INVERSION OF FRUSTA AS IMPACT ENERGY ABSORBERS

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ABSTRACT

In this paper a noval crushing mode of frusta is presented for the first time. The details of the plastic inversion of frusta as energy absorbers are given. The deformation modes of capped frustum are investigated both experimentally and analytically. An Explicit version of ABAQUS 5.7-3 finite element (FE) code is used for computing and describing the proposed deformation mode. Good agreement is obtained between the experimental results and the FE predictions.

KEYWORDS

Energy Absorber, Frusta Inversion, Finite Element.

1. INTRODUCTION

Energy absorbers are systems that convert kinetic energy into other forms of energy, such as elastic strain energy in solids and plastic deformation energy in deformable solids. The converted energy may be reversible, as in pressure energy in compressible fluids, and elastic strain energy in solids, or irreversible, as in plastic deformation. The process of conversion for plastic deformation depends, among other factors, on the magnitude and method of application of loads, transmission rates, deformation displacement patterns and material properties [1].

The predominant domain of applications of collapsible energy absorbers is that of crash protection. Such systems are installed in high-risk environments with potential injury to humans or damage to property. The aim is to minimize the risk of injury or damage by controlling the deceleration pulse during impact. This is achieved by extending the period of dissipation of the kinetic energy of the system over a finite period of time. Cushioning devices on vehicle bumpers, crash retards in emergency systems of lifts and crash barriers used as roadblocks are everyday examples.

Familiar plastic deformable energy absorber units include cylindrical shells [2], wood-filled tubes [3], foam-filled columns [4], sand-filled tubes [5], PVC shells [6], tube inversions [7] and tubular elements [5]. The active absorbing element of an energy absorption system can assume several common shapes such as circular tubes [8], square tubes [9], multicorner metal columns [10], frusta [11] and rods [12]. Axisymmetrical and circular shapes provide perhaps the widest range of all choices for use as absorbing elements because of their favorable plastic behavior under axial forces, as well as their common occurrence as structural elements.