0-5597: Evaluation of Warm Mix Asphalt New Technology

Background

Warm mix asphalt (WMA) is a generic term for a variety of technologies that allow the producers of hot mix asphalt (HMA) to lower the temperatures at which the material is mixed and placed on the road. Reductions of 50ºF to 100ºF have been documented. These temperature reductions: reduce fuel consumption, enhance compaction, allow for increase in haul distances, and extend the paving season.

During the first half of this research study, the Texas Department of Transportation (TxDOT) had only placed 1000 tons of warm mix as a demonstration. By the end of the third year of the study, TxDOT had placed more than 1,000,000 tons of warm mix and allowed the use of warm mix in all dense-graded mixtures through the implementation of a Special Provision 341—020. This research focused on learning as much as possible during this span of time regarding the effects of WMA technologies on mixture design, lab performance characteristics, and field performance. An ongoing implementation study is underway to continue to monitor performance of warm mix field sections.

What the Researchers Did

TxDOT initiated this study in 2006 to evaluate warm mix asphalt as a new technology. Initially a literature search was completed and published in 2007 as the first research report from this study (report 0-5597-1). In addition, a laboratory and field evaluation of different WMA technologies was conducted.

Mix designs were developed in the laboratory at three mixing and compaction temperatures to evaluate the effects of the WMA additive on selection of asphalt content. The effects of WMA were also evaluated on the following performance properties:

- Hamburg wheel tracking test (HWTT),
- overlay test,
- resilient modulus,
- mixture workability and compaction,
- binder viscosity,
- surface free energy analyses, and
- fatigue analysis.

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Investigations of field demonstration projects were conducted. Samples of the plant mixes were obtained during construction and lab-molded properties were determined. Field performance of the projects was evaluated after one year of service and cores were taken and evaluated for: HWTT, overlay test, indirect tension, and density.

Ground-penetrating radar (GPR) was used to assess the uniformity of construction of WMA compared to HMA, and X-ray computed tomography (CT) tests were conducted on field cores to evaluate air void distribution. Falling weight deflectometer testing was conducted on one of the WMA sections constructed as a thick structural layer.

What They Found

In terms of mixture design, researchers found that dense-graded WMA mixtures that are designed with the additive will have a significantly lower optimum asphalt content than the corresponding mixture without the WMA additive. Even when the mixing and compaction temperature is reduced to 60ºF below that used for HMA, compaction was enhanced sufficiently to cause a reduction in density and, thus, optimum asphalt content.

The cracking performances (from fatigue and overlay testing) indicate that WMA has the potential to improve the cracking resistance of a mix. While WMA field mixtures did increase in stiffness during the first year of service, some WMA technologies still showed a slight improvement in cracking resistance.

Surface free energy tests and Hamburg wheel tracking test results indicate that WMA mixtures may be susceptible to moisture damage, particularly during the first few months of service. However, extensive field construction of warm mix projects has not revealed any moisture susceptibility issues.

Field performance of WMA projects evaluated in this study have been equivalent to comparable HMA projects. The oldest WMA pavement in Texas is 3 years old and is performing similarly to the HMA control section. Cores from field projects taken 1 year after construction indicate a significant "stiffening" of the WMA mixes as measured by HWTT, overlay test, and indirect tensile strength. GPR readings of WMA projects indicate that they are as uniformly constructed (in terms of density) as corresponding control HMA sections. X-ray CT data indicate that the density or air void distribution with depth in the mat may be even more uniform than HMA. FWD data indicate structural strength characteristics are similar to HMA.

What This Means

The use of warm mix asphalt has been fully implemented by TxDOT and allowed for use in all dense-graded mixtures through Special Provision 341—020. Test procedures have been modified to accommodate warm mix asphalt technologies. Field performance of WMA has been equivalent to HMA, and some laboratory tests indicate that WMA may offer some performance benefits. While there are still some concerns related to the potential for moisture susceptibility in these mixtures, no problems have been identified yet in the field.

TxDOT engineers should take care to ensure that the improved laboratory compactability and resulting possible increase in lab-molded density of WMA do not result in overall lower asphalt contents for dense-graded mixtures, which could result in a lack of mixture durability.

For More Information:
0-5597-1 A Synthesis of Warm-Mix Asphalt

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