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Design and Structural Analysis of Cylindrical Shell

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Abstract- *cylindrical shells are made by metals used to store fuel, LPG etc. under high pressure and temperature than atmospheric condition. Shells normally having uniform wall thickness to withstand internal pressure during operating conditions. Here shell structure supported by I section ribs are riveted to the inner surface of the cylinder and are considered as load carrying elements. Geometric modelling has done by using SOLID EDGE, FE analysis has been carried for internal pressure, vacuum and wind pressure by using ABAQUS.*

Keywords— **Cylindrical Shell Structure; Uni Form Wall Thickness; T Section Internal Ribs; ABAQUS Results**.

INTRODUCTION

Cylindrical shell may be defined as closed container to store fuel or gas under pressure higher than the atmosphere. Cylindrical tanks with different shape and size are used in the chemical and petrochemical industries. Among the different types of shells, cylindrical shells are particular importance. Researchers have been trying to changes on the sidewall and material of these shells to increase their resistance against the load and decrease their weight. Variety of tanks that used in different industries has caused that design and installation of these reservoirs is very important.

Figure 0.1 Gas storage tank

Cylinder shell bottoms are influenced by failure of some parts in the base circumference. This failure occurs due to the dissimilar geometry or compressibility of the dirt store. And at the same time foundation experiences non-uniform load to the structure, only limited area of structure experiences uniform stresses of the soil stratum. But heavy rains, tropical storms and cyclones are damage the tanks so that tank design should in such a way that to withstand all these factors.

Material

There are so many materials have used in fabrication of vessels. The selection will be based on appropriate design standards. Selection of materials which tell stability of shell with maximum allowable stress. In this project have considered Mild steel material.

Problem Definition

Cylindrical shell structures becomes fail due to high internal pressure, wind pressure, vacuum pressure and in many cases buckling may happens. To overcome the failures in this project we have analyzed that stability of gas storage tank under the influence of internal pressure when a structure is fully loaded condition. Also carried analysis when a structure subjected to wind and vacuum pressure during the tank is empty. The analysis results is interpreted and improvements are implemented for safe operating conditions. Analysis is carried out using ABAQUS package.

Methodology

The basic step is to create a geometric model of cylindrical shell for standard dimension by using UNI GRAPHICS modeling tool. Once the geometry is created as per specifications it is imported into HYPER MESH for messing. The finite element model is prepared by meshing it with appropriate elements like linear quadrilateral, contact elements and constraining the model by applying material properties and boundary conditions. The finite element model is imported to ABAQUS to carry out structural analysis.

Following are the steps involved in Methodology:

Step1: GEOMETRIC MODEL has created by UNI GRAPHICS as per SPECIFIC dimensions which considered by literature survey
Step 2: Meshing carried out by HYPERMESH by selecting appropriate element like linear quadrilateral and in this step

we have introduced I SECTION stringers to the inner surface of the tank which supports the tank against internal and external pressure.
Step 3: Structural analysis has been carried out to view stresses which induced in the shell by ABAQUS
Step 4: Results are INTREPRETED

Geometric Modeling

The geometric model of cylindrical shell structure. The modeling has been done using UNIGRAPHICS software. Specification of shell:

- Height of the cylindrical shell=10 meters
- Diameter of the cylindrical shell = 6 meters and
- Thickness of the cylindrical shell = 6mm
- Total height of cylinder = 13 m
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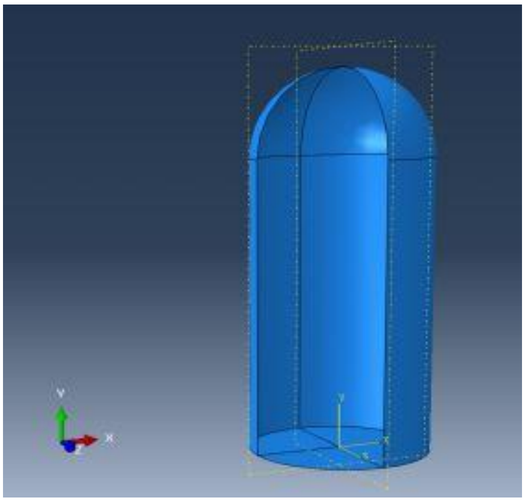

Figure 0.1 Geometric model

Meshing

Finite Element model generated for the geometric model of the cylindrical shell structure using linear quadrilateral elements. These elements are selected because of the cylindrical shell structure as shown in fig 2.2

Figure 0.2 discretized model

I Section Stringers:

I section stringers are used in the work as load carrying elements and are riveted to inner surface of the tank have made by the same material. I beam structures support the metallic structure as well as load.

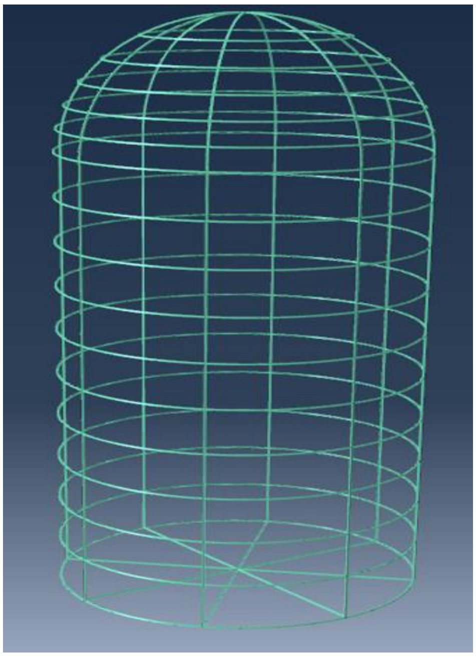

Figure 0.3 I beam skeleton

Figure 2.4 shows the cylinder shell has supported by skeleton of T beams which made by the dimensions given below in the fig 2.5

Figure 0.4 I section beam

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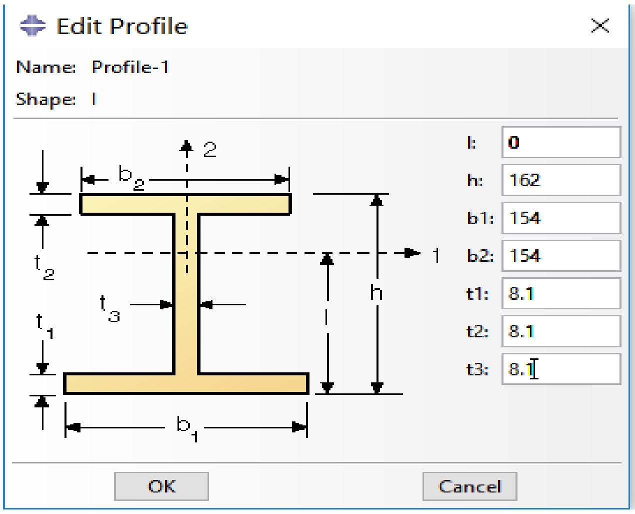

Figure 0.5 Specification of I stringers

I section consists of two sections called web and flange. A side of flange mounted to the inner surface of the shell which is completely constrained in all DOF.

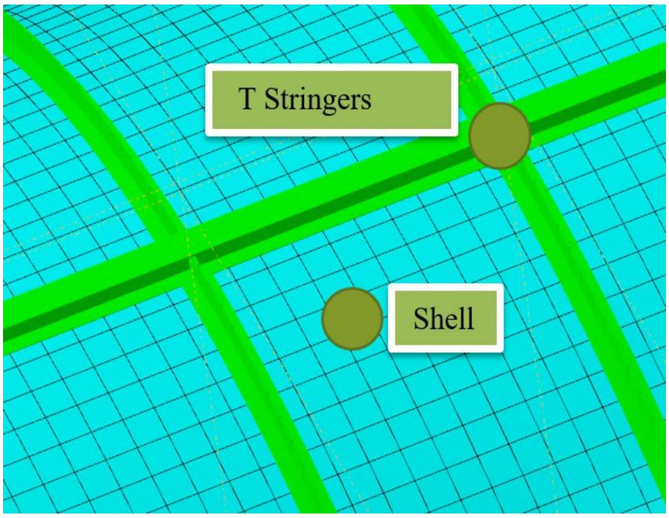

Figure 0.6 Shell body and T stringers

Specification of I sections

The Skeleton of I beam stringers made by mild steel, the gap between two stringers is one stringer/one meter along the height of the tank. In vertical direction, ribs are 45° apart from each other. The flanges of such ribs are riveted to the inner periphery of the tank which completely constrained in all DOF. These ribs are used as load caring elements

Loads and Boundary Conditions

The analysis has been conducted for the boundary conditions including of gas pressure inside the shell, wind pressure and vacuum conditions.

1) Shell Subjected To Internal Pressure

In this loading condition shell subjected to internal pressure of 0.785 Mpa. Here seen in the fig 2.7 arrows are striking outside which means that pressure acting on the internal surface

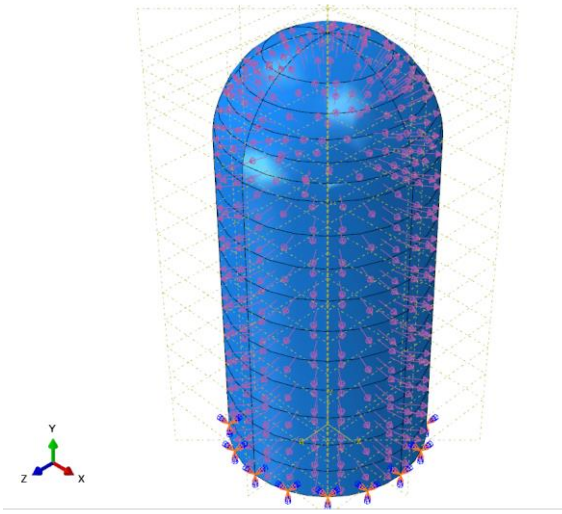

Figure 0.7 Tank subjected to internal pressure

2) Shell subjected to vacuum and wind pressure

In this loading condition shell under influence of vacuum and wind pressure magnitude of -0.1 Mpa and 0.000138 Mpa respectively.

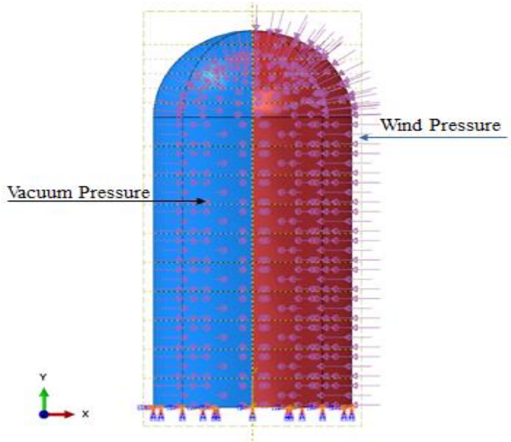

Figure 0.8 Tank subjected to vacuum and wind pressure

In the fig 2.8 seen that both wind and vacuum pressure acting on either side of the shell. Vacuum is created when a gas is withdraw from a shell and at the time tank experiences the wind pressure.

3) Boundary condition

Here the structure is considered as cantilever shell which bottom fixed in all DOF.

RESULTS & DOISCUSSION

In this section we have viewed the results of the shell structure by using ABAQUS tool.

Shell subjected to internal pressure

Analysis on the shell structure during internal pressure and acting on it.

4) Stress Plot.

Fig 3.1 shows the maximum stress induced inside the shell when the gas pressure of 0.785 MPa applied is of 383.2MPa.

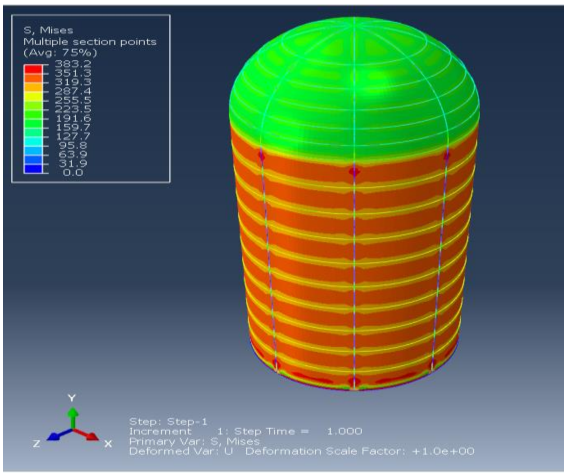

Figure 0.1 Stress plot under internal pressure (Full model)

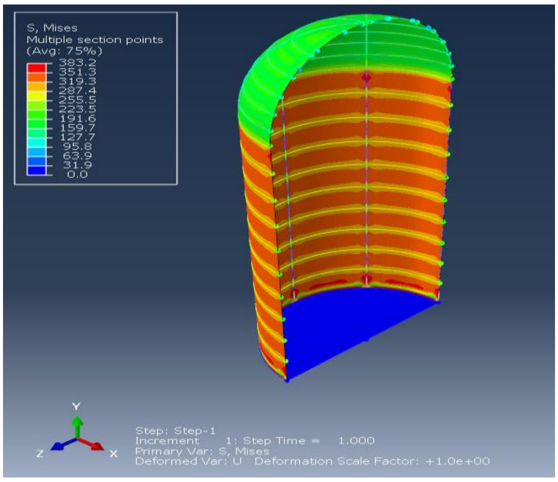

Figure 0.2 Stress plot under internal pressure (Half model)

5) Displacement Plot.

From figure 3.3 it can be seen the maximum displacement of 6.4 mm has been observed in the shell structure when the gas pressure is applied

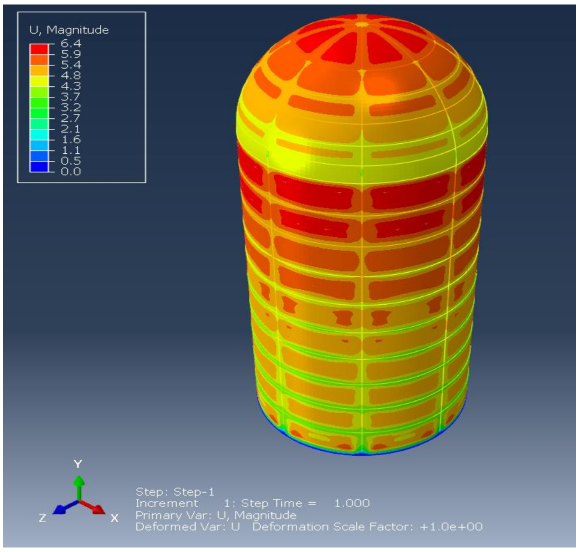

Figure 0.3 Displacement plot under internal pressure

Shell subjected to vacuum and wind pressure

Analysis on the shell structure during Vacuum pressure and wind pressure acting on it.

6) Stress Plot

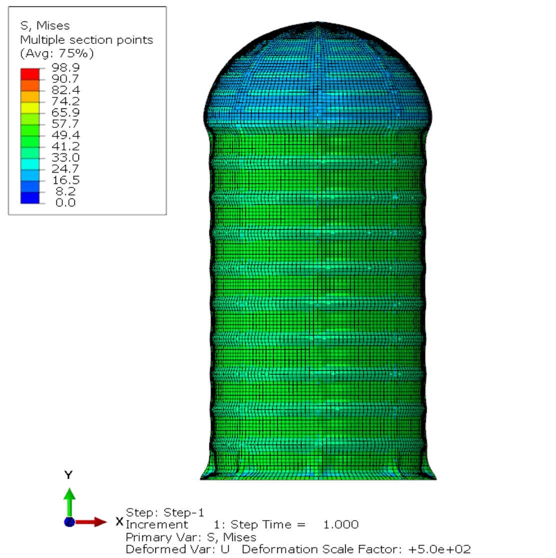

Figure 0.4 Stress plot under vacuum & wind pressure

From figure 3.4 it can be seen that stress in the shell structure when the vacuum Pressure and the wind Pressure is applied and maximum stress of 98.9 MPa is observed in the shell structure.

7) Displacement Plot.

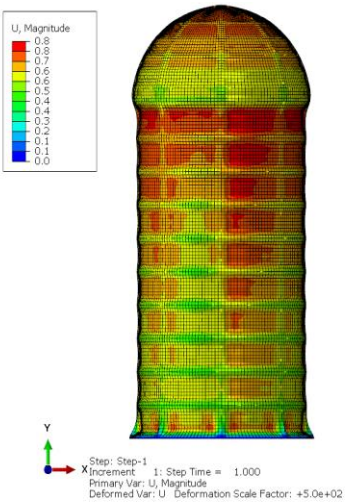

Figure 0.5 Displacement plot under vacuum & wind pressure

From figure 3.5 it can be seen maximum displacement of 0.8 mm is observed to the right of the shell structure where the wind load is applied.

CONCLUSION

- Shell structure with dome shape at the top along with stringers is used to analyse under gas pressure, vacuum and wind loading conditions.
- Nonlinear material properties were considered for analysis.
- Stresses and deflections for gas pressure loading were found to be 382.2MPa and displacement of 6.4 mm respectively.
- Stresses and deflections for vacuum and wind loading were found to be 98.9Mpa and displacement of 0.8 mm respectively

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