Analysis of Solid and Hollow Wall of Circular Steel Petroleum Tank for Stresses in Staad-Pro

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Abstract—*There are various types of storage tanks, for example, above ground, ground resting, flat bottomed, cylindrical tanks for the storage of petroleum, liquefied gases, water, etc., concrete or steel silos for the storage of coal, grains, cement etc., concrete, aluminium, steel or FRP tanks including elevated tanks for the storage of water, underground tanks for the storage of oil and water and spherical tanks for the storage of high pressure liquefied gases. The trend in recent years is for the seismic and blast design of these large storage tanks in terms of safety and the environmental impact on society as a whole. In this work attempt has been made to analyze a storage tank holding a capacity of 1.5 lakh hazardous petroleum liquid. Appropriate standards and design codes are used, material selection is done in accordance with the requirements of the recent edition IS codes and an adequate design method is chosen. Design specifications of the storage tank are presented. Two tanks; a hollow and solid are considered having the same thickness. The tank is designed according to the IS code and, the nominal diameter is 12m without space constraint, height is 14.1m, number of course is 1. The bottom thickness is 8mm. Carbon steel according to IS:2062-1969 was selected for the design. Tanks are analyzed for maximum absolute stresses, major principal stresses, minor principal stresses and max von mis stresses.*

Index Terms - Staad Pro, Hollow section, Steel tank, Absolute stresses, Major principal stresses, Minor Principle stresses,

1 Introduction

Cylindrical liquid storage ground supported, thin wall tanks are widely used all over the world in many applications such as, fuel transmission stems, water supply systems and other public and industrial facilities. Failure of this tank may result life threatening explosion or fire, significant financial loss and severe environmental damage. Since the continuous functioning is essential during and after an earthquake, it is of great importance to public safety. Many liquid storage tanks require special consideration in their design to resist seismic loads. Since the 1960' extensive researches have resulted in many advances in design of the behaviour of liquid or gaseous storage tank. A number of models has been generated from the results of these research. In engineering practice Some of these models have been accepted and incorporated.

Design is an interactive process between the architectural and functional requirements and the fabrication and strength aspects. In a design, all these aspects need to be considered in a balanced way. Due to the special features, hollow sections are of more importance than for solid steel structures. The various aspects of hollow sections thus should be known to designer. Many examples in nature show the excellent properties of the hollow shapes with regard to loading in bending, torsion and compression in all directions. These properties are combined together with different shapes for architectural applications. Furthermore, the closed shape without sharp corners reduces the area to be protected and increases the corrosion protection life. The internal void can be used in various ways, e.g. to provide fire protection, to increase the bearing resistance by filling with concrete etc. Additionally, ventilation systems or heating sometimes make use of the hollow section columns. In a good design not only does the strength have to be considered, but also many other aspects, such as material selection, fabrication including protection, welding and inspection, erection, in service inspection and maintenance.

2 OBJECTIVE

The objectives of the study is to explain the concept of hollow construction and to describe the elements comprised of solid and hollow steel structures and to evaluate the performance of hollow and solid structures under hydrostatic loading. The parameter considered for comparison is thickness of the tank.

3 MODELLING

A storage tank of 1.5 lakh litres capacity that would be able to safely carry major petroleum products was designed to satisfy relevant standards and codes. The design consideration, calculations, fabrication and erection for tank was done and tanks are analyzed for maximum absolute stresses, major principal stresses, minor principal stresses and max von mis stresses. Two tanks were considered for the analysis. Tank 1 was solid tank and tank 2 was hollow tank i.e. the total thickness of tank 1 was equal to the total thickness of two wallas of tank 2 with a hollow opening of 50mm between the two walls. Table 2 illustrates the thickness of tank 1 and tank 2 that is considered.

In the design of the tank, following considerations were taken

As shown in table 1. Table 2 shows the detail of thickness that is considered in analysis.

TABLE 1. Input Data

Description	Values
Diameter, D	12m
Total Tank Height of Shell, H1	14.1m
Maximum Design Liquid Level, H2	13.634m
Net Design Liquid Height, H2	13.27m
Nominal Capacity, Q1	1595.3m3
Gross Capacity, Q2	1542.59m3
Effective Capacity, Q3	1500m3

TABLE 2. Details of thickness of tank 1 and tank 2

TANK 1	TANK 2
10	5+#+5
14	7+#+7
18	9+#+9
22	11+#+11
26	13+#+13

Note: # indicated the hollow space between the inner and outer wall of the tank.

4 ANALYSES

The above mentioned tanks models are analyzed using Staad-Pro V8i software. The tank models are analyzed by applying hydrostatic load on the walls of the tank. The analysis is done of tanks with fullfilled condition and anchored support. Tank 1 and Tank 2 are applied same hydrostatic force on the inner side of inner walls and stresses are calculated for both solid and hallow tank. The parameters analysed are absolute stress, major principal stresses, minor principal stresses and maximum von mis stresses. Following tables gives the value of maximum and minimum stresses obtained for the different parameters for tank 1 and tank 2 with same thickness.

TABLE 3: Stresses for tank with thickness 10 mm

10mm thick	Tank 1 (Solid Wall)		Tank 2(Hollow Tank)	
Parameters	Maxi. Value	Mini. Value	Maxi. Value	Minimum Value
Max. Absolute Stresses	1.00285	0	1.00669	0
Principal Major Stress	0.430924	0	0.75571	-0.012025
Principal Minor Sress	0	-0.652616	0	-0.835083
Max Von Mis Stresses	1.19969	0	1.452	0

TABLE 4: Stresses for tank with thickness 14 mm

10mm thick	Tank 1 (Solid Wall)		Tank 2(Hollow Tank)	
Parameters	Maximum Value	Minimum Value	Maximum Value	Minimum Value
Max. Absolute Stresses	1.00185	0	1.00441	0
Principal Major Stress	0.331029	0	0.575027	-0.01205
Principal Minor Sress	0	-0.64475	0	-0.82874
Max Von Mis Stresses	1.13081	0	1.307	0

TABLE 5: Stresses for tank with thickness 18 mm

10mm thick	Tank 1 (Solid Wall)		Tank 2(Hollow Tank)	
Parameters	Maximum Value	Minimum Value	Maximum Value	Minimum Value
Max. Absolute Stresses	1.00124	0	1.00324	0
Principal Major Stress	0.274854	0	0.46899	-0.01208
Principal Minor Sress	0	-0.64036	0	-0.82526
Max Von Mis Stresses	1.09432	0	1.22719	0

TABLE 6: Stresses for tank with thickness 22 mm

10mm thick	Tank 1 (Solid Wall)		Tank 2(Hollow Tank)	
Parameters	Maximum Value	Minimum Value	Maximum Value	Minimum Value
Max. Absolute Stresses	1.00078	0	1.00253	0
Principal Major Stress	0.239429	0	0.399432	-0.01211
Principal Minor Sress	0	-0.63761	0	-0.82307
Max Von Mis Stresses	1.07213	0	1.17744	0

TABLE 7: Stresses for tank with thickness 26 mm

10mm thick	Tank 1 (Solid Wall)		Tank 2(Hollow Tank)	
Parameter	Maximum Value	Minimum Value	Maximum Value	Mini. Value
Max. Absolute Stresses	1.00039	0	1.00204	0
Principal Major Stress	0.21534	0	0.350431	-0.01214
Principal Minor Sress	0	-0.63575	0	-0.82158
Max Von Mis Stresses	1.05744	0	1.14379	0

Thus, from the above table graph was plotted of thickness verses the various stresses taking both tanks into consideration. The graphs obtained were as follows.

FIGURE 1: Graph of thickness verses maximum von mis stresses for tank 1 and tank 2.

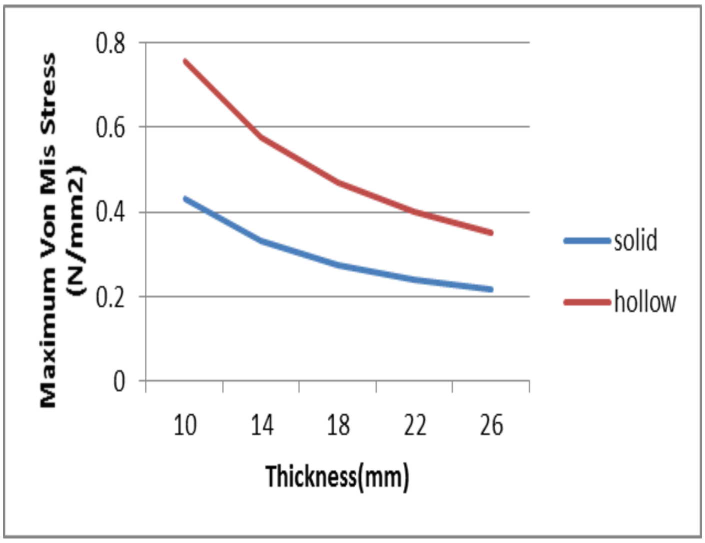


FIGURE 2: Graph of thickness verses maximum absolute stresses for tank 1 and tank 2.

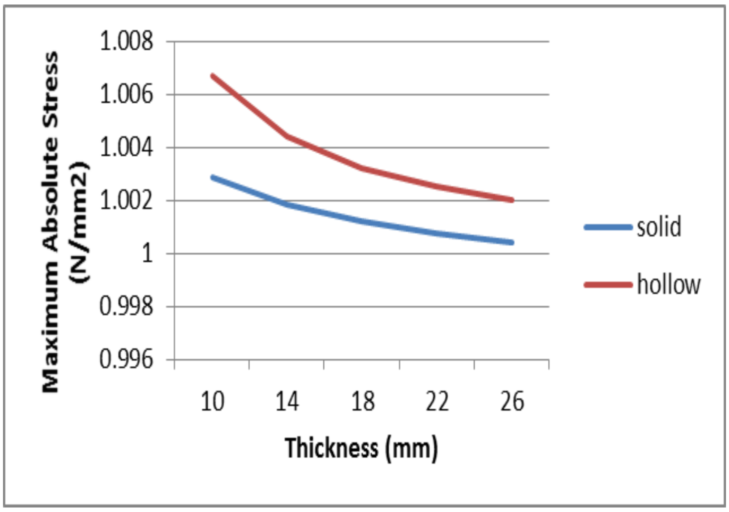
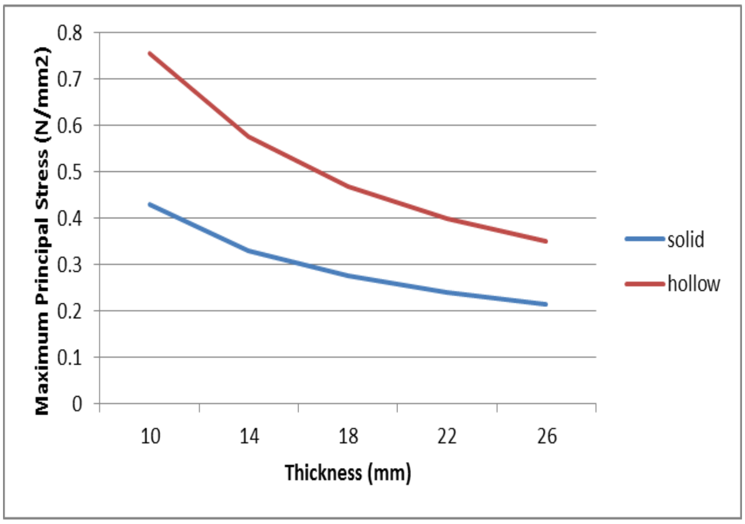


FIGURE 3: Graph of thickness verses maximum principal stresses for tank 1 and tank 2.



5 RESULTS AND DISCUSSIONS

1) It is seen that the maximum absolute stress of the solid tank is less as compared to hollow tank.

2) The major principal stresses foe solid section are more than hollow section.

3) The value for minor principal stresses for both tanks is zero.

4) As the stresses in hollow tank rae lessthan the stresses in solid tank with same thickness, solid sections are more efficient than hollow section.

5) As the theory states, with the increase in stresses deformation goes on increasing. Hence, the deformation of hollow tank is more as compared to solid tank.

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