Towards the mesh insensitive modeling of composite damage in an explicit crash simulation

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The usage of advanced composite materials is a fundamental step towards the energy efficient design and construction in broad range of industrial applications. However, this requires a profound knowledge about the nonlinear macroscopic properties of the material, which is among others driven by inelastic material behavior of the individual constituents and a variety of characteristic damage mechanisms. Especially for safety relevant parts this includes a reliable modelling of the post critical softening behavior of the material. Since a direct modeling of the microscopic and mesoscopic material structure is not feasible in numerical analysis of a composite part, robust effective material models need to be applied.

To this end, a hybrid composite material model has been developed. Based on the ideas presented in [1] it combines a pre-critical continuum formulation with a cohesive based post-critical softening law. Compared to pure failure models [2] and continuum damage approaches [3], it allows not only for a failure detection, but also for a mesh independent modelling of intralaminar damage mechanism based on the incorporation of a characteristic length for the degradation process. Furthermore, an efficient modelling of potentially orthotropic plasticity phenomena is achieved by the multiaxial generalization of an endochronic plasticity approach.

The performance of the formulated model is subsequently evaluated against standard continuum damage formulations as well as experimental tests. This includes academic tests as well as advanced crash simulations.

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