
# Review and Benchmark Study on the Analysis of Low-Velocity Impact on Composite Laminates

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# Review and Benchmark Study on the Analysis of Low-Velocity Impact on Composite Laminates

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**Abstract**

For the analysis of low-velocity impact damage many analytical and numerical models were developed by various authors. These models range from simple approaches with a single degree of freedom up to finite element models on micro-scale. The prediction of delamination, fiber failure, and inter-fiber damage, as well as a physically sound kinematic behavior, are usually the objectives of these simulations. However, achieving satisfactory results requires massive computation and modeling efforts. In the present paper, we review the capability to capture impact damage on the coupon and the structural level. For this purpose, a large compendium of analytical and numerical analysis methods from various authors is considered. Based on existing works, six representative modeling approaches of different abstraction scales are derived and considered on a qualitative and quantitative benchmark study. We analyze all models regarding their advantages and deficiencies. With two experimental coupon impacts, all approaches are tested on their predictive capabilities on the coupon level. The applicability of these methods on the structural level is evaluated according to the benchmark results. Modeling approaches included in the benchmark range from high-fidelity models on meso-scale, macro-scale shell models, and analytical estimations. The focus is put on stacked layer models with solid or shell elements and various cohesive zone approaches.

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