

Study on Analysis & Design of Intz Water Tank a Review Paper

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How to cite this paper: Pammy Barnawal | Nitesh Kushwaha "Study on Analysis & Design of Intz Water Tank a Review Paper" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-1, December 2019, pp.1253-1256, URL: www.ijtsrd.com/papers/ijtsrd30034.pdf



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INTRODUCTION

Water tanks are very important components of lifeline. They are critical elements in municipal water supply, fire fighting systems and in many industrial facilities for storage of water. A reinforcement concrete tank is a very useful structure which is meant for the storage of water, for swimming bath, sewage sedimentation and for such similar purposes. Reinforced concrete overhead water tanks are used to store and supply safe drinking water. With the rapid speed of urbanization, demand for drinking water has increased by many folds. Also, due to shortage of electricity, it is not possible to supply water through pumps at peak hours. In such situations overhead water tanks become an indispensable part of life. As demand for water tanks will continue to increase in coming years, quick prediction of tanks before its design will be helpful in selection of tanks for real design. In general water tanks can be classified test under three heads: -

1. Tank resting on the ground
2. Elevated tanks supported on staging
3. Underground tank

From the shape point of view water tank may be of several types: -

1. Circular tank
2. Rectangular tank
3. Spherical tank
4. Intze tank
5. Circular tank with conical dome

In the construction of concrete structures for the storage of water and other liquids, the imperviousness of concrete is most essential. The permeability of any uniform and thoroughly compacted concrete of given mix proportion is mainly depend on water cement ratio. The increase in water-cement ratio result in increase in the permeability. The decrease in water cement ratio will therefore be desirable to decrease the permeability, but very much reduced water-cement ratio may cause compaction difficulties and prove to be harmful also. For a given mix made with particular materials, there is a lower limit to the water-cement ratio which can be used economically on any job. It is essential to select a richness of mix compatible with available aggregates, whose particle shape and grading have an important bearing on workability, which must be suited

to the means of compaction selected. Efficiency compaction preferably by vibration is essential. It is desirable to specify cement content sufficiently high to ensure that through compaction is obtainable while maintaining a sufficiently low water-cement ratio. The quantity of cement should not be less than 330 kg/m³ of concrete. It should also be less than 530 kg/m³ of concrete to keep the shrinkage low. In thicker sections, where a reduction in cement content might be desirable to restrict the temperature rise due to cement hydration, lower cement content is usually permissible. It is usual to use rich mix like M 30 grade in most of the water tanks.

Design of liquid retaining structure has to be based on the avoidance of cracking in the concrete having regard to its tensile strength. It has to be ensured in its design that concrete does not crack on its water face. Cracking may also result from the restraint to shrinkage, free expansion and contraction of concrete due to temperature and shrinkage and swelling due to moisture effects. Correct placing of reinforcement, use of small sized bars and use of deformed bars lead to a diffused distribution of cracks. The risk of cracking due to overall temperature shrinkage effects may be minimized by limiting the changes in moisture content and temperature to which the structure as a whole is subjected. Cracks can be prevented by avoiding the use of thick timber shuttering which prevent the easy escape of heat of hydration from the concrete mass. The risk of cracking can also be minimized by reducing the restraints on the free expansion or contraction of the structure. For long walls or slabs founded at or below the ground level, restraints can be minimized by founding the structure on a flat layer of concrete with interposition of sliding layer of some material to break the bond and facilitate movement. However, it should be recognized that common and more serious causes of leakage in practice, other than cracking, are defects such as segregation and honey combing and in particular all joints are potential sources of leakage.

Literature Survey

GENARAL

In this chapter the research background is shown as previous work done by the researchers and engineers on INTZ water tank under seismic and wind loading conditions.

➤ **L. P. Shrivastava & Akshit Lamba (2019)**

A design analysis for water tank based on new IS code 3370-2009 and draft code of 1893-Part 2. They considered two mass models one being the impulsive one and the other being the convective model. Simulation work is performed on STAAD Pro on Intze type water tank supported on frame staging. The loading conditions were seismic and wind forces. From this study, it was clear that for elevated tanks, two degree of freedom idealization of tank showed better results when they were compared with the one degree of freedom of idealization. The model was loaded with earthquake loads (seismic loads) followed by Wind loads on the columns of the tank and summed up by considering the self-weight of the entire assembly. Few observations were made – the first being the variation of hydrodynamic pressures on the geometrical aspects of the tank, the second being the comparison of total base shear and moment for empty and full conditions of the tank and the last being a comparative study among time period, base shear and base moment for impulsive and convective modes of vibration.

➤ **Hasan Jasim Mohammed (2018), 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. A computer program has been developed to solve numerical examples using the Indian IS: 456-2000 Code equations. The results shown that the tank capacity taken up the minimum total cost of the rectangular tank and taken down for circular tank. The tank floor slab thickness taken up the minimum total cost for two types of tanks. The unit weight of water in tank taken up the minimum total cost of the circular tank and taken down for rectangular tank.

➤ **Gareane A. I. Algreane, Siti Aminah Osman and Othman A. Karim, (2017), conclude that:**

The soil and water behavior of elevated concrete water tank under seismic load. An artificial seismic excitation has been generated according to Gasparini and Vanmarcke approach, at the bedrock, and then consideration of the seismic excitation based on one dimension nonlinear local site has been carried out. Seven cases are chosen to make comparisons with direct nonlinear dynamic analysis, mechanical models with and without soil structure interaction (SSI) for single degree of freedom (SDOF), two degree of freedom (2DOF), and finite elements method (FEM) models. The analysis is based on superposition modal dynamic analysis. SSI and fluid structure interaction (FSI) have been accounted using direct approach and added mass approach respectively. The results show that a significant effects obtained in shear force, overturning moment and axial force at the base of elevated tank.

➤ **Vijay K. Puri and Shamsher Prakash, (2016), concludes that:**

Design of foundations in earthquake prone areas needs special considerations. Shallow foundations may experience a reduction in bearing capacity and increase in settlement and tilt due to seismic loading. The reduction in bearing capacity depends on the nature and type of soil and ground acceleration parameters. In the case of piles, the soil-pile behavior under earthquake loading is generally non-linear.

The nonlinearity must be accounted for by defining soil-pile stiffness in terms of strain dependent soil modulus. A comparison of observed and predicted pile behavior under dynamic loads has attracted the attention of several investigators. The lateral dynamic pile response of single piles predicted by analytical models often yields higher natural frequencies and lower resonant amplitudes compared to those determined from field tests in horizontal vibrations only. This has been found to be due to overestimated shear modulus and radiation damping of the soil. The authors made an investigation to determine a simple method to improve the theoretical predictions of piles embedded in fine soils. Based upon this investigation shear strain dependent reduction factors are proposed for determining the shear modulus and damping for pile response calculations.

➤ **Meen-Wah Gui and Balasingam Muhunthan (2016), conclude that:**

The accurate prediction of the bearing capacity of shallow foundations on granular soils has been complicated by their stress dependent strength behaviour and the surface roughness of the foundation soil interface. These are accounted for using empirical relations in the current state of practice. In this study, the stress dependent behaviour of soils is accounted for using a strength dilatancy relationship. The method of slip line has been extended to incorporate this relationship and the effects of surface roughness to derive the depth dependent bearing capacity factor N_q . The results are presented in terms of angle of friction, depth/diameter ratio, and the effect of surface roughness of the wedge/cone. Extended method of slip line has also been carried out in order to evaluate the stress dependent strength behaviour of soil. The results have been compared with centrifuge test results and the comparison result shows that the variable $-\phi$ type of analysis together with the provision of soil compressibility could lead to realistic estimates of bearing capacity of foundations having depth shallower than the critical depth.

➤ **Luis A. Godoy, (2015), conclude that:**

The damage due to buckling in thin-walled, short cylindrical aboveground tanks is discussed. Various sources of buckling are considered, including wind, earthquake, support settlement and vacuum during emptying of the tank. In all cases the tanks were modeled using finite elements, and the results include the buckling load and associated buckling mode, and the post buckling equilibrium path. The results have been obtained using the computer packages ABAQUS and ALGOR. Experiments on flexible small-scale tanks with settlement of the supports on a sector of the foundation were conducted. Also, wind tunnel tests were carried out on rigid tanks with and without a roof to evaluate the pressure distribution due to wind.

➤ **Kavita Harsha, (2015), conclude that:**

Due to enormous need by the public, water has to be stored and supplied according to their needs. Water demand is not constant throughout the day. It fluctuates hour to hour. In order to supply constant amount of water, we need to store water. So to meet the public water demand, water tanks need to be constructed. They are grave elements in municipal water supply, firefighting systems and in many industrial amenities for storage of water. Intze type tank is commonly used overhead water tank in India. These tanks

are designed as per IS: 3370 i.e. Code of practice for concrete structures for storage of liquids. BIS implemented the revised version of IS 3370 (part 1& 2) after a long time from its 1965 version in year 2009. Presently large number of overhead water tanks is used to distribute the water for public utility. Most of the water tanks were designed as per old IS Code: 3370-1965 without considering earthquake forces. The objective of this dissertation is to shed light on the Intze water tank designed considering the earthquake forces according to Indian standard code: 3370-2009 and draft code 1893-Part 2, (2005) considering two mass modal i.e. impulsive and convective mode method. Intze tank supported on frame staging. Also this report includes analysis by STAAD Pro for wind and seismic forces. Finally the results are validated with the results of manual calculation. From the present study, it was observed that, for elevated tanks the two degree of freedom idealization of tank have shown better results when compared to single degree of freedom of idealization.

➤ **Hemishkumar Patel¹, (2015), conclude that:**

This paper is an application of optimization method to the structural Analysis and design of Intze elevated water tanks, considering the total economy 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. A computer program has been developed to solve numerical examples. The results shows that the tank capacity taken up the minimum economy for Intze tank. The tank floor slab thickness taken up the minimum economy for tanks. The unit weight of water in tank taken up the minimum economy for Intze tank.

➤ **B. Dean Kumar and B.L.P. Swami (2014), concludes that:**

Wind flows relative to the surface of ground and produces loads on the structures standing on the ground. The effect of the wind on the structures is of prime importance. Most of the designers consider the static effect of wind on the structure. But for tall structures the wind interacts with the structure dynamically. The Indian standard code IS 875 (Part-3) 1987 deals with the wind effects on the structures. Water towers are critical structures from the point of the wind effect. Towers of height 16 m, 20 m, 24 m and 28 m are considered in the present analysis. Fundamental frequency is computed by the method given in Indian standard IS 1893-1984. In the computation of fundamental frequency two conditions a) Tank empty and b) Tank full with water are considered. It is found from the study that static pressures are less compared to those given by the gust effectiveness factor method (GEFM). Dynamic interaction between the fluctuating wind component and the structure are considered in GEFM and equivalent static wind pressures are evolved. GEFM is more rational and realistic and recommended for wind load design of water towers.

➤ **Sanjay P. Joshi (2012), 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 use of the equivalent cylindrical tanks model in place of the Intze tank

model are small. Therefore, for design purpose the values available for equivalent cylindrical tank may be used.

➤ **R Jaiswal, Shraddha Kulkarni and Pavan Pathak 2011, conclude that:**

Liquid storage tanks constitute an important component of life line systems such as water distribution system, petroleum plants etc. Seismic design of liquid storage tanks requires knowledge of sloshing frequency of liquid and hydrodynamic pressure on the wall. This in turn, requires proper analysis of fluid-tank interaction under seismic excitation. In the design codes, mechanical analogs of tank-fluid system are commonly used to obtain the sloshing frequency, hydrodynamic pressure and design seismic forces. Such mechanical analogs are and developed for simple geometries, like circular and rectangular tanks. However, for tanks of other shapes and for tanks with internal obstructions, there are a very few studies on the mechanical analogs. In the present paper, experimental and numerical study is taken up to obtain the sloshing frequency of liquid contained in tanks of other shapes and tanks with internal obstructions.

➤ **Sanjay P. Joshi (2009), 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 use of the equivalent cylindrical tanks model in place of the Intze tank model are small.

➤ **Luis A. Godoy, (2005), conclude that:** The damage due to buckling in thin-walled, short cylindrical aboveground tanks is discussed. Various sources of buckling are considered, including wind, earthquake, support settlement and vacuum during emptying of the tank. The results have been obtained using the computer packages ABAQUS and ALGOR.

➤ **Hasan Jasim Mohammed (2000), 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.

OBJECTIVES

➤ To Study Modeling, analysis and Design of INTZ water tank.

CONCLUSION

If the design of intze type elevated water tank is divided into two parts namely super structure (above columns) and sub structure (upto columns) the analysis of results of this study reveals that with the change in the wind speed and/or the bearing capacity of soil, there is an appreciable change in required quantities of concrete and steel for sub structure while these is almost no change in the required quantities of concrete and steel for super structure.

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