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Experimental investigation on energy absorption of steel spherical shells

M. Shariati[1], H. R Allahbakhsh[2], A. R. Shariati[3], S. Nazarian[4], E. Sanati[5]
[1]Professor, Ferdowsi University of Mashhad, Faculty of Engineering, Mechanical Department; Tel: 05138805159,
[2]M. SC, Shahrood, University of technology, Shahrood;
[3]BSc student, Ferdowsi University of Mashhad, Faculty of Engineering, Mechanical Department;
[4]BSc student, Ferdowsi University of Mashhad, Faculty of Engineering, Mechanical Department;
[5]BSc student, Ferdowsi University of Mashhad, Faculty of Engineering, Mechanical Department;

*(corresponding author: mshariati44@um.ac.ir)

***Abstract*- In this paper, the energy absorption of steel thin walled hemi-spherical shells are investigated under compression loadings. Loadings are applied to specimens using a rigid flat plate. Also the effects of geometrical parameters of specimens like as diameter and thickness are studied on buckling load. The experimental tests performed using an Instron 8802 servo-hydraulic machine. Result shown that the higher diameter spherical absorbed less load than the one of lesser diameter in same thickness.**

Keywords -Buckling, Thin-walled structure, Hemi-spherical shell, Experimental test.

I. INTRODUCTION

Thin-walled shell structures such as cylindrical, spherical and conical shells are widely used in engineering, e.g., aircraft, spacecraft, automobiles, nuclear reactors, tanks for solid and liquid storage as well as their transportation. Hence, the dynamic response and failure of thin shells are of considerable theoretical and technical importance and have drawn great interests and concerns from many researchers [1, 2]. The same study was presented on analysis of post-buckling behavior of elastic spherical shells compressed between rigid plates by Updike and Kalnins [3, 4]. Morris and Calladine [5] followed these experiments by a theoretical study. Updike [6] adopted a similar deformation mechanism and presented an analytically model for a thin-walled spherical shell compressed between rigid plates.

Prasad and Gupta [7] presented the results of tests at different rates of compression and those of impact tests conducted on aluminum spherical domes. A similar study was carried out by Dong [8] and presented the results of impact tests at different speeds of compression on a thin-walled spherical shell.

This paper, was studied the effect of diameter thickness on the energy absorption behavior of hemi-spherical shells. Several experimental buckling tests were performed using an INSTRON 8802 servo hydraulic machine. All the three stages of deformation, namely, local flattening, inward dimpling and multiple lobes, were studied for analysis.

II. EXPERIMENTAL TESTS

a. *Geometry of specimen.*

In this study, thin-walled hemi-spherical shells with three different middle diameter (D= 102, 77, 53 mm), and four different thickness (t = 0.7, 0.8, 1.0, 1.2 mm) were analyzed. Fig. 1 shows the geometry of the specimens. According to this figure, parameters (D, d, t, h) show the middle diameter, upper and lower diameter, thickness and height of the hemi-spherical shells, respectively.

Hemi-spherical are made by joining two semi-spherical with each other using a slight braze welding joint. Also all semi-spherical were made using the spinning sheet metal forming process. From steel sheets of different thicknesses (Fig. 2).

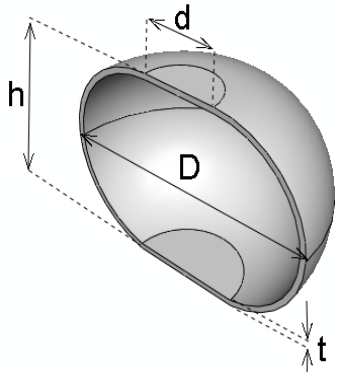

Fig. 1. Cut view of specimens

Fig 2. Manufactured hemi-spherical by two semi-sphericals.

b. *Material properties*

The hemi-spherical shells used for this study were made of mild steel alloy. The mechanical properties of this steel alloy were determined according to ASTM E8 [10] standard, using the INSTRON 8802 servo hydraulic machine. The stress–strain curve, is shown in Fig. 3. Based on the linear portion stress–strain curve, there was computed as E =150 GPa and σ = 404 MPa for steel.

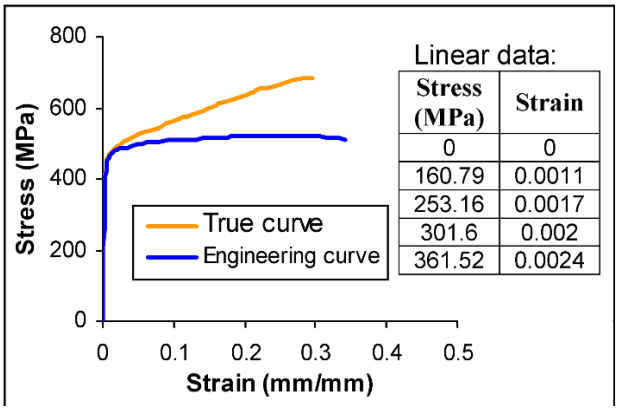

Fig.3: Stress-strain curve.

III. Experimental Results

It was found that for shells of constant thickness, if the radius is increased, the mean collapse load value is decreased. In continue Fig.4 shows experimental load–deformation curves of three different diameter with thickness 1 mm specimens in loading with rigid plate.

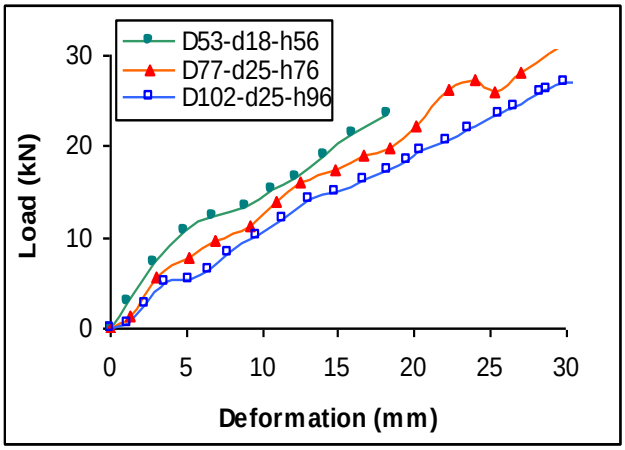

Fig. 4. Experimental load–deformation curves of three Different diameter with thickness 1 mm specimens in loading with rigid plate.

IV. Conclusion

In this paper, the behavior of hemi-spherical shells which have been made of mild steel, with different diameter are analyzed experimentally. Result shown that the higher diameter spherical absorbed less load than the one of lesser diameter. While keeping the thickness value as 1.0 mm, if the diameter is increased from 53 to 77mm, the mean load value decrease 12%, and if the diameter is increased from 77 to 102 mm the mean load decrease 4.7% .

V. References

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