Characterizing Fatigue of Asphalt Binders Using Viscoelastic Continuum Damage Mechanics

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Abstract

Fatigue cracking, either top-down or bottom-up, is one of the major distresses for asphalt pavements. As the binding agent, asphalt binder plays a critical role in the fatigue resistance of hot mix asphalt (HMA). Accurate characterization and proper selection of fatigue-resistant asphalt binders could prolong the fatigue life of asphalt pavement. The fatigue indicator currently being used in Superpave Binder specification is based on the fatigue behaviors of asphalt binders within the undamaged, linear viscoelastic range. There have been some controversies on the validity of this parameter. In reality, HMA, as well as asphalt binder, develops cracks under repeated traffic loads. Therefore, there is a need to characterize the fatigue behaviors at a stage of damage with employing a more fundamental approach to understand the true fatigue mechanism of asphalt binder. This paper studied the application of viscoelastic continuum damage (VECD) mechanics which has been successfully applied to HMA, to test results of asphalt binders in the shear mode under various loading conditions. The results indicated that VECD can be effectively applicable to asphalt binders, which presents a good potential to characterize asphalt binder and predict its contribution to fatigue resistance using a fundamental approach that parallels some of the advanced work carried on asphalt mixtures. The importance of this potential is it could allow for a unified model for fatigue of mixtures and binders.