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Three dimensional FE analysis of interfacial fibre/matrix debonding in fibre-reinforced composites

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ABSTRACT

Interfacial fibre/matrix debonding is one of the most relevant micromechanical failure mechanisms in fibre reinforced composite materials. This failure topology has been amply observed in composites, particularly in layers whose reinforcing direction is not aligned with the predominant external loading [1].

The interfacial debonding generally evolves stably along interface up to a critical length (or angles, using a polar coordinate setting centered in the fibre centroid) at which it modifies its propagation direction and kinks into the matrix, and continuing its progression and possibly experiencing a coalescence with adjacent microcracks. In this setting, one of the fundamental aspects that characterize this failure mechanism relies on the mixed-mode character of the interfacial debonding. This is a direct consequence of the dissimilar mechanical properties of the fibre and the matrix, which has a pivotal influence on the fracture toughness of bi-materials interfaces.

At present, from the numerical point of view, most of the investigations dealing with interfacial debonding regard bi-dimensional (plane strain) models and characterize the inelastic character of the interface using cohesive zone models (CZMs) or alternative interface models. This is the case of the recently proposed Linear Elastic Brittle Interface Model (LEBIM), which consists of a linear traction-separation law up to a critical point at which the material point fails abruptly [2, 3].

This contribution concerns with the three FE dimensional analysis of the interfacial fibre/matrix debonding using LEBIM. This numerical technique aims at providing a closer insight into the study of the initiation and evolution of the fibre/matrix debonding, where the potential “crack tunneling” and free-edge effects are incorporated in the simulations [4].

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