Stone Matrix Asphalt: Impact on Performance and LCCA

Richard Willis, National Asphalt Pavement Association

Illinois Bituminous Conference
December 12, 2018
WELCOME TO THE 1st International Conference on Stone Matrix Asphalt
SMA – A Brief History

• Germany, 1968
  • 50th Anniversary

• United States, early to mid-90s
  • Wisconsin, Virginia, Maryland

• Europe vs. US
  • Europe – few changes since inception
  • US DOTs – Some changes since inception
  • US Private or P3 Roads – Many changes
Why Does it Work?

The Right Ingredients

The Right Proportion
Why Does it Work?

The Right Ingredients
• High quality stone
• Premium asphalt
• Something to prevent draindown
• Filler

The Right Proportion
• Gap graded mixture
  • Stone on stone contact
• Typically polymer modified at higher asphalt contents
• Draindown inhibitor
• Higher filler content
SMA Stone Structure

Stone on Stone Structure  Filled SMA Structure

*Courtesy of Ray Brown
It’s the Same ... But Not Really
What Do These Ingredients/Proportion Provide

- Improved durability
  - Gap-graded agg
- Rutting resistance
  - Stone on stone contact
  - Polymer modification
  - High filler content
A Willingness to Learn
Wisconsin

WisDOT SMA Pilot Program

*Courtesy of Debbie Schwerman

- Factors investigated
  - Traffic
  - Aggregate LA Wear
  - Stabilizer type & dosage
  - NMAS (5/8” vs. 3/8”)
  - Base material

- Performance monitoring after 5 years

- Performance measures
  - Pavement Distress Index (PDI)
  - Ride - IRI
  - Rutting/Cracking
  - Friction and Noise

Location of SMA Projects and Control Sections
Regions Separated by LA Wear Values
# WisDOT SMA Pilot Program

**Detailed Project Information**

<table>
<thead>
<tr>
<th>Project</th>
<th>Base Pavement</th>
<th>ADT/Yr. Const.</th>
<th>Max Agg. Size</th>
<th>Hardness Region</th>
<th>LA Wear</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-43, Waukesha</td>
<td>CRCP</td>
<td>42,200 1992</td>
<td>3/8” (9.5 mm)</td>
<td>3</td>
<td>26</td>
</tr>
<tr>
<td>I-43, Walworth</td>
<td>JRCP</td>
<td>11,650 1993</td>
<td>5/8” (16 mm)</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>USH 151, Lafayette</td>
<td>AC over thin-edged PCC</td>
<td>6,350 1993</td>
<td>5/8” (16 mm)</td>
<td>3</td>
<td>38</td>
</tr>
<tr>
<td>STH 21, Juneau</td>
<td>AC over dense base over PCC</td>
<td>4,200 1993</td>
<td>3/8” (9.5 mm)</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>USH 45, Vilas and Oneida</td>
<td>AC</td>
<td>5,940 1993</td>
<td>5/8” (16 mm)</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>STH 63, Washburn</td>
<td>AC</td>
<td>5,872 1993</td>
<td>3/8” (9.5 mm)</td>
<td>1</td>
<td>24</td>
</tr>
</tbody>
</table>

*Courtesy of Debbie Schwerman*
Wisconsin

WisDOT SMA Pilot Project

Construction Issues - Bleeding

- Higher temperature sensitivity observed for PMA mixes
  - Draindown above 305°F
  - Sticking in truck box below 290°F
- Projects constructed well before the invention of WMA/compaction aide additives

*Courtesy of Debbie Schwerman
## Performance – Cracking and PDI

*Courtesy of Debbie Schwerman

<table>
<thead>
<tr>
<th>Test Sections (LA Wear Region)</th>
<th>% Cracking</th>
<th>PDI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean SMA</td>
<td>Mean Control</td>
</tr>
<tr>
<td>STH 63 (Reg 1)</td>
<td>26</td>
<td>69</td>
</tr>
<tr>
<td>STH 21 (Reg 2)</td>
<td>72</td>
<td>78</td>
</tr>
<tr>
<td>I-43 Wauk. (Reg 3)</td>
<td>48</td>
<td>68</td>
</tr>
<tr>
<td>USH 45 (Reg 1)</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>USH 151 (Reg 2)</td>
<td>52</td>
<td>67</td>
</tr>
<tr>
<td>I-43 Wal. (Reg 3)</td>
<td>6</td>
<td>38</td>
</tr>
</tbody>
</table>

- Pavement was surveyed pre-overlay. Cracking extent was used as a baseline to evaluate SMA effectiveness
- PDI = f(Cracking, Flushing, Ravelling, Rutting). PDI > 60 triggers rehab.
Virginia’s Experience

*Courtesy of Trenton Clark
Virginia’s Experience

Percentage of System

- Interstate
- Primary

*Courtesy of Trenton Clark
Others Nearby

• Missouri uses SMA
  • Contractors can innovate with recycled materials such as RTR and some RAP
• Maryland
  • Secretary Rahn – “Why wouldn’t you use SMA?”
• Georgia
  • Experimenting with different aggregate properties to still maintain performance
To Fiber or Not to Fiber …

• WMA additives
• Recycled tire rubber
• Recycled asphalt shingles
• What next???
# Summary – Flexible Pavements

<table>
<thead>
<tr>
<th>Highway Agency</th>
<th>Performance Measure</th>
<th>Predicted Service Life (Years)</th>
<th>SMA</th>
<th>Superpave</th>
<th>SMA Life Extension (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama DOT</td>
<td>Pavement Condition Rating</td>
<td>16.2</td>
<td>16.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colorado DOT</td>
<td>Rutting Cracking</td>
<td>17.0</td>
<td>17.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georgia</td>
<td>PACES Rating</td>
<td>16.0*</td>
<td>11.0*</td>
<td></td>
<td>5.0</td>
</tr>
<tr>
<td>Maryland SHA (Interstate)</td>
<td>Rutting Cracking Index</td>
<td>24.8</td>
<td>26.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maryland SHA (Principal Arterial)</td>
<td>Rutting Cracking Index</td>
<td>32.2</td>
<td>24.0</td>
<td></td>
<td>8.2</td>
</tr>
<tr>
<td>Minnesota DOT</td>
<td>Ride Quality Index Surface Rating</td>
<td>16.6*</td>
<td>11.3*</td>
<td></td>
<td>5.3</td>
</tr>
<tr>
<td>Virginia DOT</td>
<td>Critical Condition Index</td>
<td>19.0</td>
<td>14.4</td>
<td></td>
<td>4.6</td>
</tr>
</tbody>
</table>

*Note: *PMS data from a limited number of pavement sections

*Courtesy of Fan Yin*
### NAPA/NCAT Study on Performance

#### Summary – Composite Pavements

<table>
<thead>
<tr>
<th>Highway Agency</th>
<th>Performance Measure</th>
<th>Predicted Service Life (Years)</th>
<th>SMA Life Extension (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois Tollway</td>
<td>Overall Condition Rating Survey</td>
<td>13.5</td>
<td>9</td>
</tr>
<tr>
<td>Maryland SHA (Principal Arterial)</td>
<td>Rutting Cracking Index</td>
<td>21.8</td>
<td>19.6</td>
</tr>
<tr>
<td>Michigan DOT</td>
<td>Overall Distress Index</td>
<td>22.2</td>
<td>21.3</td>
</tr>
<tr>
<td>Pennsylvania DOT (Interstate)</td>
<td>Overall Pavement Index</td>
<td>21.1*</td>
<td>22.2</td>
</tr>
<tr>
<td>Pennsylvania DOT (Non-Interstate)</td>
<td>Overall Pavement Index</td>
<td>24.5*</td>
<td>11.0</td>
</tr>
<tr>
<td>Virginia DOT</td>
<td>Critical Condition Index</td>
<td>23.1</td>
<td>12.8</td>
</tr>
</tbody>
</table>

*Note: *PMS data from a limited number of pavement sections

*Courtesy of Fan Yin*
NAPA/NCAT Study on Performance

LCCA Case Study Summary

![Graph showing EUAC ($/lane mile) for SMA and Superpave for States 1, 2, and 3]

*Courtesy of Fan Yin*
What’s Coming

• A new SMA Best Practices Manual from NAPA
• Updated SMA page on NAPA Website
  • New reports
  • Conference presentations
• Webinar on NAPA/NCAT study – Jan 28, 2019
Thank you!

rwillis@asphaltpavement.org