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ABSTRACT

Thin-walled tubes have exhibited extraordinary advantages in lightweight and energy absorption for crashing scenarios. Geometric configuration of such tubal structures is of decisive effects on crashing behaviors. In this study, crash characteristics of conventional square tube and a criss-cross tube were first conducted using both experimental and numerical analyses, through which the finite element (FE) models were well validated. It was also revealed that the energy absorption of the criss-cross sectional tube was about 150% higher than that of square column with the same weight. Further, a range of criss-cross sections was parametrically modeled with spline curves and a parametric study was subsequently performed to explore the effects of different parameterized shapes on crashing characteristics. It was found that the geometric parameters significantly affected crashworthiness of the criss-cross tubes, and the criss-cross tubes with spline curve (CCT_SPL) surpass the criss-cross tubes with straight line (CCT_STR) in crashworthiness with the same weight. Finally, to optimize the crashworthiness of parameterized criss-cross tubes, the non-dominated sorting genetic algorithm II (NSGA-II) was adopted to seek optimal criss-cross shapes for improving specific energy absorption (*SEA*) and reducing the peak crashing force (F_{max}), simultaneously. The optimization results indicate that the CCT_SPL profiles with reasonable geometric parameters are superior to the CCT_STR counterparts with an increase of 11.1% in terms of specific energy absorption.

Keywords: Crashworthiness; Energy absorption; Criss-cross configurations; Parameterization, Spline curves; Shape optimization.