Evaluating Cracking Resistance Test Methods for Asphalt Pavements

What Was the Need?
In Minnesota’s climate, low-temperature cracking in asphalt pavement can lead to premature damage, cracks across asphalt lanes and rough surfaces that tax drivers and road agency budgets.

To improve low-temperature resistance in asphalt, engineers require effective testing methods that examine the performance of mixtures and structures designed to better handle the cold.

MnDOT uses the disk-shaped compact tension (DCT) test to evaluate asphalt pavement designs, but the process is too labor- and time-intensive to use in the field to evaluate the quality of a mixture during production and placement.

The indirect tensile asphalt cracking test (IDEAL-CT), a laboratory procedure developed by the Texas Transportation Institute, offers a relatively inexpensive alternative based on projections of low-temperature behavior in an ambient testing environment. It is a fast, monotonic indirect tensile test performed at 77 degrees Fahrenheit (25 degrees Celsius) with readily available laboratory equipment, minimal sample preparation and no instrumentation. While some previous research found the two approaches yielded similar results, other projects found the approaches produced quite different results.

What Was Our Goal?
Researchers evaluated the IDEAL-CT as a quicker, more accessible alternative to the DCT test in examining asphalt mixture performance, reducing wait time from days to hours. If effective, the IDEAL-CT could be added to a suite of performance tests as part of a new balanced mix design (BMD) approach under development to replace volumetric, recipe-based asphalt mix design practices.

What Did We Do?
Following a review of existing research to identify potential differences in approaches that may account for differences in results, investigators identified new construction projects scheduled during the 2018 and 2019 construction seasons that may have been particularly susceptible to low-temperature stresses.

With help from the Technical Advisory Panel (TAP), the research team gathered several dozen samples of asphalt plant mixtures from selected sites in 2018 and a similar number of batch mixture, binder and aggregate samples from the 2019 sites. Laboratory tests then assessed the low-temperature performance of binders and mixtures from these locations.

Researchers examined the results of binders and mixtures to determine the quality of the materials and the effectiveness of three binder test approaches, the comparative effectiveness of the two mixture test approaches and the impact of various binder levels in the 2019 samples.

What Did We Learn?
Binders from both construction seasons offered good to very good resistance to cracking. The Minnesota binders performed well in terms of aging and ductility, and MnDOT’s current binder testing approach worked well.

A newer, faster and less-expensive method for predicting low-temperature cracking resistance shows promise for design, quality control and quality assurance. Test results match well with the older method, which cannot be used for quality control.
Low-temperature testing of mixtures found that samples from each season resisted aging well and offered good to excellent cracking resistance when mixtures included optimal asphalt binder content. In the 2018 asphalt mixtures, results showed that the time between molding and testing samples can vary by as long as two weeks without affecting IDEAL-CT results. Cracking resistance in the 2018 mixtures generally improved with higher binder content.

Testing of 2019 samples developed more precise results on the impact of binder content on low-temperature cracking. Those mixtures with asphalt content short of optimum by more than 0.5% failed to meet preferred cracking index values; those at optimum or higher asphalt content passed preferred performance standards.

The IDEAL-CT can be useful in quality control (QC) checks of asphalt mixture batches that are being hauled to a construction site. The IDEAL-CT can also be useful for examining quality assurance (QA) in the mixes during the first two weeks after the installation. MnDOT’s current low-temperature crack testing method, DCT, suits QA but not QC. Test results for the two methods matched well in this study. Differences in storing and aging conditions of loose mixtures in previous research may account for test result variability between laboratories.

**What’s Next?**

BMD testing shows that the optimal asphalt content for cracking resistance may not always precisely match volumetric, recipe-based mix designs. This affirms the need for effective mixture performance tests like the IDEAL-CT, although there remains some resistance to this test because of its use of ambient temperatures, despite the IDEAL-CT’s advantage in terms of time and expense over the DCT test.

MnDOT has not yet fully embraced BMD, though it has been deploying some BMD testing approaches in asphalt mix design procedures. Further piloting and testing at MnROAD will be required before BMD can be fully developed for MnDOT use. MnDOT may also consider using some of the binder testing interpretive approaches used in this research.