Contractor Mix Design Options

2018 in Review and a look ahead

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Cynthia Williams - Illinois Tollway
Deputy Chief of Program Implementation
About the Tollway

Part of a dynamic transportation network
• Connects to regional transit network
• Supports three international airports
• Part of one of the nation’s largest interstate systems

Five roadways

294-mile system across 12 counties

Serves more than 1.6 million vehicles a day
The Tollway’s SMA Innovation Evolution

• Implemented FRAP and RAS
• Higher asphalt binder replacement
• Implemented WMA
• Ground tire rubber
• Rejuvenators
Cost Savings – Created by Innovations

Contractor options
- Asphalt binder replacement
- Ground tire rubber
- Rejuvenators
- Use of aggregates
- Performance testing

RESULT: Durable and affordable asphalt mixes
Stone-matrix asphalt (SMA) used for all mainline overlays

2008 to 2009 – Full-depth asphalt on the Jane Addams Memorial Tollway (I-90) in Rockford area

2015 – Reagan Memorial Tollway (I-88) rehabilitation

2018 – Veterans Memorial Tollway (I-355) overlay

2018 – I-88 rehabilitation, Edens Spur, I-294 @ O’Hare

Seven asphalt producers
A Look at What Got Us Here
Shoulders
The Tollway’s Sandbox
Coarse Aggregate for Tollway SMA

**Friction Surface SMA**
- High-traffic pavements and curves
- Coarse aggregate: quartzite, granite, diabase/trap rock, crushed steel slag

**Binder SMA and Surface SMA**
- Coarse aggregate: typically crushed gravel (also surface aggregates)
- 2008 friction evaluation – acceptable for tangents
Coarse Aggregates for Tollway SMA

• Friction aggregates – Non-Illinois sources, except slag
• Crushed gravel – Southern Wisconsin and Northern Illinois
• 2015 – Evaluated local crushed gravel and dolomite sources
• 2018 – Implemented aggregate testing, including coarse FRAP
Local Aggregates for Tollway SMA

2015 evaluation approach

• Aggregate breakdown – Micro-Deval
  • Mini LA abrasion
  • Compares to national research

Category I & II FRAP

• Extract using the analyzer
• Run through the Micro Deval

2018 – Micro-Deval specifications for coarse aggregates and FRAP
RAP/FRAP for Tollway Asphalt

Quality sources

• Tollway requires documentation of the RAP source
• Tollway mainline RAP is separated from shoulder or IDOT mixes*

RAP and FRAP production

• RAP/FRAP stockpiles must be tested at a required interval
• All gradation and percent AC must be within a tolerance of mix design JMF targets
RAS

Quality sources

• Guidelines developed with IEPA
• Source and contractor testing
• Option for up to 5 percent RAS in mixes
Asphalt Binder Replacement – 2009 SMA

• This table was introduced into Tollway specifications in 2009 – and was for SMA mixes only

• The intent was to incentivize fractionalization of RAP and use of RAS

<table>
<thead>
<tr>
<th>Reclaimed Material</th>
<th>Binder Replacement %</th>
<th>Asphalt Binder Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category I FRAP only</td>
<td>0 -20</td>
<td>SBS PG 76-22</td>
</tr>
<tr>
<td>Category I FRAP only or with RAS</td>
<td>21 - 30</td>
<td>SBS PG 70-28</td>
</tr>
<tr>
<td>Category I FRAP &amp; RAS</td>
<td>31 - 50</td>
<td>SBS PG 64-34</td>
</tr>
</tbody>
</table>
## Asphalt Binder Replacement Now

<table>
<thead>
<tr>
<th>Reclaimed asphalt material (as allowed in Tollway Tables 7 &amp; 8)</th>
<th>RAP(^1)/FRAP/RAS</th>
<th>FRAP only or with RAS</th>
<th>Category 1 FRAP with RAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABR</td>
<td>0-17%</td>
<td>18-33%</td>
<td>34-50%(^2)</td>
</tr>
<tr>
<td><strong>Allowable Mix Options</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMA and IL-4.75</td>
<td>SBS 70-28 GTR PG 70-28 PG 58-28 10% Dry GTR</td>
<td>SBS 64-34 GTR PG 64-34 PG 52-34(^3) 10% Dry GTR</td>
<td></td>
</tr>
<tr>
<td>Binder and surface course</td>
<td>PG 58-28</td>
<td>PG 52-34(^3)</td>
<td></td>
</tr>
<tr>
<td>Asphalt stabilized subbase</td>
<td>PG 58-28(^4)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1/ RAP not allowed in SMA

2/ Allowed up to 60 percent ABR on N50 IL 19.0mm binder

3/ PG 46-34 shall be considered an equivalent to PG 52-34

4/ Allowed up to 65 percent ABR on asphalt stabilized subbase
Tollway’s Approach to Equivalent Performance

Balanced Mix Design

Rutting
Hamburg @ 20,000 passes
SMA < 6.0mm

Contractor Options
- Warm mix
- ABR
- PG binder grade
- SBS polymer
- GTR (terminal and dry process)

...and now,
Rejuvenators are coming soon...

Cracking
DCT
SMA ≥ 600 J/m²
2018 SMA Mix Designs

- Six contracts
- Seven producers
- 323,151 tons of SMA
- Five “local” sources used
- Micro Deval = 7.7 to 11.6
- 17 of 18 SMA designs used coarse FRAP

Good Quality RAP
# N80 IL 12.5 REC SMA - Performance

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Tollway Mix #</th>
<th>Mixture Description</th>
<th>ABR</th>
<th>Modification</th>
<th>DCT</th>
<th>Hamburg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plote</td>
<td>90WMA 1841</td>
<td>Binder</td>
<td>50.1</td>
<td>PG 46-34 +10% ECR (dry process)</td>
<td>652 J/m²</td>
<td>-1.83 @20,000</td>
</tr>
<tr>
<td>Curran</td>
<td>90WMA 1833</td>
<td>Surface</td>
<td>37.1</td>
<td>PG 46-34 +10% ECR (dry process)</td>
<td>1510 J/m²</td>
<td>-5.92 @20,000</td>
</tr>
<tr>
<td>Geneva</td>
<td>90WMA 1839</td>
<td>Friction surface</td>
<td>25.8</td>
<td>PG 58-28 +12 GTR (terminal)</td>
<td>967 J/m²</td>
<td>-4.61mm @20,000</td>
</tr>
<tr>
<td>Rock Road</td>
<td>90WMA 1824</td>
<td>Friction surface</td>
<td>37.6</td>
<td>SBS PG 64-34</td>
<td>904 J/m²</td>
<td>-3.36mm @20,000</td>
</tr>
</tbody>
</table>
I-88 Innovation Success Story

Mill and overlay of existing composite pavement

Contractor options being utilized

- Mainline options
  - Dry-process GTR
  - Terminal GTR
  - Hybrid GTR/SBS
  - SBS polymer
- Shoulder
  - Option for use of rejuvenators
Cost Savings on I-355

<table>
<thead>
<tr>
<th>Shoulder Overlay</th>
<th>Mainline Overlay Army Trail</th>
<th>Mainline Overlay Lane 1</th>
<th>Mainline Overlay All Other</th>
<th>Add-A-Lane</th>
<th>New Shoulders</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMA 1.75&quot;</td>
<td>SBS or GTR WMA 2.5&quot;</td>
<td>SMA Friction 12.5 N80</td>
<td>SMA Friction 12.5 N80</td>
<td>SMA 12.5 N80</td>
<td>9.5 N70</td>
</tr>
<tr>
<td>9.5 N70</td>
<td>4.75 N50</td>
<td>4.75 N50</td>
<td></td>
<td></td>
<td>19.0 N50</td>
</tr>
<tr>
<td>SMA 12.5 N80</td>
<td></td>
<td></td>
<td></td>
<td>19 N90</td>
<td>19.0 N50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19 N70</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19 N 50</td>
<td></td>
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</tbody>
</table>

Substantial overlay from I-55 to Army Trail Road

4 inch SMA over existing PCC

Full-depth asphalt add-a-lane
## Systemwide Cost Savings Realized

<table>
<thead>
<tr>
<th>Item</th>
<th>Depth, inch</th>
<th>Layer Description</th>
<th>Tons</th>
<th>$/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>Stone matrix WMA surface friction course, IL-12.5, N80 (135 Lb/SY/In)</td>
<td>204,771</td>
<td>$81.02</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Stone matrix WMA binder course, IL-12.5, N80 (114 Lb/SY/In)</td>
<td>118,380</td>
<td>$87.07</td>
</tr>
<tr>
<td>3</td>
<td>Var</td>
<td>Polymerized WMA binder course (112 Lb/SY/In)</td>
<td>93,782</td>
<td>$80.09</td>
</tr>
<tr>
<td>4</td>
<td>Var</td>
<td>WMA surface course (112 Lb/SY/In)</td>
<td>100,596</td>
<td>$93.87</td>
</tr>
</tbody>
</table>
Future Warm Mix changes

Contractor options
• 0-20 RAP – can use foaming
• Any FRAP, RAS or >20 percent RAP – chemical foaming required

Cold weather
• Chemical foaming only when beyond temperature specifications
• Increase 50 percent additive from mix design target

<table>
<thead>
<tr>
<th>Minimum Ambient Air Temperature (In shade)</th>
<th>WMA Binder Course</th>
<th>WMA Surface Course</th>
<th>WMA IL-4.75</th>
</tr>
</thead>
<tbody>
<tr>
<td>32°F and Rising</td>
<td>40°F and Rising</td>
<td>50°F and Rising</td>
<td></td>
</tr>
</tbody>
</table>
The Future of Balanced Mix Design

Resultant Binder Testing

Resistant to rutting and cracking for a specific temperature range /traffic level

Where we are going.... you won’t need volumetrics!

Hamburg
Recovered PG Grade of the Mix

Extraction, recovery and grading of each individual design

This is the ONLY way to know the final PG grade in the pavement

Factors that will affect PG grade

- ABR
- Source of RAS/FRAP
- Virgin binder
- Rejuvenator, warm-mix additive or modifier
Recovered Binders

Next step in performance testing

 Targets on recovered binders

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulders</td>
<td>PG 64-22</td>
</tr>
<tr>
<td>Mainline</td>
<td>PG 70-22</td>
</tr>
<tr>
<td>High volume</td>
<td>PG 76-22</td>
</tr>
</tbody>
</table>

What’s the real PG in the road?
# N80 IL 12.5 REC SMA – Recovered Grading

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Tollway Mix #</th>
<th>Mixture Description</th>
<th>ABR</th>
<th>Modification</th>
<th>Recovered Grading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plote</td>
<td>90WMA 1841</td>
<td>Binder</td>
<td>50.1</td>
<td>PG 46-34 +10% ECR (dry process)</td>
<td>PG 72.5-24.9</td>
</tr>
<tr>
<td>Curran</td>
<td>90WMA 1833</td>
<td>Surface</td>
<td>37.1</td>
<td>PG 46-34 +10% ECR (dry process)</td>
<td>PG 70.1-23.2</td>
</tr>
<tr>
<td>Geneva</td>
<td>90WMA 1839</td>
<td>Friction surface</td>
<td>25.8</td>
<td>PG 58-28 +12 GTR (terminal)</td>
<td>PG 73.2-28.9</td>
</tr>
<tr>
<td>Rock Road</td>
<td>90WMA 1824</td>
<td>Friction surface</td>
<td>37.6</td>
<td>SBS PG 64-34</td>
<td>PG 78.9-30.2</td>
</tr>
</tbody>
</table>
THANK YOU