

Study on Optimization and Crash Worthiness of A Composite Side Car Door

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Abstract: *The increasing demand for lightweight, fuel-efficient vehicles has led to the widespread adoption of composite materials in automotive structural components. This study focuses on the optimization and crashworthiness analysis of a composite side car door, aiming to enhance impact resistance while minimizing weight. A finite element model of the side door was developed using advanced composite layups, including carbon fiber-reinforced polymer (CFRP) and glass fiber-reinforced polymer (GFRP). Material selection, ply orientation, and stacking sequence were optimized using a multi-objective optimization framework to achieve a balance between mechanical performance and manufacturability. Crashworthiness was evaluated through virtual simulations under side-impact scenarios in accordance with NCAP regulations. Key performance metrics such as intrusion distance, energy absorption, and peak impact force were analyzed. The optimized composite design demonstrated a significant improvement in energy absorption (up to 30%) and a reduction in door weight by 40% compared to traditional steel structures, without compromising safety. This research highlights the potential of tailored composite structures in enhancing automotive safety and performance. The integration of optimization techniques and crash simulations offers a practical approach for next-generation lightweight vehicle design.*

Keywords: carbon fiber-reinforced polymer

