Crashworthiness optmization of composite tubes by experiments and simulations

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Abstract

For energy absorption structures of a particular material, changing their geometrical dimensions can generally cause great change of their energy absorption capacity. The main content of this paper is to investigate the influence rule of the specific energy absorption (SEA) caused by the dimensional changes (intermediate diameter, wall thickness and upper end diameter of the tube), stacking sequence and ply orientation and talk about the impacts of this rule under different conditions, including different materials, combined structures (metal-FRP tube) and foam filling. Firstly some glass fiber reinforced polymer (GFRP) tubes were fabricated using filament winding technology and quasi-static compression tests were conducted to hollow tubes, polyurethane foam-filled tubes and aluminum foam-filled tubes respectively. Finite element models of hollow GFRP, aluminum and aluminum-FRP tubes and polyurethane foam-filled and aluminum foam-filled composite tubes were built respectively. Configurations of models include circular, square and tapered (5 different upper end diameters) tubes. And their SEA were obtained under quasi-static load condition. The result show that changing upper end diameter of the tube can definitely affect its energy absorption capacity, but sensitivities of SEA to dimensional change is different because of different materials and foam filling.

Keywords: Crashworthiness, GFRP, Optimization, Ply angle, Foam filling, Thin-wall tube