Warm Mix Asphalt
Introduction and Processes
Original driver of WMA was the need to reduce emissions especially in non attainment areas
 Counties Designated "Nonattainment"
for Clean Air Act's National Ambient Air Quality Standards (NAAQS) *

Legend **
- Yellow: County Designated Nonattainment for 3 NAAQS Pollutants
- Blue: County Designated Nonattainment for 2 NAAQS Pollutants
- Green: County Designated Nonattainment for 1 NAAQS Pollutant

* The National Ambient Air Quality Standards are health standards for lead, carbon monoxide, sulfur dioxide, ground level 8-hr ozone, and particulate matter (PM-10 and PM2.5). There are no nitrogen dioxide nonattainment areas.
Warm Mix Asphalt

- WMA is produced with special additives or technologies at temperatures 30 to 70°F lower than typical HMA.
- Some people define WMA as having a maximum temperature approximately 275 degrees F.
Use of Warm Mix Asphalt

- Reduces emissions
- Reduces fuel use
- Reduces oxidation during production
- Improves compactibility
- Often used as compaction aid for late season paving
- Similar performance to HMA
Some Early Concerns

- Cost
- Equipment Adjustments
- Performance
  - Moisture Susceptibility
  - Rutting
Overview

- Use of WMA in the USA
- WMA Categories
- Opportunities & Challenges with WMA
Mixes underneath silos
HMA on left, foamed asphalt on right
Lower fumes and emissions (~30-90%)
There are now over 30 WMA processes
WMA Categories

1. Organic Additives
2. Chemical Additives
3. Asphalt Foaming Technologies
   a. Foaming additives
   b. Water Injection Systems
4. Combinations of above
WMA Categories

1. Organic Additives
   - Sasobit (Sasol)
   - SonneWarmix (Sonneborn)
   - Rediset (Akzo Nobel) — *also contains chemical additives*
   - Bitutech PER (Engineered Additives)
   - LEADCAP (KICT-KUMHO)
   - Thiopave (Shell)
WMA Categories

2. Chemical Additives (Surfactants)
   - Evotherm (MeadWestvaco)
   - Cecabase RT (Arkema Group)
   - HyperTherm/QualiTherm (QPR)

Typical dosage rates of 0.2 to 0.5% of the binder

Many of the WMA Chemical Additives provide anti-stripping additive compounds
3. Asphalt Foaming Technologies
   a. Foaming Additives (Zeolites)
      - Advera (PQ Corp.)
      - Aspha-min (Eurovia)

   Foaming Additive rates are typically 0.25 to 0.30% by weight of mix.
WMA Categories

3. Asphalt Foaming Technologies
   b. Water Injection Systems
      • Accu-Shear (Stansteel)
      • AquaBlack (Maxam)
      • AquaFoam
      • Double Barrel Green (Astec)
      • Eco-Foam II (AESCO/MADSEN)
      • Meeker Warm Mix
      • Terex WMA System
      • Ultrafoam GX2 (Gencor)

Most water injection foaming systems add 1 to 2% water by weight of binder.
WMA Categories

4. Combinations
   - Low Emission Asphalt (McConnaughay)
     - Combined foaming and chemical additives
     - Mix production temperatures are typically lower than other WMA processes
Three most common WMAs

- Foam
- Evotherm
- Sasobit
Energy Savings with WMA

- Fuel savings for WMA in Europe have been reported to be from 20 to over 50% for some WMA technologies.
- US studies have reported burner fuel savings of 0 - 30%, with 15 to 25% being typical.
Reduced Emissions with WMA

- Especially noticeable at load-out
## Observed Reductions in Emissions

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(*) Reported as NO₂
All values reported are in percentages.

From FHWA
Better Work Environment
Improved Compactability

- Improves workability and ease of compaction
- Compaction is important to long term performance of mixture
- Allows placement and compaction during cooler weather
Overlaying a Crack Sealed Pavement

- Overlaying pavements with joint/crack sealant typically results in bump
- Bumps do not roll out, results in poor ride and lack of density
- WMA has been used to solve this problem
Better Workability?

- Most contractors report WMA improves workability
- Some also report finish to be better, especially at joints.
Long Haul Distances

- Haul times with WMA from 1 to 3 hours reported
  - Generally successful in achieving target density
  - Crusting / lumps of mix less than with HMA
- Some contractors use normal mix temperatures so in this case, the WMA technology is just a compaction aid
Cold Weather Paving

- Several example projects using WMA to pave in near freezing temperatures have been reported
- Also often used for long haul distances
Plant Concerns with WMA

• Lower production temperatures could lead to:
  • Less efficient burner operation
  • Incomplete drying of the virgin aggregates
  • Condensation in the baghouse
  • Increase amperage on motors
Lab Tests on WMA

- Nearly all WMA mixes produced to date have used HMA mix designs
- Lower mix temperatures cause less asphalt absorption for some aggregates that can change volumetric properties
- Lab tests for rutting and moisture damage potential for WMA commonly yield less favorable results compared to HMA
Combining WMA and RAP

- WMA technologies can improve the ability to properly coat aggregates and RAP during production.
- Lower production temperatures will reduce plant aging of binders which may allow for increased use of RAP without grade bumping.
- Many agencies allow higher RAP with WMA.
Placement of Foamed Asphalt with 30% RAP

- Material was workable and easy to place and compact
- Reduced smoke
Cost of WMA Technologies

- Added costs for WMA vary by technology and economy-of-scale. Costs generally range between about 50¢ to $4 per ton of asphalt mix.
- Some costs may be offset by energy savings and other benefits.
Summary of WMA Use

- First test section placed in 2004
- 19.2 million tons of WMA in 2009
- 47.6 million tons of WMA in 2010
- Approximately 500 million tons of asphalt mixture per year
- Some contractors use WMA on most all work---they simply increase the temperature of the mix for HMA
- FHWA five year goal beginning about 2 years ago is for WMA to be 50% of all mixes
WMA status at end of 2011, FHWA

- 40 state DOTs had specifications for WMA
- More than 30 WMA technologies
- At least 30 state DOTs had met the WMA target values
Agency Specifications

- WMA technology product acceptance list
- Sometimes lots of effort to get on product acceptance list
- Very similar to HMA Spec
- Sometimes test methods or criteria are adjusted
Performance of WMA has been good even though lab test results often less desirable than that for HMA
NCHRP Projects Completed, Underway, and Projected

- NCHRP 9-43  Mix Design Properties for WMA
- NCHRP 9-47  Engineering Properties, Emissions, and Field Performance of WMA Technologies
- NCHRP 9-47A  Properties and Performance of WMA Technologies
- NCHRP 9-49  Performance of WMA Technologies: Stage I--Moisture Susceptibility
- NCHRP 9-49A  Performance of WMA Technologies: Stage II--Long-Term Field Performance
- NCHRP 9-52  Short-Term Laboratory Conditioning of Asphalt Mixtures
- NCHRP 9-53  Properties of Foamed Asphalt for WMA Applications
- NCHRP 9-55  Recycled Asphalt Shingles in WMA Mixtures
Other Resources

- www.warmmixasphalt.com
- NAPA (www.asphaltpavements.org)
  - Warm Mix Asphalt: Best Practices, 3rd Ed. (QIP-125)
- FHWA-NHI Courses
- NCAT short courses, webinars, and website
Any Questions???