and concerns for implementation of both the process and the software. Several of the discussion topics talked about the need for more state-by-state information that could be used for individual DOTs to assess progress and shape their own customization of MEPDG.

Aside from the specific elements of MEPDG that are documented in the full report, participants found that DOTs can clearly learn from each other’s experiences and utilize that knowledge to repeat success and avoid mistakes. Additional information sharing about MEPDG deployment through reports, training and events will be very useful as states implement the process for the first time or continue to make refinements and improvements over long-term usage. FHWA in particular discussed a desire to periodically hold regional forums on MEPDG implementation and the experience of this peer exchange would support that goal.

Introduction

The Wisconsin Department of Transportation (WisDOT) Materials Management Section, with funding and organizational support provided by the WisDOT Research Program, hosted a peer exchange for the American Association of State Highway and Transportation Officials (AASHTO) Region 3 member states to examine issues relating to implementation of the Mechanistic-Empirical Pavement Design Guide (MEPDG) process. Ten states were represented at the peer exchange.

MEPD was developed by the National Cooperative Highway Research Program (NCHRP) in the early 2000s as a more realistic characterization of in-service pavements with uniform guidelines for designing flexible, rigid, and composite pavements. This approach incorporates traffic analyses, calibration to local conditions and design reliability measures. It is used to analyze causes of pavement distress including fatigue, rutting, and thermal cracking in asphalt pavements, and cracking and faulting in concrete pavements. ME design is supported nationally by the *Mechanistic-Empirical Pavement Design Guide, a Manual of Practice* and the AASHTOWare Pavement ME Design software.

This report presents the key observations from the peer exchange discussions.

Objectives

The peer exchange objectives were to identify the following:

1. What is working well in MEPD implementation and how is it achieving desired results?
2. What are the implementation steps that states should emulate to help ensure success?
3. What elements in MEPD implementation could create problems, costs or concerns for states?
4. What questions could be addressed by other agencies such as the Federal Highway Administration (FHWA), AASHTO, NCHRP, etc.

Participants

Organization	Name
FHWA	Khaled Al-Akhras
FHWA	Chris Wagner
Illinois DOT	Charles Wienrank
Indiana DOT	Tommy Nantung
Iowa DOT	Chris Brakke
Kansas DOT	Jonathan Marburger
Kentucky Transportation Cabinet	Paul Looney
University of Kentucky	Clark Graves
Michigan DOT	Larry Dropiewski
Michigan DOT	Mike Eacker
Michigan DOT	Justin Schenkel
Minnesota DOT	Luke Johanneck
Missouri DOT	John Donahue
Ohio DOT	Patrick Bierl
Wisconsin DOT	Tony Allard
Wisconsin DOT	Robert Aurit
Wisconsin DOT	Laura Fenley
Wisconsin DOT	Steve Krebs
Wisconsin DOT	Randy Luedtke
Wisconsin DOT	Tom Nelson
Wisconsin DOT	Todd Peschke
Wisconsin DOT	Tim Stoikes

Peer Exchange Support

Organization	Name
Applied Research Associates, Inc.	Jagannath Mallela (Presenter)
University of Wisconsin – Madison Construction & Materials Support Center	Gary Whited (Facilitator)
WisDOT Research Program staff	Daniel Yeh
WisDOT Research Program staff	Diane Gurtner
WisDOT Research Program staff	Kimberley Dinkins

Agenda

Day 1

12:30 – 1:00 pm	Welcome / Participant introductions
1:00 – 1:15 pm	Review agenda and peer exchange goals Steve Krebs, WisDOT Materials Management Section Gary Whited, UW-Madison Construction & Materials Support Center
1:15 – 2:45 pm	Topical discussion #1 – Calibration Introduction by Luke Johanneck, Minnesota DOT
3:00 – 4:45 pm	Topical discussion #2 – Materials testing Introduction by John Donahue, Missouri DOT
4:45 – 5:00 pm	Day one wrap-up / day two preview Gary Whited, UW-Madison Construction & Materials Support Center

Day 2

8:30 – 10:15 am	Topical discussion #3 – Traffic Introduction by Tommy Nantung, Indiana DOT
10:30 – 12:15 pm	Topical discussion #4 – Design acceptances Introduction by Mike Eacker, Michigan DOT
1:00 – 2:15 pm	Presentation – MEPDG software experience Jagannath Mallela, Applied Research Associates
2:30 – 4:15 pm	Topical discussion #5 – Moving from development to deployment Introduction by Laura Fenley, Wisconsin DOT
4:15 – 5:00 pm	Day two wrap-up / initial outline of findings report Gary Whited, UW-Madison Construction & Materials Support Center

Day 3

8:30 – 12:00 am	Group development of findings report / next steps / closing remarks

Mechanistic Empirical Pavement Design

AASHTO Region 3 States Implementation Timeline (as of September 2013)

State	Decision	Materials research	Calibration	Training	Beta testing / partial adoption	Adopted as primary tool	Own version
Illinois						IL version 1989, update 2011	X
Indiana	2000 / 2005	2000	Verification	8 weeks w/6 days specific to MEPDG		Jan 2009, Chapter 304	
Iowa	2004	X++	X		2014	2015	
Kansas	2000's		2013 HMA 2014 PCC			Unknown	
Kentucky	1998	Unbound early 2000s	2013/2014			KY HMA version 1981	X
Michigan	2005 - research started 2010 – implementation plan	X	Sept. 2014 completion		Fall 2014	2016?	
Minnesota	2000	Early 2000s -present				2014 for rigid MnDOT ME version	X
Missouri	Early 2004	2005-2008				2004	
Ohio	Mid 1990s	Mid 1990s - 2004	2009			Unknown	
Wisconsin	1998	2000	2006, 2010, 2013	2003 / 2013	2011	Jan 2014	

Implementation Timeline Notes:

Illinois (Charles Wienrank). IL not implementing MEPDG in the foreseeable future. They are using their own procedure developed in 1989, updated in 2011. IL doesn't use centralized pavement design. Each region does their own.

Indiana (Tommy Nantung). Decision process started in 2000. 5 PhDs work on MEPDG. In 2005 decided to definitely go with MEPDG. IN doesn't do calibration – they do verification. Nantung conducted the training – 6 weeks initially last year. This year will do training updates. MEPDG implemented as primary tool in 2009.

Iowa (Chris Brakke). Decision made in 2002. First contract with Iowa State University for implementation plan in 2005. Fifty-year climatic database for each county. Calibration done but will need to be redone. Beta testing will be in 2014.

Kansas (Jonathan Marburger). Kansas has been considering MEPDG starting in early 2000s. University of Kansas is currently working on HMA calibration. Materials testing also done at Kansas State University. Training at Auburn summer of 2013. No set target date for beta testing but is actively moving toward MEPDG implementation in the coming years.

Kentucky (Paul Looney). University of Kentucky is the research arm. Currently have an ME process (since 1981). Decision on MEPD made during 1998-2000 time period. Reconsidered due to the large amount of inputs/expense. Got the DarwinME license about a year ago and have been working with IT to get the database accessible. Pulling together lots of data. Need to do verification. Two people went to training a few weeks ago. Will most likely implement in central office first.

Michigan (Mike Eacker). Research started in 2005. Some materials completed, some ongoing. Calibration research project with Michigan State University should be completed in 2014. Haven't yet done much training, although Michigan State has done some introductory training. Shooting to begin transition in fall 2014, with full implementation sometime in 2016.

Minnesota (Luke Johanneck). Started to review for potential use in 2000. Currently a lot of pressure from industry. MnDOT's own rigid design tool being worked on by the University of Minnesota. Training is an area of concern. MnPave (MnDOT's asphalt pavement design tool for lower volume roads) is being used by cities and counties but not by MnDOT yet. Hopefully will be implementing MnPave for state use in 2014.

Missouri (John Donahue). The decision to use MEPD was made and adoption started in 2004. Calibration began in 2005. All pavement design is done centrally so only a few people will use. Currently using only for new pavement.

Ohio (Patrick Bierl). Decision on MEPD was made in the mid 1990s. Materials research completed. Calibration contract with Applied Research Associates, Inc. (ARA) completed in 2009; results differ from national calibration. In-house re-calibration is ongoing. Will only be a few people in central office who will need to use software. Adoption date undetermined.

Wisconsin (Laura Fenley). MEPD decision was made in 1998. Materials research started just before 2000. Calibration started in 2006; with another project in 2010; will finish in 2013. Training on ME design theory given in 2003; software training 2013. Have been preparing for deployment since 2011. Will be adopting in 2014.

Topical discussion #1 – Calibration

Table 1 (Overview of Calibration Discussion)

What's working well	Steps to emulate	Concerns	Questions / needs	Other
Local calibration enhances knowledge, comfort level	Process flow: - Verification - Validation - Calibration - Revalidation	Need better information on software updates to determine recalibration needs	Synthesis of what national defaults are being used by which states and which have been locally calibrated (KY may take lead)	Integration of value engineering and ME process
Monitor in-service ME designed pavements and monitor for future calibration	Perform sensitivity analysis of inputs for local calibration	ME only predicts quantity, not severity of distress	Make calibration manual simpler	Local calibration helps to communicate policy with industry (tied to design acceptance)
	Utilize different sets of data in the process steps			
	Key investment is to update climate tables by state (if significant factor in designs)			

Calibration Discussion Notes:

Calibration introduction – Luke Johanneck, Minnesota DOT

MnDOT's original goal was to have a 2002 deployment. The University of Minnesota was doing the calibration; however, as new versions came out there were corrections that had to be made.

When calibrating, there should be limits on the number of variables. There is a need to know what inputs to change.

Calibration Process

IL – Did their own with help from University of Illinois.

IN – Adopted HMA Superpave in 1996 and refined in 2000. Beginning to implement open graded drainage layer in concrete pavement in 1992. The MEPDG models are verified against national calibration. Continue to monitor projects to further verify the performance in the field. Is MEPDG perfect? No, but it is better than the AASHTO Pavement Design Guide of 1993.

IA – Local data to calibrate. Iowa State did calibration w/DarwinME software.

KS – University of Kansas is doing the calibration.

KY – University of Kentucky will do calibration.

MI – Michigan State University doing as a 3-part project 40+ mix designs tested for HMA; rehab design; calibration.

MN – University of Minnesota did calibrating. Used some MnRoad data.

MO – MoDOT did the field testing. ARA did calibration analysis. Used a composite score for severity and quantity. ME only predicts quantity, not severity of distress. Used only for new pavement design. Rehabilitation is a greater problem. (MoDOT does alternate bidding; each project gets concrete and asphalt bids.)

OH – ARA contract used historical LTPP data from across the state for original calibration. Historical condition data doesn't easily fit the software requirements (e.g. rutting, cracking etc.). How are other states handling pavement condition measurements for calibration? Top down vs. bottom up cracking both being measured as fatigue cracking? ODOT does a manual statewide pavement condition survey every year. Doing in-house re-calibration now.

WI – Has the data. ARA did first calibration in 2006. Coefficient of thermal expansion (CTE) values seem to be high. Second round of calibration done by Marquette University. Need to validate.

FHWA – NCHRP has a project regarding national calibration issues.

Rutting in unbound material is over-estimated. For design, national models are good enough. High RAP/RAS mixes may be tough. Biggest question – how does top-down cracking happen?

TRB has an archived webinar on NCHRP 719. http://www.trb.org/Main/Blurbs/167582.aspx

New Asphalt Institute report, Calibration Factors for Polymer-Modified Asphalts Using M-E Based Design Methods (ER-235).

http://www.asphaltmagazine.com/news/detail.dot?id=9ba1827c-02a2-4da7-ae2b-52bdbdf307dd

Miscellaneous:

*Variability of models.

*Comfort level of sensitivity analysis.

*What's going to happen each time a new version is released?

*Life cycle cost factors affect paving industries.

Terms – (from Local Calibration Guide) – definitions from Jag Mallela

Verification: Sensitivity (engineering reasonableness, checking statistical rules)

Validation: (precedes calibration – to check the models reasonableness)

Calibration: (statistical step used if there are things that don't line up in validation step)

Then re-validation if needed.

Topical discussion #2 – Materials Testing

Table 2 (Overview of Materials Testing)

What's working well	Steps to emulate	Concerns	Questions / needs	Other
Missouri example of how to select soil values to use (refer to MODOT report)	Inputs for materials testing are a state DOT policy decision (level, tightness of QC/QA) but need to be consistent with design inputs and construction specs	Won't have in situ properties for design on sections 2-3 years out; use expectations instead, but do you use CBR or soil classification or other method?		Ranges not large for Resilient Modulus
	Calibration needed for stabilized soil layers	Need to recalibrate CTE (all states)		Good correlation between level 2 and level 1 for dynamic modulus with conventional (unmodified) mixtures
	Low temperature HMA testing important for northern states to capture thermal cracking	Switch to AASHTO T-336, but value must be converted (FHWA source)		Need to train staff that modulus values are different from AASHTO 93

Materials Testing Discussion Notes:

Materials testing introduction – John Donahue, Missouri DOT

Long-term pavement performance (LTPP) data.

Looking at individual types of mixes – mixes are ever-evolving.

At time model were developed – not all mixes were tested. (e.g. Superpave not until 1997.)

Another specialty mix, Stone Matrix Asphalt (SMA), not represented.

Constrained if newer pavements aren't included.

Other issues:

- Widening roads, can't evaluate exactly as original
- More recycled materials being used
- Never-ending process – always will be new mixes
- Unbound materials (especially subgrades) -- designs often 3 years ahead of project, don't have complete control of the aggregates (use of materials library)
- Soils can be another issue – may be conservative when estimating
- Materials – lab batch testing
- Testing -- DOT doing own vs. using universities/consultants

<u>Material Testing</u>

IL – Testing done primarily at University of Illinois. Actively doing more testing.
IN – Did own material testing in-house. Tested soils, concrete, asphalt; used various parameters. See if major contractors follow the spec. The representative samples from the contractors are representatives of the materials input parameters in MEPDG. The concrete strength and the asphalt dynamic modulus depends on how strong the spec of the agency. Doing testing on more new contractors samples.
IA – originally tested 21 mixes. Continue to test on new projects.
KS – select dynamic modulus at universities, resilient modulus currently based (typically) on liquid limit correlation
KY – about 10 years ago did testing for materials library
MI – CTE, HMA materials, unbound modulus - falling weight deflectometer (FWD) data used. Education and training hurdles – looking at modulus differently from AASHTO 93 to ME (ME uses "optimum" values).
MN – binder testing in lab, resilient modulus – continuing to build up the database. Uses the MEPDG defaults for now.
MO -- did about 30 different soils representative of the state. (Catalog by classification)
OH – not doing Coefficient of Thermal Expansion (CTE) tests routinely, materials library was created with a research project completed in 2004 by Ohio University to merge all prior research that included relevant materials and material properties. Have not been adding to it, however research since then has included ME material testing when applicable. Have not decided on modulus.
WI – testing, none in-house. Soils data, asphalt data, concrete data.

FHWA – The thickness of unbound aggregate layers is not as sensitive with ME as with AASHTO 93. FHWA initiated round robin test.

Jagannath Mallela, ARA – Different DOT agencies can decide what to input but need to be consistent with local testing. Catalog of values in the report. Geotech wants to use resilient modulus. Low-temperature testing. Default values for level 3 are overly compliant.

Question -- how does freeze-thaw affect?

Day 1 Wrap-up

One of the ME Design input parameters is the stiffness of the unbound layers. This stiffness can be obtained from laboratory testing (Resilient Modulus), estimating an R-value from a CBR test, or back calculating based upon an FWD test. Jag reinforced that what method you used to determine the stiffness for the local calibration should also then be used for obtaining the design input. It is important to be consistent. This is a significant question for DOTs to consider at the outset of implementing ME design.

Areas to especially take note of for local calibration of flexible pavement are: rutting of subgrade (current models over-predict), thermal cracking (default values may be overly compliant), and top down cracking.

There is a reason to do local calibration – to raise comfort level of the department and industry. Typically the number of projects used for local calibration depends on funding. However, more is usually better.

For calibration, quality is very important. Base model needs to be based on the best data possible. There is a need for more climate data.

For materials testing, whatever model is used must be consistent (need to carry forward from calibration to testing).

Dynamic modulus values show good correlation between level 1 and level 2.

Topical discussion #3 – Traffic

Table 3 (Overview of Traffic)

What's working well	**Steps to emulate**	**Concerns**	**Questions / needs**	**Other**
Level 3 spectra on national model seems to be accurate for rural interstate (MO example)	Confidence of Weigh-In-Motion (WIM) data (perform QC/QA)	Need best practices on WIM and other traffic data collection for ME		Value of ESALs? Shifting to number of trucks and classification
Truck Weight Roadway Groups (TWRG)	Utilize LTPP-PLUG	Concern that high percentage of unclassified trucks may be in the WIM data		
	Don't design too many different pavements on a single project even to reflect traffic (like ramps)	Nontraditional trucks (farm implements, OSOW, etc)		
	Need to talk to local engineers for local knowledge (such as traffic generators)	Calculating truck traffic growth rate, seasonal changes		
	Need coordination to get traffic data better suited to ME needs			
	Evaluate / confirm traffic model; create own only if necessary			

Traffic Discussion Notes:
Traffic introduction – Tommy Nantung, Indiana DOT
MEPDG is a "practical" pavement design tool
Traffic is the most important data for design.

Where do you get traffic data?

How do they collect the traffic data?

Planning people are interested in the peak (throw out the thunderstorm data, snowstorm data).
Geotechnical departments want conservative because of freeze-thaw
Weigh-in-motion (WIM) stations can't classify all trucks. What are unclassified trucks?

<u>Traffic Data Collection</u>
IL – 5 WIM stations. 107 count/classification sites. Looking at impacts of proposed legislation to allow for 97,000 lbs on 6-axles
IN – 57 permanent WIM stations and 125 Automatic Vehicle Classification system. Did not change data collection but changed data processing analysis to classify the unclassified trucks.
Trucks sometimes avoid the weigh stations by using alternate routes.
IA – use WIM data.
KS – 5 permanent WIM stations; also collecting portable WIM data. The WIM and vehicle classification data is loaded and maintained in a database specifically used to provide direct output to the MEPD "system". Issues with WIM information lining up with average daily traffic (ADT) data.
KY – historically had about 30 WIM sites, past 8-9 years have not been collecting a lot of WIM data
Total volume counts, truck counts – do several hundred per year to get averages.
MI – get data from traffic department. 40 WIM sites, 17 classification sites. Use pure count of vehicles; percentage of trucks. It's critical to have traffic sub-committee to help understand the traffic inputs.
MN – 6 WIMs. Not much change in load spectrum based on time of year. MEPDG default was heavier than almost all of the WIM sites. Developed two standard axle spectras for the ME Design tool based on WIM data. One is an average of the WIM sites (not much variation across the state) and one is heavy (near a sugar beet facility).
MO – 11 permanent WIMs, also portable WIMs (quality of the portable was not as good, didn't use)
Added a few more permanent WIMs. Have been doing a lot of interchanges which calls for figuring out ramp maneuvers. From a construction standpoint, can't have different pavement designs for 4 different ramps. Primarily place on rural routes; usually don't place WIMs on urban roads. Must consider safety factors involved in installing equipment.
OH – completed a research project with the University of Akron in 2012 to characterize traffic data for use in ME software. Project used data from 143 permanent sites (93 AVC and 50 WIM).
WI – has 13 WIM sites (all new within the past year), 4 more WIMs going in this year.
Traffic people now more connected with the pavement people
FHWA – Need to put level of detail into perspective; can get lost in the weeds of data.
FHWA developed the LTPP-PLUG (Pavement Loading User Guide) software (more ways to pick appropriate road use option). Information was presented at TRB in 2013 and will present again in 2014. There are also webinars.

Miscellaneous:
There are 3 types of WIM sensors: Bending plate, Piezo, and Quartz sensor.

MEPDG use is helping states to clarify WIM data.
For most states, no difference in data collection & data processing between pre- and post- MEPDG.

There can be difficulty explaining to Traffic areas that Class 1 sensor is not the same as a Class 1 site.

Factors to consider with traffic data:
Hours of truck distribution
Directional distribution
Lane distribution
Axle load distribution
Traffic wander

Design for worst case
Facilitator Gary Whited asked the question – do we still need Equivalent Single Axle Loads (ESALs)? Consensus of participants was, yes, because it provides a frame of reference. IL still uses ESALs in their design procedure.

International Roughness Index (IRI) is one of the distress thresholds which is significant and most felt it was one that needed to "pass" for an acceptable design.

Topical discussion #4 – Design Acceptances

Table 4 (Overview of Design Acceptances)

What's working well	**Steps to emulate**	**Concerns**	**Questions / needs**	**Other**
ME provides a level tool for alternative bidding (if industry has accepted reliability and thresholds)	Utilize NCHRP report 703	Set policy on what inputs could be varied by designer – industry may not be able to support	Want synthesis on how states are setting reliability and performance threshold levels under ME	States are not using all performance criteria, depending on applicability & appropriateness
Plot curves at different reliability	Use mean values in design – handle risk through reliability which is subjective for each state	Potential issues with design-build, PPP and consultant designs	Hot topic – dowel bar inserters	
	Indiana hierarchy for distress predictions			

Design Acceptances Notes:

Design Acceptances introduction – Mike Eacker, Michigan DOT
Michigan has an ME website:
http://www.michigan.gov/mdot/0,4616,7-151-9623_26663_27303_27336_63969---,00.html
Also a newsletter: M.E.'s ME Report (posted on website above)
Another publication: Implementing the Mechanistic-Empirical Pavement Design Guide in Michigan
http://www.michigan.gov/documents/mdot/MDOT_Research_Spotlight_Implementing_MEPDG_298420_7.pdf
MI – pushing to do ME for alternate bids.

Alternate bids:
Alternate bidding doesn't need to be a lot of extra work; can develop guidance in specs for how to handle.

NCHRP Report 703 deals with the issue of alternate bidding. (Jag Mallela is one of the authors)
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_703.pdf

Design for a level of service life. Design life is different than service life.

Most of the states present do alternate bids (except IA and WI).
FHWA guidance -- http://www.fhwa.dot.gov/pavement/t504039.cfm
MI uses actual prices; KY & MO do not take user costs into account; MO uses Life Cycle Cost Analysis (LCCA) on alternate bid projects. Started alternate bid about the same time as MEPD so it was easy to use together.

ME analysis – what thresholds have to pass? Design reliability for IRI.

IL – uses 95% reliability in their ME design process; does not allow changes in input.
IN – debate between practical and academic. IRI – roughness is subjective perception of pavement roughness (should consider safety as a threshold). Looked at historical data. Need to do thresholds by observation in the roughness database, actual pavement roughness, and safety consideration.
IA – 90% reliability for local calibration, may go higher for interstate.
KY – Rehabilitation for functional distress, not design distress
MI – Trying to get thresholds from Pavement Management System (PMS) data
MN – Thresholds - run at 50%-90%. 95% seems a little high based on our experiences. Don't have a way now to justify changing default inputs.
MO – use 50% reliability in the ME design but setting low distress levels (have received some criticism for). Would like to adjust for type of road.
WI – uses AASHTO 72 for initial input. Try to optimize pavement design. Thresholds have not been set for ME yet; need to come to consensus. Do a sensitivity study. More conservative on interstates.

FHWA – IRI is not a structural response. Pavement designers should look at a range of designs (hard to write that into a design manual).

Jag Mallela – IRI is related to structural design, recommendation to use "mean" values as inputs.
Have to manage risk / reliability (policy decision for each DOT).
IRI is an important driver for customer satisfaction.
Also recommendation to look at climate and setting thresholds.

Other design inputs?

Concrete Pavement

Joint spacing, dowel size:
IN – does allow widened slab, design the joint-spacing from 15 to 18 feet to reduce thickness (not skewed, not variable)
IA – can adjust joint spacing, not just change thickness
KS – will follow standard drawings for determining joint spacing and dowel size
KY – has established standards
MI – currently based on slab thickness but may explore allowing variations on a project-by-project basis in the future
MN – dowels are required for all new PCC construction; dowel diameter is standard and is dependent upon design PCC thickness; joint spacing is 12 feet or 15 feet
OH – has established standards
WI – has established joint spacing standards (two different joint spacings, depending on thickness); dowel bar size is based on thickness; mostly uses widened slabs
States are comfortable with setting standards and limiting input variation.
There is potential for misuse of the MEPDG with design-build & public-private partnerships.

Centralized vs. Decentralized Design

Centralized design: IA, KS, KY (some exceptions), MO, OH (most design central, but lower volume design is decentralized),), MI (pavements over $1 million)
Decentralized: IL, MI (if less than $1 million), MN, WI
IN depends on cost (consultants will have to be certified)

FHWA – will be requiring projects of a certain size to begin using value engineering (VE) process.

Presentation – AASHTOWare® Pavement ME Design™ User Experience

Jagannath Mallela, Vice President, Applied Research Associates, Inc.

AASHTOWare Pavement webpage: http://www.aashtoware.org/Pavement/Pages/default.aspx
Latest update to software in July 2013, try to time license and software updates together
Only two AASHTO people are supporting all products.
Help desk – technical issues (M-F, 8:00 – 5:00 CST)
Software help is designed to be different than the "Manual of Practice." In-software help is currently not available.
Primary designee should be the person most responsible for implementation of this pavement design software, not the business unit or IT person, so that the emails about updates, etc. go to the correct person.
Webinars – users can attend live sessions with presenters; recorded webinars can be viewed by anyone.
Mantis bug reporting system – webpage lists the frequent issues; will be a webinar on the use of Mantis.
Service Unit support from AASHTO – hands-on training (service units don't expire).

Suggestions for improvement:

- Explanations of fields
- Check-boxes
- Clearinghouse/repository for info about what different states have calibrated, etc.
- Publish ARA's validation/verification info with new releases
- 2004 set of documents should be posted to the AASHTO website

AASHTO Customer satisfaction survey results:
Information is posted on website: http://www.aashtoware.org/Pavement/Pages/Customer-Survey.aspx

Demographics – most respondents were state DOTs
About 15 states have done local calibration
Only about 34% of people have used Mantis
Interest in AASHTO user group for ME design software? 82% said yes; need to figure out funding (maybe through a pooled fund or an AASHTO technical services group)
FHWA will have regional group meetings in the interim (for states)
Software installation – Most highly or moderately satisfied
Software is an improvement over previous pavement design method -- over half thought it was a significant improvement; 25% do not know yet
Communications – feedback could be better (TRB sessions, National users group, etc.)

AASHTO plans to do the survey every two years
AASHTO monitors the customer support

Current & Planned Activities:
Educational license released in July 2013, demo version (limited to 25 students per university)
HTML help
Running ME in virtual environments (not supported on iPad, but can be used use on it)

NCHRP 1-41 Reflective cracking model incorporation
GIS data linkages with ME design

Topical discussion #5 – Moving from Development to Deployment

Table 5 (Overview of Development to Deployment)

What's working well	Steps to emulate	Concerns	Questions / needs	Other
Industry involvement	Set levels of design to reflect input (good, better, best?) and establish policy	Need to introduce ME concept, not just software	Guide examples – CO, UT, AZ … should develop national clearinghouse	
Good buy-in from executive staff	Training needed – method depends on centralization level and consultant use	Need user guide / manual and supporting files, especially for decentralized design	Identify specific adjustments that will be needed with each software update	
NCAT ME software training (asphalt)	Set policies regarding limitations on inputs and levels		Will there be support or other problems if a state DOT doesn't automatically accept every software upgrade	
	Use a pavement design orientation for other related staff (e.g. roadway design)		Are states using for just new/reconstruct or also for rehab?	
	Establish plan for periodic future reviews, evaluations, calibrations		May need NCAT-type training for concrete	

Development to Deployment Notes:
Development to Deployment introduction – Laura Fenley, Wisconsin DOT
WI has a lot of consultants doing designs. Is there a good method for training them? Some regions are doing all the designs because it takes less time than reviewing consultants' designs.

Training:
IN – Consultants need to take eight National Highway Institute (NHI) courses (including more than the ME software). Once consultants are certified, they have to be renewed every year.

Jag Mallela provided info on states outside those attending the peer exchange.
CO – DOT staff did train-the-trainer sessions for consultants. (CO has a 600-page design manual that they give to consultants, published online, revised to include ME in the manual.)
UT – Finished implementation in 2008. Had training sessions every two months (for the first two years).

Communication:
IN – public information office communicates
MI – newsletters, listserv emails, subcommittees
Communication to pavement industry: Most states present included industry in the process to go to ME design.
Communication to upper management: Implementation plans, roadmap of activities, list of tasks, dates, continue to provide updates to management; need to communicate the size of this investment.

Miscellaneous:
Implementation best practice: Have an implementation plan.
Need to have a policy and document it.
Decentralized design model needs much more ME training and a good user guide.
Should recalibrate on a regular schedule (e.g. every 5 years).
New climate data may cause a need to recalibrate.
FWD should be used when doing rehabilitation designs with MEPDG.

Current FWD Use
IL – 1 FWD, primarily used for research
IN – has 4
IA – 2 FWDs, used for testing network
KS – has 2
KY – has 1, primarily used for research; use limited
MI – research, location specific, forensics
MO – has 1, used for forensics, or projects with extenuating circumstances (not used for inventory)
OH – 2 FWDs used for statewide minor rehabilitation designs of "4-lane" projects using ODOT's own mechanistic overlay design procedure as well as for research
WI – just got a new one

Climatology Data
IN – Got from university climatology department.
IA – Got from agriculture department at Iowa State University.
MI – Project to assess and improve climate data starting October 1.

Day 2 Wrap-up

Key take-aways:
Traffic data important (number of trucks and classification)
Coordination needed between groups (pavement design and traffic)
Planning section QC/QA on WIM data
Not a lot of "how to" on collecting traffic data – 2 reports: NCHRP – TWRG, LTTP-PLUG
Load spectra – Michigan terminology replacing levels with good/better/best.
Identify which type of distress is important for each state
Comparing flex & rigid alternate designs
ME design provides a good methodology for evaluating alternate pavement bids
WI & IA not doing alternate bids (MI on a limited basis)
NCHRP 01-37 best report on MEPD, also training and implementation manual (on TRB website)
Implementation plan – one big initiative goes faster
Getting upper management on board does not seem to be a problem

Mechanistic-Empirical Pavement Design Peer Exchange

References and Links

AASHTO:

- AASHTOWare Pavement
  http://www.aashtoware.org/Pavement/Pages/default.aspx

- Mechanistic-Empirical Pavement Design Guide, Interim Edition: A Manual of Practice, AASHTO, 2008
  https://bookstore.transportation.org/collection_detail.aspx?ID=37

- Guide for the Local Calibration of the Mechanistic-Empirical Pavement Design Guide, AASHTO, 2010
  https://bookstore.transportation.org/item_details.aspx?ID=1744

- AASHTO T-336 standards for coefficient of thermal expansion
  https://bookstore.transportation.org/item_details.aspx?ID=1885

FHWA:

- LTPP–PLUG: Plug Your Traffic Loading Data Gaps, May 2013
  (Publication Number: FHWA-HRT-13-013)
  http://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/13089/13089.pdf

- TechBrief: Coefficient of Thermal Expansion in Concrete Pavement Design, October 2011
  (Publication Number: FHWA-HIF-09-015)
  http://www.fhwa.dot.gov/pavement/concrete/pubs/hif09015/hif09015.pdf

NCHRP:

- NCHRP Project 01-37A -- Development of the 2002 Guide for the Design of New and Rehabilitated Pavement Structures
  http://apps.trb.org/cmsfeed/trbnetprojectdisplay.asp?projectid=218

- NCHRP Project 01-40 -- Facilitating the Implementation of the Guide for the Design of New and Rehabilitated Pavement Structures
  http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=221

- NCHRP Report 538 -- Traffic Data Collection, Analysis, and Forecasting for Mechanistic Pavement Design, 2005 (NCHRP Project 1-39)
  http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_538.pdf

- NCHRP Report 669 -- Models for Predicting Reflection Cracking of Hot-Mix Asphalt Overlays, 2010 (NCHRP Project 01-41)
  http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_669.pdf

- NCHRP Report 703 -- Guide for Pavement-Type Selection, 2011.
  http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_703.pdf

- NCHRP Report 719 -- Calibration of Rutting Models for Structural and Mix Design, 2012
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_719.pdf

- NCHRP Synthesis 20-05/Topic 44-06 (Active). Implementation of AASHTO Mechanistic-Empirical Pavement Design Guide (MEPDG) and Software.
http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3358

Transportation Pooled Fund Program:

- TPF-5(177), Improving Resilient Modulus Test Procedures for Unbound Materials
http://www.pooledfund.org/Details/Study/404

State links:

- NHI training courses required by INDOT
(131026, 131033, 131060, 131062, 131063, 131103, 131109, 132040)
http://www.nhi.fhwa.dot.gov/default.aspx

- Michigan ME website (M.E.'s ME Report newsletter can be accessed here)
http://www.michigan.gov/mdot/0,4616,7-151-9623_26663_27303_27336_63969---,00.html

- Implementing the Mechanistic-Empirical Pavement Design Guide in Michigan, MDOT Research Spotlight on Report RC-1516
http://www.michigan.gov/documents/mdot/MDOT_Research_Spotlight_Implementing_MEPDG_298420_7.pdf

- Characterization of Truck Traffic in Michigan for the New Mechanistic Empirical Pavement Design Guide (Report RC-1537)
http://www.michigan.gov/documents/mdot/MDOT_Research_Report_RC-1537_316196_7.pdf

- Preparation for Implementation of the Mechanistic-Empirical Pavement Design Guide in Michigan (Report RC-1593)
http://www.michigan.gov/documents/mdot/MDOT_RC-1593_417976_7.pdf

- Implementing the AASHTO Mechanistic Empirical Pavement Design Guide in Missouri
Volume I: Study findings, conclusions, and recommendations
http://wisdotresearch.wi.gov/wp-content/uploads/MoDOT_MEPDG_Vol_I_FINAL.pdf
Volume II: MEPDG model validation and calibration
http://wisdotresearch.wi.gov/wp-content/uploads/MoDOT_MEPDG_Vol_II_FINAL.pdf

Peer Exchange Abbreviations and Acronyms

AASHTO – American Association of State Highway and Transportation Officials

AADT – Average Annual Daily Traffic

AADTTT – Average Annual Daily Truck Traffic

ARA – Applied Research Associates, Inc.

AVC – Automatic Vehicle Classification

CBR – California Bearing Ratio

CTE – Coefficient of Thermal Expansion

DOT – Department of Transportation

ESAL – Equivalent Single Axle Load

FHWA – Federal Highway Administration

FWD -- Falling Weight Deflectometer

GIS – Geographic Information System

HMA – Hot Mix Asphalt

IRI – International Roughness Index

IT – Information Technology

JPCP – Jointed Plain Concrete Pavement

LCCA – Life Cycle Cost Analysis

LTPP – Long-Term Pavement Performance

MEPD – Mechanistic-Empirical Pavement Design

MEPDG – Mechanistic-Empirical Pavement Design Guide

NCAT – National Center for Asphalt Technology

NHI – National Highway Institute

NCHRP – National Cooperative Highway Research Program

OSOW – Oversize, Overweight

PPP – Public-Private Partnership

QC/QA – Quality Control / Quality Assurance

RAP – Reclaimed/Recycled Asphalt Pavement

RAS – Reclaimed/Recycled Asphalt Shingles

SMA – Stone Matrix Asphalt

TWRG – Truck Weight Roadway Groups

VE – Value Engineering

WIM – Weigh In Motion