DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Evaluating the Performance of Warm Asphalt Mixes

Warm mix asphalt technology uses less energy, improves working conditions, and extends paving opportunities

Pavement

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Project Title:
Performance of Warm Asphalt and Low-Energy Mixes: Phases 1, 2, and 3

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WHAT IS THE NEED?

Warm mix asphalt (WMA) provides many advantages over traditional hot mix asphalt (HMA). HMA demands high temperatures that require high-emission, energy-intensive processes, and it cannot be applied in cold outdoor temperatures. In contrast, WMA uses less energy to produce and emits less fumes and smoke. The lower temperature requirements of WMA allows for longer hauls between asphalt plants and construction projects—especially useful in rural districts that are not near a production site—nighttime work to minimize traffic disruptions, and extending the paving period into winter in cooler areas.

California is considering using WMA to support environmental initiatives. A variety of WMA technologies and products are available. Before implementing WMA statewide, research was required to determine whether the necessary density can be achieved at lower temperatures and how well the different WMA options perform under heavy loads and wet conditions.

WHAT WAS OUR GOAL?

This project consisted of three phases to test whether WMA technology can meet the stateâ€™s endurance and environmental requirements and reduce the impacts associated with the use of HMA.

WHAT DID WE DO?

In the first two phases, Caltrans, in partnership with the University of California Pavement Research Center, constructed test tracks with a standard dense graded mix to study the differences between four WMA technologies in terms of production processes, construction procedures, and short-, medium-, and long-term performance using a temperature of 250

degrees Fahrenheit, and how they compared to conventional HMA produced at 310 degrees Fahrenheit.

In the third phase, the researchers compared the performance of two gap-graded, rubberized asphalt mixes, produced and constructed at conventional HMA temperatures, with seven WMAs, produced and compacted at 36–60 degrees lower than the control.

The researchers used a Heavy Vehicle Simulator (HVS) to test the rutting performance and moisture sensitivity of the various mixes. They also performed laboratory tests on all the mixes to assess rutting, fatigue, and moisture sensitivity. The lab tests confirmed the HVS results, indicating that less expensive lab testing protocols can be used to assess future WMA products. Laboratory and test track performance was also validated in a number of field experiments around the state on a range of mixes.

WHAT WAS THE OUTCOME?

Warm mixes provide adequate compaction at lower temperaturesâ€"a reduction of at least 60 degrees is possibleâ€"although rolling operations might need to be adjusted to ensure optimal compaction.

Based on the HVS and laboratory test results, the WMA technologies tested do not significantly affect rutting performance or moisture sensitivity. The lower production temperatures might cause the paving to be a little softer the first few months after construction, but it performs the same as the HMA after that. Laboratory moisture sensitivity testing indicated that all the mixes were potentially susceptible to moisture damage. However, there was no difference in the level of moisture sensitivity between the control HMA and the WMA mixes. Laboratory beam fatigue testing indicated no effect on fatigue cracking performance. WMA on gap-graded rubber mixes can achieve equal or potentially better rutting performance than HMA when standard specified construction and performance limits for HMA are met. In the field testing, WMA test sections showed equal and sometimes better performance than the HMA controls, especially on projects involving long hauls or low air temperatures.

Going forward, Caltrans pavement engineers have tested protocols and an acceptance process for placing WMA manufacturers on an approved list.

WHAT IS THE BENEFIT?

WMA offers environmental, worker, and productivity benefits. The lower temperatures reduce manufacturing and construction emissions. Workers are exposed to less fumes and heat, and because of the reduced fumes and smoke, more asphalt paving can be done in urban areas that have air quality restrictions. WMA also extends paving opportunities into winter and at night because it can be applied in colder temperatures. Nighttime paving minimizes traffic disruptions. The use of WMA technologies in projects involving long hauls and rubberized mixes is especially beneficial. In most cases, WMA improves compaction, which improves long-term performance.

IMAGES

Figure 1: Rubberized warm mix asphalt paving at the Pavement Research Center