Dynamic Inelastic Behavior of Random Fiber Reinforced Composites for Automotive Applications

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Abstract

Damage constitutive models based on micromechanical formulation and combination of micromechanical and macromechanical effects are presented to predict dynamic inelastic behavior and progressive damage in random fiber reinforced 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. Progressive interfacial fiber debonding models are subsequently considered in accordance with a statistical function to describe the varying probability of fiber debonding. First, an effective elastoplastic constitutive damage model for aligned fiber reinforced composites is proposed. A micromechanical damage constitutive model for three- and two- dimensional random fiber reinforced composites is then developed. Finally, the complete progressive damage constitutive model is implemented into finite element code DYNA3D to simulate the dynamic inelastic behavior and the progressive damage of the composite structures. This allows prediction of the mechanical response of large composite structures and eliminate the need for expensive large-scale experiments. The computational capability also plays a significant role in the optimizing the design of complex mechanical systems composed of composite materials.

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