AASHTO PAVEMENT ME NATIONAL USERS GROUP MEETINGS

TECHNICAL REPORT:
FOURTH ANNUAL MEETING—NEW ORLEANS, LA
NOVEMBER 6-7, 2019

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1. INTRODUCTION

Background

In 2008, the American Association of State Highway and Transportation Officials (AASHTO) published an interim edition of the *Mechanistic-Empirical Pavement Design Guide (MEPDG): A Manual of Practice (MOP)*. That groundbreaking document presented the first mechanistic-empirical (ME) pavement design procedure based on nationally calibrated pavement performance prediction models (AASHTO 2008). A second edition of the *MOP* containing updated information, additional guidance, and improved nationally calibrated models was published in 2015 (AASHTO 2015).

An accompanying software program, AASHTOWare Pavement ME Design (PMED), was developed and released in 2011. Multiple updates have been made to the software since its initial release, with the latest version (v2.5.5) made available in June 2019. As part of a previous release (v2.4)[1] in July 2017, the standalone software program Deflection Data Analysis and Backcalculation Tool (BcT, v1.0) was made available to generate backcalculation inputs (using the EVERCALC algorithm) from falling weight deflectometer (FWD) files for use in rehabilitation design. And in October 2019, the web-based Calibration Assistance Tool (CAT, v1.0) was made available to help agencies conduct local calibrations of the PMED performance models. Collectively, the MEPDG and the AASHTOWare software and support tools provide an improved process for conducting pavement analyses and for developing designs based on ME principles.

Implementation of the MEPDG has been proceeding throughout North America since its release. The number of adopting agencies has continued to grow, and many other agencies have made good progress on key parts of the process, including developing appropriate design inputs, establishing material and traffic databases, and training staff or consultants in the proper use of the procedure. Additionally, while the AASHTO *Guide for the Local Calibration of the MEPDG* was published in 2010 (AASHTO 2010), most agencies are actively engaged in calibrating the ME performance models to local conditions, policies, and materials.

Highway Agency Peer Exchange Meetings

In September 2013, the Wisconsin Department of Transportation (WisDOT) initiated an outreach program to conduct an MEPDG implementation peer exchange meeting with SHAs in AASHTO Region 3 (covering Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin). The intent of that peer exchange was to share experiences with five key aspects of MEPDG implementation: calibration, materials testing, traffic data, design acceptance, and deployment (WisDOT 2013). The Wisconsin peer exchange meeting proved successful in providing SHAs with a platform for exchanging and sharing ideas, experiences, tips, and concerns in relation to implementing the MEPDG.

[1] PMED v2.4 is the formal designation given to the software corresponding to the release of BcT 1.0. The actual downloadable version from the AASHTOWare website is listed as v2.3.1.

In 2014, the FHWA, in conjunction with AASHTO and others, sponsored four additional peer exchange meetings to foster the sharing of SHA experiences and to facilitate ME implementation effort. These meetings were held at the following locations and dates:

- Southeast AASHTO Region 2, Atlanta, Georgia, November 5-6, 2014.
- Southwest AASHTO Region 4, Phoenix, Arizona, January 20-22, 2015.
- Northwest AASHTO Region 4, Portland, Oregon, April 14-15, 2015.
- Northeast AASHTO Region 1, Albany, New York, May 13-14, 2015.

The results of the four peer exchange meetings were summarized in an FHWA technical report titled *AASHTO MEPDG Regional Peer Exchange Meetings* (Pierce and Smith 2015). This report can be accessed at https://www.fhwa.dot.gov/pavement/dgit/hif15021.pdf.

National Users Group Meetings

To continue the sharing of experiences and the dissemination of information related to ME design, and to facilitate the more rapid adoption of the MEPDG and the AASHTOWare PMED software, Transportation Pooled Fund Study TPF-5(305) (*Regional and National Implementation and Coordination of ME Design*) is now sponsoring ME implementation meetings to be held annually at the national level. Four meetings have been conducted to date, as listed below, and future meetings are being planned.

- Meeting #1: Indianapolis, Indiana (December 14-15, 2016).
- Meeting #2: Denver, Colorado (October 11-12, 2017).
- Meeting #3: Nashville, Tennessee (November 7-8, 2018)
- Meeting #4: New Orleans, Louisiana (November 6-7, 2019).

This report documents the results of the fourth annual meeting held in New Orleans. It includes all pertinent materials and information shared in the meeting and covers the various technical topics presented and discussed by the participants. It also presents key takeaways from the meeting and the proposed next steps for aiding and facilitating the implementation of ME pavement design within highway agencies.

Meeting Goals

The overall goal of the AASHTO Pavement ME National Users Group meetings is to provide SHAs, PHAs, and other stakeholders with a forum for the exchange of information and ideas. Specific objectives include updating participants on enhancements to the ME design procedure and software, providing participants with an opportunity to discuss issues related to the procedure and software, providing demonstration-based training on the latest version of the software, and identifying future training, software, and research needs.

Participants

A total of 85 attendees participated in the fourth annual Pavement ME Users Group meeting, including representatives from 29 SHAs, two Canadian PHAs, six consulting firms, five universities, four industry groups, FHWA, and AASHTO. The meeting was facilitated by Mr. Kelly Smith (Applied Pavement Technology, Inc. [APTech]), with assistance from Mr. Chris

Wagner and Mr. Tom Yu (FHWA). A complete list of the meeting participants and their contact information is provided in Appendix A.

Agenda

The meeting agenda is provided in Appendix B.

Speakers and Presenters

In addition to introductory and opening remarks by Mr. Chris Wagner (FHWA ME Pooled Fund Manager), and informational messages from Mr. John Donahue (Missouri DOT, Chair of AASHTOWare PMED Task Force and Member of AASHTO Committee on Materials and Pavements [COMP]) and Ms. Tara Liske (Manitoba Infrastructure [MI], Canadian Liaison to the PMED Task Force), the meeting featured presentations from 20 participants. The presentation materials are provided in chronological order in Appendix C.

2. PRE-MEETING SURVEY

Two weeks before the ME Users Group meeting, SHA/PHA participants were asked to complete a short on-line survey pertaining to their agency's ME design practices. The intent of the survey was to stimulate thoughts in preparation for the meeting and to generate information to help guide the meeting discussions. Responses were received from a total of 29 agencies (27 SHAs, 2 PHAs), with a summary of the results presented in tables 1 through 15 and in figures 1 through 4. (Note: The implementation maps in figures 3 and 4 include the pre-meeting survey results, **supplemented by** results from the 2016, 2017, and 2018 pre-meeting surveys and two previous polls [shown in hatching]—the 2015 ME Peer Exchange survey [Pierce and Smith 2015] and a Transportation Association of Canada [TAC] ME User Group scan). Although the number of respondents in the pre-meeting survey represent about half of the SHAs, it is clear that several agencies have already implemented PMED or are getting close to doing so.

Table 1. Pavement ME implementation status.

Question	Total Responses	Yes	No
1a. Has your agency implemented Pavement ME Design for the design of asphalt pavements and overlays?	29	13	16
1b. If No, does your agency intend to implement it and if so, by what year?	16	3 (2020) 3 (2022) 1 (2024) 8 (TBD)	1
2a. Has your agency implemented Pavement ME Design for the design of concrete pavements and overlays?	29	14	15
2b. If No, does your agency intend to implement it and if so, by what year?	15	2 (2020) 3 (2022) 1 (2024) 7 (TBD)	2

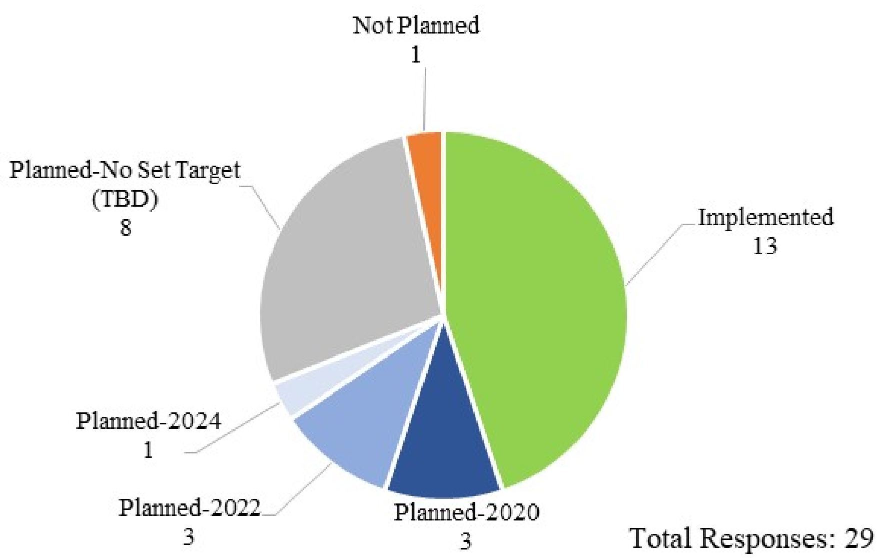

Figure 1. Pavement ME implementation status for asphalt pavements and overlays.

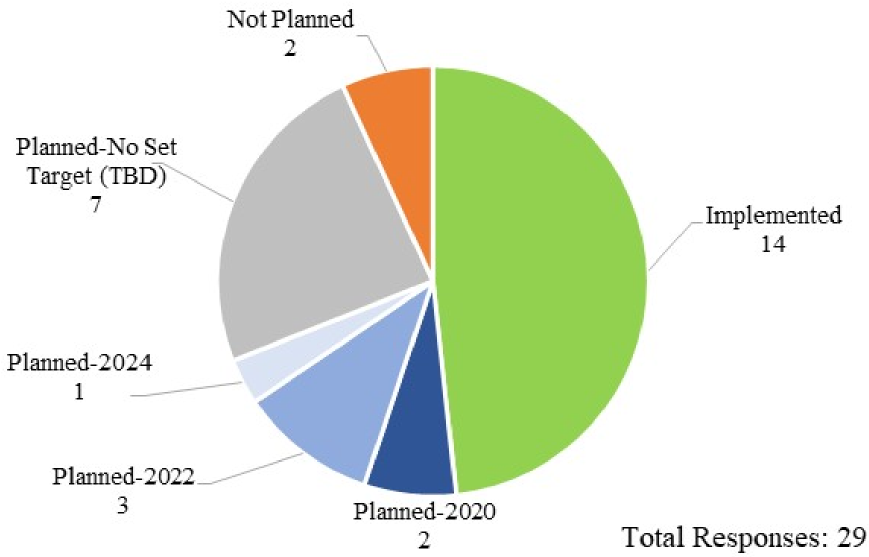

Figure 2. Pavement ME implementation status for concrete pavements and overlays.

Table 2a. Implementation status by asphalt pavement type.

3. For which types of asphalt pavements has your agency implemented or plan to implement Pavement ME Design?	Total Responses	Implemented	Planning to Implement
New Conventional (Thin or Nominal hot-mix asphalt [HMA] on unbound base)	23	9	14
New Deep-Strength (Thick HMA on unbound aggregate base)	24	11	13
New Full-Depth (HMA on stabilized or unstabilized subgrade)	23	9	14
New Semi-Rigid (HMA on stabilized base/subbase)	20	7	13
HMA Overlay on Existing Asphalt Pavement	24	7	17
HMA Overlay on Existing Intact or Fractured Concrete Pavement	21	6	15

Table 2b. Implementation status by concrete pavement type.

4. For which types of concrete pavements has your agency implemented or plan to implement Pavement ME Design?	Total Responses	Implemented	Planning to Implement
New Jointed Plain Concrete (JPC)	26	11	15
New Continuously Reinforced Concrete (CRC)	10	4	6
JPCP Overlay on Existing Pavement	21	8	13
CRCP Overlay on Existing Pavement	8	2	6

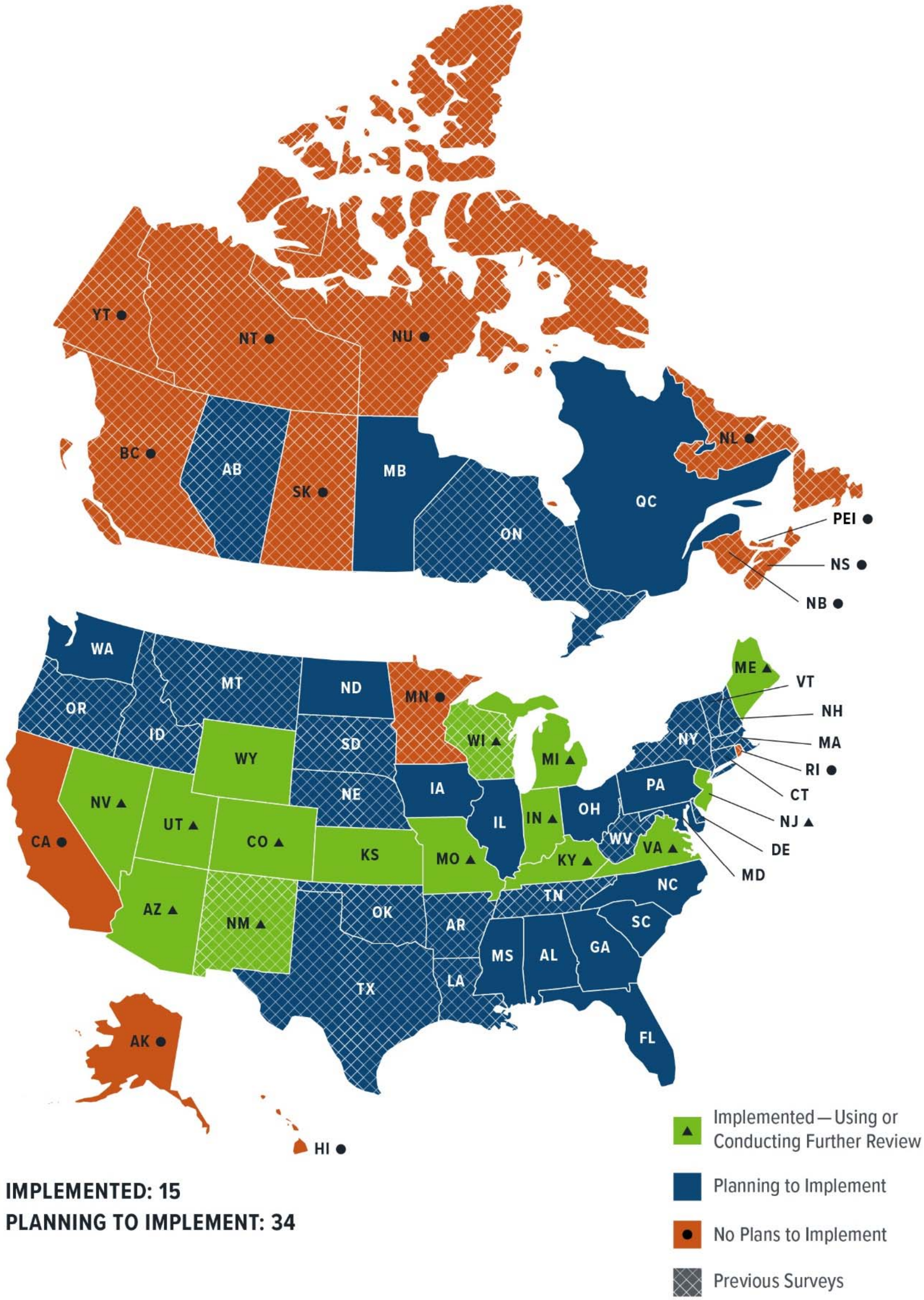

Figure 3. Implementation status by SHA/PHA—asphalt pavements and/or overlays.

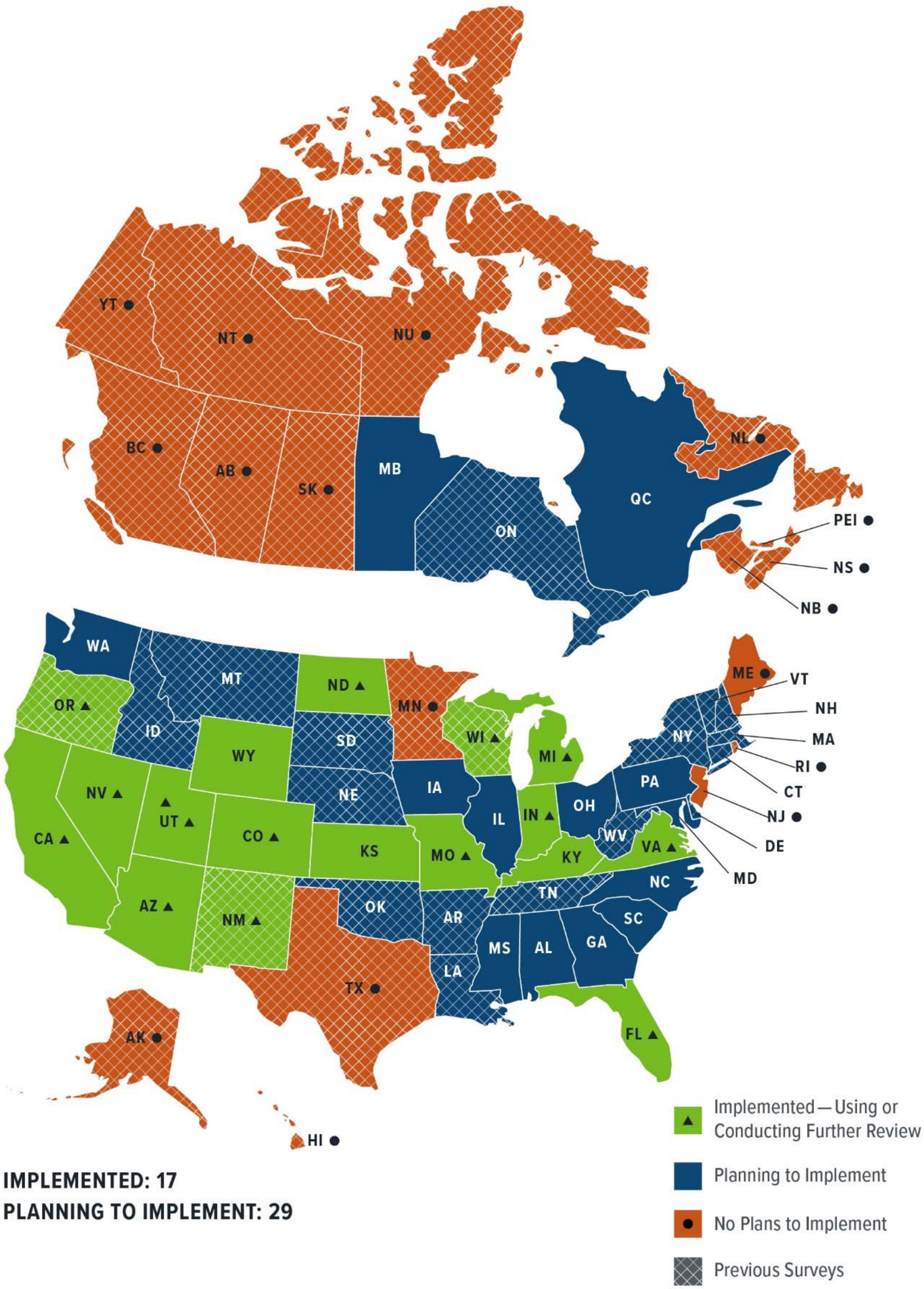

Figure 4. Implementation status by SHA/PHA—concrete pavements and/or overlays.

Table 3. Implementation challenges.

5. What has been the most difficult or challenging technical aspect of implementation (select top two)?	Total Responses
Compatibility of performance measures and threshold criteria	2
Designing pavement structures with features that are not included in Pavement ME or that have not been calibrated (e.g., thin portland cement concrete [PCC] overlays, permeable asphalt- or cement-treated bases, geogrids and other reinforcing materials)	7
Availability of data to adequately characterize inputs	9
Characterization of traffic	0
Characterization of climate	0
Characterization of subgrade, subbase, and/or base material properties	1
Characterization of HMA material properties	0
Characterization of PCC material properties	0
Backcalculation analysis for characterizing existing pavement and subgrade properties	1
Sensitivity testing of key design inputs	0
Availability of performance data to adequately perform local calibration and verification	7
Local calibration and verification of performance model coefficients	18
Other: ➢ Have yet to start implementation process. ➢ Adequate staffing required to handle local calibration, verification, and implementation efforts. ➢ Efficient organizational structure so collected data could be compiled, modified, and analyzed in a more efficient manner for use within Pavement ME. ➢ Inconsistent distress prediction. ➢ Local calibration.	4

Table 4. Hierarchical input levels.

6. What hierarchical input level does your agency use for the following key input parameters (Level 1=site/project specific, Level 2=estimated from correlations or regional-specific, Level 3=global/default)	Total Responses	Level 1	Level 2	Level 3
Truck Volume Distribution	25	11	13	1
Lane and Directional Distributions	25	7	14	4
Axle Load Distributions (single, tandem, tridem)	25	4	15	6
Subgrade Resilient Modulus	25	8	15	2
Unbound Base/Subbase Modulus	25	2	18	5
Chemically Stabilized Layer Modulus	24	2	13	9
HMA Dynamic Modulus	25	4	14	7
HMA Creep Compliance and Indirect Tensile Strength	25	4	9	12
HMA Volumetric Properties	25	4	16	5
PCC Elastic Modulus	24	1	15	8
PCC Flexural Strength	23	1	15	7
PCC Coefficient of Thermal Expansion	24	2	15	7
Existing Pavement Moduli	23	8	10	5

Table 5a. Condition threshold levels, Pavement ME Design vs. agency values.

7a. Does your agency use the Pavement ME Design default threshold levels (table 7.1 of 2015 MEPDG Manual of Practice) for distress and smoothness or agency-selected values?	**Total Responses**	**Default Thresholds**	**Agency Thresholds/Values**
Pavement ME Design default values or agency-selected values	26	4	22

Table 5b. Condition threshold levels, agency values.

7b. If agency-selected values, what are the values used for high-type Interstate/Freeway facilities?	**Total Responses**	**Agency Thresholds/Values**	
HMA smoothness (IRI), in/mi	19	≤100 (2) 101-125 (0) 126-150 (4) 151-175 (9)	176-200 (0) Default (0) TBD or Varies (1) Not applicable (3)
HMA alligator (bottom-up) cracking, % lane area	20	0-5 (1) 6-10 (9) 11-15 (2) 16-20 (1) 20-25 (4)	25-30 (0) 30-35 (1) Default (0) TBD or Varies (1) Not applicable (1)
HMA total rut depth, in	20	0.00-0.125 (0) 0.126-0.25 (2) 0.26-0.375 (3) 0.376-0.50 (8) 0.51-0.625 (1)	0.626-0.75 (2) >0.75 (1) Default (0) TBD or Varies (1) Not applicable (2)
HMA transverse thermal cracking, ft/mi	19	≤500 (2) 501-1000 (8) 1001-1500 (4) > 1500 (1)	Default (0) TBD or Varies (1) Not applicable (3)
JPC / CRC smoothness (IRI), in/mi	18	≤100 (1) 101-125 (0) 126-150 (3) 151-175 (9)	176-200 (2) Default (1) TBD or Varies (1) Not applicable (1)
JPC mean joint faulting, in	19	0.00-0.125 (13) 0.126-0.25 (4)	Default (1) TBD or Varies (1)
JPC transverse slab cracking, %	20	1-5 (1) 6-10 (14) 11-15 (3)	16-20 (0) TBD or Varies (1) Not applicable (1)

Table 6a. Local calibration.

8a. Has your agency conducted a local calibration?	**Total Responses**	**No**	**Yes**
Local Calibration	28	11	17

Table 6b. Local calibration history.

8b. How many calibrations has your agency performed?	HMA Models	PCC Models
1	9	8
2	5	3
3	3	1
≥4	0	0

Table 6c. Local calibration software.

8c. For which software versions has your agency performed a local calibration?	HMA Models	PCC Models
Pre-DARWin-ME	0	0
DARWin-ME	0	0
v0.6-rigid	0	1
v0.9	1	1
v1.0	1	1
v1.1	1	0
v1.2	0	0
v1.3	1	1
v2.0	1	1
v2.1	3	1
v2.2	2	1
v2.3	2	2
v2.3.1	3	2
v2.5	3	0
v2.5.2	0	0
v2.5.3	1	1
v2.5.5	2	1
Unknown	0	0

Table 6d. Use of locally or nationally calibrated models.

8d. Which performance prediction models were analyzed and which type of calibration values (National/Default or Local) are currently being used?	Included in Local Calibration Analysis	National	Local	Not Applicable
HMA smoothness (IRI)	13	5	7	1
HMA longitudinal (top-down) cracking	5	5	4	4
HMA alligator (bottom-up) cracking	12	5	6	1
HMA transverse thermal cracking	8	6	4	2
HMA reflective cracking	9	4	3	5
HMA rutting (asphalt layer only)	13	3	7	3
HMA rutting (total)	12	3	8	2
JPC smoothness (IRI)	10	5	5	2
JPC transverse slab cracking	8	4	6	3
JPC mean joint faulting	8	3	7	3
CRC smoothness (IRI)	4	3	1	9
CRC punchouts	3	2	2	9

Table 7. Incorporation of Modern-Era Retrospective Analysis for Research and Applications (MERRA).

Question	Total Responses	GBWS	NARR	MERRA-1 (MERRA-2)
9a. What climate dataset is your agency currently using for HMA design?	21	4	4	2 (11)
9b. What climate dataset is your agency currently using for PCC design?	20	4	16	0

Table 8a. Traffic database, development.

10a. Has your agency developed a comprehensive traffic database for use in Pavement ME Design?	Total Responses	Yes	No
Comprehensive Traffic Database	27	13	14

Table 8b. Traffic database, traffic input hierarchical levels.

10b. If Yes, does the database include Level 1 project-specific vehicle class distribution inputs and/or Level 2 vehicle class distribution factors (for truck traffic clusters defined by location and highway functional class)?	Total Responses
Level 1 project-specific vehicle class distribution	5
Level 2 vehicle class distribution factors for truck traffic clusters	10

Table 9a. Use of falling weight deflectometer (FWD) backcalculation.

11a. Does your agency use backcalculation of FWD data to characterize the existing pavement and subgrade for rehabilitation design?	Total Responses	Yes	No
FWD Backcalculation Used	27	17	10

Table 9b. Use of FWD backcalculation, flexible pavement programs/methods.

11b. If Yes, what *flexible pavement* backcalculation programs/methods are used to establish the necessary Pavement ME Design inputs?	**Total Responses**
BOUSDEF	0
ELMOD	6
ELSDEF	0
EVERCALC	3
MODULUS	4
WESDEF	0
MODCOMP	1

Table 9c. Use of FWD backcalculation, rigid pavement programs/methods.

11c. If Yes, what *rigid pavement* backcalculation programs/methods are used to establish the necessary Pavement ME Design inputs?	**Total Responses**
AREA method	3
Best-Fit method	4

Table 9d. Use of FWD backcalculation, composite pavement programs/methods.

11d. If Yes, what *composite pavement* backcalculation programs/methods are used to establish the necessary Pavement ME Design inputs?	**Total Responses**
Outer AREA method	2
Best-Fit method	4

Table 9e. Use of Pavement ME Backcalculation Tool (EVERCALC).

11e. If Yes, is the Pavement ME Backcalculation Tool (using EVERCALC) being used?	**Yes**	**No**
EVERCALC Used	6	0

Table 10. Materials database/library status.

12. Has your agency developed a materials database or library for quick and reliable establishment of Pavement ME Design inputs?	Total Responses	Yes	No
Subgrade (including chemically stabilized)	26	10	16
Untreated Base/Subbase	27	17	10
Treated Base/Subbase	25	8	17
HMA	27	18	9
PCC	26	10	16

Table 11. Evaluation of unbound materials and subgrade.

13. Has your agency evaluated or sensitivity-tested the impacts of subgrade, subbase, and base layer resilient moduli on the resulting layer thicknesses?	Total Responses	Yes	No
Subgrade (including chemically stabilized)	26	16	10
Untreated Base/Subbase	27	18	9
Treated Base/Subbase	25	8	17

Table 12. Asphalt material characterization.

14. Which of the following types of asphalt mixes has your agency developed Level 1 or Level 2 inputs for use in Pavement ME Design?	Total Responses
Warm-Mix Asphalt (WMA)	8
HMA with Rubber-Modified Binder	2
HMA with Reclaimed Asphalt Pavement (RAP)	9
HMA with Recycled Asphalt Shingles (RAS)	0

Table 13. Concrete pavement design features.

15. Which of the following JPC design inputs has your agency evaluated or sensitivity-tested to determine the impacts on PCC thickness?	Total Responses
Transverse Joint Spacing	14
Fixed versus Random Transverse Joint Spacing	3
Dowel Bar Size	15
Dowel Bar Spacing / Placement Configuration	3
Dowel Bar Shape	2
Tied versus Untied Shoulders	12
Slab Width	12

Table 14a. Participant suggestions, software improvements.

16. Do you have any suggestions for software improvements?
Allow MERRA data to be used in new versions.
CIR/FDR/Thin concrete/Geosynthetic Modeling Rehab modeling (composite - asphalt over concrete).
Please slow down on revisions and give agencies a chance to catch up with the current version of the software.
Making the software web-based would help alleviate IT issues that agencies need to deal with internally since the files are local.
Independent evaluation of each models including all variables. All variables should have practical significance and follow a logical trend.
More calibration options such as being able to save and import calibration sets and being able to select from past calibration sets.
We have a problem when running ME that it crashes Excel when running designs. If this hasn't already been corrected, this should be.
Module for PCC longitudinal cracking.
Include results from frost heave research when available. More thoroughly vet the new version of the software before releasing.
A module to calculate the effects of stone matrix asphalt (SMA).
Easy to calibrate.

Table 14b. Participant suggestions, research needs.

17. Do you have any research needs requests?
Thin HMA Overlay < 1 inch.
Non-standard roadway templates (e.g., drainage layers). Non-standard mixtures (e.g., SMA, High RAP mixes).
Widened slab seems to overly reduce terminal results. We think that more research should be conducted on the effect of widened slabs and how to better model this in ME.
LCCA module.
We are awaiting the results of NCHRP 01-59. PennDOT is conducting its own research on the sensitivity of faulting to the CTE and the slab width.
Characterization of existing pavement, guidance on when to use Level 1 vs. Level 2 input and sensitivity of each inputs on the predicted distresses.
How to model existing composite pavement (i.e. HMA on top of PCC) when applied multiple overlay.
Previous NCHRP studies such as 9-51 (Recycling Materials Properties for Pavement Design) provided CIR, CCPR, and Material Input for Pavement ME software. However, the study didn’t address or provide guidance on how to handle volumetric properties of such materials in Pavement ME software.
The current fatigue cracking model in PMED software is very sensitive for AC binder content and air voids. Recycled materials typically have 10-15% and low binder content. This created high fatigue cracking prediction by the software. There should be a study to develop a new model for recycled materials to resolve some of the shortcomings of the current flexible cracking model included in the software.
Characterization of SMA and polymer-modified asphalt mixes in PMED. The current testing protocol to determine rutting coefficients and the dynamic properties of such material would not enable designers to quantify the benefit of such premier mixes. Dynamic modulus test results for SMA and polymer modified binders are lower than regular mixes. This would imply that the rutting resistance of SMA is not better than dense graded mixes.
Longitudinal cracking on JPCP. Top-down cracking on HMA.

Table 14c. Participant suggestions, training needs.

18. Do you have any specific training needs?
Training for beginning users.
Training on the current/newest version of the software.
We need more training on overlay designs. We have had trouble establishing inputs and design practice/standards for these. Our limited testing of these modules has shown unreasonable results.
FWD back-calculation and how to implement in ME Design. Calibration Assistance Tool.
HMA implementation.
Understanding the fundamental working mechanism of PMED software. Various damage models and their empirical correlations.
Online training materials and videos.
We need training on performing local calibrations according to the new manual that was recently published.

3. INTRODUCTORY SESSION

Mr. Chris Wagner (FHWA) opened the fourth annual ME Users Group meeting by welcoming both new and returning participants, recognizing their valued efforts in implementing ME design principles, and discussing the fundamental importance of the meeting. He informed the group that the New Orleans meeting is the final meeting covered by the current contract but noted that plans are being made for a new contract that continues the meetings. In closing, he encouraged participants to continue to be proactive in their implementation efforts and to make the most of the Users Group meeting through learning, sharing, and communicating with peers.

Mr. John Donahue (Missouri DOT) provided a high-level overview of the latest efforts of the AASHTOWare PMED Task Force. He touched upon the recent rollout of CAT v1.0 and the successful delivery of two training webinars on the tool in October 2019. He also described the current roadmap for software development, including the ongoing incorporation of the HMA top-down cracking (TDC) model, the release of the next version of PMED (v2.6, which will include the TDC model) in February 2020, and the longer term development of the PMED Web Technology Application (WTA). Lastly, Mr. Donahue reported on some key changes to the Task Force, including his rotation off the panel in June 2020, his replacement as Chair at that time by Mr. Clark Morrison (North Carolina DOT), and the recent departure of Ms. Karen Strauss (Oregon DOT). These changes create two open positions on the Task Force.

Ms. Tara Liske (Manitoba Infrastructure) updated the participants on the implementation activities of the Transportation Association of Canada (TAC) Pavement ME User Group. Ms. Liske recently assumed the role of TAC Liaison from Mr. Felix Doucet (Quebec Ministry of Transportation). She prefaced her talk by noting that the TAC Pavement ME User Group was established in 2008 and that the 25 members interact with each other through a series of regular meetings (two in-person meetings and two conference calls per year). She also mentioned that the group will be involved in a host panel discussion at the upcoming TAC conference to be held in September 2020 in Vancouver, British Columbia. Key activities that the group has been involved in recently include:

- JPC pavement design trials that are evaluating thickness requirements with and without dowel bars and with varying dowel bar sizes.
- Continual update of the 2014 Canadian User Guide (Canadian Guide: Default Parameters for AASHTOWare Pavement ME Design [TAC 2014]).

Future work activities include training and modeling for HMA TDC. A copy of Ms. Liske's presentation is featured as presentation 1 in Appendix C.

4. AGENCY IMPLEMENTATION STATUS

Session 2 of the meeting focused on agency reporting of MEPDG implementation status. Mr. Kelly Smith began the session by presenting the HMA and PCC implementation maps developed from the 2016, 2017, and 2018 Users Group meetings (see presentation 2 in Appendix C). These maps showed a slight increase in the number of agencies that have implemented PMED since the first meeting. And while the number of agencies planning to implement PMED for new asphalt pavements and asphalt overlays also increased slightly, the number planning to implement PMED for new concrete pavement and concrete overlays decreased slightly. Mr. Smith pointed out that the maps would be updated based on the results of the 2019 meeting (including the pre-meeting survey); those updated maps were presented previously in Chapter 2 as figures 3 and 4.

Following Mr. Smith's presentation, meeting participants were asked to provide a brief update on their agency's implementation status (e.g., Has implementation occurred? If not, when will it occur?). Participants were asked to touch upon specific implementation challenges and solutions, and whether local calibrations have been performed and if calibrated models are currently being used. The agency briefings progressed around the room. Each briefing was made by one individual representing a given agency.

Table 16 summarizes the information reported by each SHA/PHA. A summary of key aspects of MEPDG implementation and use by each agency is provided in table 17.

Table 16. MEPDG implementation status of participating SHAs/PHAs.

Agency	Status/Update
Alabama DOT	• Have been looking at Pavement ME since 2005, but have not implemented it and don't expect implementation to occur very soon. Currently using AASHTO 93. • Investigated the differences between AASHTO 93 and PMED in 2006. • Completed traffic study. • Completed material characterization of subgrade soils. • Participating in NCAT Asphalt Mixture Performance Tester pooled fund study. • Semi-implemented training course for consultants. • Conducting sensitivity analysis of subgrade soils and models. • Developing materials libraries and databases. • Adding additional calibration sites and extending data collection effort. • Have two ME projects currently on the docket: local verification and characterization of asphalt mixes.
Alberta MOT	• No update; not present at meeting. For latest info, see 3rd Annual Meeting technical report.
Arizona DOT	• User guide has been prepared and is available upon request. • Traffic study completed. Identified three traffic clusters and eight truck traffic distributions. Installed 10 additional WIM sites. • Materials characterization completed around 2000. • Conducting and comparing parallel designs using AASHTO 1993, Arizona DOT Structural Overlay Design for Arizona (SODA) procedure, and PMED v2.1. • Implemented PMED for asphalt pavement rehabilitation. • Evaluating v2.5. • Conducting global calibration.
Arkansas DOT	• No update; not present at meeting. For latest info, see 1st Annual Meeting technical report.
California DOT	• PMED used only for concrete designs. A catalog is used, based on an earlier study of Pavement ME. • UC-Davis is working on calibration and preparing/revising the existing design catalog.

Table 16. MEPDG implementation status of participating SHAs/PHAs (continued).

Agency	Status/Update
Colorado DOT	• Full PMED implementation on July 1, 2014. • Conducted local calibration in 2010-2011. • Performed AASHTO 1993 and PMED parallel designs 2012-2014. • Developed individual rutting models for HMA mixes with different binders (Marshall, Superpave, and PMA). • Completed modulus characterization for cold in-place recycling (CIPR) and doing the same for full-depth reclamation (FDR). • Sensitivity study for SMA is ongoing. • Completed database, dynamic modulus sensitivity testing on 105 asphalt mixes (statewide and regional modulus values). • Evaluating PCC widened-lane issue (8-inch thickness for high traffic using 12.5-ft lane is not reasonable). • Currently not using BCOA; they have their own spreadsheet tool for this. • Contracted with ARA to validate PMED v2.5 with MERRA. Now using v2.5. • CDOT Pavement Design Manual (https://www.codot.gov/business/designsupport/materials-and-geotechnical/manuals/pdm) has ME design procedures for HMA, PCC, and overlays. • Current focus is on the characterization of polymerized asphalt.
FHWA Federal Lands	• No update; not present at meeting. For latest info, see 3rd Annual Meeting technical report.
Florida DOT	• Implemented PMED for concrete designs only. Currently using v2.3. Will validate/recalibrate once the national models have been recalibrated to include MERRA data. • PMED for HMA designs not implemented; waiting for the release of the TDC model. AASHTO 1993 still being used for HMA. • Design phase for concrete pavement test road (2018-2019), construction anticipated 2020. • Software available to all DOT staff. • Design manual available at: https://www.fdot.gov/roadway/pm/publications.shtm. • Extensive study completed for evaluation of rutting and TDC. • No longer using soil-cement bases. • Currently constructing concrete test road. • Working with FHWA on MERRA data to achieve better coverage.
Georgia DOT	• Asphalt pavement design close to implementation. • Still in process for concrete design implementation; have issues with CTE testing. • University of Georgia conducting study for training and software. Past research by the university on PMA and SMA mixtures resulted in expanded HMA database in 2016. • Assessment of LTPP distress types modified to Georgia DOT. • Working to utilize level 2 inputs as much as possible. • Initial calibration conducted in 2015; plan to calibrate PMED after the release of v2.5. • Expanding WIM data. • Included as a beta tester for the Calibrator Tool, determining on how to integrate into practice. • Working on validation.
Idaho Transportation Department (TD)	• No update; not present at meeting. For latest info, see 2nd Annual Meeting technical report.
Illinois DOT	• Developed their own ME design procedure in the 1980s and updated it in the early 2000s. • No plans to implement PMED in the next 5 years. • Purchased PMED license in 2018 for evaluation purposes. • Having challenges with evaluation of unbonded concrete overlays and composite pavements. • Plan on using Calibrator Tool. • Starting to use PMED for analysis.

Table 16. MEPDG implementation status of participating SHAs/PHAs (continued).

Agency	Status/Update
Indiana DOT	• Full implementation in 2009 (first section designed and built that year). • Currently perform ME designs using PMED v2.3. • Have had issues with later versions (e.g., lengthy run times using v2.5). • ME design procedure is featured in INDOT Design Manual, Chapter 304, Comprehensive Pavement Analyses (https://www.in.gov/indot/design_manual/files/Ch304_2013.pdf). • Developed materials database in 2000. • Developed traffic database and conducted sensitivity study in 2004. Currently conducting second round of traffic analysis data. • Local calibration performed using data from 103 calibration sections and using accelerated pavement testing (APT) for local calibration effort. • Refining and recalibrating the models based on performance of as-built (2009) pavement sections. • Conduct validation of design results. • Evaluating issues with overlay design (new design is fine) and potential use of geosynthetics. • Interested in evaluating recycled materials (e.g., CIR) with PMED.
Iowa DOT	• Have been attempting to implement PMED for many years; work still in progress. • Currently using AASHTO 93 for asphalt design and PCA for concrete design. • Fourth recalibration effort is currently being conducted. • Addressed PCC widened-lane issue (moved from 14 ft to 12 ft, due to longitudinal cracking). • Evaluating NARR vs. MERRA (need information on global bias). • Plan on implementation by the end of 2019; potentially using PerRoad theory-based design limits. • Evaluating PerRoad vs PMED. • PMED designs for low traffic are resulting in thin sections due to structural-based criteria; ride criteria will change this.
Kansas DOT	• Working on implementation for both asphalt and concrete designs; however, not fully trusting of results at this time. Hence, conducting parallel designs using AASHTO 1993 and PMED. • Conducted local calibration using Level 3 data. • Kansas State University developed concrete pavement database; on-going research for full-depth concrete pavements and base stabilization. • Need to conduct improved HMA material characterization; not sure if they have any bottom-up cracking (cores needed to verify). • Having issues with widened slab design and stabilized materials. • Need to verify calibration efforts, but we have limited staff. • Kansas State University is doing a research project on subgrade resilient modulus and HMA overlays (completed calibration of HMA overlay on concrete and now calibrating HMA overlay on asphalt). • Conducting additional testing on cement-treated bases. • Evaluating where to put research efforts and the level of effort needed (lab testing and field studies). • Using PMED v2.5 with AASHTO 1993. • Hope to implement soon, but no deadline has been established.
Kentucky Transportation Cabinet	• Continuing use of online tool (ME design catalog for asphalt pavements, based on hundreds of runs using PMED v2.3). See: https://transportation.ky.gov/Highway-Design/Pages/Pavement-Design.aspx. • Currently not pursuing PMED implementation for concrete pavement. They don't have a sufficient number of PCC sites and the potential savings using PMED is not there. • Have not conducted local calibration; however, validation effort has confirmed v2.3 and v2.5. • Conducted limited dynamic modulus testing. • Traffic studies not yet performed. • CBR is a significant input to ME design.
Louisiana DOTD	• Conducted local calibration for v2.2/2.3. • Conducting parallel designs using AASHTO 1993 and PMED v2.5. • Research Center is updating calibration factors using v2.5.5. Implementation will occur following the calibration. • Extensive use of inverted pavements; however, unable to model for design determination. • Having issues with widened slab design. • Plan to use Calibrator Tool.

Table 16. MEPDG implementation status of participating SHAs/PHAs (continued).

Agency	Status/Update
Maine DOT	• Had been using PMED with global calibration factors. However, because v2.5 gave drastic shift in cracking predictions, they are now conducting parallel designs using AASHTO 1993 and PMED. • Looking for internal ME champion and working with universities to help move forward. • Good progress on climate database and traffic data from WIM sites. • Working on characterizing unbound base materials (including resilient modulus testing). • Evaluating results of accelerated pavement testing level 1 inputs to level 3 inputs. • Conducting PG binder testing and asphalt mix characterization. • Focusing on extracting historical data for calibration effort. • Focusing on characterization of recycled materials. • Using global calibration coefficients. • Adding 5 to 6 projects to local calibration sites. • Working with management to move forward with PMED implementation or revert back to DARWin. • Conducting local calibration using Calibrator Tool.
Manitoba Infrastructure	• Using AASHTO 1993 exclusively. Previously conducted parallel designs using AASHTO 1993 and PMED, however encountered various issues with PMED (concern with MERRA data quality, high longitudinal cracking prediction, insensitivity to base/subgrade, IT firewall problems). • PMED local calibration assisted in revision of AASHTO 1993 unbound layer coefficients. • Developed database for pavement materials. • Level 1 inputs for base and subgrade materials and level 3 for subbase. • Traffic data available from 7 WIM sites. Developed Level 1 traffic inputs. Currently conducting traffic analysis. • Level 1 asphalt binder and mix characterization completed (for penetration-grade binder). • Using PMED on special projects. • Have encountered inconsistent results with asphalt pavement crack prediction.
Maryland SHA	• AASHTO 1993 is primary design method, and can be supplemented by PMED, but not required. Engineering judgment is final call. • PMED mostly implemented; a local calibration is needed and is currently being conducted in-house by ARA staff. • Completed materials characterization and traffic study. • Need more WIM sites for better traffic characterization. • University of Maryland conducted asphalt concrete (AC)/unbound base sensitivity analysis (E* not changing significantly with time) and study on comparing AASHTO 1993 designs and ME designs). • Design parameters are available in the MDSHA Pavement Design Guide (https://www.roads.maryland.gov/OMT/pdguide0616.pdf).
Michigan DOT	• Fully implemented for new HMA and new PCC design in 2014. On hiatus 2015-2018. • Second recalibrated completed and reimplementation using v2.5.3. • Traffic characterization and climate characterization projects complete. • HMA characterization database completed for Level 1 inputs. • MDOT User Guide for ME Pavement Design is a good platform for user and is available at: (https://www.michigan.gov/documents/mdot/MDOT_Mechanistic_Empirical_Pavement_Design_User_Guide_483676_7.pdf). • Conducting JPCP, HMA full-depth, and recycled material designs, with AASHTO 1993 as initial and PMED as final (use PMED results, if within ±1 in of the AASHTO 1993 design). • Challenges with obtaining additional pavement performance data. • Working on efforts to include rehabilitation designs (high interest). • Evaluating changes in software. They find it difficult to keep up with what has changed. Calibration is costly, especially when having to do it multiple times. Looking forward to automated calibration. • Additional analysis is needed on JPCP. Because of limited concrete sections and historical performance data, it is hard to identify the breaks in the performance curves. Widened slab design is also an issue. • Use WIM and Level 2 cluster data based on WIM for traffic. Next research coming out in 2018 to update clustering.

Table 16. MEPDG implementation status of participating SHAs/PHAs (continued).

Agency	Status/Update
Mississippi DOT	• Asphalt pavement field study (completion expected in 2018). No PCC study due to funding limitations. • Evaluating FWD results. • Assessing impact of construction and materials variability. • Characterizing unbound materials. • Critical deficiency was no calibrated fatigue cracking model for cementitious-stabilized layer. • Structural section at NCAT to evaluate subgrade soil, soil-cement base layer, etc. • Current focus is on rehabilitation design. • In the process of local calibration. Due to gaps in performance data, recently undertook an extensive field study (led by Allen Cooley). Data collected from 64 sections throughout the state. Analysis will begin soon, but additional years of performance data will be needed.
Missouri DOT	• Implementation in 2004 (national models). • Local calibration in 2009. Second calibration completed in 2019 – identified several needed changes. • Hoping to incorporate MERRA in near future. • Conducting recycled HMA characterization. • Currently focusing on AC/AC overlays (complete evaluation early 2018). • Evaluating what threshold criteria to use; trying to strike balance between threshold and thickness. • Concerned with the quality of condition data. • Evaluating the incorporation of RAP and RAS (2019).
Nebraska DOT	• No update; not present at meeting. For latest info, see 3rd Annual Meeting technical report.
Nevada DOT	• Full implementation in July 2015 using v2.3.1. Currently migrating to v2.5.2 for HMA. Adopted national calibration factors for JPC, but further work on JPC is not a focus due to its limited use. • AASHTO 1993 and PMED parallel designs. • Added two additional WIM sites. • Will locally calibrate models as their included in the PMED. Have locally calibrated the asphalt rutting and bottom-up fatigue cracking models. Default calibration factors are used for IRI. • Adopted national calibration values for JPCP. • CTE testing on four aggregate sources. • AI Report ER235 on performance differences (no lab testing) between PMA binders and neat binders (Calibration Factors for Polymer-Modified Asphalts Using M-E Based Design Methods https://mxo.asphaltinstitute.org/webapps/displayItem.htm?acctItemId=244). • Evaluating uncommon materials (CIR, open-graded wearing surface, and stress-absorbing interlayers) and how to incorporate them into the design process. • Conducting research on unbound materials and impacts of swelling soils. • Developing robust catalog for PMA mixes, which are used on all highway systems. • Using Calibrator Tool. • CIR is major interest.
New Jersey DOT	• Using PMED v2.5.5, focusing on new and rehabilitated asphalt pavements. Approximately 50 to 60% of designs are for composite pavements. Very little concrete is used. • Use AASHTO 1993 as a cross check, but do not change the PMED results. • Materials characterization completed for Level 1 inputs. • Traffic user's manual development completed for level 1 inputs. • Training for designers is on-going. • Plan on conducting a local calibration using the Calibrator Tool.
New Mexico DOT	• No update; not present at meeting. For latest info, see 3rd Annual Meeting technical report.
North Carolina DOT	• Implemented PMED for new HMA designs on major projects (2011-2015). Currently using AASHTO 1993 with PMED shadow designs using global coefficients. Moving to re-implement PMED. • Local calibration was conducted, but it was not perfect. They had concerns with the effort (including effects of aggregate base issues) and there has been numerous model and software updates since the original calibration. • Completed characterization of concrete materials (thermal properties dependent on fine-aggregate characteristics). • Completed WIM study despite lack of WIM sites.

Table 16. MEPDG implementation status of participating SHAs/PHAs (continued).

Agency	Status/Update
North Dakota DOT	• PMED implemented for concrete pavement design (primarily using national default values). Using North Dakota DOT-determined values for CTE. • Conducting parallel designs with AASHTO 1993 and PMED v2.3.5; need to populate database more for comparison purposes. • Local calibration conducted for concrete pavements in 2013-2014. Recalibration for flexible pavements planned for when v2.5 comes out. • Need to evaluate WIM data. • Conducting materials characterization study and working on a materials catalog.
Ohio DOT	• Currently using AASHTO 93. • Working on local calibration.
Oklahoma DOT	• No update; not present at meeting. For latest info, see 3rd Annual Meeting technical report.
Ontario MOT	• No update; not present at meeting. For latest info, see 3rd Annual Meeting technical report.
Oregon DOT	• No update; not present at meeting. For latest info, see 3rd Annual Meeting technical report.
Pennsylvania DOT	• 12 WIM sites for traffic data. • Collecting samples for materials characterization of SMA and 9.5-mm, PG 76-22. • LTPP in-place concrete is JRCP; however, new designs are JPCP. As a result, they are having issues with calibrating JPCP due to limited historical performance data. • For PCC, evaluating long-life design (mix optimization), CTE effects, and performance on asphalt- and cement-treated bases (ATB and CTB). • Using LTPP and Superpave In-Situ Stress/Strain Investigation (SISSI) sites for local calibration. • Received ARA training in ME theory and PMED applications. • Frost-heave is having significant effect on thickness and they are having difficulties with which resilient modulus sequences to use; waiting for results of NCHRP 1-59 research (anticipated 2021). • Using PMED v2.5.5 used by Central Office as a design check for AASHTO 93 designs. • Local calibration conducted in 2017 on asphalt pavements (v2.3.1) and revisited in 2018 (v2.5); concrete pavements in 2018; decided to stick with global calibration coefficients. • Newest version of PMED showed increase in thermal cracking; will sponsor a research study on this. • Significant thickness decrease with concrete designs using a widened lane; however, results in longitudinal cracking. • University of Pittsburgh conducting research to determine relationship between CTE and faulting; CTE varies widely across the state (anticipated completion 2021). • University of Pittsburgh Center for Impactful Resilient Infrastructure Science & Engineering is pursuing simplified ME approach to rigid design (PittRigid), expected to be released early 2020. • Full implementation anticipated in 2022.
Quebec MOT	• Continuing evaluation of the software through special projects; working with partners to determine if they're ready for implementation. • Conducting sensitivity analysis with TAC design trials. • Conducting PMED beta testing for SI versions. • Revise implementation plan with availability of recalibrated asphalt models and calibration tool. • Providing presentations on software.
South Carolina DOT	• PMED not yet implemented. They are comparing results to their 1974 interim design guide, as well as PerRoad and other methods. • Conducting local calibration, with completion by the end of 2019. • Considering regional calibration effort with Virginia and North Carolina DOTs. • Considering use of global calibration coefficients and comparing results to AASHTO 1972. • Dynamic modulus, sensitivity testing, and CTE studies completed. • University of South Carolina conducting subgrade characterization and design catalog work. • Need more WIM sites.
Tennessee DOT	• No update; not present at meeting. For latest info, see 3rd Annual Meeting technical report.
Texas DOT	• No update; not present at meeting. For latest info, see 2nd Annual Meeting technical report.

Table 16. MEPDG implementation status of participating SHAs/PHAs (continued).

Agency	Status/Update
Utah DOT	• Fully implemented. Conducting pavement designs using PMED since 2011; required all Federal Aid - Local pavement designs in 2015. • Using PMED v2.5. • Using Level 1 traffic inputs. • Completed resilient modulus testing of soils and unbound aggregate materials. • Completed CTE testing. • Characterization of different asphalt types is of high interest. • Calibration and validation were conducted using both LTPP and SHA pavement sections. • Pavement Design Manual of Instruction available at: https://www.udot.utah.gov/main/uconowner.gf?n=20339215312776663. • Challenges modeling pavement structures (materials - e.g., SMA) outside the norm. • Implemented BcT backcalculation tool, 6 ft x 6 ft BCOA designs, and Map-ME.
Virginia DOT	• Implemented PMED (v2.2.6) for new HMA and PCC on January 1, 2018. Currently beta testing v2.5 to assess differences with v2.2.6. • Post-implementation plan and rehabilitation assessment research needs statement (RNS) developed in 2018. • Initial local calibration for HMA and CRCP in 2015. • Use level 1 for bound materials. • Conducting research to differentiate inputs for various HMA types (different aggregate size, PMA, and SMA). • Need training on basics of PMED. • Challenges with subbase and subgrade characterization. • Overlay design currently a major focus.
Washington State DOT	• No update; not present at meeting. For latest info, see 3rd Annual Meeting technical report.
Wisconsin DOT	• Full implementation of PMED in 2014 for new and reconstruction design of HMA and PCC pavements; however, have had problems and reverted back to AASHTO 72 in 2019. • Currently using v2.1. Planning on verification/recalibration with v2.5 in the near future. • Traffic analysis study completed, use site specific data. • Completed HMA materials characterization. • Local calibration completed in 2010. • Not currently conducting rehab designs but may re-consider this after the v2.5 calibration. • Developed an original pavement design manual and subsequently updated and streamlined it. Manual is continually being updated.
Wyoming DOT	• Implemented PMED in 2012; however, did not mention to upper management. • University of Wyoming conducting study to determine base modulus. • Budget cuts in 2017 stalled PMED evaluation efforts. • 75% of staff uses newer PMED version, remaining staff using older versions.

Table 17. Summary of key aspects of MEPDG implementation and use.

Agency	HMA Characterization	PCC Characterization	Unbound Base/Subbase and Subgrade Soil Characterization	Local Calibration	Parallel Design	Implementation	User Guide
Alabama DOT	Developing database; planning on local verification and asphalt mix characterization (2019)	Developing database	Subgrade soils	Adding more calibration sites	Investigated difference in AASHTO 93 and PMED (2006)	In progress	—
Alberta MOT	***	***	***	***	***	***	***
Arizona DOT	Yes	Yes	Yes	2010-2012; use global calibration defaults	2012-current	Yes, PMED used solely for asphalt rehab	Yes
Arkansas DOT	*	*	*	*	*	*	*
California DOT	—	—	—	In progress	—	Concrete designs only	—
Colorado DOT	Yes, including CIPR dynamic modulus; polymerized asphalt (2019)	—	—	2010-2011	2012-2014	Yes, 2014; currently using v2.5	Yes
FHWA Federal Lands Highways	***	***	***	***	***	***	***
Florida DOT	Rutting and top down cracking	Developing concrete pavement test road	—	Ongoing (3rd calibration); constructing concrete test road (2019)	—	Yes, PCC only; currently using v2.3	Yes
Georgia DOT	Some HMA	Some CTE	—	Initial calibration in 2015; planned after v2.5 release	—	HMA only; PCC in-progress	—
Idaho TD	**	**	**	**	**	**	**
Illinois DOT	—	—	—	—	—	Purchased v2.5 in 2018 for evaluation purposes only	—
Indiana DOT	Yes	Yes	Yes	2009	—	Yes, 2009	Yes
Iowa DOT	—	—	—	Ongoing (3rd calibration)	—	Planned by end of 2019	—
Kansas DOT	Ongoing	Completed	Ongoing, base stabilization	Ongoing (2nd calibration)	Yes, v2.5 and AASHTO 1993	Yes, but conducting parallel design while reassessing procedure	—
Kentucky Transportation Cabinet	Limited dynamic modulus testing	No	—	Verification using v2.3 and v2.5	—	Yes, HMA only (online Design Catalog)	Yes
Louisiana DOTD	Yes	Yes	Yes	Calibration using v2.5	Yes	Expected 2019	—
Maine DOT	Yes	No	Yes, working on subbase data	In progress	—	Yes, HMA only	—

Table 17. Summary of key aspects of MEPDG implementation and use (continued).

Agency	HMA Characterization	PCC Characterization	Unbound Base/Subbase and Subgrade Soil Characterization	Local Calibration	Parallel Design	Implementation	User Guide
Manitoba Infrastructure	Yes	—	Level 1 for base and subgrade, Level 3 for subbase	Yes	Yes, previously (now using AASHTO 1993 solely)	Special projects only	—
Maryland SHA	Yes	—	Yes	On hold until release of v2.5	Yes	Supplements AASHTO 1993 only	Yes
Michigan DOT	Yes, Level 1	—	—	Yes, v2.5.3	Yes	Yes, 2014 (on hiatus 2015-2018)	Yes
Mississippi DOT	Ongoing	—	Ongoing	In progress	—	—	—
Missouri DOT	Conducting recycled HMA characterization	—	—	Initial (2009). 2nd calibration (2019)	—	Yes, 2004 (national models)	—
Nebraska DOT	***	***	***	***	***	***	***
Nevada DOT	Yes	CTE testing on four aggregate sources	On-going	HMA only; national calibration values for PCC	Yes	Yes, 2015	Draft guide for HMA pavement
New Jersey DOT	Level 1	—	—	—	Yes, AASHTO 1993 used as cross check only	Yes, HMA only (v2.5), crosscheck with AASHTO 1993	Traffic user's manual
New Mexico DOT	***	***	***	***	***	***	***
North Carolina DOT	Yes	Almost completed	Yes	Yes, but need to recalibrate	Yes, use AASHTO 1993 with PMED shadow design	Yes, 2011-2015 (currently using AASHTO 1993, but will re-implement PMED in future)	—
North Dakota DOT	Yes	Yes	Yes	2013/14 (PCC), HMA recalibration when v2.5 is released	Yes	Yes, PCC (primarily default values, NDDOT CTE values) (v2.3.5)	—
Ohio DOT	—	—	—	In progress	—	—	—
Oklahoma DOT	***	***	***	***	***	***	***
Ontario MOT	***	***	***	***	***	***	***
Oregon DOT	***	***	***	***	***	***	***
Pennsylvania DOT	Yes, includes WMA, SMA, and RAP	Yes; CTE affects faulting (completion 2021)	Yes	2017 asphalt pavements (v2.3.1), revisited in 2018 (v2.5) for asphalt and concrete pavements; use global calibration coefficients	Yes, for truck traffic > 500 veh/day	AASHTO 1993 design check (v2.5.5); full implementation anticipated 2022	—
Quebec MOT	Yes	Yes	—	In progress	—	In progress	—
South Carolina DOT	Yes	Yes	—	Ongoing	—	In progress	—

Table 17. Summary of key aspects of MEPDG implementation and use (continued).

Agency	HMA Character-ization	PCC Character-ization	Unbound Base/Subbase and Subgrade Soil Characterization	Local Calibration	Parallel Design	Implementation	User Guide
Tennessee DOT	***	***	***	***	***	***	***
Texas DOT	**	**	**	**	**	**	**
Utah DOT	—	Yes	Yes	Yes	Yes, since 2011	Yes, 2011	Yes
Virginia DOT	Level 1	—	—	2015	—	Yes, 2018; problems and reverted back to AASHTO 72 (2019)	Yes
Washington State DOT	—	—	—	2002	—	In progress (design catalog in 2013)	—
Wisconsin DOT	Yes	Level 3	Level 3	2010 using v2.1 (plan to recalibrate with v2.5 in 2019)	—	Yes, 2014 (new and reconstruction); rehab potentially in 2019	Yes (updating)
Wyoming DOT	—	—	On-going study to determine base modulus	—	—	Yes, 2012	—

*No update; not present at meeting. For latest info, see 1st Annual Meeting technical report.
**No update; not present at meeting. For latest info, see 2nd Annual Meeting technical report.
***No update; not present at meeting. For latest info, see 3rd Annual Meeting technical report.
—No data.

5. AASHTOWARE PMED SOFTWARE UPDATE

Session 3 of the meeting included an AASHTO briefing on purchasing and licensing of the AASHTO *PMED* software, followed by a short message on customer relations. It also featured a presentation from the software developer (ARA) regarding the latest enhancements to the program. Summaries of the information presented and surrounding discussions are provided below. Copies of the presentations are featured as presentations 3 and 4 in Appendix C.

1. ***Software Announcements and News* (Ms. Vicki Schofield, AASHTOWare)**—This presentation directed users to the AASHTOWare PMED website (www.aashtoware.org/pavement/) and ARA support site (www.me-design.com/) for information on purchasing, installing, and using the latest PMED software (v.2.5.5), and for accessing a variety of technical materials and training resources. It also discussed the supplemental tools available to PMED users, the planned enhancements to PMED, and the current status of software licensing.

   Ms. Schofield recited all the tools that are available to PMED users (CAT v1.0, BcT v1.0, rePave, MapME, DRIP, XML Validator) and described the most recent tools (CAT and rePave) in more detail. She noted the delivery dates of the two CAT training webinars (October 10 and 22, 2019) and referred participants to the webpage containing the training presentations (https://me-design.com/MEDesign/Webinars.html).

   Ms. Schofield touched upon the primary enhancement being made to the next version of PMED (v2.6, scheduled for release in February 2020), that being the incorporation of the HMA TDC model. She stated that the number of enhancements in this round of software updates was reduced to give greater focus to the development of the PMED WTA. Initiated in FY 2019, the WTA development project is expected to produce a deployable version of the program in FY 2022.

   Finally, Ms. Schofield gave a quick breakdown of the current (October 2019) number of SHA (38) and PHA (5) license-holders, as well as the types of licenses held by other organizations (56 no-cost educational, 117 private sector companies and universities, 16 international). Among SHAs and PHAs, the numbers of licenses are comparable to 2018; however, for other organizations, the numbers have increased considerably.

2. ***Customer Relations* (Ms. Tinika Fowlkes, AASHTOWare)**—Ms. Fowlkes explained her role at AASHTO as (a) providing support for all AASHTOWare products and (b) managing customer engagement by connecting them to the right resources. Ms. Fowlkes conducted a real-time, online survey of the participants using Mentimeter.com. A summary of the survey response results is provided below.

   - How likely are you to recommend the AASHTOWare Pavement ME Design software to a peer or colleague (0 to 10 scale [0=very unlikely, 10=very likely])?
     - Overall Average Score (49 responses): 6.6.
     - SHA/PHA Average Score (27 responses): 6.2.
     - Federal Agency Average Score (4 responses): 7.0.
     - Academic/Private Average Score (11 responses): 8.0.
     - Other Average Score (7 responses): 5.6
   - Explanations for high scores.

- Important tool that produces the most realistic designs.
- Most thorough design software available.
- Lots of uses beyond just pavement design (e.g., can examine relationships between inputs and distresses).

- Explanations for medium scores.
  - Very capable software, but needs improvements.
  - Good program and continually getting better.
  - Still unknowns, working through the issues.
- Explanations for low scores.
  - Too complex and lack of confidence in results.
  - Too expensive and hard to use.
  - Implementation is difficult and calibration is time-consuming.

3. ***Software Updates and Enhancements* (Mr. Chad Becker, ARA)**—The focus of this presentation was on the enhancements and updates made to the current version of PMED (v2.5.5, released in June 2019) and those being made to the next software release (PMED v2.6, scheduled for February 2020) and to the subsequent web-based software release (PMED WTA v1.0).

   Key enhancements and new features of each software version are summarized below.

   PMED v2.5.5 (June 2019)
   - Integration of Google Maps for climate station identification and selection.
   - Integration of the rePave Pavement Scoping Tool developed by NCE (Newt Jackson) under SHRP2 Project R23.
   - Integration of CAT v1.0, which will allow users to upload their own calibration projects and use them in conjunction with the primary calibration data set (LTPP) to calibrate the PMED models in a highly expedited manner. In addition to accessing the two CAT webinars (https://me-design.com/MEDesign/Webinars.html), users can access other CAT resource materials (e.g., calibration guide, software user manual) by registering/logging in at https://pmed-cat.com/CAT.

   PMED v2.6 (February 2020)
   - Inclusion of the HMA TDC model developed by Dr. Bob Lytton (Texas A&M University) under NCHRP Project 1-52.
   - Incorporation of the third edition of the *MEPDG MOP*.

   PMED v2.6.x (July 2020), PMED v2.x.y (July 2021), PMED WTA v.1 (February 2022)
   - Evolution of PMED v2.6 into PMED WTA, involving:
     - Report module and behavior module refactoring (i.e., restructuring existing code).
     - Data persistence model development.
     - Adaptation of new web-based user interface.
     - Alpha and beta testing (completed by January 2022).

   A large number of participants expressed an interest in being able to customize the user interface to hide the display of certain input parameters. Asked what the main benefits of WTA are, Mr. Becker cited the updatable database (like CAT) and improved user experience and support. And, asked when an update to the EICM will take place, he noted that this requires a calibration and that 2020 is when this work is supposed to end.

6. PAVEMENT ME RESEARCH

Session 4 of the meeting consisted of brief updates on current NCHRP and FHWA ME research activities. Summaries of the information presented and subsequent discussions are provided below. A copy of the NCHRP presentation is featured as presentation 4 in Appendix C (Note: The FHWA research summary did not include a slide presentation).

1. ***NCHRP Research Summary* (Mr. Kelly Smith, APTech)**—Mr. Smith provided a brief overview of past, current, and future NCHRP research efforts pertaining to the MEPDG and *PMED* software. Table 18 lists the relevant NCHRP projects and their timeline.

2. ***FHWA Research Summary* (Mr. Tom Yu, FHWA)**—Mr. Yu indicated that the FHWA is fully in support of AASHTO pavement ME design. He also suggested that the design community may be too precise in efforts to determine structural layer thickness, when precision is not necessarily needed. Mr. Yu stressed the importance of the pavement foundation on pavement performance and asserted that failures happen due to foundation issues. He contended that the focus should be less on surface thickness and more on ensuring that the pavement foundation is properly and fully considered.

   Mr. Yu provided an update on several new FHWA projects, including:

   - Pavement Design Catalog project should be completed by the end of 2019.
   - Pavement Preservation Strategies for PCC Long-Life Performance, interim report is available.
   - Effective Foundation Design for Concrete Pavements: 10 Case studies (ARA report).
   - Failure Criteria for Pavement Foundation: New project just underway.
   - Using Intelligent Compaction (IC) for Quality Assurance: Project underway.

Table 18. Timeline of NCHRP research projects related to MEPDG and the PMED software.

NCHRP Project	Title	Year Completed	Included in *PMED*
1-37A	Development of the 2002 Guide for the Design of New and Rehabilitated Pavement Structures: Phase II	2004	–
9-30	Experimental Plan for Calibration and Validation of HMA Performance Models for Mix and Structural Design	2004	No
1-39	Traffic Data Collection, Analysis, and Forecasting for Mechanistic Pavement Design	2004	Indirectly
1-40	Facilitating the Implementation of the Guide for the Design of New and Rehabilitated Pavement Structures	2006	No
1-40A	Independent Review of the Recommended Mechanistic-Empirical Design Guide and Software	2006	–
9-23A	Implementing a National Catalog of Subgrade Soil-Water Characteristic Curve (SWCC) Default Inputs for Use with the MEPDG	2007	No
1-42A	Models for Predicting Top-Down Cracking of Hot-Mix Asphalt Layers	2009	No (see 1-52)
1-40B	User Manual and Local Calibration Guide for the Mechanistic-Empirical Pavement Design Guide and Software	2009	–
1-40D(01)	Technical Assistance to NCHRP and NCHRP Project 1-40A: Versions 0.9 and 1.0 of the M-E Pavement Design Software	2009	–
1-41	Models for Predicting Reflection Cracking of Hot-Mix Asphalt Overlays	2010	Yes
1-40D(02)	Technical Assistance to NCHRP and NCHRP Project 1-40A: Versions 0.9 and 1.0 of the M-E Pavement Design Software	2011	–
1-47	Sensitivity Evaluation of MEPDG Performance Prediction	2011	No
9-23B	Integrating the National Database of Subgrade Soil-Water Characteristic Curves and Soil Index Properties With the MEPDG	2012	No
9-30A	Calibration of Rutting Models for HMA Structural and Mix Design	2012	Yes
4-36	Characterization of Cementitiously Stabilized Layers for Use in Pavement Design and Analysis	2013	FY 2017
1-48	Incorporating Pavement Preservation into the MEPDG	2013	Future[1]
20-05, Topic 44-06	Implementation of the AASHTO Mechanistic-Empirical Pavement Design Guide and Software	2014	No
20-07, Task 327	Developing Recalibrated Concrete Pavement Performance Models for the Mechanistic-Empirical Pavement Design	2014	2014
1-51	A Model for Incorporating Slab/Underlying Layer Interaction into the MEPDG Concrete Pavement Analysis Procedures	2016	Future[2]
1-52	Top-Down Cracking Model for Asphalt Pavements	2017	2019[2]
9-51	Material Properties of Cold In-Place Recycled and Full-Depth Reclamation Asphalt Concrete for Pavement Design	2017	Software addendum
1-50	Quantifying the Influence of Geosynthetics on Pavement Performance	2017	Future[2]
1-53	Improved Consideration of the Influence of Subgrade and Unbound Layers on Pavement Performance	2018	Future[2]
20-07, Task 422	User Review of the AASHTO Guide for Local Calibration of the MEPDG	2018	No
1-61	Evaluation of Bonded Concrete Overlays on Asphalt Pavements	2020	TBD
1-59	Including the Effects of Shrink/Swell and Frost Heave in ME Pavement Design	2021	TBD
20-50(21)	Enhancements of Climatic Inputs and Related Models for Pavement ME Using LTPP Climate Tool (MERRA-2)	2021	TBD

[1] Limited treatment types.

[2] AASHTO PMED Task Force top priority.

7. ME RESEARCH INTO PRACTICE

Session 5 of the meeting featured presentations on the incorporation of ME research into practice, via the PMED software. Summaries of the information presented and subsequent discussions are provided below. Copies of the presentations are featured as presentations 6 through 8 in Appendix C.

1. ***MEPDG Manual of Practice Edits* (Mr. Harold Von Quintus, ARA)**—In this presentation, Mr. Von Quintus chronicled the three editions of the *MEPDG MOP* and described the updates included in the latest version of the manual. The first (interim) edition was published in 2008. Many corrections and enhancements were made to that document, leading to the publication of the second edition in 2015. According to Mr. Von Quintus, some comments on the first edition were not received in time to incorporate into the second edition. These comments, along with the results of a 2016 technical audit, provided the basis for the latest manual update. Also covered in the latest update are all the PMED software enhancements that occurred since FY 2015.

   Mr. Von Quintus reported that the third edition of the *MEPDG MOP* was recently balloted and affirmed by AASHTO and is in the process of being published. It will be included in the next release of PMED (v2.6) in February 2020. However, the manual will not cover the NCHRP 1-52 TDC model that is featured in the software.

2. ***NCHRP 1-52 Top-Down Cracking Model* (Mr. Harold Von Quintus, ARA)**—TDC is a commonly reported cracking mechanism in asphalt pavements. Initiating at the surface and propagating to the bottom of the asphalt layer, this type of cracking is typically manifested as a longitudinal crack in the wheelpath. The current performance model for predicting TDC in PMED is fatigue strength- and bending beam-based, and follows the same principles as bottom-up fatigue cracking. For many years, however, it has been recognized that this type of cracking cannot be adequately modeled in the same way as bottom-up cracking. Thus, NCHRP Project 1-52 was initiated in 2013 to develop a more rational analysis procedure for predicting TDC. In 2018, a fracture mechanics-based crack propagation model (similar to the transverse cracking model) was successfully developed in the study and verified for use.

   In this presentation, Mr. Von Quintus gave an update on the effort to incorporate the NCHRP 1-52 TDC model into PMED. He also provided an overview of the model, discussed the required PMED inputs, reflected on the distinctions between bottom-up and top-down cracking, and showed some example results of TDC prediction.

   According to Mr. Von Quintus, the TDC integration work has been completed and alpha testing of the model within PMED is nearly complete. Beta testing will be initiated in November 2019 and will be finalized in time for the release of PMED v2.6 in February 2020 (Mr. Von Quintus noted that volunteers for beta testing are currently being sought). A webinar covering the TDC model is expected to take place around the release of the new software.

   Mr. Von Quintus mentioned two notable items about the new TDC model. First, the model uses separate mechanics for single-tire and dual-tire loading scenarios. Second, the "crack length" term used in the NCHRP 1-52 report has a different connotation than what is used in PMED. In NCHRP 1-52, "crack length" refers to "crack depth." While not a major challenge for the integration process, the programming formulas in PMED had to account for this inconsistency in terminology.

Traffic and climate inputs for the TDC model are already PMED inputs, and thus the user will see no software change in these respects. Also, although pavement structure will continue to be defined by the user, the TDC model converts the structure into a 3-layer system (asphalt wearing surface, base course, and subgrade) for analysis purposes. The key changes to PMED inputs relate to the asphalt layer properties. Asphalt content by total weight of mix and the aggregate gradation parameter "y" are now required inputs, although the latter can be calculated from the user-defined mix gradation.

Mr. Von Quintus reported on the crack interpretation issues encountered during the TDC model global calibration process. He presented the detailed criteria that were developed and applied to LTPP data to more accurately identify bottom-up and top-down cracking and to distinguish true TDC from TDC caused by construction-related defects (e.g., segregation). Using selected LTPP sections, he also showed the improvements made in the predictive capability of the new TDC model. He noted that a decision would soon be made regarding the TDC unit of measure—length of wheelpath or percent of wheelpath area—to be used in PMED v2.6.

Responding to various questions, Mr. Von Quintus indicated that reflective cracking is considered bottom-up cracking and that, based on the crack identification criteria used in global calibration, the designs generated using the new TDC model will tend to the conservative side. He indicated that PMS data can be used for local calibration purposes, but advised that the data undergo the proper quality control checks and the necessary conversions to LTPP format (for data consistency).

3. ***Calibration Assistance Tool Demonstration* (Mr. Wouter Brink, ARA)**—As mentioned previously, the CAT v1.0 tool was recently made available to help users expedite the process of conducting a local calibration. A step-by-step calibration guide and CAT software user manual were also developed and are available to users. Two training webinars were delivered in October 2019; the first one being an introduction to the tool and the second one focused on managing calibration projects. Both webinars are posted on the Pavement ME website (https://me-design.com/MEDesign/Webinars.html).

   In this presentation, Dr. Brink provided an overview of the CAT tool, described the six-part calibration process; discussed the tool assumptions, requirements, and limitations; and demonstrated the software in a brief walk-through. Dr. Brink reported that the tool was developed in accordance with the 11-step procedure given in the AASHTO Local Calibration Guide (2010) and that it is a full-factor web application, consisting of a calibration database with LTPP and user-defined test sections. He emphasized that the tool requires significant user engagement. Descriptions of the six parts of the tool, and the series of manual and automated steps associated with each part, are as follows:

   - Part 1, Getting Ready for Calibration—The sampling matrix is established, test sections are selected, and the matrix is populated with data from the calibration database. The user selects the pavement and distress types to be used and the program selects the sections that fit the criteria for each distress type.
   - Part 2, Review Distress Data—The distress data are extracted and reviewed, statistics for the data are computed, and a decision is made about the sufficiency of the number

of test sections for the matrix. The program develops a distribution (and statistics) of the distress levels and pavement ages and presents an experimental matrix showing the sections that fit the cells of the matrix.

- Part 3, Set-up Project Files and Execute ME Design—Project design files are established, batch file runs are made, and the predicted performance data are extracted for analysis.
- Part 4, Data Analysis and Interpretation of Distress Predictions—Comparisons between predicted and measured distress values are made (including bias and standard error calculations) and the calibration coefficients to be modified are selected. The program yields measured vs. predicted values for each distress and lists the statistics needed to determine if a local calibration is needed (hypothesis test results). If a hypothesis fails, the program directs the user to a page that allows them to filter through the factors, replot/recalculate the statistics, and identify the focus of the local calibration.
- Part 5, Optimization of Calibration Coefficients to Eliminate Bias—Batch file runs are made to optimize the coefficients to eliminate bias and minimize standard error. The program uses Excel Solver-like calculations to perform the optimization for the selected distress types.
- Part 6, Validation and Accepting the Final Results—Final calibration coefficients and standard deviation results are extracted in an XML format that is compatible with PMED.

The requirements for running CAT consist of having (1) a PMED license, (2) PMED DGPX files, and (3) measured distress data. Mr. Brink indicated that all licensees share the same server and that the server operates on a first-come, first-serve basis. A maximum of 60 hours of CAT runs has been established, so as to avoid clogging of the system. However, as noted by Mr. Chad Becker (ARA), users can contact the Help Desk to request more time, if needed.

8. AGENCY IMPLEMENTATION EXPERIENCES

Session 6 of the meeting featured two presentations on agency implementation experiences. Summaries of the information presented and subsequent discussions are provided below. Copies of the presentations are featured as presentations 9 and 10 in Appendix C.

1. ***Old Implementer Updates: Effects of Utah DOT's Recalibration Effort on HMA Pavement Design and Changes to the Agency's Manual of Instruction* (Mr. David Holmgren, Utah DOT)**—The Utah DOT has been conducting pavement designs using PMED since 2011. An initial local calibration for new asphalt pavement and overlays (focusing on the bottom-up fatigue cracking, transverse cracking, rutting, and IRI models) was performed in 2009. This was followed by a second local calibration in 2013 that focused on the rutting models. With the agency's transition to PMED v2.5, a third calibration involving all of the above models was needed and was performed in 2019. This presentation covered the results of that calibration effort.

   Mr. Holmgren prefaced his discussion by noting that the agency does a lot of preventive maintenance treatments (thin overlays, chip seals, microsurfacing, etc.) on its roads now and that the treatments seem to have affected the results of the calibration. For instance, under the 2019 calibration, the predicted developments of rut depth and bottom-up cracking were significantly less than those predicted using the earlier calibrated models. Corresponding reductions in the IRI trends were also observed. Transverse cracking trends, on the other hand, were significantly increased as a result of the 2019 calibration.

   To illustrate the effects of the new calibration coefficients on new/reconstructed asphalt pavement thickness, Mr. Holmgren showed the design HMA thicknesses obtained for several Utah projects. For Interstate pavements (and at 95 percent design reliability), increases between 2 and 4.5 inches were observed with the newly calibrated models. For non-Interstate pavements (90 percent design reliability), reductions up to 2 inches and increases up to 1.5 inches were observed. The thickness increases were largely attributed to the changes in the transverse cracking model coefficients.

   Mr. Holmgren reported that the DOT decided to adopt the new calibration factors and has updated its *Pavement Design Manual of Instruction* to reflect this. He also demonstrated the expected effects of the recalibration on pavement designs statewide. In the analysis, roughly 8,700 lane-mi of road would require a change in HMA thickness no greater than 0.5 inches, about 6,300 lane-mi would see a reduction in thickness between 1 and 1.5 inches, and about 8,500 lane-mi would see an increase in thickness between 1 and 4.5 inches.

2. ***Implementer Backtracking: New Jersey Implementation Experiences* (Ms. Nusrat Morshed, New Jersey DOT)**—The New Jersey DOT uses PMED v2.5.5 to design new and reconstructed asphalt pavements, and to perform parallel designs (with AASHTO 1993) for asphalt overlays. Through its work with Rutgers University and other entities, it has developed comprehensive PMS, materials, and traffic databases to support ME design, as well as traffic clusters based on data from 90 WIM sites.

   In this presentation, Ms. Morshed reviewed the designs of five projects to demonstrate the agency's experiences, challenges, and insights gained with PMED. Projects 1 and 2 focused on reconstruction with asphalt on two heavily trafficked roads (37 and 170 million cumulative trucks, respectively, for the specified 50-year design period). In the design for both projects, the predicted IRI exceeded the DOT's 170-in/mi threshold, and for Project 1, the predicted rutting barely exceeded the 1-inch threshold. For Project 2, Ms. Morshed illustrated the reduced pavement cross section obtained with PMED, as compared with AASHTO 1993.

Projects 3 and 4 focused on 10-year asphalt overlay designs obtained for two moderately trafficked roads (6.2 million cumulative trucks each). For Project 3, Ms. Morshed illustrated how the predicted amount of AC total transverse cracking (thermal + reflective) exceeded the 3,000-ft/mi threshold for both the 3-inch overlay and 8-inch overlay design. For Project 4, she showed how the predicted amount of AC total fatigue cracking (bottom-up + reflective) exceeded the 25 percent threshold.

Lastly, Project 5 looked at the design of a reconstructed pavement involving an asphalt surface placed on a rubblized PCC pavement. The 50-year design truck traffic for this project was 12.6 million. The predicted IRI and AC total transverse cracking (thermal + reflective) exceeded the respective thresholds of 170 inches/mi and 1,000 ft/mi. Ms. Morshed compared the layer moduli obtained via FWD both before and after reconstruction. The subbase and subgrade values were found to be the same, whereas the modulus for the rubblized concrete layer obtained after reconstruction was significantly greater than the value obtained before reconstruction (i.e., post-rubblization, pre-surfacing). Ms. Morshed also compared and discussed the structural service lives obtained with PMED (≥50 years) and AASHTO 1993 (≥20 years).

In closing, Ms. Morshed stressed the inability of AASHTO 1993 to capture the benefits of specialized mixes (e.g., SMA, bottom rich base course [BRBC]) used by the New Jersey DOT.

9. INNOVATIONS/IMPROVEMENTS IN TRAFFIC AND CLIMATE FORECASTING

Session 7 of the meeting featured two presentations on the important ME design topics of traffic and climate forecasting. Summaries of the information presented and subsequent discussions are provided below. A copy of the presentation on traffic forecasting is featured as presentation 11 in Appendix C (Note: At the request of the presenter, the traffic presentation has not been included in the report).

1. ***Updated Traffic Data Cluster Methodology for Locations where WIM Station is not Present* (Mr. Justin Schenkel, Michigan DOT)**—The Michigan DOT fully implemented PMED for new HMA and PCC design in 2014. Between 2015 and 2018, the agency suspended the use of the program to evaluate issues with software versions and to recalibrate the performance models. Traffic inputs were also evaluated, and the methodologies used and the results of the evaluation were the centerpiece of this presentation.

   Mr. Schenkel began the presentation with a summary of the DOT's first traffic characterization study, which was completed in 2009. That study identified significant Level 1 traffic inputs (e.g., monthly distribution factors [MDF], truck traffic classifications [TTC], axle load spectra [ALS]) based on 3 years (2005-2007) of data collected from 44 Weigh-in-Motion (WIM) and classification stations located throughout the state. It also developed Level 2 inputs using cluster analyses to group sites with similar characteristics.

   Mr. Schenkel discussed the need for an updated traffic study, noting the addition of several more traffic monitoring sites, the development of locally calibrated PMED performance models (the previous study used global coefficients), and the shortcomings of the original cluster analysis method. In the updated study, which was completed in 2018, 5 years (2011-2015) of traffic data collected from 59 WIM and classification stations were used. Two different clustering methods were used in the development of updated Level 2 inputs: (a) the traditional hierarchical approach, which uses a decision tree and DOT freight data, and (b) a simplified approach, which uses combinations of attributes (e.g., functional class, urban/rural, AADTT, number of lanes, vehicle class 9 distribution levels). Mr. Schenkel illustrated and described each approach, and showed the results of an extensive PMED design sensitivity analysis performed using inputs from each approach. In comparison with design lives obtained using Level 1 inputs, no practical differences were observed between the two Level 2 approaches.

   In closing, Mr. Schenkel shared that the Michigan DOT's *User Guide for ME Pavement Design* will be updated soon. Asked if the newly developed clusters were cross-checked with the national clusters, Mr. Schenkel indicated that they were not but agreed that it should be done.

2. ***Impact of Warming Temperature on Pavement ME Outputs Considering Climate Change Effect* (Dr. Hao Wang, Rutgers University)**—Dr. Wang presented the preliminary findings of an ongoing study looking at the impacts of climate change (manifested through temperature warming) on pavement overlay performance (as determined via PMED). He contrasted the historical-based (1985-present) MERRA-2

climate data used in PMED and the projection-based (2010-2099) global climate model (GCM) developed by climate scientists. He also discussed the climate change stressors and their possible negative effects on material and pavement performance (e.g., temperature warming leads to asphalt binder aging and asphalt mix softening, milder winters change the freeze-thaw patterns in unbound layers, changes in precipitation alter the temporal soil moisture content and groundwater levels).

Dr. Wang next described the constructs of the study. Twenty-one LTPP test sections in New Jersey were used to conduct a local calibration of the PMED v2.5 bottom-up fatigue cracking and rutting models. MERRA-2 data (1985-2004) were used, along with traffic cluster inputs developed from New Jersey WIM stations. A model asphalt pavement structure and design traffic loading were then established to predict the performance of an overlay (3-inch mill and 3-inch HMA) using PMED with the two respective climate data sets—MERRA-2 and GCM. Using a 10 percent threshold value for total fatigue cracking, the service lives of the overlays were determined corresponding to each climate data source. A similar analysis was performed using a different overlay strategy (3-inch mill and 6-inch HMA) and a 20 percent threshold for total fatigue cracking. In both analyses, the temperature warming effect inherent in the GCM resulted in increased fatigue cracking and rutting, and correspondingly reduced overlay service lives—4 to 21 percent for the 3-inch mill and 3-inch overlay option and 20 to 35 percent for the 3-inch mill and 6-inch overlay option.

10. PAVEMENT ME Q&A FORUM

Day 2 of the Users Group meeting resumed with Session 8 consisting of a presentation on the AASHTOWare customer survey results and an open discussion between the Pavement ME Task Force and user group attendees. Summaries of the information presented and subsequent discussions are provided below. A copy of the presentation on the AASHTOWare survey results is featured as presentation 12 in Appendix C.

1. ***AASHTOWare Customer Survey* (Mr. Bob Shugart, Alabama DOT)**—AASHTO routinely conducts a survey of users to capture a sense of customer satisfaction with the developed software. Highlights from the 2019 survey include the following:
   - A majority of respondents (>70 percent) are using the Windows 10 operating system.
   - PMED software versions currently being used by the respondents include:
     - v2.2: ~10 percent.
     - v2.3: ~30 percent.
     - v2.5: ~55 percent.
   - A majority of respondents (~75 percent) would not use PMED on tablet or iPad, if available.
   - Approximately 50 percent of respondents indicated that they have completed local calibration, ~40 percent have not, and ~10 percent are in progress.
   - Respondents' reported frequency of software use:
     - Daily: ~10 percent.
     - Weekly: ~45 percent.
     - Monthly: ~25 percent.
     - Rarely: ~20 percent.
   - Less than 15 percent of the respondents have used the tools (e.g., XML validator, DRIP, MapME, and APIs) located on the PMED website.
   - Approximately 15 percent of respondents indicated using the BcT.
   - Primary design types evaluated by the respondents using PMED include the following:
     - New flexible pavement: 91 percent.
     - New JPC pavement: 91 percent.
     - AC overlay on AC pavement: 62 percent.
     - New CRC pavement: 41 percent.
     - AC overlay on JPC pavement: 38 percent.
2. ***Open Discussion with Pavement ME Design Task Force* (Facilitated by Mr. Bob Shugart and other ME Task Force members)**—The following summarizes the Q&A with the ME Task Force Members:
   - The Engineering Stack Exchange can provide good design information and work-arounds (Bob Shugart).
   - Will there be annual updates to the MOP so that it is more closely related to the software (Ian Rish)?
     - *It would be difficult to do this in real time from a practical standpoint. Addendums will be issued to fill the gap (John Donahue).*

- Task Force members were asked to look at the PCC side of design as much as the AC side. Caltrans has a lot of divisions/districts that are buying the software. There is a need to have a bridge between these groups and to simplify the purchasing process (Mehdi Parvini).
  - *A lot of this will depend on the agency's IT department (Bob Shugart).*
  - *Georgia DOT has worked with its IT department to work out these issues (Ian Rish).*
- Is there an opportunity for multi-year licenses (Casey Nash)?
  - *The problem with multi-year licensing is limitation of funding and historically it has not been done. The underlying issue is that AASHTO would have to specify a 10 percent increase in cost each year. This question could be put on a future AASHTO survey (Vicki Schofield).*
- Is it possible to use service units for multi-year license (Tom Yu)?
  - *No (Vicki Schofield).*
- For concrete designs, are agencies seeing more cracking or faulting (Tom Yu)?
  - *Pennsylvania is mostly seeing faulting (Josh Freeman).*
  - *On high-level traffic with dowels you can still have faulting issues. You can consider the use of the widened slab design to help control faulting (Tom Yu).*
  - *The widened slab design in Iowa has been an issue in terms of longitudinal cracking. Our 20-ft joint spacing may be a contributing factor, but we're also sure that part of it is a curling and warping issue. We have gone back to a standard 12-ft wide slab (Chris Brakke).*
  - *PMED doesn't have a longitudinal cracking model (Dulce Feldman).*
  - *Wisconsin was one of first states to use the widened slab design (Tom Yu).*
  - *Laura Fenley (formerly Wisconsin DOT) indicated that Wisconsin, like Iowa, had curling and warping issues with the widened slab design (Chris Brakke).*
- Is a major software release preferred over a minor enhancement? Virginia DOT's challenge has been that, if there is a minor change in the files (e.g., climate, etc.), then we have to work with the IT group to make the program operational (Girum Merine).
  - *This pertains to the Data Persistence Model (who is the data administrator). In a cloud-based program, this will be a challenge. There are a lot of issues with custodianship of data, IT issues, etc. ARA has brought this to the attention of the Task Force (Chad Becker).*
- Have any agencies had issues with overly thick PCC or overly thin AC pavements (Tiripan Mandal)?
  - *There have been a few instances of a very thin AC pavement (say 1.5-2 inches). Usually this is related to a user that does not understand Pavement ME. Also, most agencies have a minimum AC thickness criterion (Harold Von Quintus).*
  - *Virginia DOT has looked at this issue and developed minimum thickness requirements (Girum Merine).*
  - *Engineering judgment has to be properly applied (Bob Shugart).*
  - *Agencies should be careful when designing for PCC. There is a real need to consider the pavement support (Mehdi Parvini).*
- The Pavement ME Task Force strongly encourages comments on the survey (Bob Shugart).

11. DESIGN ISSUES AND APPLICATIONS

Session 9 of the Users Group meeting included four presentations on specific design issues and applications related to flexible pavements. Summaries of the information presented and subsequent discussions are provided below. Copies of the presentations are featured as presentations 13 through 16 in Appendix C.

1. ***Practitioner's Guide for Mechanistic-Empirical Design of Pavements with R²AMs* (Mr. Harold Von Quintus, ARA)**—Resource responsible asphalt mixtures (R^2AMs) are asphaltic-based materials containing one or a combination of recycled products, including high (≥35 percent) reclaimed asphalt pavement (RAP), recycled asphalt shingles (RAS), ground tire rubber (GTR), and high polymer-modified asphalt. Such mixtures can also include other unique materials, such as WMA and cold-recycled mixtures. This presentation discussed the work conducted under the FHWA project, *Deployment of Performance-Based Technologies for Mechanistic-Empirical Pavement Design and Resource-Responsible Materials Design*, focusing specifically on one of its two key products, the Practitioner's Guide for Mechanistic-Empirical Design of Pavements with R^2AMs (currently in the process of being published).

   Mr. Von Quintus began the presentation by describing the challenge of using R^2AMS—that being that the global calibration of the PMED transfer functions was completed using standard, neat/virgin asphalt mixtures and that the lab-derived k-values from the calibration are not applicable to R^2AMS. He then presented the nine asphalt mixtures used in the testing program (five high RAP mixes, three wet-mix GTR mixes, and one polymer-modified mix) and the mixture properties determined for those mixes through laboratory testing:

   - Dynamic modulus.
   - Plastic strain coefficients (k_{1r}, k_{2r}, k_{3r}).
   - Indirect tensile (IDT) strength and creep compliance.
   - Fatigue strength coefficients (k_{1f}, k_{2f}, k_{3f}).
   - Endurance limit.

   Mr. Von Quintus illustrated several of the test results for R^2AMs and discussed some of the key takeaways in relation to neat/virgin mixes. For each material property, he summarized the distresses that are impacted, whether or not added data manipulation from the lab data is needed, and if PMED Level 3 inputs are applicable to R^2AMs (none were found to be applicable). He also compared the plastic strain and fatigue strength coefficients developed for each mix type and for neat/virgin mixes.

   Mr. Von Quintus acknowledged that the number of mixes tested in the study was limited. He also indicated that the results will not be included in the upcoming release of PMED v2.6. In response to a question regarding use of the endurance limit in PMED, Mr. Von Quintus stated the *MEPDG MOP* recommends against using it, because it was not included in the original model calibration. Also, if it is used, it should be recognized that it is only applicable to bottom-up cracking; it should not be considered for TDC.

2. ***Characterization of Base, Intermediate, SMA, and Polymer-Modified Dense-Graded Asphalt Mixtures for Pavement ME* (Dr. Hari Nair, Virginia DOT)**—The Virginia DOT implemented PMED for new flexible and rigid pavement design on January 1, 2018. As part of the implementation, Level 1 inputs were established for three VDOT HMA mix types—surface mix (SM), intermediate mix (IM), and base mix (BM). However, the characterization of IM and BM mixes were based on limited testing of mixes that were produced several years ago and are not representative of current mixes that use higher amounts of RAP. Additionally, the rutting calibration coefficients are the same for all three mixes.

   Dr. Nair's presentation reported on the on-going efforts by Virginia DOT to develop updated PMED design inputs for IM and BM mixes, and new inputs for SMA and polymer-modified (SM E) mixes, which were not previously evaluated. For each mix type, several mixes from 2018 field projects were tested in the lab for volumetric properties, dynamic modulus, and repeated load permanent deformation. Following the testing, several pavement designs (PMED v2.2) were developed for three traffic levels (2,000, 4,000, and 8,000 AADTT) meeting the DOT design requirements. A sensitivity analysis was conducted for each mixture by changing the dynamic modulus, binder properties, and in-place field density.

   One finding from the study is that the dynamic modulus as measured in the lab is not enough to explain the differences among mixes. As a result, the DOT will continue to use the average dynamic modulus values for BM and IM mixes. Also, because the lab-derived k-values for permanent deformation were considerably different for the mixes and different from the PMED v2.5 k-values, it is likely that mix-specific permanent deformation coefficients will need to be established for use in PMED v2.5 .

   Asked if there were any issues with the high binder contents used in the SMA and SM E mixes, Dr. Nair replied that there were not.

3. ***Sensitivity of Pavement ME Fatigue Cracking Predictions on Effective Binder Contents* (Dr. Mohammadreza Mirzahosseini, Purdue University)**—Voids in mineral aggregate (VMA) is an important HMA mix parameter that is used in the QC/QA programs of many SHAs. If VMA is too low, there is not enough room in the mixture for sufficient asphalt binder to adequately coat the individual aggregate particles, which in turn can adversely affect fatigue performance and mixture durability. VMA minimum requirements in Indiana are 15 percent for 9.5-mm mixes and 13 percent for 19-mm mixes.

   The focus of this presentation was on the sensitivity of PMED to HMA mix quality, as set forth by varying deviations from the VMA_{design} value. Dr. Mirzahosseini described the framework for the study, which involved extensive lab testing and PMED modeling of a 9-inch full-depth asphalt pavement located in Indianapolis, IN. Three case designs (each comprised by an asphalt surface layer, intermediate layer, and base layer) were evaluated for the effect of VMA deficiency (defined as ΔVMA_{design} / Δv_{be}) on bottom-up and top-down cracking performance, as follows:

   - Case I: Three different surface layer mixes with VMA deficiencies of 0.3, −1.6, and −2.9 percent. The intermediate layer and base layer mixes had VMA deficiencies of 0 percent.

- Case II: Three different intermediate layer mixes with VMA deficiencies of 0, −1.4, and −2.9 percent. The surface layer mix had a VMA deficiency of 0.3 percent, while the base layer mix had a VMA deficiency of 0 percent.
- Case III: Three different base layer mixes with VMA deficiencies of 0, −1.4, and −2.9 percent. The surface layer mix had a VMA deficiency of 0.3 percent and the intermediate layer mix had a VMA deficiency of 0 percent.

Analysis results indicated that PMED is sensitive to VMA deficiency for two scenarios: (1) TDC under Case I and (2) bottom-up cracking under Case III. Performance life reductions of 10 percent and 13 percent, respectively, were computed corresponding to the most deficient mix (VMA deficiency = −2.9 percent).

4. ***Advanced Use of Pavement ME v2.3 for Major Project Full-Depth Pavement Design with High-Performance Materials using Material Property Global Recalibration* (Mr. Bob Kluttz, Kraton Polymers)**—In 2009, the National Center for Asphalt Technology (NCAT) incorporated several unique paving products in sections at the NCAT test track. Kraton Polymers were featured in a flexible pavement section containing a highly polymer-modified asphalt (HiMA) mix in a reduced asphalt layer cross section (5.75 inches vs. 7 inches used in the control section). In this presentation, Mr. Kluttz discussed the performance of the HiMA test section and presented the results of an effort to implement this technology into PMED through the adjustment of global calibration factors.

   After 5 years and 17 million ESALs, the control section had experienced 6 mm of rutting and 10 percent surface cracking, and was subsequently resurfaced. After almost 6 years and 20 million ESALs, the HiMA section had experienced negligible rutting and 6 percent surface cracking (predominantly superficial TDC).

   Given the disparity between the good performance exhibited by the HiMA section in the field and the poor performance initially predicted by PMED using the global coefficients, Mr. Kluttz showed the need for global calibration and presented a strategy that included developing a HiMA mixture master curve, determining the endurance limit from fatigue testing, and revising the fatigue and rutting global calibration factors (k_{f1}, k_{f2}, k_{f3}, k_{r1}, k_{r2}, and k_{r3}) based on fatigue and deformation testing. The results of the recalibration analysis produced very good matches between the predicted and actual levels of rutting and cracking.

12. LOCAL CALIBRATION EXPERIENCES

Session 10 of the meeting consisted of two presentations on agency efforts to calibrate and validate the MEPDG, with one of the efforts involving the use of the new CAT tool. Summaries of the information presented and subsequent discussions are provided below. Copies of the presentations are featured as presentations 17 and 18 in Appendix C.

1. ***Field and Laboratory Work to Locally Calibrate the New Pavement Design Guide for Mississippi DOT* (Mr. Allen Cooley, Burns Cooley Dennis)**—In this presentation, Dr. Cooley provided an update on one of the Mississippi DOT's most notable studies relating to PMED implementation. State study number 263, initiated in 2013 under contract to Burns Cooley Dennis (BCD), was designed to provide the required information for the local calibration of the MEPDG performance models through extensive field sampling, testing, and evaluation of pavement test sections located throughout the state.

   The study is focused only on asphalt pavements and consists of three phases, each involving a variety of activities, as follows:

   - Phase I: Coring, GPR testing, distress mapping, and selecting locations to evaluate typical/non-typical cracking.
   - Phase II: FWD testing and FWD data analysis.
   - Phase III: Sampling pavement layers and determining pavement thicknesses, coring selected typical/non-typical cracks and areas of GPR anomalies, conducting DCP testing, and conducting laboratory testing of pavement materials (e.g., HMA, granular materials, stabilized materials, and subgrade soils).

   According to Dr. Cooley, 64 test sections were evaluated in the study and all the data collected in the effort are in the process of being checked for quality and organized into Excel spreadsheets (for local calibration analysis) and PDF files (for historical records). Dr. Cooley described the various work activities and displayed some of the findings of the distress measurements and results of the laboratory testing. He noted that a significant amount of TDC was observed.

2. ***Maine DOT's Experience with First Local Calibration using Beta Version of Calibrator* (Mr. Casey Nash, Maine DOT)**—The Maine DOT implemented PMED for asphalt pavements (global calibration factors) in 2016, but currently uses AASHTO 1993 with PMED v2.5.5 design checks and engineering judgment to develop a final design. Recently, the agency embarked on an effort to conduct its first local calibration and to use the new automated calibration tool (CAT) for that purpose. This presentation described the experiences and results of the local calibration analysis.

   Mr. Nash reported that the analysis was originally intended to use performance data (rutting, cracking, and IRI) from (a) ME-specific research sections constructed since 2016, and (b) pavement management system (PMS) sections constructed between 2006 and 2014. However, due to a change in the ARAN data collection vehicle in 2015 and differences in the way cracking data were collected as a result of the vehicle change, only the PMS performance data were used for the local calibration. Furthermore, while data for 50 PMS sections (each 500 ft long) were extracted for use, only 21 sections could be used following quality control (QC) checks of the data.

Verification of the PMED global rutting model showed an obvious bias toward over-prediction of total rutting. Bias in the IRI global model was not as obvious. Calibration of the rutting model using CAT resulted in new set of calibration factors (AC rutting β_{r1}, β_{r2}, and β_{r3}, granular base rutting β_{s1}, subgrade rutting β_{s1}). Mr. Nash demonstrated the CAT analysis through several program screenshots and commented on how easy the tool is to use.

In closing his presentation, Mr. Nash described the ME-specific research sections that will be used in future local calibrations. Twelve projects have been completed to date and an additional 4 to 5 projects per year are anticipated. A detailed work plan covering project identification/selection (pre-construction), sampling and testing (construction), and post-construction data collection has been developed and is being used.

13. SOFTWARE TRAINING

Session 11 of the meeting featured demonstration-based training on the use of PMED for two different design applications (inverted pavements and semi-rigid pavements), followed by a presentation on the development of a video-based MEPDG training program. The demonstration-based training included live use of the PMED software, supplemented with various output screen shots and Microsoft PowerPoint slides. A summary of each block of the training is provided below, along with key discussions generated by the presentations. A summary of the video-based training presentation and corresponding discussion is also provided. Copies of the training presentations are featured as presentations 19 and 20 in Appendix C.

1. ***PMED Training Block 1—Designing Inverted Pavements* (Mr. Harold Von Quintus, ARA)**—The first training block covered the design of inverted pavements, which is characterized as an HMA pavement placed on an unbound aggregate base layer and a cement-treated base (CTB) layer. This type of pavement is not a design strategy option in PMED and must be designed as a new flexible pavement. Mr. Von Quintus noted that a key assumption in the design is that the unbound aggregate layer eliminates any reflection cracking from the underlying CTB. He also noted that the key aspects of this design are the modulus values used for the unbound layer and the CTB.

   To demonstrate the design in the PMED software, Mr. Von Quintus used a new pavement in Mississippi as an example. The design consisted of a 2-inch HMA surface placed on an 8-inch unbound aggregate base (A-1-a), and on an 8-inch CTB (simulated as an unbound base with average resilient modulus of 1,000,000 psi [Level 3 design]). The WinJULEA elastic layer analysis software was used to calculate a bulk stress of 40 psi for the aggregate layer, and based on relationships developed using LTPP data, this bulk stress yielded resilient modulus values of 45,000 psi for high-quality aggregate base and 24,000 psi for low-quality aggregate base. PMED performance prediction charts corresponding to the high- and low-quality bases showed that the total rutting threshold of 0.45 inches was reached at 10 years and 4 years, respectively. Mr. Von Quintus pointed out that, because subgrade rutting will not occur below the CTB layer, the predicted subgrade rut depth should be excluded from the computation of total rut depth.

   The following summarizes the Q&A regarding the Inverted Pavement Design demonstration.

   - Can backcalculated values be used to establish the layer moduli?
     - *Backcalculated values are okay to use, but it is critical that the moisture content at the time of FWD testing be defined, and this requires sampling (Mr. Von Quintus).*
   - Is the unbound aggregate layer considered to be a sandwich layer?
     - *No (Mr. Von Quintus).*
   - Is there a way to apply moisture adjustment to the resilient modulus in PMED?
     - *No, it is hard-coded in the software (Mr. Von Quintus).*
   - Does the program assume that the value entered was optimum?
     - *Not necessarily. Different locations will have different compactive efforts and different temperatures, and thus the optimums could be different (Mr. Von Quintus).*

- Where did the default values of moisture content come from?
  - *Army Corps of Engineers. They use modified values for different compactive efforts (Mr. Von Quintus).*
- When using BcT to breakdown a project into unique segments, should multiple moisture contents be used.
  - *Yes, it is important to establish and use the correct moisture values for each segment (Mr. Von Quintus).*
- C-factors seem to be the weakest part when it comes to use of backcalculated moduli. How much data are behind the development of the C-factors?
  - *There is an LTPP report that covers this and it goes back to the Benkelman Beam tests used at the AASHO Road Test. One soil, one condition, and one set of structures gave a value of 0.33. LTPP then looked at the legitimacy of this value. LTPP did deflection and moisture contents at approach and leave ends (and had cores and borings). The analysis used every LTPP site available at the time. Very aggressive checking of the data was performed (Mr. Von Quintus).*

2. ***PMED Training Block 2—Designing Semi-Rigid Pavements* (Mr. Harold Von Quintus, ARA)**—The second training block covered the design of semi-rigid pavements, which consist of an HMA pavement placed on any type of cement stabilized layer (e.g., CTB, soil-cement). Key aspects/assumptions of this design include an established relationship between the elastic modulus and modulus of rupture of the cement-stabilized layer and full bond retention over the design period between the HMA and cement-stabilized layers.

   To demonstrate the design in the PMED software, Mr. Von Quintus again used a new pavement in Mississippi as an example. The design consisted of a 4-inch HMA surface placed on a 9-inch soil cement base with an elastic/resilient modulus of 1,000,000 psi. Based on established relationships between the 28-day elastic modulus and flexural strength for different HMA thicknesses, a modulus of rupture value of 235 psi was selected for design. As depicted in a graph containing the elastic modulus-flexural strength relationships, the selected value provides greater resistance to fatigue cracking. PMED performance prediction charts for the design showed 14 years of performance, based on total rutting and AC total (thermal + reflective) cracking. However, Mr. Von Quintus pointed out that, similar to inverted pavements, rutting in the layers below the cement-stabilized layer will not occur and thus the predicted rut depth in these layers should be excluded from the computation of total rut depth. He also noted the importance of using appropriate load transfer efficiency (LTE) values for fatigue and transverse cracks that are based on calibrations or actual measurements.

3. ***Innovative and Effective Training Modules and Methods for Pavement Designers for Rapid Deployment and Continuous Operation of MEPDG* (Dr. Stephan Durham, Dr. Sung-Hee Kim, and Mr. Hampton Worthey, University of Georgia)**—In recognition of the many challenges with PMED implementation (e.g., local calibration, staff turnover, lack of adequate training resources), the University of Georgia undertook the development of an MEPDG training program for Georgia DOT staff and its contractors/consultants. The program, developed under Georgia DOT Research Project (RP) 17-18, focuses on the origins and significance of the MEPDG inputs and their

implications on design, as well as on the associated procedures required for successful implementation.

Dr. Durham indicated that the training program is intended to bridge the gap between existing pavement design methods and the MEPDG, and is particularly geared towards those who are reluctant to converting to the MEPDG and those who lack the necessary resources for converting. He shared the objectives of the program as related to on-demand learning (easily accessible software platform and simple, informative program navigation) as well as to advanced learning (hands-on laboratory training and material property testing).

Mr. Worthey described the six training program modules, as listed below, and showed two videos—Module Overview and Example Lab Test Tutorial—to help illustrate the program.

- Module 1–MEPDG Basics.
- Module 2–MEPDG Inputs and Implementation for Subgrade and Base Materials.
- Module 3–MEPDG Inputs and Implementation for AC Pavement.
- Module 4–MEPDG Inputs and Implementation for JPCP.
- Module 5–MEPDG Inputs and Implementation for CRCP.
- Module 6–Hands-on Lab Training Workshop at University of Georgia Engineering Research Education Center.

Dr. Kim described the next steps in the development of the training program, which include integration into the DOT's Learning Management System (LMS), continued improvements to the training module videos, and updating the MEPDG training documents based on products from on-going DOT research studies. Dr. Kim also showed a short virtual reality video, which served as an idea for applying the virtual concept to lab testing.

Ms. Schofield (AASHTO) predicted there would be interest in this type of training program nationally.

14. ADDITIONAL PAVEMENT ANALYSIS TOOL FOR THE INTEGRATION TO PERFORMANCE ENGINEERED PAVEMENTS

Session 12 of the Users Group meeting featured a presentation on the development of a software program that integrates pavement structural design and mixture design. A summary of the information presented and subsequent discussions are provided below. A copy of the presentation is featured as presentation 21 in Appendix C.

1. ***FlexPave* (Mr. Richard Duval, FHWA)**—The FHWA's Performance Engineered Pavements (PEP) initiative unifies several existing performance focused programs under a single strategic program vision. It integrates long-term pavement performance with pavement structural design, mixture design, construction, and materials acceptance for both asphalt and concrete pavements. This presentation described the test methods that serve as the basis for PEP, as well as the ongoing development of software tools for developing performance-engineered mix designs (PEMD).

   Mr. Duval emphasized at the outset that the PEP tools are not intended to be a replacement for PMED. He indicated that it is up to the highway agency to determine which pavement structural design program to use, and that the results from the structural design are then used with the PEP tools to develop performance-related specifications (PRS) and mix designs and to test for performance acceptance.

   For asphalt pavements, the governing test methods include the dynamic modulus test, cyclic fatigue test, and stress sweep rutting test, all conducted using the Asphalt Mixture Performance Tester (AMPT). The software tools include FlexMAT (mixture analysis), FlexPAVE (pavement performance analysis), and FlexMIX (PEMD analysis), which are all packaged within the PASSFlex program. Although initial versions of each tool have been developed and are available to state agencies, the overall PASSFlex program is still under development. For concrete pavements, the counterpart PASSRigid program has been developed, but is currently being updated.

   In response to a question from Mr. Von Quintus (ARA) regarding the FlexPave performance models, Mr. Duval reported that the models were globally calibrated (based on 60 projects from around the world); no project-level calibration was performed. Mr. Shugart added that the models are finite-element models that calculate damage, and that the global calibration translates loss in modulus to distress.

15. FUTURE OF THE NATIONAL ME USERS GROUP

At the conclusion of the meeting, Mr. Wagner reiterated to the group that the New Orleans meeting is the final meeting under the current contract. He noted that, while the TPF-5(305) Pooled Fund is also nearing completion, the financial contributions made over the years by member agencies has yielded enough funds to continue the annual meetings. The FHWA plans to convene the TAC members before the end of the year to discuss the best way to use the funds for those future meetings (meeting format, content, duration, frequency, etc.). Based on the outcomes of that meeting, steps will be taken to solicit and secure a new contract that continues the meetings.

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