Warm Asphalt Mixes

by

R. Gary Hicks, CP2 Center

and

Steve Seeds, APTech

May 18, 2007
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.
Strategies

- Engineering Controls
- Best Management Practices
- Low Fuming Asphalts
- Warm Mix Asphalt
What is Warm Mix Asphalt?

- **Hot Mix Asphalt**: 275-325°F
- **Warm Mix Asphalt**: 250-275°F
- **Cold Mix Asphalt**: 60°F
Brief History

• 1997 German Bitumen Forum
• 2000 Second Euroasphalt & Eurobitume Congress (Barcelona)
• NAPA 2002 European Scan Tour
  – Germany and Norway
• NAPA 2003 Annual Convention
  – San Diego
• World of Asphalt 2004
• 2005-2006 – Numerous U.S. Field Trials
• 2007 – FHWA/AASHTO Scan Tour
Goals for Warm Mix Asphalt

• Use existing Hot Mix Asphalt plants

• To meet existing standards for Hot Mix Asphalt specifications

• Focus on dense graded mixes for wearing courses

• WMA quality = Hot Mix Asphalt quality
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
Late Season Paving

HMA Time = 14 min.

WMA Time = 29 min.

For $\Delta T = 125^\circ F$
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
Available WMA Technologies

- WAM Foam – Shell/Kolo Veidekke
- Zeolite – Eurovia/Hubbard Construction
- Sasobit – Sasol Int./Moore and Munger
- Evotherm – MeadWestvaco
- Low Energy Asphalt – Fairco
- Others
WAM-Foam

- Two Phase Addition of Asphalt
  - Aggregate coated with “soft” asphalt
  - Hard asphalt foamed to mix with pre-coated aggregate
  - Requires plant modification for foaming
WAM Foam installation in an Asphalt Batch-Plant

2000
Warm Asphalt Mixes by adding aspha-min®, a synthetic zeolite
Aspha-Min®

- Add 0.3 percent by mass to mix
  - Water is released at high temperatures
    - Range of 185 to 360°F
    - Foams the asphalt
      - Reduced viscosity
- Reported by Eurovia
  - 54°F reduction
  - Fuel savings of 30%

Aspha-Min® is a fine white powder
Aspha-Min®
Aspha-min Field Sections

- Paving project in Germany – Fall 2003
- Orlando Paving Company – First U.S. trial February 2004
- World of Asphalt – March 2004
- Charlotte, NC – Blythe Construction – September 2004
- Ohio – Shelly Companies -2005
- New Hampshire – Tilcon – 2005 – Late Season Paving
Seeing is Believing!

Hot Mix 314 F

Warm Mix 254 F

138.1 pcf

138.5 pcf
<table>
<thead>
<tr>
<th>Product of</th>
<th>Sasol Wax GmbH (Germany)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fischer-Tropsch paraffin wax</td>
<td>Fine crystalline long chain aliphatic hydrocarbon</td>
</tr>
<tr>
<td></td>
<td>Produced from coal gasification</td>
</tr>
<tr>
<td>Available in</td>
<td>Flakes or powdered form</td>
</tr>
<tr>
<td></td>
<td>2, 5, 20, and 600 kg bags</td>
</tr>
</tbody>
</table>
Maryland Experience

• Two Field Trials
  – Both with Sasobit – Fischer-Tropsch Wax
  – Applications
    • High RAP Content – Not Warm Mix
    • Washington Beltway Paving – Warm Mix
Maryland Field Trial

45% RAP with Sasobit added
Frankfurt Airport

- Bear heaviest aircraft in 2-3 hours
- Reduced cooling, key to 300-step project

Asphalt Case Studies presented at NAPA Convention Feb 17, 2005
evotherm
Warm Mix Asphalt Technology
EVOTHERM Technology Overview

- Innovative chemical additive technology
- Openly available to end-users; no licensing
- Delivered in binder to drum or batch plant
- Developed to optimize chemical structure
- Molecular structure imparts coating, workability, strength, and adhesion
Immediate Release to Traffic
Evotherm North American Field Trials

- 2005
  - San Antonio
  - Indiana
  - Ontario
  - California
  - NCAT Test Track
Low Energy Asphalt

- Developed by Fairco – France
- Marketed by:
  - Advanced Concepts Engineering – Van Nuys, CA
Low Energy Asphalt

- Coarse Aggregate heated to 130°C.
- CA coated with binder.
- Cold, wet sand + filler added.
- Leaves plant at 90°C.
- Plant modification required.
- Conventional paving equipment
Low Energy Asphalt
Applications

• Dense-graded mixes
  – Majority of projects
  – RAP – Wisconsin and Missouri
• SMA
  – Maryland – Washington Beltway
• Open-graded mixes
  – Florida
  – China
• Asphalt-Rubber
  – California
Reduced Emissions
Data provided by suppliers.

- **Aspha-min** – North Carolina – 265°F
  - 17.6% decrease in SO\textsubscript{2}
  - 3.2% decrease in CO\textsubscript{2}
  - 35.3% decrease in total hydrocarbons
  - 6.1% decrease in NO\textsubscript{x}
- **Evotherm** – Canada – 140°F
  - 45.8% decrease in CO\textsubscript{2}
  - 63.1% decrease in CO
  - 41.2% decrease in SO\textsubscript{2}
  - 58% decrease in NO\textsubscript{x}
- **Direct comparisons are discouraged** – different plants, different weather, different temperatures
What Have We Learned?

- WMA additives improve compaction, both in the lab and in the field.
- In the lab, rutting increases with lower temperatures – may not translate to the field.
- Moisture, trapped in the aggregates and introduced into the mix, still a concern. Long-term affects unclear. Can mitigate effect in lab.
Recommendations

- At this time, determine optimum asphalt content without warm asphalt additive
- If mixing temperature is below 250 °F, consider using stiffer binder grade
- Conduct tensile strength ratio tests at anticipated production temperatures
Things We Need to Go Forward

• Larger trials
• A robust product evaluation protocol
• **WE NEED A PERFORMANCE TEST!**
• Better understanding of effect on rutting and moisture damage
• Procedures for mix design and QC/QA (Do they need to be different?)
• A way for Agencies to specify
  – Temperature reduction?
  – Binder grade?
What is the State of WMA?

• Not ready for prime time – yet!
• Driving forces could accelerate implementation
  – Energy costs
  – Emissions requirements
• The time is **now** to develop and learn how to use