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Benefits of Warm Mix Asphalt
6/9/2008

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Warm Mix Asphalt Offers Benefits
to Producers, Contractors and Owners

by Tom Kuennen

Warm mix asphalt (WMA) is getting road agencies, paving contractors and asphalt producers closer to a fumes-free asphalt mix that will result in lower mix emissions and radiated heat.

Warm asphalt mixes attract interest because of their potential for reduced plant emissions in different stages of production, benefits in construction in the field, and reduced energy consumption in the plant.

Other benefits may be a construction season which extends well into the cooler seasons, longer hauls of asphalt mix with less worry about the mix losing heat, less fuel needed to bring mixes to temperature, and perhaps less problematic siting of asphalt plants, important for metro areas.

"This technology could have a significant impact on transportation construction projects in and around non-attainment areas such as large metropolitan areas that have air quality restrictions," said Matt Corrigan, asphalt pavement engineer in Federal Highway Administration's (FHWA) Office of Pavement Technology.

Warm mix asphalt is not a single product, but a variety of technologies that reduce the temperatures at which asphalt mixes are produced and placed. WMA processes generally reduce the viscosity of the asphalt through a variety of means, and enable the complete coating of aggregates at lower temperatures at temperatures 35 to 100 deg F lower than conventional hot mix asphalt (HMA).

WMA reduces mix viscosity

In North America, the vast majority of pavements are made in hot mix asphalt plants. The liquid asphalt is a relatively small part of the mix (typically 5 to 7 percent) and performs as a visco-elastic binder between the fine and coarse mineral aggregate.

Because WMA technologies generally reduce viscosity, they may reduce compaction challenges associated with cooled mixes or cold weather, possibly lower the amount of rollers required at a job site, and reduce the risk of failed compaction with stiff mixtures.

Conventional HMA production takes place above 280 deg F, not to exceed 325 deg F, and placement and compaction between 260 and 300 deg F. Before mixing with hot liquid asphalt, fine and coarse aggregates are heated to high temperatures to drive off moisture, to ease coating of the mineral aggregates with the liquid asphalt, and to keep the complete mix fluid enough to be workable during placement.

In addition to consumption of prodigious amounts of natural gas, fuel oil or powdered coal, heating of liquid asphalt to these temperatures produces volatile organic compound (VOC) fumes which may either be vented to the exterior, or collected with fume enclosures and revented back into the process.

Like any other industrial facility, fumes from asphalt plants are an issue for regional air quality in areas that are not in compliance with federal air quality standards. However, plentiful research indicates there is no evidence that these fumes are harmful to either workers or nearby residents.

Nonetheless, use of today's warm mixes has the potential to all but eliminate emissions, giving a plant owner a powerful tool to use in the permitting process. Warm asphalt mixes produce emissions at a greatly reduced level from conventional HMA plants, thus enabling permitting of asphalt plants in air pollution nonattainment areas, or where there is local opposition.

Substantial reductions in emissions

Data surveyed by last year's WMA technology European scanning tour – and articulated in the tour's February 2008 report, Warm-Mix Asphalt: European Practice, indicate plant emissions are significantly reduced. Typical expected reductions are 30 to 40 percent for CO2 and sulfur dioxide (SO2), 50 percent for volatile organic compounds (VOCs), 10 to 30 percent for carbon monoxide (CO), 60 to 70 percent for nitrous oxides (NOx), and 20 to 25 percent for dust. Actual reductions vary based on a number of factors.

The FHWA WMA European study tour reported in February 2008 that tests for asphalt aerosols/fumes and polycyclic aromatic hydrocarbons (PAHs) indicated significant reductions compared to HMA, with results showing a 30 to 50 percent reduction. "It should be noted that all of the exposure data for conventional HMA were below the current acceptable exposure limits," the panel noted.

The tour also reported burner fuel savings with WMA typically range from 11 to 35 percent, with fuel savings potentially higher (possibly 50 percent or more) with lower-temperature warm mix technologies.

One such lower-temperature technology is Evotherm. "By lowering the temperature of production we are avoiding some of the potential degradation to binder that can occur at production higher temperatures," said Everett Crews, Ph.D., MeadWestvaco technical manager for Evotherm.

Evotherm is different from other warm mix technologies in its ability to produce mixes around 200 deg F, Crews said. "Other warm mix technologies produce material at temperatures up to 260 deg F," he said. "Evotherm is unique in that we can push the lower limit lower. We have made mixes at below 200 deg F that have performed very well."

While they come at a cost premium, warm asphalt mixes can save money in the plant through reduced energy costs. While this historically has been less of an issue in the U.S. than it is in Europe, with its higher-cost energy sources, in 2007 and 2008, skyrocketing energy costs in the United States are making this more of a benefit.

Improved working conditions via WMA

But there are other, powerful benefits to warm mix asphalt. For example, in addition to lower fumes and emissions, at the October 2007 Young Leaders Conference of the National Asphalt Pavement Association, NAPA president Mike Acott said WMA has the potential to improve working conditions, reduce energy consumption and plant wear, open job sites earlier, enable cool weather paving, aid compaction for stiff mixes, increase plant production, store mix longer, and permit longer haul distances. The lower temperature helps decrease binder aging as well, NAPA's Acott said.

The reduced heat of WMAs is a big bonus for sun-drenched cities like those in Texas, where temperatures routinely hit the high-90s and higher on summer afternoons. City crews report the mix being much cooler, and that's ideal for placing asphalt when it's 95 or 100 deg in summer.

Texas contractors sometimes have jobs in far-flung Texas that may be as long as a 150-mile haul. For these warm mix technology is ideal, eliminating the need to run mix as high as 350 deg F, as hot as allowed, before loading into trucks with tarps for the three-hour ride. WMA has the potential to improve that situation.

Similarly, warm mixes may allow construction of pavements in colder weather, because contractors may no longer fear critical loss of temperature in the cold. The result may be a longer construction season extending into the winter in some regions of the country.

Warm mixes can allow faster construction of pavements made up of deep lifts of asphalt, for example intersections, which need to be opened as soon as possible. Because the mix is not so hot to begin with, less time is required to cool the mix before the next lift is placed.

These benefits have been noted overseas. In its February 2008 report, FHWA's WMA European Scanning Tour reported WMA enabling paving in cooler temperatures and still obtaining density, hauling the mix longer distances and still have workability to place and compact, enabling the ability to compact mixture with less effort, and the ability to incorporate higher percentages of reclaimed asphalt paving (RAP) at reduced temperatures.

WMA eases higher RAP content

WMA needs to be reconciled with the increasing use of reclaimed asphalt pavement (RAP) in mixes. But new research released in 2008 indicates that WMA could allow contractors and agencies access to substantial savings associated with high RAP mixes.

In their January 2008 Transportation Research Board peer-reviewed technical paper, Using Warm Mix Asphalt Technology to Incorporate High Percentage of Reclaimed Asphalt Pavement (RAP) Material in Asphalt Mixtures, authors Rajib B. Mallick, associate professor, Worcester Polytechnic Institute, Prithvi "Ken" Kandhal, associate director emeritus, National Center for Asphalt Technology at Auburn University, and Richard L. Bradbury, Maine DOT, found that it's possible to produce mixes with 75 percent RAP with similar air voids as virgin mixes at lower than conventional temperatures using 1.5 percent Sasobit WMA additive.

"Warm Mix Asphalt (WMA) technology offers a solution to utilize the current state of the art technology to enable us to utilize more RAP at a relatively lower temperature in HMA mixes," Mallick, Kandhal and Bradbury reported earlier this year. "The addition of a significantly lower grade of binder, PG 42-42 at a rate of 1.5 percent by weight of mix, produced a mix that is most comparable to a virgin mix."

That's significant because high mix temperatures can degrade the residual aged asphalt binder still present in the RAP, producing blue smoke. Warm mixes can produce useful product without exposing RAP to relatively high temperatures in the plant.

Warm mix asphalts are compatible with Superpave mix designs. Furthermore, in February the FHWA European scanning tour found WMA technologies have been used with all types of asphalt mixtures, including dense-graded asphalt, stone matrix asphalt (SMA), and porous asphalt. WMA has been used with polymer-modified binders in addition to mixes containing high-content RAP.

WMA has been placed on pavements with high truck traffic, up to 3,500 heavy vehicles per day, which over a 20-year design period would be expected to exceed 30 million 18-kip-equivalent single-axle loads. WMA has also been placed at bus stops, on airfields, and on port facilities.

"In the United States the bulk of our applications have been dense graded surface mixes," said Evotherm's Crews. "These typically have 19mm (3/4-in.) or 12.5mm (1/2-in.) nominal maximum aggregate size, sometimes down to 9.5mm (3/8-in.)

(1/2-in.) nominal maximum aggregate size, sometimes down to 9.5mm (1/3-in.) NMAS. In other countries we are seeing WMA being used in project-scale quantities, as opposed to demo-scale, and we expect the U.S. market to move in that direction this year."

Warm mix asphalt incorporating Evotherm technology from MeadWestvaco Asphalt Innovations is placed at demonstration in San Antonio
Warm mix asphalt in San Antonio demo is compacted as part of International Public Works Congress & Exposition September 2007

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