International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com ǁ Volume 2 Issue 4ǁ April 2016 ǁ PP 25-30

DESIGN AND EVALUATION OF THE SUPER STRUCTURE OF INTAZE WATER TANK

Pooja malviya
Dr. Pradeep kumar
DEPARMENT OF CIVIL ENGINEERING
IES INSTITUTE OF TECHNOLOGY & MANAGMENT
BHOPAL (M.P.)

ABSTRACT - Water storage reservoirs and overhead tank are used to store water. To achieve imperviousness of concrete, higher density of concrete should be achieved. Today, water demand is increasing day by day. The scarcity of water for public uses is becoming an problem. The water demand is fluctuating throughout the day. Continuous water distribution may result in heavy loss of water by the users. To save water, water harvesting schemes have been implemented and supported by the government. The water harvesting from different sources is to be stored at various levels and regions. Therefore, construction of water tanks is required having minimum capital cost and time with specified quality.
In this thesis using ESR & GSR software. The thesis describes, water tanks constructed in different regions having different soil conditions. The cost of water tanks is evaluated on basis of the soil conditions and taking account of seismic and wind effects on water tanks. The design of appropriate water yanks are evolved by using working stress method. The main objective of this project to study the effect of seismic and wing on reinforcement and concrete elevated intze water tanks in seismic zones II,III,IV and V or wind zone I, II, III, IV and V for black coton, ordinary and soft murum soil conditions for different component of super stucture of the intze water tanks.

1. INTRODUCTION

Storage tanks are built for storing water, liquid petroleum, petroleum products and similar liquids. Analysis and design of such tanks are independent of chemical nature of product. They are designed as crack free structures to eliminate any leakage. Adequate cover to reinforcement is necessary to prevent corrosion. In order to avoid leakage and to provide higher strength concrete of grade M20 and above is recommended for liquid retaining structures. To achieve imperviousness of concrete, higher density of concrete should be achieved. Permeability of concrete is directly proportional to water cement ratio. Proper compaction using vibrators should be done to achieve imperviousness. Cement content ranging from 330 Kg/m^3 to 530 Kg/m^3 is recommended in order to keep shrinkage low.

Types of Water Tank:
Basing on the location of the tank in a buildings tanks can be classified into three categories.
Those are:

- Underground tanks
- Tank resting on grounds
- Overhead tanks

In most cases the underground and on ground tanks are circular or rectangular is shape but the shape of the overhead tanks are influenced by the aesthetical view of the surroundings and as well as the design of the construction. Steel tanks are also used specially in railway yards. Basing on the shape the tanks can be circular, rectangular, square, polygonal, spherical and conical. A special type of tank named Intze tank is used for storing large amount of water for an area.

The overhead tanks are supported by the column which acts as stages. This column can be braced for increasing strength and as well as to improve the aesthetic views.

The various sources of water can be classified into two categories: Surface sources, such as

1. Ponds and lakes,
2. Streams and rivers,
3. Storage reservoirs, and
4. Oceans, generally not used for water supplies, at present.

Sub-surface sources or underground sources, such as springs, Infiltration wells, and Wells and Tube-wells.

It is found that for storing large volumes of water an elevated tank, provided with flat floor slab, works out to be an uneconomical design. It is mainly on account of the fact that flat floor slab, becomes too thick for large diameter tanks. Intze tank is best suitable under such circumstances. An intze tank essentially consists of a top dome (rool), the cylindrical wall and the floor slab, which is a combination of conical dome and bottom spherical dome. Being subjected to direct compression, the thickness of the domical floor slab, works out to be much less and hence it proves to be economical alternative to flat slab floor.

Indian sub-continent is highly vulnerable to natural disasters like earthquakes, draughts, floods, cyclones etc. Majority of states or union territories are prone to one or multiple disasters. These natural calamities are causing many casualties and innumerable property loss every year. Earthquakes occupy first place in vulnerability.

Types of Water Tanks:

A water tank is used to store water to tide over the daily requirements. It is used to overcome the water related problem in the areas. It will help to store water during flood as well as drought seasons.

In general, water tanks can be classified under three heads. The classfication of water tanks on basis of their structure with respect to ground.

- Tanks resting on grounds.
- Elevated tanks supported on staging.
- Underground tanks

From the shape point of view, water tanks may be of following types.

- Circular tanks.
- Rectangular tanks.
- Spherical tanks.
- Intze tanks.
- Funnel tanks.

Rectangular water tanks are used to store small capacity of water. For economy these tanks should be square in plan and their height should half of the side. But these tanks are uneconomical for large capacities. This type of tank is smaller capacity; the cost of shuttering for circulars tanks becomes high. Rectangular tanks are normally not used uneconomical and also its exact analysis is difficult. For a given capacity, perimeter is least for circular tank.

Circular Water Tank:- The simplest form of water tank is circular tank. For the same amount of storage the circular tank requires lesser amount of material. More over for its circular shape it has no corner and can be made water tight easily. It is very economical for smaller storage of water up to 20000000 liters and with diameter in the range of 5 to 8m. The depth of the storage is between 3 to 4m. The side walls are designed for hoop tension and bending moments.

Intze tanks provided with conical and spherical bottom dome gives an economical solution. The proportion of conical and spherical bottom dome is selected in such a way, so that outward thrust from bottom dome balances the inward thrust due to conical dome. Through it is quite economical from material point of view but the cost of formwork is higher in comparison to other shapes.

Dutta etal. (2009) presented comprehensive study on dynamic characteristics of RC elevated tanks supported by cylindrical shaft staging. The results were validated analytically using finite element analysis and by small-scale experimentation.

Amani etal. (2010) evaluated resonant frequencies in an RC elevated spherical container partially filled with water using finite element method and verified the results experimentally. The overall dynamical response of elevated spherical tanks subjected to horizontal base motion and free vibration and containing water at different levels were carried out. He investigated that for spherical tank, essentially three independent mass-motions are necessary; translation (structural), sloshing (convective) and pendulum motions. Therefore, three degrees of freedom is required for the analysis.

Pavan S. Ekbote and Dr. Jagadish. G. Kori (2013), During earthquake elevated water thanks were heavily damages or collapsed. This was might be due to the lack of knowledge regarding the behaviour of supporting system of the water tanks again dynamic action and also due to improper geometrical selection of staging patterns of tank. Due to the fluid structure interactions, the seismic behaviour of elevated water tanks has the characteristics of complex phenomena. The main aim of this study is to understand the behaviour of supporting system (or staging) which is more effective under different response spectrum method with SAP 2000 software. In this Paper different supporting system such as cross and radial bracing studied.

Sanjay P. Joshi (2000), conclude that: Equivalent mechanical model for rigid type tanks for horizontal vibration is developed. Parameter of the model are evaluated for a wide range of shapes of the tank and compared with those of the equivalent cylindrical tanks. It is shows that the errors associated with the sue of the equivalent cylindrical tanks model in place of the Intze tank model are small.

Hasan Jasim Mohammed (2011), conclude that: An application of optimization method to the structural design of concrete rectangular and circular water tanks, considering the total cost of the tank as an objective function with the properties of the tank that are tank capacity, width and length of tank in rectangular, water depth in circular, unit weight of water and tank floor slab thickness, as design variables.

Harajli and Naaman (1984, 1989):- Tested twelve different sets of simply-supported Beams. Each set comprised two identical beams. One beam was tested to failure under Monotonie loading, while the second beam was tested in fatigue at a constant load range simulating full live load. Based on test results they developed a model for cornputing the Increase in crack width under cyclic fatigue loading.

Sudhir K. Jain and sajjad sameer U (1993):- In the seismic analysis, the effect of Accidental torsion must be included.

- An expression for calculating sloshing height of water may be introduced in the code.
- The effect of hydrodynamic pressure for tanks with rigid wall and the tanks with flexible wall should be considered separately, as force in the tanks with flexible wall in higher than those tanks with rigid wall.

Dr. Suchita Hirde and Dr. Manoj Hedaoo (2011):- This paper presents the study of Seismic performance of the elevated water tank for various seismic zones of India for various heights and capacity of elevated water tank for different soil condition. The effect of height of water tank earthquake zones and soil conditions on earthquake force has been presented in this paper with the help of the analysis of 240 models of various parameters. The study is carried out on RCC circular elevated water tank with M-20 grade of concrete and Fe-415 grad of steel and SMRF are considered for analysis. Elevated water tank having 50,000 liters capacity with staging height 12m., 16m., 20m., 24m., 28m. Considering 4m. Height of each panels are considered.

Raju etal (1973):- Tested eight 2.7 m span simply supported pretensioned concrete Beams with non-prestressed reinforcement. They proposed a formula to calculate crack width considering the percentage of non-prestressed reinforcement.

Malhotra et al. (2000):- Provides the theoretical background of a simplified Seismic design procedure for cylindrical ground-supported tanks. Seismic responses, base Shear, overturning moment, and sloshing wave height are calculated by using the site Response spectra and performing a few simple calculations.

2. METHODOLOGY-

PROJECT AIM & PROBLEM OVERVIEW

The design of overhead Intze Water Tank is carried out using the computer aided design software SEPL Esr-Gsr. The design is carried out as per relevant analysis procedures combined with Indian Standard Codes of Practices. The water tank dome is designed by Limit stress method. The foundation forces at the level of safe bearing capacity are also evaluated and then manually foundation design can be done. The software also gives the shape description of the tank and keeping various parameters, one can change the governing parameter to get the optimum result and safe design with economy.

PROJECT DATA: Structural design of R.C.C. ESR of capacity 1400000 liters.

Location of site: Bhopal

Systema data

Type of Container	:	Intze
Staging System Chosen	:	Column Braced Trestle

Foundation System Chosen	:	Isolated Column Footing
Staircase Location	:	Outside

Project Information:

Project Name	:	Malviya
Job No.	:	2015/ESR/
Date of Project	:	15/10/2015
Location of site	:	Bhopal
Taluka	:	Bhopal
District	:	Bhopal
Design Unit	:	1A

Geometrical Data

Required Capacity	:	1400 m^3
Outlet Level (OL)	:	10.000 m
Average Ground Level	:	100.000 m
Foundation Level	:	96.850 m
Water Table Level (WTL)	:	90.000 m
Free Board (FB)	:	0.300 m
Plaster thickness (Pt)	:	0.020 m
Ht. of Water in Cylindrical portion (Hcyl)	:	6.247 m
Ht. of Conical Shell (Hcsh)	:	1.968 m
Dead Storage Height (DS)	:	0.100 m
Water Depth (Hw):(Hcyl+Hcsh-DS-Pt)	:	8.095 m
Full Supply Level (FSL):(OL+H)	:	18.095 m
Design Water Depth (Wh): (IIw + FB + DS + Plaster Thk)	:	8.515 m
Diameter of Cylindrical Portion i/i	:	20.000 m
Bottom Diameter c/c	:	16.000 m
Slope of conical shell (a)	:	45.000^o
Wind Speed	:	39.000 m/s
Water Density (Wd)	:	1000.000 kg/m^3
Seismic Zone	:	5

Soil properties

Soil Description	:	Black cotton soil
Safe Bearing Capacity At Depth 3.150m	:	20.000 $tonne/m^2$

Cost of material

Reinforcement	:	40 Rupees per K.g
Concrete	:	2500 Rupees per m^3

3. RESULTS AND DISCUSSION

QUANTITY OF REINFORCEMENT AND CONCRETE IN INTZE WATER TANKS Analysis of reinforcement and concrete in intze water tanks is determined for various seismic zones and wind zones under different soil conditions.

Result of the two type of analysis

I. Seismic analysis

II. Wind analysis

Results are described below:-

SEISMIC ANALYSIS

Effect of Seismic analysis over quantity of different materials used in water structured with different types of soil conditions. Considering three of soil conditions

1. Black cotton soil: Black cotton soil is taken as primary condition and the following parameters of steel and concrete are evaluated for intze tanks on ground. The variation of steel and concrete are shown and discussed for different seismic zones. Comparative studies of all zones are examined and best outcome is determined from this study.

a. Quantity of reinforcement: The reinforcement quantity in diffenrent component of superstructure in intze water tanks for different seismic zones.

The quantity of reinforcement different seismic zones for black cotton soil are shown in Table 5.1 and 5.1

Table 5.1 Quantity of Reinforcement.

S.No.	Component	Zone 2 (K.G.)	Zone 3 (K.G.)	Zone 4 (K.G.)	Zone 5 (K.G.)
1	Top dome	3678.74	4435.958	4935.968	4935.958
2	Top ring beam	765.306	998	1012.644	1022.34
3	Middle ring beam	5476.23	5909.256	5998.68	6392.66
4	Conical shell	12612.62	131.54	13268.45	13568.24
5	Bottom dome	2876.89	2987.66	3010.32	3282.64
6	Bottom ring beam	46988.46	49872.34	51829.34	53820.78
7	Cylindrical wall	10123.89	10348.68	10568.98	10876.68
	Total	82522.14	87706.19	90624.36	93899.3

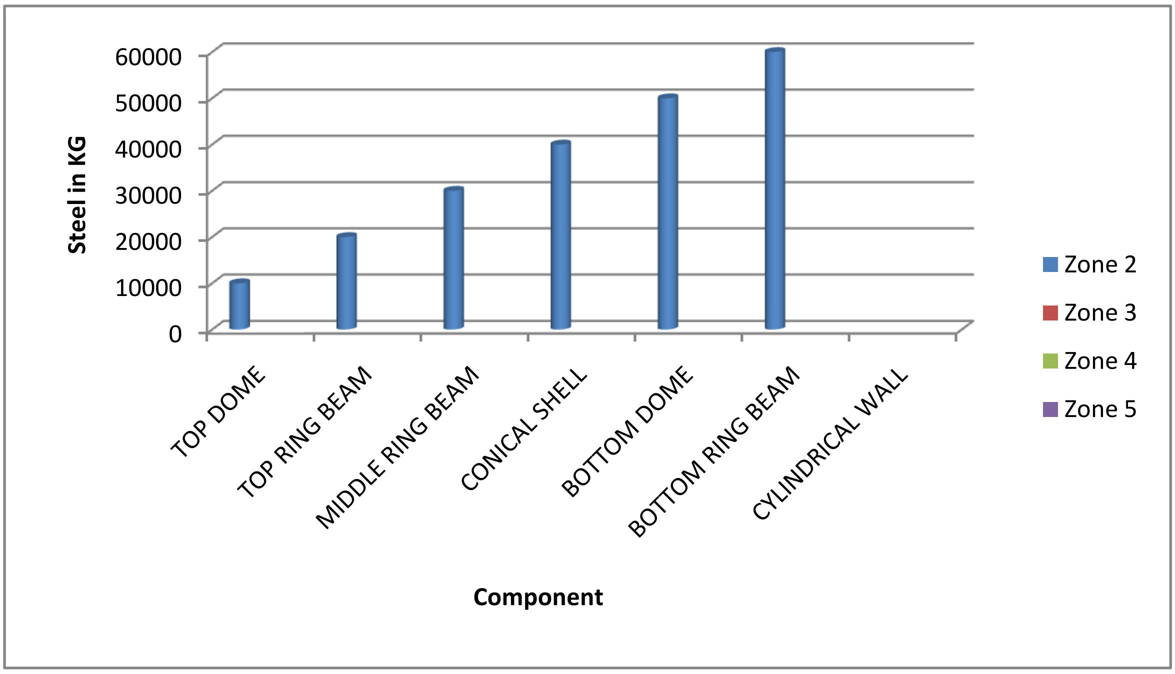

Figure 5.1 Quantity of Reinforcement.

Graph as shown in fig. 5.1 shows the variation of reinforcement quality of different members of intze water tanks under black cotton soil conditions.

- Maximum reinforcement is required in bottom ring beam of the tanks.
- Minimum reinforcement is required in to ring beam of the tanks.
- Bottom ring beam reinforcement increases with increases the seismic zones in all other component.
- Reinforcement in seismic zone (4) and zone (5) is almost constan.
- Cylindrical wall quantity of reinforcement is equal.

b. Quantity of Concrete: The quantity of concrete in different component of superstructure in the water tanks for different seismic zones.

The quantity of concrete in different seismic zones for black cotton soil are shown in Table 5.2 and Fig. 5.2

Table 5.2 Quantity of Concrete.

S.No.	Component	Zone 2 (M^3)	Zone 3 (M^3)	Zone 4 ($M^{3)}$	Zone 5 (M^3)
1	Top dome	50.45	60.33	67.267	67.267
2	Top ring beam	23.298	31	41.821	45.789
3	Middle ring beam	75.398	95.907	95.907	95.907
4	Conical shell	92.898	105.67	112.88	118.78
5	Bottom dome	86.276	98.378	105.66	110.98
6	Bottom ring beam	233.736	239.86	245.66	252.98
7	Cylindrical wall	157.358	162.56	165.44	175.729

4. CONCLUSIONS AND FUTURE SCOPE OF THE STUDY

In this study the seismic and wind analysis of the intze water tanks. For all the above mentioned 1400 m^3 capacities, analysis has been carried out by using Esr-Gsr software. Earthquake analysis is carried out for different soil conditions and different earthquake and wind zone. The main objective of this project to study the rffect of seismic and wind on reinforcement and conrete elevated intze water tanks is seismic zone II, III, IV, and V or wind zone I, II, III, IV and V for black cotton, ordinary and soft murum soil conditions for different component of super structure of the intze water tanks.

FUTURE SCOPE OF THE STUDY

Following scope of the study are given below.

1. In design of an Intze tanks for varying seismic, wind zone and the results.
2. By using the ESR-Gsr, anyone can develop any other software.
3. Seismic effect considered in the software are based on IS codes. Due to the recent occurrence of various earthquake zone, detailed analysis of such soil may be required for safe design of such tanks.
4. In this study R.C.C. structure have been considered. The study can be extended to steel structures.

References

[1]. Is Code- 1893-2002

[2]. Is: 3370 (1965) (Part I) "Code of practice for Concrete Structures for the storage of Liquids" General Requirements, Bureau of Indian Standard, New Delhi.

[3]. IS: 875-1987 (Part I-IV), "Code for design consideration of loads on structures", Bureau of Indian Standards, New Delhi.

[4]. IS: 456-2000, "Code of practice for plain and R.C. Structures", Bureau of Indian Standards, New Delhi.

[5]. I.C. Syal, A.K. Goal, "Reinforced concrete structures", Bureau of Indian Standards, New Delhi.

[6]. IS:3370-1967 Part I-IV, "Code of practice for concrete structures for the storage of liquids", Bureau of Indian Standards, New Delhi.

[7]. IS :1893-2002, " Criteria for Earthquake Resistant Design of structures", (Fifth Revision) Bureau of Indian Standards, New Delhi.

[8]. Luis Godoy, "Damage Due to Buckling In Above Ground storage Tank:, University of Puerto Rico.

[9]. NZS 3106, 1986, : Code of practice for concrete structures for the storage of liquids:, standards Association of New Zealand, Wellington.

[10]. IITK-GSDMA Guidelines for Seismic Design fo storage Tanks provisions with commentary and explanatory examples.

[11]. IS: 456 (2000) "Plain and Reinforced Concrete- Code for Practice" Burial of Indian Standard, New Delhi.

[12]. Manish N. Gandhi, Prof. A. Rajan "Necessity of Dynamic Analysis of Elevated Water storage structure Using.Different Bracing in Staging International Journal of Research in Advent Technology, Vol. 2, No.2, February 2014.

[13]. B.N. Dutta, 2009 "Estimating and costing In Civil Engineering", Twenty-Sixty Revised Editing UBS Publishers, Distributors Pvt. Ltd. New Delhi.

[14]. J.Krishna, and O.P. Jain (2000) "Plain and Reinforcement Concrete" Nem Chand and Bros, Vol.1 and Vol.2