ICME Approach to Compression Strength after Impact Modeling

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Integrated computational materials engineering (ICME) is a methodology where a hierarchical multiscale simulation is used to determine a material's characteristics and performance. The idea of developing multiscale mathematical models to understand a material has existed for a long time. With the 21st century advancements in the computational power of personal and super computers, multiscale integrated modeling has also advanced by adding more physics to the microscale models and integrating those results into progressive failure of macroscale models. The "Integrated Computational Methods for Composite Materials (ICM2)" program intends to employ ICME methodology to composite materials in an aircraft structural application. The ICM2 framework develops a process that links a composite material's processing characteristics to its material properties and structural relationships, which are then applied to predict overall processibility, manufacturability, and system performance. The linked material properties are applied to predictive analysis models to show overall effects of residual stresses, spring in effects, and notched laminate strength properties such as open-hole compression and compression strength after impact (CAI). This paper will discuss the analysis and correlation of the predictive CAI models with the ICM2 material microscale analysis providing the property inputs.

CAI remains an important design allowable in composite aircraft. Low speed impacts to a laminate either in service or during manufacturing can leave a damaged area in the part. This damaged area can result in a failure of the laminate under compression loading at a stress/strain level that is far below the lamina's compression failure allowable. The primary mechanism leading to this failure is a sublaminate buckle in the area of the impact damage which leads to crack growth from the impact delaminations. The CAI test is a difficult configuration to model due to the shape and amount of damage created at impact.