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Harmonic and Buckling Analysis of Pressure Vessels Using Various Stiffeners

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ABSTRACT

A weight vessel is intended to store the gases or fluids at a weight other than encompassing weight. The engine instance of the rocket or sub marine will goes about as the weight vessel. The weight vessels will encounter various burdens when they are in working condition. The heaviness of the weight vessel assumes imperative job when it is moving inverse to gravity like rockets. This will influence the size and cost. So the weight must be decreased by presenting various things which may incorporate composites (or) stiffeners. In the current work to decrease the weight, stiffener case was picked. From the writing it was seen that pressure vessels will likewise flop because of the clasping and symphonious burdens. In the current work pressure vessels with various structures were examinations for both consonant and clasping loads by utilizing the limited component reproduction programming Ansys workbench 17.0. The stiffeners chose in the work are roundabout, rectangular, helical, division, rectangular opened, direct x-crossed and quadratic x-crossed. Clasping loads from Eigen esteem clasping examination and distortion, worries at reverberation from the consonant investigation were contemplated and best stiffener which yields great outcomes was suggested.

Keywords*: Buckling load, stiffener, Harmonic analysis, ANSYS Workbench*

INTRODUCTION

A weight vessel is a holder intended to store the liquids at a weight pretty much from barometrical weight. These weight vessels might be of any shape and any size, for example, circle, chamber, oval and so forth. The most utilized plan of weight vessel is a chamber with hemispherical tops at the closures called heads.Cylindrical vessels are for the most part utilized in the enterprises. In the vast majority of the ventures to decrease the weight and to give the extra firmness, different stiffener are utilized. A stiffener is an additional material which gives extra solidness to the segment. V.N. Skopinsky [1] broke down the consequences of the flexible plastic pressure bends and decided as far as possible weight for circular weight vessels. Medhavi Sinha [2] surrounded the outcomes and indicated that use of legitimate stiffener influences the pressure circulation through the contact surfaces and increment a definitive minute limit of the contacts. Jerzy Domanski [3] advanced multi-criteria of room inside the constrain vessels to lessen Weight, producibility, movability and working it at comfort conditions. Mutahir Ahmed [4] supported that loop pressure differs with decline in thickness of weight vessel. Md Musthak [5] proposed that seat backing of a weight vessel will have basic job to help the weight vessel, it ought to be planned so that it can hold up under the vessel load and inward weight of the compartments. Mr. Yogesh B. Khule [6] supported that pressure vessels consistently bear weight and warm loadings and named it as thermo-mechanical loadings. I. Fakhari Golpayegani [7] proposed Carbon Fiber Reinforced Polymers which are having immense number of uses where high explicit firmness and quality aides in auxiliary weight decrease and augmentation of eco-friendliness. Mohd. Asghar Zaidi arranged structures by isotropic materials are not

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proficient since the hub stresses utilize just a large portion of that of the structure capacities however now, with the coming of composites, the material can be customized so more strands are laid toward the path where the anxieties are High. S. Bhavya [9] dealt with the premise of obstruction change is intended for it and warming framework are consolidated right now and the estimations of weight are assessed in the little chamber. The watched opposition change in pressure demonstrated hysteresis, and causes an impressive blunder in the weight estimation. Eswara kumar A [10] given the significance of lattice and co-ordinate framework while dissecting barrel shaped items.

METHODOLOGY

Pressure vessel is treated as cylinder with no caps and modelled in solid works software. Harmonic analysis and Eigen value buckling analysis were performed by using the Ansys workbench. The schematic view is as shown in figure 1 &2.

Figure 1. Buckling analysis

Figure 2. Harmonic analysis

PROBLEM MODELLING

The length of the cylinder is taken as 300 mm, inner diameter is 200 mm and external diameter is 236mm as shown in fig. 3. Thickness of stiffener is 8mm, modelled on cylinder whose thickness is 10mm. All stiffener designs were modelled with a thickness of 8mm, then compared with basic cylinder.

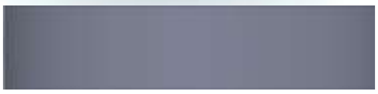

Figure 3.Main geometry

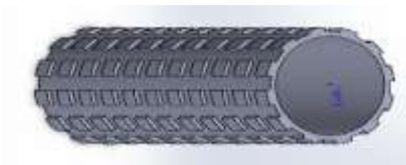

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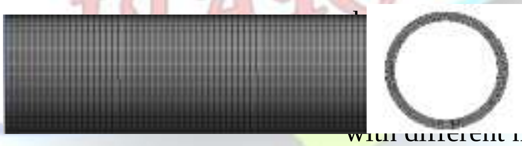
Figure 4. Circular shaped stiffeners

Figure 5. Rectangular stiffeners

Figure 6. Sector Shaped stiffeners

FINITE ELEMENT MESHING

Eight nodded hexahedron elements was used to perform the meshing operation with an element size of 10. Cylindrical coordinate system is assigned to the geometry because it is in cylindrical shape.



a) Front view b) Top view

Figure 11. Meshing of basic cylinder

ANALYSIS

Harmonic analysis

Harmonic analysis was used to find the deformation and stresses in resonance conditions. To find the natural frequencies modal analysis was performed. The forced frequency range was fixed for analysis as 4000Hz. Now the top and bottom surfaces are made constrained (Fixed) and an internal pressure of 50MPa is applied on the inner surface of the cylinder. The frequency responses of the deformation and normal stresses were studied at the resonance condition.

Buckling analysis

Buckling analysis was used to know the stability of the structure. Here the bottom end is fixed in all DOF and [illegible] also fixed except in the Z- direction. [illegible]plied on the top surface as well as the [illegible] magnitude of 1MPa. Then it is studied with different mode shapes.

Material Properties

It is a low carbon steel which combines a high yield strength greater than SAE 4130 with good toughness and weldability. 15CDV6 can be readily welded with very little loss of properties during welding and without the need for further heat treatment and it is assigned to the component at the beginning of the meshing. The properties of the material are:

Density (ρ): 7850.00 kg/m3

Poisson's ratio (ν): 0.32

Young's modulus (E): 194GPa

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Strength of materials: 1253Mpa

RESULT & DISCUSSIONS

Buckling results

The variation of the bucking load w.r.t the different stiffeners were plotted in the figure 12. It comprises of the first three buckling mode values.

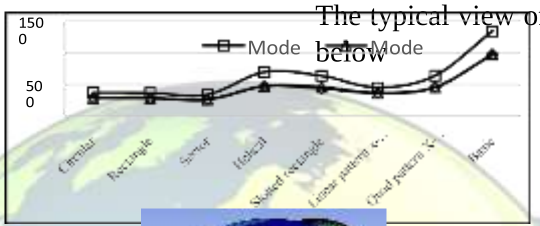

Figure 12. Buckling modes of the stiffeners

It was observed that as modes are increases, the buckling load values are increasing. Among the stiffeners considered, helical shaped stiffener contains the high buckling load. But all these stiffener designs have less buckling load than the basic one. The buckling load of the helical stiffener is 696.5 MPa.

The typical view of mode shapes of buckling is shown below

Model 1 Model 2 Model 3

Figure 13. Mode shapes of the main cylinder

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Harmonic results

The normal stress for various stiffeners in X- direction at first resonance condition are plotted and shown in figure 14.

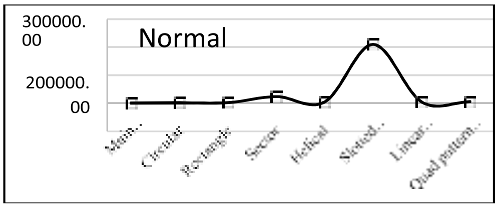

Figure 14. Frequency response for normal stresses in X direction

From the figure 14, circular stiffener has least normal stress in X-direction with 1168.71 MPa.

The normal stress for various stiffeners in Y- direction at first resonance condition are plotted and shown in figure 15.

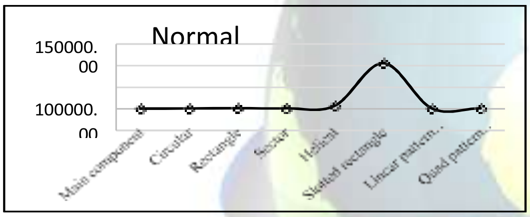

Figure 15. Frequency response for normal stresses in Y direction

From the above graph circular stiffener is having lower stress value

The normal stress for various stiffeners in Z- direction at first resonance condition are plotted and shown in figure 16.

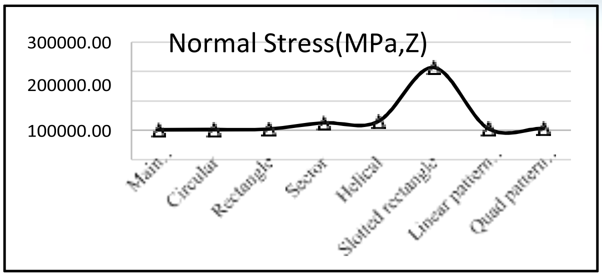

Figure 16. Frequency response for normal stresses in Z direction

From the figure 16 it was clear that the circular stiffener has least normal stress in Y-direction with 75.5 MPa.

CONCLUSION

From the above perceptions it was closed for the clasping loads helical stiffener configuration is suggested. In any case, for the consonant burdens, roundabout stiffener configuration was acceptable on the grounds that it contains lower distortions and stresses contrasted with staying one. Yet, all these are not as much as superior to fundamental chamber. From this any place clasping is significant, helical stiffener configuration will be suggested. Any place symphonious burdens basic, roundabout stiffener plans will be prescribed among the thought about structures.

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