

Crashworthy capacity of a hybridized epoxy-glass fiber aluminum columnar tube using repeated axial resistive force

Abstract

A combination of aluminum columnar member with composite laminate to form a hybrid structure can be used as collapsible energy absorbers especially in automotive vehicular structures to protect occupants and cargo. A key advantage of aluminum member in composite is that it provides ductile and stable plastic collapse mechanisms with progressive deformation in a stable manner by increasing energy absorption during collision. This paper presents an experimental investigation on the influence of the number of hybrid epoxyglass layers in overwrap composite columnar tubes. Three columnar tube specimens were used and fabricated by hand lay-up method. Aluminum square hollow shape was combined with externally wrapped by using an isophathalic epoxy resin reinforced with glass fiber skin with an orientation angle of $0^{\circ}/90^{\circ}$. The aluminum columnar tube was used as reference material. Crushed hybrid-composite columnar tubes were prepared using one, two, and three layers to determine the crashworthy capacity. Quasi-static crush test was conducted using INSTRON machine with an axial loading. Results showed that crush force and the number of layers were related to the enhancement of energy absorption before the collapse of columnar tubes. The energy absorption properties of the crushed hybrid-composite columnar tubes improved significantly with the addition of layers in the overwrap. Microscopic analysis on the modes of epoxy-glass fiber laminate failure was conducted by using scanning electron microscopy.