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NONLINEAR PREDICTIONS IN LAMINATED COMPOSITES AND STRUCTURES

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Continuous fiber reinforced polymer materials have found widespread application in high tech products. Their high specific stiffness and strength make them excellent choices for lightweight components. Challenges may arise from their complex behavior beyond the elastic limit, the wide variety of nonlinear mechanisms, and the pronounced directional sensitivity. To better exploit the potential of such composites appropriate constitutive material models are required to predict their response. Moreover, such models need to be suited for utilization in structural analyses to compute the behavior of composite components. This should exceed classical "first ply failure" considerations to evaluate stress redistribution and, consequently, component's strength reserve and peak load. Additionally, it may be of interest whether damage growth in the component is stable or unstable.

A nonlinear constitutive material law [1] is reviewed which models the mechanical response of a unidirectional reinforced composite ply under plane stress assumption. It is based on a phenomenological description in terms of continuum damage mechanics enriched by plasticity mechanisms. An older version of this model also participated in the "Third World Wide Failure Exercise" [2]. The constitutive model is implemented for implicit as well as explicit time integration schemes within the Finite Element Method, i.e. in *Abaqus/Standard* and *Abaqus/Explicit (Dassault Systèmes Simulia Corp., Providence, RI, USA).*

Various applications of the model are shown spanning from predictions for unidirectional reinforced layers to structural analyses. The latter comprise Open Hole Tension Tests and L-shaped laminates in which ply nonlinearities as well as delamination mechanisms are considered simultaneously. Finally, the model is employed in the simulation of textile composites modeling yarns in woven or braided layers [3].

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