VDOT MECHANISTIC-EMPIRICAL PAVEMENT DESIGN (MEPDG) IMPLEMENTATION

2018 Virginia Concrete Conference
Richmond, Virginia

Girum Merine, PE
Senior Pavement Engineer, VDOT Material Division

March 2, 2018
Presentation Outline

I. Introduction and background of MEPDG
II. Overview of MEPDG design process
III. Design of Concrete Pavement using AASHTOWare Pavement ME
IV. VDOT MEPDG Implementation Overview
VDOT HAS ADOPTED MEPDG!!!

- As of **January 1st, 2018** MEPDG is official design method
- AASHTOWare Pavement ME software
- Where does VDOT use MEPDG?
  - Interstate and Primary routes
    - New, reconstruction, and lane widening
  - We will continue to use VDOT’s Secondary & Subdivision Pavement Design Guide & Procedures on Secondary & Subdivision streets*
    - Some high volume secondary roads with AADT > 10,000 maybe designed using MEPDG at discretion of Districts Material Engineer.
I. INTRODUCTION AND BACKGROUND OF MEPDG PROCEDURE
What is **Mechanistic Empirical Pavement Design Guide (MEPDG)**?

- Based on Mechanistic-Empirical principles
- Performance based on distress and ride quality

**Mechanistically:**
- Calculates pavement responses (stresses, strains, and deflections) due to loading and environment.
- Use pavement responses to compute incremental damage overtime.

**Empirically:**
- Link structural response and pavement distresses (i.e. rutting, cracking, faulting, punchout, and IRI etc.)

- Developed by AASHTO
Why Do We Need a New Pavement Design Procedures?

- Current practice is AASHTO 1993 pavement design guide
  - Developed based on road tests from 1958-60

- Limitations
  - 1950s materials, traffic, and construction methods
  - One subgrade type (A-6)
  - One environment (Ottawa – Illinois)
  - Only 2 years of service
    - Limited traffic
    - Environment
  - One PCC and HMA mix
MEPDG Development

- AASHTO Joint Task Force on Pavements (JTFTP) initiated MEPDG in late 1990s
- Performance studies such as LTPP and MnRoad provided inputs to MEPDG development
- Various NCHRP studies (NCHRP 1-37A, 1-40A, 1-40D)
- Adopted as AASHTO’s Interim Pavement Design Guide in 2008
Fundamental Differences between AASHTO 93 & MEPDG

<table>
<thead>
<tr>
<th>Parameter</th>
<th>AASHTO 93</th>
<th>MEPDG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic</td>
<td>Equivalent Single Axle Load (ESAL) and traffic volume</td>
<td>Axle load spectrum, volume distributions, tire pressure, etc.</td>
</tr>
<tr>
<td>Climate</td>
<td>Impacts not adequately accounted for</td>
<td>Weather station data; actual impact of temperature &amp; moisture on material responses.</td>
</tr>
<tr>
<td>Design Criteria</td>
<td>Serviceability Index</td>
<td>Actual distresses used by the agencies to manage their roadway system.</td>
</tr>
<tr>
<td>Model development</td>
<td>One location/materials</td>
<td>~2,500 LTPP locations, wider range of materials</td>
</tr>
</tbody>
</table>
How many states are adopting MEPDG?

- Implemented (Asphalt pavement and/or overlays): 14 states
- Planning to implement (Asphalt pavement and/or overlays): 31 states

Source: MEPDG National User Group Meeting, December 2016
How many states are adopting MEPDG?

- Implemented (Concrete pavement and/or overlays): 13 states
- Planning to implement (Concrete pavement and/or overlays): 32 states

Source: MEPDG National User Group Meeting, December 2016
II. OVERVIEW OF MEPDG DESIGN PROCESS
MEPDG Design Process

Climate

Materials

Traffic

Layer Properties

Stress, Strain, or Deflection

Transfer Function

Distress

Compare

Performance Threshold

Adjustment
MEPDG Design

- It is not just about thickness or structure!!
- Improved handling of climatic effects and traffic loadings
- Various hierarchical Input Levels
  - Depending on availability of information & project
- Performance based on distress and ride quality
  - Measurable unlike PSI
- Ability to calibrate and set threshold limits to local conditions
III. Design of Concrete Pavements using AASHTOWare Pavement ME
Types of New Concrete Pavement Designed Using Pavement ME

- Continuously Reinforced Concrete Pavements (CRCP)
- Jointed Plain Concrete Pavements (JPCP)
Rigid Pavement Distress Predicted by Pavement ME

- Continuously Reinforced Concrete Pavements (CRCP)
  - Punchouts
  - IRI

- Jointed Plain Concrete Pavements (JPCP)
  - Joint Faulting
  - Transverse Cracking
  - IRI
Rigid Pavement Design - Pavement ME

Required Inputs

- Thickness
- PCC Material Volumetrics and aggregate type
- Thermal Properties
- Mix Properties
- Strength
- JPCP Design Properties (joint spacing, slab width, dowel diameter, etc.)
- CRCP Design Properties (% steel, bar diameter, shoulder type, base type, etc.)

VDOT MEPDG User Manual contains information regarding Virginia Specific input parameters.
Impact of Various Inputs in predicted distress

Effect of Slab width on JPCP Transverse Cracking

- 12 ft Slab Width
- 14 ft Slab Width

TT = 3500

11.5 - in slab

Virginia Department of Transportation
Impact of Various Inputs in predicted distress

Effect of Joint Spacing on JPCP Transverse Cracking

Figure 3.4.15. Sensitivity of JPCP transverse cracking to slab thickness and joint spacing.

Source: NCHRP 1-37 A - Chapter 4
Impact of Various Inputs in predicted distress

Effect of Shoulder Type on CRCP # punch out

- AC Shoulder
- Tied PCC Shoulder
- Separate PCC Shoulder

Pavement Age (Years)

# Punchout per mile

8 - in Slab
12 - ft slab width
IV. VDOT MEPDG
IMPLEMENTATION OVERVIEW
VDOT MEPDG Implementation Journey

Develop Inputs
- Materials
- Traffic
- Climate

Review Models
- Local Calibration
- Understanding output

Training
- Staff
- Software Shadow Design

Policy
- Connect with VDOT business practices (user manual, MOI)

January 1st, 2018
Fully Implemented
MEPDG Implementation Working Groups

- **Technical Working Group (TWG)**
  - Members (VDOT, VTRC, Industry, FHWA)
  - Work on technical issues (user manual, modelling, and input values)
  - Meets once a month to discuss on technical issues

- **Stakeholder Group**
  - Consists of VDOT, FHWA, VTRC and Industry
  - Periodic updates on progress & timeline
    - Monthly Teleconference
Where does VDOT use MEPDG?

- Interstate and Primary routes
  - New, reconstruction, and lane widening
- We will continue to use VDOT’s Secondary & Subdivision Pavement Design Guide & Procedures on Secondary & Subdivision streets*
  - Some high volume secondary roads with AADT > 10,000 maybe designed using MEPDG at discretion of Districts Material Engineer.
How Does MEPDG incorporated into VDOT Practice?

- VDOT has developed MEPDG User Manual
- User Manual is available for downloading:
- Updates on MOI Chapter III and VI were included in regards to MEPDG
- Training to VDOT and Consultants
- All VDOT specific inputs files are available in VDOT external site for downloading:
What’s Beyond Implementation?

- Provide continuous support for VDOT and Industry pavement designers
- Review of pavement designs
- Plan incorporation of MEPDG for rehab projects
- Review and assess new software versions
- Enhancement of material library
- Set up a long term planning for continuous enhancements
Thank You

Any Questions?

Girum Merine
(girum.merine@vdot.virginia.gov)