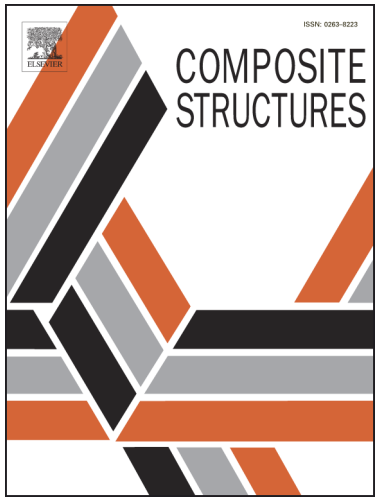

Energy absorption analysis for tapered multi-cell tubes improved by foams: theoretical development and numerical simulation

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Abstract

In this paper, Energy absorption characteristics of tapered multi-cell tubes improved by foams are studied. For the energy absorption process, a theoretical formulation is developed to represent the mean crush load of the foam-filled tubes considering a combination of mean crush loads due to non-filled tube, the foam-filler, and a frictional resistance between them (interaction effects). The formulation is based on the assumptions including equivalent segmented non-tapered single-cell tubes as well as a parallel resisting force of the contributors (non-filled tubes, foam-filler, and interaction effects). Moreover, an extensive numerical analysis on the crushing of the foam-filled tapered multi-cell tubes, with a taper angle ranging from 0 to 7 degrees, a wall thickness ranging from 0.25 to 3 mm, and a cell number ranging from 1×1 to 10×10, is conducted to evaluate the effects of side wall tapering, cross section's division into multiple cells and wall thickness enlargement on the crashworthiness characteristics. Analyses indicate that there are significant enhancements in the energy absorption behavior of the foam-filled tubes with respect to the non-filled ones. As a special case, the force-displacement results obtained in the numerical simulation are verified against those experimentally observed and reported in the literature for a foam-filled non-tapered single-cell tube.

Keywords: Foam-filled tapered multi-cell tube; energy absorption; crashworthiness;

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