MICROMECHANICAL DAMAGE AND CONSTITUTIVE MODELING FOR IMPACT SIMULATION OF RANDOM FIBER COMPOSITE STRUCTURES

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ABSTRACT

Micromechanical damage models are presented to predict impact behavior and damage evolution in random fiber composites. To estimate the overall elastoplastic damage responses, an effective yield criterion is derived based on the ensemble-volume averaging process and the first-order effects of eigenstrains due to the existence of discontinuous fibers. The proposed effective yield criterion, together with the assumed overall associative plastic flow rule and the hardening law, constitutes the analytical foundation for the estimation of effective elastoplastic behavior of ductile matrix composites. Progressive interfacial fiber debonding models are subsequently considered in accordance with the Weibull's statistical function to describe the varying probability of fiber debonding. First, the debonded fibers are assumed to be voids in ``complete debonding model''. In the subsequent derivation, the *partial* debonding is taken to be the underlying debonding mode; and a partially debonded elastic fiber is replaced by an equivalent, transversely isotropic fiber for the homogenization in ``partial debonding model''. Efficient step-by-step iterative computational algorithms are also presented to implement the proposed damage models. Finally, the progressive damage model is implemented into finite element program DYNA3D to solve large-scale problems such as automobile components and structures under impact loading.

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