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An Investigation on Collapse of Square Columns Reinforced by Fractal Geometry Method

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Abstract
This article is a research on the crashworthiness of steel thin-walled columns with square sections. These shells are reinforced by alumina foam which is placed on the shell based on an arrangement according to fractal geometry. Fractals were thinned out in a few steps and examined. The samples are placed under axial loading and as we know, the surface below the load-displacement diagram represents the amount of absorbed energy. It should be noted that all analyzes have been performed by ABAQUS software. Finally, it was concluded that the addition of aluminum reinforcement to adsorbent improved the energy absorption parameters. It was observed that with increasing fractal geometry stages, buckling potential increased, however energy absorption parameters are improved. Finally, the specimen with fractal geometry of the third stage with alumina foam was known as the best absorber.

Keywords: Energy absorber, Thin-walled structure, Fractal, Aluminum foam.

Introduction

Today, the energy absorption capacity of structures has been investigated in many industries such as automobile manufacturing, shipbuilding, aerospace and etc. [1-6] and the aim of researchers is production of absorbers that show the highest absorption capacity in controlled conditions. Impact energy absorbers are structural mechanical elements that if the force enters them, they act. In fact, an energy absorber is a system that can convert all or part of the kinetic energy in order to reduce the damaging force into another form of energy transferred to the structure.

Today, energy adsorbents are made and used in many ways. The main types of them are thin-walled structures, which have the highest amount of energy absorption in the region of their plastic shape change [7]. Lightweight, high energy absorption capacity, low space, high buckling length, better buckling, high energy absorption to weight, availability, and cost-effectiveness are the advantages which cause the thin wall structures became one of the best absorption systems. Researches to use of these systems and also optimize of these systems is a new scientific issue in the mechanics of impact [8]. Extensive research on energy absorbers as well as thin-walled structures has been carried out. Arabzadeh and Zaynuddini [9] examined the dynamic response of submersible pressure tubes exposed to transverse impact loads. They showed that the characteristics of the seabed may have very significant effects on the diameter of the pipe, especially in relatively low internal pressure, the maximum impact load and the maximum depth of the indentation increase with increasing the depth of the tube placement in the bed. In this research, the amount of energy absorption and the shape of the hollow tubes with square and circular sections filled with foam under transverse impact load were investigated by experimentally and numerically. Finally, the amount of energy absorption and their deformation mechanism were compared. Abdavi [10] was studied the absorbed energy by corrugated composite tubes in two axial and radial loading modes and concluded that the absorbed energy in axial loading mode is about 30 times the absorbed energy in transverse loading. Di Paolo [11] experimented on square steel square tubes. In general, axial force increases to the point where the first buckling is determined at a maximum force value, and the load-shift fluctuations are related to the progressive chains. Foam is a physical body composed of two distinct gas and solid phases. In fact, foams form a uniform distribution of a phase gas in a solid or liquid phase (each phase can be one of three states of matter), so the cavities contained in them completely by liquid or solid phases which are unrelated. The foams are divided into two large metal and nonmetallic (polymer) groups [12-13]. The importance of using lightweight and high strength structures has made that metal foams interest to many researchers, especially aluminum foams. Gupta and Venkatesh [14] presented a two dimensional numerical model for the symmetric transformation of axial loaded semispherical shells, which consistently met the numerical and experimental studies. Liu [15] investigated honeycomb structures with different shapes. They concluded that in triangular Honeycomb structures, more energy is absorbed from the square than the square, and in the chassis positioning, more energy is absorbed from the square positioning, and the adsorbent was deformed at higher height. Razinick [16] studied screen energy absorbers. He forced by a spherical tip projectile at a speed of 100 m/s to a 0.8 mm thick steel plate and obtained the following results: If the page lubricates, it absorbs less energy than dry. The failure occurs in less time with increasing speed of the projectile. More energy is absorbed if energy increases. The rupture radius increases by increasing speed.