Warm-Mix Asphalt using Sasobit: The Petersburg-Mitkof Hwy Experience

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Alaska DOT&PF

Asphalt Pavement Summit
Anchorag, 18-Nov-09

What is Warm Mix Asphalt?

- Hot Mix Asphalt 280 - 325°F
- Cold Mix Asphalt ~ 60°F
- Warm Mix Asphalt ~ 200°-270°F

Technologies Marketed in U.S.

<table>
<thead>
<tr>
<th>WMA Technology</th>
<th>Process Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adona</td>
<td>Additive/Foaming</td>
</tr>
<tr>
<td>Asphalmix</td>
<td>Additive/Foaming</td>
</tr>
<tr>
<td>DustBind R1™</td>
<td>Chemical Additive</td>
</tr>
<tr>
<td>Double RAMP6® Green</td>
<td>Foaming</td>
</tr>
<tr>
<td>EvoTherm™</td>
<td>Chemical Additive</td>
</tr>
<tr>
<td>Genor®</td>
<td>Foaming</td>
</tr>
<tr>
<td>(LEA) Low Energy Asphalt</td>
<td>Foaming (moisture in fine aggregate)</td>
</tr>
<tr>
<td>Redset™ WMX</td>
<td>Chemical Additive</td>
</tr>
<tr>
<td>REXX™</td>
<td>Chemical Additive</td>
</tr>
<tr>
<td>Sasobit</td>
<td>Organic Additive</td>
</tr>
<tr>
<td>StanSteel®</td>
<td>Foaming</td>
</tr>
<tr>
<td>Synthetic Zeolite</td>
<td>Foaming</td>
</tr>
<tr>
<td>Tocx®</td>
<td>Foaming</td>
</tr>
<tr>
<td>WAM-Foam</td>
<td>Foaming</td>
</tr>
<tr>
<td>Recent Technology</td>
<td></td>
</tr>
</tbody>
</table>
Really 3 General Types of WMA

- Wax
- Chemical Additive
- Foaming

WMA Benefits

- Paving Benefits
  - Compaction aid
  - Cool-weather paving
  - Longer haul distances
  - Use of higher percentages of RAP
  - Less restriction, enabling more production in non-attainment areas
  - Extend the paving season
- Reduced Fuel Usage
- Reduced Emissions
- Improved Working Conditions for Paving Crew

WMA Trials and Demonstrations
3 WMA Projects in Alaska

- Petersburg South Mitkof Highway Project (Sasobit Wax)
- Alaska Highway, Tok, Foaming Project
- EVOTHERM, Anchorage International Airport

Alaskan WMA Demonstration
South Mitkof Highway Upgrade
Phase II
September - October, 08
Project Information

- CDS Milepoint 16.24 to 23.74
- Paving length = 7.5 miles (39,606 ft)
- Two-lane 24 ft rural highway, unpaved
- AADT = 250, 3% trucks, EAL-2026 = 50k
- 3-inch Single Lift
- ~ 25,000 Tons WMA
- Contractor: SECON
- Paving: Sep. ‘08
MD Developed using Standard 50 blow Marshall, Compacted @ Conventional 300°F w/o Sasobit Additive,

Checked w/Additive and Reduced Comp. Temperature (~ 250°F)

<table>
<thead>
<tr>
<th>300°F w/o Wax</th>
<th>300°F w/ Wax</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Content = 5.0%</td>
<td>AC Content = 5.0%</td>
</tr>
<tr>
<td>2.5 % Voids (&lt; than desired)</td>
<td>3.5 % Voids (ok)</td>
</tr>
<tr>
<td>VMA 13.9 %</td>
<td>VMA 14.8 %</td>
</tr>
<tr>
<td>VFA 82 % (&gt; than desired)</td>
<td>VFA 76 % (ok)</td>
</tr>
</tbody>
</table>

Sasobit Additive

- Sasobit (High MP Wax)
- Added at Refinery
- Rate of 1.5% by Wt. of AC (~ 30 lbs/ton)
- PG 58-28+ Specified
- ER of 50% min. (AASHTO T-301 25°C)

Binder Properties with and w/o Additive

- Acceptance Samples w/o Additive, Before Construction
- Construction Samples w/wax for information

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Acceptance</th>
<th>Information</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-313 BBR</td>
<td>w/o wax</td>
<td>w/wax</td>
<td></td>
</tr>
<tr>
<td>Stiffness</td>
<td>All 6 ok</td>
<td>All 6 ok</td>
<td></td>
</tr>
<tr>
<td>m-value</td>
<td>All 6 ok</td>
<td>None ok</td>
<td>.281</td>
</tr>
<tr>
<td>T-316 BV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Britt. Vic.</td>
<td>All 6 ok</td>
<td>All 6 ok</td>
<td></td>
</tr>
<tr>
<td>T-315 GSR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G*/Sin δ O, RTFO, PAV</td>
<td>All 6 ok</td>
<td>5 ok, 1 deg</td>
<td></td>
</tr>
<tr>
<td>ER</td>
<td>All 6 ok</td>
<td>All 6 ok</td>
<td>PG 70-D4-20</td>
</tr>
</tbody>
</table>
Final PG Grade with wax

6 samples tested
PG 70-24 1 result
PG 70-25 4 results
PG 70-26 1 result

Plant
- Drum Dryer Plant: 350 TPH
- Aggregate source: 1 mile from plant

PG 58-28+ Asphalt Binder
US Oil & Refining, Tacoma, WA
Post-Construction Smoothness - LISA

Ride Measurements
PI Simulation LWP

<table>
<thead>
<tr>
<th>Southbound XL Lake to Ferry Terminal</th>
<th>Northbound Ferry Terminal to XL Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average 3.8 inches/mile (9/14/08)</td>
<td>Average 3.3 inches/mile (9/14/08)</td>
</tr>
<tr>
<td>Average 5.2 inches/mile (8/30/09)</td>
<td>Average 4.7 inches/mile (8/29/09)</td>
</tr>
</tbody>
</table>

Rut Measurement Averages
LWP in each Lane

<table>
<thead>
<tr>
<th>Southbound XL Lake to Ferry Terminal</th>
<th>Northbound Ferry Terminal to XL Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td>.006 inches (9/26/2008)</td>
<td>.001 inches (9/29/2008)</td>
</tr>
<tr>
<td>.010 inches (7/17/2009)</td>
<td>.015 inches (7/17/2009)</td>
</tr>
</tbody>
</table>

One year later no significant rutting
FWD Evaluation

WMA Modulus $E = 515$ ksi

Laboratory Tests

The Asphalt Institute

- Type II-B, 19 mm NMAS
- PG 58-28+, Binder = 5%, VTM = 2.5%
- 10 boxes; re-heat, compact

Tests:
- Tensile Strength Ratio: 1 freeze-thaw cycle
- Asphalt Pavement Analyzer: 45°C
- Hamburg Wheel Tracker: 45°C
- Dynamic Modulus: 4°C, 20°C, 35°C

TSR – Indirect Tensile Strength Test
Effect of Moisture on Asphalt Concrete Paving Mixtures
AASHTO T283/JASTM D4867

Composite Method Freeze/Thaw

<table>
<thead>
<tr>
<th>Dry</th>
<th>Wet</th>
<th>Wet</th>
<th>Wet</th>
<th>Wet</th>
<th>Wet</th>
<th>Wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Dry Strength, MPa 30°C
51 51 51 51 51 51 51

Water Absorption, %
2.5 2.5 2.5 2.5 2.5 2.5 2.5

TAI: Air voids = 6.9%, 113°F
Hamburg Wheel Tracking

TAI: Air voids = 6.8%, 113°F

Simple Performance Tester (Asphalt Mixture Performance Tester)
Dynamic Modulus Comparisons

Frequency = 10 Hz
TAI, 1.5% Sasobit Mix, Air Voids = 6.7%

<table>
<thead>
<tr>
<th>Temperature</th>
<th>4°C</th>
<th>20°C</th>
<th>35°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyn. Modulus, ksi</td>
<td>1,600</td>
<td>650</td>
<td>200</td>
</tr>
</tbody>
</table>

Frequency = 10 Hz
AUTC, Control Mix, Air Voids = 4.6%

<table>
<thead>
<tr>
<th>Temperature</th>
<th>4°C</th>
<th>21°C</th>
<th>38°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyn. Modulus, ksi</td>
<td>1,900</td>
<td>800</td>
<td>220</td>
</tr>
</tbody>
</table>

Bid Data for WMA Project

- Mix Price $60/ton 22,500 tons total
  (typical price for 401(1))
- AC Price $750/ton 1145 tons total
- (w/o Wax Additive $720/ton)
Lessons Learned
- Field density achieved in all cases
- Saved ≈ 20-30% in fuel at the plant (1 gal/ton)
- Temperature at plant hard to regulate
- Mix handled similarly as HMA
- Workers noted no handling difficulties
- No smoke
- Additive didn’t seem to affect mix design
- Sasobit does stiffen binder

PG Grading Implications
- Original binder grade met PG 58-28 (PMA)
- Elastic Recovery (AASHTO T-301) > 50%
- After 1.5% Sasol Wax addition
  - PG Binder changed to PG 70-25
  - Degree of stiffening is crude dependant
- Sasol wax does stiffen the binder
- Elastic recovery was unaffected

What’s Next
- More Field Monitoring
- Annual Inspections for the next 2 years
Why Warm Mix?

- Warm Mix can address a variety of needs
  - Improved compaction
  - Fuel Savings
  - Environmental
  - Working conditions
- Significant research already completed
- Future looks warm!

For What We Know Now:

WMA = HMA

QUESTIONS???

http://warmmixaspalt.com/
WMA: Best Practices, NAPA, QIS-125
WMA: Contractors’ Experiences, NAPA, IS-134