PUTTING RESEARCH TO WORK **BRIEF**

Specifications for Use of WMA Technology in Delivering HMA and Non-Conventional Mixtures

Recent national research efforts have focused on the development and evaluation of warm mix asphalt (WMA) technologies as a means to reduce the environmental impact and enhance the performance of conventional hot mix asphalt (HMA). As a result, draft specification language, mix design criteria and standard test methods have been provided to promote the use of WMA by state agencies.

What is the problem?

Current WisDOT mix design specifications allow for a variety of non-conventional products, including high recycled asphalt pavement (RAP), recycled asphalt shingle (RAS) and stone matrix asphalts (SMAs). In order to fully realize potential environmental and performance related benefits of WMA, mix design criteria that are applicable to both conventional and non-conventional mix types is needed. In addition, use of WMA as a viable alternative to HMA has presented states with the challenge of discerning between products for acceptance testing.

Research Objective

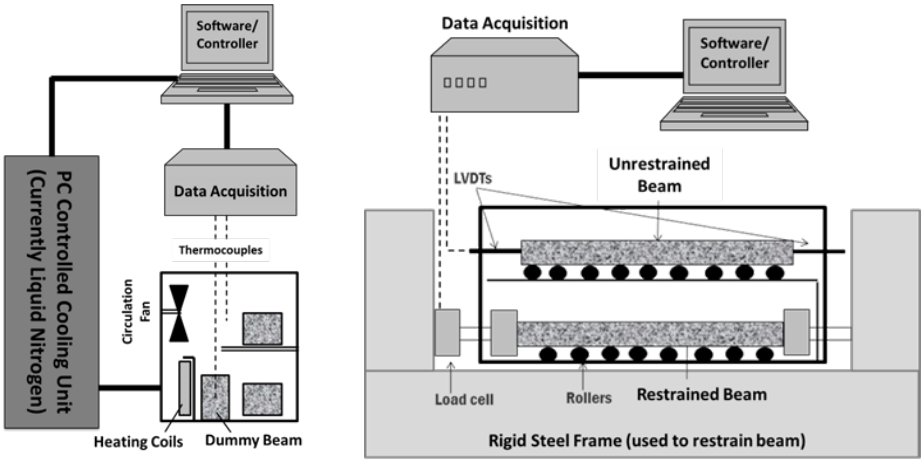
This research project was intended to develop recommended specifications for asphalt concrete covering all types of mixtures included in Section 460 of the Wisconsin Standard Specifications.

Methodology

Four laboratory experiments addressed: (1) the potential for minimum temperature limits for mixtures incorporating RAS, (2) short-term conditioning for flow number and Asphalt Thermal Cracking Analyzer testing, (3) the development of a repeatable coating test for mix design and quality control, and (4) initial criteria limits for the Asphalt Thermal Cracking Analyzer test.

Based on the findings, two draft specifications were prepared: one that includes performance testing and one that does not. The specification with performance tests uses the flow number and Asphalt Thermal Cracking Analyzer to evaluate rutting and thermal cracking resistance of the mixture. The other specification relies on binder replacement limits to provide acceptable resistance to thermal cracking.

A sampling and testing plan was prepared for initial field validation of the two specifications and used on two field validation projects: Capitol Drive near Milwaukee and State Trunk Highway (STH) 70 near Woodruff.



(a) Front View (b) Side View

Schematic of the Test Apparatus for Measurement of Mixture Thermo-Volumetric Properties

Investigator

Ramon Bonaquist
Advanced Asphalt Technologies, LLC
aatt@erols.com

Results

From laboratory tests:

- RAS binders properly mix with new binders, even at the highest WMA process temperatures. A minimum production temperature of 300°F for mixtures containing RAS was included in the draft specifications.
- Short-term conditioning concluded that a two step process can be used with WMA mixtures to simulate construction and early in-service aging. When this conditioning is applied to HMA, the rutting resistance is equal to the standard AASHTO R30 conditioning for performance tests. When applied to WMA, the rutting resistance of WMA mixtures ranges from 60 to 90 percent of HMA mixtures, which is reasonable considering the reported field performance of WMA mixtures.
- Boiling tests found equal coating extent was achieved during mixing, but the quality of coating was influenced by viscosity for most conventional and modified binders tested. A moderate relationship between coating quality and tensile strength ratio from AASHTO T283 was also observed.
- Thermo-volumetric properties of mixtures alone do not appear to be related to thermal cracking resistance of mixtures. Development of thermal strain in an unrestrained sample and thermal stress build-up in a restrained sample are needed to obtain a complete evaluation of thermal cracking performance.

From field validation tests:

- Flow number and Asphalt Thermal Cracking Analyzer tests can be used to assess mixture performance. Overall, fabrication and testing takes approximately three days.
- Portions of the volumetric design procedure were validated. Volumetric properties of laboratory samples compared well with those for field produced mixtures. The correction factor for the water injection foaming process for STH 70 was 0.7 percent, approximately one half of the allowable tolerance for verification results in current WisDOT specifications.
- Characterization of RAS and RAP showed that it is important to measure the binder content of the recycled materials during production. In some cases, there were significant differences between the binder contents reported in the mix designs and those measured during production.
- Reliability against thermal cracking is reduced with addition of recycled materials in the mixtures.
- There was good agreement between the blending charts and the binder recovered from production mixtures. The blended binder reliability analysis developed in WHRP 0092-10-06 provides a reasonable and flexible approach for determining allowable binder replacement.
- Moisture sensitivity testing should be included on production mixtures.

Recommendations

Completed project work has shown promise in using performance related tests for the design and acceptance of asphalt concrete mixtures. Specimen fabrication and testing time severely limit the frequency that Asphalt Thermal Cracking Analyzer tests can be conducted for the flow number. WisDOT should consider investigating other performance related tests that require less time, specifically the high temperature IDT test for rutting resistance and an acoustic emission test to characterize the embrittlement temperature of asphalt concrete mixtures. Both of these tests can be conducted on the gyratory specimens that are fabricated for normal volumetric quality control. The primary recommendation concerning draft specifications developed in this project is that additional validation work is needed before either specification can be considered for implementation. A wider range of projects should be considered, particularly high-recycle content mixtures produced at reduced temperatures using various WMA processes. Wider testing will provide additional data to further refine draft specifications and important data on mixture composition that can lead to performance improvement of asphalt mixtures.

Project Manager

Judie Ryan
WisDOT Bureau of Technical Services
judith.ryan@dot.wi.gov

This brief summarizes Project 0092-12-02,
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