REVIEW OF LABORATORY ASPHALT FATIGUE PREDICTION MODELS

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Abstract

Fatigue in asphalt pavements is the incremental damage that asphalt materials suffer as they receive multiple variable loadings that do not necessarily exceed their yield strength. Accurate prediction of asphalt fatigue comes in handy in the development of asphalt materials with high fatigue life as well as in the estimation of fatigue life of asphaltic pavement materials. This review paper looks at the phenomenological models, dissipated energy models and fracture mechanics models, which are the three models that have been used over the years to model asphalt fatigue behaviour in the laboratory. The phenomenological models relate the numbers of load cycles applied on an asphalt sample and the resultant asphalt tensile strains. The approach has been found to be deficient in tracking crack initiation and progression. The dissipated energy models on the other hand are based on the premise that work is done whenever a material is loaded. The models have been successfully used to track crack initiation and propagation and to isolate dissipated energy that goes into fatigue from that which performs mechanical work. Despite that success, the dissipated energy coefficients have been noted to change with the mode and frequency of loading as well as the temperature. The third approach, fracture mechanics models, is based on the premise that asphaltic materials have inherent discontinuities that form the basis of crack initiation. Fracture mechanics models predict asphalt fatigue using either linear fracture mechanics approach or non-linear fracture mechanics approach. The Linear fracture mechanics method assumes that asphalt will always operate within the linear-elastic region while non-linear fracture mechanics method assumes that it will at times be loaded beyond the linear elastic region. The non-linear fracture mechanics approach comes across as the most promising method as it considers both the inherent materials discontinuities and the loading regimes that are expected in the field. Both linear and non-linear fracture mechanics approaches face challenges in finding specimen geometry that match laboratory sample preparation procedures to field coring shapes. The three models reviewed are 2-dimensional and do not consider seasonal and diurnal temperature dynamics in laboratory work. A 3-dimensional model using non-linear elastic fracture mechanics approach is suggested as an alternative.

Key words: Asphalt fatigue, dissipated energy, phenomenological approach, fracture mechanics