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An apparatus for mixed-mode fracture characterization of adhesive joints

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Abstract

This paper describes a method of measuring the toughness of adhesive joints in various mixed mode combinations from mode I (opening) to mode II (shear) relying exclusively on the load-displacement curve obtained from an universal testing machine and the displacement from two linear variable differential transformers (LVDT) connected to the specimen beams. The novelty of the method reported here is that it does not use a visual crack length measurement, instead employing a method that deduces the crack length from the displacement obtained from LVDTs. Relying exclusively on the three machine outputs described, it allows for an automated data reduction scheme and, therefore, results in an easier analysis that is both accurate and not depending on human observation. Validation of the mixed-mode results was performed using classic mixed-mode tests and classic pure-mode tests which provided comparable results, therefore validating the apparatus results.

Keywords: Mixed-mode, Fracture energy, Fracture envelope, Double Cantilever Beam (DCB), End-Notched Flexure (ENF)

1. Introduction

Adhesive bonding of structures used in aeronautic and automotive industries is an important process that has been shown to improve the strength to weight ratio of the overall structure. Interest in adhesive joints is growing, and the additional knowledge to further improve the design criteria in order to forecast the joint behavior under service loads is always welcome. Fracture mechanics is a useful methodology to characterize adhesive joints and is supported by damage mechanics, which defines the cohesive parameters and embodies a powerful tool for simulation and design of adhesive joints. To apply these tools, adhesive joint fracture toughness characterization in mode I, mode II and mixed mode (I+II) must be obtained, and there are several tests proposed to achieve that goal. Toughness is usually expressed in terms of the critical value for the strain release rate, G_c, which is the energy

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