Warm Mix Asphalt
SCAN
May – June 2007
Norway-Germany-Belgium-France
Our Visit

- Background
- Warm Mix Technologies
- European Experience
- SCAN Findings
- Implementation Direction
What’s the Purpose of a SCAN Tour?

• FHWA’s Office of International Programs identifies and evaluates innovative foreign technologies and practices that could significantly benefit US transportation systems

• Main channel for accessing innovation is the International Scanning Program

• Program jointly undertaken with FHWA, AASHTO, and NCHRP
What is WMA?

• Allows reduction of temperatures at which asphalt mixes are produced and placed
  – Reduces viscosity at lower temps
  – Allows the complete coating of aggregate
Issues of Interest

The purpose of the SCAN was to investigate and implement innovative technologies and policies related to WMA. Topics of interest included:

• WMA processes
• Mix design & construction practices
• WMA performance
• Limitations
• Benefits
Our Team

- Eric Harm, chairman
- John D’Angelo, co-chairman
- Gaylon Baumgardner
- John Bartoszek
- Matthew Corrigan
- Jack Cowsert
- Tom Harman
- Mostafa (Moe) Jamshidi
- Wayne Jones
- Dave Newcomb
- Brian Prowell, reporter
- Ron Sines
- Bruce Yeaton

- Illinois DOT
- FHWA
- Paragon Technical Services
- Payne & Dolan
- FHWA
- North Carolina DOT
- FHWA
- Nebraska DOT
- Asphalt Institute
- NAPA
- Adv. Materials Services LLC
- P.J. Keating
- Maine DOT
2007 WMA Scan Team
Who Did We Visit?

- Oslo, Norway
- Frankfurt, Germany
- Köln, Germany
- Brussels, Belgium
- Paris, France
- Nantes, France
What Did the Scan Team Do?
Factors Driving Development of WMA

- The environment and sustainable development concerns, “Green Construction”
  - Reduction in energy consumption
  - Reduction in CO₂ emissions
- Extension of paving season and potential for longer haul distances
- Improvement in field compaction
- Welfare of workers, particularly with Gussasphalt, which is not used in the US
European Experience

The PUSH for Implementation

- Norway
  - Contractor/Supplier Driven
- Germany
  - Contractor Driven
  - Bitumen Forum
  - Gussasphalt (Fumes)
- France
  - Contractor Driven/Agency Supported
  - Sustainable Technologies
- Netherlands
  - Contractor Driven
What is Gussasphalt?

Also called mastic asphalt, Gussasphalt is not SMA. It is a binder rich mixture placed at 0% voids with coarse aggregate rolled into the surface. Typically placed at 450°F.
European Mix Design Practices

- Mix design practices varied from country to country
- Some gyratory, some Marshall
- Some empirical, some fundamental
- All used performance tests!
European Standards- Marking Road Materials CE TC227

User Needs

Surface Characteristics

Asphalt Pavement (In Situ)

Asphalt Mixture

Constitutive Materials
WMA Technologies

- Organic Additives
- Foaming Systems w/ Stabilizers
- Emulsion Systems
- Others…
Warm Mix Asphalt Technologies

- **Organic, Wax-like additives**
  - Sasobit® – Sasol International
  - Asphaltan B – Romanta
  - Fatty Acid Amides – Licomont S 100

- **Foaming Processes**
  - Aspha-min zeolite – MHI/Eurovia
  - Low Energy Asphalt – Fairco/Eiffage Travaux Publics
  - WAM Foam – Kolo Veidekke/Shell/BP
  - LEAB® – BAM

- **Emulsion Based**
  - Evotherm™ – MeadWestvaco

- **Vegetable based synthetic binders**

- **Emerging US Technologies**
Classification of WMA by Temperature Range

- Latent Heat of Vaporization
- Heating
- Vaporization
- Drying
- Cold Mix
- Warm Asphalt
- WMA
- HMA

Temperature, °F

Fuel/Ton
Licomont® BS 100

- Mixture of fatty acid amides
- Softening point ~ 286°F
- Available as powder or granules
- Sübit – modified binder used in Germany
- Similar products used in roofing industry
L.E.A’s sequential mixing

**PHASE 1**
- 120°/150°C
- Dry, hot coarse aggregates

**PHASE 2**
- 170°C
- Coarse aggregates are coated by all the asphalt

**PHASE 3**
- Moisture from fine aggregates triggers asphalt foaming

**PHASE 4**
- Foamed asphalt encapsulates fine aggregates

**PHASE 5**
- 90°C
- 100°C
- Thermal equilibrium reached
  All aggregates uniformly coated

Courtesy of Fairco
Set of six retractable Nozzles inject foam Into BAM's pugmill
Laboratory Foaming
Placement and Compaction

“Business as usual”
Primarily use:
• Heavy, tamping bar, vibratory screed pavers
• Steel-wheel vibratory and static rollers
• Workability generally good
Performance of WMA

Rv152, Hp3, Km 0.046-2.339
Akershus

Date

Rut depth (mm)

90 %-value
Mean value

0 5 10 15 20 25 01.11.88 01.11.89 01.11.90 01.11.91 01.11.92 01.11.93 01.11.94 01.11.95 01.11.96 01.11.97 01.11.98 01.11.99 01.11.00 01.11.01 01.11.02 01.11.03 01.11.04 01.11.05
Performance of WMA

• Consensus of European Countries that WMA should provide **equal or better** performance than HMA
  – Norway – performance mixed, problems not attributed to WMA
  – Germany – performance same or better, developed guidelines to allow use of waxes and zeolite
  – France – toll road operator, district, and city of Paris pleased with performance to date
### Retrospective & Prospects

**Here: B 3, Schönstadt-Schwarzenborn**

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<tr>
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<tr>
<td>Postcompaction in main lane</td>
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<tr>
<td>Cracking</td>
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<td><strong>Laboratory testing</strong></td>
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<tr>
<td>Resistance to thermal distortion</td>
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<td>Cryogenic behaviour</td>
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<tr>
<td>Aging of the binder</td>
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<tr>
<td>Adhesion</td>
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</table>

**Source:**

„Erfahrungssammlung über die Verwendung von Fertigprodukten und Zusätzen zur Temperaturabsenkung von Asphalt"; bast 08/2006

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**BASSt Official rating**

Table 2: Qualitative Bewertung der Erprobungsfelder im Vergleich zum Referenzfeld

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</table>

\(^1\) auf niedrigem Niveau; \(^2\) gleich; \(^3\) entspricht Referenzfeld; \(^4\) gleich oder günstiger
Benefits of WMA

- Reduced Emissions
- Reduced Fuel Usage
- Paving Benefits
  - Pave in cool weather and still obtain density
  - Haul mix longer distances and still have workability
  - Improved compaction
  - Facilitate deep patches
  - Ability to use more RAP
- Reduced Worker Exposure
Reduced Emissions

- $\text{CO}_2$ reduced 30-40%
- $\text{SO}_2$ reduced 35%
- VOC reduced 50%
- CO reduced 10-30%
- $\text{NO}_x$ reduced 60-70%
- Dust reduced 20-25%
Reduced Emissions

CO₂  SO₂  VOC  CO  NOx  Dust

Percent

-80 -70 -60 -50 -40 -30 -20 -10 0
Benefits of WMA

No Fugitive Emissions
SCAN Challenges
Adapt technologies from low production European batch/drum plants to higher production plants used in the US.
Coarse Aggregate must be DRY

- Aggregates used in Europe have relatively low water absorptions, < 2%
- Aggregates routinely used in the US have higher water absorptions
- Best Practices should be used to minimize the moisture content in aggregate
Initial product approval; how do we sort out the good products from the bad?
Products should be approved on a national or at least a regional basis

- German agencies, industry, and academia have jointly developed a “Merkblatt” or guidelines for the use of WMA.

- In France, SETRA performs certifications of new products. Cooperatively supported between agency and industry.
Individual Contractors are going to have to determine which WMA process will work over the widest range of applications.

In the past changes have been mandated by agencies. In Europe, contractors have staffs who routinely do research to develop new products.
The overall performance of WMA must be as good as HMA. On a life-cycle basis, if WMA does not perform as well, there will not be energy savings or reduced emissions in the long run.

- Build sections with HMA controls
- Data collection guidelines
- Monitor for 3 to 5 years
Implementation Goals

• WMA should be an acceptable alternative to HMA at the Contractor’s discretion, provided the WMA meets applicable HMA specifications.
Implementation Goals

• An **approval system** needs to be developed for new WMA technologies. The approval system should be based on performance testing and supplemented by field trials.
  – WMA TWG should lead the development of a performance based evaluation plan for new WMA products.
  – Realistically, such a system is needed for a broader range of modifiers/technologies used in HMA.
Implementation Goals

• The WMA SCAN Team will provide technology transfer of the information gained through presentations, articles, and reports.

• Best practices need to be implemented for handling and storing aggregates to minimize moisture content, burner adjustment, and WMA in general or specific technologies.
Implementation Goals

• Encourage more field trials with:
  – Higher traffic
  – Larger size with representative production of WMA
  – Built in conjunction with a control section
  – Monitored for a minimum of three years by the agency
  – Data collection guidelines, developed by the WMA TWG can be found at:
    http://www.hotmix.org/view_article.php?ID=537

• The factors affecting the economic viability of WMA need to be identified and tracked.
Conclusions

• There is a consensus among the WMA SCAN Team that WMA is a viable technology and that US Agencies and the HMA Industry need to cooperatively pursue this path.

• The US has already made great strides in evaluating WMA, thanks in part to Public-Private Partnerships like the WMA TWG and the WMA SCAN Tour.
Thank You!

Questions/Discussion?
WAM-Foam

• Two Phase addition of asphalt
  – Aggregate coated with “soft” asphalt
  – Hard asphalt foamed to mix with pre-coated aggregate
  – Soft asphalt controls minimum placement temperature
  – Material placed as low as 80 C (176 F), 50 – 60 C (90 – 108 F) reduction
  – Requires plant modification for foaming, estimated at $50,000 - $70,000. No additional costs thereafter
  – Special asphalt feeds may be required
WAM Foam Installation in Hot Mix Asphalt Plant

2000
Zeolite

• Zeolites are crystalline hydrated aluminum silicates
• When the Zeolite is heated, it gives up its internal moisture, approximately 21% by weight, microscopically foaming the asphalt
• Aspha-min is typically added at 0.3% by TWM
Granulated aspha-min®
Sasobit®

• Fischer-Tropsch synthetic waxes – Sasobit
  – Produced by treating hot coal or natural gas feed stocks with steam in the presence of a catalyst
  – They are long-chain aliphatic hydrocarbon waxes with a melting point of more than 208°F
  – Added to binder or directly into mix
  – May negatively impact low temperature properties
Chemical Structures of Modifiers 1-3

- Sasobit
  - Hydrocarbons (linear)
  - Hydrocarbons (branched)

- Montan Wax
  - Fatty Acid Amide
31 degree F reduction in compaction temperature
Evotherm®

- Emulsion – approximately 70% binder residue
- Chemical package provides mixing, coating, workability, compaction and adhesion (e.g. anti-stripping agents)
- Some steam liberated upon mixing
Water injector located on the liquid asphalt intake on drum.
Tamping bars on heavy, tamping bar, vibratory screed paver