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Analysis of Rectangular Water Tank Behavior Under Different Types Loading by Using Stadd Pro Software

PROF. PATEL NIKUNJ R	Assistant Professor Civil Engineering Sadar Patel College of Engineering, Bakrol
PROF. JUGAL MISTRY	Assistant Professor Civil Engineering Sadar Patel College of Engineering, Bakrol

ABSTRACT

Storage reservoirs and overhead tank are used to store water, liquid petroleum, petroleum products and similar liquids. The force analysis of the water tanks is about the same irrespective of the chemical nature of the product. 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 Rectangular Water Tank, Stadd Pro, Dead load, Hydrostatic load, Wind load

Introduction

The water is source of every conception. In day to day life, one cannot live without water. The overhead liquid storing tank is the most effectual storing competence used for domestic or even industrial rationale. Depending upon the location of the water tank, the tanks can be name as overhead, on ground and underground water tank. The tanks can be made in different shapes like rectangular, circular and intze types. The tanks can be made of RCC or even of Structural steel. Steel tanks are widely used in railway yards. Overhead tanks and storage

Reservoirs are used to store water, liquid petroleum and similar liquids. Reservoir is a general tenure used to liquid storage structure and it can be below or above the ground level. 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 ofwater tank because of the low shuttering cost compare to theCircular water tank. Rectangular water tank required more construction material than the circular water tank.

The wall of these Tanks is subjected to water pressure. Water tanks are used to store water and are designed as crack free structures, to eliminate any leakage. In this work design of four types of rectangular water tanks resting on ground is presented. The Codes are prepare to fulfill the general requirements for the design and construction of concrete structures for storage of liquid, mainly water. At present two codes are available to give the reference about the water retaining structures. IS 3370:2009 and the PCA Table. Liquid storage materials include water, wastewater, process liquids, cement slurry, petroleum, and other liquid products.

I WATER YANK 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 of moment 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

The Architectural Institute of Japan they had discussed the topic" DESIGN RECOMMENDATION FOR STORAGE TANKS AND THEIR SUPPORTS WITH EMPHASIS ON SEISMIC DESIGN However, It is envisaged by publishing the English version of "Design Recommendation for Storage Tanks and Their Supports" that the above unique design recommendation will be promoted to the overseas countries who are concerned on the design of storage tanks and the activities of the Architectural Institute of Japan will be introduced them too. It is addressed how this recommendation is in an advanced standard in terms of the theory of the restoring force characteristics of the structure considering the Elephant Foot Bulge (EFB), the effect of the uplifting tank and the plastic deformation of the bottom plate at the shell-to-bottom juncture in the event of earthquake, the design spectrum for sloshing in tanks, the design pressure for silos, and the design methods for the under-ground storage tanks as well. The body of the recommendation was completely translated into English but the translation of the commentary was limited to the minimum necessary parts for understanding and utilizing the theories and equations in the body. The sections 2.7 Timbers and 4.9

Wooden Storage Tanks are omitted as they are not common in overseas countries. Listing of some Japanese references are omitted and some new references are added in this English version..

The seismic design calculations for other types of storage tanks have been similarly reviewed and amended to take into account data obtained from recent experience and experiments. Design recommendation for sloshing phenomena in tanks has been added in this publication. Design spectra for sloshing, spectra for long period range in other words, damping ratios for the sloshing phenomena and pressures by the sloshing on the tank roof have been presented. For above-ground vertical cylindrical storage tanks without any restraining element, such as anchor bolts or straps, to prevent any overturning moment, only the bending resistance due to the uplift of the rim of bottom plate exists. This recommendation shows how to evaluate the energy absorption value given by plasticity of the uplifted bottom plate for unanchored tanks, as well as the *Ds* value of an anchored cylindrical steel-wall tank. As the number of smaller under-ground tanks used for the storage of water and fuel is increasing in Japan, the Sub-committee has added them in the scope of the recommendation and provided a framework for the seismic design of under-ground tanks. The recommendation has accordingly included a new response displacement method and a new earth pressure calculation method, taking into account the design methods adopted by the civil engineering fraternity. For silo design, additional local pressure which depends on eccentricity of discharge outlet, and equations which give approximate stress produced by this pressure are given in this 2010 publication.

Veeresh Varur, Dr.S.B.Vankudre,Prabhavati P. they had discussed the topic" Optimization of Water Tank"

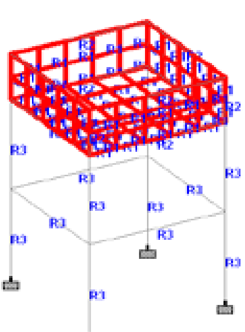
The paper gives idea for safe design with minimum cost of the tank and give the designer the relationship curve between design variable thus design of tank can be more economical, reliable and simple. The paper helps in understanding the design philosophy for the safe and economical design of water tank. The wall of tanks subjected to pressure and the base is subjected to weight of Water. In below paper, reinforced concert resting on ground monolithic with the base are design and their results are made optimum

III PRELIMINARY EXPERIMENTAL INVESTIGATION

The computer program for the project is done using MATLAB version 9.0. The program is written for the normal design and later to optimize the area of steel the optimization method using N Pandian function is called in mat lab to minimize the values.

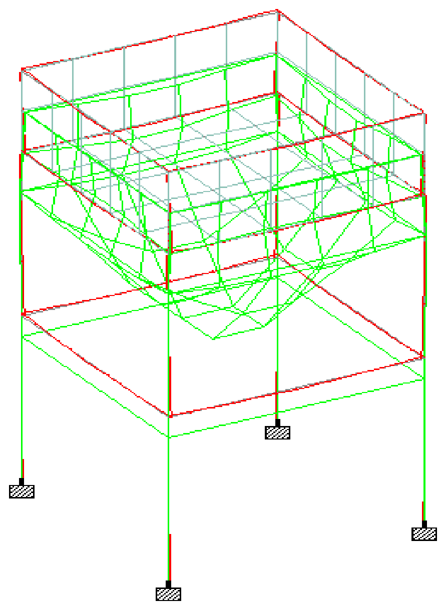
1. User defined material data like span, load and grade of concrete and steel are to be given as input
2. Effective span is calculated by adding the effective depth to the span
3. Load calculations (g) has to b given as input total dead load and wind load are calculated as per IS-875 PART1 and 3 respectively
4. Maximum bending moment and shear force has to be calculated
5. With the maximum bending moment the area of steel is to be calculated.

PRIMARY DATA OF RECTANGULAR WATER TANK



3D VIEW OF RECTANGULAR WATER TANK

DEFLECTED SHAPE OF RECTANGULAR WATER TANK



FINAL RESULT OF DIFFERENT LOAD COMBINATION ON RECTANGULAR WATER TANK

water tank 2.std - Beam End Force

Beam	L/C	Node	Axial Force kN	Shear-Y kN	Shear-Z kN	Torsion kNm	Moment-Y kNm	Moment-Z kNm
24	1	8	24.183	5.301	-0.000	-0.000	0.021	4.101
23	1	7	24.184	5.301	0.000	0.000	-0.021	4.101
19	1	3	-0.928	5.299	0.000	-0.000	0.001	4.040
20	1	4	-0.928	5.299	-0.000	0.000	-0.001	4.040
2	1	5	-17.347	5.302	0.000	0.000	0.004	3.973
11	1	13	-17.348	5.302	-0.000	-0.000	-0.004	3.973
22	1	6	-18.302	5.301	-0.000	-0.000	-0.004	3.815
21	1	5	-18.303	5.301	0.000	0.000	0.004	3.815
21	5	5	0.715	0.415	-0.003	-0.009	0.014	1.043
22	5	6	0.715	0.415	0.003	0.009	-0.014	1.043
22	5	14	-0.715	-0.415	-0.003	-0.009	-0.003	1.033
21	5	13	-0.715	-0.415	0.003	0.009	0.003	1.033
2	3	5	0.711	0.382	0.007	0.012	-0.022	0.960
11	3	13	0.711	0.382	-0.007	-0.012	0.022	0.960
2	3	6	-0.711	-0.382	-0.007	-0.012	-0.011	0.951
11	3	14	-0.711	-0.382	0.007	0.012	0.011	0.951
12	2	16	-0.308	-0.023	-0.009	0.001	-0.025	0.060
3	2	8	-0.309	-0.023	0.009	-0.001	0.025	0.060
3	2	7	0.308	0.023	-0.009	0.001	0.021	0.057
12	2	15	0.308	0.023	0.009	-0.001	-0.021	0.057
22	3	14	0.680	-0.000	-0.000	-0.000	-0.013	0.018
21	3	13	0.680	-0.000	0.000	0.000	0.013	0.018
24	5	16	-0.318	-0.006	-0.016	0.001	-0.038	0.016
23	5	15	-0.318	-0.006	0.016	-0.001	0.038	0.016
22	3	6	0.342	-0.000	-0.000	-0.000	-0.001	0.016
21	2	5	0.342	-0.000	0.000	0.000	0.001	0.016
11	4	14	0.602	0.000	-0.000	-0.000	0.010	0.013
2	4	6	0.602	0.000	-0.000	0.000	-0.010	0.013

water tank 2.std - Support Reaction

Node	L/C	Force-X kN	Force-Y kN	Force-Z kN	Moment-X kNm	Moment-Y kNm	Moment-Z kNm
9	1	0.412	265.204	-0.521	-0.697	0.001	-0.557
10	1	-0.407	265.192	-0.521	-0.697	-0.001	0.540
1	1	0.412	265.191	0.516	0.683	-0.001	-0.557
2	1	-0.407	265.179	0.516	0.683	0.001	0.540
1	5	-0.011	8.661	4.910	13.101	-0.002	0.014
10	4	0.011	8.661	-4.910	-13.101	-0.002	-0.014
9	4	-0.011	8.661	-4.910	-13.101	0.002	0.014
2	5	0.011	8.661	4.910	13.101	0.002	-0.014
2	2	-4.903	7.936	-0.006	-0.008	-0.002	14.897
1	3	4.903	7.936	-0.006	-0.008	0.002	-14.897
9	3	4.903	7.936	0.006	0.008	-0.002	-14.897
10	2	-4.903	7.936	0.006	0.008	0.002	14.897
9	2	-4.927	-7.936	-0.005	-0.006	-0.000	14.953
2	3	4.927	-7.936	0.005	0.006	-0.000	-14.953
10	3	4.927	-7.936	-0.005	-0.006	0.000	-14.953
1	2	-4.927	-7.936	0.005	0.006	0.000	14.953
2	4	-0.009	-8.661	-4.920	-13.127	0.001	0.011
1	4	0.009	-8.661	-4.920	-13.127	-0.001	-0.011
9	5	0.009	-8.661	4.920	13.127	0.001	-0.011
10	5	-0.009	-8.661	4.920	13.127	-0.001	0.011

IV . CONCLUSION

1. Deflection is high due to settlement of supports.
2. Stability of water tank affected by intensity of wind load.
3. At the mid span of top portion get maximum bending moment.
4. Fluid density must be considered in design.
5. Connected beam get maximum axial force due to load combination as per IS-875 PART3.

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