

Practical Application of Viscoelastic Continuum Damage Theory to Asphalt Binder Fatigue Characterization

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Abstract

The ability of the binder phase of an asphalt mixture to resist fatigue damage can have a profound effect on the service life of an asphalt pavement. An accurate and efficient test method for evaluating the fatigue characteristics of asphalt binder has thus far been elusive due to excessive time requirements or equipment limitations. This paper presents a new attempt to use existing testing procedures (the Dynamic Shear Rheometer) to estimate fatigue resistance in a relatively short period of time. The test involves subjecting binder specimens to a monotonic constant strain-rate shear testing at intermediate temperatures. To evaluate fatigue performance a parameter is derived from the test results by integrating the area under the stress-strain curve to the maximum stress value. Initial validation is carried out by testing binders used in the FHWA Accelerated Loading Facility (ALF). The results collected at the same temperature used in the ALF are shown to accurately rank the fatigue resistance of pavements tested in full scale. The data collected in the new test can also be used for a fundamental analysis procedure based on the Viscoelastic Continuum Damage (VECD) theory to estimate fatigue of binders under varying levels of traffic and pavement conditions. The procedure is modeled after the extensive work already published on mixtures. There are, however, challenges in applying the theory to modified binders that are believed related to the non-linear behavior of some modified binders. These challenges can prove to be critical in accurately applying the fundamental approach to modified binders.

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