Mixing HMA for Performance

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Disclaimer

This presentation is based upon work in progress under project:

ICT-R27-161- CONSTRUCTION AND PERFORMANCE MONITORING OF VARIOUS ASPHALT MIXES

Project Chair: James S. Trepanier

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Outline

- SuperPave Controls for HMA
- Performance Measure in HMA Pavement
- Distress Seen in Total Recycle Asphalt Section
- Typical HMA Project Types
- Performance of Various Asphalt Mixes (IHR 161)
- Thoughts for Future Specification Development Using Flexibility Index

SuperPave Specification Controls

- VMA, N-Design, Air Voids, Density and Asphalt Grade
- Each Impacts Performance
  - Raveling/Weathering/Segregation
  - Block Cracking
  - Transverse Cracking
  - Rutting
  - Centerline Joint Distress,
Additional Controls

- TSR (AASHTO T-283) – Rutting (Stripping)
- Minimum Tensile – Rutting
- Maximum Tensile – Cracking
- Hamburg – Rutting (Stripping)
- Material Transfer Devices (MTD) and Anti-Segregation Controls
- Smoothness Incentive/Penalty

HMA Performance Measures

<table>
<thead>
<tr>
<th>Construction Related Distresses</th>
<th>Mix Related Distresses</th>
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</thead>
<tbody>
<tr>
<td>Ride</td>
<td>Rutting</td>
</tr>
<tr>
<td>Raveling/Weathering/Segregation</td>
<td>Transverse Cracking</td>
</tr>
<tr>
<td>Longitudinal Cracking</td>
<td>Block Cracking</td>
</tr>
<tr>
<td>(Paver Segregation and Roller Tears)</td>
<td>Raveling/Weathering/Segregation</td>
</tr>
<tr>
<td>Centerline Joint Distress</td>
<td>Centerline Joint Distress</td>
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<table>
<thead>
<tr>
<th>Design Related Distresses</th>
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<tbody>
<tr>
<td>Rutting (Remaining Layers)</td>
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<tr>
<td>Reflective Transverse Cracking</td>
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</tbody>
</table>
Distress Driving Rehabilitation

Block Cracking

Centerline Cracking
Distress Driving Rehabilitation

Raveling/Weathering/Segregation

“Where Excellence and Transportation Meet”

Distress Driving Rehabilitation

Rutting

“Where Excellence and Transportation Meet”
Distress Driving Rehabilitation

Transverse Cracking

2013 TRA Project Distress Surveys

<table>
<thead>
<tr>
<th>26th Street</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
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<table>
<thead>
<tr>
<th>Harrison Street</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
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<td>5</td>
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2013 TRA Project Distress Surveys

### Richards Street

<table>
<thead>
<tr>
<th>Year</th>
<th>Image 1</th>
<th>Image 2</th>
<th>Image 3</th>
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</thead>
<tbody>
<tr>
<td>2014</td>
<td><img src="image1.png" alt="Image 1" /></td>
<td><img src="image2.png" alt="Image 2" /></td>
<td><img src="image3.png" alt="Image 3" /></td>
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<tr>
<td>2015</td>
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<td><img src="image5.png" alt="Image 2" /></td>
<td><img src="image6.png" alt="Image 3" /></td>
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<tr>
<td>2016</td>
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<td><img src="image8.png" alt="Image 2" /></td>
<td><img src="image9.png" alt="Image 3" /></td>
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</table>

### Wolf Road

<table>
<thead>
<tr>
<th>Year</th>
<th>Image 1</th>
<th>Image 2</th>
<th>Image 3</th>
</tr>
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<tbody>
<tr>
<td>2014</td>
<td><img src="image10.png" alt="Image 1" /></td>
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<td>2016</td>
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<td><img src="image17.png" alt="Image 2" /></td>
<td><img src="image18.png" alt="Image 3" /></td>
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</tbody>
</table>

“Where Excellence and Transportation Meet”

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### HMA Project Types

- **New Full-Depth HMA**
- **New Composite (HMA over PCC)**
- **Overlays of Existing**
  - Bare PCC
  - Mill and Fill of Existing Overlay (2.25-3.0”)
    - Existing Thick OL (3-8+” HMA) over PCC
    - Existing Thin OL (2.25-3”) over PCC
    - Full-Depth HMA
    - Other Stabilized Base (Cement or Pozzolanic)

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**Typical HMA Rehabilitation Designs**

**Existing Thick & Thin HMA/PCC/Bare PCC and Full Depth HMA**

6-8” HMA

2.5-3” HMA

Old PCC

HMA

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**Typical HMA Rehabilitation Designs**

**Rehabilitated Thick & Thin HMA/PCC/Bare PCC and Full Depth HMA**

6-8” HMA

2.5-3” HMA

Old PCC

HMA

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Typical HMA Rehabilitation Designs

**Existing Thick HMA/PCC**

**Before**
- 6-8" HMA
- Old PCC

**After Improvement**
- Mill ~2.25"
- 1.5" HMA
- 0.75" Poly 4.75
- 3.75" - 5.75"
- Old PCC

Crack Initiation

**Existing Thick HMA/PCC**

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Crack Initiation
HMA on PCC (Bare or HMA Milled Off)

Old PCC

Crack Propagation
HMA on PCC (Bare or HMA Milled Off)

Old PCC
# 161 Experimental Mixes

<table>
<thead>
<tr>
<th>ASPHALT PG</th>
<th>ABR %</th>
<th>RAP %</th>
<th>RAS %</th>
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<tbody>
<tr>
<td>64-22</td>
<td>58-22</td>
<td>LOW</td>
<td>HIGH</td>
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<tr>
<td>58-28</td>
<td>58-34</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>52-28</td>
<td>52-34</td>
<td></td>
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**Material Sampling**

**Plant Mix**  
Lab Compacted (PMLC)

**Cores**
Testing

Binder PG Grading  Asphalt Content/Mix Verification  Moisture Damage (TSR)

Marshall Stability  Cantabro Loss  Texas Overlay

Testing

Complex Modulus Test  Hamburg Wheel Track  Semi Circular Bending Beam

Flow Number  IDT Fracture / Creep Compliance  Beam Fatigue

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Texas Overlay Tester

Crack Propagation
HMA on PCC (Bare or HMA Milled Off)
Surface HMA FI vs. Cracking

1st Winter: \[ y = -176.4 \ln(x) + 385.7 \]
\[ R^2 = 0.70 \]

2nd Winter: \[ y = -309.6 \ln(x) + 699.5 \]
\[ R^2 = 0.96 \]

3rd Winter: \[ y = -337.0 \ln(x) + 860.1 \]
\[ R^2 = 0.98 \]

IDOT Proposed Min 8.0
Washington St. Leveling Binder

I-FIT FI = 7
Laydown 5/29/15
Photo 6/9/15

4.75 Leveling Binder
0.75-Inch
PG 70-28
AC: 8.0%
ABR: 29%
RAP: 24%
RAS: 4.9%

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HMA Testing “Book Ends”

Too Soft

Too Hard
Too Soft “Book End” Full Imp. 2014
Hamburg Wheel Test

The Other “Book End”

- I-FIT and Flexibility Index
Research to Specification

- Single FI for all mixes?
  - Simple Goal for all Mixes
  - Single Value may not be Best Engineering Approach to Obtain Desired Performance

- Multiple FI’s
  - More Complex – Expands Number of Mixes
  - HMA Overlay Surface/Level Binder Values?
  - Full Depth HMA (Surface and Binder) Values?
  - HMA Shoulder Different Value?

Mixing HMA for Performance

- High Flexibility Demand
  - Level Binder Over PCC Pavement
  - Thin HMA Overlays

- Moderate Flexibility Demand
  - Thick Overlays of PCC Pavement
  - Thin Mill and Fill of Thick Overlay

- Low Flexibility Demand
  - Shoulders
Mix Use and FI Demand

Decreasing Flexibility Demand

Leveling Binder  | Surface  | Shoulder
---|---|---
High FI  |  | Low FI

Impacts

- Leveling Binder
  - Re-Engineer Mix to Provide Cross-Section Design Needs
  - PG Grades, Recycle and Gradation
- With Better Understanding of Cross-Section Influence on Cracking….
  - Data sets can be Refined
  - Establish I-Fit/FI Specification Values
Design Possibilities

- Leave HMA In-Place
  - No Milling – Existing Must be Stable
  - Hot-In-Place Recycle
  - Cold-In-Place Recycle
- Increase HMA Overlay Thickness
  - Must have Reasonable FI
  - Cost for Extra Material is Issue

Mixing HMA for Performance

- All Cross-Sections Benefit from Higher FI Mixes Resulting in Reduced Transverse Cracking
- Thin Overlays of PCC Pavement have High FI Demand
- Leveling Binder (Directly on PCC Pavement)
  - High Flexibility Demand
  - Could have Benefits from FI Value > 8.0
Reports (IHR 27-161)

- 2-Interim Reports
  - 2015 (Published)
  - 2016 (Jan 2017 +/-)

- Final Report
  - Dec 2017

Questions
THANK YOU

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