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A NOVEL TECHNIQUE IN MECHANICAL EVALUATION OF ADHESIVE JOINTS SUBJECT TO MONOTONIC AND FATIGUE LOADINGS

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Adhesive joints are normally subject to static and fatigue loadings in their entire service-life duration. Various types of mechanical tests are needed in order to evaluate the joint performance under different working conditions that might also involve environmental degradation and mixed-mode loading. In this work, a series of cyclic tests on double-cantilever-beam (DCB) specimens have been conducted under opening loads (mode-I) at room temperature. The main objective of this work was to evaluate the mechanical performances of a toughened structural epoxy adhesive of 3M under monotonic and fatigue loadings. DCB specimens were made from aluminum bars in accordance with ASTM standard D 3433 and then tested by implementing a novel testing technique. A series of crack detection sensors (Vishay CD-23-10A) were bonded to one face of DCB specimen and were used for crack length measurements and also for controlling the testing machine in switching between quasi-static and fatigue load cases. The testing machine had two aligned hydraulic actuators applying bending forces on upper and lower arms of DCB specimen. Five constant-amplitude cyclic tests were carried out on the same specimen in load control with a load ratio of 0.1. Prior to each cyclic loading, the quasi-static value of critical strain energy release rate (G_{Ic}) in adhesive layer was first determined. The influence of testing frequency was also investigated by varying the testing frequency from 4 to 20 Hz. The fatigue performance of each configuration was represented by a power law relationship and was compared for different frequencies. The test results revealed that the fatigue damage occurred at lower load levels when compared with quasi-static fracture loads. The influence of fatigue loading on mechanical performance of adhesive joints should be considered in adhesive joint design.