NUMERICAL SIMULATIONS OF THE COLLAPSE BEHAVIOUR OF A NEW FOAM-FILLED STRUCTURE

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In this paper, we conduct extensive three dimensional finite element analyses to study the crush behaviour of a new structure containing two ultra-light concentric thin cylinders filled with polymeric foam. The main objective of the study was to investigate the effect of the different geometrical design parameters on the optimum crashworthiness characteristics of the composite structure. Specifically, it was desired to determine the influence of the thickness and the relative radii of the concentric cylinders, and the density of the polymeric foam on the specific energy absorption and the associated modes of collapse.

Finite element simulations were carried using LS-DYNA explicit finite element package. The outer tube was modelled using Belytchko-Lin-Tsay four-noded shell elements with reduced integration and piece-wise-linear plastic material model. The PVC foam core was modelled using eight-noded solid elements with reduced integration and hourglass control and isotropic foam material model. The loading conditions were simulated using a pair of rigid loading platens, located at the top and the bottom of the composite cylinder, respectively. The interfaces between the foam filler, the outer and inner cylinders, and the loading platens were modelled using contact elements with user-defined penalty parameters. Extensive convergence tests were carried-out to ensure that different model parameters accurately simulate the quasi-static axial crush behaviour of this newly devised structure. The numerical results reveal an optimum geometrical configuration, which results in maximising the specific energy absorption, while maintaining a stable mode of collapse.