AASHTOWare Pavement ME Design™ Update

Linda Pierce, NCE
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Discussion Topics

- MEPDG & Pavement ME Design
- Software updates
- What’s next in software enhancements
- Agency implementation status
**AASHTO/AASHTO Pavement Design**

- Interim Guide for Rigid Pavements (1962)
- Interim Guide for the Design of Pavements (1972)
- Rigid Design Revisions (1981)
- Rigid Supplement (1998)

1958 - 1998

**AASHO Road Test**

40 years

**NCHRP 1-37A**

- 1998-2004
- Develop guide & software
- New & rehabilitated pavements
- Mechanistic-empirical based models
- Similar inputs
  - Traffic
  - Climate
  - Materials
  
  Estimate damage & predict performance
**Design/Analysis Overview**

**INPUTS**
- Performance Criteria
- Pavement Structure
- Climate
- Materials
- Traffic

**TRIAL DESIGN**
- Pavement Response Model
- Damage Accumulation
- Damage/IRI Model

**Build it**
- Meet Performance Criteria?
  - YES
  - NO
  - Modify Design

**Pavement Types**

- **Asphalt**
  - New construction
  - Asphalt overlay
  - Concrete overlay

- **Rigid**
  - New jointed plain
  - New continuously reinforced
  - Asphalt overlay
  - Concrete overlay
    - Bonded
    - Unbonded
    - Short jointed

- **Semi-Rigid**
  - New asphalt over chemically stabilized base
  - Asphalt overlay
Hierarchical Input Levels

- Level 1
  - Based on measured values
- Level 2
  - Limited test results & correlations
- Level 3
  - Regional averages or expert opinion

Analysis is the same regardless of input level

Reliability

Probability that the predicted distress will be less than the critical distress over the design period

<table>
<thead>
<tr>
<th>Functional Class</th>
<th>Urban</th>
<th>Rural</th>
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<tbody>
<tr>
<td>Interstate</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Principal Arterial</td>
<td>90</td>
<td>85</td>
</tr>
<tr>
<td>Collector</td>
<td>80</td>
<td>75</td>
</tr>
<tr>
<td>Local</td>
<td>75</td>
<td>70</td>
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</tbody>
</table>
Traffic Characterization

- Axle load spectra
  - Class 4+ vehicles
  - Axle configuration
  - Axle weight
- Data collection
  - Weigh-in-Motion
  - Automated Vehicle Classification
  - Vehicle Count

Asphalt Materials

- Layer thickness
- Air voids
- Effective binder content
- Poisson’s ratio
- Unit weight
- Binder type
  - PG, viscosity, or penetration grade
- Creep compliance
- Dynamic modulus
- Reference temperature
- Indirect tensile strength
  - Correlated (level 3)
- Heat capacity
- Thermal conductivity

Input Levels 1-3
Concrete Materials

- Thickness
- Poisson’s ratio
- Unit weight
- Coefficient of thermal expansion
- Heat capacity
- Thermal conductivity
- Aggregate type
- Cementitious content
- Cement type
- Water/cement ratio
- Curing method
- Reversible shrinkage
- Zero-stress temp.
- Time 50% shrinkage
- Ultimate shrinkage
- Strength

Base Material Types

- Asphalt
- Concrete
- Chemically stabilized
  - Cement
  - Lime cement
  - Lime fly ash
  - Lime stabilized
  - Soil cement
- Sandwiched granular
- Non-stabilized
  - A-1-a to A-3
  - RAP (plant & in-place)
  - Crushed gravel
  - Crushed stone
  - Permeable aggregate
  - River-run gravel
**Base Materials**

- Thickness
- Poisson’s ratio
- Coefficient of lateral earth pressure
- Resilient modulus
- Gradation
- Plasticity Index
- Liquid Limit

**Foundation**

**Type**
- Subgrade
  - A-1-a to A-7-6
- Bedrock
  - Highly fractured & weathered
  - Massive continuous

**Inputs**
- Thickness
- Poisson’s ratio
- Coefficient of lateral earth pressure
- Resilient modulus
- Gradation, PI, PL
Climate

• Temperature  
  – Asphalt  
    o Fatigue cracking, thermal cracking, & rutting  
  – Concrete  
    o Slab cracking & faulting (JPCP) & punchouts (CRCP)

• Freeze/Thaw  
  – JPCP performance

• Relative Humidity  
  – Moisture gradients JPCP & CRCP

• Seasonal Variation  
  – Resilient modulus

• Moisture Content  
  – Rutting unbound layers

Performance Prediction

• Predict performance at any point in time

• Asphalt  
  – IRI  
  – Rutting  
  – Cracking

• Semi-Rigid  
  – IRI  
  – Rutting  
  – Cracking

• Plain Jointed Concrete  
  – IRI  
  – Slab cracking  
  – Faulting

• Continuously Reinforced Concrete  
  – IRI  
  – Punchouts
**Characterizing Existing**

- Pavement condition surveys
- Core samples
  - condition, thickness, material testing
- Soil borings
  - Subgrade modulus, depth to stiff layer
- Other
  - Ground penetrating radar, seismic analysis of surface waves, impact echo

**Local Calibration**

- Local Materials
- Local Climate
- Local Traffic
- Other Local Inputs
- Measured Distresses

**ME Analysis**

**Predict Distress Profile**

**Within tolerance?**

- Yes: End
- No: Adjust Calibration Factors

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57th Idaho Asphalt Conference, October 26, 2017
AASHTO Products

• Manual of Practice
• Calibration Guide
• Software

Software Updates

• 2015 (v2.2)
  - Drainage Requirements in Pavements
  - MapME
  - Level 1, 2, & 3 inputs applicable for PCC & AC overlays of asphalt pavements
  - Reflection cracking model
  - Concrete pavement global re-calibration
  - Plastic deformation for each asphalt layer
Software Updates (continued)

• 2016 (v2.3)
  – Code modernization & review
  – Technical audit
  – Bonded concrete overlay design
  – North American Regional Re-analysis climate database
    o 1083 locations
    o 37 years continuous data

Software Updates (continued)

• 2017 (v2.4)
  – Correct unbound layer rutting model
  – Backcalculation tool
    o Pre-processing
    o Stiffness value determination
    o Post processing results
  – Revisions based on technical audit
• January 2018 (v2.5)
  - Manual of Practice integration
  - Tran. crack access to inputs/outputs
  - Access to dynamic modulus calculations
  - Modern-Era Retrospective Analysis for Research & Applications data
    - Continuous hourly estimate of all climate-related data (NASA)
  - Re-calibrate flexible & semi-rigid models

PaveME weather database

MERRA grid points
31 mi x 37 mi grid
Software Updates (continued)

- July 2018 (v2.6)
  - Report customization
  - Input comparison filter tool
  - Maintenance strategy tool
  - Level 1 tensile strength
    - Transverse crack prediction

Asphalt Pavements
- Cold milling
- Microsurfacing
- Thin/ultra thin overlays
- Hot in-place recycling

Concrete Pavements
- Diamond grinding
- Thin/ultra thin overlays

What’s Next?

- Influence of Geosynthetics on Pavement Performance (NCHRP 1-50)
  - Unbound base layers
  - Planned for FY 2019

[Graph showing pavement age versus rutting depth]
What’s Next? (continued)

• Slab/Underlying Layer Interaction in Concrete Pavements (NCHRP 1-51)
  - Planned for FY 2019

What’s Next? (continued)

• Top-Down Cracking in Asphalt Pavements (NCHRP 1-52)
  - Anticipated completion by end of 2017
  - Planned for FY 2019
What’s Next? (continued)

• Automated Local Calibration Tool
  – Significant agency challenge (time & $)
    o Section selection and data assembly
    o Potentially thousands of software iterations
  – Planned for **FY 2019**

What’s Next? (continued)

• Material Properties of CIP & Full-Depth Reclamation (NCHRP 9-51)
  – Software **Addendum** planned after release of final report
What’s Next? (continued)

• Influence of Subgrade/Unbound Layers (NCHRP 1-53)
  - Anticipated completion June 2018
  - Planned for FY 2020

Testing

Existing Pavements

Property

Implementation Status

Implemented
Implemented Asphalt Only
Implemented Concrete Only
Evaluating
No plans to implement
Input Levels

No. of Responses

- Truck Volume Dist
- Lane/Dir Dist
- Axle Load Dist
- Subgrade Modulus
- Unbound Base Modulus
- Chem Stab Layer Modulus
- Existing Pavmt Moduli

No Response Level 1 Level 2 Level 3

Input Levels (continued)

No. of Responses

- HMA Dynamic Modulus
- HMA Creep/Tensile Strength
- HMA Volumetrics
- PCC Elastic Modulus
- PCC Flexural Strength
- PCC CTE

Level 1 Level 2 Level 3
Performance Thresholds

Thresholds (continued)

No. of Responses

IRI Range (inch/mile)

0 101-125 126-150 151-175 176-200 TBD NA

No. of Responses

% Area (asphalt) or % Slabs (concrete)

< 5 6-10 11-15 16-20 TBD

Fatigue cracking  Slab cracking
Thresholds (continued)

Implementation Challenges

- Local calibration
- Designing pavements with features not included or have not been calibrated
- Material characterization (all layers)
- Traffic characterization
- Availability of performance data to verify/calibrate prediction models
User Group Meeting

• FHWA Transportation Pooled Fund
  – Conduct meetings
    o Information sharing
    o Identify implementation issues
    o Identify research needs
    o Organize regional/national implementation efforts

User Group Meeting (continued)

• Annual Meeting Dates
  1. December 14-15, 2016 - Indianapolis
  2. October 11-12, 2017 - Denver

http://www.pooledfund.org/Details/Study/549
Questions?

Linda Pierce
Principal
lpierce@ncenet.com
505.603.7993