Florida Department of Transportation Research

Effects of Laboratory Heating, Cyclic Pore Pressure, and Cyclic Loading on Fracture Properties of Asphalt Mixture

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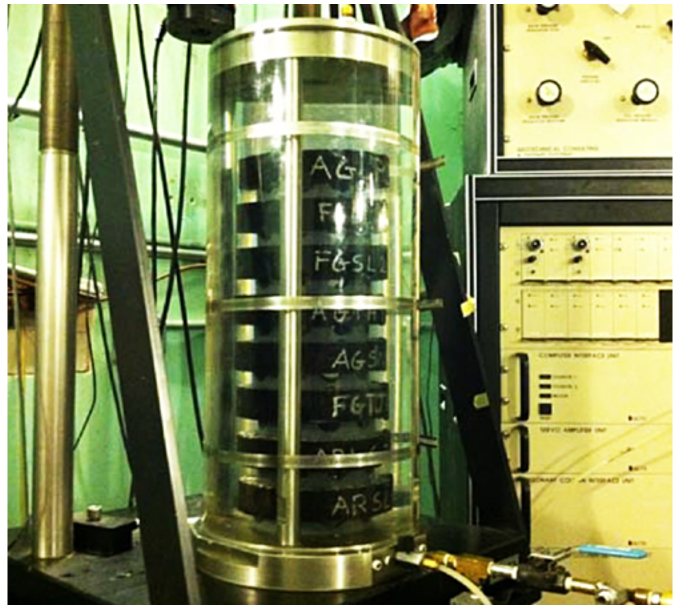
Asphalt pavement ages continuously, beginning with production and construction and thoughout its service life. “Aging” refers to many changes in asphalt properties over time that generally result in increased pavement damage. Because aging is often a long-term effect, understanding the processes that lead to aging requires a means of simulating and accelerating them using laboratory conditioning methods. Much previous research focused on binder, but studies have shown that aging is influenced by both binder and aggregate. In fact, aggregate can mitigate aging in asphalt.

In this project, researchers from the University of Florida (UF) evaluated several laboratory conditioning procedures on granite, limestone, and/or hydrated lime mixtures. They investigated three procedures, alone and in combinations — heat oxidation conditioning (HOC), cyclic pore pressure conditioning (CPPC), and repeated load conditioning (RLC) — to simulate the effects of heat oxidation, moisture, and load.

The researchers found that the most effective approach for inducing changes in damage and fracture-related properties combined HOC and CPPC. The most appropriate level of HOC was found to be the Superpave Long-Term Oven Aging (LTOA) procedure. CPPC was achieved using a cyclic pore pressure of 5 to 25 psi and was based on previous UF research (Florida Department of Transportation project BC354-11).This combination of specific levels of HOC and CPPC effectively reduced the failure strain and fracture energy (FE) limit of mixtures to levels consistent with those observed in the field. HOC used alone seemed unable to reduce the FE limit to field-observation levels, although it was able to embrittle mixtures by increasing stiffness and reducing failure strain and FE limit somewhat.

CPPC appeared to be particularly useful, first as an adjunct to HOC, but also because it induced internal pressure similar to the effect of repeated loading experienced by mixtures in the field. CPPC provided a uniformly distributed stress state, whereas RLC did not, and thus appeared to be more suitable for inducing microdamage without fracture. RLC was able to induce damage, but the method itself was impractical because of the difficulty of inducing damage without fracture.



The triaxial chamber for cyclic pore pressure conditioning allows for precise application of stress in three different directions.

Research results showed that the addition of hydrated lime improved cracking performance of granite mixtures. In addition, the limestone mixtures exhibited better cracking performance than granite mixtures without lime but did not perform as well as granite mixtures treated with hydrated lime. The beneficial effect of hydrated lime appeared to diminish with higher levels of oxidative aging.

The results of this research lay a foundation for mixture-level assessment of asphalt pavements, a deeper understanding of hot-mix asphalt, and the production of more durable, lower maintenance pavements.

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For more information, visit http://www.dot.state.fl.us/research-center