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An experimental investigation on energy absorption of thin-walled bitubal structures by inversion and axial collapse

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Abstract
This paper investigate a new design model for energy absorption of empty and polyurethane foam-filled circular bitubal tubes. In this study, an experimental technique is used to evaluate crashworthiness parameters and crushing behavior of the bitubal energy absorbers under compressive quasi-static loading. One of the aims of this new and innovative design is to increase the energy dissipation maximally through the tube inversion and the axial collapse, simultaneously. To do so, the inner tube with inversion and the outer tube with the collapse leads to a dissipation of energy in the deformation process. However, the stable collapse in the outer tube is required for a complete inversion of the inner tube. Therefore, by creating outer grooves at some determined areas along tube length, a long tube is divided into small parts to prevent asymmetric folding. In the present work, the effects of shrink-fitting and polyurethane foam are studied to control the sudden force applied to the main part of the structure when the accident occurs The results of experimental tests show that the energy absorption capacity of bitubal specimens are greater than that of monotubal ones. Also, the foam-filled in the bitubal structures and the shrink-fitting of tube leads to increase the energy absorption and the specific energy absorption in comparison with the simple ones. The proposed method would help to reach the improved crashworthiness structure in the hope of reducing the occupant injury in a collision.

Keywords:

Bitubal structure, Inversion, Shrink-fitting, Polyurethane foam, Energy absorption

1 Introduction

Thin-walled tubes are commonly used as energy absorber elements in crashworthiness applications due to their excellent load-carrying capacity and energy absorbing characteristics. This elements are widely used in transportation systems such as automotive, trains, cruise ships, aerospace. When a thin-walled tube is axially compressed, the deformation mechanisms of tube could be classified as: progress buckling [1], global bending [1], inversion [2-4], expansion [5] and splitting [6]. During axial collapse, a thin-walled tube can deform in three different ways, axisymmetric buckles (concertina mode), non-symmetric (diamond mode) and mixed mode or global Euler buckling mode (Fig. 1). This depends primarily on the geometrical dimensions of