Warm Mix Asphalt (WMA)

- What is it?
  - Introduced in Europe in the mid-1990s
  - How it works!
    - Reduced mixing and paving temperatures (up to 4°C cooler)
    - Reduced viscosity—viscosity-temperature profile of the asphalt binder (temporary or permanent)
    - Longtime aggregate coating at lower temperatures

Reported Benefits:
- Lower final test
- Lower emissions
- Reduced noise and odors
- Reduced operations overhead
- Lower fuel consumption
- Reduced pavement thickness
- Longer effective pavement life
- Enhanced roadway safety
- Reduced heat island effect
- Reduced atmospheric pollutants
- Enhanced material uniformity
- Using higher percentage of RAP
- Reducing thermal and block cracking
- Enhanced moisture resistance

Concerns:
- Lower sustainability
- Higher cost
- More sensitive to aggregate variation
- Interactions between lower temperatures and lower asphalt binder content

WMA – Environmental and Health Benefits
- Reduction in CO₂ and SO₂ ~ 30 - 40%
- Reduction in VOC ~ 50%
- Reduction in CO ~ 10 – 30%
- Reduction in NOx ~ 60 – 70%
- Reduction in dust ~ 20-25%

Worker Exposure – In Europe, tests for asphalt aerosols/fumes and polycyclic aromatic hydrocarbons (PAHs) indicated 30 – 50% reductions compared to HMA.

Moisture Susceptibility

Concerns:
- Less binding of virgin-aggregate, and, in some cases, the introduction of water for foaming will lead to trapped moisture and could increase stripping potential. Could also lead to raveling/illblinding.
- Lower absorption of asphalt could also lead to adhesion stripping/raveling problems. Lower temps could reduce interface bond.

Selected Findings:
- In Texas, moisture content readings on WMA have been as high as 5%.
- Koeppinger et al. (2007) reported susceptibility for Samskrit mixes at low temperatures. Other report potential improvement w/time.

Rutting

Concerns:
- Lower aging (under-oxidation) of binder during production could lead to lower rutting potential in the field.
- Could lead to mix design rejection in areas where Hamburg or other permanent deformation test is used in design.
- Permanent deformation could also lead to moisture damage.

Field Experience:
- In Texas, WMA mixes have been passing their Hamburg spec. so far.

Recommendation:
- Include permanent deformation testing in laboratory investigation (dry and wet Hamburg tests). If failing, extract/recover/retreat binder.

Warm Mix and RAP

Rationale:
- Lower aging (under-oxidation) of binder afforded by warm mix production can counterbalance over-oxidation present in RAP.
- Very attractive possibility. From an environmental, economical, and perhaps even performance standpoint.

Concerns:
- Counterbalance theory relies on mixing of virgin and RAP binder.
- The higher the RAP, the higher the variability, moisture potential, etc.

Recommendation:
- Carefully consider the use of RAP for early projects. Use performance tests such as PG27-28 to ensure and Hamburg is adaptable into designs, and to monitor (field) mixes.

Outline
- Asphalt Concrete Sustainability
- Warm Mix Asphalt (WMA)
- WMA Benefits and Concerns
- WMA Technologies
- ATREL Testing
- What’s Next?
WMA technologies

15 common WMA technologies in the U.S.

- Sasobit
- Th projects

WMA Technologies

The WMA methodologies can be categorized into three main groups:

1. Using organic additive or wax:
   - Sasobit: Fischer-Tropsch wax (Sasobit GmbH, Germany)
   - Th projects: low molecular weight modified wax (Romamin, Germany)
   - WMA: low-temperature asphalt binder (MeadWestvaco, USA)

2. Using chemical additives:
   - Sasobit: microscopic filler (MeadWestvaco, USA)
   - Th projects: binder (Sasobit GmbH, Germany)
   - WMA: binder (Sasobit GmbH, Germany)

3. Using water or moisture to reduce foaming:
   - Double Barrel Green (Green Industries, USA)
   - Sasobit: WMA System (Green Industries, USA)
   - Th projects: WMA Systems (Green Industries, USA)

Astec Double Barrel Green system

- Uses a multi-nozzle foaming device to microscopically foam the asphalt
- 4X faster than existing systems
- 50% of water per ton of mix
- 45°F lower temp.
- 4X lower fuel

WAM Foam

5-stage process:

- 4th stage: asphalt binder
- 5th stage: asphalt binder

UIUC/GMP Warm-Mix Study

Literature Review:

- Completed Summer 2010, recently revised
- 25 articles identified and summarized
- Most projects reported dealt with highways
- Non-asphalt airfield projects
- European: Sandsfield project (Nato click)
- USA: Boston Logan

- Boston Logan: WMA Project:
  - BW 41: cell constructed with WMA in asphalt
  - MA 09: experimental
  - Overall assessment: very successful (airport, runway, and roadway)

- Being studied on FAA/GSC project:

http://www.aiia.org/2010/03/02/20100504-292491-618211
Single use plastic bag with the words "no double use".
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### ASTM Specification

- Specification
- Typical Load-CMOD Curves
- Fracture Energy – IDOT RC Study

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### Fracture Energy Threshold Evaluation

- Pooled Fund Thermal Cracking Study

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### DC(T) as RAP Proof Tester:

- Plot showing DC(T) values
- Compared to threshold values

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### Warm-mix Evaluation with DC(T)

- Chart showing comparison of warm-mix and traditional asphalt
- The chemically modified warm mix used in this project had superior fracture properties compared to the reference HMA. Demonstrates how performance tests can be used to gain additional confidence when used in conjunction with WMA projects.

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### C(T) Interface Bond Test

- Diagram of bond test setup

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### Next Steps

- Identify project(s) - ASAP
- At ORD and/or
- By contractors who produce for ORD
- Attend and sample projects – Spring/Summer tests
- Sampling at various stages in construction and service
- Conduct laboratory testing – Summer/Fall 2010
- Subset of tests to be run during mix design/construction
- Briefings of test results at IDOT
- Report – Early in 2011

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### Questions?

- Thank you for your attention