

Energy absorbing performance of metal thin-walled tube with a pre-folded origami pattern

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Abstract

As a kind of energy absorbing structure, thin-walled tube has the advantages of light weight, high strength, simple manufacturing process and low cost, and thus being widely used in energy dissipation system of motor vehicles, aerospace and high-speed trains. Under the axial loading, the thin-walled tube is compressed into plastic folds and therefore dissipating the kinetic energy by converting it to plastic deformation. thin-walled tubes with different geometric shapes and sizes have different energy absorption performance because of different plastic folds pattern. For a thin-walled circular tube, which the ratio of the diameter to thickness is less than 50 and the ratio of the length to thickness is less than 2, is possibly to be compressed into ring mode plastic folds under axial loading.

It is an effective method to introduce the deformation-induced structure on the thin-walled tube to improve the energy absorption performance of the thin-walled tube. For example, a circular tube with or without deformation-induced structure has different energy absorption performance, as the plastic folds pattern may change from ring mode to diamond mode. In recent years, the origami deformation-induced structure has been paid great attention. The origami project which transforms folk art into engineering design has been widely used in the fields of architecture, automobiles, robots, aerospace and biological sciences. By mapping the folded paper creases to the thin-walled tube can make the plastic folds occur at the position of creases during compression. Thin-walled tube with origami deformation-induced structure has two protruding advantages, that is low peak load and low load fluctuation.

In this paper, a new origami deformation-induced structure is presented, as shown in Figure 1, the real line indicates the outer convex fold, the dotted line indicates the inner concave fold. The corresponding geometric models are established by applying the origami deformation-induced structure to thin-walled square tube, circular tube and polygon tube,

respectively. Then the effect of the geometric parameters of the origami deformation-induced structure on the energy absorption performance of the thin-walled tube was studied by the quasi-static compression simulation based on ANSYS/LS-dyna.

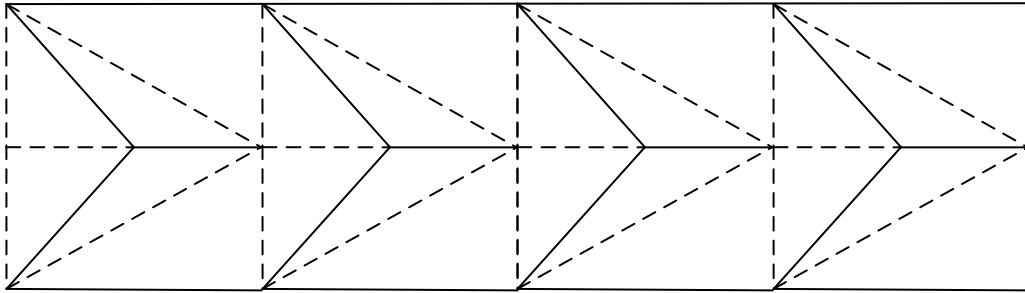


Figure 1 Schematic diagram of origami configuration