Title: Development of Quality Control Test Procedure for Characterizing Fracture Properties of Asphalt Mixtures

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Project Objective

The main objective of this study is to investigate the use of SCB test as a quality assurance/quality control (QA/QC) measure for field construction. In particular, the objectives include: Compare the fracture properties of AC mixtures using the Semi-Circular Bend (SCB) test to those of the fatigue beam test (FBT) and to evaluate the impact of moisture damage on the fracture and fatigue properties as determined by SCB and FBT.

Problem Statement

Fatigue cracking is a primary distress in asphalt pavement due to repetitive stresses and strains caused by traffic loading and environmental factor such as temperature differences. The fatigue resistance of AC is investigated by a number of fatigue testing. In California, the Asphalt Research Program performed a five year study on the fatigue performance of AC mixtures. The FBT developed during these studies well predicted the asphalt mixture fatigue performance. However, the relatively long testing period and the high variability in the test results make the FBT almost unpractical for quality assurance/control testing. Therefore, a quality control test that is simple to perform and well correlated to the fatigue beam test is needed to support the frequently required quality assurance/control testing. As such the SCB test is being selected in this study for further evaluation because it is simple to perform (it can be conducted using regular stabilometer that is used in the mix design), inexpensive (one compacted specimen makes four SCB specimens), and simple to analyze (the output parameter is indicative of the dissipated energy during the crack propagation).

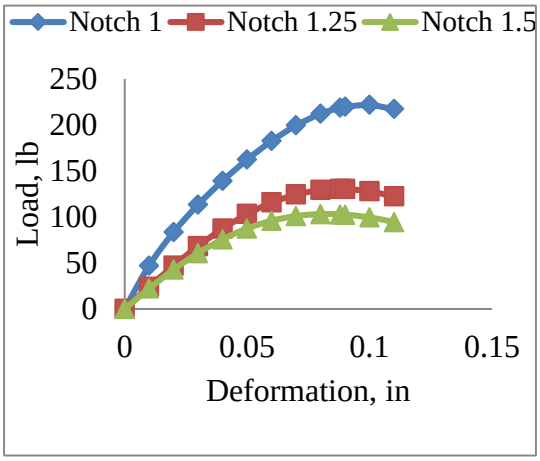
Research Methodology

Two binder types, PG64-10 and PG58-22, were used in this study. The job mix formulas for each mix type considered were identical except for the binder type. The asphalt binder met California specifications. Granite was the predominate aggregate used in the AC mixture types considered. Figures 1 and 2 present the experimental results of the deformation-load curve and the strain energy change with notch depth. These relationships were used to calculate the critical strain energy release rate Jc

Results

The critical strain energy release rate, which called the critical value of J-integral or J_c was determined for each semi-circular specimen tested. Three notch depths of 25.4-, 31.8- and 38.0

mm (1-, 1.25-, and 1.5 in.) were used in this study. The tests were conducted at 20°C. A semi-circular specimen was loaded monotonically until fracture under a constant cross-head deformation rate of 0.5 mm/min (0.02 in./min.) in a three-point bend load configuration.



Figures 1 the deformation-load curve

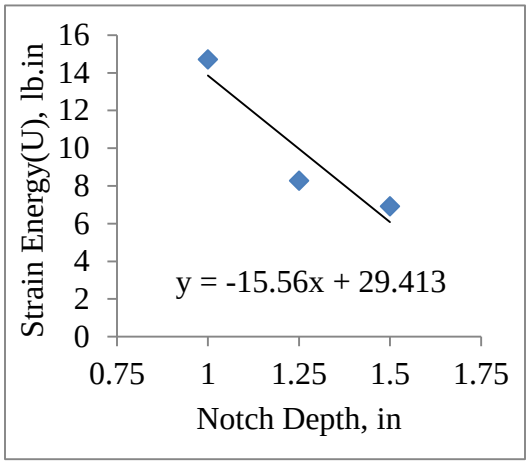


Figure 2, strain energy change with notch depth

The SCB J_c values were normally distributed. The J_c value ranged between 1.524 kN/m and 0.268 kN/m (8.7 and 1.53 lb/in) for all the specimens in this study. The PG64-10 mixture achieved higher J_c values compared to PG58-22 mixture for both dry and wet conditions. Analysis of variance (ANOVA) was used, considering two variables, namely binder type and specimen condition. The ANOVA indicated that there is no significant effect of the mixture type on the measured SCB J_c, however, there is significant effect of the condition (dry Vs wet) on the measured SCB J_c as indicated by the P-value.

FBT was conducted according to AASHTO T-321. A test temperature of 20°C and a stain level of 350 micro-strain were used. The number of load cycles to failure was determined as the number of cycles for a 50% reduction in initial stiffness and dissipated energy. Six AC mixture beam specimens were prepared for each mix.

Analysis of variance was performed on the effect of mixture type and the condition of the mixtures on FBT initial dissipated energy and cycles to failure (N_f). The ANOVA indicated that there is no significant effect of the mixture type and condition on the measured initial dissipated energy. Similar to the SCB J_c, the ANOVA indicated that there is no significant effect of the mixture type on the measured N_f, however, there is significant effect of the condition (dry Vs wet)

The SCB J_c parameter and the FTB N_f ranked the dry mixtures higher than the wet mixtures for PG64-10 and PG58-22 mixtures. In addition, SCB J_c and FBT N_f had similar ranking for the wet mixtures. For the dry mixtures the J_c had ranked the PG64-10 mixture higher than the PG58-22 mixture, however the FBT N_f ranked the PG58-22 higher than the PG64-10. In general, SCB J_c had similar ranking to the FBT N_f. In terms of coefficient of variability (%CV) the FBT N_f exhibited higher variability than those of SCB J_c. The results of this pilot study indicate that the SCB test has a great potential as QA/QC test of fracture properties of asphalt mixtures.