Implementation Team

INDOT Pavement Steering Committee

INDOT Research and Development

INDOT Pavement Engineering Office, Planning Office

Traffic Load Spectra
Materials, Design Features, and Climate
Specifications and Design Manual
WIM and Traffic Data
Roadmap for MEPDG Implementation in Traffic Inputs

1. Review Preparedness (Data, Knowledge, and Equipment)
2. Traffic Data Processing Plan
3. Weigh-In-Motion Data Acquisition and Pre-Processing
4. Weigh-In-Motion Data Processing and Analysis
5. Identify errors and issues in traffic data
6. Truck Weight Road Group Data Verification
7. Database Development for Load Spectra
8. GIS Software for Load Spectra
9. TWRG Deployment
## Traffic - Review Preparedness

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Equipment</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Some sites</td>
<td>Some sites</td>
<td>✓</td>
</tr>
<tr>
<td>Level 2</td>
<td>Study</td>
<td>Some regions</td>
<td>✓</td>
</tr>
<tr>
<td>Level 3a</td>
<td>Study</td>
<td>Some regions</td>
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</tr>
<tr>
<td>Level 3b</td>
<td>Coverage counts</td>
<td>Coverage counts</td>
<td>✓</td>
</tr>
</tbody>
</table>
Roadmap for MEPDG Implementation in Traffic Inputs

1. Review Preparedness (Data, Knowledge, and Equipment)
2. Traffic Data Processing Plan
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Required input data

- Basic inputs such as
  - AADTT,
  - % truck, and
  - Operational speed

- Traffic volume adjustment factor such as
  - Monthly adjustment, class distribution, and hourly distribution

- Other general traffic inputs such as
  - Axle numbers for single, tandem, tridem, and quad axle groups
  - Axle load distribution, and
  - Axle configuration
Roadmap for MEPDG Implementation in Traffic Inputs

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Planning data: 126,005 AADT
WIM actual data: 101,199 AADT
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9. TWRG Deployment
Indiana has 56 WIM sites, 7 more to come

Provide files for:
- Monthly Adjustment Factor
- Vehicle Class Distribution
- Hourly Distribution
- Axle Load Distribution

Groups
- A for AADTT = 1 to 3,000
- B for AADTT = 3,001 to 6,000
- C for AADTT = 6,001 to 20,000
- D for AADTT > 20,000
Roadmap for MEPDG Implementation in-Traffic Inputs

Review Preparedness (Data, Knowledge, and Equipment)

Traffic Data Processing Plan

Weigh-In-Motion Data Acquisition and Pre-Processing

Weigh-In-Motion Data Processing and Analysis

Identify errors and issues in traffic data

Truck Weight Road Group Data Verification

Database Development for Load Spectra

GIS Software for Load Spectra

TWRG Deployment
Roadmap for MEPDG Implementation in Traffic Inputs

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Generate locations of WIM and AVC in GIS maps

One click to a GIS map to export traffic data to MEPDG
Review Preparedness (Data, Knowledge, and Equipment)

Sensitivity Analysis

Design Features, Materials, and Construction data requirements

Identify errors, sensitive and critical, and importance of parameters

Experimental Design for Material Inputs

Mini LTPP Project Construction

Field Monitoring and Field and Lab Testing

Data Collection and Analysis

Local Calibrations
### Flex

<table>
<thead>
<tr>
<th>Level</th>
<th>Data</th>
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<th>Knowledge</th>
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<tbody>
<tr>
<td>1</td>
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<td>x</td>
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</tr>
<tr>
<td>2</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Default</td>
<td>N/A</td>
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### Rigid

<table>
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<th>Knowledge</th>
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</thead>
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<td>1</td>
<td>Some sites, Study</td>
<td>✔ (Research &amp; M-T)</td>
<td>✔</td>
</tr>
<tr>
<td>2</td>
<td>Study</td>
<td>✔</td>
<td>✔</td>
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<tr>
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### Soil

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<tr>
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<td>On-going study</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>2</td>
<td>On-going study</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>3</td>
<td>Default</td>
<td>✔</td>
<td>✔</td>
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</table>
Review
Preparedness
(Data, Knowledge,
and Equipment)

Sensitivity Analysis

Design Features,
Materials, and
Construction data
requirements

Identify errors,
sensitive and critical,
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parameters

Experimental Design
for Material Inputs

Mini LTPP Project
Construction

Field Monitoring and
Field and Lab
Testing

Data Collection and
Analysis

Local Calibrations
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Roughness</th>
<th>Faulting</th>
<th>Percent Slabs Cracked</th>
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</thead>
<tbody>
<tr>
<td>Level 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modulus of Rupture</td>
<td>S</td>
<td>NS</td>
<td>VS</td>
</tr>
<tr>
<td>Compressive Strength</td>
<td>S</td>
<td>NS</td>
<td>VS</td>
</tr>
<tr>
<td>Level 2</td>
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</tr>
<tr>
<td>Compressive Strength</td>
<td>S</td>
<td>NS</td>
<td>VS</td>
</tr>
<tr>
<td>20-year/28-day Ratio</td>
<td>S</td>
<td>NS</td>
<td>VS</td>
</tr>
<tr>
<td>Level 1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Modulus of Rupture</td>
<td>S</td>
<td>NS</td>
<td>VS</td>
</tr>
<tr>
<td>Modulus of Elasticity</td>
<td>S</td>
<td>NS</td>
<td>VS</td>
</tr>
<tr>
<td>20-year/28-day Ratio</td>
<td>S</td>
<td>NS</td>
<td>VS</td>
</tr>
</tbody>
</table>
## Sensitivity Analysis - Concrete

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Roughness</th>
<th>Faulting</th>
<th>Percent Slabs Cracked</th>
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</thead>
<tbody>
<tr>
<td>Permanent Curl/Warp Effective Temperature Difference</td>
<td>VS</td>
<td>VS</td>
<td>VS</td>
</tr>
<tr>
<td>Joint Spacing</td>
<td>VS</td>
<td>VS</td>
<td>VS</td>
</tr>
<tr>
<td>Dowel Bar Diameter</td>
<td>MS</td>
<td>MS</td>
<td>NS</td>
</tr>
<tr>
<td>Pavement Thickness</td>
<td>S</td>
<td>MS</td>
<td>VS</td>
</tr>
<tr>
<td>Poisson’s Ratio</td>
<td>MS</td>
<td>MS</td>
<td>S</td>
</tr>
<tr>
<td>Coefficient of Thermal Expansion</td>
<td>VS</td>
<td>VS</td>
<td>VS</td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>S</td>
<td>MS</td>
<td>VS</td>
</tr>
<tr>
<td>Parameter</td>
<td>IRI</td>
<td>Alligator Cracking</td>
<td>Permanent Deformation</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----</td>
<td>--------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>AC Thickness</td>
<td>S</td>
<td>VS</td>
<td>S</td>
</tr>
<tr>
<td>PG-Grade</td>
<td>NS</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>$</td>
<td>E^*</td>
<td>$</td>
<td>NS</td>
</tr>
<tr>
<td>Poisson’s Ratio</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Air voids (L1)</td>
<td>NS</td>
<td>S</td>
<td>NS</td>
</tr>
<tr>
<td>Effective Binder Content (L1)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Surface Short Wave</td>
<td>S</td>
<td>NS</td>
<td>S</td>
</tr>
<tr>
<td>Average Tensile Strength</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>$</td>
<td>D^*</td>
<td>$</td>
<td>NS</td>
</tr>
<tr>
<td>Coefficient of Thermal Contraction</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Heat Capacity</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
</tr>
<tr>
<td>Group or Screen</td>
<td>Field Number</td>
<td>Input name</td>
<td>Typical Value</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>-----------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Design Features</td>
<td>34</td>
<td>Slab thickness (inch)</td>
<td>This field is not an input, it comes from Layer #1 input</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>Permanent Curl/Warp Effective Temperature difference (degrees)</td>
<td>-10</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>Joint Spacing (feet)</td>
<td>15-30</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>Sealant Type</td>
<td>None, Liquid, Silicone, and Performed</td>
</tr>
<tr>
<td></td>
<td>38</td>
<td>Dowel Transverse Joint</td>
<td>Check item</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>Dowel Diameter (inches)</td>
<td>1&quot; to 1.5&quot;</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>Dowel Spacing (inches)</td>
<td>12&quot;</td>
</tr>
<tr>
<td></td>
<td>41</td>
<td>Edge support: Tied Shoulder</td>
<td>Based on design</td>
</tr>
<tr>
<td></td>
<td>42</td>
<td>Edge Support: Long Term LTE (%)</td>
<td>50% to 70% for sawed longitudinal joint with tie bar, 30% to 50% for construction longitudinal with tie bar, 0% for no tie bar</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>Edge support: Widened Slab</td>
<td>Check item</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>Edge Support: Slab width (feet)</td>
<td>12 to 14 feet</td>
</tr>
</tbody>
</table>
Catalog of Local Inputs – Field Parameter Locations in the MEPDG
Map of soil of Indiana (finishing January 2009)

Level 1 soil input

- FWD seasonal testing
  
  \[
  \log k_1 = 6.660876 - 0.22136 \times \text{OMC} - 0.04437 \times \text{MC} - 0.92743 \times \text{MCR} - 0.06133 \times \text{DD} + 10.64862 \times \%\text{comp} + 0.328465 \times \text{SATU} - 0.04434 \times \%\text{sand} - 0.04349 \times \%\text{SILT} + 0.01832 \times \%\text{CLAY} + 0.027832 \times \text{LL} - 0.01665 \times \text{PI}
  \]

- \[
  k_2 = 3.952635 - 0.33897 \times \text{OMC} + 0.076116 \times \text{MC} - 2.45921 \times \text{MCR} - 0.06462 \times \text{DD} + 6.012966 \times \%\text{comp} + 1.559769 \times \text{SATU} + 0.020286 \times \%\text{sand} + 0.002321 \times \%\text{SILT} + 0.011056 \times \%\text{CLAY} + 0.077436 \times \text{LL} - 0.05367 \times \text{PI}
  \]

- \[
  k_3 = 2.634084 + 0.124471 \times \text{OMC} - 0.09277 \times \text{MC} + 0.366778 \times \text{MCR} - 0.01168 \times \text{DD} - 1.32637 \times \%\text{comp} + 1.297904 \times \text{SATU} - 0.01226 \times \%\text{sand} - 0.00512 \times \%\text{SILT} - 0.00492 \times \%\text{CLAY} - 0.05083 \times \text{LL} + 0.018864 \times \text{PI}
  \]
Roadmap for MEPDG Implementation – Material and Design Feature Inputs

Review
Preparedness
(Data, Knowledge, and Equipment)

Sensitivity Analysis

Design Features, Materials, and Construction data requirements

Identify errors, sensitive and critical, and importance of parameters

Experimental Design for Material Inputs

Mini LTPP Project Construction

Field Monitoring and Field and Lab Testing

Data Collection and Analysis

Local Calibrations
## Sensitive, Critical, and Important Data

<table>
<thead>
<tr>
<th>Group of Screen</th>
<th>Field Number</th>
<th>Input Name</th>
<th>Typical Value</th>
<th>Proposed Indiana Value</th>
<th>Status of input</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Features</td>
<td>34</td>
<td>Slab thickness (inch)</td>
<td>This field is not an input, it comes from Layer #1 input</td>
<td>Input in parameter #66</td>
<td>Option</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Permanent Curl/Warp Effective Temperature difference (degrees)</td>
<td>-10</td>
<td>-10</td>
<td>Sensitive and Critical</td>
<td>Do not change this value until further research</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Joint Spacing (feet)</td>
<td>15-30</td>
<td>9&quot; to 12&quot; = 20 feet, 13&quot; to 16&quot; = 18 feet</td>
<td>Sensitive and Critical</td>
<td>Can be changed to optimize the curling stress</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Sealant Type</td>
<td>None, Liquid, Silicone, and Performed</td>
<td>Silicone or preformed</td>
<td>Important</td>
<td>INDOT Manual Chapter 52</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Dowel Transverse Joint</td>
<td>Check item</td>
<td>Check this item</td>
<td>Sensitive and Critical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Dowel Diameter (inches)</td>
<td>1&quot; to 1.5&quot;</td>
<td>Thickness &lt;9&quot; = 1&quot;, between 9&quot; to 12&quot; = 1.25&quot;, &gt;12&quot; = 1.5&quot;</td>
<td>Sensitive and Critical</td>
<td>INDOT Standard Drawing E-503-CCPJ-01</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Dowel Spacing (inches)</td>
<td>12&quot;</td>
<td>12&quot;</td>
<td>Important</td>
<td>INDOT Standard Drawing E-503-CCPJ-01</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Edge support: Tied Shoulder</td>
<td>Based on design</td>
<td>Based on design</td>
<td>Sensitive and Critical</td>
<td>INDOT Standard Drawing E-503-CCPJ-07</td>
<td></td>
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<tr>
<td>42</td>
<td>Edge Support: Long Term LTE (%)</td>
<td>50% to 70% for sawed longitudinal joint with tie bar, 30% to 50% for construction longitudinal with tie bar, 0% for no tie bar</td>
<td>60%</td>
<td>Important</td>
<td>Not critical to Indiana</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Edge support: Widened Slab</td>
<td>Check item</td>
<td>Check this item if the slab width is wider than 12 feet</td>
<td>Sensitive and Critical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>Edge Support: Slab width (feet)</td>
<td>12 to 14 feet</td>
<td>Slab width</td>
<td>Sensitive and Critical</td>
<td>Lane + widen edge</td>
<td></td>
</tr>
</tbody>
</table>
Final preparation for input files (October 2008)
Changes in INDOT Pavement Design Manual
Changes in INDOT Standard Specifications
Training October 12, 13, and 14, 2008
  - INDOT pavement designers, FHWA Indiana Office
  - Industry representatives
Start January 1, 2009
Another training, March 16 and 17, 2009
  - Consultants
  - HMA and Concrete industry participants
I-465 in Indianapolis
JPCP – MEPDG 13 inches
JPCP – AASHTO 1993 15 inches

SR-13 in Hancock Co.
HMA – MEPDG 11 inches
HMA – AASHTO 1993 12.5 inches
Roadmap for MEPDG Implementation - Material and Design Feature Inputs

- Review Preparedness (Data, Knowledge, and Equipment)
- Sensitivity Analysis
- Design Features, Materials, and Construction data requirements
- Identify errors, sensitive and critical, and importance of parameters
- Experimental Design for Material Inputs
- Mini LTPP Project Construction
- Field Monitoring and Field and Lab Testing
- Data Collection and Analysis
- Local Calibrations
- HMA local calibration
  - INDOT implemented Superpave in 1996
  - Tune-up and refinement
    - 1996 to 2000
  - Changes in standard specification
    - 2000 to 2005
  - Tremendous performance difference
    - Rutting
    - Fatigue cracking
    - Thermal cracking
- What to calibrate to?
  - No full depth LTPP section in Indiana
  - Pavements prior to 2005 do not represent current practices
Concrete Pavement local calibration

- Adopted drainable base in 1992
- Changes in standard specification since then
- No pavement joint faulting in Indiana
- Have to calibrate only against mid-slab cracking
Do your homework

Traffic and soil inputs are the most difficult to make them correct (error prone)
  - Take a lot of efforts and expertise
  - Take a lot of time

Find errors in input parameters first and do local calibration (smaller errors)

Simplify the inputs
  - Provide input files, catalog of local inputs
  - Show to the potential users the locations of each input

Buy-in from your executive staff

Don’t throw away your AASHTO 1993 yet
Questions