Research Projects ND 2011-02, UND 2011-01, & NDSU 2011-02

Kyle Evert.
NDDOT - Materials & Research Division
Topics

• **MR 2011-02** - Evotherm 3G, Advera WMA and Foamed Asphalt Comparison
  • Objective
  • Scope
  • Evaluation
  • Construction

• **UND 2011-01** - Evaluation of the Rut Resistance Performance of Warm Mix Asphalts in North Dakota

• **NDSU 2011-02** - Warm Mix Asphalt Processes Applicable to North Dakota
Objective

- The objective of this project is to compare the performance of WMA produced using Evotherm 3G, Advera® WMA, and the foamed asphalt process.
Scope

- This research project will use thin lift paving projects to evaluate the WMA production processes and performance.
  - SS-3-015(010)060-Evotherm 3G WMA, Foamed Asphalt, & HMA
  - SS-3-015(018)073-Evotherm 3G WMA, Foamed Asphalt, & HMA
  - SS-4-003(011)159-Advera® WMA & HMA
  - SS-4-041(012)057-Advera® WMA & HMA
  - SCB-6-032(045)219-Evotherm 3G WMA with recycled asphalt & HMA with recycled asphalt
Evaluation

Pavement Distress

- Rutting measurements
- Thermal cracks
- Cracking distresses caused by loading and traffic

Construction

- Density
- Temperature
- Fuel Consumption
2” Thin Lift Overlay
• Advera® WMA
• Approximately 5 miles of WMA
• Approximately 5 miles of HMA for Control
• Blade Leveling
SS-3-041(012)057 Photos

Advera in tote. Physical appearance of powdered sugar.
SS-3-041(012)057 Photos
# SS-3-041(012)057 Compaction Control

## ND 41 - WMA Compaction Control

<table>
<thead>
<tr>
<th>Date</th>
<th>Core Density</th>
<th>Maximum Theoretical Density</th>
<th>Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>142.6</td>
<td>153.0</td>
<td>93.2%</td>
</tr>
</tbody>
</table>

## ND 41 - HMA Compaction Control

<table>
<thead>
<tr>
<th>Date</th>
<th>Core Density</th>
<th>Maximum Theoretical Density</th>
<th>Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>141.2</td>
<td>153.7</td>
<td>91.9%</td>
</tr>
</tbody>
</table>
### ND 41 - WMA Fuel Consumption

<table>
<thead>
<tr>
<th>Type</th>
<th>Gallons of Burner Fuel</th>
<th>Total Tons of Mix</th>
<th>Gal/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total/Average</td>
<td>13,564</td>
<td>9,674</td>
<td>1.39</td>
</tr>
</tbody>
</table>

### ND 41 - HMA Fuel Consumption

<table>
<thead>
<tr>
<th>Type</th>
<th>Gallons of Burner Fuel</th>
<th>Total Tons of Mix</th>
<th>Gal/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total/Average</td>
<td>17,315</td>
<td>11,995</td>
<td>1.44</td>
</tr>
</tbody>
</table>
SS-3-041(012)057
Field Temperatures

ND 41 Field Temperatures - WMA vs. HMA

Temperature, F

Windrow  Behind Paver  1st Roller  2nd Roller  3rd Roller

WMA  HMA
SS-6-032(045)219

- 2” mill and fill
- Evotherm 3G
- Use of recycled asphalt
- Approximately 5 miles of WMA
- Approximately 5 miles of HMA used for control
- Evotherm mixed by supplier
SS-6-032(045)219
SS-6-032(045)219
## SS-6-032(045)219 Compaction Control

### ND 32 - WMA Compaction Control

<table>
<thead>
<tr>
<th>Date</th>
<th>Core Density</th>
<th>Maximum Theoretical Density</th>
<th>Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>138.8</td>
<td>150.1</td>
<td>92.5%</td>
</tr>
</tbody>
</table>

### ND 32 - HMA Compaction Control

<table>
<thead>
<tr>
<th>Date</th>
<th>Core Density</th>
<th>Maximum Theoretical Density</th>
<th>Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>139.6</td>
<td>150.7</td>
<td>92.6%</td>
</tr>
</tbody>
</table>
### ND 32 - WMA Fuel Consumption

<table>
<thead>
<tr>
<th>Type</th>
<th>Gallons of Burner Fuel</th>
<th>Total Tons of Mix</th>
<th>Gal/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total/Average</td>
<td>11,652</td>
<td>7,429</td>
<td>1.62</td>
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</tbody>
</table>

### ND 32 - HMA Fuel Consumption

<table>
<thead>
<tr>
<th>Type</th>
<th>Gallons of Burner Fuel</th>
<th>Total Tons of Mix</th>
<th>Gal/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total/Average</td>
<td>15,232</td>
<td>8,958</td>
<td>1.72</td>
</tr>
</tbody>
</table>
SS-6-032(045)219
Field Temperatures

ND 32 Field Temperatures - WMA vs. HMA

Temperature, F

- Windrow
- Behind Paver
- 1st Roller
- 2nd Roller
- 3rd Roller

Temperature Not Available for HMA

WMA
HMA

North Dakota Department of Transportation

17
SS-4-003(011)159

- 2” Thin Lift Overlay
- Advera® WMA
- Approximately 5 miles of WMA
- Approximately 5 miles of HMA used for control
- Blade Leveling
### ND 3 - WMA Compaction Control

<table>
<thead>
<tr>
<th>Date</th>
<th>Core Density</th>
<th>Maximum Theoretical Density</th>
<th>Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>142.7</td>
<td>153.7</td>
<td>92.8%</td>
</tr>
</tbody>
</table>

### ND 3 - HMA Compaction Control

<table>
<thead>
<tr>
<th>Date</th>
<th>Core Density</th>
<th>Maximum Theoretical Density</th>
<th>Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>141.7</td>
<td>153.8</td>
<td>92.1%</td>
</tr>
</tbody>
</table>
## Fuel Consumption

### ND 3 - WMA Fuel Consumption

<table>
<thead>
<tr>
<th>Type</th>
<th>Gallons</th>
<th>Total Tons</th>
<th>Gal/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total/Average</td>
<td>13,168</td>
<td>9,467</td>
<td>1.38</td>
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</tbody>
</table>

### ND 3 - HMA Fuel Consumption

<table>
<thead>
<tr>
<th>Type</th>
<th>Gallons</th>
<th>Total Tons</th>
<th>Gal/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total/Average</td>
<td>14,473</td>
<td>8,861</td>
<td>1.63</td>
</tr>
</tbody>
</table>
SS-4-003(011)159
Field Temperatures

ND 3 Field Temperatures - WMA vs. HMA

<table>
<thead>
<tr>
<th>Location</th>
<th>Temperature, F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windrow</td>
<td>260</td>
</tr>
<tr>
<td>Behind Paver</td>
<td>240</td>
</tr>
<tr>
<td>1st Roller</td>
<td>220</td>
</tr>
<tr>
<td>2nd Roller</td>
<td>190</td>
</tr>
<tr>
<td>3rd Roller</td>
<td>160</td>
</tr>
</tbody>
</table>

- WMA - Blue
- HMA - Red
Missing Data

- SS-3-015(010)060 & SS-3-015(018)073 – Project was pushed until 2012
Summary

- 26,569 tons of WMA in 2011.
- Compaction is not an issue.
- Fuel Consumption – 3.5% to 15.4% decrease in burner fuel with WMA.
- Field Temperature
  - Advera – WMA 10 degrees less HMA behind paver
  - Evotherm – WMA 25 degrees less HMA behind paver
- ND 15 project has been pushed until 2012 construction season.
UND - Evaluation of the Rut Resistance Performance of Warm Mix Asphalts in North Dakota

- Asphalt Pavement Analyzer (APA)

- 32 six inch φ cores collected from 2010 WMA projects

- 12 wet cores and 12 dry cores tested

- 8,000 Loading Cycles per test
2010 WMA Projects

- ND 11 - near Ashley ND
  - 8,319 tons of Evotherm WMA
  - 2” overlay
  - Crack Pattern returned but no rutting.
- ND 20 – Near Devils Lake
  - 15,113 tons of Evotherm WMA
  - 2” overlay
  - Crack Pattern returned but no rutting.
- Both Experimental projects have same distresses as control sections.
Asphalt Pavement Analyzer (APA)
UND - Evaluation of the Rut Resistance Performance of Warm Mix Asphalts in North Dakota
UND - Evaluation of the Rut Resistance Performance of Warm Mix Asphalts in North Dakota

APA Rut Values: Wet Case

<table>
<thead>
<tr>
<th>Specimen Numbers (WMA,HMA)</th>
<th>Rut Depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.2</td>
<td>10</td>
</tr>
<tr>
<td>20.4</td>
<td>9</td>
</tr>
<tr>
<td>22.6</td>
<td>8</td>
</tr>
<tr>
<td>24.8</td>
<td>6</td>
</tr>
<tr>
<td>30.14</td>
<td>5</td>
</tr>
<tr>
<td>32.16</td>
<td>4</td>
</tr>
</tbody>
</table>

WMA vs HMA
UND - Evaluation of the Rut Resistance Performance of Warm Mix Asphalts in North Dakota

- Generally, WMAs had higher rut values in comparison with the HMA control specimens
  - **Dry Condition**: WMA higher by 13%
  - **Wet Condition**: WMA higher by 29%
- 19 specimens passed the 9.0 mm criterion
  - The failed 5 were WMA (3 dry & 2 wet)
  - 6 out of the 7 WMA specimens that passed had rut values > 8.0 mm
NDSU – Warm Mix Asphalt Processes Applicable to North Dakota

• Research by Magdy Abdelrahman
• Literature review and survey of surrounding states additives and processes.
• Recommendation of techniques, equipment, and additives are provided in this research.
• Available at
  
  www.dot.nd.gov/divisions/materials/researchlist.htm
Questions?