INDUSTRY'S FOOTPRINT

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UP FOR ADOPTION

Virginia gives the green light for executing more warm-mix asphalt applications

Rising energy costs and the need to reduce greenhouse gases have focused growing attention on the potential benefits of warm-mix asphalt (WMA) in the U.S.

Key environmental factors for using WMA include the potential for reduced emissions and energy consumption at the plant. However, state departments of transportation also are interested in WMA because it provides workability at lower temperatures—which allows greater hauling distances and times and improves compaction under less-than-ideal conditions—and a longer paving season into colder weather. With these advantages in mind, the Virginia Department of Transportation (VDOT) and its research arm, the Virginia Transportation Research Council (VTRC) began efforts in 2006 to determine if WMA was a technology that Virginia would want to adopt.

In August 2006, two trial sections on rural primary routes in Rappahannock and Highland counties were paved with WMA using the Sasobit additive.

Both VDOT and the contractors had positive initial reactions to the construction experiences at both sites, so a third site using Evotherm technology was installed in late October on a more heavily trafficked urban route outside Williamsburg, Va. VTRC continues to track the long-term performance of all three sites for VDOT.

Lab homework

Based on the results of the trial installations and laboratory study, VDOT developed a special provision for WMA and is allowing the use of the material starting with the 2009 construction season.

The lab evaluation included comparisons of volumetric properties, moisture susceptibility, rutting resistance and fatigue performance between the HMA and WMA mixtures used in each section.

VTRC also modeled the long-term performance of the two test sections in accordance with the *Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures*, or the *Mechanistic-Empirical Pavement Design Guide* (MEPDG).

The lab study included mixtures produced both at the plant and in the lab. The plant-produced HMA and WMA were sampled during construction of the first two trial sections in 2006. In addition, for Mixture A, HMA was produced in the lab using the plant-production temperatures, and WMA was produced in the lab at 230°F, 265°F and 300°F. In all cases, mixing and compaction temperatures were the same. For Mixture B, VTRC tested only plant-produced HMA and WMA.

Volumetric props

There were no significant differences in the volumetric properties between the HMA and the WMA mixtures used in this study. The plant and lab mixtures had similar properties, including the WMA mixtures produced in the lab at different temperatures.

Fatigue and rutting evaluation

The rutting susceptibility of the mixtures was compared using the Asphalt Pavement Analyzer. The average results and standard deviations are shown in Figure 1. Testing was performed at 122°F. A 120-lb load

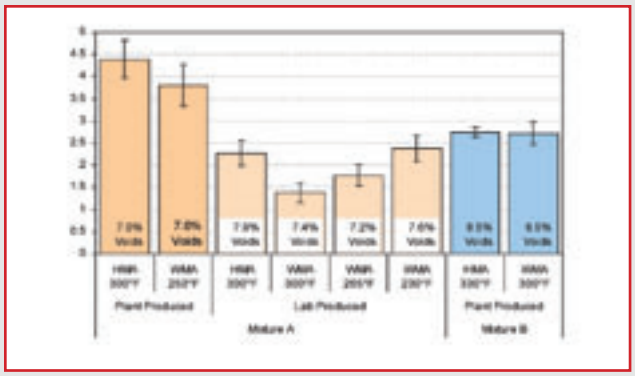

Figure 1. APA rut test results.

was applied at 120 psi. No significant differences were found between the plant-produced HMA and WMA mixtures. The plant-produced WMA rutted slightly less than the HMA. However, these differences were not statistically significant.

Third-point beam fatigue tests were performed on the mixtures to evaluate fatigue performance. The tests were performed at 77°F. A 10-Hz haversine load was used to apply constant strain conditions. The plant-produced HMA and WMA for both Mixtures A and B performed very similarly.

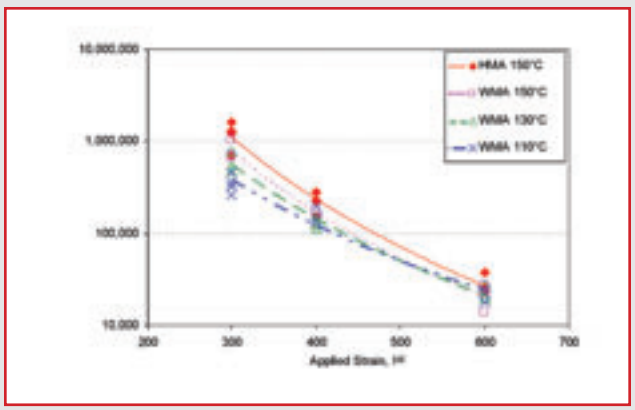

Figure 2. Fatigue results for laboratory-produced mixtures.

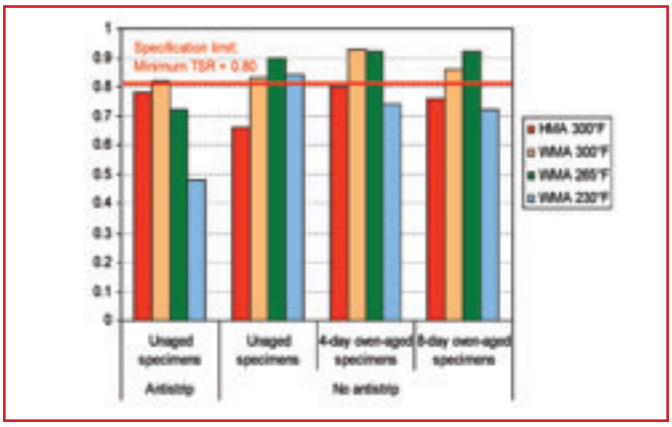

Figure 3. TSR results for laboratory-produced mixtures.

Moisture susceptibility

Moisture susceptibility was evaluated using Tensile Strength Ratio (TSR) tests and Hamburg tests. TSR testing did not provide a complete understanding of moisture susceptibility. Figure 3 shows the lab-produced mixture results. Several mixes failed the TSR requirement of 0.8. All failing mixtures, except the 230°F WMA, appeared to perform well in other testing. Antistrip was beneficial to the HMA but not the WMA. Aging seemed to improve TSR values for all mixes except the 230°F WMA.

The Hamburg wheel-track test results indicated the plant-produced HMA and WMA both resisted moisture similarly. The warm mix produced at 230°F was the only sample to fail, and it failed the limit for maximum rut depth. The sample had a rut depth of 11.8 mm at 15,000 cycles, so the test was stopped. All other samples were below 10 mm.

Predicted performance using MEPDG

To investigate the long-term differences between HMA and WMA performance, researchers modeled both trial sections using the MEPDG. The MEPDG considers traffic loading, climate, pavement structure and material characteristics to evaluate a pavement for fatigue cracking, permanent deformation and thermal cracking. It uses mechanistic analysis and transfer functions to estimate deterioration and predict performance.

This study used default inputs for material properties, except the surface layer where specific test data were available. Each section for Mixtures A and B used unique inputs since the pavement structure, location and traffic loads were different. The MEPDG analysis showed the same long-term predicted performance by the HMA and WMA for both mixtures. All predicted distresses met the targets for the Mixture A site.

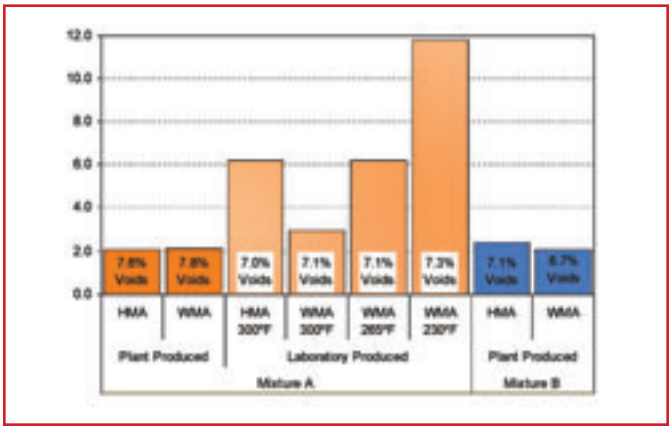

Figure 4. Hamburg rut test results for all mixtures. The WMA 230°F sample was stopped after 15,000 test passes.

Approval processed

Results of this study indicated that WMA produced with Sasobit should have the same general properties and response to testing as HMA. Rutting and fatigue results indicated similar performance between the HMA and WMA, and analysis using the MEP-DG supported this. Although TSR results were not particularly convincing, Hamburg testing indicated that the WMA did not appear to be more susceptible to moisture damage than the HMA.

Based on the lab evaluation and the trial experiences, VDOT proceeded with implementation of WMA for the 2009 construction season. A committee made up of industry and VDOT representatives developed a permissive specification to allow the use of technologies that apply for and are then placed onto VDOT's Approved Warm Mix Asphalt Products and Processes List. VDOT also is placing this specification in all 2009 plant mix schedules. In the specification, acceptance property requirements for WMA do not differ from those for HMA, with the exception of temperature and TSR value requirements.

The Virginia Transportation Research Council will continue to monitor the current WMA trial sites and selected future WMA sites to determine how WMA performs over the long term.

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