Florida Department of Transportation Research

Development of a Binder Fracture Test to Determine Fracture Energy
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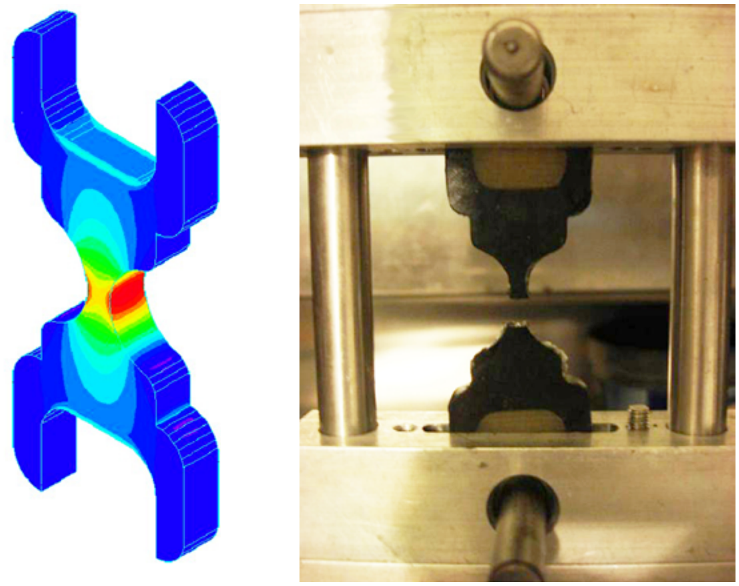
Asphalt binder makes up a relatively small percentage — 4% to 8% — of the hot mix asphalt used in pavements, but its performance as a binder is critical to the longevity of road surfaces. Asphalt is a material whose flexibility changes with temperature. Therefore, it is important to understand the influence that asphalt binder has on the cracking performance of a specific asphalt mixture. Unfortunately, current binder test methods do not accurately predict cracking performance at intermediate temperatures. However, the strong correlation of fracture energy and fracture resistance in asphalt mixtures offers the possibility of an improved fracture test and interpretive system.



Binder samples are shaped like bow-ties for testing in the load frame. On the left, finite element analysis shows the stress pattern in binder samples during testing. On the right, a sample mounted in the custom-built loading frame after testing.

Researchers from the University of Florida who have developed other refinements of asphalt testing were contracted to develop new fracture testing methods. The new fracture testing and interpretation system was developed based on finite element analysis and displacement measurements at different loading rates and temperatures. The testing regime measured fracture energy of binder consistently at intermediate temperatures.

The new test was applied to a range of binders, including unmodified binder, SBS-modified binder (SBS = styrene butadiene styrene), rubber-modified binder, and hybrid binders (consisting of both SBS and ground tire rubber) either from pressure aging vessel (PAV) residue or binder recovered from field test sections. Statistical analysis of test results showed that the new test system clearly differentiated binders by fracture energy values. Expected trends in fracture energy between binders were observed. It was also shown that for the same binder, fracture energy is independent of loading rate and test temperatures evaluated in this study. Thus, fracture energy appeared to be a fundamental property of binder, which did not depend on test condition and could be determined by tests performed at a single temperature and loading rate.

Results also showed that different types of binder have different characteristic true stress-true strain curves, which can be used to identify binder type, modifier type, and relative content. Basic principles were proposed to identify the presence of modifier from true stress-true strain curves. A detailed testing protocol was outlined to help assure the appropriate loading rate range so that the complete true stress vs. true strain curve could be identified for accurate determination of fracture energy.

Improved asphalt testing methods can lead to better material design specifications and more durable pavements which significantly lower maintenance and replacement costs.

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