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QUASI BRITTLE MATRIX COMPOSITE MATERIALS: A COMPUTATIONAL APPROACH BASED ON DISCONTINUOUS-LIKE FE AND FRACTURE MECHANICS DEBONDING SIMULATION

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ABSTRACT

The simulation of the damaging mechanisms observed in fibre reinforced composite materials is considered in the present paper. In particular the case of quasi brittle matrix composite is accounted for; in such a case matrix damage and subsequent failure is often associated to the creation and propagation of cracks, whose opening is mitigated by the presence of the reinforcing fibre phase.

On the other hand, the effectiveness of fibres on the composite's load bearing capacity is heavily affected by the debonding phenomenon.

Both degrading mechanisms are considered in the present study; matrix cracking is accounted for by adopting a discontinuous-like FE approach [1, 2-4], allowing to introduce and propagate cracks depending on the matrix stress field, while fibre-matrix detachment is simulated through a fracture mechanics approach, assessed through a crack growth model (corresponding to debonding, Fig. 1) based on the critical interface fracture energy $\mathcal{G}_{ic}$ [5]; the remote critical stress causing debonding advancing can be written as:

$$\sigma_c^{\infty} \geq \sqrt{E_i \cdot \mathcal{G}_{ic}} \,/\, K^*_i \cdot \sqrt{\pi l} \qquad (1)$$

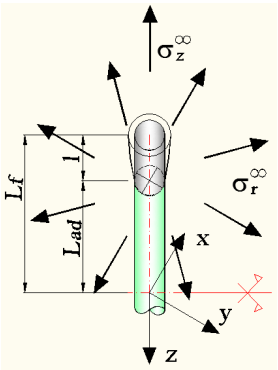

Fig. 1. Debonded extremity of a fibre under remote radial (σ_x^{∞}) and axial (σ_z^{∞}) stress.

where the dimensionless interface SIF K^*_i has been used. The main mechanical aspects of the developed model are described and discussed; it is shown as the two damaging issues are properly described by the proposed computational approach.

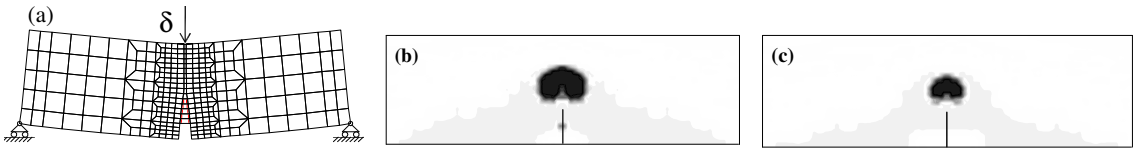

Fig. 2. FE model of a three point bending beam (a); crack path (a) and fibre debonding for: $\mathcal{G}_{ic} = 5N/m$ (b), $\mathcal{G}_{ic} = 20N/m$ (c).

Some numerical applications are finally presented (e.g. Fig. 2) and the main capabilities of the model in brittle FRC mechanical modelling are illustrated.

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