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Analysis of Circular Water Tank Stresses Under Hydrostatic Loading by Using Stadd Pro Software

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ABSTRACT

The present study reports the analysis and design of an elevated circular water tank using STAAD.Pro V8i. The design involves load calculations manually and analyzing the whole structure by STAAD.Pro V8i. The design method used in STAAD. Pro analysis is Limit State Design and the water tank is subjected to dead load, self – weight and hydrostatic load due to water.This paper presents a parametric study concerning behavior and design of overhead Rectangular concrete tank subjected to static loading conditions with special emphasis on IS:3370, PCA , and STAAD-Pro. The effect of the different tank aspect ratio, end condition for same capacity is reviewed and considered in the Analysis and Design.

KEYWORDS Circular Water Tank, Stadd Pro, Hydrostatic load, Stresses, Deflection.

INTRODUCTION

An elevated water tank is a large water storage container constructed for the purpose of holding water supply at certain height to pressurization the water distribution system. The liquid storage tanks are particularly subjected to the risk of damage due to earthquake-induced vibrations. A large number of overhead water tanks damaged during past earthquake. Majority of them were shaft staging while a few were on frame staging type Elevated water tanks consist of huge water mass at the top of a slender staging which are most critical consideration for the failure of the tank during earthquakes. Elevated water tanks are critical and strategic structures and damage of these structures during earthquakes may endanger drinking water supply, cause to fail in preventing large fires and substantial economic loss. Since, the elevated tanks are frequently used in seismic active regions also hence, seismic behavior of them has to be investigated in details.

Hydrodynamic pressures on tanks under earthquake forces play an important role in the design of the tank. When the tank is in full condition, earthquake forces almost govern the design of these structures in zones of high seismic activity. The failure of these structures may cause some hazards for the health of the citizens due to the shortage of water or difficulty inputting out fire during the earthquake golden time. The performance of elevated water tanks during earthquakes is of much interest to engineers, not only because of the importance of these tanks in controlling fires, but also because the simple structure of an elevated tank is relatively easy to analysis and, hence, the study of tanks can be informative as to the behavior of structures during earthquakes.

Reservoirs below the ground level are normally built to store large quantities of water. The overhead tanks are supported by the column which acts as stage. This elevated water tanks are built for direct distribution of water by gravity flow and are usually of smaller capacity. For storing a small and medium capacity of water the Rectangular water tank is preferable. Rectangular water tank are mainly use for the Industrial water storage, treatment of waste water, Storage of a large amount of water etc. Shuttering of rectangular tank is easy to place at construction site compare to the circular water tank. Rectangular water tanks are used for smaller capacities of water tank because of the low shuttering cost compare to the Circular water tank. Rectangular water tank required more construction material than the circular water tank.

IWATER TANK IN GENERAL

The water tank is used to store water to tide over the daily requirements. Water tanks can be of different capacity depending uponthe requirement. Water tanks can be of different capacity depending upon the requirement of consumption. There different type of water tank depending upon the shape, position with respect to ground level etc. In general water tanks can be tanks, resting on ground, elevated tanks, and underground tanks. From the shape point of view water tank may be of several types

1. Circular tanks
2. Circular tanks with conical bottoms
3. Rectangular tanks

The walls of Rectangular tank are subjected to bending moments both in horizontal as well in vertical direction. The analysis ofmoment in the wall is difficult since water pressure results in a triangular load on them. The magnitude of the moment will depend upon the several factors such as length, breadth and height of tank, and conditions of the support of the wall at the top and bottom edge. If the length of the wall is more in compression to its height the moment will be mainly in vertical direction i.e. the panel will bend as a cantilever. If, however, height is larger in comparison to length, the moments will be in horizontal direction, and the panel will bend as a thin slab supported on the edges. For intermediate condition bending will take place both in horizontal as well as in vertical direction. In addition to the moments, the walls are also subjected to direct pull exerted by water pressure on some portion of side walls. The wall of the tank will thus be subjected to both bending moment as well as direct tension. The aim of the work can be started as follows: the analysis of water tank is carried out considering the side wall as simply supported slabs and optimum design values is introduced by means of N Pandean method.

II LITERATURE REVIEW

Hariteja N., Yogesh Kaushik, Rohit Varma M., Sachin Sharma and Sameer Pathania they had discussed the topic"Seismic Assessment of Elevated Circular Water Tank"

However, they reports the analysis and design (Response Spectrum Analysis, Frequency Analysis and Time History Analysis) of an elevated circular water tank using STAAD.Pro V8i. The design involves load calculations manually and analyzing the whole structure by STAAD.Pro V8i. The design method used in STAAD.Pro analysis is Limit State Design and the water tank is subjected to live load, dead load, self – weight and seismic loads. Seismic load calculations are done as per IS 1893-2000. Response Spectrum Analysis gives displacement, bending moment, shear force, axial force, and torsion values. Eigen solution so obtained helps in determining the base shear and various peak story shear values of the structure. Frequency analysis gives the natural frequency of the structure and time history, which defines the behavior of the structure in certain interval of time against various functions like velocity, displacement and acceleration and hence the graphical solutions has been drawn for each analysis. This study prevails the response spectrum, frequency and time history analyses of an elevated circular water tank using STAAD.Pro V8i (for displacement, bending moment, shear force, axial force, and torsion) for determining the base shear and various peak story shear values of the structure which helps in studying the behaviour of the structure during different types of loading effects. Three different analyses i.e. Response Spectrum, Raleigh Frequency, Time History analyses on pre calculated load values has been discussed. Response spectrum analysis gives displacement, bending moment, shear force, axial force, and torsion values. Eigen solution so obtained helps in determining the base shear and various peak story shear values of the structure. Frequency analysis gives the natural frequency of the structure and time history analysis defines the behaviour of the structure in certain interval of time against various functions like velocity, displacement and acceleration. Hence the graphical solution has been drawn for the each analysis.

G.P.Deshmukh, Ankush.S.Patekhede. They had discussed the topic" ANALYSIS OF ELEVATED WATER STORAGE STRUCTURE USING DIFFERENT STAGGING SYSTEM"

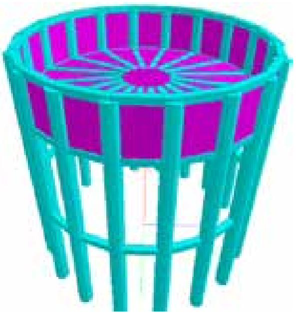
Eleven models are used for calculating base shear and nodal displacements After calculating base shear and nodal displacements of eleven models for empty, half filled & full condition of container applying with different types of bracing system in staging then economy point of view project study suggest such type of bracing which gives minimum base shear as well as considerable displacement for measure earthquake zones

III PRELIMINARY EXPERIMENTAL INVESTIGATION

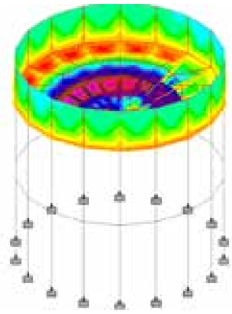
The computer program for the project is done using Stadd Pro version V8i.The program is written for the normal design and later to calculation the area of steel the optimization method using concrete design function is called in stadd pro to post processing.

1. User defined material data like span, load and grade of concrete and steel are to be given as input
2. Effective span is calculated by adding the effective depth to the span
3. Load calculations has to be given as input total DEAD load and HYDROSTATIC LOAD are calculated as per IS-875 PART1.
4. Maximum stresses and deflections has to be calculated
5. With the maximum bending moment the area of steel is to be calculated.

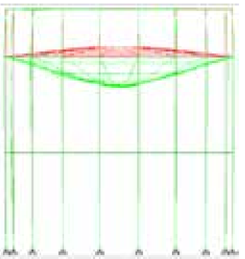
3D VIEW OF CIRCULAR WATER TANK



STRESSES CREATED IN CIRCULAR WATER TANK



DEFLECTED SHAPE OF CIRCULAR WATER TANK



FINAL STRESSES AND DEFLECTION OF CIRCULAR WATER TANK

CIRCULAR_WATERTANK_PAPER1.std - Plate Center Stress

Shear, Membrane and Bending | Summary | Principal and Von Mis | Summary

			Principal		Von Mis		Tresca	
	Plate	L/C	Top N/mm2	Bottom N/mm2	Top N/mm2	Bottom N/mm2	Top N/mm2	Bottom N/mm2
Max Pri	377	1 DL	3.534	2.241	3.114	6.154	3.534	6.961
Min Pri	435	1 DL	-3.924	0.657	3.406	1.729	3.924	1.967
Max Pri	488	1 DL	-0.261	2.966	1.730	2.149	1.843	3.304
Min Pri	321	1 DL	-1.314	-12.188	3.526	10.556	3.994	12.188
Max Vo	321	1 DL	2.680	-5.987	3.626	10.556	3.994	12.188
Min Vo	317	1 DL	0.043	-7.806	0.074	7.430	0.086	7.806
Max Vo	321	1 DL	2.680	-5.987	3.526	10.556	3.994	12.188
Min Vo	457	1 DL	-0.219	0.378	0.657	0.475	0.738	0.533
Max Tr	321	1 DL	2.680	-5.987	3.526	10.556	3.994	12.188
Min Tre	317	1 DL	0.043	-7.806	0.074	7.430	0.086	7.806
Max Tr	321	1 DL	2.680	-5.987	3.526	10.556	3.994	12.188
Min Tre	457	1 DL	-0.219	0.378	0.657	0.475	0.738	0.533

IV. CONCLUSION

1. Deflection can be reduce by bracing system.
2. Stability of water tank can be improved by providing heavy column at bottom level.
3. At the mid span of top portion get maximum stresses.
4. Fluid density must be considered in design.
5. Slab thickness also effect on deflection.

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