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DESIGN OF OVER HEAD WATER TANK

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ABSTRACT

Overhead tank is an important and very common public utility structure. 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. Storage reservoirs and overhead tank are used to store water. All tanks are designed as crack free structures to eliminate any leakage. The principle objective of this paper is to plan and design a Circular Overhead Tank of 25 lakh litres capacity for khadki region. In this paper all structural elements of circular water tank are designed.

Keyword: Circular water tank, Overhead

1. INTRODUCTION

Elevated tanks are supported on staging which may consist of masonry walls, R.C.C. columns braced together. The walls are subjected to water pressure. The base has to carry load of water and tank load. The staging has to carry load of water and tanks. The staging is also designed for wind forces.. NBKR Institute of Science and Technology (NBKRIST) is an autonomous engineering college established in 1979 located at Vidyanagar, Kota mandal, Nellore, Andhra Pradesh. It was established in the year 1979 under the stewardship of former chief minister Sri. N. Janardhana Reddy. The College is the second oldest of all the private Engineering Colleges in undivided Andhra Pradesh. It was proposed to construct a over head circular water tank of 15 lakh capacity and to provide quality drinking water to all around the NBKRIST College campus

2. LITERATURE REVIEW

[1] Mr. ManojNallanathel, Mr. B. Ramesh, Mr. L. Jagadeesh had done the "DESIGN AND ANALYSIS OF WATER TANKS USING STAAD PRO" This paper includes the study of Design of water tank both overhead and underground tank of shapes rectangular, square and circular shapes the paper includes the study of shape deflections and the actions produced when the tank is empty or full using STAAD PRO is discussed.From these designs it is showed that corner stresses and maximum shear and bendingstresses are found to be less in case of circular tanks than remaining other designs and theshapes of water tanks plays vital role in the stress distribution and overall economy. Byusing 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 bysurrounding 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 givesaccurate results for shear force and bending moment than convenient method.

[2] Miss. Neha S. Vanjari, Krutika. M. Sawant, Prashant S. Sisodiya,(7 July2017)had done the "DESIGN OF CIRCULAR OVERHEAD WATER TANK" This paper gives an overall designing procedure of an overhead circular intze tank using working state method from IS 3370:2009. Elevated water tanks provide head for supply of water. When water has to be pumped into the distribution system at high heads without any pumps for supply however pumps are necessary for pumping only till tank is filled. Once it is stored in tank the gravity creates the pressure for free, unlike pumps. We need pressurized water to fledge and make taps ejectwater at an appropriate rate. Elevated tanks do not require continuous operation of pump, as it will not affect the distribution system since the pressure is maintained by gravity. Strategic location of tank can equalize water pressure in the distribution system

[3] The pressure of water flowing out of an elevated tank depends upon the depth of the water in tank .A nearly empty tank probably will not provide enough pressure while a completely

full tank may provide too much pressure the optimal pressure is achieved at only one depth.While elevated tank provide can provide the best pressure, they are far more expensive and generally, it is used where supply is high demand Elevated circular water tanks with large capacity and flat bottom needs large reinforcement at the ring beams. To overcome this in intze tank, by providing a conical bottom and another spherical bottom reduces the stresses in ring beams. Intze tank is more economical for high capacity reducing the steel requirement.

[4] Ms. Pranjali N. Dhage, 2-Mr. Mandar M. Joshi (April 2017)PankajLaddhad Institute of Technology and Management Studies, BuldanaFrom above mentioned detailed study and analysis some of the conclusions can be made as follows For same capacity, same geometry, same height, with same staging system, in the same Zone, with same Importance Factor & response reduction factor; response by Equivalent Static Method to Dynamic method differ considerably. It also state that even if we consider two cases for same capacity of tank, change in geometric features of a container can show the considerable change in the response of elevated water tank. At the same time Static response shows high scale values that of the Dynamic response. It happens due to the different picks of time periods and hydrodynamic factors are ignored during the analysisthey will affect vigorously and collapse of the structure can takes place.

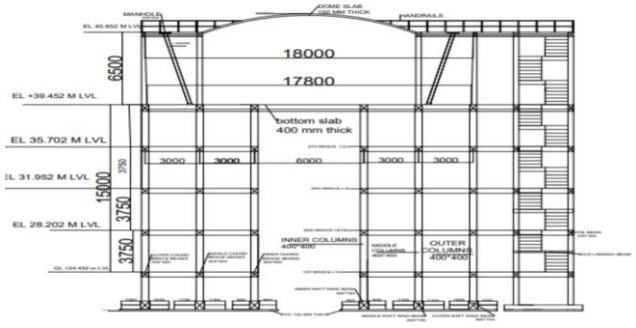
[5] Design and Analysis of a Water Tank GouravPattanaik1 Prof. Sagarika Panda2M.Tech Scholar, Department of Civil Engineering, Centurion Institute of Technology, India Professor, Department of Civil Engineering, Centurion Institute of Technology, IndiaIn a water tank design and analysis increase in live load causes failure of beams and columns.So it can be clearly observed that increase in live load causes failurein the structure.

[6] Planning Analysis And Design Of Over Head Circular Water Tank In N.B.K.R.I.S.T. Using Stad Pro Software Arunkumar, O Sriramulu, N VenkateswarluThe proposed tank in NBKRIST College campus designed in STAAD Pro software • Design of tank is safe from the software design with respect to loads applied. For small capacities we go for rectangular water tanks while for bigger capacities we provide circular water tanks. Since our proposed tank is of 12lakh capacity we had Planned analyzed and designed the circular over head tank in STAAD Pro softwareDesign of water tank is a very tedious method.

[7]Analysis Of Circular And Rectangular Overhead Watertank (March 2014)Hemishkumar Patel, Dr. JayeshkumarPitrodaTotal water load in Rectangular tank is slightly higher than water load in circular tank A hoop tension force for Circular tank is lower compare to Rectangular tank for higher capacity. An axial force in column due to total water load in Circular tank is lower compare to Rectangular tank for higher capacity.Software results compare to IS code calculation is higher.

[8] Design and Analysis of Overhead Water Tank at Phule Nagar, AmbernathSagarMhamunkar, MayurSatkar, DipeshPulaskar, Nikhil Khairnar, ReetikaSharan.Elevated circular water tank with large capacity and flat bottom needs large reinforcement at the ring beam, to overcome this in intze tank, by providing a conical bottom and another spherical bottom reduces the stresses in ring beams. intze tank is more economical for high capacity reducing the steel requirement. Per capita demand has been calculated which helped us, to know about the water consumption in residential area and further helped in design the tank. Limit state method was found to be most economical for design of water tank as the quantity of steel and concrete needed is less as compare to working stress method.After manual design and analysis in staad pro our structure is safe.

3. PLAN OF A OVERHEAD CIRCULAR WATER TANK:



4. DESIGN CRITERIA:

ELSR Capacity	: 1500 KL
Type	: Circular
Staging	: 15m

Staging type : Columns

SBC : 20 t/m2

Depth of foundation : 2 m

Average G.L : 14.5 m

5. MATERIALS OF CONSTRUCTION

The following main material has been proposed for the construction of the Over head circular water tank.

1. Reinforcement : HYSD /T.M.T bars of grade Fe500.
2. PCC : M15 Grade of concrete
3. Reinforced concrete : M30(fck = 30N/mm2) for all elements
4. BRICK : Confirming to IS :1077,class5.0,
   Minimum compressive strength = 3.5N/mm2

6.LOADS:

[1] DEAD LOAD: The weight of all permanent construction including domes, ring beams, shafts, walls, stair case, slabs and foundation are considered. The unit weights of materials are in accordance with IS: 875-1987. The unit weight of Concrete (RCC),Soil,, Structural steel and brick masonry is taken as 25 kN/m3 ,18 kN/m3 ,78.5 kN/m3 and 19.1 kN/m3

[2] LIVE LOAD: The Live load on roof slab, walk way slab and staircase be 1.5 kN/m2 , 1.5 kN/m2 and 2.0 kN/m2 respectively

[3] WATER LOAD: Weight of water due to gross volume is calculated and applied on bottom of container unit wt. of water is 10 kN/m3

[4] WIND LOAD: As per figure -1 IS: 875(PART-3)-1978) design wind pressure = 0.6Vz2 = 2117.01 N/m2

[5] EARTH QUAKE LOAD (EQ): It is in zone-III as per IS 1893 part1 2002 Seismic coefficient αh = βIFo(Sa/g) β , coefficient of depending upon soil foundation = 1 I, factor depending upon importance of factor = 1.5 Fo, seismic zone factor for average acceleration spectra = 0.16 Sa/g is considered as per CI 6.3.5,(IS 1893,part-1).

7.CLASSIFICATIONS

Classification based under three heads:

[1] Tanks resting on ground

[2] Elevated tanks supported on staging

[3] Underground tanks.

Classification based on shape of tank

[1] Circular tanks

[2] Rectangular tanks

[3] Spherical tanks

[4] Intze tanks

[5]Circular tanks with conical bottom

8. OVERHEAD WATER TANKS AND TOWERS

Overhead water tanks of various shapes can be used as service reservoirs, as a balancing tank in water supply schemes and for replenishing the tanks for various purposes. Reinforced concrete water towers have distinct advantages as they are not affected by climatic changes, are leak proof, provide greater rigidity and are adoptable for all shapes.

Components of a water tower consists of-

A. Tank portion with -

1. Roof and roof beams (if any)
2. sidewalls
3. Floor or bottom slab
4. floor beams,

B. Staging portion, consisting of-

1. Columns
2. Bracings and
3. Foundations

Types of water Tanks may be –

a) Square-open or with cover at top
b) Rectangular-open or with cover at top
c) Circular-open or with cover at which may be flat or domed.

Among these the circular types are proposed for large capacities. Such circular tanks may have flat floors or domical floors and these are supported on circular girder.

The most common type of circular tank is the one which is called an Intze Tank. In such cases, a domed cover is provided at top with a cylindrical and conical wall at bottom. A ring beam will be required to support the domed roof. A ring beam is also provided at the junction of the cylindrical and conical walls. The conical wall and the tank floor are supported on a ring girder which is supported on a number of columns.

Usually a domed floor is shown in fig a result of which the ring girder supported on the columns will be relieved from the horizontal thrusts as the horizontal thrusts of the conical wall and the domed floor act in opposite direction.

Sometimes, a vertical hollow shaft may be provided which may be supported on the domed floor.

9.THE DESIGN OF THE TANK WILL INVOLVE THE FOLLOWING

1) The dome at top usually 100 mm to 150 mm thick with reinforcement along the meridians and latitudes. The rise is usually l/5th of the span.
2) Ring beam supporting the dome. The ring beam is necessary to resist the horizontal component of the thrust of the dome. The ring beam will be designed for the hoop tension induced.
3) Cylindrical walls: This has to be designed for hoop tension caused due to horizontal water pressure.
4) Ring beam at the junction of the cylindrical walls and the conical wall. This ring beam is provided to resist the horizontal component of the reaction of the conical wall on the cylindrical wall. The ring beam will be designed for the induced hoop tension.
5) Conical slab, this will be designed for hoop tension due to water pressure. The slab will also be designed as a slab spanning between the ring beam at top and the ring girder at bottom.
6) Floor of the tank. The floor may be circular or domed. This slab is supported on the ring girder.
7) The ring girder: This will be designed to support the tank and its contents.The girder will be supported on columns and should be designed for resulting bending moment and Torsion.
8) Columns: These are to be designed for the total load transferred to them. The columns will be braced at intervals and have to be designed for wind pressure or seismic loads whichever govern.
9) Foundations: A combined footing is usual provided for all supporting columns. When this is done it is usual to make the foundation consisting of a ring girder and a circular slab.

10. WATER CONSUMPTION RATE

It is very difficult to precisely assess the quantity of water demanded by the public, since there are many variable factors affecting water consumption. The various types of water demands, which a city may have, may be broken into following class.

Water Consumption for Various Purposes:

Sr. No	Type of consumption	Normal Range (lit/capita/day)	Average	%
1	Domestic Consumption	65-300	160	35
2	Industrial and Commercial Demand	45-450	135	30
3	Public including Fire demand uses	20-90	45	10

4	Losses and Waste	45-150	62	25

11. FACTORS AFFECTING PER CAPITA DEMAND:

• Size of the city: Per capita demand for big cities is generally large as compared to that for smaller towns as big cities have sewered houses.

• Presence of industries

• Climatic conditions.

• Habits of economic status.

• Quality of water: If water is aesthetically and medically safe, the consumption will increase as people will not resort to private wells, etc.

• Pressure in the distribution system.

• Efficiency of water works administration: Leaks in water mains and services; and un authorised use of water can be kept to a minimum by surveys.

• Cost of water.

• Policy of metering and charging method: Water tax is charged in two different

ways: on the basis of meter reading and on the basis of certain fixed monthly rate.

12. FLUCTUATIONS IN RATE OF DEMAND:

Average Daily Per Capita Demand

= Quantity Required in 12 Months/ (365 x Population)

If this average demand is supplied at all the times, it will not be sufficient to meet the fluctuations.

•Seasonal variation: The demand peaks during summer. Firebreak outs are generally more in summer, increasing demand. So, there is seasonal variation .

•Daily variation depends on the activity. People draw out more water on Sundays and Festival days, thus increasing demand on these days.

•Hourly variations are very important as they have a wide range. During active household working hours i.e. from six to ten in the morning and four to eight in the evening, the bulk of the daily requirement is taken. During other hours the requirement is negligible. Moreover, if a fire breaks out, a huge quantity of water is required to be supplied during short duration, necessitating the need for a maximum rate of hourly supply.

So, an adequate quantity of water must be available to meet the peak demand. To meet all the fluctuations, the supply pipes, service reservoirs and distribution pipes must be properly proportioned. The water is supplied by pumping directly and the pumps and distribution system must be designed to meet the peak demand. The effect of monthly variation influences the design of storage reservoirs and the hourly variations influences the design of pumps and service reservoirs. As the population decreases, the fluctuation rate increases.

13. POPULATION FORCASTING

This quantity should be worked out with due provision for the estimated requirements of the future. The future period for which a provision is made in the water supply scheme is known as the design period.

Design period is estimated based on the following:

• Useful life of the component , considering obsolescence, wear, tear, etc.

• Expandability aspect.

• Anticipated rate of growth of population, including industrial, commercial developments & migration-immigration.

• Available resources.

• Performance of the system during initial period.

14. POPULATION FORECASTING METHODS.

The various methods adopted for estimating future populations are given below. The particular method to be adopted for a particular case or for a particular city depends largely on the factors discussed in the methods, and the selection is left to the discretion and intelligence of the designer.

1. Incremental Increase Method

2.Decreasing Rate of Growth Method

3.Simple Graphical Method

4.Comparative Graphical Method

5.Ratio Method

6.Logistic Curve Method

7.Arithmetic Increase Method

8.Geometric Increase Method

POPULATION FORCASTING FOR YEAR 2030

YEAR	POPULATION	INCREASE PER DECADE	INCREMENTAL INCREASE	PERCENTAGE INCREASE	DECREASE IN PERCENTAGE INCREASE
1990	74000	-	-	-	-
2000	76608	2608	-	3.52	-
2010	78684	2076	532	2.70	0.82
2020	80000	1316	760	1.68	1.03
TOTAL		6000	1292	7.89	1.85
AVERAGE		2000	646	2.63	0.925
2030	82646	-	-	-	-

15. CONCLUSIONS

Water tanks are considered to be expensive but they are considered to reach present and future population.They are considered to highly economical and safely store the portable water. Water can be distributed to number of houses, industries and public places by means of a network of a distribution system. Thus water tanks are considered to be supporting systems and useful for the society.

REFERENCE-

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[10] M.Tech Scholar, Department of Civil Engineering, Centurion Institute of Technology, India Professor, Department of Civil Engineering, Centurion Institute of Technology, India

[11] Planning Analysis And Design Of Over Head Circular Water Tank In N.B.K.R.I.S.T. Using staad Pro Software Arunkumar.

[12] Design and Analysis of Overhead Water Tank at Phule Nagar, Ambernath

[13] Sagar Mhamunkar1, Mayur Satkar2, Dipesh Pulaskar3, Nikhil Khairnar4, Reetika Sharan5