Innovative Warm Mix Asphalt Projects: The Contractor’s Perspective

NESMEA 2009
Portland, ME
October 7th 2009
ROD BIRDSALL, PE
What is Warm-Mix Asphalt (WMA)?

- Asphalt Mix produced at 40-100°F less than conventional HMA
- Typically 212-280°F vs. 320°F
- Produced and placed with conventional HMA equipment
Why Use WMA?

- Environmentally Sound
- Reduces greenhouse gas emissions
- Reduces energy use
- Improves workability
- Reduces binder aging
- Reduces paving temperatures
- Offers the potential to increase the % of RAP used in mix
- Offer the potential to extend the paving season
## Warner Bros., LLC.

**Design of Bituminous Concrete Mixtures**

### Project Information
- **Project:** Tri State Materials
- **Mix:** MHD Binder Course
- **Pavement Type:** 40% Rap Binder
- **Plant Location:** Trew stone LLC., East Deerfield, MA
- **Date:** 5/10/2009

### Stockpile Gradations - % Passing

<table>
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<tr>
<th>Material</th>
<th>Blend</th>
<th>1-1/2&quot;</th>
<th>1&quot;</th>
<th>3/4&quot;</th>
<th>1/2&quot;</th>
<th>3/8&quot;</th>
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<th>#8</th>
<th>#16</th>
<th>#30</th>
<th>#50</th>
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<td>29</td>
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<td>Natural Sand</td>
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<td>100</td>
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<td>100</td>
<td>93</td>
<td>80</td>
<td>58</td>
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<tr>
<td>3/8&quot; Crushed Stone</td>
<td>15</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>96</td>
<td>22</td>
<td>2</td>
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### Job Mix Formula

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### Action Limit

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### Suspension Limits

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### Aggregate

**Coarse:**
- Trew Stone LLC.
- East Deerfield, MA

**Fine:**
- Natural Sand: Delta Sand and Gravel Inc., Sunderland, MA
- Screenings: Trew stone LLC., Deerfield, MA

**Asphalt:**
- Source(s): Tri State Materials
- Grade: PG 52-34

**Other:**

**Temperature:**
- Mixing: 265 f
- Final Compaction: 225 f
Log Viscosity vs. Temperature

- Virgin Binder
- w/ 1.84%
- w/ 2.77%

Temperature, deg C

Log Viscosity
<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Compaction Temperature (°c)</th>
<th>Weight - grams</th>
<th>Maximum Sp Gr (G&lt;sub&gt;max&lt;/sub&gt;)</th>
<th>Sample Height (mm)</th>
<th>Bulk Sp Gr (G&lt;sub&gt;bb&lt;/sub&gt;)</th>
<th>% G&lt;sub&gt;mm&lt;/sub&gt;</th>
<th>% Air Voids</th>
<th>VMA</th>
<th>VFB</th>
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<tr>
<td>A1</td>
<td>49.0 1.0</td>
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<td>123.1</td>
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</table>

**Binder:** PG 64-22 with ECObIT
19.0mm NY Ecobit Mix Master Curve

Dynamic Modulus ($E^*$), kPa

Reduced Frequency, Hz

- 4°C
- 20°C
- 40°C
- Fitted Model
I-78 Somerset County, NJ - AR OGFC

- I-78 mile marker 29 to 42
- 77,270 AADT with 30% trucks
- 9.5mm AR OGFC, placed 1 inch compacted
- 8.5% Design Binder content using ASTM D-6114 AR
- Average IRI after paving 35 inches per mile (previously 70)
I-78 Somerset County, NJ - AR OGFC with NuStar EVOTHERM
Overlay Tester

- Sample size: 6’’ long by 3’’ wide by 1.5’’ high
- Loading: Continuously triangular displacement 5 sec loading and 5 sec unloading
- Definition of failure
  - Discontinuity in Load vs Displacement curve
Typical NJ DOT (Surface Course) Overlay Mixes

59°F, 0.025" Horizontal Deflection

- HPTO: 144 cycles
- 9.5H76: 24 cycles
- 9.5mm SMA: 50 cycles
- 12.5M76: 22 cycles
- 12.5H76: 7 cycles
- 12.5mm SMA: 81 cycles
- MOGFC-1: 33 cycles
- AR-OGFC: 756 cycles
The use of warm mix asphalt may help in reducing cracking potential of asphalt mixtures

- Reduces oxidation aging of base asphalt binder at higher temperatures
- Reduces polymer degradation at higher temperatures
- May reduce asphalt binder absorption when produced at lower temperature (results in higher effective asphalt contents)
Overlay Results at Different Mixing Temperatures

Lab Produced 12.5mm Superpave Mixture with PG76-22

Overlay Tester Fatigue Life (cycles)

77°F, 0.025 Inches Deflection

- 315°F
- 270°F
- 230°F

Overlay Results at Different Mixing Temperatures:

- 76-22
- 0.5% Sasobit
- 1% Sasobit
- 1.5% Sasobit
- 1% Rediset
- 2% Rediset
- 0.6% Evotherm
Overlay Tester Cracking Results

NJ I78, 2009

Horizontal Deflection = 0.025 Inches

Overlay Tester (cycles)

Test Temperatures (F)

AR-OGFC WMA
AR-OGFC

Horizontal Deflection = 0.025 Inches

Overlay Tester (cycles)

Test Temperatures (F)
Emissions Testing

- Looked at quantifying emission reduction at paver with and without WMA
- Used portable emissions tester mounted to railing on back of paver (where workers would stand)
Example of Typical Emissions at Paver

- Warming Paver
- Using WMA
- Switched Back to HMA

Hydrocarbons, ppm

Temperature Immediately Behind Screed, °F

7:42 PM 8:05 PM 8:30 PM 8:55 PM 9:20 PM 9:45 PM 10:05 PM 10:30 PM 11:11 PM 11:40 PM 12:35 AM 12:55 AM
- AR GG mix – 1/2 ″ nominal maximum size
- 7.5% ASTM D-6114 AR Binder
- 1 ¼ ″ compacted over micro-milled surface
- 20,000 ton night paving project
- Current spec requires 55F pavement temperature
- With ECOBIT®, Mass Highway will reduce pavement temperature to 45F for last 5,000 tons
Hamburg Test Results - PA Landers Lab Produced ARGG Mix (Rt.3)
Samples from All States Asphalt

- Control NO ECOBIT
- 1.0% ECOBIT
PaveCool (Minnesota DOT program)

Research

An Asphalt Paving Tool For Adverse Conditions

Download PaveCool software:
http://www.dot.state.mn.us/app/pavecool
PaveCool 2.4 - Simulation Results

Input File: PaveCool
Project: PA Landers Asphalt Rubber Gap Graded + 1% ECOBIT

<table>
<thead>
<tr>
<th>Project Date &amp; Time</th>
<th>Start Rolling*</th>
<th>Stop Rolling*</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/02/09 12:10 PM</td>
<td>1 min. (272 °F)</td>
<td>22 min. (154 °F)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HMA Mix Type</th>
<th>Binder Grade</th>
<th>Thickness</th>
<th>Delivery Temp.</th>
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</thead>
<tbody>
<tr>
<td>Coarse/SMA</td>
<td>PG 82-28</td>
<td>1.50 in.</td>
<td>300 °F</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Air Temp.</th>
<th>Wind Speed</th>
<th>Clear &amp; Dry</th>
<th>Latitude</th>
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</thead>
<tbody>
<tr>
<td>35.0 °F</td>
<td>10 mph</td>
<td>Clear &amp; Dry</td>
<td>42.0 ° North</td>
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</table>

<table>
<thead>
<tr>
<th>Existing Surface</th>
<th>Moisture</th>
<th>State</th>
<th>Surface Temp.</th>
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<tbody>
<tr>
<td>AC</td>
<td>N/A</td>
<td>M A</td>
<td>35.0 °F</td>
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</tbody>
</table>

* Some asphalt mixtures will require compaction start and stop times different from those recommended by this program. As always, good judgement must be exercised in order to ensure a properly compacted surface. Special considerations should be made for polymer modified asphalt binders. In this case, manufacturer guidelines should supersede recommendations made by this program. Consult the Help file for further details. In no event will the Minnesota Department of Transportation, the University of Minnesota or their suppliers be liable for damages or expenses arising out of the use of this program.
Cooling Curve

HMA Temperature, °F

- Cooling Curve
- Start Temp/Time
- Stop Temp/Time

Time, minutes

Simulation Time: 09/02/09 2:51 PM
WMA is:

- Environmentally sound
- Greatly reduces emissions
- Reduces Binder aging
- Has been used successfully in many applications
- Offers the potential to increase the % of RAP in mix
- Offers the potential to extend the paving season
- Very user Friendly
Products & Services

- ECOBIT™ WMA Binder
- Asphalt Rubber SAM & SAMI
- FiberMat® SAM & SAMI
- NovaChip®
- Chip Seals
- Liquid Calcium/Magnesium Chloride
- Full Depth Reclamation
- Hot & Cold Mix Asphalt
- CRMB for HMA

Rod Birdsall, PE
Consultant
(800) 343-9620
(413) 687-2208 (Mobile)
rbirdsall@asmg.com