Mechanistic-Empirical Pavement Design Guide -Implementation-

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Focus of Presentation

Regional & Individual Implementation Considerations or Issues to define inputs, defaults, and calibration values.

- Similar activities & inputs between agencies
- Operational & policy differences between agencies
Common Implementation Questions & Issues

- How do we determine the inputs?
- How do we use the software?
- Are the default values applicable?
- Are the predictions accurate enough?
- Are the calibration factors applicable?
Global Defaults & Calibration Values

LTPP GPS Test Sections Used in Calibration & Validation of Distress Prediction Models

Confirmation of global values for each agency.
Establish Similarities & Differences Between Agencies

- Site Features
  - Climate
  - Foundation
  - Traffic

- Design Features
- Materials & design procedures

- Design strategies
- Materials & construction specifications
- Acceptance policies
- Maintenance strategies
- Operational policies

All will affect the experimental plan for implementation.
On-Going National Implementation Efforts


On-Going Local Implementation Studies and Efforts
Many similar questions & issues between agencies.

We have decided to implement the new M-E Design Guide!

How do we begin?

Will we get a better design?

What will it cost?

What am I responsible for?

How can I make time for this?
Important Activities for Implementation

- **Training:**
  - Determining inputs & using software.

- **Communication:**
  - Departments need to know what information is needed & how it is used.

- Establish sensitivity of inputs to distress
- Identify problem areas and solutions for software use
Implementation Approach:
Video conferencing to share successes, problems, & knowledge

Agencies with similar design features & conditions.
Implementation Areas & Technology Transfer

Training & communications within & between departments

- Traffic
- Materials
- Construction
- Calibration
Implementation Issues:
Highlights from 3 Agencies
Traffic Characterization
[Missouri, Montana, Utah Traffic Libraries]

- How many trucks?
- What type of trucks?
- How much do they weigh?
Expanding the Realm of Possibility

Traffic Library Expectation

Missouri, Montana, & Utah:
Traffic volume & weight inputs for every state maintained roadway.

Overlay Project; traffic inputs obtained from library.

Share traffic data for primary arterial roadways
Missouri DOT Traffic Data Collection Program

- 34, 41%
- 25, 30%
- 13, 16%
- 11, 13%

Count Sites  Class Sites  WIM (IRD 1067)  WIM (ADR 3000)
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WIM Sites Analyzed

- ID 188 (IS 35)
- ID 182 (IS 29)
- ID 420 (IS 435)
- ID 440 (IS 635)
- ID 470 (MO 210)
- ID 555 (US 54)
- ID 740 (US 71)
- ID 750 (MO 171)
- ID 760 (IS 44)
- ID 206 (US 65)
- ID 441 (US 65)
- ID 302 (US 61)
- ID 500 (IS 70)
- ID 625 (MO 79)
- ID 645 (US 40)
- ID 658 (US 67)
- ID 610 (IS 55)
- ID 930 (IS 44)
- ID 920 (US 60)
- ID 030 (US 412)

- IRD 1067 WIM (included)
- ADR 3000 (included)
- IRD 1067 (not included)
- Additional stations
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**WIM Data Availability - Years**

![Bar chart showing the number of years for different WIM data availability categories.](chart.png)

- 182-1-1 (RPA-I)
- 182-5-1 (RPA-I)
- 188-1-1 (RPA-I)
- 188-5-1 (RPA-I)
- 500-3-1 (RPA-I)
- 500-7-1 (RPA-I)
- 760-3-1 (RPA-I)
- 760-5-1 (RPA-I)
- 930-3-1 (RPA-I)
- 930-5-1 (RPA-I)
- 470-5-2 (RPA-O)
- 740-5-1 (RPA-O)
- 441-5-1 (RPA-O)
- 470-5-1 (RPA-O)
- 420-1-1 (UPA-I)
- 655-7-1 (RPA-O)
- 658-1-1 (RPA-O)
- 440-5-1 (UPA-I)
Material Characterization

Material modulus is the key property.

Dynamic Modulus of HMA

Resilient Modulus of Unbound Materials

Static Modulus of concrete

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Material Testing - Equipment Purchased for Implementation

Unbound Mtls.
- Montana - No
- Missouri - No
- Utah - Yes

HMA
- Montana - No
- Missouri - Yes
- Utah - Yes

PCC
Most agencies have equip.
Material Property Library

Resilient modulus for standard materials
- Laboratory testing
- DCP or FWD testing

Master curve for typical HMA mixtures
- Laboratory testing
- Volumetric properties

 Crushed Aggregate

<table>
<thead>
<tr>
<th>Resilient Modulus, ksi</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
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</thead>
<tbody>
<tr>
<td>Applied Vertical Stress, psi</td>
<td></td>
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</table>

Dynamic Modulus Regression Equation

<table>
<thead>
<tr>
<th>Temperature, F</th>
<th>E x 10^6 psi</th>
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<tbody>
<tr>
<td>40</td>
<td>1</td>
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<tr>
<td>50</td>
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<td>110</td>
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<td>140</td>
<td>100</td>
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</table>
Local Calibration

A difficult & costly issue to resolve!
Comparison of Predicted & Measured Rutting

- HMA Rutting
- Line of Equality

- Total Rutting
- Line of Equality

Measured Total Rutting, inches

Calculated Rutting, Level 3 Inputs, inches

Measured Total Rutting, inches

Calculated Rutting, Level 3 Inputs, inches

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Predicted & Measured Distress

Why are these so different?

- Montana SPS-1 Sections
- Line of Equality
- Montana SPS-9 Sections

Preceded Rut Depths, inches

Measured Rut Depths, inches

0 0.05 0.1 0.15 0.2 0.25 0.3
**Local Calibration Effort**

- How close is close enough?
- Calibration costs exponentially increase with a reduction in error term!

<table>
<thead>
<tr>
<th>State</th>
<th>Type</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>Missouri</td>
<td>Rigid &amp; Flexible</td>
<td>Correlate calibration factors to material parameters</td>
</tr>
<tr>
<td>Montana</td>
<td>Flexible &amp; Semi-Rigid</td>
<td>Determine calibration factors for semi-rigid; develop correlations</td>
</tr>
<tr>
<td>Utah</td>
<td>Rigid &amp; Flexible</td>
<td>Calibration – A future activity</td>
</tr>
</tbody>
</table>
Accuracy of Designs & Costs

Error term affects construction costs!

Construction costs, Units

Cost of Implementation, $/units

Error, %

Agency A
Agency B

Construction costs

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### Local Calibration - Number of Sites

<table>
<thead>
<tr>
<th>Agency</th>
<th>Type of Sites</th>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>Missouri</td>
<td>LTPP &amp; Non-LTPP</td>
<td>HMA – 50+</td>
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<tr>
<td></td>
<td></td>
<td>PCC – 30+</td>
</tr>
<tr>
<td>Montana</td>
<td>LTPP &amp; Non-LTPP</td>
<td>HMA – 40+</td>
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<tr>
<td></td>
<td></td>
<td>PCC – 0</td>
</tr>
<tr>
<td>Utah</td>
<td>LTPP &amp; Non-LTPP</td>
<td>Limited</td>
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Coverage - Local Calibration Sections & Continuous WIM

- GPS 1/SPS 3
- GPS 4
- GPS 4/SPS 4
- GPS 5
- GPS 6A
- GPS 6B
- GPS 7A/7S
- GPS 7B
- SPS 5
- SPS 6
- SPS A600
- SPS 7
- SPS 8
- SPS 9A
Successful Implementation Plan

1. Top management and stakeholder support
2. Form a steering committee
3. Develop step-by-step action plan
   - Methodical execution
   - Use all available resources & existing data.
     - LTPP
     - Experimental Sections
     - Etc.
Steering Committee

Geotech

Materials

Planning

Research

Pavt. mgmt

DESIGN

Knowledge Management

Central office

District offices

Industry

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Action Plan

Phase I - Assess needs and prepare work plan

Phase II – Execution of work plan

Phase III – Pilot project and future plans
Technology Transfer & Implementation Products

Available Products:

- Management video
- Interactive CD for software
- Implementation notes
- Training course
- Guide text & appendices.
- User’s Manual in support of software.
Future Improvements

NCHRP 9-30
Experimental Plan for Calibration & Validation of HMA Performance Models for Mix & Structural Design

NCHRP 1-42
Top-Down Cracking of HMA Layers

NCHRP 1-41
Selection of a Reflection Cracking Model for HMA Layers

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Summary

- Implementation will require a coordinated effort.
- Implementation should be completed through technology transfer:
  - Within departments of an agency
  - Between departments
  - Between agencies
Coordinated Effort Between Agencies

Similarities
- Share examples, experiences, data
- Populate database
- Materials testing

Differences
- Material & construction specifications
- Maintenance strategies
- Policies
Thank you for your attention.