Why Warm Mix Asphalt?

2009 Alaska Paving Summit

Today’s Discussion

- What is WMA?
- Benefits of WMA
- Available Technologies
- National Perspective
- State DOT’s Perspective
- Local Agency Perspective
- WMA Contractors Experience

What is WMA?

- Warm Mix Asphalt
  - Like HMA, but Cooler
  - Typically 212-275°F
  - Many WMA Technologies
  - Similar Stiffness (compactability) at Reduced Temperatures
  - Produced with minor plant modifications
  - Placed with Conventional Equipment
  - Many Benefits over HMA
**WMA Environmental Benefits**

- Reduces Fuel Consumption Avg. 20% (NAPA)
- RAP (Reclaimed Asphalt Pavement) Friendly
- Reduces Odors at Plant and Paving Site
- Reduces Mat Temperatures at Paving Site
- Reduces Greenhouse Gas Avg. 10% (NAPA)
- Reduces Overall Plant Emissions

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**Environmental Aspect is Key**

From NCHRP 9-47

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**Reducing Emissions is Critical**

- “The federal government has officially designated Fairbanks a nonattainment area for PM 2.5.”
- “The clock is ticking... Fairbanks shares the new fine particulate designation with Los Angeles; Tacoma, Wash; Milwaukee; Philadelphia; Cleveland; New York and 40 other cities.”

Anchorage Daily News
November 17, 2009
Reduced Emissions

Astec Double Barrel Green

HMA Temp = 320°F
WMA Temp = 270°F

Stack Emissions Testing
(Lafarge Report)

<table>
<thead>
<tr>
<th>Combustion Gas</th>
<th>HMA Production</th>
<th>15% RAP/5% MSM</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>15.2%</td>
<td>15.8%</td>
<td>-</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>4.8%</td>
<td>4.1%</td>
<td>10.9%</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>1.005E-6 lb/t²</td>
<td>9.814E-7 lb/t²</td>
<td>10.4%</td>
</tr>
<tr>
<td>Sulphur Dioxide (SO₂)</td>
<td>1.403E-8 lb/t²</td>
<td>1.707E-8 lb/t²</td>
<td>-14.3%</td>
</tr>
<tr>
<td>Nitrogen Oxides (NOₓ)</td>
<td>1.707E-7 lb/t²</td>
<td>1.566E-7 lb/t²</td>
<td>8.3%</td>
</tr>
<tr>
<td>Average Mix Temperature</td>
<td>326°F</td>
<td>262°F</td>
<td>24.2%</td>
</tr>
<tr>
<td>Average Stack Temperature</td>
<td>228°F</td>
<td>198°F</td>
<td>15.6%</td>
</tr>
</tbody>
</table>

Energy Savings
(Lafarge Report)

<table>
<thead>
<tr>
<th>Mix</th>
<th>Moisture (%)</th>
<th>Mix Temperature (ºF)</th>
<th>Asphalt Volume Produced (ton)</th>
<th>MBtu</th>
<th>Mixflow</th>
<th>Energy Savings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMA - 15% RAP/5% MSM</td>
<td>4.5</td>
<td>336</td>
<td>275</td>
<td>79.1</td>
<td>0.29</td>
<td>24.2</td>
</tr>
<tr>
<td>HMA - 15% RAP/5% MSM</td>
<td>4.2</td>
<td>262</td>
<td>937</td>
<td>110.1</td>
<td>0.22</td>
<td></td>
</tr>
</tbody>
</table>

MBtu = Million British Thermal Units
**WMA Paving Benefits**
- Equal or Better Compactability
- Longer Haul Potential
- Cooler Weather Paving Potential
- Improves Crack Resistance

**Mix Stiffness vs. Temperature**

**Cooling Rate/Compaction Time**

- 50°F Temperature Drop
  - HMA = 3.6°F/min = 14 min
  - WMA = 2.4°F/min = 21 min
  - ≈ 1.5 Times
**Combining WMA and RAP**

- FHWA Binder Guidelines for RAP in HMA
  - 0-15% RAP – No Change in Virgin Binder
  - 15-25% Bump Virgin Binder Down 1 Grade
  - > 25% Use Blending Chart to Determine Virgin Binder Grade

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**Available WMA Technologies**

- 3 Categories
  - Foaming
  - Chemical
  - Wax (organics)

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**Available WMA Technologies**

- Foaming (Water Based)
  - Water-Injection Foaming Process
    - Astec Double Barrel Green
    - Gencor Green Machine Ultra Foam GX
    - Maxam
    - Terex
    - Stansteel
    - WAM
    - Advera PQ (Synthetic Zeolite)
    - Others...
Foam Warm Mix Process

Existing AC Pump

Counterflow Drum

Click to Start "Warm Mix"

Expansion Chamber

Existing AC pipe

Water Pump

Foam Injection pipe running along side existing AC pipe

Astec Double Barrel Green

TOP VIEW

DS GREEN MANIFOLD

Foam Nozzle Elongated Foam Nozzle Open

NORMAL STARTING DB GREEN FORM LD TIME

Coating Thicknesses
Available WMA Technologies

- Wax (Paraffin Wax Based Systems)
  - Sasobit
  - …others

- Chemical (Surfactant Based Systems)
  - Evotherm (Several Generations)
  - Emulsion Technology (ET)
  - Dispersed Asphalt Technology (DAT)
  - Revix
  - Rediset WMX
  - More every day
National Perspective
- Nationally Driven
- WMA Technical Working Group (TWG)
  - NAPA, Agencies, Academia... Promoting
- TWG Deliverables
  - WMA Guide Specifications
  - Testing Framework for Initial Pilot Projects
  - Support for Various National Cooperative Highway Research Program (NCHRP) research projects to address Specification Challenges

National Perspective
- Specification Challenges
  - Laboratory Mix Design
    - Lab Foaming Equipment
    - Effects on Binder Content
    - Effect on Binder Properties
  - Lab Properties vs. Field Properties
    - Sample Conditioning to Match Performance

National Perspective
- Over 1,000 WMA Projects Nationally to date
- Within 5 Years 50% AC will be WMA (NAPA 2008)
- US EPA Green Highways Program (GHP)
- TARP Money to Agencies for Energy Reductions?
- 39 States Have Initiated WMA Trial Projects
10 States have Permissive Specifications

- Texas
- Oklahoma
- Alabama
- Virginia
- Ohio
- Delaware
- Kentucky
- Louisiana
- Maryland
- Wisconsin
- Michigan
- South Carolina
- North Carolina
- Tennessee
- Florida

**State DOT’s Quotes**

- **Florida**
  “Florida is implementing the use of WMA as the choice of the Contractor. This is proceeding well with no issues to date.”

- **Kentucky**
  “As reported in the Spring 2009, the Kentucky Transportation Cabinet has revised its specifications to permit WMA produced by the water-injection foaming process at the contractors option.”

- **Oklahoma**
  “WMA mix designs may be used as an alternative to our standard HMA mix designs.”

*NCAT Newsletter Fall 2009*
### Local Agency Perspective

- Attending WMA Forums and Events
- Monitoring National Progress
- Monitoring Local DOT progress
- Witnessing WMA Demonstration Projects
- Agency or Contractors/Producers
- Becoming Proactive
- Using WMA on Pilot Projects
- Adding Contractor Option to Local Standards

### A Contractors Experience

- Granite Construction Technologies Used To Date
  - Astec Double Barrel Green (Foam)
  - Evotherm DAT (Chemical)
  - Maxam (Foam)
  - Sasobit (Wax)
  - Gencor (Foam)
  - Stansteel (Foam)
Granite Experience - State DOT

- WSDOT - SR 520 Sammamish Parkway (5,300 tons/20% RAP)
- WSDOT - I-5 Northbound 52nd Ave (6,000 tons/20% RAP)
- WSDOT - SR 101 SR 6 (4,400 tons/20% RAP)
- WSDOT - SR-12 Mitchell Rd (2,600 tons/20% RAP)
- WSDOT - SR-546 Guilde Meridian (4,000 tons/20% RAP)
- WSDOT - SR-6 Grays Harbor Project (3,000 tons/20% RAP)
- WSDOT - SR-532 Starbird Road project (3,000 tons/20% RAP)
- Caltrans - SR 70 Oroville (1,430 tons/15% RAP)
- Caltrans - SR 1 Fort Bragg (2,500 tons)
- Caltrans - SR-101 Scotia (2,600 tons RHMA)
- Caltrans – Dist. 1 Maintenance (misc. tonnage/15% RAP)
- UDOT - Wall Ave Region 1 (6,000 tons/15% RAP)

Granite Experience - Local Agencies

- Washington - City of Ocean City (40,000 tons/30% RAP)
- Nevada - City of Reno (100 tons/30% RAP)
- Nevada - Washoe County/Corps of Engineers (500 tons/35% RAP)
- California - City of Coachella (1,000 tons/15% RAP)
- California - City of Palm Desert (400 tons/15% RAP)
- California - City Of Indio (1,000 tons/15% RAP)
- California - County of Kern right-of-way (100 tons/20% RAP)
- Utah - City of Cottonwood Heights (240 tons/25% RAP)
- Utah - County of Salt Lake (1,200 tons/25% RAP)
- Utah - City of Keysville (250 tons/25% RAP)
- Utah - City of Ogden (300/25% RAP)
- Utah - City of South Ogden (50 tons/25% RAP)
- Utah - Salt Lake City (75 tons/15% RAP)
- Utah - City of Vernal (300 tons/25% RAP)
- Alaska - City of Anchorage (1,300 tons)
- Alaska - City of Anchorage (1,300 tons)

Granite Experience Private Owners

- California - Blue Diamond Sacramento - (900 tons 20% RAP)
- California - Cameron Airport - (250 tons/20% RAP)
- California - Geyser Industries (3,000 tons/15% RAP)
- California - Granite Const. Sacramento - (250 tons/20% RAP)
- California - Granite Const. Bakersfield - (225 tons/10% RAP)
- California - Granite Const. Bakersfield - (225 tons/20% RAP)
- California - Granite Const. Indio - (650 tons/15% RAP)
- California - Granite Const. Indio - (250 tons/30% RAP)
- Arizona - Granite Const. Tucson - (325 tons/15% RAP)
Granite Indio Plant Access Road Warm Mix Asphalt Test Sections, Indio Ca

Rubberized Crack Filler
(No Swelling)

City of Indio, CA

½ Dense Graded
Plant Temp: 270 F. (Astec Double Barrel)
Job Temp/Breakdown Rolling: 230 F.
Intermediate Rolling: 175 F.
Final Rolling: 160 F.
Average Density: 93% RICE
Ted Stevens International

¾” Dense Graded PG 64-34 PM
Plant Temp: 285 F. (Evotherm)
Job Temp: 260 F.
Avg. Density: 95% RICE

Caltrans SR-101 Scotia, CA

¾” RWMA Type G
Plant Temp: 250 F. (Evotherm)
Job Temp: 230 F.
Ambient Temp: 55 F.
Density: 92-94 RICE
**Caltrans SR-101 Scotia, CA**

**Cameron Airpark, Cameron Park, CA**

- ½" Dense Graded
- Plant Temp: 270 F. (Gencor)
- Job Temp: 245 F.
- Density: 92-96% RICE
1400 tons of 1/2" DGAC w/ PG 64
1400 tons of 1/2" DGAC w/ PG 64
3 Month Detour on SR 70
AADT 18,500, Trucks 15% on 5% Grade

Plant Temp: 240 F.
Job Temp: 230 F. (Evotherm)
Density: 92-94% RICE

Breakdown Roller Temp 183 – 225 F
92% RICE achieved at 160 F.

No Smoke!
No Odor!
Recap

- WMA is Replacing HMA Nationwide
  - Within 4 Years 50% of AC will be WMA
  - Some States >50% WMA
- States DOT’s are Implementing WMA
  - 39 States Running Trial and Demonstration Projects
  - 15 States Have Permissive (Contractor option) Specifications
- Reduces Greenhouse Gas Emissions
  - 10% on Average (NAPA 2009)

RECAP

- Reduces Energy Consumption
  - 20% on Average (NAPA 2009)
- Improves Paving Efficiency
  - Allows for Longer Hauls
  - Cooler Weather Paving
- Allows for Higher RAP Contents
  - Reduces Virgin Binder Stiffness
RECAP

- Improves Performance
  - Equal or Better Compaction
  - Improves Long Term Durability (crack resistance)

- Will Ultimately Reduce Cost to Owner
  - Contractor Option
  - WMA
  - RAP

Thank You