Project Info

- Provide remote overnight parking area for very heavy aircraft on three PCC hard stands.
- The project required demolishing the previous hardstands and apron, excavating peat from the sub base, building a new sub base, and constructing new hardstands and paving in September with PMA.
- On July 17, 2009 Granite requested to use Warm mix asphalt using the Evotherm additive on the project.
DOT Approval Criteria

- Historical performance
  - NCAT test track performance – no failures
  - HVS testing – Cal Trans: good performance
- Job Mix design (Marshall & Superpave)
  - No change in PG 64-34 properties
  - Pass APA with not more than 1mm difference from mix without Evotherm. Spec ≤ 3mm
- Field produced mix must meet:
  - APA design specifications
  - All acceptance tests must meet specifications

Viscosity Comparison, 0.5% Type M1

Temperature ranges from 286 to 41 degrees Fahrenheit. From the thermal imaging it is apparent that the heat is distributed very evenly through the pavement as it exits the screed. This well distributed heat pattern also corresponds to achieving even compaction throughout the entire mat because it has been shown that compaction is proportionately related to temperature.
HWD Testing – Good Results

Granite Paving Video

- Paving with 0.5% Evotherm, Type M1
- Metered into the asphalt cement storage tank at the asphalt plant
- Mixing was accomplished by circulating pumps
- Plant operation was not modified
- Started as hot mix then lowered temperature

EVOTHERM
Warn Mix Asphalt Technology
Evotherm
What is it?

• Comprehensive chemical package
• Optimized to deliver
  – Mixing
  – Coating
  – Workability
  – Compaction
  – Adhesion

Surfactant Chemistry

Lipophilic
“Oil Loving”
Tail

Hydrophilic
“Water Loving”
Head Group

Micelle Formation

Evotherm Delivery Systems

• Evotherm DAT
  – Chemical concentrate solution directly injected
    into asphalt line at plant
  – 85 - 100°F cooler than HMA
• Evotherm 3G
  – Water-free version, suitable for both terminal-add
    and plant-add
  – 65 - 85°F cooler than HMA
What is Warm Mix?

Conventional Hot Mix
- 350°F
- 300°F
- 250°F
- 200°F
- Ambien

Foamed Asphalt

Warm Mix Asphalt

Cold Mix

Evotherm

How does it work?

- Delivered at 0.3-0.7% by asphalt weight (5-11 oz by mix weight)
- Effective temperature range
  - Mix temperature
    - 250-170°F
  - Compaction temperature
    - 235-160°F

Evotherm Advantages

- Easy to Use
- Proven Performance
- Lowest Temperatures
Evotherm 3G - Minnesota

Advantages of Evotherm

• Easy to use
  – Can be produced in any mix plant
  – Same production & lay down equipment as conventional mix
  – Easy mix design evaluations
  – No plant modifications
  – Zero capital investment – lab or plant

Evotherm Pump
Evotherm Plant Injection

Evotherm Terminal Addition

Advantages of Evotherm

• Proven track record of performance
  – Hundreds of projects
  – 9 independent studies
  – 15+ DOT Evaluations
  – 10+ million ESAL on NCAT Test Track
• < 2 mm of rutting
**NCAT Performance**

- Proven track record of performance
  - More than 400 projects
  - 9 independent studies
  - 15+ DOT Evaluations
  - 10+ million ESAL on NCAT Test Track
    - < 2 mm of rutting
  - Caltrans HVS Evaluation
    - Same performance as HMA

**Advantages of Evotherm**

- Proven track record of performance

**Heavy Vehicle Simulator Results**

- Failure rut depth = 12.5 mm
Advantages of Evotherm

- Lowest Temperatures
  - 70 - 100°F cooler than HMA
  - Large compaction window
  - Reduced thermal segregation
  - Extended hauls & paving season
  - Longer service life
  - Major reductions in fuel & emissions
  - Increased usage of RAP

Advantages of Warm Mix

- Larger compaction window

Texas DOT - San Antonio

Limestone
PG76-22
3000 Tons,
T mix: 240°F
ΔT: 95°F
Advantages of Warm Mix

• Larger compaction window
• Reduced thermal segregation
Advantages of Warm Mix

- Larger compaction window
- Reduced thermal segregation
- Extended hauls & paving season
Anchorage—HMA at 50°F

Anchorage—Evotherm at 50°F

Anchorage—Evotherm at 35°F
Extended Season Paving
New York City, 8 Dec. 08, 40% RAP PG 64-22

Evotherm mix temperature behind the screed

Ground temperature at 7 a.m. was < 15°F

Extended Season Paving
New York City, 8 Dec. 08, 40% RAP PG 64-22

Paving
Compaction

Interest in EVOTHERM: Extended Season Paving
New York City, 8 Dec. 08, 40% RAP PG 64-22

Air voids of cores at > 92% of Gmm
Excellent joint compaction
Cold Weather Paving

280 mile, 8 hour haul
10°F air temperature
Bridge resurfacing

350°F production
240°F delivery

Advantages of Warm Mix

• Larger compaction window
• Reduced thermal segregation
• Extended hauls & paving season
• Longer service life

Reduced Binder Aging
TxDOT Core After 1 Year

Hot Mix Control

TxDOT OVERLAY CRACK TESTS WITH EVOTHERM

Stress Crack

TxDOT OVERLAY CRACK TESTS WITH EVOTHERM

TTI Overlay Tester Results
Advantages of Warm Mix

- Larger compaction window
- Reduced thermal segregation
- Extended hauls & paving season
- Longer service life
- Major reductions in fuel consumption and emissions

Stack Emissions

200 °F Evotherm, 310°F HMA control
Reduced Emissions

Hot Mix

Jobsite Emissions vs. HMA

Below Detectable Limits

Total Organics

Benzene Solubles
Jobsite Emissions:
Interstate-78 NEW JERSEY

HMA Control

Lower Production
Temperatures Mean
Significantly Lower
Fumes & Odors

Advantages of Warm Mix

• Larger compaction window
• Reduced thermal segregation
• Extended hauls & paving season
• Longer service life
• Major reductions in fuel consumption and emissions
• Increased usage of RAP

Increased RAP

Source: D. Williams - MoDOT

<table>
<thead>
<tr>
<th>High RAP Warm Mix Asphalt</th>
<th>Control</th>
<th>20% RAP</th>
<th>28% RAP</th>
<th>35% RAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pen</td>
<td>29</td>
<td>39</td>
<td>37</td>
<td>28</td>
</tr>
<tr>
<td>Viscosity</td>
<td>25,920</td>
<td>16,087</td>
<td>16,728</td>
<td>23,470</td>
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<tr>
<td>Ductility</td>
<td>36</td>
<td>79</td>
<td>54</td>
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<tr>
<td>DSR 64</td>
<td>7.35</td>
<td>4.39</td>
<td>5.74</td>
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<td>MSCR</td>
<td>26</td>
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<td>DSR 70</td>
<td>3.48</td>
<td>2.11</td>
<td>2.91</td>
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<tr>
<td>BBR -12</td>
<td>0.394</td>
<td>0.437</td>
<td>0.406</td>
<td>0.393</td>
</tr>
</tbody>
</table>

Source: D. Williams - MoDOT
# Workability of High RAP Mixes

![Graph showing workability of high RAP mixes](image)

## High RAP Binder Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>40% RAP HMA Control</th>
<th>40% RAP Evotherm WMA</th>
<th>Superpave Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix Production Temperature, °F</td>
<td>330</td>
<td>248</td>
<td>not applicable</td>
</tr>
<tr>
<td>Viscosity (Pas)</td>
<td>1.357</td>
<td>1.017</td>
<td>3 Pa-s max</td>
</tr>
<tr>
<td>G''tanδ at 64°C, kPa</td>
<td>9.80</td>
<td>5.31</td>
<td>not applicable to field binder samples</td>
</tr>
<tr>
<td>G''tanδ at 70°C, kPa</td>
<td>4.54</td>
<td>2.59</td>
<td></td>
</tr>
<tr>
<td>G''tanδ at 76°C, kPa</td>
<td>2.18</td>
<td>1.27</td>
<td></td>
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<tr>
<td>G''tanδ at 82°C, kPa</td>
<td>1.08</td>
<td>0.642</td>
<td></td>
</tr>
<tr>
<td>G''tanδ at 88°C, kPa</td>
<td>0.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration (dmm)</td>
<td>15</td>
<td>23</td>
<td>not applicable</td>
</tr>
<tr>
<td>BBR Stiffness (MPa)</td>
<td>222</td>
<td>158</td>
<td>300 MPa max</td>
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<tr>
<td>m-value</td>
<td>0.296</td>
<td>0.326</td>
<td>0.300 min</td>
</tr>
<tr>
<td>Pressure Aging Vessel G'' x sinδ, kPa</td>
<td>5663</td>
<td>3215</td>
<td>5000 kPa max</td>
</tr>
</tbody>
</table>

*EVOTHERM HIGH-RAP MIXTURE MEETS PG 76-22 BINDER GRADE*

*HMA FAILS*
Evotherm at Anchorage Intl.