Warm Mix Asphalt
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The Future of Flexible Pavements

12th Annual Minnesota Pavement Conference
St. Paul, MN
February 14, 2008
General Trends

- Regulations
- Activism
- Higher Production Temperatures
- Increasing Energy Costs
Current Non-Attainment Areas

FIGURE 3: Counties not attaining the National Ambient Air Quality Standards (NAAQS) of the Clean Air Act, April 2005.
Warm Mix Classifications

- Cold Mix
- Warm Mix
- Half-Warm Asphalt
- WMA
- HMA

Temperature, °F

Fuel/Ton

NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION
Brief History

1997 German Bitumen Forum
2000 Second Euroasphalt & Eurobitume Congress (Barcelona)
NAPA 2002 European Scan Tour – Germany and Norway
NAPA 2003-2008 Annual Meetings
World of Asphalt 2004
2005-2007 – Numerous U.S. Field Trials
2007 – FHWA/AASHTO Scan Tour
Advantages of Lower Temperatures

- Lower fumes and emissions (~30-90%)
- Lower energy consumption (~30%)
- Lower plant wear
- Decreased binder aging
- Early site opening
- Cool weather paving
- Compaction aid for stiff mixes
- Cooler working conditions
## Technology Providers

<table>
<thead>
<tr>
<th>Foaming Methods</th>
<th>Chemical Modifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Advera - PQ</td>
<td>• Evotherm - MeadWestvaco</td>
</tr>
<tr>
<td>• Aspha-min - Hubbard</td>
<td>• Rediset – Akzo-Nobel</td>
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<tr>
<td>• Astec Double-Barrel Green</td>
<td>• Revix – Mathy-Ergon</td>
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<tr>
<td>• Low Energy Asphalt - Fairco</td>
<td>• Sasobit - Sasol</td>
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<td>• Terex</td>
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<tr>
<td>• WAM Foam - BP</td>
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</table>
Plant Foaming Techniques

• Astec Double Barrel Green
• BP WAM-Foam
• Terex
ASTEC Double Barrel Green

Water ~2% of AC content
BP WAM-Foam

Soft Binder – Coat Aggregate
Hard Binder - Foamed
Material Foaming Processes

- Hubbard Construction – Aspha-min
- PQ – Advera
- McConnaughey – Low Energy Asphalt
McConnaughey - LEA

Additive

Wet Sand
PQ - Advera
Additives

- Akzo-Nobel - Rediset
- Mathy Construction/Ergon - Revix
- MeadWestvaco – Evotherm
- Sasol - Sasobit
Rediset™ wmx

- Solid Additive – Pastilles
- Added to the asphalt
- Also can be added to the mix at the hot-mix plant
Mathy-Ergon Revix

• A surfactant solution injection technology developed in 2004
  – Moisture in mix at plant <1% with good field densities
  – Mixes made in lab at 230°F with completely dry aggregate coated and compacted adequately.

• If aggregate coated, then mix can be compacted
MeadWestvaco Evotherm

- Added at ~5% of the AC content
- 85% water / 15% “chemical package”
SASOBIT (Organic paraffin wax)

Added at ~2-3% of AC Content
Applications

• Dense-graded mixes
  – Majority of projects
  – RAP – Wisconsin and Missouri
• SMA
  – Maryland – Washington Beltway
• Open-graded mixes
  – Florida
  – China
• Asphalt-Rubber
  – California
Chattanooga - Loadout

Astec Double Barrel Green
Control
Temp = 320°F

WMA
Temp = 270°F
Yellowstone Paving

Control
Temp = 320°F

Advera
Temp = 245°F
CDOT WMA Project I-70
Performance
Colorado I-70

Asphalt Content, %

<table>
<thead>
<tr>
<th>Control - A</th>
<th>Advera</th>
<th>Control - S</th>
<th>Sasobit</th>
<th>Control - E</th>
<th>Evotherm</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>6.4</td>
<td>6.5</td>
<td>6.4</td>
<td>6.2</td>
<td>6.4</td>
</tr>
</tbody>
</table>

5.8 - 6.5
Performance
Colorado I-70

Lab Voids, %

Control - A  Advera  Control - S  Sasobit  Control - E  Evotherm
Performance
Colorado I-70

![Bar chart showing performance comparison between Control - A, Advera, Control - S, Sasobit, Control - E, and Evotherm with TSR values ranging from 0% to 120%].

Control - A | Advera | Control - S | Sasobit | Control - E | Evotherm
Performance
Colorado I-70

Hamburg Rut Depth, mm

Control - A  Advera  Control - S  Sasobit  Control - E  Evotherm
## LEA Field Density

<table>
<thead>
<tr>
<th>Mix</th>
<th>Avg. Gmb</th>
<th>Avg. %Gmm</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMA control – Rt. 96B</td>
<td>2.278</td>
<td>94.1</td>
<td>1.43</td>
</tr>
<tr>
<td>LEA control – Rt. 96B</td>
<td>2.298</td>
<td>95.6</td>
<td>0.51</td>
</tr>
</tbody>
</table>
Absorption

Warm Mix  Hot Mix
Reduced Emissions
Data provided by suppliers.

- Aspha-min – North Carolina – 265°F
  - 17.6% decrease in SO₂
  - 3.2% decrease in CO₂
  - 35.3% decrease in total hydrocarbons
  - 6.1% decrease in NOₓ

- Evotherm – Canada – 140°F
  - 45.8% decrease in CO₂
  - 63.1% decrease in CO
  - 41.2% decrease in SO₂
  - 58% decrease in NOₓ

- Direct comparisons are discouraged – different plants, different weather, different temperatures
About Us

The Warm Mix Asphalt Technical Working Group (WMA TWG) is led by individuals in the public and private sectors who are committed to the development of Warm Mix Asphalt in the United States. Experts from the National Asphalt Pavement Association (NAPA), State Departments of Transportation (DOTs), Federal Highway Administration (FHWA), National Center for Asphalt Technology (NCAT), American Association of State Highway and Transportation Officials (AASHTO), and many others meet regularly to discuss issues and share knowledge for the advancement of Warm Mix Asphalt.

For more information on these organizations, visit the following websites:

- National Asphalt Pavement Association
- Departments of Transportation
- Federal Highway Administration
- National Center for Asphalt Technology
- American Association of State Highway and Transportation Officials
New Publication

Quality Improvement Series 125

Warm-Mix Asphalt: Best Practices

NAPA NATIONAL ASPHALT PAVEMENT ASSOCIATION
International Conference on Warm Mix Asphalt

- November 11-13, 2008
- Nashville, Tennessee
- Program
  - Design
  - Construction
  - Pavement Performance
  - Environmental Performance
  - Technologies
Why we need Warm Mix

- Better air quality
- Better energy efficiency
- Better performance
- Better compaction
- Better working conditions
Where are we?

- Development is proceeding rapidly.
  - More technology providers
- Over 72 Field Trials to date.
- Adoption will happen within the next few years.
- Permissive specifications must be developed
  - Texas?
  - Ohio?
  - Missouri?
Where are we?

• All applications of HMA have been tried:
  – Dense-graded
  – SMA
  – OGFC

• What research is needed?
  – Mix Design – NCAT and NCHRP
  – Engineering and Environmental Performance
  – NCAT and NCHRP Efforts
Conclusions

• Warm Mix is the Future of Asphalt Mixtures.
• Technology providers coming forward.
• Industry and agencies must work together to make it happen.
• Advantages outweigh concerns.
• Will add to versatility of the material.