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DESIGN AND ANLYSIS OF WATER TANKS USING STAAD PRO

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ABSTRACT

Water tank is a structure used to store water for supplying to households as drinking purpose, for industries as a coolant and irrigational water for agricultural farming in some areas. Water tanks are classified on bases of their shapes and position of structure. In this paper, we had discussed about the design of water tanks of both overhead and underground tanks of shapes rectangular, square and circular shapes are designed and analysed using Staad pro. From the analysis results concluding about the influence of shape factor in design loads and how shapes of the tanks play predominant role in the design and in stress distribution and overall economy.

Keywords: water tanks, structural design and analysis, loading applications, plates stress contouring's.

INTRODUCTION

Water tanks are the structures used for storing drinking potable water. In present scenario, there is much emphasis for water storage projects all around the world. Water plays predominant role in day-to-day life, so water storage is not a need it is necessary to store the water. In design of water tanks, design aspects is to be followed as per code books and loads is to be applied carefully. Water tanks are classified into two types based on position and shape of the tank.

Based on the location the water tanks are classified into three ways:

1. Underground water tanks
2. Tank resting on grounds
3. Elevated or overhead water tanks.

Also, the water tanks are classified based on shape:

1. Circular tanks
2. Rectangular tanks
3. Intez tanks
4. Circular tank with conical bottom
5. Square tanks

LITERATURE REVIEW

[1] Issar Kapadia et al., had done the "DESIGN, ANALYSIS AND COMPARISON OF UNDERGROUND RECTANGULAR WATER TANK BY USING STAAD PROVI8 SOFTWARE". This paper includes the study of UG Rectangular tank that how the shape deflected and what are the actions will be

produced when tank empty or full by using STAAD Pro software is discussed.

[2] B.V. Ramana Murthy, M Chiranjeevi had done the "DESIGN OF RECTANGULAR WATER TANK BY USING STAAD PRO SOFTWARE". In this paper he said that this mini project is conducted for a period of 15 days from 21-05-2010 to 07-06-2010 to have complete practical knowledge of various techniques and problems faced in the field. A different topic like Construction Aspects, Design Parameters, Details of Formwork, Details of reinforcement, Process of Water Treatment Plant and Execution have been dealt with in the course of our mini project.

[3] Thalapathy .M et al., had done "ANALYSIS AND ECONOMICAL DESIGN OF WATER TANKS". In this paper he said this project gives the detailed analysis of the design of liquid retaining structure using working stress method. This paper gives idea for safe design with minimum cost of the tank and give the designer relationship curve between design variable. This paper helps in understanding the design philosophy for the safe and economical design of water tank.

DESIGN OF WATER TANKS

Design Aspects to Be Followed:

- Location of the water tank (overhead or underground).
- Purpose of water storage?
- Volume of water tank need to hold. based on usage of water by the people in that area.
- Dimensions of the tanks is to be calculated.
- Loads and loading combinations are to be applied according to code books.
- Is pressure required for delivering water?
- Hydraulic loads imposed by water on the inner surface is to be determined for fully and partially-filled tank conditions.
- Wind and earthquake design considerations allow water tanks to survive seismic and high wind events.

Parameters for selecting Materials

- Materials selected for construction should be impervious.
- If iron/steel materials are taken, it should not be rusted.
- Materials should be highly resistant to fire or frost conditions.
- It can be easily repairable.
- Cost of materials should be economical.

STAAD PRO DESIGN OF WATER TANKS

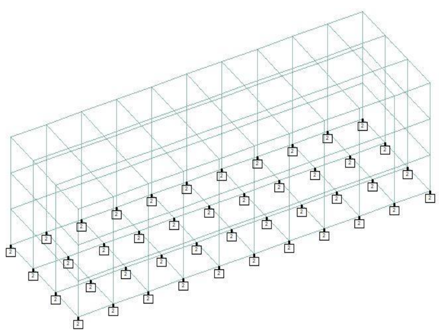

Figure 1 UNDERGROUND RECTANGULAR TANK DESIGN

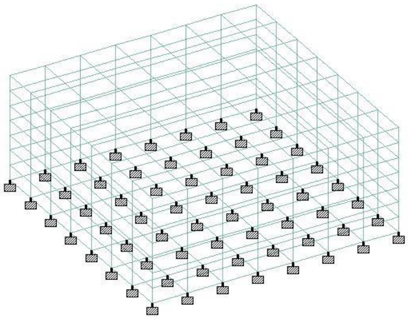

Figure 2 UNDERGROUND SQUARE TANK DESIGN

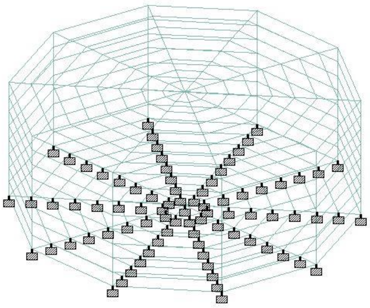

Figure 3UNDERGROUND CIRCULAR TANK DESIGN

Table 1 DESIGN PARAMETERS CONSIDERED for UNDERGROUND TANKS

Underground tanks	**Length/Radius**	**Breadth**	**depth**	**Uplift pressure**
Rectangle	9.90m	3.275 m	2.45 m	20kn/m^2
square	5.80m	5.80m	5.80 m	20kn/m^2
circular	3.30m	-	2.45 m	20kn/m^2

STAAD PRO DESIGN OF OVERHEAD TANKS

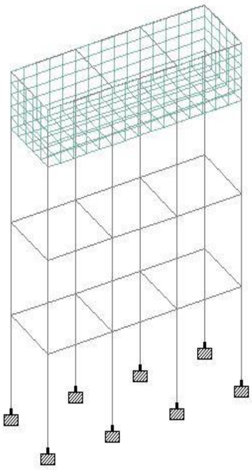

Figure 4 OVERHEAD RECTANGULAR TANK DESIGN

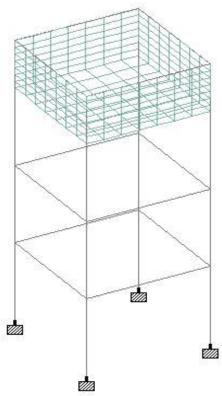

Figure 5 OVERHEAD SQUARE TANK DESIGN

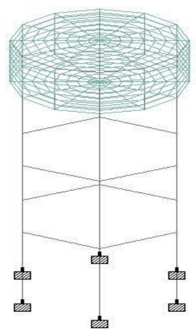

Figure 6 OVERHEAD CIRCULAR TANK DESIGN

Table 2 DESIGN PARAMETERS CONSIDERED FOR OVERHEAD TANKS

Over head tanks	Leng th/Ra dius	breadt h	depth	heigh t	Wind loads
Rect angle	9.90 m	3.275 m	2.45 m	12m	40m/ s
Squa re	5.80 m	5.80m	5.80 m	12m	40m/ s
Circ ular	3.30 m	-	2.45 m	12m	40m/ s

LOADING COMBINATIONS CONSIDERED FOR UNDERGROUND AND OVERHEAD TANKS

UNDERGROUND TANKS

1. 1.5((Gravity+ Hydrostatic) + Live Load + Earth Pressure)
2. 1.2((Gravity+ Hydrostatic) +Uplift Pressure+ Live Load+ Earth Pressure)
3. 1.5(Live Load+ Uplift Pressure)

OVERHEAD TANKS

For overhead, the loads and loading combinations are considered for two different conditions of tanks.

FOR PARTIALLY FILLED

1. 1.5(DL+HL+WL(+X))
2. 1.5(DL+HL+WL(-X))
3. 1.5(DL+HL+WL(+Z))
4. 1.5(DL+HL+WL(-Z))
5. 1.5(DL+WL(+X))
6. 1.5(DL+WL(-X))
7. 1.5(DL+WL(+Z))
8. 1.5(DL+WL(-Z))
9. 1(DL+HL+WL(+X))
10. 1(DL+HL+WL(-X))
11. 1(DL+HL+WL(-X))
12. 1(DL+HL+WL(+Z))
13. 1(DL+HL+WL(-Z))

FOR FULLY FILLED TANK

1. 1.5(DL+HL(HALF)+WL(+X))
2. 1.5(DL+HL(HALF)+WL(-X))
3. 1.5(DL+HL(HALF)+WL(+Z))
4. 1.5(DL+HL(HALF)+WL(-Z))
5. 1(DL+HL(HALF)+WL(+X))
6. 1(DL+HL(HALF)+WL(-X))
7. 1(DL+HL(HALF)+WL(+Z))
8. 1(DL+HL(HALF)+WL(-Z))

NOTE: DL- Dead load, HL- Hydraulic load, WL(+x)- Wind load in +ve X direction, WL(-x)- Wind load in –ve X direction, WL(+z)- Wind load in +ve Z direction, WL(-z)- Wind load in –ve Z direction.

RESULTS

PLATE STRESS

Plate stresses refers to the bending of plates due to application of loads on the plates results in the deflection of plates. The stresses in the plate can be calculated from these deflections. Once the stresses coming on plates are known, then failure theories can be applied to determine whether these plates will fail under a given load or not. Below figures shows stress contouring on plates which is obtained after analysis in Staad pro shows in different colours for different values of stresses on plates.

PLATE STRESS CONTOURINGS FOR UNDERGROUND TANKS

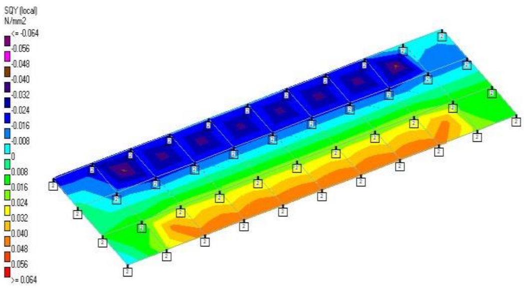

Figure 7:PLATES STRESS ON BOTTOM PALTE OF UNDERGROUND RECTANGULAR TANK

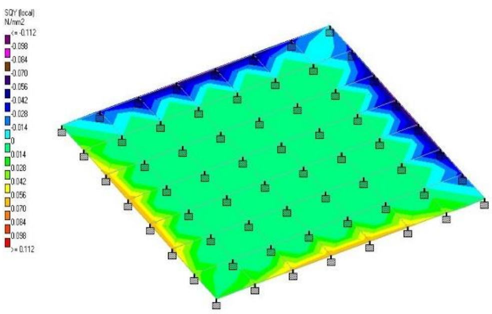

Figure 8: PLATES STRESS ON BOTTOM PALTE OF UNDERGROUND SQUARE TANK

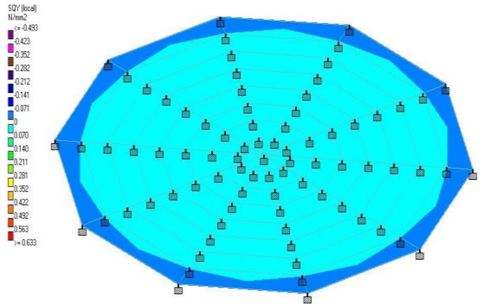

Figure 9: PLATE STRESSES ON BOTTOM PALTE OF UNDERGROUND CIRCULAR TANK

PLATE STRESS CONTOURINGS FOR OVERHEAD TANKS

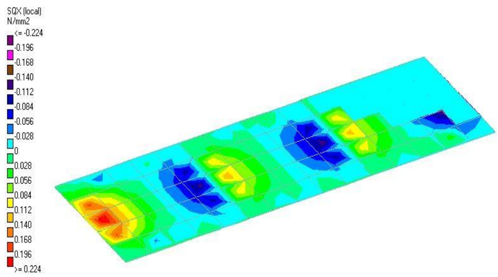

Figure 10: PLATE STRESSES ON BOTTOM PALTE OF OVERHEAD RECTANGULAR TANK

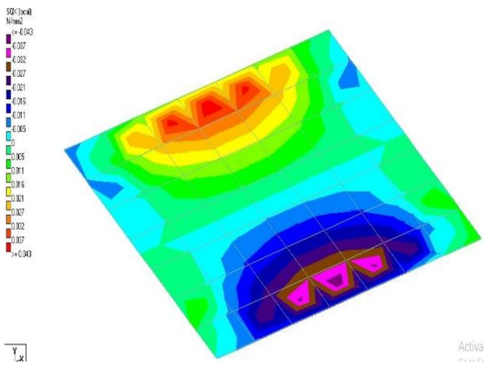

Figure 11: PLATE STRESSES ON BOTTOM PALTE OF OVERHEAD SQUARE TANK

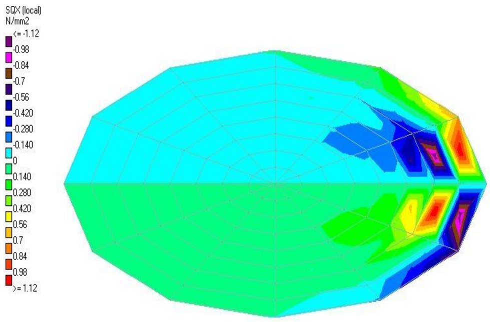

Figure 12: PLATE STRESSES ON BOTTOM PALTE OF OVERHEAD CIRCULAR TANK

Table 3: LOCAL SHEAR STRESS AND BENDING MOMENT VALUES OBTAINED AFTER ANALYSIS

Water Tanks Based On Position	Water Tanks Based On Shape	SQX		SQY		MX		MY	
		Min	Max	Min	Max	Min	Max	Min	Max
Underground Tank	Rectangular	-0.0635	0.0635	-0.0635	0.0635	-7.836	1.806	-10.676	3.819
	Square	-0.0559	0.0559	-0.1119	0.1119	-1.878	3.010	-7.131	7.131
	Circular	-0.2865	0.2865	-0.4931	0.6332	-0.829	1.052	-107.874	24.930
Overhead Tank	Rectangular	-0.2236	0.2239	-0.2422	0.2422	-8.024	9.507	-14.201	16.649
	Square	-0.0427	0.0427	-0.0427	0.0427	-4.200	2.359	-4.200	3.222
	Circular	-0.0189	0.0189	-0.5593	0.7328	-0.627	0.882	-131.437	30.099

CONCLUSION

From this designs it is showed that corner stresses and maximum shear and bending stresses are found to be less in case of circular tanks than remaining other designs and the shapes of water tanks plays vital role in the stress distribution and overall economy. By using Staad pro, the results obtained will be very accurate than conventional results.

In Underground tank, Uplift pressure plays predominant role in design which is caused by surrounding soil on outside walls of tank. The shape of the tanks plays predominant role in the design of overhead and underground water tanks. Usage of Staad pro in design gives accurate results for shear force and bending moment than convenient method.

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