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ANALYSIS AND DESIGN OF RCC OVERHEAD WATER TANK FOR SEISMIC AND WIND LOADS

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Abstract-Major capacity overhead circular shaped tanks are used to store a variety of liquids, e.g. water for drinking, fire fighting, petroleum, chemicals, and liquefied natural gas. A water tank is used to store to tide over the daily requirements. Intze tank is a type of elevated water tank supported on staging circular tanks is defined as bottom portion of circular tank, as the bottom portion is provided in flat shape and it is observed that bottom thickness and reinforcement is found to be heavy. It is found in analysis that the bearing capacity increases for the same wind speed volume of concrete and quantity of steel both are decreased. The observed bearing capacity of the soil is 200 KN/m2. In this present study structural aspects such as Axial forces, shear forces and bending moments are compared for different structural components of tank. The main aim of the study is to evaluate the effect of lateral forces (like seismic and wind forces) on elevated water tanks. For the sake of simplification of analysis, STAAD Pro. V8i is use. The results which are obtained from STAAD are used for the design of respective members of the tank and an attempt is made to understand its behaviour structurally.

Keywords: Finite element method, Dynamic Analysis, RCC over head tank, Shear forces, Bending Moments.

I. Introduction

Water is life line for each sort of animal in this world. All around the world liquid stockpiling tanks are used generally by areas and organizations for water supply, firefighting systems, inflammable liquids and distinctive chemicals. Thus, water tanks accept a key part for open utility and furthermore present day structure having vital motivation to secure unfaltering water supply from longer division with sufficient static head to the desired range under the effect of gravitational force. With the quick addition of human masses, enthusiasm for drinking water has extended by various folds. In like manner due to insufficiency of force at various spots in India and around the making nations, it is implausible to supply water through pumps at zenith hours. In such circumstances raised water tanks transform into a basic bit of life.

An Overhead RCC intze sort tank is a champion amongst the most extensively used tanks with the true objective of securing and supplying water. It is used as raised water tanks to perform the required head of water. The vault shapes in various parts of the tank makes it reasonable and essentially profitable. Since there is no specific blueprint models for an intze sort tank most of the tanks are being overdesigned. Such a condition requires all around examination of the diverse parameters required in arranging the tank. In the present study, it clarifies a parametric examination of the tank checking its cost considerations. We have moreover tried to clear up different segments which can particularly decrease the material cost of the tank.

II. Literature Review

Different written works has exhibited as specialized papers till date on the Wind and Seismic examination of Elevated Water Tanks. Different issues and the focuses are secured in that analysis i.e., winds pace of different urban communities according to seismic zones, hydrodynamic weight, and element reaction of confined arranging and so forth. Some of those are talked about underneath:

Hasan Jasim Mohammed (2011), presume that: An utilization of streamlining strategy to the basic outline of cement rectangular and round water tanks, considering the aggregate expense of the tank as a target capacity with the properties of the tank that aretank limit, width and length of tank in rectangular, water profundity in roundabout, unit weight of water and tank floor section thickness, as configuration variables.

Pavan S. Ekbote and Dr.Jagdish G. Kori: Amid quake lifted water tanks were vigorously harms or fallen. This was may be because of the absence of learning with respect to the conduct of supporting arrangement of the water tanks again dynamic activity furthermore because of despicable geometrical choice of organizing examples of tank. Because of the liquid structure associations, the seismic conduct of hoisted water tanks has the attributes of complex marvels. The fundamental point of this study is to comprehend the conduct of supporting framework which is more successful under various reaction range strategy with STAAD programming. In this paper diverse supporting frameworks, for example, cross and outspread propping concentrated on.

III. Methodology

In the present study Finite Element Method is used for analysis. Different methods used for methodology are as follows

1. The Finite Difference Method
2. The Boundary Element Method

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In the finite element method (FEM) of analysis, a complex region defining a continuum is discretized into simple geometric shapes called finite elements. The material properties and the governing relationships are considered over these elements and expressed in terms of unknown values at elements corners.The physical problems which were so far intractable and complex for any closed bound solution can now be analyzed by this method. The details of FEM, model used in the present investigation for FE analysis and validation details are presented in this chapter. The structural plan is restrained on all its edges and is modelled in 3D solid elements for validation purpose. The results obtained from FE analysis shown good agreement with experimental values for different papers. This validated model will be used to carry out and the design is safe for construction

IV. Modeling and Analysis

In this study, previous projects are referred for the numerical modeling and developed a elevated water tank in STAAD (pro.). The following are the some views of elevated water tank.

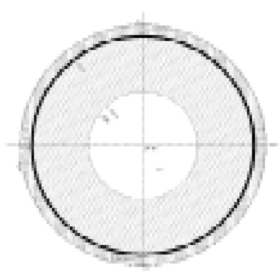

Fig 1 : The plan at bottom of the tank

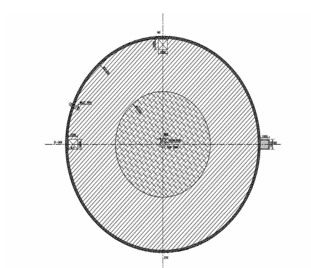

Fig 2 : The pla at top of the tank

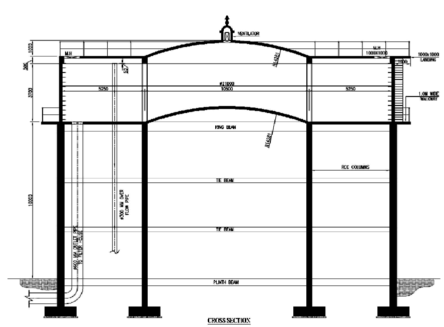

Fig3. The above figure shows cross section of the overhead tank

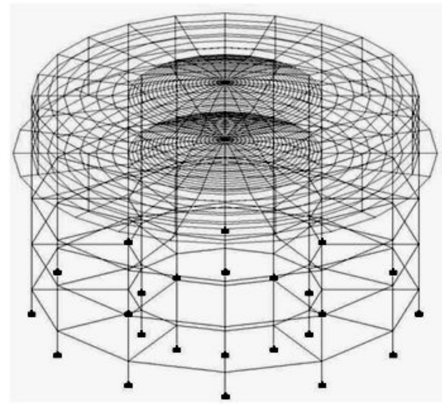

Fig4.The above figure shows the Shows Developed 3D Model in STAAD

V. Results and Discussion

Table 5.1: Table shows Shear force and Bending Moment values of OHT for Load case 1(SL X+) Description

Description		Element number	Moment-Z kNm	Shear-Y kN
Columns	Min	1	-67.07	95.17
	Max	307	341.24	168.45
Ring beams @ Bottom of the tank	Min	4050	-152.50	-110.18
	Max	4071	152.50	110.18
Ring beams @ Top of the tank	Min	4129	-0.33	0.26
	Max	4160	0.33	-0.26
Tie beams	Min	2020	-310.19	225.87
	Max	2017	310.19	-225.87

Table 5.2: Table shows Shear force and Bending Moment values of OHT for Load case 3(SL Z+)

Description		Beam	Moment-Z kNm	Shear-Y kN
Columns	Min	211	-77.08	45.29
	Max	210	77.08	-45.29
Ring beams @	Min	4031	-152.50	-110.18
	Max	4090	152.50	110.18

Bottom of the tank				
Ring beams @ Top of the tank	Min	4145	-0.33	0.26
	Max	4144	0.33	-0.26
Tie beams	Min	2028	-310.19	-225.87
	Max	2009	310.19	225.87

Table 5.3: Table shows Shear force and Bending Moment values of OHT for Load case 5 (WL X+)

Description		Element number	Moment-Z kNm	Shear-Y kN
Columns	Min	12	-14.07	32.13
	Max	107	81.96	-48.50
Ring beams @ Bottom of the tank	Min	4050	-20.91	-15.14
	Max	4071	20.91	15.14
Ring beams @ Top of the tank	Min	4140	-0.34	0.22
	Max	4149	0.34	-0.22
Tie beams	Min	2016	-70.70	-51.47
	Max	2021	70.70	51.47

Table 5.4: Table shows Shear force and Bending Moment values of OHT for Load case 7 (WL Z+)

Description		Element number	Moment-Z kNm	Shear-Y kN
Columns	Min	202	-16.47	9.06
	Max	203	16.47	-9.06
Ring beams @ Bottom of the tank	Min	4031	-20.91	-15.14
	Max	4090	20.91	15.14
Ring beams @ Top of the tank	Min	4131	-0.34	0.22
	Max	4158	0.34	-0.22
Tie beams	Min	2029	-70.70	51.47
	Max	2009	70.70	51.47

Table 5.5: Table shows Shear force and Bending Moment values of OHT for Load case 10 (Hydrostatic Load)

Description		Element number	Moment-Z kNm	Shear-Y kN
Columns	Min	301	-7.41	-3.03
	Max	312	7.41	3.03
Ring beams @ Bottom of the tank	Min	4007	-18.88	4.04
	Max	4033	17.49	0.61
Ring beams @ Top of the tank	Min	4162	-0.79	0.00
	Max	4125	0.79	0.00
Tie beams	Min	3030	-0.67	-0.09
	Max	3009	0.29	0.00

Table 5.6. Different Time period and Frequencies for the structure

Mode Shape No	Time period(s)	Frequency(Hz)
Mode 1	0.5275	1.8954
Mode 2	0.3680	2.7170
Mode 3	0.3378	2.9597
Mode 4	0.1794	5.5716
Mode 5	0.1430	6.9904
Mode 6	0.1403	7.1234
Mode 7	0.1375	7.2719
Mode 8	0.1340	7.4620
Mode 9	0.1335	7.4897
Mode 10	0.1316	7.5935
Mode 11	0.1300	7.6870
Mode 12	0.1298	7.7004

VI. Conclusions

In this study some of the most important key design considerations for RCC Overhead water Tank under Seismic and Wind Loads are discussed.

1. For Columns maximum bending moment occurred in Z-direction for the member 306 is 511.864 KNm with a shear force of 252.673 KN for the load combination 21.
2. For Ring beams @ Bottom of the tank maximum bending moment occurred in Z-direction for the member 4022 is 382.35 KNm with a shear force of 355.039 KN for the load combination 13.

3. For Ring beams @ Top of the tank maximum bending moment occurred in Z-direction for the member 4138 is 29.086 KNm with a shear force of 28.579 KN for the load combination 12.
4. For Tie beams maximum bending moment occurred in Z-direction for the member 2008 is 471.68 KNm with a shear force of 350.95 KN for the load combination 24.
5. Finally structure designed for maximum displacement values. Reinforcement considered from STAAD analysis for beams & columns

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