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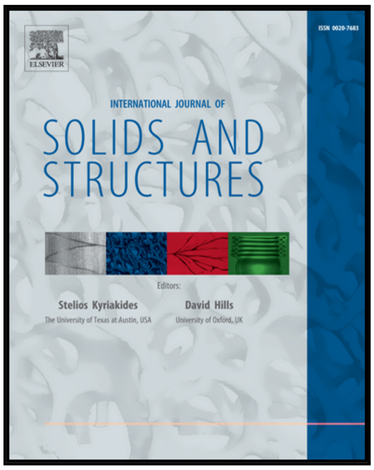

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On G_c, J_c and the characterisation of the mode-I fracture resistance in delamination or adhesive debonding

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Abstract

We focus on the mode-I quasi-static crack propagation in adhesive joints or composite laminates, where inelastic behaviour is due to damage on a relatively thin interface that can be effectively modelled with a cohesive-zone model (CZM). We studied the difference between the critical energy release rate, G_c, introduced in linear elastic fracture mechanics (LEFM), and the work of separation, Ω, i.e. the area under the traction-separation law of the CZM. This difference is given by the derivative, with respect to the crack length, of the energy dissipated ahead of the crack tip per unit of specimen width. For a steady-state crack propagation, in which that energy remains constant as the crack tip advances, this derivative vanishes and $\Omega = G_c$. Thus, the difference between Ω and G_c depends on how far from steady-state the process is, and not on the size of the damage zone, unlike what is stated elsewhere in the literature. Therefore, even for very ductile interfaces, $G_c = \Omega$ for a double cantilever beam (DCB) loaded with moments and their difference is extremely small for a DCB loaded with forces. We also show that the proof that the critical value of the J integral, J_c, is equal to the nonlinear energy release rate is not valid for a non-homogeneous material. To compute G_c for a DCB, we use a method based on the introduction of an equivalent crack length, a_{eq}, where the solution is a product of a closed-form part, which does not require the measurement of the actual crack length, and of a corrective factor where the knowledge of the actual crack length is required. However, we also show that this factor is close to unity and therefore has a very small effect on G_c.

Keywords: DCB test, mode-I delamination, data-reduction schemes, fracture toughness, crack length measurement, cohesive zone models

1. Introduction

In the last few years, the validity of data-reduction methods derived from linear elastic fracture mechanics (LEFM), for the experimental determination of the fracture resistance during adhesive joint debonding or composite delamination in presence of 'large-scale' fracture processes, has been seriously questioned [1, 2, 3, 4, 5]. Although not

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