Local Calibration of the MEPDG for HMA Pavements in Missouri

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MEPDG Implementation

- Decision made in 2004 by MoDOT Pavement Team members, including FHWA, MAPA, and ACPA to fully incorporate the MEPDG into new pavement design activities
- MoDOT contracted with ARA to calibrate the national distress models for local conditions
HMA Distresses of Interest

• Fatigue cracking
• Rutting
• Thermal cracking
Local Calibration Data Collection

- Data collection, testing, and analysis efforts split into two tasks
  - In-service pavement performance data for local calibration of distress models
    - Collected through field testing and (if necessary) project records for each identified MoDOT section
    - Imported from LTPP database for LTPP sections
  - Material testing data for MEPDG input libraries, local calibration defaults, and design guidance
    - Obtained through sampling and testing typical HMAs from active projects
    - Obtained through testing field sample cores from in-service pavements
In-Service Data Collection

• 500-ft section units
• 3 - 4 cores sampled from each section
  – Asphalt lift thicknesses
  – Bulk and maximum specific gravities
  – Air voids
  – Gradations
  – Asphalt contents
• FWD testing performed on all sections
• Manual cracking (2 obs./unit) & rutting (1 obs./unit)
• Historical IRI
# In-Service (Deep Strength) HMA Factorial

<table>
<thead>
<tr>
<th>HMA Thickness</th>
<th>4-8 inches</th>
<th>&gt; 8 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design Method</strong></td>
<td>Dir. Comp./ Marshall</td>
<td>Superpave</td>
</tr>
<tr>
<td><strong>Base Type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4” Crushed Stone</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>24” Rock Base</td>
<td></td>
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</tr>
</tbody>
</table>

*MODOT Sections  
*LTPP Sections*
Age of New HMA Pavement Sections

<table>
<thead>
<tr>
<th>Age, Years</th>
<th>No. of Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 5</td>
<td>2</td>
</tr>
<tr>
<td>5 to 10</td>
<td>2</td>
</tr>
<tr>
<td>10 to 15</td>
<td>8</td>
</tr>
<tr>
<td>15 to 20</td>
<td>1</td>
</tr>
<tr>
<td>20 to 25</td>
<td>1</td>
</tr>
<tr>
<td>25 to 30</td>
<td>4</td>
</tr>
<tr>
<td>30 to 35</td>
<td>2</td>
</tr>
</tbody>
</table>

MODOT & LTPP SPS-8 Sections

LTPP GPS-1, GPS 6A, SPS-3 & SPS-8 Sections
Geographic Distribution of New HMA Sections Selected for Local Calibration
Illustration of a Typical Section and 500-ft Sample Units
Magnitudes of Measured Distress – MoDOT and MO LTPP HMA Pavements

HMA Rutting (in)

Fatigue Cracking (% lane area)
Magnitudes of Measured Distress – MoDOT and MO LTPP HMA Pavements
Material Testing (Level 1)

Fatigue cracking
- Dynamic modulus

Rutting
- Dynamic modulus

Thermal cracking
- Creep compliance
- Tensile strength
Dynamic Modulus

- Testing performed with in-house AMPT
- Three replicate gyratory-compacted samples of each mix type
- Air voids – 4%, 6.5%, and 9%
- Polymer-modified and neat (dependent on PG grade)
Dynamic Modulus

- Test frequencies – 25, 10, 5, 1, 0.5, and 0.1 Hz
- Test temperatures – (14)*, 40, 70, 100, and 130 °F
  *estimated
- Mixes completed included
  - SP125 PG76-22 (2)
  - SP190 PG76-22
  - SP190 PG70-22
  - SP190 PG64-22
  - SP250 PG70-22
  - SP250 PG64-22
  - BP1 PG64-22
AMPT
Predicted (with Witczak model in MEPDG) and Measured Dynamic Modulus Master Curves for SP125 PG76-22

Mix 5-94 (SMA)
Predicted vs. Measured Dynamic Modulus for SP125 PG76-22
Master Curves @ 70F Temperature AV level=6.5

-6 -4 -2 0 2 4 6 8 10
log(tr)

2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
log(E*)

SP190 PG76-22
SP125 PG76-22
SP125 PG64-22
SP190 PG70-22
SP250 PG70-22
SP250 PG64-22
SP190 PG64-22
(SMA)
Dynamic Modulus Findings

• MEPDG dynamic modulus equation provides a reasonable prediction
• Air void range between 4 and 9 percent has minimal affect on dynamic modulus
Creep Compliance and IDT

- Testing performed under contract with Missouri University of Science and Technology (MS&T)
- AASHTO T-322
- Wearing course mixes only
  - SP125 @ PG64-22, 70-22, and 76-22
  - SMA @ PG76-22
  - BP-1 @ PG64-22
Creep Compliance and IDT

- Creep compliance -
  - Test loading times – 1, 2, 5, 10, 20, 50, and 100 s
  - Test temperatures – -20, -10, and 0 ºC

- Indirect Tensile Strength tested at -10 ºC
IDT and Creep Compliance Equipment
Specimen
Set Up
SP125 PG70-22 @ 6.5% Voids
6 Mixes @ 6.5% Voids & 0°C

Creep Compliance (1/GPa) vs. Time (sec)

- SMA 76-22
- 125 76-22
- 100 64-22
- 125 70-22
- 35 Blow 64-22
- 100 70-22
IDT Strength: All Mixes @ 6.5% Voids @ -10°C

<table>
<thead>
<tr>
<th>Mix</th>
<th>100</th>
<th>100</th>
<th>35 Blow</th>
<th>SMA</th>
<th>125</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG64-22</td>
<td>0% RAP</td>
<td>100% RAP</td>
<td>PG64-22 20% RAP</td>
<td>PG76-22 0% RAP</td>
<td>PG76-22 0% RAP</td>
<td>PG70-22 10% RAP</td>
</tr>
</tbody>
</table>
100 Second Creep Compliance vs IDT Strength: -10°C

\[ D(t) = -0.0001 (S_t) + 0.161 \]

\[ R^2 = 0.5524 \]

\[ n = 14 \text{ mix/\% voids combinations} \]
Local Calibration/Validation Steps

1. Assemble best possible input data for each sample unit
   a) Backcast initial IRI from historical IRI data for each section
   b) Backcast initial AADTT and compute growth rate from historical traffic data
   c) Assume MODOT specific defaults where project specific data is not available

2. Execute MEPDG runs

3. Examine predicted versus measured distress plots

4. Assess bias and error

5. Make suitable engineering and statistical analyses to calibrate models and to reduce bias and error
New HMA Pavements—Measured

Predicted total rutting, in

Measured total rutting, in

\[ y = 1.8x \]
\[ R^2 = 0.33 \]
\[ \text{SEE} = 0.08 \text{ in} \]
\[ N = 50 \]

\[ y = 0.92x \]
\[ R^2 = 0.56 \]
\[ \text{SEE} = 0.03 \text{ in} \]
\[ N = 50 \]
New HMA Pavements—Measured

NCHRP 1-40D
\[ y = 0.9203x \]
\[ R^2 = 0.5677 \]
\[ N = 220 \]
\[ SEE = 11.2 \text{ in/mi} \]
Thank You!

Questions?

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