WARM MIX ASPHALT

GOAL

Reduce fossil fuel use at the hot mix asphalt plant, decrease emissions at the plant, and decrease worker exposure to emissions during placement.

CREDIT REQUIREMENTS

Reduce the mixing temperature of hot mix asphalt by a minimum of 50°F from that recommended as the mixing temperature by the asphalt binder supplier. Mixing temperature shall be measured as the temperature of the mixture as it exits the mixing drum (for drum plants) or pugmill (for batch plants). This reduced temperature mix must comprise a minimum of 50% of the total project pavement (hot mix asphalt or portland cement concrete) by weight.

Details

This credit requires a recommended HMA mixing temperature to be provided by the asphalt binder supplier. This recommended temperature should be as if no WMA technology were to be used. If the recommended mixing temperature is provided as a range, use high end of the range for calculation of the required 50°F degree reduction.

Note that concrete products do not qualify for this credit.

Several additives and plant equipment options are available for WMA technology. All are acceptable. Based on regional availability, one additive or equipment type may be preferred over another.

DOCUMENTATION

- A copy of the WMA mix design should be submitted. The mix design should have the following items highlighted:

  a. Name of WMA technology used
  b. If an additive was used, percentage by weight of binder or by weight of mix
  c. Total tons of high-type pavement on the project, including Portland cement concrete and asphalt concrete (hot, warm and cold mix)
  d. Total tons of WMA pavement used
  e. WMA mix temperature as it exits the drum (drum plant) or pugmill (batch plant)
  f. Recommended asphalt binder mixing temperature from the asphalt binder supplier.
  g. Total fuel used in the burner per ton of WMA
  h. Total fuel used in the burner per ton of HMA if HMA was used. If HMA was not used, a general plant average is acceptable.

- A photo taken during placement of the mix, clearly labeled to identify the WMA.

PT-3

3 POINTS

RELATED CREDITS

✓ MR-4 Recycled Materials

SUSTAINABILITY COMPONENTS

✓ Ecology
✓ Equity
✓ Experience

BENEFITS

✓ Reduces Fossil Fuel Use
✓ Reduces Air Emissions
✓ Reduces Greenhouse Gasses
✓ Improves Human Health & Safety
✓ Reduces First Costs

APPROACHES & STRATEGIES

- Consider specifying a temperature reduction at the plant of a minimum of 50°F in the design documents and list all approved additives or methods allowed to achieve this temperature reduction.

Example: Case Study – Warm Mix Asphalt on I-90 in Vantage, WA

The Washington State Department of Transportation (WSDOT) recently completed a 10.6 mile mill-and-overlay project on the eastbound truck lane of Interstate 90 between Vantage and George, WA (WSDOT, 2008). Part of the project (approximately 5.0 miles) was paved using conventional HMA, while the remaining final 5.6 miles was paved using WMA. The same contractor, production plant, trucks and paving equipment were used for both mixes. Both mixes were placed in one two-inch lift and contained 20 percent recycled asphalt pavement (RAP), the maximum allowed by WSDOT without special testing. The mix design was half-inch Superpave with 5.2 percent PG76-28 binder. Sasobit® was added to the warm mix at 2.0 percent by weight of the binder. The Sasobit® additive was provided by Sasolwax, Inc. and produced at the Sasol South Africa plant in Sasolburg, RSA. The additive cost was roughly $25,000 (including shipping), or about two percent of the total $1.36 million paving portion of the project.

Based on field data collected, the WMA was mixed at 300°F and the HMA was mixed at 350°F. This resulted in a 23.5 percent reduction of diesel fuel use in the burner. The manufacturing processes for these two types of asphalt pavement were generally identical, save that the WMA includes the Sasobit® additive to allow a lower production temperature to be used in the burner. (It is worth noting that this temperature was much higher than the minimum temperature necessary for the additive, according to Sasolwax) (Sasol Wax Gmbh, 1997).

Other notes on this project:

- Field compaction test results (using standard WSDOT procedures) averaged 93.7 for WMA (11 lots with 5 random samples per 400-ton lot) and 93.6 percent for HMA (19 lots), with WMA allowing more time for the rollers to reach compaction.
- During placement, infrared photographs taken during observations indicated that temperatures were more uniform across the WMA mat than the HMA mat.

More information on that project can be found here: http://www.wsdot.wa.gov/Projects/I90/WGeorgePaving/

POTENTIAL ISSUES

1. Monitor the plant operations to ensure that the temperature is maintained at 50°F below the recommended mixing temperature.
2. Do not use recommended mixing temperatures that might result in asphalt binder thermal degradation, typically defined by the Asphalt Institute as temperatures above 350°F (175°C).

RESEARCH

Warm mix asphalt (WMA) is a relatively new technology to the United States' paving industry that shows great promise to reduce both the amount of energy used in constructing hot mix asphalt (HMA) pavements and the air emissions associated with pavement construction. WMA is commonly used in Europe, where non-renewable resources are strictly regulated and often heat and fuel energy required for conventional hot mix asphalt (HMA) are cost-prohibitive (D'Angelo et al., 2008). Lately, WMA has become an intriguing environmental marketing incentive, both popularized and heavily advocated, and the material is becoming more accepted due to the relatively new sustainability movement among engineering and construction professionals. Emphasis on climate change, energy conservation and human health impacts has brought WMA paving to the forefront of this newfound environmental movement. Recent field and laboratory studies (Hurley, 2006; Wasiuddin, Selvamohan, Zaman, & Guegan, 2007) conducted in the U.S. have produced positive results, indicating that WMA is a viable option to reduce the potential environmental and societal impacts associated with paving and construction.

Most of the warm mix asphalt studies and research cite several positive and few negative traits of the material. Particularly detailed research and references can be found in the Kristiandottir's thesis (2006) and Ghandi's dissertation (2008). Both of these researchers review the existing types of warm-mix additives available, discuss the engineering properties of the materials and additives in detail, and address potential applications such as cold weather paving and high recycled content mixes. The most common incentives cited are lower fuel consumption during the mix production and improved compaction and workability during placement of the mix (Kristjansdottir, 2006). Both of these traits allow for more uniform mat temperatures and extended compaction time.

However, long-term WMA performance data in U.S. applications is scarce because the technology is so recent. Noted drawbacks generally include slightly heightened concern for rutting potential, thought to be due to inadequate drying of the aggregates for use in the lower temperature mixes (Hurley, 2006; Kristiandottir, 2006; Wasiuddin, Selvamohan, Zaman, & Guegan, 2007; Ghandi, 2008) and, simply, cost (Muench, Kristiandottir, Pierce, & Willoughby, 2007).

More recently, interest in warm mix material has sparked field experiments for performance testing with using a higher content of recycled asphalt pavement (RAP) to alleviate stiff mixes (Mallick, Bradley, & Bradbury, 2007) and a noteworthy short-duration high-load study at the NCAT track (Prowell, Hurley, & Crews, 2007). Generally, the results show agreement with the benefits noted above for comparing performance of WMA with a similarly designed and placed mat of HMA.

Air emissions contribute to global warming, acid rain and smog formation throughout the lifecycle of a pavement. Additionally, studies have shown that asphalt paving may have detrimental effects on human health (Herrick, McClean, Meeker, Zwack, & Hanley, 2007; Gasthauer, Maze, Marchand, & Amouroux, 2008) due to the presence of volatile hydrocarbons (PAHs, polycyclic aromatic hydrocarbons) released when the asphalt is heated. For example, the most common gas emitted from bituminous pavements is naphthalene which is classified by the Environmental Protection Agency (EPA) as a carcinogen. Lifecycle emissions come from transportation sources, any construction or demolition equipment, stationary manufacturing equipment and any part of the manufacturing process that uses fossil fuels as an energy source (including electricity). Other substance emissions come from fumes of the pavement itself during both the manufacturing process and construction, which can adversely affect human health. Air emissions are thus highly regulated by the EPA. Of particular interest are emissions during the paving process, which are known to directly impact worker health (NIOSH, 1997).

Fossil fuel derivations, such as coal, diesel fuel, and gasoline are major inputs to all processes in the production of asphalt pavements. These fuels are used in many types of paving equipment during aggregate excavation, truck and rail transportation, manufacturing equipment (such as burners and crushers), paving construction (and deconstruction), and in disposal at landfills. Also, electricity and heat at the plant are generated using mostly non-renewable fossil fuel sources in most U.S. locations. This credit focuses on reducing lifecycle air emissions only from the mix production and placement processes by encouraging reduced fuel use at the plant through use of a temperature-lowering warm mix additive.

Lifecycle assessments (LCA) have been completed by various institutions attempting to identify and quantify air emissions and energy use for asphalt pavements (Zapata & Gambetese, 2005; Meil, 2007; Horvath, 2007). Zapata & Gambetese (2005) note that because existing LCAs vary in method, they tend to produce contradictory results according to their input variables and model assumptions. Further, reliable and publicly accessible data on environmental emissions or fuel consumption for any type of HMA pavement, including WMA, is rare, outdated or simply does not currently exist. However, the EPA published general emissions estimation techniques for standard hot mix plants based on average U.S. data collected for the 1997 industry census (EPA, 2000). Since air emissions increase with higher temperatures, and WMA allows for lower temperatures to be used in production, it follows that WMA applications will generally reduce emissions during the pavement production process.

GLOSSARY

EPA	Environmental Protection Agency
HMA	Hot mix asphalt
LCA	Lifecycle assessment
PAH	Polycyclic aromatic hydrocarbon
WMA	Warm mix asphalt

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