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Crashworthiness of Different Composite Tubes by experiments and simulations

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Abstract: Composite tubes show a good energy absorbing ability and they have great potential as energy absorbing components to replace traditional metal structures in automobiles, aircrafts and other transportation. This paper aims to investigate the impacts of geometrical parameters, including intermediate diameter, wall thickness and upper end diameter, on the specific energy absorption (SEA) of composite tubes, metal tubes, foam-filled tubes and hybrid tubes. The mechanical characteristics (axial compression response) of these tubes were numerically predicted by commercial finite element (FE) package LS-DYNA. Quasi-static axial compression tests were performed to determine failure parameters of glass fiber reinforced polymer (GFRP) used in this paper. Stress-strain curves of polyurethane foam and aluminum foam were also obtained by tests. Finite element models of hollow GFRP, aluminum and aluminum-FRP tubes and polyurethane foam-filled and aluminum foam-filled composite tubes were established respectively. Configurations of these numerical models include circular, square and tapered (5 different upper end diameters) tubes. In optimization part, structural parameters optimization was carried out by response surface method (RSM). Results review that in general, SEA of circular tubes increases with smaller diameter-thickness ratio. In comparison part, SEA of circular, square and tapered tubes were compared. Results show that changing upper end diameter of tubes has great impacts on their energy absorption capacity, but sensitivities of SEA to geometrical parameters and cross-section shapes differ depending on materials of tubes and foam filling.

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