Discrete Damage Modeling of Compression Strength After Impact

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The Discrete Damage Modeling (DDM) method is extended for progressive failure analysis in laminated composites for compression strength after impact. DDM uses the Regularized eXtended Finite Element Method (Rx-FEM) for the simulation of matrix cracking at initially unknown locations and directions independent of the mesh orientation. All plies are tied together by using cohesive interfaces, which are allowed to delaminate. A cohesive interface model is used both for Rx-FEM transverse ply cracking as well as delamination propagation. Matrix cracks in two adjacent plies interact through the interface cohesive model and their presence is a major delamination initiator. Damage was inserted into the model by super-imposing nondestructive evaluation onto the model. Delaminated regions are represented as cohesive zone model with weak interfacial properties to avoid interpenetration of the plies. Transverse matrix cracks could be pre-imposed into model via similar processes degraded "crack initiating" material properties. The compression strength after impact of IM7/977-3 laminates has been predicted and compared to experimental data. The results for the $[45/0/-45/90]_{4s}$ stacking sequence are presented here. The predictions capture most trends, and showed good agreement with post damage analysis; however, significant studies are required to develop a reliable methodology for quantitative composite residual strength prediction.

Figure 1. Pre-imposing Nondestructive Evaluated Damage into DDM to Predict Residual Strength