Warm Mix Asphalt

---

The Future of Flexible Pavements

Northeast Pavement Preservation Partnership

November 8-10, 2010
General Trends

- Regulations
- Activism
- Higher Production Temperatures
- Increasing Energy Costs
Current (2008) Non-Attainment Areas

Nonattainment Areas Map – Ozone (8-hour)
United States

Nonattainment Areas Map – Particulate (size < 10 micrometers)
United States

Nonattainment Areas Map – Particulate (size < 2.5 micrometers)
United States
Warm Mix Demonstration Projects in the U.S.
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
2008 – Permissive Specifications
Potential 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
Warm Mix Asphalt Technical Working Group

- Members: FHWA, NAPA, SAPA, AASHTO, State DOTs, NCAT, Contractors, Labor, NIOSH
- Mission: Evaluate and validate WMA and share information
- Purpose: Guidance for research and implementation of WMA
Technology Overview**

- WAM-Foam
- Low Emission Asphalt
- Aspha-Min
- Advera
- Sasobit
- REVIX
- Evotherm
- Cecabase RT
- Thiopave
- Rediset WMX
- Lea-co
- Miconnaughay Technologies
- AquaFoam
- Ultrafoam GX
- Terex
- Accu•Shear
- Aquablack
- Double Barrel Green

**FHWA does not endorse any particular proprietary product or technology.
Others** …

Trinidad Lake Asphalt (TLA)
Astec Green Pac
AESCO/Madsen Eco-Foam II
Sonneborn AdRap
Herman Grant
More to come …

Many technologies also used Internationally
Applications

- **Dense-graded mixes**
  - Majority of projects
  - RAP – Wisconsin and Missouri
- **SMA**
  - Maryland – Washington Beltway
- **Open-graded mixes**
  - Florida
  - China
- **Asphalt-Rubber**
  - California
Plant Foaming Techniques

- Small amount of moisture introduced to binder ahead of mixing
  - Steam causes volume expansion
  - Expansion allows for coating at lower temperatures
Material Foaming Processes

- Use water-bearing zeolite which releases moisture at high temperatures.
- Use a carefully controlled amount of moisture in sand added to hot coarse aggregate and asphalt.
Additives

• Long-chain paraffin
  – Viscosity reduced at high temperatures
  – Harden at service temperatures

• Surfactant based
  – Reduce surface tension of binder
  – Coating at lower temperatures
Chattanooga - Loadout

Control
Temp = 320°F

WMA
Temp = 270°F
Yellowstone Paving

Control
Temp = 320°F

Warm Mix
Temp = 245°F
Production and Paving Notes

- Work to minimize aggregate moisture.
- Make sure the burner is tuned for the temperature.
- Keep baghouse temperature above condensation point.
- Consider superheating aggregate ahead of RAP.
- Follow normal placement practices.
RAP and WMA

- Will RAP and New Binders Mix at WMA Process Temperatures?
- Interfacial Mixing Study
  - Atomic Force Microscope
- Lab Mixing Studies
  - Dynamic Modulus Evaluation

Courtesy AAT
NCHRP 9-43 - Sasobit

<table>
<thead>
<tr>
<th>Testing Condition</th>
<th>Measured</th>
<th>Estimated for Complete Mixing</th>
</tr>
</thead>
<tbody>
<tr>
<td>39.2 F, 10 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39.2 F, 1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39.2 F, 0.1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>68 F, 10 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>68 F, 1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>68 F, 0.1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>95 F, 10 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>95 F, 1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>95 F, 0.1 Hz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dynamic Modulus, ksi

- Measured
- Estimated for Complete Mixing

Courtesy AAT
Binder Grade and WMA

- Down to about 230°F, no adjustment.
- Below this, may consider one high temperature grade greater.
- Low temperature grade is being evaluated.
CDOT WMA Project I-70

Performance
Performance
Colorado I-70
<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 SO$_2$
  - 3.2% decrease in CO$_2$
  - 35.3% decrease in total hydrocarbons
  - 6.1% decrease in NO$_x$

- Evotherm – Canada – 140°F
  - 45.8% decrease in CO$_2$
  - 63.1% decrease in CO
  - 41.2% decrease in SO$_2$
  - 58% decrease in NO$_x$

- Direct comparisons are discouraged – different plants, different weather, different temperatures
States that have or will have Permissive WMA Specifications
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
How Does WMA Fit Into Pavement Preservation?

- Thin Lift HMA
  - Wider Paving Temp Range
  - Longer Haul Distances
  - Late Season Paving
- Specialty Mixes
  - Rubber Modified Binders and Mixes
  - Open-Graded Friction Courses
  - SMA
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 30M tons to date.
• Adoption will happen within the next few years.
• Permissive specifications must be developed.
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
  – Need long-term performance studies
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.