Warm Mix Asphalt: “Going Beyond Foaming”

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Outline

• WMA Technologies
• WMA Usage
• Why Use a WMA Additive?
• Summary
WMA Technology Categories

1. Foaming Processes
   a. Foaming additives
   b. Water injection systems

2. Organic additives

3. Chemical additives

4. Hybrid Technologies

20 + WMA products marketed in the United States fit into one of these categories
Another WMA Resource

• NAPA Quality Improvement Publication 125
• 3rd Edition
For Each WMA Technology Category…

- How does it work?
- Temperature reduction
- Potential concerns
- Example products and dosage
- How do you use it?
How Do Foaming Processes Work?

- Water expands 1600 times when converted to steam at atmospheric pressure
  - Water turns to steam
  - Steam is encapsulated by viscous asphalt binder producing foam
  - The foamed asphalt occupies greater volume
  - Improves coating and compaction at lower temperatures
Ways to Produce Foamed Asphalt

**Water Injection**
- Nozzles on plant
- 1.25 to 2.0 % water by weight of AC
- 30 to 50 °F reduction in mixing and compaction temperature

**Additive**
- Synthetic zeolites
  - 20 % water
- Dose at 0.1 to 0.3 % by weight of mix
- 50 to 70°F reduction in mixing and compaction temperature
Concerns With Foaming Processes

- Will all binders foam?
- Is all foam equal?
- How long is the foam effective?
- Can foamed asphalt be replicated in the laboratory for mix design?

These issues are being investigated in NCHRP Project 9-53, Properties of Foamed Asphalt for Warm Mix Asphalt Applications
Example Foaming Processes

• Water Injection
  – AESCO/Madsen
  – Astec
  – Gencor
  – Herman Grant
  – Maxam
  – Meeker
  – Stansteel
  – Tarmac
  – Terex

• Additive
  – Advera
  – Aspha-min
How are Foaming Processes Used

• Water Injection
  – Nozzle
  – Accurate control of AC and water
  – Plant controls

• Additives
  – Weighing system
  – Conveyor system
    • Pneumatic
    • Auger
How Do Organic Additives Work?

- Waxes or other hydrocarbon modifiers
  - Improve lubrication
  - Reduce viscosity

- Temperatures
  - 50 to 70 °F reduction in mixing and compaction temperature
Concerns With Organic Additives

• Grade Changes?
  – Some waxes increase high PG and decrease low PG
  – Other organic additives may decrease both high and low PG

• Grade binder after addition
Example Organic Additives & Typical Dosage

- **Example Products**
  - Sasobit
  - SonneWarmix
    - ECOBIT
  - LEADCAP
  - BituTech WA1

- **WMA Dosage**
  - 0.5 to 1.5 % by weight of binder

- **Modifier Dosage**
  - 2.0 to 4.0 % by weight of binder
How are Organic Additives Added?

At binder terminal
- Low shear
- Preferred

Binder supply at plant
- Tanks with agitation
- In-line (molten)

Mixing chamber at plant
- Additive directed into binder
  - Pneumatic
  - Auger
How Do Chemical Additives Work?

- **Surfactants (surface active agents)**
  - Reduce surface tension between polar aggregate and non-polar asphalt
  - Improves wetting and reduces internal friction

- **Temperatures**
  - 50 to 90 °F reduction in mixing and compaction temperature
Concerns With Chemical Additives

- **Effect on Binder Grade**
  - Grade binder with additive

- **Aggregate mineralogy and effectiveness**
  - Perform mix design with additive
Example Chemical Additives & Typical Dosage

• Example Products
  – Evotherm
  – CECABASE RT
  – QualiTherm
  – Rediset LQ
  – LEA Lite

• WMA Dosage
  • 0.20 to 0.75 percent by weight of binder
How are Chemical Additives Added?

At binder terminal
• Preferred

Binder supply at plant
• Tanks with agitation
• In-line
Hybrid WMA Technologies

- Combination of two or more WMA technologies
- Marketed Product
  - LEA
- Created by producer to address weaknesses in a technology
  - Using a chemical additive with a water injection system to improve coating at lower temperatures
WMA Usage

- NAPA Asphalt Pavement Mix Production Survey
- Survey of Producers
- Categories
  - DOT
  - Other Agency
  - Commercial
- Technologies
Estimated Producer WMA Usage

Percent of Total Tonnage

- 2009: 5.4%
- 2010: 13.2%
Estimated Producer WMA Usage (by Technology)

<table>
<thead>
<tr>
<th>Year</th>
<th>Organic Additive %</th>
<th>Plant Foaming %</th>
<th>Additive Foaming %</th>
<th>Chemical Additive %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>0.29%</td>
<td>82.7%</td>
<td>1.5%</td>
<td>15.5%</td>
</tr>
<tr>
<td>2010</td>
<td>0.88%</td>
<td>78.8%</td>
<td>0.7%</td>
<td>19.6%</td>
</tr>
</tbody>
</table>
Why Use an Additive?

- Ease of Use
- Lower Effective Temperature Range
- Alter Binder Grade
- Anti-Strip Properties
Ease of Use

- Greater Use of WMA
- WMA Additives at Terminal
  - Chemical
  - Organic
- Reduces Additive Cost
- No Modifications
Lower Temperature Range

Temperature Reduction, °F

HMA

Plant Foaming

Foaming & Organic Additives

Chemical Additives
Alter Binder Grade

• Some Organic Additives
• Increase High Temperature Grade
  – One to two grade levels
  – Reduce polymer loading
• Decrease Low Temperature Grade
  – High RAP mixtures
Anti-Strip Properties

- Some Chemical Additives

![Graph showing the average difference in TSR for Process A, Process B, and Process C. The graph is labeled NCHRP 9-43 Mix Design Study.]
Key Points

- WMA Use is Increasing
- Variety of Ways to Produce WMA
- Plant Foaming is Most Popular But Additives are Gaining Market Share
  - Terminal Addition Decreases Cost and Requires no Plant Modifications
  - Allow Production at Lower Temperatures
  - Alter Binder Grade
  - Anti Strip Properties
Questions/Discussion

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