Critical Factors Affecting Asphalt Concrete Durability

Research Objectives

- Evaluate the department's current asphalt mixture criteria relative to best practices associated with durability.
- Quantify the effects of effective binder volume, low temperature performance grade, recycled binder content and polymer modification of the resistance of typical Wisconsin mixtures to aging and load associated cracking.

Research Benefits

- Regression models can be used for specification improvement
- 9.5 mm mixtures with higher design volume of effective binder have greater resistance to cracking compared to 12.5 mm mixtures
- Recent specification changes will improve the cracking resistance of asphalt concrete mixtures,
- Increased service life requires less maintenance and results in cost savings

Principal Investigator

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

Project Manager

Carl Johnson
Stark Asphalt
carlj@starkasphalt.com

Background

Raveling and surface initiated cracking are the primary distresses associated with asphalt durability issues. The durability of asphalt concrete refers to the ability of the mixture to resist deterioration as it ages. Traditionally, durability has been addressed in asphalt mixture design and construction through a combination of: asphalt binder specifications; aggregate specifications; limits on volumetric properties; testing and requirements to minimize moisture sensitivity; and in-place compaction requirements.

Although these requirements have been largely successful, highway agencies question whether the durability of asphalt concrete surface mixtures can be improved either through changes to mixture composition or the use of performance related mixture testing. This research was performed to evaluate the Wisconsin Department of Transportation (WisDOT) current mixture criteria relative to best practices associated with durability. The cost savings from increasing the average service life of asphalt surface courses would be of substantial benefit to the department.

Methodology

A synthesis of current practice was conducted to identify mixture compositional factors affecting asphalt mixture durability and promising methods for improving pavement durability, and two experiments were conducted. The first experiment used laboratory prepared mixtures and was designed to develop relationships among four compositional factors affecting asphalt mixture durability and (1) cracking resistance as measured by semi-circular bend (SCB) testing at intermediate temperatures, as well as (2) age hardening as measured by laboratory oven aging tests. Effective binder volume, recycled binder content, virgin binder low temperature grade and polymer modification were evaluated at three levels to address possible non-linear effects, and the interaction among factors.

The second experiment used plant mixtures to verify estimates of cracking resistance obtained from the regression equations developed from the laboratory prepared mixtures experiment.

The regression equations were then used to evauate WisDOT mixture design criteria. This included an evaluation of recent changes made by WisDOT to improve asphalt mixture durability and other changes that WisDOT should consider.

"This research project highlighted some of the positive changes made in asphalt paving specs in recent years, while still recommending further opportunities for improvement. The possibility of more durable asphalt pavements is something that everyone in Wisconsin will benefit from."

– Barry Paye, WisDOT

Interested in finding out more?

Final report is available at: WisDOT Research website.

Results

The laboratory study concluded that cracking resistance was significantly affected by aging, volume of effective binder, amount and type of recycled binder, low temperature grade of the virgin binder and polymer modification. Although cracking resistance decreased with aging, mixtures with improved as constructed cracking resistance also had improved resistance to cracking after simulated, long term aging. Cracking resistance improved with: (1) increasing volume of effective binder; (2) decreased virgin binder low temperature grade; (3) decreased recycled binder content; and (4) increased polymer modification.

The regression models developed from the laboratory experiment were used to evaluate recent specification changes made by WisDOT. This evaluation concluded that the changes will improve the cracking resistance of asphalt concrete mixtures, with the greatest improvement occurring for overlays. However, changes in composition of the mixtures normally produced in Wisconsin will have little effect on aging characteristics.

Recommendations for Implementation

The regression models developed from the laboratory experiment can be used to further modify asphalt concrete mixture specifications to improve the cracking resistance of asphalt concrete mixtures used in Wisconsin. For instance, they show that 9.5 mm mixtures with higher design volume of effective binder have greater resistance to cracking compared to 12.5 mm mixtures. This may warrant consideration of the department expanding the use of 9.5 mm mixtures in surface course mixtures. Additionally, the department may consider use of polymer modified asphalt in conjuction with recycled binder for Northern Asphalt Zone pavements where softer binder grades are not readily available.

Recommendations for improving the aging characteristics of Wisconsin mixtures cannot be made, since changes in composition of the mixtures had little effect on results in testing. However, the department should monitor the aging characteristics of binders and any additives intended to improve the low temperature properties of asphalt binders for use with mixtures incorporating recycled binders.

This brief summarizes Project 0092-14-06,
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