Warm Mix Asphalt
Rubber Concrete

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Overview

- What is Warm Mix Asphalt
- What are Features/Benefits
- Rubber Binder Study
  - Advera WMA
  - Results
- Rubber Demonstration
What is Warm Mix Asphalt?

Hot Mix Asphalt is modified in order for it to be produced and placed at lower temperatures.

Production and placement temperature is between 185°F and 275°F.
Warm Mix Asphalt

- Emissions Reduction
- Energy Savings
- Paving over Crack Sealing – no Bumps
- More even Densities across the Mat.
Yellowstone National Park

- Temperature was more uniform over the mat
Warm Mix Asphalt

Other Benefits

- Wider the Paving Window
  - Night Paving
  - Longer Hauls
  - Extended paving season

- Compaction Aid for Stiff Mixes
  - RAP
  - RAS
  - Polymer Modified
  - Rubber
Rubber Asphalt Study

Objective: to confirm the effect of Advera WMA on Rubber Binder Properties and Rubber Asphalt Mix Performance.

- Binder Grade PG 64 – 16
- 18% Crumb Rubber
- Warm Mix Technology – Advera WMA
- CRM Binder Viscosity @ 190C (Pa-s) 2.688
Advera® WMA

- **Synthetic Zeolite**
  - Hydrated Aluminosilicate
  - **Contains 18-21% water**
  - Standard size and quality for consistency.
  - Environmentally and Worker Friendly
    - **EPA – GRAS.**
Advera® WMA

How does it work?

- **Dosage** – 0.25% on Asphalt Mix (5lbs/ton)
- **Upon heating above 100°C water is emitted from the zeolite structure causing micro-foaming in the asphalt concrete.**
  - Controlled foaming - No visual change in the asphalt concrete
  - Time released for longer workability
  - Improves Workability, and thus compaction for overall improvement in density.
Advera WMA
How does it work?
Time Release of Water

- DSC/TGA test run by Texas A&M
## Binder Properties

<table>
<thead>
<tr>
<th></th>
<th>No Aging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Virgin Binder</td>
</tr>
<tr>
<td>Viscosity, Pa-s</td>
<td>0.43 (135°C)</td>
</tr>
<tr>
<td>$G^*/\sin \delta$, kPa (64°C)</td>
<td>1.207</td>
</tr>
<tr>
<td>Failure Temp (°C)</td>
<td>67.05</td>
</tr>
</tbody>
</table>

### Oven Aging @ 120°C for 3 days

<table>
<thead>
<tr>
<th></th>
<th>No Aging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Virgin Binder</td>
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<tr>
<td>Viscosity, Pa-s</td>
<td>0.48 (135°C)</td>
</tr>
<tr>
<td>$G^*/\sin \delta$, kPa (64°C)</td>
<td>3.53</td>
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<tr>
<td>Failure Temp (°C)</td>
<td>73.9</td>
</tr>
</tbody>
</table>

Addition of zeolite to the CRM Binder in general increases viscosity and stiffness of the CRM Binder.
# Binder Properties

<table>
<thead>
<tr>
<th></th>
<th>RTFO 163°C</th>
<th>RTFO 130°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Virgin Binder</td>
<td>CRM Binder</td>
</tr>
<tr>
<td>G*/*sin δ, kPa (28°C)</td>
<td>4.16</td>
<td>14.55</td>
</tr>
<tr>
<td><strong>PAV Residue</strong></td>
<td><strong>PAV Residue</strong></td>
<td><strong>PAV Residue</strong></td>
</tr>
<tr>
<td>(after RTFO @ 163°C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G*/*sin δ, kPa (64°C)</td>
<td>2890</td>
<td>388</td>
</tr>
<tr>
<td>Stiffness (60), Mpa (-6°C)</td>
<td>114</td>
<td>91.6</td>
</tr>
<tr>
<td>M Value(60), Mpa (-6°C)</td>
<td>0.368</td>
<td>0.293</td>
</tr>
</tbody>
</table>

Reducing the RTFO temperature significantly lowers the creep stiffness and significantly increases the m-value of the CRM Binders.
Creep Compliance of CRM Binder

CRM binders containing zeolite may undergo more strain when loaded for long durations.
Creep Recovery Test

CRM CRM + Advera WMA
3 Pa Loading

CRM CRM + Advera WMA
10 Pa Loading

CRM CRM + Advera WMA
50 Pa Loading
The Addition of zeolite has increases the complex, elastic and viscous modulus of the CRM Binder.
Rubber Demonstration
August 2008

- Massachusetts – I-295 from Rhode Island Boarder to Interchange with I-95.
- Night Paving
- 3,000 Tons
- Gap Graded Mix
- Superpave Gyrations \( (N_{\text{design}}) = 100 \)
Rubber Demonstration

- MA Specification Range
  - PG 58-28 with 20% Rubber 6.5% Min. Binder Content
  - Air Voids 3-6%
  - VMA 18-23%

- Aggregate Composition
  - 23% - 12.5 mm Aggregate
  - 55% - 9.5mm Aggregate
  - 10% - Stone Sand
  - 10% - Natural Sand
  - 2.0% - Baghouse Fines
Rubber Demonstration

- **HMA Rubber**
  - Production: 350°F
  - Placement: 310-330°F

- **WMA Rubber**
  - Production – 290-300°F
  - Placement – 275-290°F
Rubber Demo Benefits

- Improved workability of the mix – Improved Placement
- Hand work was improved versus Hot Mix Rubber.
- Although the temperature was still hotter than official warm mix definition of 185°F – 275°F, the odor and smoke was reduced.
Benefits in Rubber Asphalt

Better Workability of the Asphalt Mix Allows

- Extension of the Paving Window
  - Longer Haul Times due to wider paving window.
  - Ease of hand work
  - Place at lower temperatures

- Reduction in Production Temperatures Reduces Emissions
  - Reduce Blue Smoke complaints
  - Reduce Recordable Emissions

- Reduction in Production Temperatures Reduces Energy Consumption
  - Depending on mix it may be possible to save up to 30% on energy costs.
California Demo Planned

- CA 94: San Diego County – Spring 2009
- Contract Number 11-296404
- ½” RHMA-O PG 64-16
- 3 technologies and control – Each section will be approximately 3.5 miles in length.
Questions?

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