Using Warm Mix Technology to Improve Application of Asphalt Rubber in California

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By DingXin Cheng, Ph.D., P.E.
R. Gary Hicks, Ph.D., P.E.
and Lerose Lane, P.E.

CP2 Center, California State University, Chico
What is “RWMA”? 

- Warm mix asphalt (WMA) is used to describe technologies that reduce the production and placement temperatures of asphalt mixes.
- Asphalt rubber generally requires higher production and placement temp’s.
  - RWMA (Both Gap Graded and Open Graded)
  - Asphalt rubber spray applications (i.e., seal coats)
Who is using RWMA in California?

- California
  - Caltrans (California DOT)
    - I-5 Projects—at least 5 major projects
    - SR 1, SR 99, SR 70, SR 101, SR 152, CA-94 and more
  - Local agencies
    - City of Stockton
    - City of Roseville
    - LA County
    - City of Fort Bragg
    - Others
Advantages Observed Using Warm Mix

- Reduced Fuel Usage
- Reduced Emissions
  - Production at the plant
  - Placement in the job site
- Improved Worker Conditions with Lower Emissions
- Improved Compaction in the Mat with Cooler Temperatures
  - Enables improved quality night time paving
  - Allows longer haul distances
- Provides a Longer Construction Season
- Saves Contractor Equipment Costs
Types of Warm Mix Technologies

- Organic Additive or Wax
- Chemical Additive or Surfactant
- Water for Foaming
- Website for Current Information
  - www.warmmixasphalt.com
  - Supplier’s Own Websites Per Product

More than 20 products currently available
WMA Technologies Used in California

- Rediset used by City of Stockton for PG76-22 terminal blend overlay project
- Engineered Additive WRM used by City of Roseville for AR chip seal project
- Astech PER from Engineered Additive used by Caltrans, District 6 for AR chip seal project
- Sasobit used by City of Stockton for PG76-22 terminal blend overlay project
- Evoterm-Used on some Caltrans projects
- Advera-Used on some Caltrans projects
## Typical WMA Production and Paving Temperatures

<table>
<thead>
<tr>
<th>WMA ADDITIVES</th>
<th>Production Temp (°F/°C)</th>
<th>Paving Temp (°F/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double Barrel Green</td>
<td>250-275 / 121-135</td>
<td>~235 / 113</td>
</tr>
<tr>
<td>Evotherm™</td>
<td>180-250 / 82-121</td>
<td>160-240 / 71-116</td>
</tr>
<tr>
<td>Rediset WMX</td>
<td>~265 / ~129</td>
<td>~225 / 107</td>
</tr>
<tr>
<td>REVIX</td>
<td>245-265 / 118-129</td>
<td>205-225 / 96-107</td>
</tr>
<tr>
<td>Sasobit</td>
<td>200-280 / 93-138</td>
<td>150-250 / 66-121</td>
</tr>
<tr>
<td>WAM Foam</td>
<td>212-248 / 100-120</td>
<td>176-230 / 80-110</td>
</tr>
<tr>
<td>Zeolite</td>
<td>~275 / ~135</td>
<td>&gt;212 / &gt;100</td>
</tr>
<tr>
<td>RHMA</td>
<td>325-375 / 163-191</td>
<td>285-350 / 141 - 177</td>
</tr>
</tbody>
</table>
Asphalt Rubber (AR) Usage

- Asphalt Rubber—used since mid 1960’s
  - Use pioneered by City of Phoenix, Arizona
  - Arizona DOT fully implemented AR program 1988
  - Arizona has used 4.2 million tons of AR
  - Arizona has recycled 15 million used tires

- California—used AR since 1980’s
  - 30% of HMA placed includes AR
  - AR more difficult to place than non-rubberized mix
  - AR requires higher mixing temperatures to achieve workability
  - Higher mixing temperatures result in increased emissions
Asphalt Rubber (AR) Warm Mix

- Benefits of Warm Mix in AR
  - Production and placement temperature reduction
  - Improved workability
  - Lower emissions
  - Energy Savings = Cost Savings
  - Increased production

- AR Temperature Range with Warm Mix
  - Mixing -280-300 °F
  - Compaction-250-275 °F
Additional Benefits of AR with Warm Mix

- Reduced Fatigue Cracking
  - Clemson University Study (2008) determined that warm mix improved “the rheological properties of both the un-aged and aged binders”. Fatigue life is greater for AR with warm mix
  - Determined warm mix additives offset the increase of production and compaction temperatures induced by the addition of rubber
## Selected AR with Warm Mix Technologies Constructed in California

<table>
<thead>
<tr>
<th>Road Name</th>
<th>Location (PM: n/n)</th>
<th>Date Constructed</th>
<th>Warm Mix Additive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa Clara Rte. 152</td>
<td>Santa Clara</td>
<td>March 2006</td>
<td>Sasobit</td>
</tr>
<tr>
<td>Interstate 5</td>
<td>Santa Nella (105.9/106.4)</td>
<td>September 2008</td>
<td>Astec DBG &amp; Evotherm</td>
</tr>
<tr>
<td>Interstate 5</td>
<td>Orland</td>
<td>May 2009</td>
<td>Evotherm</td>
</tr>
<tr>
<td>Interstate 5</td>
<td>Near Firebaugh, Fresno Co. (PM 37.2 to PM 45.0)</td>
<td>September 2010</td>
<td>Astech PER &amp; Engineered Additives WMA</td>
</tr>
<tr>
<td>CA-94</td>
<td>San Diego</td>
<td>June 2009</td>
<td>Advera, Evotherm, Sasobit</td>
</tr>
<tr>
<td>SH 70</td>
<td>Marysville</td>
<td>July 2009</td>
<td>Evotherm</td>
</tr>
<tr>
<td>SR-101</td>
<td>Fortuna (54.2/56.3)</td>
<td>September 2009</td>
<td>Evotherm</td>
</tr>
<tr>
<td>SH 99</td>
<td>Sutter County</td>
<td>November 2009</td>
<td>Evotherm</td>
</tr>
<tr>
<td>Various</td>
<td>City of Roseville</td>
<td>September-October 2010</td>
<td>Engineered Additives WMA</td>
</tr>
</tbody>
</table>
Locations of Selected California RWMA Projects (2011)
Current Projects in CP² Center Database (Mostly Asphalt Rubber Warm Mix)
Santa Clara SR 152 Project (2006-2010)

- 1.75” Overlay on shoulder, using 200 tons of RHMA-G with Sasobit.
- Mix produced at 280 °F, a drop of 40 degrees from the normal production temperature of 320 °F.
Near Orland, I-5--Caltrans District 3 (2009)

- Project Description
  - Remove OGFC
  - Replace with 1.2” RHMA-O
  - 18,000 Tons placed with Evotherm
  - Temperature started at 320 °F and dropped to 300 °F
  - Temperature dropped again to 290 °F
  - Temperature dropped again to 285 °F
Near Orland, I-5--Caltrans District 3 (Continued) (2009)

- Base binder was PG 64-16 with 18.5% crumb rubber
  - Estimated 168 tons of scrap tire used
  - Caltrans specifies a blend of scrap tire rubber and high natural rubber
  - This project used rubber blend of 75% scrap tire rubber and 25% high natural rubber
Near Orland, I-5--Caltrans District 3 (Continued) (2009-2010)

- Project is still performing well in 2011
- It’s expected to last as long as a non-warm mix project.

2009 Construction

2010
Near Firebaugh, I-5—Caltrans District 6
Asphalt Rubber Spray Application(2010)

• Project Description
  • Constructed as part of a RHMA-G overlay with a chip seal application on the shoulders
  • Agreed between Contractor and Caltrans to place a trial section of warm mix asphalt rubber seal coat on the northbound median shoulder
  • Location—I-5, Fresno County, PM 37.2 to PM 45.0

- **Mix Design**
  - PG 64-16 base binder with 18% rubber
  - Warm mix additives
    - Engineered additives WMA at 1.5%
    - Astech PER at 0.5%

- **Application Rates**
  - Binder applied at 0.6 gal/sq yd
  - 3/8” hot pre-coated chips applied at 30 lbs/sq yd

- Thermal Picture of Hot Chip Application, Temperature of binder on grade 302 °F.
- Binder temp. in distribution truck--340 °F.

- 3/8 inch Chip Seal Mat (hot pre-coated chips) rolled after application.
- Rolling can occur up to 15 min. after application with warm mix

Completed Project after 5 months

- Why use a chip seal on shoulder application?
- Can serve in place of a rumble strip
- Preserves shoulder at a lesser cost than an overlay
Conclusions

- Warm Mix (WM) can be used with AR for night time paving and in cooler climates
- WM increases workability of AR mixes
- WM can reduce fuel usage by reducing production temperature by 30-80 °F
- WM can reduce emissions up to 80% at production and during paving
- WM in California appear to be performing well
- WM AR chip seals can offer agencies a maintenance treatment for cracked and aged pavements at a lesser cost than a 1 inch overlay
- WM can reduce energy costs
- WM can allow a longer construction season in adverse climates
Recommendations

- More agencies should consider WM with AR for cooler temperature such as night time
- More trials should be done using AR with spray applications
- California’s use of both products is increasing
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  - Cathrina Barros
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  - Al Ochoa
  - Kee Foo
- References for this presentation are available in our paper
The End

- Questions?