Warm Mix Asphalt

48th Annual Idaho Asphalt Conference
October 23, 2008

Warm Mix Asphalt Scan Tour
May-June 2007
Norway-Germany-Belgium-France

The Tour:
• Scanning tour to Europe organized by:
  – The American Association of State Highway and Transportation Officials (AASHTO) &
  – The Federal Highway Administration (FHWA)
• To meet agencies using WMA Technology
• Suppliers and contractors developers
Warm Mix Asphalt

The Team:
- Represented a wide variety of HMA interests.
  - Three state DOT's
  - AASHTO
  - FHWA
  - Asphalt suppliers
  - HMA contractor industry
  - Consultant.

Purpose of the scan to gather information
- On technologies used to produce WMA
- Emphasis on long-term field performance

The Team identified the following specific topics:
- **WMA Processes**
  - What processes, materials and construction practices are used?
- **Mix Design and Construction Practices**
  - How do they differ from current standards?
- **WMA Performance**
  - Rutting, fatigue cracking, thermal cracking, moisture damage, etc.?
- **Limitations of WMA**
  - What class pavement, traffic volumes?
- **WMA Benefits**
  - What are the benefits and future plans for WMA?
Driving Factors in Europe including:
- Environmental concerns
- Sustainable development
- “Green Construction,”
- Reduction of energy consumption
- Reduction in CO₂ emissions
- Reduced worker exposure

Kyoto Agreement
- Reduced CO₂ emissions
  – Mandated as part of the EU’s ratification
- No direct impact the HMA industry in Europe.
- Industry has taken a proactive approach
  – Reduce CO₂ emissions
  – Reduce Worker Exposure

New EU regulation REACH
- Registration, Evaluation, Authorization of Chemical
- Substances, enforced in 2007.
- Requires information on potential exposure
- Derived Non-Effect Levels (DNEL).
  – Asphalt binders are included.

- Research
  – Correlation between temperature and fumes
- Anticipated DNEL
  – Application temperatures of > 200 °C (392 °F).
- Well above HMA placement temperature
  – Particularly in the U.S.
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

Gussasphalt:
- Also called mastic asphalt, is not SMA
- Binder rich mixture placed at 0% voids
- Sidewalks, building construction, and autobahn
- Coarse aggregate chips rolled into the surface
- Typically placed by hand at 450 °F (235 °C)
Warm Mix Asphalt

Gussasphalt (mastic asphalt) in Germany
- Application temperatures > 392 °F (200 °C)
- Makes up 1.6 percent of the total HMA
- Used in most European Cities
- Usage is relatively small,
  - Technology agencies do not want to give up.

Warm Mix Asphalt

WMA Technologies
- Several ways to classify WMA technologies
  - One is by temperature reduction
    - Hot Mix Asphalt > 275 °F (135 °C)
    - Warm Mix Asphalt > 212 °F (100 °C)
    - Half-Warm asphalt mixtures < 212°F (100 °C)

Warm Mix Asphalt

As a result of these concerns in Europe
- New technologies developed
  - Lower the production
  - Placement temperatures
- Referred to as Warm Mix Asphalt (WMA).
Warm Mix Asphalt

Three major classes of WMA technologies:

- Processes that use some form of additive
- Processes that use water
- Processes that use both water and additive

Processes that use waxes:
- Decreases viscosity above the melting point of wax

The type of wax must be selected carefully:
- Melting point higher than the in-service temperatures
  - Permanent deformation may occur – rutting
- Minimize embrittlement at low temperatures
  - Thermal Cracking issues

Fischer-Tropsch synthetic waxes
- Sasobit
  - Hot coal or natural gas feed stocks
    - treated with steam and a catalyst
  - Long-chain hydrocarbon
  - Waxes with a melting point of 208°F
  - Added to binder or directly into mix
  - Negative impact low temperature properties
Organic, Wax-like additives

- Asphaltan B – Romanta
  - Montan Wax
    - Fossilized plant wax.
    - Melting point is 82-95°C (180-200°F).
    - Also known as lignite wax or OP wax,
    - Hard wax obtained by
      - solvent extraction of lignite or brown coal.

- Fatty Acid Amides
  - Melting point: 141–146°C.
  - Used as modifiers in asphalt for a number of years
  - Available in various forms.
  - Used in roofing asphalt since late ‘70s early ‘80s

Processes that introduce small amounts of water

- Injected via a foaming nozzle
- Use a hygroscopic material such as zeolite
  - Blended with the dry aggregate
  - Releases water at elevated temps over time
- When the water turns to steam:
  - It expands by a factor of 1,673
  - Expands & cools the asphalt
  - Reduces the viscosity.
  - Amount of expansion varies depending
    - amount of water added
    - temperature of the binder
Warm Mix Asphalt

Foaming Processes

• WAM Foam
  – Kolo Veidekke/Shell Norway
  – A process, not an additive or material.
  – Contractor maintains two binder grades,
    • Blends in-line to produce the desired binder grade.
    • Aggregate
      – Heated to approximately 266 °F (130 °C)
      – Coated with the soft binder or 20 to 30 % of the total binder content.

The hard binder is then foamed
  • Water at a rate of 2 to 5 percent of hard binder
    (approximately 1.6 lbs of water per ton of mix)
  • The resulting binder grade would be a 70/100 Pen binder, unaged.
Foaming Processes LEA’s
- Low Energy Asphalt – LEA, EBE, EBT
  - French Companies:
    - Fairco/Eiffage
    - Travaux Publics
    - Nynas
  - LEAB®
    - Dutch Company:
      - BAM Contracting Company

Foaming Processes
- Aspha-min zeolite – MHI/Eurovia
  - Synthetic zeolite composed of alumosilicates.
  - Contains approximately 20 percent water of crystallization
  - Water is released by temperature over time.
  - Added to the mixture before or with the binder
    - Aspha-min is typically added at 0.3% by TWM
  - Creates a controlled foaming effect
    - Increases volume, reduces viscosity.
  - Gradual release of water reportedly provides a 6 to 7 hour period of improved workability,
    - Lasts until the temperature drops below 212°F (100°C)

- Low Energy Asphalt
  - LEA, EBE, EBT
    - Course Aggregate only heated to 300°F (150°C)
    - Coated with total Binder content
    - Additive
      - .5% weight of binder
      - To improve coating & adhesion
    - Wet fine aggregate added
      - Foams binder coating
      - Encapsulates course and fine aggregate
    - Laydown temp >212°F
Warm Mix Asphalt

**LEA’s sequential mixing**

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

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

**PHASE 3**
- 100°C
- Moisture from fine aggregates triggers asphalt foaming

**PHASE 4**
- 90°C
- Thermal equilibrium reached
- All aggregates uniformly coated

**PHASE 5**
- 170°C

---

**Foaming Processes LEA’s**

- **LEAB® – BAM**
  - Dries aggregate to 203°F(95°C)
  - Heats RAP in separate dryer 230-239°F(110-115°C)
  - Binder Foamed in into pugmill
  - Additive
    - .5% weight of binder
    - To improve coating & adhesion

- **Low Energy Asphalt**
  - Nynas (LT Asphalt)
    - Uses a foaming process and hygroscopic filler
    - About 0.5 to 1.0 percent of a hygroscopic filler
      - To control and sustain moisture foaming.
    - Aggregates are heated to 194°F(90°C)
    - Penetration graded binder is foamed
      - Mixed with the aggregates along
      - Hygroscopic filler
Warm Mix Asphalt

LEAB®

Set of six retractable Nozzles inject foam Into BAM's pugmill
Warm Mix Asphalt

Placement and Compaction

“Business as usual"
Primarily use:
• Longer Season
• Early opening to trafficking
• Longer hauls
• Wet weather paving
• Multi-lift construction
• Workability

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
Warm Mix Asphalt

Warm-Mix Asphalt: European Practice

Office of International Programs, FHWA-HPIP, Room 3325, U.S. Department of Transportation, Washington, DC 20590

international@fhwa.dot.gov

www.international.fhwa.dot.gov

Emerging U.S. Technologies

Water injector located on the liquid asphalt intake on drum.
Warm Mix Asphalt

**Emulsion Based**

- Evotherm™ – MeadWestvaco
  - Emulsion mixed with hot aggregates
  - Mix temperature between 185 to 240 °F
  - The emulsion uses a chemical package
    - to enhance coating, adhesion, and workability.
  - Water in the emulsion flashes off as steam
  - A new process has been developed called DAT,
    - Same chemical package
    - Diluted with a small amount of water
    - Injected in-line just before the mixing chamber.

**Ohio Demo Project**

- 2.70 mile Evotherm,
  - Everett Crews, Ph.D., Technical Manager, Asphalt Innovations, MeadWestvaco Corp.
- 2.70 mile Aspha-min,
  - Barry McKeon, Technical Manager, Hubbard Construction
- 3.07 mile Sasobit,
  - Larry L. Michael, Asphalt Consultant to Sasol Wax Americas, Inc.
- 3.03 mile Control Section:
NCHRP 9-47 “Engineering Properties, Emissions, and Field Performance of Warm Mix Asphalt Technologies”

- The research project is intended to provide:
  - Recommended modifications to the preliminary WMA mix design and analysis procedure under developed in NCHRP Project 9-43 (NCAT)
  - Protocol for laboratory evaluation of WMA performance;
  - Guidelines for WMA production and construction
  - Updated emissions measurement protocol
  - 42 month time frame

- Contacts
  Ed Harrigan  
  Senior Program Officer  
  NCHRP  
  eharriga@nas.edu

  Mike Anderson  
  Principal Investigator  
  Asphalt Institute  
  manderson@asphaltinstitute.org

---

Thanks!

H. Wayne Jones  
Senior Regional Engineer  
Asphalt Institute  
wjones@asphaltnstitute.org