FHWA PAVEMENT ME USER GROUP MEETINGS

Sixth Annual National Meeting of the AASHTO Pavement ME User Group (PMEUG)
Technical Report

December 14-16, 2021 (Virtual Meeting)

https://www.pooledfund.org/Details/Study/549

Meeting Highlights and Key Takeaways

Attendance

- A total of 228 attendees participated in the meeting representing FHWA, AASHTO, the National Research Council of Canada, 38 state highway agencies, 5 Canadian provincial highway agencies, 1 county, 19 consulting firms, 20 universities, and 3 industry groups.

Agency Report-Outs

- Among the 38 reporting agencies, the PMED software version usage is as follows:
  - v1.0: 2 agencies using.
  - v2.1: 2 agencies using.
  - v2.2: 2 agencies using.
  - v2.3: 4 agencies using and 1 agency evaluating or in process of using.
  - v2.5: 5 agencies using.
  - v2.6: 11 agencies using, 7 agencies evaluating or in process of using, and 2 agencies with plans to use in the future.
  - v3.0: 1 agency with plans to use in the future.
  - Unspecified: 2 agencies.
- Agencies continue to work toward implementation by conducting material characterization (several agencies are focused on base layer characterization), sensitivity analyses, model calibration or re-calibration, and updating of agency PMED manuals.

AASHTO and PMED Software Updates

- AASHTOWare continues to support implementation efforts through PMED webinars.
- The NCHRP 1-51 concrete slab interface friction model has been integrated and will be available in PMED v3.0.
- The rigid pavement global recalibration is complete and includes the integration of MERRA climate data and the NCHRP 1-51 slab interface friction model.
- PMED v3.0, the web-based application, is anticipated for release on July 1, 2022.
- PMED v3.0 will include the full suite of supplementary tools, such as MapME, the Calibration Assistance Tool (CAT), and the Backcalculation Tool (BcT).

Open Forum Discussion—Practical Approaches to PMED Design of Overlays

- Agencies are challenged with obtaining Level 1 design inputs.
- The more reliable the inputs, the improved confidence in the resulting design analysis.
- Discussions centered around challenges and how best to determine the highest level of inputs given time, staffing, and budget constraints.

Meeting Highlights and Key Takeaways (continued)

PMED Software Training

- Topic 1: Perpetual/Long-Life Design of Flexible Pavements – Linda Pierce (NCE).
- Topic 2: Designing with Geotextiles – Harold Von Quintus (ARA).
- Topic 3: Unbonded PCC Overlay Design – Julie Vandenbossche (University of Pittsburgh).

PMEUG Future Events

- The 2022 User Group meeting will be held in the November/December timeframe and is expected to be held as a face-to-face meeting.
- Two PMED software training webinars are being planned for 2022. The first one is being targeted for April and the second one for August.
- Planning of the Implementation RoadMap workshop is underway. It is being targeted for April of 2022 and is expected to be face-to-face.

PMEUG Future Training Topics

- Potential future training topics (in order of preference):
  - Overlay Design using Limited Available Data on the Existing Pavement.
  - Consideration of Subgrade Stabilization in Design.
  - PMED Models and Calculations: A Journey through the PMED Engine.
  - Linking Design with LCCA: Application of Structural and Functional Life Predictions.
  - Sustainability and Resiliency in Design.
  - Traffic Data Characterization and Input Level Selection.
  - Thin Preventive Maintenance Overlay Design.
  - Perpetual/Long-life Concrete Design.
  - Continuously Reinforced Concrete (CRC) Pavement Design.

TUESDAY, DECEMBER 14

1. Call to Order, Introductions, and Meeting Agenda and Goals – Dr. Linda Pierce NCE)

Linda Pierce called the meeting to order at 11:00 a.m. Central Standard Time (CST) and formally welcomed everyone to the 6th annual meeting of the American Association of State Highway and Transportation Officials (AASHTO) Pavement ME User Group (PMEUG) (see Attachment 1 for a complete list of attendees). She introduced other members of the project team, including Kelly Smith and RoseMary Evans with Applied Pavement Technology, Inc. (APTech) and Julie Vandenbossche with the University of Pittsburgh, and referenced the vital role of the Transportation Pooled Fund (TPF)-5(305) study (*Regional and National Implementation and Coordination of ME Design*) in the conduct of the annual meetings. After discussing the meeting agenda (see Attachment 2), she and Kelly reviewed the virtual meeting protocols and stressed the importance of audience participation.

2. FHWA Welcome – Dr. Jennifer Albert (FHWA)

Jennifer Albert welcomed everyone to the annual meeting and expressed her optimism for returning to an in-person event in 2022. She strongly encouraged attendees to engage, participate, and ask questions in order to achieve a successful meeting outcome.

Jennifer provided a short summary of the FHWA task order covering the PMEUG meetings. The 3-year task order was initiated in August 2020 and involves the planning and conduct of three annual meetings, the development and delivery of up to six software training webinars, and the development of a Pavement ME Design (PMED) Implementation RoadMap supported by a 1.5-day RoadMap workshop. Jennifer recapped the events that have taken place to date (i.e., the 2020 User Group meeting and two software training webinars in 2021) and spoke on the events planned for 2022. She noted that upon completion of the task order, it is expected that AASHTO will assume responsibility for conducting future meetings.

Jennifer reported on plans for the Montana DOT Pavement Design Peer Exchange, an in-person event originally proposed for 2020 but now scheduled for March 2022. The DOT has a renewed interest in PMED implementation and desires discussions and input from other agencies regarding various implementation issues. Jennifer also briefed the participants on FHWA's effort to update its Pavement Design Policy. FHWA is working on developing language for the policy and is moving forward with rulemaking. A brief description of the rulemaking and the planned schedule is available at Reginfo.gov (RIN 2125-AF96).

Jennifer concluded her talk by mentioning other FHWA activities, including an update of its website (https://www.fhwa.dot.gov/pavement/), development of a pavement design clearinghouse (https://www.fhwa.dot.gov/pavement/pavement policy/), and a nearly completed study linking pavement design to asset management (link forthcoming). Jennifer can be contacted at jennifer.albert@dot.gov.

3. AASHTO COMP and PMED Task Force Remarks – John Donahue (Missouri DOT) and Clark Morrison (North Carolina DOT)

John Donahue, Chair of Technical Subcommittee 5D (Pavement Design) of the AASHTO Committee on Materials and Pavements (COMP), provided a brief update on the subcommittee's activities. He indicated that a revised version of the 2008 AASHTO *Guide for Pavement Friction* was balloted and approved by the COMP in 2021 and that a published version is expected in late spring or early summer of 2022. John also reported on efforts to incorporate language on permeable pavements (i.e., pervious concrete, permeable asphalt, interlocking pavers) into the AASHTO *Pavement Design, Construction, and Management Handbook* (https://store.transportation.org/Common/DownloadContentFiles?id=1442). Finally, John informed the group that he is stepping down as chair of Technical Subcommittee 5D and that he will be succeeded by Dulce Rufino Feldman (California DOT).

Clark Morrison, Chair of the AASHTOWare PMED Task Force, reported on the current membership of the task force and recognized the following individuals for their contributions as the PMED v3.0 technical review team:

- Xingwei Chen (Louisiana DOTD).
- Jason Blomberg (Missouri DOT).
- Justin Schenkel (Michigan DOT).
- Nick Cosenza (Indiana DOT).
- Clark Graves (University of Kentucky).
- Paul Mykytka (WSP).

4. Canadian Update – Susanne Chan (Ontario MOT)

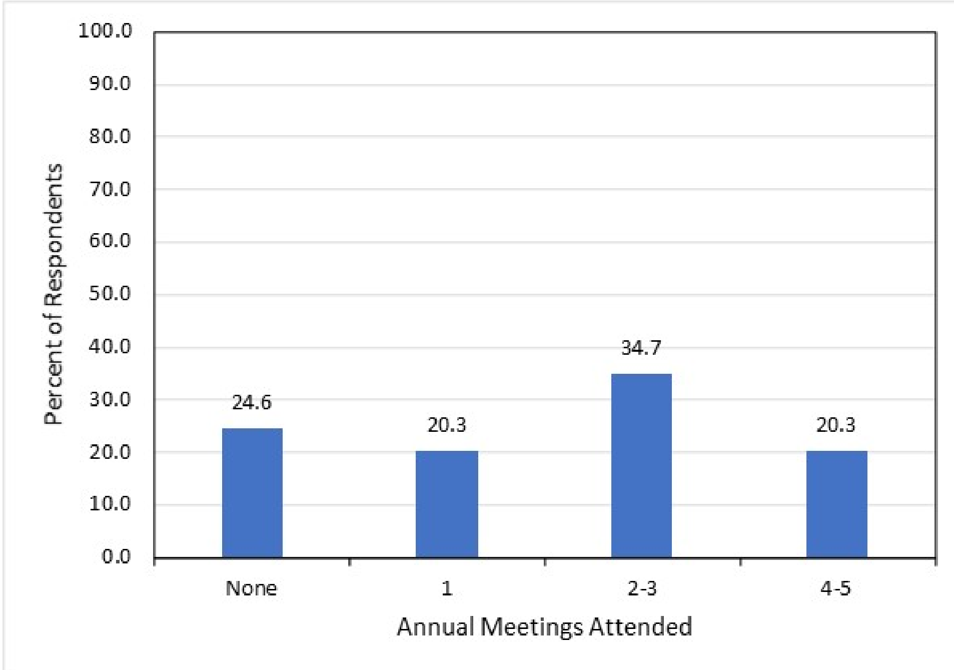
Susanne Chan updated the participants on the activities of the Transportation Association of Canada (TAC) ME Pavement Design Subcommittee. This group consists of 28 active members representing highway agencies, consultants, industry, and academia. Its meetings have been conducted regularly since 2008 and have featured invited speakers covering various topics. At the 2021 TAC Conference, it hosted panel discussions on PMED inputs.

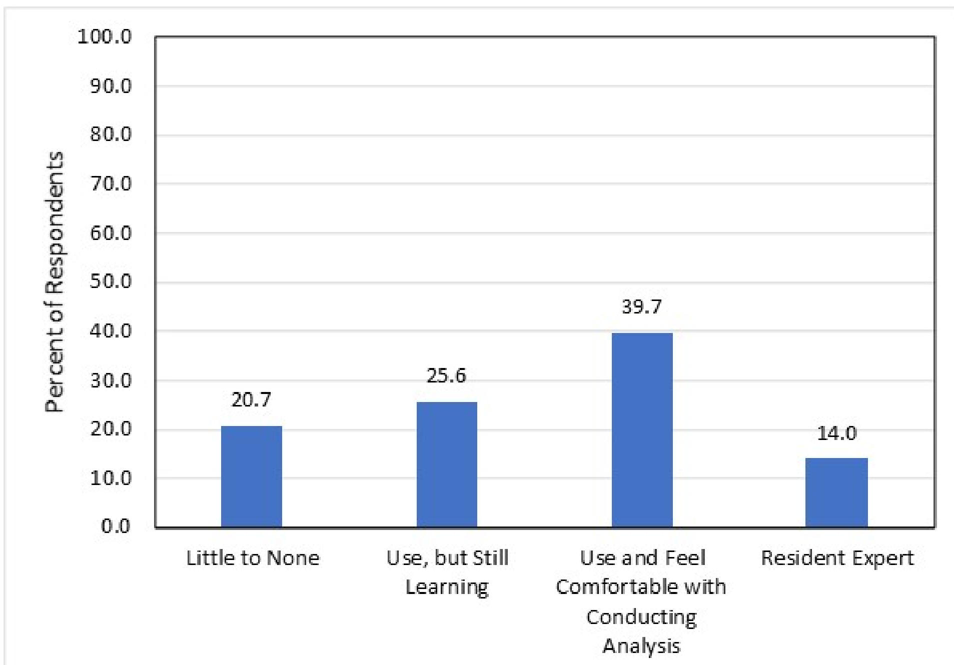
Susanne spoke on several recent ME design trials undertaken by the subcommittee. The trials are primarily focused on pavement performance associated with different foundation (granular base and subbase, subgrade) designs, but also include a trial on the performance of thin asphalt pavements. She reported on other work activities, including the development of a step-by-step Pavement ME User Guide (v2.6), continued updates to the *Canadian User Guide: Default Parameters for AASHTOWare Pavement ME Design*, and the compilation of PMED challenges and limitations for consideration by the AASHTO PMED Task Force.

Following Susanne's presentation, the APTech project team introduced the first two poll questions to the group:

- *How many annual PMEUG meetings have you attended (prior to this meeting)?*
- *What is your level of Pavement ME Design knowledge/expertise?*

A total of 118 and 121 people, respectively, responded to the poll questions and the results are shown below. As can be seen, nearly 25 percent of the respondents have not attended a meeting prior to this one, whereas 55 percent have attended at least two meetings. For those that have attended just one annual meeting, it is suspected that most attended last year's virtual meeting. Over half of the poll participants indicated a strong or fairly strong understanding of Pavement ME Design. About 25 percent professed to using the design procedure but continuing to learn about it, while about 20 percent reported knowing little or nothing about the procedure.





5. Agency Implementation Updates/Report-Outs – Designated Agency Speakers

This session of the meeting focused on agency reporting of PMED implementation status. As in past meetings, Linda Pierce and Kelly Smith showed the group the latest implementation maps for asphalt and concrete PMED and requested that each designated agency speaker provide an update of their agency's implementation status. Speakers were also asked to touch upon how PMED is being used (e.g., formal use on all projects or only select projects, sole use or parallel use with other design procedures, evaluation/research only) or not used, what the agency's future plans are for PMED use, what implementation-related activities (including calibrations) have been going on, and what challenges and issues have been encountered.

A summary of the key aspects of PMED implementation provided by the various agency speakers is provided in the table below. In addition, the information presented by the speakers was used to update the PMED implementation maps. These maps are shown after the table.

State/ Province	HMA Character-ization	PCC Character-ization	Unbound Layer & Subgrade Soil Characterization	Local Calibration	Parallel Design	Implementation	Current PMD Version	User Guide/ Design Manual
AL	Developed database for Level 1 & 2; conducted local verification and asphalt mix characterization (2019)	Developing database	Subgrade soils completed; study on limestone bases	Adding calibration sites, sensitivity analysis, local calibration of asphalt (Nov 2022)	Conducting design comparisons with AASHTO 1993	Trained field personnel; use AASHTO 1993	N/A	N/A
AK (no 2021 update)	Ongoing dynamic modulus University studies	N/A	Ongoing studies	N/A	N/A	No plans	N/A	Alaska Flexible Pavement Design Manual
AB	Level 1 and 2 inputs (150 road segments)	N/A	Some testing	Working on site selection	Consultant designs (150 projects)	In progress	v2.6.1	Pavement Design Manual
AZ	Completed	Completed	Completed	2010-2012; use global calibration defaults; recalibration with v2.6	2012-current	2019; parallel with AASHTO 1993 and AZDOT SODA method on select projects	v2.1 evaluating v2.6	Pavement Design Manual; update with v2.6
AR (no 2021 update)	Completed	—	Completed	Asphalt only	AASHTO 1993	Planning to implement	—	In progress
BC (no 2021 update)	N/A	N/A	N/A	No plans	N/A	No plans. Currently reviewing other agency efforts	—	N/A
CA	N/A	N/A	N/A	Global coefficients applicable to California conditions	N/A	2008 JPCP and CRCP only	—	Updating Highway Design Manual, Chapter 620
CO	Yes, including CIPR dynamic modulus; polymerized asphalt (2019)	—	—	2010-2011; full calibration anticipated 2021	2012-2014 with AASHTO 1993	2014	v2.3.1; plans to implement v2.6.2 in 2022	ME Pavement Design Manual
CT (no 2021 update)	—	—	—	—	—	Planning to implement	—	—
DE (no 2021 update)	—	—	—	—	—	Planning to implement	—	—
FL	Rutting and top-down cracking; Texas A&M study for v2.6	Constructed concrete pavement test road (52 sections)	—	Developing roadmap (complete 2023)	AASHTO 1993 for asphalt designs, evaluating v2.6	Concrete only, AASHTO 93 for asphalt	v2.2.6	Rigid Pavement Design Manual
GA	Added polymer mix types	Finishing concrete properties soon	—	Initial calibration in 2015 (v2.2.3). Plan to use CAT for v2.6 calibration	Continuing comparison testing	Planning to implement; currently using AASHTO 72/81	In progress v2.3.1; looking at v2.6, implement v3.0 in future	Yes

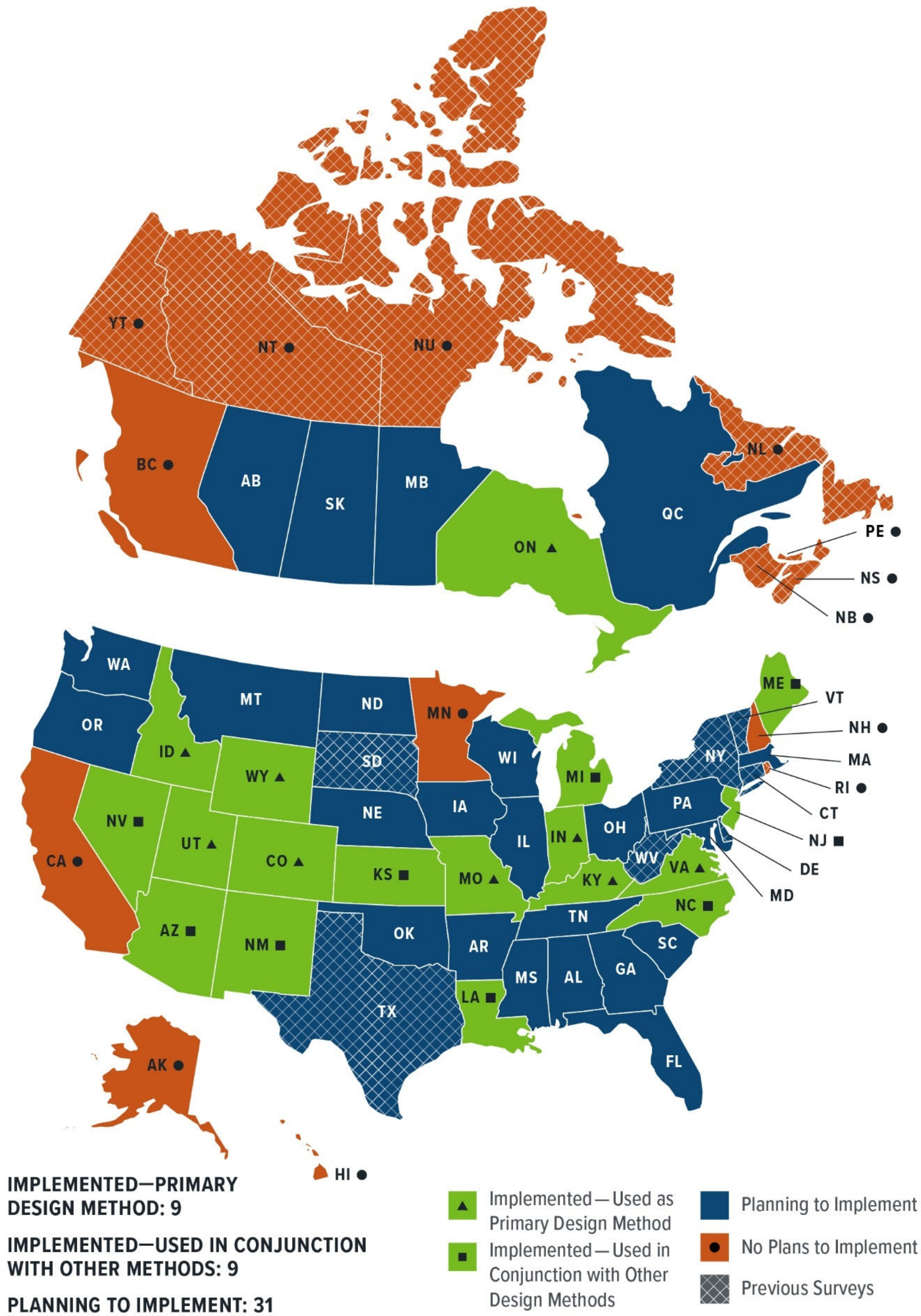
State/ Province	HMA Character-ization	PCC Character-ization	Unbound Layer & Subgrade Soil Characterization	Local Calibration	Parallel Design	Implementation	Current PMD Version	User Guide/ Design Manual
HI (no 2021 update)	Moving toward polymer-modified and SMA mixes	N/A	N/A	N/A	N/A	No plans	—	N/A
ID	Completed; noted issues	Completed	Completed	Initiated in 2012, 2018-19 completion	PMED consultant designs	2020	Noted issues with v2.5.3 calibration	—
IL	N/A	N/A	N/A	N/A	N/A	Use IDOT ME design method. Potentially will use PMED to develop CRCP design catalog	—	N/A
IN	Level 1 and 2 inputs	Level 1 and 2 inputs	Level 1 and 2 inputs	2009/10; 2017 rutting models	—	2010; approximately 500 designs per year	v2.3; v2.6 in near future	
IA	Need creep compliance	Need additional CTE testing	Need better base and subgrade inputs	Completed (3rd calibration)	PCA for concrete and PerRoad for asphalt pavements	Planning to implement; not using for asphalt overlay design	—	—
KS (no 2021 update)	Completed	Completed	On-going, base stabilization	Completed (2nd calibration)	AASHTO 1993	Yes, but conducting parallel designs while reassessing procedure	v2.5	Planning to develop internal document
KY	Limited dynamic modulus testing	No	—	Verification using v2.3 and v2.5	—	HMA, concrete 2019 (online design catalog based on v2.5)	v2.6 for asphalt overlays	Pavement Design and website access
LA	Completed	Completed	Completed	v2.3 for both asphalt and concrete	AASHTO 1993	Yes, but conducting parallel designs	In process v2.6.1	Pavement Design Guide
ME (no 2021 update)	In progress	No	Yes, working on subbase data	v2.6	AASHTO 1993 & PMED with global coefficients	HMA only; but have concerns with moving forward	v2.6	—
MB	Completed	—	Level 1 for base and subgrade, Level 3 for subbase	Collecting data on 30 sites	AASHTO 1993 (selected projects)	Planning to implement v2.6 once successfully calibrated	v2.6	Updating User Manual
MD	Completed	—	Completed	Local calibration for HMA only (June 2022); looking at v2.6	AASHTO 1993 & PMED with national models	Planning to implement. On hold for funding reasons	—	Pavement & Geotech Design Guide updated
MA (no 2021 update)	—	—	—	—	—	Planning to implement	—	—
MI	Completed (Level 1)	—	Completed	3rd effort planned 2022	Use AASHTO 1993; ±1 inch deviation with PMED	Originally 2014; on hiatus 2015-2018; all reconstruction projects 2019	v2.3 v2.6 planned 2022	ME Pavement Design User Guide
MN	N/A	N/A	N/A	N/A	N/A	Use MnDOT ME design procedure;	v1.1 for concrete	N/A
MS	On-going (69 LTPP field section); follow-up using SMA and polymer-modified mixes	—	Processing FWD data for stabilized base and subgrade	In progress	—	Planning to implement in 2022	—	—

State/ Province	HMA Character-ization	PCC Character-ization	Unbound Layer & Subgrade Soil Characterization	Local Calibration	Parallel Design	Implementation	Current PMD Version	User Guide/ Design Manual
MO	Conducting recycled HMA characterization; additional Level 1 inputs	—	—	Initial calibration in 2009, 2nd calibration in 2019	—	2004 (national models)	v2.6.1	—
MT	—	—	Using R-value for subgrade, but looking to go to resilient modulus	—	Using AASHTO 1993	No plans at this time	—	—
NE	—	—	—	Initiated 2019; use mostly global coefficients	—	Planning to implement 2021	v2.6	In progress
NV (no 2021 update)	Completed	Completed	Database (regional calibration) of unbound SWCC inputs	Asphalt reflective cracking model; national calibration values for concrete	AASHTO 1993	2015	v2.3.1	Updating ME Design Manual
NB (no 2021 update)	—	—	—	—	—	No plans	—	—
NH (no 2021 update)	—	—	—	—	AASHTO 1972	No plans	—	—
NJ	Completed Level 1	—	—	Flexible pavements only	AASHTO 1993 for resurfacing; using PMED as a cross check	Yes	v2.6.1	Traffic User's Manual
NM (no 2021 update)	Yes	CTE study	—	asphalt only	AASHTO 1993	2019	—	—
NY (no 2021 update)	—	—	—	—	—	Planning to implement	—	—
NL (no 2021 update)	—	—	—	—	—	No plans	—	—
NC	Completed	Completed	Yes	New calibration study for flexible designs	Yes, use AASHTO 1993 with PMED shadow design	Yes, 2011-2015, currently using AASHTO 1993, but will re-implement PMED in future	—	—
ND	Working on HMA mix characterization	Yes	Yes	2013-2014 concrete, asphalt recalibration with v2.5 release	AASHTO 1993 for asphalt rehabilitation, new PCC and PCC overlay designs	Yes, concrete (primarily default values, NDDOT CTE values); AASHTO 1993 for asphalt	v2.5.5	—
NS (no 2021 update)	—	—	—	—	—	No plans	—	—
OH	—	—	—	2009 LTPP sites resulted in over and under design comparisons; will recalibrate in 2022	—	No specific plans. PMED sometimes used for major rehabilitation designs.	—	—
OK (no 2021 update)	—	—	—	PCC only; asphalt underway	AASHTO 1993	Planning to implement (AASHTO 1993 primarily used)	—	—

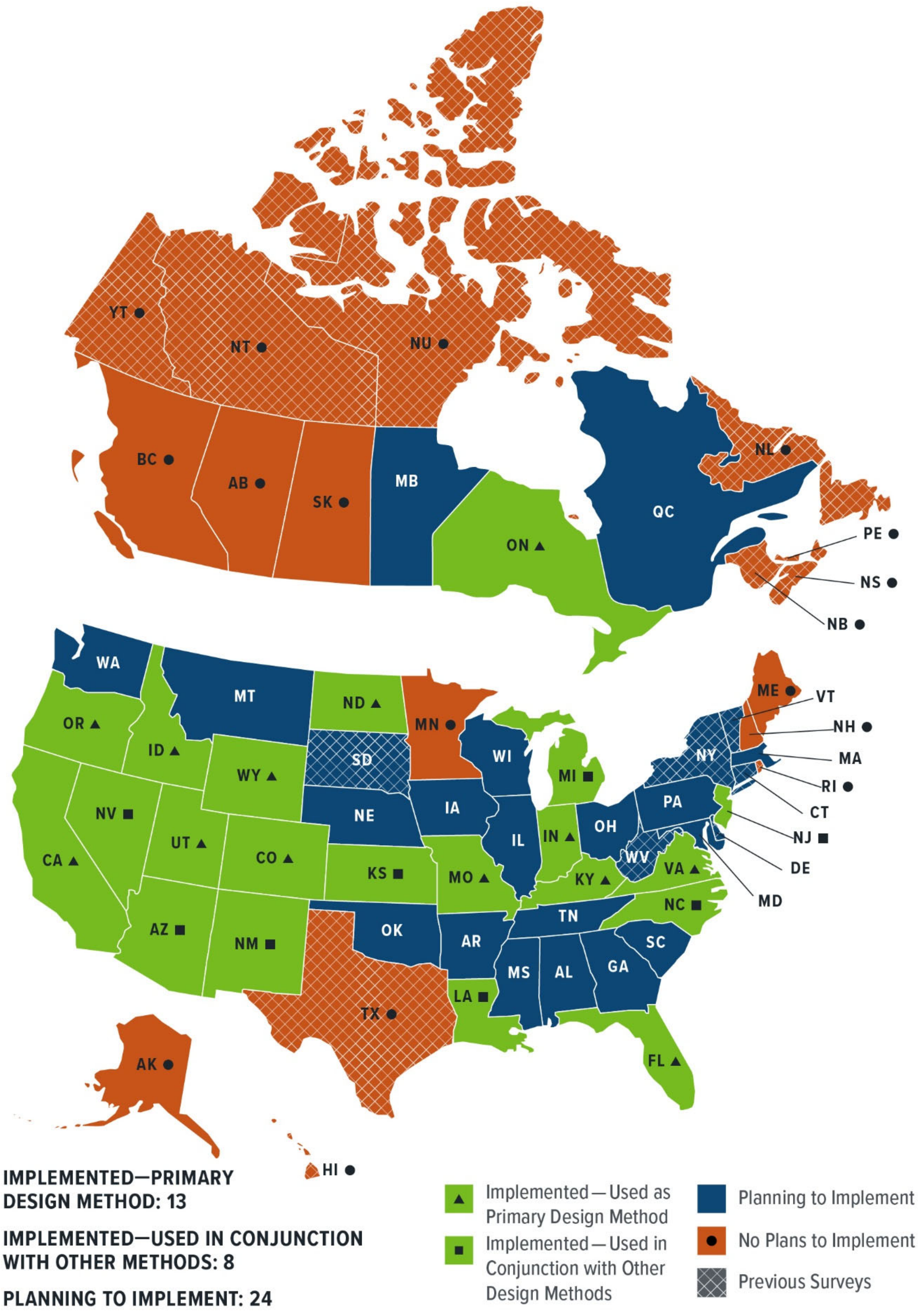
State/ Province	HMA Character-ization	PCC Character-ization	Unbound Layer & Subgrade Soil Characterization	Local Calibration	Parallel Design	Implementation	Current PMD Version	User Guide/ Design Manual
ON	Level 3	Level 3	Level 3; some subgrade characterization	v2.5.1 asphalt models (2015); verifying concrete models	Yes	Consultants required to use PMED as check for high-profile projects; agency use for forensic studies and project-specific designs	v2.6	Updating Design Guide; developing step-by-step guide
OR	Completed	Completed	—	Poor validation results for asphalt pavements	—	CRCP designs	v2.5	Yes
PA	Completed; includes SMA and RAP	Completed	Completed	2017 asphalt and concrete (v2.3.1), 2018 review with v2.5; use local calibration coefficients for asphalt and concrete	Yes, AASHTO 1993 (for truck traffic > 500 vehicles)	Concern with quantifying frost heave, impact of CTE, and faulting; waiting for NCHRP 1-59 implementation; PITT-RIGID simplified version of PMED	v2.5.5; looking at v2.6	User Guide, Pavement Policy Manual
PE (no 2021 update)	—	—	—	—	—	No plans	—	—
QC	Completed	Completed	—	Year 1 of 3 for asphalt pavements (200 sections, no sampling or testing); challenges with quantifying traffic, subgrade, top-down vs. bottom-up cracking, and incorporating frost heave in design	—	In progress	—	—
RI	Conducting materials characterization	—	Conducting materials characterization	Regional effort	—	No plans	—	—
SK	Collected data will work with PMED	—	Collected data will work with PMED	—	—	Developing an implementation plan	v2.6	—
SC (no 2021 update)	Completed	Completed	Aggregate base, cement treated/stabilized bases and subgrades	On-going study	AASHTO 1972 for lower volume routes	Developing design catalog	—	—
SD	—	—	—	—	—	Research study to look at full-, partial, or no PMED implementation	—	—
TN	Completed 2013	Completed 2013	Completed 2013	2015	AASHTO 1993	Planning to implement by August 2021	—	User Manual and Input Design Guide
TX (no 2021 update)	Completed	—	—	—	—	Considering asphalt models only	—	—

State/ Province	HMA Character-ization	PCC Character-ization	Unbound Layer & Subgrade Soil Characterization	Local Calibration	Parallel Design	Implementation	Current PMD Version	User Guide/ Design Manual
UT	Completed, working on top-down cracking, E* curves, and data library	Completed	Completed	Completed	No (PMED is only design method used)	2010; new and reconstruction only	v2.6.1	Pavement Design Manual of Instruction
VT	Underway	—	Underway	National calibration values (2015)	AASHTO 1993	Planning to implement	v2.5.4	Draft
VA	Level 1	—	—	2015	—	2018, new and reconstruction (ADTT > 10,000)	v2.2.6	Yes
WA	—	—	—	JPCP in 2005 and asphalt in 2008	—	In progress. Design catalog updated in 2009 is used as a baseline	v1.0	Pavement Design Policy
WV (no 2021 update)	—	—	—	—	—	Planning to implement	—	—
WI	Updating	Completed	Completed	2014 using v2.1. Recalibration in progress with v2.5.5	—	Pilot implementation in 2014, problems and reverted back to AASHTO 1972 (WisPave 4) in 2018	v2.1; but inconsistent design results	Yes (updating when recalibration is complete)
WY	—	—	On-going study	2012-2015 study, use local calibration coefficients	—	Implemented in 2012; challenges with reclamation and CIR projects	v2.6	—

PMED Implementation Status (12/14/21)—Asphalt Pavements and/or Overlays



PMED Implementation Status (12/14/21)—Concrete Pavements and/or Overlays



6. AASHTO Briefing – Ryan Fragapane (AASHTO)

Ryan Fragapane gave a brief overview of the AASHTOWare program management, from the highest level (AASHTO Board of Directors) down to the lowest level (product and project task forces and user groups). He described the task force member appointment process and the corresponding terms of members, once appointed.

Ryan provided links to the AASHTOWare (https://www.aashtoware.org/products/pavement) and ARA (www.me-design.com) websites and described the types of pertinent PMED information available on each site (including the PMEUG meeting and training webinar recordings and materials posted on the AASHTOWare site). He discussed three FY22 webinars put on by the Pavement ME Task Force ("Use of Reflection Cracking Control Measures and Their Simulation in the PMED Software" conducted on October 20, 2021, "Use of Innovative Materials within the PMED Software" scheduled for January 5, 2022, and "PMED v3.0" expected later in 2022) and he invited suggested topics for a fourth webinar in 2022.

Ryan provided a summary of AASHTOWare PMED licenses and described *AASHTOWare's Training and Implementation Assistance* program and *Executive Business Review* efforts. He touched upon AASHTOWare's Web Technology Application (WTA) development efforts, which were initiated in FY19 and will continue into FY22. He pointed out that alpha and beta testing of the WTA system is about to start and that deployment will take place afterwards.

Lastly, Ryan stated that AASHTOWare will take over the User Group meetings starting in FY23. They are working with the ME Task Force to outline the structure of the user group and will be seeking a chairperson(s) for the group.

Justin Schenkel inquired about the cap on the number of users that can use the educational version of the software. Ryan stated that the cap is set at 25 seats and that the purpose of the cap is to protect the intellectual property of AASHTO and its members. He indicated that the cap will be less of an issue once the WTA is deployed.

7. Software Enhancements/Updates – Chad Becker (ARA)

Chad Becker provided an overview of the enhancements and updates being made to v3.0 of the PMED software, which is scheduled for release on July 1, 2022 and will include the full suite of tools (backcalculation tool [BcT], calibration assistance tool [CAT], etc.). He reported that the recalibrated models and MERRA-2 climate data for rigid pavements have been integrated into the software, along with the slab interface friction model that was developed under NCHRP Project 1-51. He noted that acceptance testing of the slab interface friction model is underway and that all three enhancements (recalibrated models, MERRA-2 data, and interface friction model) will be made available only in PMED v3.0.

Chad provided a general demonstration of the software using various screenshots of the different modules, beginning with program registration and access. He described the process for creating new designs; selecting existing designs; and establishing, uploading, and editing the many design inputs (e.g., traffic, climate, materials properties, structure information). Enhancements in these areas include streamlined climate data retrieval, viewing of input graphs and data prior to conducting design runs (e.g., axle load distributions, dynamic modulus master curves, climate data), and an editable structure layer viewer. Enhancements are being made to the .dgpx input files, as well as .docx, .xlsx, and .pdf output files.

Chad also provided an overview of the concepts of tenants, libraries, and workspaces that are part of the new web application. Tenants pertain to an agency's administration of the software in terms of its users, roles, groups, and permissions. Libraries involve the agency's data, such as its specified performance criteria, calibration factors, and materials and traffic data. Workspaces pertain to the individual users and the framework within which users will be allowed to perform their designs.

Lastly, Chad provided a brief summary of the FY23 software development efforts. These include the migration of the BcT into the PMED v3.0 suite of tools, the JULEA refactor work (reviewing old Fortran engineering models, ensuring their correctness, and translating them to modern software engineering standards), and various user experience enhancements. Chad closed by informing the group of the AASHTOWare training webinar on "Use of Innovative Materials" scheduled for January 5, 2022.

Mohammadreza Mirzahosseini asked how traffic data for a given ESAL class and axle configuration can be imported. Chad indicated that ESALs cannot be directly imported into the application, but that they are computed for the user's convenience during the analysis run. In responding to another inquiry from Mohammadreza regarding the import of an .xml file for calibration coefficients, Chad informed that the user will click on a "context" menu that will enable loading of an .xml file into a design.

In response to a question from Joshua Freeman about what server will be used for v3.0, Chad indicated that they are targeting a "t" burstable instance in AWS, which has several advantages. Burstable instances allow a ramp up in performance and throughput during the day while accumulating credits during down times in the evenings and on weekends. Chad added that they are also considering one of the "m" instances in the event that the burstable instances are not cost effective.

Fernando Raul Yep Ramirez asked if the demo will be available to anyone interested in research. Chad indicated that there will be a beta test period (probably in May) where the software is opened to interested agencies (agencies interested in participating should contact AASHTO or ARA), but that prior to that time the demo app will only be available for testing purposes.

Responding to a question from Nadarajah Sivaneswaran, Chad confirmed that the web-based BcT will still be based on the EverCalc approach.

In addressing a question from Rami Chkaiban, Chad indicated that a user will not need to re-create old designs in PMED v3.0 and that such designs are forward compatible going back as far as v2.3. He added that it is the intent of AASHTOWare and the ME Task Force that a single license provide access to multiple versions of the software.

Finally, in response to a question from Alauddin Ahammed, Chad stated that PMED v3.0 will not include any new models developed under the NCHRP 1-53 study.

WEDNESDAY, DECEMBER 15

8. Wisconsin Calibration Update and HMA Materials Characterization – Tirupan Mandal (Wisconsin DOT)

Tirupan Mandal began his presentation by providing a brief update on the Wisconsin DOT's PMED calibration and implementation history. The agency conducted its first local calibration for flexible and rigid pavements in 2014 (using v2.1) and implemented PMED in 2016. Because of inconsistent designs due to issues with the models, the agency opted to move to parallel designs (PMED and AASHTO '72) and then reverted back to AASHTO '72 in 2017. In 2018, the Wisconsin DOT began a second local calibration effort. That effort is ongoing and is closely tied to an asphalt mixture testing study conducted between 2019 and 2021.

Tirupan described the asphalt mixture testing study in detail and presented some of the main outcomes. The study sought to update and expand the agency's HMA material properties, corresponding to recent changes in its specifications. A total of 17 surface and base mixtures, consisting of different binder grades, aggregate gradations, and varying percentages of RAP and/or RAS, were tested for dynamic modulus, creep compliance, repeated load plastic deformation, bending beam fatigue, and indirect tensile (IDT) strength. Test results led to the development of three clustered sets of dynamic moduli, six clustered sets of creep compliance and two recommended IDT strength values (for predicting the length of transverse cracks), and various calibration coefficients for both the rut depth transfer function and the bottom-up fatigue strength model.

Tirupan illustrated the differences in some of the material properties obtained through the Level 1 testing and the PMED Level 3 default model. He reported that a catalog of binders and mixtures was created (.xml files) for use in PMED flexible pavement design and he stated that the Wisconsin DOT will continue its recalibration efforts for both flexible and rigid pavements using the latest software version (v2.6).

Elie Hajj asked if there was any potential overlap moving forward between the asphalt testing study and the ongoing balanced mix design (BMD) efforts underway at the Wisconsin DOT. Tirupan stated there is no consideration of overlapping the two at this time.

Elie also asked if AASHTO is considering allowing users to change the coefficients for the Witczak prediction model for dynamic modulus, noting that the model has been observed to significantly overestimate the measured dynamic modulus of some polymer-modified asphalt mixtures. Harold Von Quintus shared that the Witczak equation is still the predominant one included in the software, but added that if agencies would like to see a different regression equation included, they can submit a request to the Pavement ME Task Force for consideration.

9. An Overview of Climate Parameter Incorporation in Structural Pavement Design and Opportunities for Resilient Adaptation – Austin Jarrell (FHWA)

Austin Jarrell provided an overview of climate parameter incorporation in pavement structural design and discussed and demonstrated opportunities for resilient adaptation. He described the differences between stationary climate data (historical observed or measured data) and future non-stationary climate data (modeled data using historical data and assumptions about GHG emissions) and compared the types of data used in the AASHTO

’72, AASHTO ’93, and MEPDG design procedures. While all three use stationary data, the MEPDG explicitly considers (on an hourly basis) temperature, precipitation, wind, sunshine, and relative humidity data (obtained from ground-based weather stations or atmospheric-based MERRA grid stations) through the enhanced integrated climatic model (EICM).

Austin used the above information as a backdrop for his master’s thesis research on opportunities for resilient adaptation. He discussed the research scope, which consisted of comparing the asphalt pavement temperature, dynamic modulus, and vertical compressive strain prediction capabilities of three versions of the EICM—the “current climate” Dempsey Model (CCDM) (currently used in PMED), the “current climate” Revised Model (CCRM) (a 2020 revision of the Dempsey Model), and the “future climate” Revised Model (FRCM) (revised Dempsey Model with future climate data obtained from the USDOT Coupled Model Intercomparison Project [CMIP]-5 tool). He also described the use of the Adaptive Layered Viscoelastic Analysis (ALVA) model for calculating total strain in the pavement.

Results of the analyses showed some differences in predicted pavement temperature distributions and asphalt dynamic moduli between the CCDM and CCRM versions, but considerably higher temperature predictions and considerably lower dynamic moduli predictions associated with the FRCM version. Additionally, a substantial increase in compressive strain was observed with the FRCM version at a pavement depth of 68 mm. Austin reported that the research study is on-going and will likely produce many additional findings. He recommended that pavement designers conduct parallel pavement design analyses using stationary and future climate data, and then use the results obtained with future data as a decision support tool.

In response to a three-part question from Justin Schenkel, Austin stated that:

1. *A site in Danville, Virginia was selected for the study and MERRA data (1997-2017) for that site was obtained and used, along with future climate data obtained from the USDOT CMIP-5 tool.*
2. *Only the differences in climate data were considered; traffic data was a constant among the analyses.*
3. *The future project used the same data set and same time frame.*

Mohammad Shafiee asked how climate inputs such as wind, humidity, and sunshine were treated for downscaling. Austin responded that these inputs are already considered in the data obtained from the USDOT CMIP-5 tool. Mohammad also asked if it is necessary to recalibrate the transfer functions that were originally calibrated with stationary climate data. Austin reported that it is not necessary to recalibrate the transfer functions.

In responding to a question from Affan Habib regarding if the MEPDG can be used for resilient design like extended and frequent flooding situations, Austin noted that his research focused only on temperature distributions, dynamic moduli, and total strains. He added that his understanding is that Pavement ME does not provide a method for accounting for increased frequency of flooding.

10. Canadian User Group Design Trials on Granular Base and Subgrade Materials – Alauddin Ahammed (Manitoba Infrastructure)

Speaking on behalf of the Canadian TAC Pavement ME Design Subcommittee, Alauddin Ahammed presented the results of the group's PMED software trials looking at the effects of granular base and subgrade materials on flexible pavement performance. These layers make up a significant portion of flexible pavement structures in Canada and the material types and properties can have a great impact on pavement performance.

Alauddin summarized the scope of the trials, which consisted of 20-year flexible designs performed using PMED v2.6 or v2.6.1 with variations in climate, granular base material, and subgrade material only. Trials 1A and 1B focused on six different granular base materials with different gradations and varying modulus and physical properties. Trial 1A modeled a 300-mm granular base placed on top of A-7-6 subgrade (no subbase layer), whereas Trial 1B modeled a 200-mm granular base placed on top of a 300-mm subbase and A-7-6 subgrade. PMED analysis involving 15 different project locations (and thus climates) throughout Canada showed no noticeable effects of granular base- (or subbase)-to-subgrade-modulus ratio on the predicted performance trends (IRI, total rutting, AC rutting, bottom-up fatigue cracking, top-down fatigue cracking, and thermal cracking). Climate conditions, on the other hand, affected all performance measures except thermal cracking, which showed no predicted performance differences by climate/location. Additionally, base material type was observed to have a noticeable impact on predicted fatigue cracking.

Trials 2A and 2B focused on the effect of granular base sources and properties and the effect of granular base gradations, respectively. The model for both trials consisted of a 200-mm granular base placed on top of 300-mm subbase and A-7-6 subgrade. In Trial 2A, PMED analysis involving six different granular base materials (and corresponding resilient moduli) designed for three project locations showed a noticeable base material impact on total rutting and a significant impact on bottom-up fatigue cracking when the resilient modulus is very low. In Trial 2B, PMED analysis involving three different base material gradations designed for three project locations showed no considerable effect on the predicted performance measures. However, a noticeable impact was observed when seasonal moduli were used instead of annual moduli.

Trials 3 and 4 focused on the effects of granular base thickness and subgrade type and stiffness, respectively. PMED analysis of alternative base/subbase structures designed for three project locations showed a significant effect on bottom-up fatigue cracking only. Analysis of six different subgrade types (and corresponding resilient moduli) designed for three project locations showed unexpected and inconsistent trends for total rutting, AC rutting, and bottom-up fatigue cracking.

Alauddin concluded his presentation by discussing upcoming Canadian software trials. These include investigations of the effect of subbase layer thickness and stiffness on flexible pavement performance, as well as studies on concrete materials and thin asphalt.

Linda Pierce inquired about the proper selection of granular base stiffness value, given the various source options (Manitoba Guide, MEPDG MOP, CBR vs M_r, lab testing) captured in slide 31 of Alauddin's presentation. Alauddin explained that for their purposes, they developed moduli from laboratory testing, and that they compare the lab-measured values *with values obtained from CBR (if the CBR-based values are too high, they try to correlate with the lab-measured values).*

In responding to a follow-up question from Linda regarding adjustment from a field (dynamic) modulus to a laboratory (static) modulus, Alauddin indicated that they do not backcalculate anything for their designs.

11. Evaluation of Soil Water Characteristic Curves in Pavement ME for Nevada's Unbound Materials – Sarah Stolte (NCE)

Sarah Stolte presented on a study completed in 2018 for the Nevada DOT that evaluated the impact of soil water characteristic curves (SWCCs) on Pavement ME Design. At the time of the study, the agency had just transitioned to the MEPDG for flexible design and had developed design property inputs for asphalt mixtures. Because similar design inputs for unbound foundation materials had not been developed, the subject study was undertaken to create a database for Nevada unbound materials via the collection and review of historical records and the collection and laboratory testing of unbound materials throughout the state. The study objectives also included conducting sensitivity analysis of the defined material properties using PMED and incorporating the materials database into Nevada DOT's MEPDG manual.

Sarah briefly described the unbound material collection effort and the subsequent laboratory evaluation work. Material properties tested included gradation, Atterberg limits, moisture density, specific gravity of solids, R-value, methylene blue value (MBV), percent fines content (PFC), SWCC, and saturated hydraulic conductivity (k_{sat}). She noted that the SWCC parameter can be defined at each of the three PMED input levels—(1) measured, (2) correlated to PI and gradation, and (3) typical value based on AASHTO soil classification. She also described the agency's then-current SWCC recommendation, which consisted of using input level 3 for base materials and the ASU soil map for subgrade materials.

After completion of the laboratory evaluation and material property development phase, the study focused on determining the impacts of the properties on new flexible pavement design. The sensitivity testing involved using the three PMED input levels and Nevada DOT's current recommendations for SWCC inputs in designs consisting of an HMA surface placed on a 16-inch aggregate base and semi-infinite subgrade. To capture the variations in traffic and climate throughout the state, a project from each of the department's three districts was used. Key findings from the sensitivity analysis were that SWCC and k_{sat} have an impact on bottom-up fatigue cracking. Additionally, the DOT's then-current SWCC recommendations underestimated the impact of SWCC and k_{sat} on design in one district, but overestimated the impact on design in another district. Lastly, the SWCC input level was shown to have little or no impact on design in a third district.

Sarah concluded her presentation by discussing the recommendations given for Nevada DOT's MEPDG manual. These included a comprehensive database for base material properties along with lab-derived district-specific design input values. District-specific Level 2 SWCC correlation models were also developed and recommended.

In response to a question from Justin Schenkel, Sarah reported that the HMA design thickness increment used in the sensitivity analysis was 0.5 inches.

12. Modulus Mapping for Deterministic Pavement Foundation Characterization: Findings from FHWA AID and Iowa DOT Program – David White (Ingios) and Chris Brakke (Iowa DOT)

David White and Chris Brakke delivered a joint presentation on modulus mapping technologies for deterministic pavement foundation characterization. The presentation covered the work of Ingios and the Iowa DOT under the FHWA's State Transportation Innovation Council (STIC) program and the Iowa DOT's Accelerated Innovation Deployment (AID) program, as well as follow-on efforts to fully implement the modulus mapping technology in Iowa.

David began the presentation by noting the advancements being made in pavement materials and the increased focus in recent years on pavement foundation aspects (from design to construction to long-term sustainable behavior). As evidence of the latter, he referred to the results of a 2021 national survey, which showed widespread interest among state DOTs for more effective QA and deterministic foundation assessment.

David described intelligent compaction (IC) and accelerated plate load testing (APLT) technologies. He discussed how testing on many foundation materials in Iowa under the STIC project resulted in only 31 percent of the tests having a k-value of at least 150 $lb/in^2/in$ (the minimum design value in Iowa DOT's rigid pavement design procedure). This provided the basis for the AID project, which transformed the IC roller into a certified modulus measurement tool, capable of real-time, full-coverage k-value measurements calibrated to the APLT. Through the identification of weak areas, the modulus mapping technology provides important timely information about additional compaction needs and/or mechanical or chemical stabilization needs.

David espoused some of the benefits of modulus mapping, including an estimated reduction in pavement costs of 10 to 20 percent, an estimated increase in pavement life of 20 to 50 percent, and the avoidance of costly project delays. He reported on the 2021 deployment of the technology on two pilot projects in Iowa: one on US 20 in Black Hawk County and one on IA 17 in Boone County. Chris added that the Iowa DOT's 5-year implementation plan calls for transitioning from the two pilot projects in 2021 to statewide implementation in 2025. He shared typical bid prices for compaction, geogrid stabilization, and cement stabilization and concluded the presentation with a brief review of the department's next steps (e.g., identifying specification and design changes, developing special provisions for future use, and making use of Federal funding to assist in implementation).

In response to a question from Prajwol Tamrakar, David and Chris reported that the bid price reported for geogrid stabilization was for a standard biaxial geogrid.

13. Use of APLT Technology in Pavement ME Design – Chris Brakke (Iowa DOT) and Garrett Fountain (Tensar)

Chris Brakke gave a follow-up presentation covering Iowa DOT's approach to using ALPT technology to supplement its pavement design process. He reported that Iowa's highway system is seriously underfunded and that there is a need to extend pavement lifespans from the current ±40 years to 100+ years. Long-life/permanent foundations are considered key in this regard, and this requires improving foundation uniformity and construction quality. Chris referenced the projects undertaken in recent years under the FHWA STIC and Iowa DOT AID programs as the key drivers for improving foundations.

Next, Chris discussed the implications of their foundation improvement efforts on pavement design (Iowa DOT is transitioning to PMED for new HMA and PCC design). He described the current lack of a process for verifying whether foundation strength design values are achieved in the field and indicated that performance specifications using modulus mapping provides an opportunity to improve the situation. For instance, APLT testing can be used to quantify in situ moduli that are achievable with a wide range of foundation materials, and the resulting values would be much closer to reality that what has traditionally been used.

In closing, Chris expressed optimism that the department can achieve their 150-lb/in^2/in design k-value for PCC through close construction monitoring via modulus mapping and through additional compaction efforts and/or stabilization activities. He solicited input and guidance on how to incorporate APLT test moduli in PMED for situations where a subgrade is mechanically (geogrid) or chemically stabilized. *Kelly Smith informed Chris and the group that this issue would likely be addressed in Harold Von Quintus' software training session on Designing with Geotextiles.*

Garrett Fountain shared Tensar's use and experience with the APLT technology. The company has conducted testing on foundation materials throughout much of North America for more than 8 years. The APLT device is transported by trailer to a job site and is capable of conducting a test at a single location in about 30 minutes.

Garrett also spoke about the uncertainties of conventional approaches in establishing design M_r values. For instance, there are several agency-established correlations between R-value and M_r, some of which vary widely from each other. Similarly, there are significant variations in FHWA-suggested ranges for M_r corresponding to different AASHTO soil classifications. Garrett stressed the importance of recognizing that foundation materials are stress dependent and pointed out that the APLT provides the ability to measure in situ the k_1, k_2, and k_3 parameters that are part of the stress-based M_r equation used in PMED.

Fernando Ramirez inquired about the source for the nomograph shown in Garrett's slides. Garrett indicated that the nomograph came from a FHWA website.

In response to a question from Alauddin Ahammed, Garrett stated that the APLT can be used on a paved surface. David White added that it can be used on both rigid and flexible pavements.

14. Practical Approaches to PMED Design of Overlays: Open Forum Discussion – Meeting Participants

Linda and Kelly led an open forum discussion related to practical approaches for PMED overlay designs; specifically, when there is limited or no project-specific field data (i.e., materials characterization, deflection testing). Participants were asked to provided viewpoints on how to determine level 2 inputs, reliability values, performance criteria, and reasonableness of results. Below are some of the key discussion items from the open forum.

- Harold Von Quintus noted that in order to reduce the risk, conducting testing to quantify the existing pavement is important.

- Bill Barstis asserted that if inputs are difficult to obtain, there may be a need to revert to a less data demanding design procedure.
- Justin Schenkel commented that Michigan DOT maintains a large pavement network, but it is difficult to due materials characterization in support of PMED. However, the Department would like to use PMED as much as possible. Justin is looking into a research project on this topic.
- Chris Brakke suggested identifying and focusing on quantifying those inputs that have the highest significance. It may be difficult to do it for all inputs, but one could select values and bracket the range, and determine if the resulting design difference is significant.
- Eric Ferrebee noted the desire to obtain as good as a design as possible, thereby focusing on conducting testing on the more critical inputs.
- Bipad Saha shared that the Virginia DOT mostly conducts asphalt mill-and-fill projects, where quantifying the existing structure is not as significant. The agency addresses rutting through mix design and is addressing bottom-up reflective cracking through other mitigation techniques.
- Kumar David noted that the Indiana DOT uses a hybrid approach—they conduct PMED analysis and use experience in selecting the final design.

THURSDAY, DECEMBER 16

15. FHWA Research Update – Tom Yu (FHWA)

Tom Yu provided an update of FHWA's Pavement Design program, which consists of three focus areas: (1) improving design practices, (2) enhancing resilience and sustainability, and (3) providing resources for effective preservation (broad interpretation) of the existing pavement network. Tom asserted that all three areas primarily involve doing good pavement engineering, and not so much reliance on the analysis tools being used.

On the topic of improving pavement design, Tom stressed the need to account for things that happen to the pavement over time, such as deterioration of materials, contamination of base layers, and distortion of pavement layers. PMED doesn't currently account for these phenomena as it is very difficult to quantify the benefits of a more permanent foundation.

Tom briefed the group on the projects that FHWA is sponsoring related to pavement design. These are listed below. He noted that FHWA sees a lot of value in getting together with state DOTs through peer exchanges and other forums to learn of their experiences and lessons learned.

- Composite Pavements Peer Exchanges (outgrowth of SHRP2 R21).
- Climate Modeling for Resilient Pavement Design.
- Inverted Pavements Technology Synthesis.
- Permeable Pavements Tech Brief.
- Intelligent Compaction (IC) Demonstration Project.
- Pavement Foundation Design and Failure Mechanisms.
- Non-Destructive Evaluation (NDE) for Pavement Evaluation (outgrowth of SHRP2 R06D).
- Introduction to ME Pavement Design Online Course (revival of old NHI course, focused on fundamentals).

16. NCHRP Research Update – Dr. Linda Pierce (NCE)

Dr. Linda Pierce updated the participants on NCHRP research projects related to PMED. She briefly discussed the complete timeline of projects, from the completion of NCHRP 1-37A in 2004 to several on-going studies, such as NCHRP 1-51 (*A Model for Incorporating Slab/Underlying Layer Interaction into the MEPDG Concrete Pavement Analysis Procedures*), NCHRP 9-54 (*Long-Term Aging of Asphalt Mixtures for Performance Testing and Prediction*), and NCHRP 20-50(21) (*Enhancements of Climatic Inputs and Related Models for Pavement ME Using LTPP Climate Tool [MERRA-2]*). Linda noted the years in which the results of some of the projects (e.g., the NCHRP 1-52 top-down cracking model in 2018/19) were incorporated into Pavement ME and cited two studies currently under consideration by the PMED Task Force—NCHRP 1-50 (*Quantifying the Influence of Geosynthetics on Pavement Performance*) and NCHRP 1-53 (*Improved Consideration of the Influence of Subgrade and Unbound Layers on Pavement Performance*).

Linda concluded her presentation by reporting on the total ME-related research sponsored to date (32 projects over 24 years at a cost of $19.5 million) and summarizing the areas where NCHRP research has been focused. With respect to the latter, asphalt has been the primary areas of focus (10 projects) whereas traffic/climate has received the least amount of focus (2 projects).

17. Software Training Topic 1: Perpetual/Long-Life Design of Flexible Pavements – Dr. Linda Pierce (NCE)

In this first of three training blocks, Linda presented on the perpetual design of flexible pavements using the PMED software program. Linda started off the session by providing an overview of perpetual asphalt pavement design. This included a definition of the pavement type (50+ years with no structural rehabilitation and designed for heaviest loads), keys to material selection (durable, strong, and flexible asphalt layers; strong, frost- and swelling-resistant foundation layers), the structural design endurance limit concept (minimizing strain to an established level whereby no accumulative damage occurs), and important construction practices (joint density, asphalt layer bonding, QC/QA, etc.).

Using a case example from the Iowa DOT (I-29, Mills County, IA), Linda demonstrated a perpetual flexible pavement design using the PMED software. After briefly describing the project, she progressed through the various input screens and discussed the basis for some of the key inputs. The structural design cross section consisted of 4 inches of HMA surface, an HMA base (varying thicknesses for PMED design analysis), a 12-inch aggregate base, a 6-in compacted subgrade, and an A-6 natural subgrade.

Linda showed the PMED performance prediction results for 16.5-inch and 17.0-inch HMA designs (4-inch HMA surface plus the HMA base) and discussed the individual distress predictions and whether they met the established thresholds. Given its importance in perpetual design, bottom-up fatigue cracking was of primary interest. Linda noted that while PMED includes the option to use an endurance limit, it was not included in the calibration effort and is not recommended for use at this time.

For the remainder of the training session, Linda summarized the PerRoad layered elastic analysis for estimating the asphalt layer endurance limit. PerRoad v4.4 was released in 2017 and is available online (http://www.asphaltroads.org/perpetual-pavement/about-perpetual-pavements/). Linda illustrated the resulting PerRoad and PMED designs for the I-29 project and discussed how one might interpret the 2.5-inch reduction in HMA thickness obtained with PerRoad (14.5 inches vs. 17.0 inches).

In responding to a question from Justin Schenkel, Kelly shared that Iowa uses a 4-inch HMA surface that consists of a 2-inch surface course and 2-inch intermediate course.

Mesbah Ahmed inquired about the PMED software version used in the demonstration. Linda confirmed that it was v2.5.5

Justin asked whether or not the PMED analysis included use of the endurance limit option. Linda stated that while the PMED is able to utilize an endurance limit, it was not included in the global calibration and therefore, is not recommended for use at this time. This was also the reason for using another layered elastic program to determine the strain at the bottom of the asphalt layer.

Tirupan Mandal asked why a 40-year design life was chosen for this type of project. Kelly responded that 40 years is the design life that Iowa DOT uses for new design and that it was just adapted for this application.

Kumar Dave inquired about the necessity of an aggregate base for a perpetual design. Linda responded that the use of an aggregate layer should be based on agency-specific conditions. The importance is to provide a foundation that will support construction of upper layers and resist damage due to the presence of freezing/thawing and swelling.

Alauddin Ahammed made a comment in relation to the presentation from Manitoba, indicating a reduction in bottom-up cracking when using an aggregate base or subbase. Linda confirmed for the cases evaluated by Manitoba, they noted a significant decrease in bottom-up fatigue cracking with an increase in granular base thickness.

18. Software Training Topic 2: Designing with Geotextiles – Harold Von Quintus (ARA)

In the second training block, Harold Von Quintus instructed participants on the design of pavements with geotextiles included in the unbound foundational layers. This presentation was comprised of four parts, beginning with how the possible inclusion of geotextiles is addressed in the *MEPDG Manual of Practice*. In this regard, the *Manual* conveys that geogrids, geotextile fabrics, and other reinforcing materials cannot be directly simulated at this time and that engineering judgment is needed to indirectly account for their presence in the pavement structure. Furthermore, while the *Manual* indicates that geotextile materials can be indirectly simulated by modifying M_r of the unbound layers or by performing a calibration, it provides no guidance on how to do this. Harold emphasized that a good engineering design strategy must consider the intended function of the geotextile (e.g., reinforcement, drainage, separation, filtration, containment) and recognize that PMED does not directly simulate contamination and decompaction.

In part 2 of his presentation, Harold steered the discussion to "moving forward" with geotextiles, given the current guidance in the *MEPDG Manual of Practice*. He mentioned several past studies that have been done on the topic and reported on what was done under the most recent study and its key product. NCHRP 1-50 (*Quantifying the Influence of*

Geosynthetics on Pavement Performance) sought to quantify the benefits of geotextiles in pavement design and develop a process for selecting an appropriate geosynthetic material for a specific project type. A key product of the study was the development of a PMED-compatible software program that uses neural networks to model stresses, strains, and deflections of a pavement system that is comprised of different geosynthetics and is subjected a variety of conditions. The software is currently under consideration by the Pavement ME Task Force and the AASHTO COMP Technical Subcommittee 5d. A decision on whether it should be integrated into PMED is expected in early 2022.

Part 3 of Harold's presentation delved into specific interim options for taking geotextiles into consideration in the PMED design process. These options focused on modification of M_r of the unbound aggregate layer, corresponding to the use of geotextiles for reinforcement, separation/filtration, or encapsulation purposes. Harold described the process by which each of these strategies impact the aggregate base modulus. For instance, reinforcement reduces decompaction of the base layer, whereas separation and encapsulation reduce contamination of the base with subgrade fines. By using a reinforcing geotextile in the pavement, confinement of the aggregate material is increased, which in turn, increases the M_r. Additionally, by keeping subgrade fine particles out of the aggregate base, the modulus for this layer can remain high over the long term. Harold also pointed out that the encapsulation strategy reduces the change in seasonal moduli as it reduces the moisture flow through the encapsulated layer. Harold presented an example application of PMED comparing the predicted distresses of a typical asphalt pavement (4-inch AC surface on an 8-inch aggregate base [M_r =24,000 lb/in^2] and A-7-6 subgrade [M_r =8,000 lb/in^2]) containing (a) no geotextile, (b) a reinforcing geotextile, and (c) an encapsulation geotextile. Using his suggested systematic approaches for adjusting M_r for the reinforcement and encapsulation strategies, he showed the benefits associated with the reinforcing strategy in terms of predicted rutting and bottom-up fatigue cracking.

In the final portion of his presentation, Harold provided a brief summary of the training session and discussed a few key takeaways. He reiterated that the *MEPDG Manual of Practice* does not directly simulate geotextiles in the design process and that, while it provides suggestions for doing so, it does not present systematic processes. He indicated that the reinforcement geotextile strategy can have an impact on the asphalt layer and aggregate base thickness, in large part by not having to apply the limiting modulus criterion outlined in the Manual (i.e., there is no need to limit the aggregate base M_r to account for decompaction). He added that the greatest benefit of the reinforcing strategy is when a stronger, higher-quality base is used over a particularly weak subgrade soil. Finally, for the separation geotextile strategy, Harold recommended it be simulated through the use of calibration coefficients.

Prajwol Tamrakar indicated there are issues with the NCHRP 1-50 ANN model and asked if PMED will use this model or a newer improved version. Harold stated that the ME task force has not yet approved the integration of the NCHRP 1-50 product into the PMED software. He added that, based on a review of the product provided by NCHRP, the ANN models could be expanded to include more design features, but that ultimately it is up to the task force and COMP to determine what gets implemented.

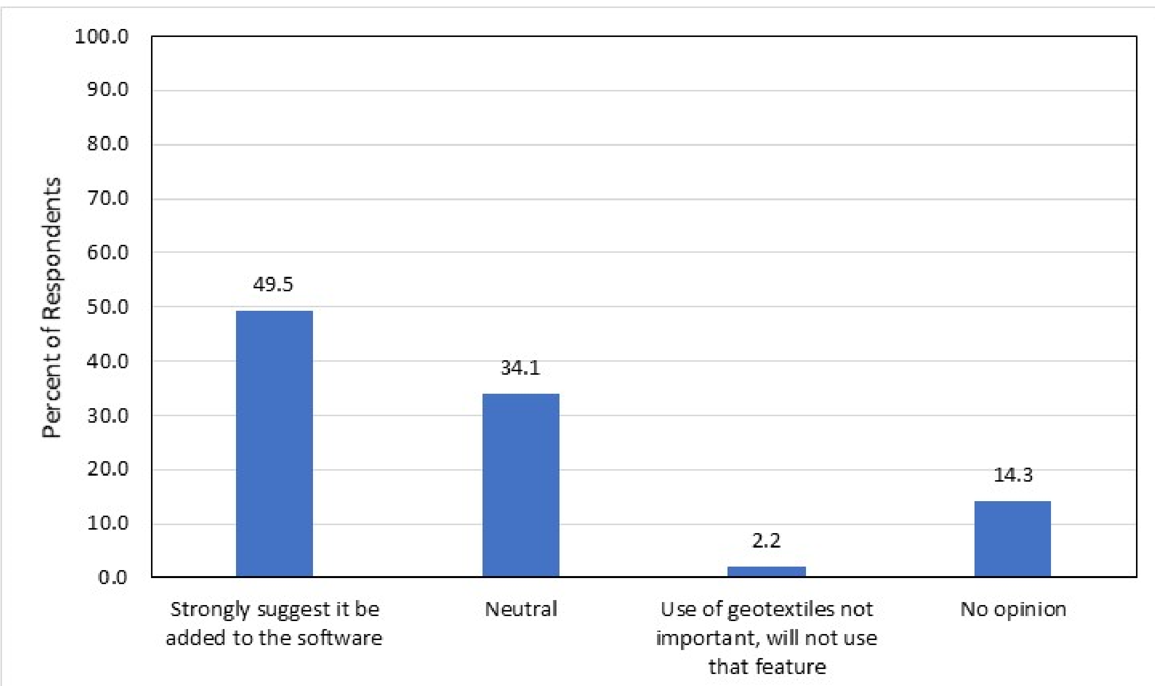
Ozair Khan asked if decompaction is covered with the change in resilient modulus of the layer from the change in seasonal degree of saturation of that layer. Harold said it is not and *added that Pavement ME Design is changing the degree of saturation from changes in water content, but those are not the same thing.*

Pankaj Patel inquired about the value of non-woven geosynthetic fabrics between asphalt layers and if future PMED versions will allow for modeling of such fabrics. Speaking from his own experience, Harold indicated that there may be some benefit from the geosynthetic in terms of the LTE in the cracks in the underlying layer, but they don't really have much impact on reflective cracking and how the asphalt mat is going to perform.

To gauge the use of geotextiles in pavement foundation design, Harold posed the following poll question to the group:

- *Regarding your agency's use of geotextiles, what is your opinion on integrating geotextiles into the PMED software?*

A total of 91 responses were received for this poll and the results are shown below. Half of the respondents strongly suggested that a geotextiles feature be incorporated into the software, whereas only 2 percent did not see them as important and would not use the feature. One-third of the respondents were neutral on the matter and 14 percent had no opinion.



19. Software Training Topic 3: Unbonded PCC Overlay Design – Dr. Julie Vandenbossche (University of Pittsburgh)

In the third training block, Julie Vandenbossche presented on PMED design of unbonded PCC overlays of existing concrete and composite pavement. She began with a brief overview of this design strategy, including the conditions feasible for its use (e.g., existing pavement is moderately or severely distressed), the need for an interlayer between the existing and new concrete slabs, and the typical joint spacings of the overlay (10 to 12 ft for thinner slabs, conventional spacings for thicker slabs).

Julie spoke about the types of interlayers available for use and their importance in overlay performance. Interlayer materials include dense- or open-graded HMA (1 to 2 inches thick) and nonwoven geotextile fabrics for bare concrete pavement applications and existing dense-graded HMA for composite pavement applications. The interlayer serves three primary roles—a drainage layer (fabric and open-graded HMA materials only); a slip plane to ensure that the slabs move independently of each other and to prevent “keying” where joint faulting exists; and a stress absorption layer to deter reflective cracking. Julie noted that, for higher levels of faulting, a thicker 2-inch HMA interlayer is needed to prevent keying.

Julie used an example project from Michigan to demonstrate the unbonded overlay design in PMED. US 131 north of Grand Rapids was originally constructed with PCC in 1970 and received an unbonded JPC overlay in 2000. The original structure consisted of 9 inches of PCC placed on a 4-inch crushed stone base (33,000 lb/in^2 modulus), a 10-inch A-3 subbase (11,000 lb/in^2 modulus), and an A-4 subgrade (7,000 lb/in^2 modulus). The unbonded overlay was 6.3 inches thick and included 13-ft joint spacings and a 1-inch HMA interlayer. The overlay lasted until 2018, when the pavement was reconstructed.

Using PMED v2.6, Julie re-analyzed the predicted performance of the overlay and compared it to the actual performance. She navigated through the various design input screens and discussed in detail several of the key inputs that were used. To enable the comparison with actual performance, she used a 50 percent reliability for the three performance parameters (joint faulting, slab cracking, and IRI). The 20-year design showed very little distress development and satisfied the threshold criteria at both the 50 and 90 percent reliability levels. Time-series plots of the PMED-predicted distresses were somewhat comparable to the measured distresses. Julie displayed pavement service records and historical photos which showed that the overlay developed substantial joint spalling (and consequential patching) after about 14 years. She indicated that poor drainage and low PCC air content may have been contributing factors to the joint failures.

Justin Schenkel commented that he was unsure if the 13-ft joint spacing for the project was actual or approximated, since Michigan DOT’s specification is 12 ft for typical overlays greater than 6 inches thick. Julie said she should have checked the project plans to confirm the spacing that was used. A subsequent review of the plans showed that a typical transverse joint spacing of 4 m (13 ft) had been specified.

Ozair Khan mentioned that a 14-ft spacing was reportedly used in a long-term pavement performance study on JPC pavement and is currently used by Caltrans. He asked when a 13-ft joint spacing was considered. Julie indicated that it is really a matter of balancing the economics of joint spacing (longer spacings mean fewer joints to be constructed and maintained) and the expected cracking performance of the pavement (longer spacings will experience increased cracking).

Asked by Kumar Dave if dowel bars were used in the unbonded concrete overlay project, Julie reported that 1.25-inch dowels were used and added that they seemed to have worked well given the low levels of faulting observed.

20. Future Software Training Topic Preferences – Kelly Smith (APTech)

Kelly Smith re-engaged the group on the issue of software training. He summarized the training topics covered in past user group meetings and explained the need to develop the future webinars around topics that are of most interest to the group. To solicit feedback, the following Mentimeter poll question was presented and participants were asked to rank the nine training topics in order from highest to lowest interest.

- *Indicate the software training topics of greatest interest to you in future webinars and user group meetings?*
  - *Overlay Design using Limited Available Data on the Existing Pavement.*
  - *Thin Preventive Maintenance Overlay Design.*
  - *CRC Design.*
  - *Perpetual/Long-Life Concrete Design.*
  - *Consideration of Subgrade Stabilization in Design.*
  - *Traffic Data Characterization and Input Level Selection.*
  - *Sustainability and Resilience in Design.*
  - *PMED Models and Calculations: A Journey Through the PMED Engine.*
  - *Linking Design with LCCA: Application of Structural and Functional Life Predictions.*

A total of 79 responses were received and the following priorities were identified:

1. Overlay Design using Limited Available Data on the Existing Pavement.
2. Consideration of Subgrade Stabilization in Design.
3. PMED Models and Calculations: A Journey Through the PMED Engine.
4. Linking Design with LCCA: Application of Structural and Functional Life Predictions.
5. Sustainability and Resilience in Design.
6. Traffic Data Characterization and Input Level Selection.
7. Thin Preventive Maintenance Overlay Design.
8. Perpetual/Long-Life Concrete Design.
9. CRC Design.

21. Future User Group Events – Kelly Smith (APTech)

Kelly briefed the participants on the plans for future PMEUG events. He showed the tentative schedule for the four remaining software training webinars (April and August of both 2022 and 2023) and noted that the topics for the webinars will be based on the topical preferences identified through the Mentimeter poll.

Kelly also spoke about the Implementation RoadMap workshop. Like the next training webinar, this meeting is being planned for April 2022. It is expected to be a face-to-face meeting that will last 1.5 days and will be hosted by a state DOT. The APTech team will begin detailed planning of this event in January of 2021, starting with a planning meeting with FHWA and the TAC members.

Lastly, Kelly touched on the plans for the 2022 PMEUG meeting. He indicated that the APTech team will target the following cities for the meeting, based on previously identified preferences of the TAC group: Salt Lake City, Utah; Phoenix, Arizona; and San Antonio, Texas. The team will coordinate with FHWA and the TAC members to select a suitable meeting facility and date for the meeting (expected to be in the November/December 2022 timeframe).

22. Meeting Wrap-Up

Linda Pierce, Kelly Smith, and Jennifer Albert thanked everyone for their participation in the meeting and expressed appreciation to all the speakers and presenters. Also, Linda reminded the group that a meeting report will be prepared and made available in the coming weeks and that 2022 events will include a couple of training webinars, the RoadMap workshop, and the annual User Group meeting. Linda adjourned the meeting at 2:40 p.m. CST.

Attachment 1. Meeting Participants

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Attachment 2. Meeting Agenda

Session 1—Tuesday December 14, 2021

Time (ET)	Session and Topics
Noon–12:45 PM	1A. WELCOME AND INTRODUCTIONS Welcome | Linda Pierce (NCE) and Kelly Smith (APTech) FHWA Welcome and Remarks | Jennifer Albert (FHWA Task Manager & Pooled Fund Manager) AASHTO COMP and ME Task Force Remarks | John Donahue (Missouri DOT, AASHTO COMP Technical Subcommittee 5D Chair) and Clark Morrison (North Carolina DOT, AASHTOWare Pavement ME Design Taskforce) Canadian Update | Susanne Chan (Ontario Ministry of Transportation, Transportation Association of Canada MEPD Subcommittee Liaison) Review of meeting agenda and goals | Linda Pierce (NCE) and Kelly Smith (APTech)
12:45–2:00 PM	1B. AGENCY IMPLEMENTATION UPDATES/REPORT-OUTS Agency briefings on implementation plans, timelines, and progress | Designated Agency Speakers
2:00-2:15 PM	BREAK
2:15-3:00 PM	1B. AGENCY IMPLEMENTATION UPDATES/REPORT-OUTS (continued) Agency briefings on implementation plans, timelines, and progress | Designated Agency Speakers
3:00-4:00 PM	1C. AASHTOWARE PAVEMENT ME DESIGN SOFTWARE UPDATE AASHTO Briefing (announcements/news, customer relations) | Ryan Fragapane (AASHTO) Software enhancements/updates (incl. new features/capabilities) | Chad Becker (ARA)

Session 2—Wednesday December 15, 2021

Time (ET)	Session and Topics
Noon–12:05 PM	OPENING Session Overview | Linda Pierce (NCE)
12:05-1:00 PM	2A. IMPLEMENTATION/CALIBRATION EFFORTS—ISSUES, CHALLENGES, SOLUTIONS Wisconsin Calibration Update and HMA Materials Characterization | Tirupan Mandal (Wisconsin DOT) An Overview of Climate Parameter Incorporation in Structural Pavement Design and Opportunities for Resilient Adaptation | Austin Jarrell (FHWA)
1:00-1:50 PM	2B. HMA, PCC, AND FOUNDATION DESIGN ISSUES AND APPLICATIONS Canadian User Group Design Trials on Granular Base and Subgrade Materials | Alauddin Ahammed (Manitoba Infrastructure)
1:50–2:00-PM	BREAK
2:00-3:30 PM	2B. HMA, PCC, AND FOUNDATION DESIGN ISSUES AND APPLICATIONS (continued) Evaluation of Soil Water Characteristic Curves (SWCC) in Pavement ME for Nevada's Unbound Materials | Sarah Stolte (NCE) Modulus Mapping for Deterministic Pavement Foundation Characterization: Findings from FHWA AID and Iowa DOT Program | David White (Ingios) and Chris Brakke (Iowa DOT) Use of ALPT Technology in Pavement ME Design | Chris Brakke (Iowa DOT) and Garrett Fountain (Tensar)
3:30-4:00 PM	2C. OPEN FORUM — PRACTICAL APPROACHES TO PMED DESIGN OF OVERLAYS Open Forum Discussion | Linda Pierce (NCE) and Meeting Participants

Session 3—Thursday December 16, 2021

Time (ET)	Session and Topics
Noon–12:05 PM	OPENING Session Overview | Linda Pierce (NCE)
12:05-12:30 PM	3A. ME RESEARCH SUMMARIES FHWA Research Update | Tom Yu (FHWA) NCHRP Research Update | Linda Pierce (NCE)
12:30-1:15 PM	3B. SOFTWARE TRAINING Perpetual/Long-Life Design of Flexible Pavements | Linda Pierce (NCE)
1:15-2:15 PM	3B. SOFTWARE TRAINING (continued) Designing with Geotextiles | Harold Von Quintus (ARA)
2:15-2:30 PM	BREAK
2:30-3:15 PM	3B. SOFTWARE TRAINING (continued) Unbonded PCC Overlay Design | Julie Vandenbossche (University of Pittsburgh)
3:15-3:45 PM	3C. FUTURE USER GROUP EVENTS Updated Poll on Training Topic Preferences | Kelly Smith (APTech) and Linda Pierce (NCE) Future Software Training Webinars | Kelly Smith (APTech) and Linda Pierce (NCE) 2022 RoadMap Workshop | Kelly Smith (APTech) and Linda Pierce (NCE) 2022 User Group Meeting | Kelly Smith (APTech) and Linda Pierce (NCE)
3:45–4:00 PM	MEETING WRAP UP Concluding remarks | Linda Pierce (NCE) and Kelly Smith (APTech)

Attachment 3. Questions and Answers

6th Annual AASHTO Pavement ME User Group (PMEUG) Meeting - Q&A Dec 14

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saha	jhuma	jhuma.saha@gov.ab.ca	Alberta, Canada is using version 2.6.1	---	---
Karim	Mohammad	Mohammad.Karim@gov.ab.ca	Version 2.6.1 in Alberta	---	---
Schenkel	Justin	schenkelj@michigan.gov	Sorry - I forgot to mention a few points - MI DOT is implemented for HMA & JPCP reconstruction, but not yet rehab. This has been very difficult due to the complexities of existing pavement sections and how to characterize them.	**Post-Meeting Response:** Thanks Justin. Characterization of the existing pavement can definitely be challenging and time consuming.	Kelly Smith
Schenkel	Justin	schenkelj@michigan.gov	I should add that currently, we use A93 for rehab design.	Got it. thanks Justin	Kelly Smith
Carlie	Karen	carliek@wsdot.wa.gov	Washington state is not currently using PMED. We used AASHTO 1993 for our design catalog and used MEPDG Version 1.0 along with WSDOT pavement historical data and experience to develop and validate of the design tables for both flexible and rigid pavements. We are trying to determine our next steps forward with implementation.	Thanks Karen.	Linda Pierce
Mirzahosseini	Mohammadreza	mhoseini@purdue.edu	How can I import Traffic data for a given ESAL class and axle configuration data?	**Post-Meeting Email Response:** ESALS cannot be directly imported into the application. ESALS are produced for users' convenience during the analysis run.	Chad Becker
Freeman	Joshua	josfreeman@pa.gov	what server will be used for V3?	**Post-Meeting Email Response:** We are going to be targeting a "t" burstable instance in AWS. This has several advantages for us. Burstable instances allow us to ramp up performance and throughput during the day while accumulating credits during down times in the evenings and on weekends. We are also considering one of the "m" instances in the event that the burstable instances are not cost effective.	Chad Becker
YEP RAMÍREZ	FERNANDO RAÚL	russel_yep@hotmail.com	Excelente el lanzamiento de Pavement 3.0,¿Estará el demo disponible para cualquier persona interesada en la investigación? **Translation: Excellent launch of Pavement 3.0, will the demo be available to anyone interested in research?**	**Post-Meeting Email Response:** We will have a beta test period (probably in May) where we open the software to interested agencies. If your agency is interested in participating, please let us know. Prior to that time the demo app will only be available for testing purposes.	Chad Becker
Mirzahosseini	Mohammadreza	mhoseini@purdue.edu	How to import XML file for calibration coefficients?	**Post-Meeting Email Response:** To import data, you'll use the context menu available in the design editor. This context menu will allow you to load your XML file into your design.	Chad Becker

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Last Name	First Name	Email Address	Question Asked	Answer Given	Answerer
Schwartz	Aaron	aaron.schwartz@vermont.gov	Tirupan, do you see any potential overlap moving forward between this specific effort and the ongoing Balanced Mix Design (BMD) efforts underway at Wisconsin DOT?	**Verbal Response:** WisDOT has been doing some BMD projects, but their current focus is on recalibration of the PMED models. There is no consideration of implementing BMD in PMED at this time.	Tirupan Mandal
				Follow-up Written Response: I personally do not see any issue between the BMD concept and the PMED library. However, there are definitely two issues. The first is the variability in the fatigue test results. The results are highly variable for the beam fatigue test. The second is there is no standard AASHTO test method for the plastic strain test, as used in the PMED. The BMD method is based on performance test for which different tests can be used. The PMED tests can be used as part of the BMD method - in my opinion excluded the beam fatigue because of its variability.	Harold Von Quintus
Hajj	Elie	elieh@unr.edu	Is AASHTO considering allowing users to change the coefficients for the Witczak prediction model for dynamic modulus? It was observed tha the model signifcanlty overestimate the measured dyanmic modulus of some polymer modified asphalt mixtures. This in particular is becoming a problem in AC overlay over AC designs using Level 1. Thank you	**Verbal Response:** There is no consideration being given at this time. The Witczak equation is still the predominant equation in the PMED software. It would be good if agencies would suggest that a different regression model be included in the software (potentially as an alternative option). **Follow-up Written Response:** One additional item that I would like to mention regarding my response to Elie's question is that the option of replacing or allowing a different dynamic modulus regression equation from Witczaks E* equation can be included, but since no agency has formally requested it, that enhancement has not been a high priority on future work items. Personally, I am confortable with Witczaks regression equation, but if agencies would like a different regression equation to be used, then that request should be submitted to the AASHTOWare task force.	Harold Von Quintus
Schenkel	Justin	schenkelj@michigan.gov	I've been thinking a lot about climate modeling in Pavement ME. (Q1) Could you clarify - what climate data is used for a historical calibration project and for new future projects? (Q2) Does the historical project use the climate data starting from the date that matches the traffic opening date (or earliest available) OR does it go back to the beginning available date of climate? (Q3) Similarly, for a future project, does it "jump" back the number of years of the entered design life and then proceed forward (so if 20-years and open date is 2022, start at 2012) OR does it start from the beginning of the available climate data (so for example 1985)? My questions are in relation to how the ME software operates.	**Verbal Response (Q1):** A site in Danville VA was selected and MERRA data was obtained for that site. For the future climate data, the data was obtained from the USDOT's CMIP5 climate tool. A spatial grid around Danville VA was selected and used. **Verbal Response (Q2):** Historical data were from 1997-2017. We compared only the difference in climate and made traffic a constant. The focus was on the differences in strain level associated with climate only. **Verbal Response (Q3):** The future project used the same data set and the same time frame. Traffic was still the same constant value.	Austin Jarrell
Schenkel	Justin	schenkelj@michigan.gov	In regards to "Future Climate Data" - I think that this is a worthwhile review, but I speculate that for designs that are 20-years (or less), the results would likely be very similar.	---	---
Schenkel	Justin	schenkelj@michigan.gov	My questions are in relation to how the ME software operates.	---	---
VonQuintus	Harold	HVONQUINTUS@AOL.COM	Good presentation and research work. Mississippi DOT had a climatoligist to generate future climate files for all of their counties. Comparing the future climate data to the existing climate data did make a difference in the predicted distresses especially for flexible pavements. Just a comment.	---	---
Shafiee	Mohammad	mohammad.shafiee@nrc-cnrc.gc.ca	Thanks a lot for the great Presentation Austin. Great forward-looking approach. (Q1) Can you please comment about how other than temperature inputs like wind, humidity, sunshine were treated for downscaling? (Q2) Also, is it necessary to re-calibrate the transfer functions that were originally calibrated with static climate? Thanks again.	**Verbal Response (Q1):** These inputs are already considered in the data obtained from the USDOT CMIP5 tool. **Verbal Response (Q2):** No, it is not necessary to recalibrate the transfer functions.	Austin Jarrell
habib	affan	affan.habib@vdot.virginia.gov	I am sorry if you already covered that. Can MEPDG be used for resilient design like extended and frequent flooding situations?	**Post-Meeting Email Response:** In the research I discussed, we focused on changes in temperature distributions using different versions of the EICM (MATLAB code models from previous research), and total strain comparison using ALVA (Viscoelastic-based MATLAB code that is different from Pavement ME strain analysis). The caveat is that we did not use Pavement ME for analysis, and only followed the MEPDG documentation to calculate necessary inputs for our total strain analysis, and temperature processing. Flooding is not as simple of a consideration when compared to temperature. Although my research focus was temperature effects, it's my understanding that Pavement ME (and MEPDG documentation) does not provide a method for accounting for increased frequency of flooding. Also, I will note that the bottom line for temperature increases (regardless of design methodology) is to increase layer thicknesses. Flooding is not so simple; it is mine, and a few other colleagues' hypothesis that increased flooding frequency and intensity is best addressed by altering foundation design. I hope this helps!	Austin Jarrell
Pierce	Linda	lpierce@ncenet.com	(Q1) Your presentation (slide 31) showed the variation in granular base stiffness. With all the information available (Manitoba Guide, MEPDG MOP, CBR vs Mr, lab testing), what value do you select (which is the right one to use)? (Q2) Is any modification in modulus made in going from laboratory to field?	**Verbal Response (Q1):** For our purposes, we have developed moduli from laboratory testing. We compare the lab-measured values with values obtained from CBR; if the CBR-based values are too high, we try to correlate with the lab-measured values. **Verbal Response (Q2):** We are not backcalculating anything for our designs.	Alauddin Ahammed
Mirzahosseini	Mohammadreza	mhoseini@purdue.edu	How can I access the recorded video and powerpoint for the current presentation?	Both will be available after the meeting.	Linda Pierce

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Schenkel	Justin	schenkelj@michigan.gov	Are AC thickness increments in half-inch, quarter-inch, or something else?	**Verbal Response:** We did it on half-inch increments.	Sarah Stolte
Tamrakar	Prajwol	ptamrakar@tensarcorp.com	Chris- What type of geogrid was in the bid price stabilization?	**Verbal Response:** Our standard specifications include approved biaxial and triaxial geogrids. The standard biaxial geogrid was used for the pilot projects. For the lab testing part of the project, we are evaluating the standard biaxial geogrids, as well as a few other geogrids.	Chris Brakke/David White
Ahammed	Alauddin	alauddin.ahammed@gov.mb.ca	What is the principle used to determine modulus in APLT?	**Post-Meeting Response:** Modulus is determined from the load-deformation response. Plate load testing is the long standing "gold standard" for assessing in situ pavement foundation support conditions. From the 1930s to 1980s, the Bureau of Public Roads, U.S. Corps of Engineers, AASHO, and several state agencies used plate load testing to determine the modulus of subgrade reaction k-value for airfield and highway applications, investigate pavement behavior, and verify/calibrate pavement thickness design equations. Realizing the very important role of plate load testing, the modern APLT system was developed. The APLT static and cyclic test processes use a controlled load duration and dwell time (e.g., as required in the AASHTO T307 laboratory test methods) for cycle times depending on the field conditions and measurement requirements. Because the APLT test system is automated, the test methods are repeatable and reproducible (i.e., no operator/system bias/error). The APLT technology measures stress-dependent elastic and permanent deformation, stress-dependent elastic and resilient modulus, and load-pulse and frequency-dependent responses. APLTs are performed on in-service pavement systems directly on the pavement layer or through a core hole through the pavement to access the underlying foundation layer, or on newly constructed pavement foundation layers.	David White
Ahammed	Alauddin	alauddin.ahammed@gov.mb.ca	Can it be used on paved surface?	**Verbal Response:** Yes, it can be run on both a rigid and flexible pavement.	Garrett Fountain/David Whit
Ahammed	Alauddin	alauddin.ahammed@gov.mb.ca	How is the modulus determined?	**Post-Meeting Response:** Modulus is determined from static or cyclic loading and is analyzed as elastic [E] (including permanent deformation), as resilient [Mr] rebound deformation only), or as modulus of subgrade reaction [k-value] (slope of stress versus deformation). Composite resilient modulus is calculated using the Boussinesq's elastic solution for linear-elastic materials. Layered analysis is performed to determine the pavement foundation aggregate base layer modulus and the top of subgrade modulus per Odemark's method of equivalent thickness (AASHTO 1993). Cyclic stress at the top of subgrade is calculated using the elastic layer analysis using the modulus ratio and the layer thicknesses. The top of subgrade stress is a function of modulus ratio, thickness of the base layer, radius of the plate, and the applied cyclic stress at the surface. Stresses can be calculated at the plate center assuming conditions of a flexible loading plate with uniform stress distribution at the surface and all layers are linear elastic with homogenous conditions.	David White
YEP RAMÍREZ	FERNANDO RAÚL	russel_yep@hotmail.com	The nomograph (slide 7)?	**Verbal Response:** The nomograph is from an FHWA website.	Garrett Fountain
Aydin	Ceren	aydincer@msu.edu	Hello, thank you for the excellent series of presentations! I have an entry level of question regarding the Resilietn Modulus. I assume the resilient modulus is here being talked is summary resilient modulus. What would be the difference in terms of pavement deisgn if we were to use stress-dependent model? Thank you very much.	**Post-Meeting Response:** We know that pavement foundation layers are subjected to a wide range of stresses under environmental and traffic loading. The new mechanistic design approach addresses the loading conditions by using a model (and associated parameters, e.g., k1, k2, and k3) in determining a stress-dependent modulus. In situ APLTs can either be performed at a given target stress condition (e.g., "worst-case" scenario as selected by the designer) or over a range of in situ stresses (to determine the constitutive model parameters) and use the critical stress condition to match with the pavement thickness design. In situ APLT modulus measurement do not need a correction like other indirect measurement methods. Multi-stress cyclic APLT is used to directly determine the in situ constitutive model parameters. In brief, the APLT results determine constitutive model parameters that are then used to calculate the resilient modulus for the pavement designer stress-conditions anticipated for the pavement structure. Typically, pavement analysis is performed to calculate the anticipated in situ stresses for design conditions. The advantage of in situ testing is lab testing suffers from limitations in matching field compaction and in situ boundary conditions. APLT measurements represent the as-constructed field conditions (i.e., field moisture, density, and stiffness).	David White
Patel	Pankaj	papatel@indot.in.gov	PMED V 3.0, for HMA pavement does it allow to model more than 3 layers of dense grade HMA layers	**Verbal Response:** PMED v3.0 will not allow more than 3 layers of HMA (a continuation of previous PMED versions).	Chad Becker/Wouter Brink

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Last Name	First Name	Email Address	Question Asked	Answer Given	Answerer
VonQuintus	Harold	HVONQUINTUS@AOL.COM	*You have very high risk for the questions asked (as a start to the open forum). We need to be focusing on doing more testing for design - not less. If we cannot or do not characterize the existing pavement, the overlay design is unknown. *If we use a simpler, easier overlay design method with less data requirements, say a layer coefficient for asphalt, base, and one factor to classify climate - do we actually think we are getting a better design that meets long term needs? *As Matt Witzcak and Mike Darter originally said in developing PMED, that was the purpose of allowing input levels 1, 2, or 3 to be used. Input level 3 is all guessed values, which just about all agencies can use that are knowledgeable to their on-site conditions. *How do you determine if the overlay thickness is reasonable? -- EXPERIENCE!!!!!!!	---	---
Speakmon	Tyler	michaelt.speakmon@cemex.com	**Open Forum Discussion Comment:** So here at Cemex when we run overlay designs (across numerous southern states), if we do not have all the existing layer conditions, we will remain conservative and use a lowest value that may be known or considered reasonable for the specific porject. By that, I mean if it is an aggregate base layer expected below the surface, we will use a lowest known value for thickness and/or strength.	---	---
Speakmon	Tyler	michaelt.speakmon@cemex.com	**Open Forum Discussion Comment:** As for the reliability we will always stick with what is prescribed or specified by the initial design, we just focus on remaining conservative on the layer properties themselves. As for the reasonable thickness, that is more project and design type specific, or at least for our purposes.	---	---
Brink	Wouter	wbrink@ara.com	**Open Forum Discussion Question:** Linda: When you mentioned the 100's of inputs for a level 1 rehab design, do you mean that every input HAS to be level 1? That will never be the case. It almost always a mix between level 1, 2 and 3 based on what is available.	The intent was not to suggest using Level 1 for all inputs (and if you did, it would be 100s of inputs), but to point out with PaveME we're no longer designing pavements using simple inputs, such as layer coefficients, thickenss, ESALs, mean monthly temperatures, etc.	Linda Pierce
Khan	Ozair	ozair.khan@dot.ca.gov	**Open Forum Discussion Comment:** Especially considering dynamic temperature model presented today further giving you higher strains than from previous methodology. Testing and having better control on material can provide a better platform to enhance it.	---	---
Speakmon	Tyler	michaelt.speakmon@cemex.com	**Open Forum Discussion Comment:** As an answer to Harold's follow-up question, I think gettting away from Pavement ME just because you lack some existing material, is not the correct approach. Pavement ME provides fairly conservative default values and gives you design input alternatives (input levels), so getting away from a more advanced design procedure like P-ME should not be our first option. It more or less highlights our need for more design guidance.	---	---
Subedi	Yogendra	Yogendras@resourceinternational.com	**Open Forum Discussion Question:** How we model the cold in place or FDR layer in ME design?	**Post-Meeting Response:** This issue was the subject of PMEUG Software Training Webinar #2 conducted on October 7, 2021 and is really an engineering decision. FDR can be modeled as either an asphalt layer or a high-strength granular layer in a new flexible pavement. The extent to which the FDR layer is stabilized and designed generally dictates the way it is modeled; if emulsion is added to the FDR material, then typically it is modeled as an asphalt layer. If the FDR material is stabilized with cementitious materials, it can be modeled as a high-strength granular layer in a new semi-rigid pavement. CIR can be modeled as either an asphalt layer or as a stiff unbound sandwich layer. At least a couple agencies have found better success with modeling CIR as an asphalt layer.	Kelly Smith

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Ahmed	Mesbah	mesbah.ahmed@vdot.virginia.gov	**Open Forum Discussion Question:** Is there any state that adopted fatigue (reflective + bottom-up) crack for ovelray design?	**Post-Meeting Response:** At least a few agencies do use fatigue cracking (bottom-up + reflective) as a criterion in their overlay design process.	Linda Pierce
Sivaneswaran	Nadarajah	nadarajah.sivaneswaran@dot.gov	Is the web-based BCT tool still be based on EVERCALC approach? :-)	**Verbal Response:** Yes, it is.	Chad Becker
Chkaiban	Rami	rchkaiban@smeinc.com	As different state agencies use different PMED versions, so whenever a 2.6.1 or in the future a 3.0 license is bought will it provide the access to the different versions needed to design pavement for different states? Or for each PMED version, a license should be bought separately?	**Verbal Response:** You will not need to re-create old designs; they are forward compatible going back as far as v2.3. If you develop a project in v2.6 and bring it into v3.0, it will update the project automatically. The issue of licensing will have to be worked out by the Task Force and AASHTO. AASHTO has had the policy of allowing a single license to access multiple versions of the software. I anticipate this to be the policy moving forward.	Chad Becker
Ahammed	Alauddin	alauddin.ahammed@gov.mb.ca	Will v 3.0 include any new model for unbound materials incluing subgrade?	**Verbal Response:** PMED v3.0 will not include any new models based on NCHRP 1-53 results.	Chad Becker

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Last Name	First Name	Email Address	Question Asked	Answer Given	Answerer
Sivaneswaran	Nadarajah	nadarajah.sivaneswaran@dot.gov	I think 9-67 was cancelled after first panel meeting.	---	---
VonQuintus	Harold	HVONQUINTUS@AOL.COM	The 70 micro-strains originally was related or determined based on the equivalent annual modulus of the asphalt based for fatigue cracking. The LTPP data from an LTPP analysis projecct tended to show 65 microstrains.	---	---
Schenkel	Justin	schenkelj@michigan.gov	A 4" top course???	Yes, Iowa uses a std 4" surface layer, and varies the AC base layer to determine total AC thickness	Kelly Smith
				Verbal Response: The 4" top course consists of a 2" surface layer and a 2" intermediate layer.	Kelly Smith/Chris Brakke
Schenkel	Justin	schenkelj@michigan.gov	Going to be way hard to get ride on placing HMA that thick	This is total surface thickness and is composed of multiple layers per Iowa DOT standard design	Linda Pierce
				Verbal Response: With separate 2" surface and 2" intermediate layers, there should be no problem getting ride. The agency's recommended layer thickness is not being exceeded.	Kelly Smith/Linda Pierce
Schenkel	Justin	schenkelj@michigan.gov	I missed the design life input - what was this?	40 years	Linda Pierce
VonQuintus	Harold	HVONQUINTUS@AOL.COM	**Chat-Box Comment to Organizers/Panelists:** For the limit on bottom-up cracking, Missouri used a value of 1 percent as the limit and a reliability of 95 percent so that bottom up fatigue cracking does not occur. You can also turn off that design criteria and simply view the damage index in the calculations.	---	---
Ahmed	Mesbah	mesbah.ahmed@vdot.virginia.gov	Which version was used in this example?	**Verbal Response:** PMED v2.5.5 was used.	Linda Pierce
Freeman	Joshua	josfreeman@pa.gov	A 4" top course usually contains a wearing and binder course layer.	Concur.	Linda Pierce
Freeman	Joshua	josfreeman@pa.gov	1.5" 9.5 mm plus 2.5" 19 mm = 4" surface layer	---	---
Schenkel	Justin	schenkelj@michigan.gov	Just to clarify - in the PMED example, did you use the endurance limit input or not?	No, endurance limit was not included in PMED analysis.	Linda Pierce
Mandal	Tirupan	tirupan.mandal@dot.wi.gov	Why was 40-year design life chosen for PMED?	Standard Iowa DOT design criteria.	Linda Pierce
				Verbal Response: Iowa's standard design life for new construction is 40 years and this value was adapted for the PMED and PerRoad example application.	Kelly Smith
Mandal	Tirupan	tirupan.mandal@dot.wi.gov	Just a note, on PerRoad, if you use the transfer function, it has slightly thicker designs	---	---
Dave	Kumar	kdave@indot.in.gov	Do you really need aggregate base for perpetual pavement	The use of an aggregate layer should be based on agency-specific conditions. The importance is to provide a foundation that will support construction of upper layers and resist damage due to freeze/thaw and swelling.	Linda Pierce
Ahammed	Alauddin	alauddin.ahammed@gov.mb.ca	Looks like the binder grades were different in two analysis. Should not that affect the fatigue.	**Post-Meeting Response:** Asphalt binder grade change was due to Iowa policy change on using PerRoad for perpetual pavement.	Linda Pierce
Brink	Wouter	wbrink@ara.com	Version Q - v2.5 still has the ft/mile units for top-down cracking as shown in the results.	---	---
Khan	Ozair	ozair.khan@dot.ca.gov	Wasn't the Manitoba study from yesterday confirmed reduction in bottom up cracking from aggregate base or aggregate sub base?	For the cases evaluated by Manitoba, they noted a significant decrease in bottom up fatigue cracking with an increase in granular base thickness.	Linda Pierce
Tamrakar	Prajwol	ptamrakar@tensarcorp.com	Harold- do you also plan to talk about "design with geogrid"? Nchrp 1-50 also deals with geogrid. And, ANN model of NCHRP 1-50 has some issues. Will PMED use old ANN model or a newer one?	**Post-Meeting Response:** The task force has yet to approve the integration of the NCHRP 1-50 product into the PMED software. Based on a review of the product provided by NCHRP, the ANN models could be expanded to include more design features, but that will be up to the task force. This item will likely be handled like the reflection cracking integration years ago. The AASHTOWare PMED team will make recommendations to the task force and COMP and those recommendations or suggestions will be discussed. The AASHTOWare PMED team will implement whatever the task force and COMP approves.	Harold Von Quintus

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Last Name	First Name	Email Address	Question Asked	Answer Given	Answerer
Khan	Ozair	ozair.khan@dot.ca.gov	Question for Harold. Isn't decompaction covered with change in resiliant modulus of the layer from change in seasonal degree of saturation of that layer?	**Verbal Response:** No, it is not. Because PMED is changing the degree of saturation from changes in water in content, but those are not the same thing. This is just the effect of moisture content on the dry density of the aggregate base that was entered as the design input in PMED. Decompaction is a separate animal and is the more important of the two.	Harold Von Quintus
Patel	Pankaj	papatel@indot.in.gov	If Geotextile - non-woven fabric used between asphalt layers then how it modified the value of asphalt layers or calibrate. In future this will allow modeling into PMED	No impact on reflective cracking (Harold's experience). Lower quality asphalt layer (susceptible to deformation), fabrics won't have much of an impact on how the asphalt mat is going to perform.	Linda Pierce
Barstis	Bill	wbarstis@mdot.ms.gov	Could FWD testing be performed on a pavement structure that includes a geogrid reinforced base layer and a similar pavement structure without geogrid in the base layer to estimate the potential increase in modulus due to the presence of the geogrid? I'm considering backcalculated modulus from the FWD deflection data.	While the concept is appropriate, the question will be whether or not the reduction in pavement deflection is significant enough to influence layer moduli (dependent on, for example, layer stiffness, layer thickness, FWD load level, temperature, moisture conditions). A number of studies have been conducted on this topic.	Linda Pierce
Dave	Kumar	kdave@indot.in.gov	can you expand on decompaction? practical meaning	**Post-Meeting Response:** Decompaction is the phenomenon whereby an aggregate base/subbase layer unloosens or deconstructs due to a much weaker subgrade support layer. The MEPDG Manual of Practice notes that the resilient modulus of these layers is dependent on the resilient modulus of the support layers, and it recommends that, for design, the resilient modulus of the aggregate layer not exceed a ratio of about 3 of the resilient modulus of the support layer in order to avoid decompation.	Kelly Smith
Khan	Ozair	ozair.khan@dot.ca.gov	Has the 0.25 inches of HMA reduction from introduction of Geogrids tested (companion) and if did, did it also provide the benefit of rut depth reduction?	**Post-Meeting Response:** Not sure I understand the question, as stated or written. To-date, the NCHRP 1-50 product has not been approved for integration into the PMED software. Until the task force and COMP approve the integration, it is difficult to state what the final benefit or outcome will be. The asphalt rut depth is determined by the laboratory-derived rut depth transfer coefficients, so I would expect there will be little reduction in the asphalt layer directly related to the inclusion of geotextiles; maybe through the calibration coefficients. The reduction in asphalt thickness will be dependent on the final improvement in the unbound layers with geotextiles or geogrids.	Harold Von Quintus
Schenkel	Justin	schenkelj@michigan.gov	I'm not sure if that Joint Spacing is 13' because that's actual or just approximated. Spec is 12' for typical overlays 6"+	**Virtual Response:** 13' was put into the PMED input file, but the project plans should have been checked to confirm this spacing. **Post-Meeting Response:** The project plans specified a typical transverse joint spacing of 4 m (13 ft).	Julie Vandenbossche
Khan	Ozair	ozair.khan@dot.ca.gov	Last year Dr. Mike Darter reported joint spacing of 14 ft from his long term performance study on JPCP. Caltrans also uses 14 ft. When was 13 ft transverse joint spacing considered?	**Virtual Response:** The more you can limit the number of joints that need to be constructed and maintained, the more economical it is as long as you're not getting increased cracking.	Julie Vandenbossche
Dave	Kumar	kdave@indot.in.gov	Did they use dowl bar for MI example of UBCO	**Virtual Response:** Michigan did use 1.25-inch dowels.	Julie Vandenbossche