NCAT Pavement Test Track

Findings from the 4th Research Cycle
Accelerated Pavement Damage
Pavement Performance Data

- Weekly
  - Rutting
  - Roughness
  - Raveling
  - Cracking
  - Response
- Monthly
  - Density
  - Friction
- Quarterly
  - Permeability
  - Noise
  - Reflectivity
2009 Track (4th Research Cycle)

- High recycled content mixes
- Warm mix asphalt
- Optimized structural design
- Alternative binder materials
- Enhanced pavement interlayers
- Pavement preservation
Wire Line Rutting Performance

Cycle of Construction by Color (Blue=2003, Red=2006, Yellow=2009); High RAP with Texture; WMA with Green Outline; Thinner Structural Sections in Brown Boxes (All Others on Perpetual Foundations); Trucking Percent Complete via Height of Gray Box on Y-axis

Avg Wheelpath Deformation via Wire Lines (mm)

Sponsored Test Sections
“GE+” Rutting Performance
"GE+" Fatigue Life Expectations

Forecast Cycles to Failure via AASHTO (millions)

- Control: 0.3
- PFC: 0.2
- RAP: 1.6
- Foam RAP: 3.8
- Foam: 0.6
- Additive: 0.6
- Thiopave-7: 0.6
- Thiopave-9: 5.6
- Kraton: 8.1
- TLA: 1.0

10 million ESAL strain cycles
100% RAP Mix with Foamed Binder
Optimized Structural Design

• Stiff subgrade & dense crushed granite base
  – 9 inch perpetual versus 24 inch ‘93 AASHTO design

• Soft subgrade with shallow lime modification
  – 10 inch failure versus 14 inch proven perpetual

• Highly polymer modified mix (HiPM)
  – 5¾ inch perpetual (?) via high fatigue tolerance
  – 10 inch on soft subgrade mill/inlay perpetual (???)

• Pre-ME AASHTO layer coefficient 0.44 ⇒ 0.54
  – ≥ 0.15 for Open Graded Surface Courses
Optimized Structural Design

(1) Flexible Fatigue Resistant Asphalt

(2) High Modulus Rut Resistant Asphalt

(3) SMA, OGFC or SUPERPAVE

Pavement Foundation
# Optimized Structural Design

<table>
<thead>
<tr>
<th>Purpose of Each Layer</th>
<th>N5 Control</th>
<th>S5 Higher RAP</th>
<th>S6 RAP+RAS</th>
<th>S13 Recyc Tires</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durable, Rut Resistant Surface</td>
<td>20% RAP 67-22 DGA</td>
<td>25% RAP 67-22 SMA</td>
<td>5% RAS 67-22 SMA</td>
<td>VIRGIN ARB12 SMA</td>
</tr>
<tr>
<td>Stiff, Strain Reducing Middle</td>
<td>35% RAP 67-22 DGA</td>
<td>50% RAP 67-22 DGA</td>
<td>50% AGED 67-22 DGA</td>
<td>35% RAP ARB12 DGA</td>
</tr>
<tr>
<td>Fatigue Resistant Base Layer</td>
<td>35% RAP 67-22 DGA</td>
<td>35% RAP 88-22 DGA</td>
<td>25% RAP 76-22+ DGA</td>
<td>VIRGIN ARB20 AZ</td>
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Green = Evotherm Q1 Additive, Blue = Astec Green Foamer
# Alternative Binder Materials

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Alternative Binder Materials

10 million ESAL strain cycles
Enhanced Pavement Interlayers
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Enhanced Pavement Interlayers

- N1A eTac 0.10/0.06
- N1B UltraFuse 0.15/0.15
- N2 Trackless 0.05/0.03
Enhanced Pavement Interlayers
Pavement Preservation

- 4.75 mm NMAS low volume road mix
- 70% limestone screenings, 30% natural sand
- 6.1% polymer modified binder
- High cost per ton, low cost per square yard
- Placed in ‘03, looks great after 32 million ESALs
- Need to reduce cost & maintain performance
Pavement Preservation
Pavement Preservation

- Polymer modified binder (control)
- Neat asphalt binder
- Neat asphalt binder on 100% RAP base
- 50% fine fractionated RAP
- 5% post consumer RAS
- Highly modified asphalt (HiMA) binder
- Ultra thin bonded wearing surface
Performance data for each section will soon be available for viewing by positioning your mouse over the section in question and left-clicking. Based on feedback from our research sponsors, the performance reports have been revised to include crack maps. The 2012 performance reports will be a fully integrated and active part of the web presentation.

- Click here for a recent rutting bar graph with ESAL update!
- Click the layout below for information specific to each section

- N1 - N11, S5 - S6, and S8 - S13 are structural sections
- All other sections have deep perpetual foundations
- Research cycle of surface placement shown by color
- Off-Track test sections on Lee Road 159 shown below

1,725,739 ESALs on the Track as of 2300 hours on March 9, 2013 (17% of the 10,000,000 ESAL goal). Rut depths recently averaged 4 mm, while roughness.
Performance Report

Surface Mix and Materials
- Year of Completion: 2009
- Mix Design Methodology: Superpave
- Specified Binder: PG76-22
- Surface Mix Stockpiles: Granite/Sand/Limestone

Structural Buildup Information
- Study HMA (in): 7
- Total HMA (in): 7
- Base Material: Granite
- Subgrade: Stiff

Research Objective: GE Foamed WMA & M-E Design + PG

Preliminary Field Performance Data

Equivalence of Single Axle Loadings in 2009 Research Cycle

Crack Map (Trussing Percent Complete via Height of Gray Map Date Box)
Construction Report

Laboratory Diary

General Description of Mix and Materials

- Design Method: WMA
- Comparative Effort: 80
- Binder Performance Grade: 76-22
- Modifier Type: Foam
- Aggregate Type: Gm/Gas/Griv
- Design Gradation Type: Fine

Construction Diary

Relevant Conditions for Construction

- Completion Date: July 16, 2009
- 24 Hour High Temperature (F): 92
- 24 Hour Low Temperature (F): 74
- 24 Hour Rainfall (in): 0.00
- Planned Sublot Lift Thickness (in): 3.0
- Paving Machine: Roadtec

Avg. Lab Properties of Plant Produced Mix

<table>
<thead>
<tr>
<th>Stone Size</th>
<th>Design</th>
<th>QG</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1&quot;)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>19 mm (3/4&quot;)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>12.5 mm (1/2&quot;)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>9.5 mm (3/8&quot;)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm (#4)</td>
<td>78</td>
<td>81</td>
</tr>
<tr>
<td>2.36 mm (#8)</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>1.70 mm (#16)</td>
<td>46</td>
<td>47</td>
</tr>
<tr>
<td>0.80 mm (#30)</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>0.40 mm (#60)</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>0.15 mm (#100)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>0.075 mm (#200)</td>
<td>5.8</td>
<td>6.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>% Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Content (Plant Setting)</td>
<td>6.5</td>
</tr>
<tr>
<td>89 Columbus Granite</td>
<td>36.0</td>
</tr>
<tr>
<td>8910 Okeilaka Limestone Screenings</td>
<td>23.0</td>
</tr>
<tr>
<td>M10 Columbus Granite</td>
<td>13.0</td>
</tr>
<tr>
<td>Shorter Coarse Sand</td>
<td>28.0</td>
</tr>
</tbody>
</table>

Plant Configuration and Placement Details

- As-Built Sublot Lift Thickness (in): 3.0
- Total Thickness of All 2009 Sublots (in): 7.0
- Approx. Underlying HMA Thickness (in): 0.0
- Type of Tack Coat Utilized: NTSG-1HM
- Target Tack Application Rate (gals): 0.04
- Approx. Avg. Temperature at Plant (F): 275
- Avg. Measured Mat Compaction: 92.3%

General Notes:
1) Mixes are referenced by quadrant (E=East, N=North, W=West, and S=South), section # (sequential) and sublot (top=1;
2) The total HMA thickness of all structural study sections (N11-N11 and S8-012) ranges from 3.5 to 14 inches by design;
3) All non-structural sections are supported by a uniform, perpetual foundation in order to study surface mix performance;
4) SMA and OGFCC refer to stone matrix asphalt and open-graded friction course, respectively; and
5) All liquid asphalt purchased for use in Track reconstruction contained LOF 6500 antistrip additive at a rate of 0.5 percent

National Center for Asphalt Technology
NCAT
at Auburn University
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HOT LINKS to download PAVE reports, review upcoming NCAT training courses, query historical weather data, view current color/radar, or preview local forecast.

17,769,738 ESALs on the Track as of 2300 hours on March 9, 2013 (17% of the 10,000,000 ESAL goal). Rut depths recently averaged 4 mm, while roughness...
Track Rut Depths

N1 - N11, S5 - S6, and S8-S13 are thinner structural sections;
All other sections have deep perpetual foundations;
Research cycle shown by color (red=2006, yellow=2009, green=2012;
Blue outline for WMA and hatching for high recycled contents

<table>
<thead>
<tr>
<th>Test Section Designation (Track Quadrant and Sequential Number)</th>
<th>Average Rut Depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E7A</td>
<td>1.2</td>
</tr>
<tr>
<td>E7B</td>
<td>1.3</td>
</tr>
<tr>
<td>E8A</td>
<td>1.0</td>
</tr>
<tr>
<td>E8B</td>
<td>1.5</td>
</tr>
<tr>
<td>E9A</td>
<td>2.7</td>
</tr>
<tr>
<td>E9B</td>
<td>2.7</td>
</tr>
<tr>
<td>E10</td>
<td>2.5</td>
</tr>
<tr>
<td>N1A</td>
<td>2.0</td>
</tr>
<tr>
<td>N1B</td>
<td>2.6</td>
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<tr>
<td>N2</td>
<td>2.2</td>
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<td>N3</td>
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<td>N4</td>
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<td>N6</td>
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<td>N10</td>
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<td>N11</td>
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<tr>
<td>N12</td>
<td>2.1</td>
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<tr>
<td>N13</td>
<td>2.7</td>
</tr>
<tr>
<td>W2</td>
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<tr>
<td>W10</td>
<td>2.0</td>
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<td>S1</td>
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<tr>
<td>S5</td>
<td>6.1</td>
</tr>
<tr>
<td>S6</td>
<td>7.5</td>
</tr>
<tr>
<td>S7</td>
<td>9.6</td>
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<tr>
<td>S8</td>
<td>10.4</td>
</tr>
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<td>S9</td>
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Questions?

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Assistant Director & Test Track Manager

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