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Damage Mesomodel Based Low-Velocity Impact Damage Analysis of Laminated Composite Structures

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Abstract : Damage meso-model for laminates is one of the most widely applicable approaches for the analysis of damage induced in laminated fiber-reinforced polymeric composites. Damage meso-model for laminates has been developed over the last three decades by many researchers in experimental, theoretical, and analytical methods that have been carried out in micromechanics as well as meso-mechanics analysis approaches. It has been fundamentally developed based on the micromechanical description that aims to predict the damage initiation and evolution until the failure of structure in various loading conditions. The current damage meso-model for laminates aimed to act as a bridge between micromechanics and macro-mechanics of the laminated composite structure. This model considers two meso-constituents for the analysis of damage in ply and interface that imparted from low-velocity impact. The damages considered in this study include fiber breakage, matrix cracking, and diffused damage of the lamina, and delamination of the interface. The damage initiation and evolution in laminae can be modeled in terms of damaged strain energy density using damage parameters and the thermodynamic irreversible forces. Interface damage can be modeled with a new concept of spherical micro-void in the resin-rich zone of interface material. The damage evolution is controlled by the damage parameter (d) and the radius of micro-void (r) from the point of damage nucleation to its saturation. The constitutive martial model for meso-constituents is defined in a user material subroutine VUMAT and implemented in ABAQUS/Explicit finite element modeling tool. The model predicts the damages in the meso-constituents level very accurately and is considered the most effective technique of modeling low-velocity impact simulation for laminated composite structures.

Keywords : mesomodel, laminate, low-energy impact, micromechanics
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