Interlayer Mixture Design

Research Objective

- Develop an alternative method for accepting interlayer mixture designs without the bending beam fatigue test.

Research Benefits

- A substantial financial savings during flexural fatigue testing
- With the proposed specification, it would be possible to do quality control and acceptance testing on IMDs using the IDEAL-CT

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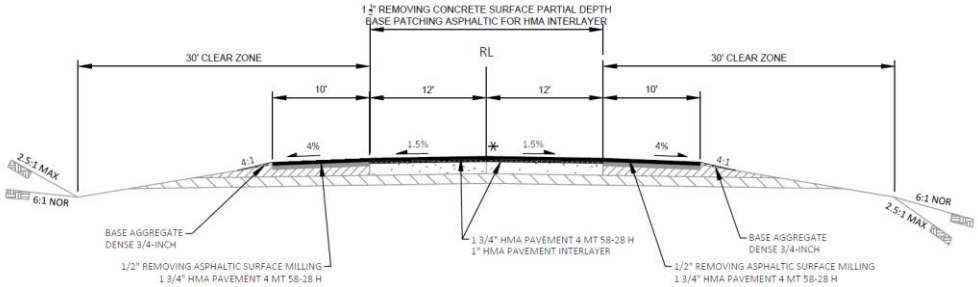
Background

The objective of this research project was to develop an alternative method for accepting interlayer mixture designs (IMDs) without the bending beam fatigue test. Mixtures accepted that use other means are expected to maintain the same level of quality that the beam fatigue test provides.

The problem addressed in this research is that the flexural fatigue testing currently used in accepting interlayer mixture designs is expensive and time-consuming. It would be very desirable if a simpler method for reliably ensuring the fatigue performance of IMDs could be developed and implemented in Wisconsin.



Typical Structure of a Wisconsin Pavement Including an IMD Layer

Methodology

The research approach involved producing 15 different mixtures, most meeting the basic binder and aggregate requirements of the IMD specification. However, a range in fatigue performance was needed to evaluate any method for predicting or controlling fatigue life. Some binders were therefore selected which would produce fatigue performance lower than needed for IMDs.

Six different asphalt binders were used in the project—five of them were from Wisconsin and typical of modified binders used in the state. These binders were differentiated by a range of tests that could potentially help to characterize fatigue performance, including dynamic modulus, double edge notched tension (DENT), elastic recovery from the multiple stress creep and recovery (MSCR) test, and the binder yield energy test.

Mixture tests used in the project as surrogates for fatigue included the Texas Overlay Test and the Ideal Cracking Test (IDEAL-CT) procedure. However, it was discovered early on that the overlay test was unable to discriminate between the performance of the IMDs because all mixes passed the test with very little reduction in stiffness.

"Deliverables from this research will now allow WisDOT to test and accept interlayer mix designs in-house that will involve an alternative, simple test method."
– Tirupan Mandal, WisDOT

Interested in finding out more?

Final report is available at:
WisDOT Research website

Results

Using the data produced through these tests, statistical analyses were performed to develop an accurate and simple model that could serve as a basis for a revised, simpler IMD fatigue specification. This model predicts IMD cycles to failure based upon binder G* at 20ºC and mixture CT_{index} at 20ºC (from the IDEAL-CT). The r_2 for this model, at 95%, suggests the model is accurate enough to serve as the basis for an IMD fatigue specification. However, it was found that binder low temperature grade was highly correlated to binder G* at 20°C. (r_2 = 92 %), so that IMD stiffness can be effectively controlled through the existing binder specification. The resulting recommended limits are a maximum binder low temperature grade of -34°C and a minimum mixture CT_{index} of 140 (after short-term oven aging). The IDEAL-CT mixture test is a simple procedure using a Marshall testing press to perform an indirect tension test at 20°C.

The cost of this procedure is about a quarter of that of the existing mixture test for IMDs—flexural fatigue testing. The proposed specification represents a savings of about $3,200 per IMD to producers, contractors, and the State of Wisconsin.

Recommendations for implementation

Based on the testing and analysis done as part of this research project, the researchers recommend the following:

1. To ensure that IMDs have a fatigue life meeting or exceeding 100,000 cycles, binders for IMDs should meet a low temperature grade no higher than -34°C (RTFOT/PAV aging), and a minimum elastic recovery (AASHTO M 332) as specified within the final report.

2. IMD mixtures should have a CT_{index} of at least 140 at 20ºC and a loading rate of 50 mm/min, following the procedure given in Appendix A of NCHRP Ideal Report 195.

3. The current STSP for Interlayer Pavements should be modified per standards specified in the final report.

4. Final recommendations on allowable ΔTc values for binders used in IMDs should be made after the WHRP project (ID 0092-23-01) on this topic is completed and the results reviewed for their implications for IMDs.

This brief summarizes Project 0092-21-04,
"Interlayer Mixture Design"
Wisconsin Highway Research Program