WIRE-MATRIX DEBONDING UNDER TRANSVERSE LOAD: Inverse identification of a cohesive zone model for the interface

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Abstract

Numerous single-fiber tests have been developed in the last decades to study interfacial debonding between fibers and matrices in composites. The most commonly used are the pull-out, push-out and fragmentation tests, but these tests focus solely on interfacial shear strength. In addition, these tests do not allow crack length measurement for a non-transparent matrix. The transverse test (1), in which the fiber is embedded perpendicularly to the loading direction, allows surface observation of debonding while under mixed-mode loading (2)(3).
In this work, the debonding of a steel wire in an epoxy matrix under transverse tensile loading is investigated. A simple method for identifying the cohesive model parameters for the wire-matrix interface is proposed, based on a so-called through-light measurement of the debonding extent. The length of the crack is optically monitored during a monotonic loading. Crack initiation occurs abruptly at the wire poles where the stress concentrates. Once initiated, crack grows progressively, which is also recorded. An inverse identification of the cohesive parameters is carried out based on these observations. A 2D plane strain finite element analysis is used with cohesive elements along the interface. The influence of mode mixity on the critical energy release rate is considered as in Hutchinson and Suo (4). The non-linear mechanical behavior response of the epoxy is also accounted for.

A restricted set of interface fracture properties is first determined using the initiation phase (remote stress and debonding angle at crack initiation). These are further refined for capturing the stable crack growth stage. The agreement between experimental data and simulations is very good, especially at crack initiation. This identification is compared with an approach using the coupled criterion (5) and the influence of cohesive zone length is discussed.

References:

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