Long-Life Asphalt Pavements for the 21st Century

WARM MIX ASPHALT TECHNOLOGY

50th Annual Illinois Bituminous Paving Conference
December 9, 2009
Champaign, IL

warmmixasphalt.com
WMA Investigation and Implementation Premise

Although there are many factors driving the development and implementation of WMA technologies globally, in order for WMA to succeed in the U.S., WMA pavements must have equal or better performance when compared to traditional HMA pavements.
What is WMA?

- Allows a reduction in the temperatures at which asphalt mixes are produced and placed
  - Reduced viscosity at lower temps
    - Complete aggregate coating
Why WMA?

Potential Advantages**
- Energy Savings
- Decreased Emissions
  - Visible and Non-Visible
- Decreased Fumes
- Decreased Binder Ageing
- Extended Paving Season
- Compaction Aid
- Increased RAP usage

**Advantages will only be realized by optimizing production operations and utilizing best practices
Why WMA?

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Brief World History

- 1995 Preliminary Lab Experiments
- 1997 German Bitumen Forum
- 2000 First International Conference of Asphalt Pavements (Sydney)
- 2000 Second Euroasphalt & Eurobitume Congress (Barcelona)
- NAPA 2002 European Scan Tour
  - Germany and Norway
- NAPA 2003 Annual Meeting
  - San Diego
Brief U.S. History

- NAPA European Scan 2002
  - Germany and Norway
- NAPA Annual Meeting 2003
  - San Diego
- World of Asphalt 2004
  - Nashville
- WMA TWG 2005
- FHWA International Scan 2007
- International WMA Conference 2008
WMA European Scan Tour

- Joint Program w/ FHWA, AASHTO, NCHRP and Industry
- Publication FHWA-PL-08-007
Initial U.S. Research Partners

2004 - 2005

- NAPA
- StateAPA
- Aspha-Min®
- EUROVIA
- Hubbard Construction Company
- Evotherm®
- Sasobit®
How Many WMA Technologies are Available in the U.S.?
How Many WMA Technologies are Available in the U.S.?

Currently Twenty (20) Technologies Marketed and Available in the U.S.
Technology Overview

- WAM-Foam
- Low Emission Asphalt
- Aspha-Min
- Advera
- Sasobit
- REVIX
- Evotherm
- Cecabase RT
- Thiopave
- Rediset WMX
- AquaFoam
- Ultrafoam GX
- Terex
- Accu-Shear
- Aquablack
- Double Barrel
- Green

**FHWA does not endorse any particular proprietary product or technology.**
Technology Overview

- TLA-X
- Iterlow-T & Hyperpave
- Static Inline Vortex Asphalt Blender
- Ad-RAP (ECOBIT)

More to come …
Many other technologies are also used internationally.

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WMA Technical Working Group (TWG)

- FHWA / NAPA sponsored
- Co-Chairs
  - Matthew Corrigan, FHWA
  - Ron White, Industry
- Represented
  - State DOT
  - State APA
  - NCAT
  - Hot Mix Asphalt Industry
  - AASHTO
  - Labor
  - NIOSH
WMA TWG Accomplishments

- www.warmmixasphalt.com
- Material Testing Framework
- Emission Testing Framework
- WMA Best Practices Document
- WMA Guide Spec for Highway Construction
- Research Needs Identified
  - Developed five (5) research statements
  - Submitted through AASHTO to NCHRP
    - All projects highly ranked by SCOR
    - Total $2.9 million
Warm Mix Asphalt: Best Practices

Quality Improvement Series (QIP) 125

- Stockpile Moisture Management
- Burner Adjustments and Efficiency
- Aggregate Drying and Baghouse Temperatures
- Drum Slope and Flighting
- Combustion Air
- RAP usage
- Placement Changes
DIVISION 400 FLEXIBLE PAVEMENTS

SECTION 401 HOT MIX ASPHALT (HMA) PAVEMENTS

401.01 Description
401.02 Material
401.03 Construction
401.04 Measurement
401.05 Payment
DIVISION 400 - Asphalt Pavements and Surface Treatments

SECTION 4XX - WARM MIX ASPHALT (WMA) PAVEMENTS

4XX.01 Description

4XX.02 Material

4XX.03 Construction

4XX.04 Measurement

4XX.05 Payment
The following references detail specifics related to plant modifications and operational changes in order to maximize the benefits of WMA production:

- Quality Improvement Series 126 (QIP 126), “Energy Conservation in Hot Mix Asphalt Production”
NCHRP 9-43 “Mix Design Practices for Warm Mix Asphalt” $500,000

NCHRP 9-47A “Engineering Properties, Emissions, and Field Performance” $900,000

NCHRP 9-49 “Long Term Field Performance of Warm Mix Asphalt Technologies”
- Phase I, Moisture Susceptibility
- Phase II, Long-Term Performance
Future National Research?

- Short Term Ageing of WMA Binders During Production
- Differences between Field Produced WMA and HMA Volumetric Properties
- Increased RAP Usage with WMA
- More to come …??
Binder ETG Research Projects

- Laboratory Evaluation: Wax Additives in Warm-Mix Asphalt Binder
- Evaluate the effect of wax additives on physical properties and characteristics of asphalt binders and their subsequent performance in mixtures.
- Project Completed and Final Report is near completion
Binder ETG Research Projects

- Asphalt – One (1)
  - Lion Oil PG64-22 Eldorado, AR Refinery
- Wax Additives – Nine (9)
  - Non-Paraffin Wax Additives
- Aggregates
  - Vulcan Barin Quarry Granite, Columbus, GA
- Mix Design
  - 12.5mm Dense Graded SuperPave Gyratory
    - ~5.5% Binder
    - ~7.0% Air Voids
WMA Trials and Demonstrations

Jan 2007

Mobile Asphalt Mixture Testing Laboratory (MAMTL)
WMA Trials and Demonstrations

Map of the United States showing locations of WMA trials and demonstrations. Key locations include Yellowstone N.P. and Alaska.

Jan 2009

Mobile Asphalt Mixture Testing Laboratory (MAMTL)
Mobile Asphalt Testing Laboratory (MATL)
## MAMTL Trailer WMA Projects

<table>
<thead>
<tr>
<th>Location</th>
<th>Mix Design</th>
<th>Lab Compaction Level, Gyrations</th>
<th>Base Binder Grade</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hall St., St. Louis, MO</td>
<td>12.5 mm Superpave</td>
<td>100</td>
<td>PG 70-22</td>
<td>Aspha-min, Evotherm, Sasobit</td>
</tr>
<tr>
<td>I-70, Dillon, CO, West of Eisenhower Tunnel</td>
<td>9.5 mm Superpave</td>
<td>75</td>
<td>PG 58-28</td>
<td>Advera, Evotherm, Sasobit</td>
</tr>
<tr>
<td>East Entrance Road, Yellowstone National Park, WY</td>
<td>19 mm Hveem</td>
<td>75</td>
<td>PG 58-34</td>
<td>Advera, Sasobit</td>
</tr>
<tr>
<td>US 190, Jasper, TX</td>
<td>19 mm Superpave</td>
<td>55</td>
<td>PG 70-22</td>
<td>Rediset WMX</td>
</tr>
<tr>
<td>SR2006 Centre Hall &amp; SR 2012 Spring Mills, PA</td>
<td>9.5 mm Superpave</td>
<td>75</td>
<td>PG 64-22</td>
<td>Aspha-min, Sasobit, LEA UltraFoam GX</td>
</tr>
<tr>
<td>I-55, Sikeston, MO</td>
<td>19 mm Superpave</td>
<td>125</td>
<td>PG 76-22</td>
<td>Aquablack</td>
</tr>
</tbody>
</table>
Dynamic Modulus ($E^*$)

- **Test Temperatures**
  - $4.4^\circ\text{C}$ (40$^\circ\text{F}$)
  - $21.1^\circ\text{C}$ (70$^\circ\text{F}$)
  - $37.8^\circ\text{C}$ (100$^\circ\text{F}$)
  - $54.4^\circ\text{C}$ (130$^\circ\text{F}$)

- **Frequencies**
  - 0.1, 0.5, 1, 5, 10, 25 Hz
Hall Street, St. Louis, MO
Immediately Compacted – Immediately Tested

- Control Mix
- Sasobit 280°F
- Sasobit 240°F
- Evotherm 280°F
- Evotherm 240°F
- Aspha-Min 280°F

Reduced Time, sec

E*, MPa
Flow Number, $F_n$

- Loading
  - Axial load applied for 0.1 second with 0.9 second rest period

- Test Temperatures
  - LTTPBind, Version 3.1 Software
  - Site pavement temperature at 50% Reliability
    - Pavement Temperature
    - Pavement Temperature + 6° C
    - Pavement Temperature - 6° C
Hamburg Wheel Track Test

AASHTO T 324

50° F to maximum of 20,000 passes
CDOT Hamburg History:
75 gyration mixtures typically fail Hamburg, but fail primarily due to plastic flow rutting rather than stripping/moisture damage.

CONTROL
9.46 mm

ADVERA
9.79 mm

*Data and Photos are Courtesy of CODOT
I-70 Hamburg Sasobit

CONTROL
17.31 mm

SASOBIT
10.49 mm

*Data and Photos are Courtesy of CODOT
I-70 Hamburg Evotherm

CONTROL
10.10 mm

Evotherm
14.86 mm

*Data and Photos are Courtesy of CODOT
Control - 3.82 mm and 4.00 mm
Advera - 3.80 mm and 3.25 mm
Sasobit - 3.28 mm and 2.60 mm

*All the testing was performed at 40°C wet and reported at 20,000 passes.
Rediset WMX

- PD 4 - 13.18 mm
- PD 10 - 18.80 mm
AASHTO T 324 - Hamburg @ 50°C
Cycles to 20mm Rut Depth

- Control 1
- Advera
- Sasobit
- Control 2
- Ultrafoam GX
- LEA a.m.
- LEA p.m.
Aquablack by Maxam

Testing currently being conducted

General Trend:

Cycles to 20 mm rut depth

Total Rut Depth

42
Control Mixture
- Dry = 67 psi, Wet = 57 psi; 85% retained

Advera Mixture
- Dry = 69 psi, Wet = 56 psi; 81% retained

Sasobit Mixture
- Dry = 76 psi, Wet = 64 psi; 84% retained
Future WMA Specifications

Emphasis on Performance

Asphalt Mixture Performance Tester (AMPT)

- Flow Number (Fn), mixture rutting
- Dynamic Modulus (E*), mixture stiffness
- Cyclic Tension – Compression, fatigue cracking

IDT Creep and Strength

- fatigue and thermal cracking

Hamburg wheel tracking

Moisture Susceptibility Testing
Written Summary of WMA @
http://www.fhwa.dot.gov/pavement/asphalt/wma.cfm
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