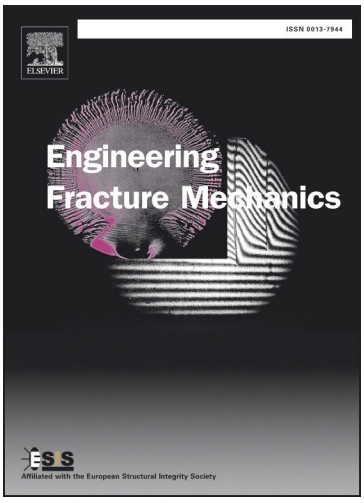

Mixed-mode fatigue crack growth and life prediction of an automotive adhesive bonding system

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Mixed-mode fatigue crack growth and life prediction of an automotive adhesive bonding system

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Abstract

Mixed-mode fatigue crack growth behavior of an automotive adhesive bonding system (AA5754O-A951-BM4601) has been investigated using a compound compact mixed-mode specimen. The test was performed under load control with 0.1 *R* ratio and 3Hz frequency. A long-distance moving microscope was employed to record the real-time length of the fatigue crack in the adhesive layer during testing. The strain energy release rate components of the crack were analyzed by finite element method. The pure-mode fatigue crack growth test results show that a given value of G_{I} results in a fatigue crack growth rate over an order of magnitude higher than for an equal value of G_{II}. The mixed-mode tests results indicate that under a given loading angle, the fatigue crack growth behavior is also influenced by the test load due to the changing shear mode ratio when the crack grows. The fatigue crack growth data were then processed by a generalized Paris relation formula and employed in the direct fatigue life prediction of single lap shear joints with the same bonding system. The life prediction shows good results in the low-cycle region but slightly conservative results in the high-cycle region when compared to coupon fatigue tests.

Keywords: Automotive joining; Adhesive joint; Fatigue crack growth; Fatigue life prediction

1. Introduction

Adhesive bonding is considered an ideal replacement or reinforcement for traditional mechanical joining methods such as welded and riveted joints in ground vehicle applications [1]. The advantages of adhesive joining include higher static/fatigue performance under the same weight, the capability of joining dissimilar materials, higher stiffness, and better damping performance. Adhesive bonding frequently represents the most convenient and cost-effective joining technique, since the bonding process can often be easily automated [2–3].