TERRA Transportation Engineering and Road Research Alliance
Partnering for Roadway Innovation
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Warm-Mix Asphalt

Warm-mix asphalt (WMA) is the generic term for a variety of technologies that allow the producers of hot-mix asphalt (HMA) pavement material to lower the temperatures at which the material is produced at the HMA plant and placed on the road. WMA is typically produced at temperatures between 200° and 275° F, while HMA usually runs 275° to 325° F.

Lowering the temperature of asphalt mixes will decrease fuel usage, fumes, and greenhouse gas emissions, preserving resources while addressing growing environmental sustainability. Potential engineering benefits include better compaction on the road, the ability to haul paving mix for longer distances, and the ability to pave at lower temperatures. In addition, researchers hypothesize that the reduced level of oxidation at the HMA plant will lead to better long-term pavement performance.

The following highlights are from a variety of sources, including published reports of research conducted at MnROAD and other research centers, as well as industry publications.

A Brief History of WMA

As a signatory to the Kyoto Accord, the European Union was compelled to look for ways to reduce greenhouse gas emissions in many ways—including paving methods. By the year 2000, the EU had introduced new paving strategies, including WMA.

U.S. scanning committees in 2002 and in 2007 investigated the European technology to pursue research and development work necessary for implementation of WMA technology. Though the Europeans had a head start on the technology, the United States has rapidly gained ground, with 17 warm-mix technologies currently available and more in development.

More than 70 WMA field trials in at least 39 states have now been conducted in the United States, and there are a number of successful WMA projects throughout the nation. Texas DOT will place over 1 million tons of WMA in 2009 as part of its regular paving projects.

Key Characteristics and Research Findings

- The goal with warm mix is to obtain a level of strength and durability that is equivalent to or better than hot-mix asphalt.
- The number of WMA technologies is expanding. They involve designing the mix with either a chemical or organic additive, or by a foaming mechanism.
- Preliminary data from a research project on I-70 in Colorado, in which WMA was compared side-by-side with conventional HMA, showed that WMA had about the same optimum asphalt content, lower air voids in field-produced mixes, comparable tensile strength, and generally favorable rutting characteristics.
- Recycled materials, such as recycled asphalt pavement (RAP) and shingles, have been used in Minnesota WMA projects with success. WMA technology allows for higher percentages of RAP by allowing for better compaction and decreasing the aging of the asphalt binder, both of which can increase the pavement service life and lead to cost savings for the taxpayer/owner of the pavement.
- The reported fuel savings of producing WMA is typically 30 to 35 percent, which translates into an approximate cost savings of $1 per ton or more. Larger savings may be driven by heat losses from the plant during mixing.
- The use of WMA as an overlay can reduce bumps from joint sealants reacting with higher temperatures, such as PCC crack sealant not compatible with HMA.
- WMA usually is easy to work with, has good uniformity, and sometimes can carry traffic earlier.
- The greater the differential between the mix and ambient temperatures, the faster the mix cools. WMA cools more slowly and allows compaction at lower temperatures.

WMA Test Cells at MnROAD

Researchers at the Minnesota Department of Transportation (Mn/DOT) are studying WMA at MnROAD to explore the potential of the material for better low-temperature cracking performance. MnROAD has one of the few WMA test sections in a cold weather climate in the United States. Several more studies are expected.

Researchers hypothesize that the reduced level of oxidation at the HMA plant will lead to better long-term pavement performance. The study also is monitoring other performance measures such as rutting, fatigue cracking, top-down cracking, and ride.

In 2008, six test cells were paved with WMA on the MnROAD mainline, which sees just under a million equivalent single axle loads (ESALs) per year. In addition, a control cell was created on the MnROAD low-volume road (LVR) with the same mix design as the WMA but produced at typical HMA temperatures without the additive.

Benefits

Environmental
- Lower greenhouse gas emissions
- Lower fuel consumption
- Reduced exposure of workers to fumes
- Allows for higher percentages of RAP

Performance
- Reduced binder aging
- More time for mixture compaction
- Improved compaction with stiff mixes

Other Expected Benefits
- Cooler working conditions
- Night paving
- Longer paving season
- Longer haul distances
- Reduced plant wear

Implementation

WMA has been used in many states, including California, Colorado, Minnesota, Missouri, New York, North Carolina, Ohio, Texas, Virginia, and Wisconsin. For example:
- TexDOT–Paris District projects, Texas (2009)
- State-Aid Highway 2, Crow Wing County, Minnesota (2009)
- Several city streets in St. Paul, Minnesota, (2009)
- MnROAD Mainline, test cells 15-19 and 23, Albertville, Minnesota (2008)
- U.S. 1 in Morro Bay, California (2008)
- Hall St. in St. Louis, Missouri (2008)
- I-70 in Dillon, Colorado (2008)
- Yellowstone National Park, Wyoming (2008)
- County Road 104, Olmsted County, Minnesota (2007)

For Further Reading

- MnROAD Phase II projects: Warm Mix Asphalt
- *2008 MnROAD Phase II Construction Report*
- Warm Mix Asphalt: Best Practices (NAPA presentation, 2008)
- An Introduction to Warm-mix Asphalt (NAPA paper, 2007)
- Is 'green' the new look of pavement? (Minnesota LTAP *Technology Exchange*)
- Warm Mix Asphalt Technologies and Research (FHWA Web site)
- Warm Mix Asphalt: European Practice (FHWA Web site)
- Mix Design Practices for Warm Mix Asphalt (NCHRP Project 09-43)
- Engineering Properties, Emissions, and Field Performance of Warm Mix Asphalt Technologies (NCHRP Project 09-47, 2009)
- Warm Mix Asphalt (National Asphalt Pavement Association Web site)
- National Asphalt Pavement Association
- Minnesota Asphalt Pavement Association

Links to these resources are on the TERRA Web site at www.TerraRoadAlliance.org

For More Information

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Partners

- Minnesota Department of Transportation (Mn/DOT)
- Minnesota Local Road Research Board (LRRB)
- Federal Highway Administration (FHWA)
- Transportation Research Board (TRB)
- University of Minnesota
- National Asphalt Pavement Association
- Minnesota Asphalt Pavement Association
- Industry representatives, including contractors and material providers

About TERRA

The Transportation Engineering and Road Research Alliance, or TERRA, brings together government, industry, and academia in a dynamic partnership to advance innovations in road engineering and construction, including issues related to cold climates. More about TERRA is online at www.TerraRoadAlliance.org.

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