"LITERATURE REVIEW ON COMPARATIVE STUDY ON ELEVATED RCC WATER TANK WITH DIFFERENT SHAPES UNDER DYNAMIC LOADS"

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ABSTRACT: *It has been observed all over the world that the elevated water tanks were collapsed or heavily damaged or failed during the earthquake's vibrations because of unsuitable design or wrong selection of supporting systems and underestimated demand or overestimated strength. Liquid storage tanks are used for several purposes such as water, oil, and gas, etc contains hazardous material causes environmental pollution and results in very destructive hazards on life and property. To overcome several damages seismic study of the tank is essential for strengthening the tank's performance and thereby damages can be reduced. The design of the tank is very complicated due to the fluid viscous structure system which is divided as impulsive and convective liquid mass, and both induced hydrodynamic pressure on the tank wall and base. The response of water tanks also depends on the soil-structure interaction which affects the performance of tanks. Elevated tanks and groundwater tank are different, based on their support condition provided. This literature work provides an idea of different aspects of circular and square Reinforced Cement Concrete (RCC) elevated water tanks which can be studied to increase sustainability and stability.*

Keywords: Fluid structure interaction, Soil structure interaction, Seismic response, Impulsive and Convective liquid mass.

1. INTRODUCTION

Now day water is used in many applications, including drinking water, irrigation, agriculture, fire suppression, agriculture farming, and human basic need in daily life and many other uses. Sufficient water distribution depends on the design of a water tank in a certain area. An elevated water tank or the groundwater tank is a large water storage container constructed to hold water supply at a certain height or the ground to pressurization the water distribution system. Water tank parameters include the general design of the tank, and choice of construction materials, linings. Reinforced Concrete Water tank design is based on IS 3370: 2009 (Parts I – IV). The distribution of water supply for a city is a lifeline that must remain functional following disaster as the water supply is essential for drinking and controlling fires, which may occur during earthquakes or any other natural calamities.

A structure that stores the water has commonly termed a reservoir. A reservoir can be built above or below the ground level. Generally, underground reservoirs are built to store water in large quantities whereas overhead tanks are built to store water in small quantities and to distribute water tanks are used to store water. Crude oil and other liquid substances in all the tanks are made leakage free for raw petroleum crude oil. It is important to analyze the structure properly for earthquake effects. So it is important to check the severity of these forces for a particular region. The main purpose of this project is to study the response of elevated water tanks to dynamic forces and to find basic design parameters. For seismic analysis, it is necessary to consider the effect of hydrodynamic pressure on the sides of the container as well as the base slab of the container. It is also necessary to consider the effect of pressure due to wall inertia & the effect of vertical ground acceleration in the seismic analysis of elevated water tanks.

Aim and objective

1. To study the effects on the behavior of two different shapes of ESR's i.e.
   1) Rectangular, 2) Circular
2. To carry out static and dynamic analysis for two different shapes of ESR's.
3. To compare the results between static and dynamic cases.
4. To analyze by IS code procedure.
5. The major aim is to reveal the degree of effectiveness of the geometric shapes for the functional requirement, with the view to achieving adequate strength and economy.

2. LITERATURE REVIEW

This section presents a review of various literatures to highlight the development and application of different techniques on elevated water tank structures. The main purposes of exhaustive literature surveys are as follows-

Thalapathy. M. et al. (2016) Studied on "Analysis and design of elevated RCC water tank" in this paper author gives the detailed analysis of the design of liquid retaining structure

using working stress method. The project takes into consideration the design of reservoir for the following cases: 1) Underground Tank, 2) Tank Resting on the ground and 3) Overhead water tank. The analytical design has been made with a Microsoft Excel sheet. The paper gives an idea for safe design with a minimum cost of the tank and gives the designer a relationship curve between the design variable. The author concluded that the height to diameter ratio is the safest economical design and according to the limit state method the design, the foundation to be most economical for a water tank as the quantity of steel and concrete needed is less as compared to the working stress method.

Sagar Mhamunkar et al. (2018) Studied "Design and Analysis of Overhead Water Tank at Phule Nagar, Ambernath" in this paper author discuss the problem to solve the innovative design and solutions to the existing problem for that study of Elevated Storage Reservoir (ESR) is undertaking. The purpose of the study of the ESR is to design and analyze safe ESR, Where the damage to the structure and its structural components even by a natural hazard such as an earthquake can be minimized. Indian standards for the design of liquid retaining structures have been revised in 2009. Limit state design method for water retaining structure was not adopted so far as the liquid retaining structure should be crack free. However, this edition of the Indian standard adopts the limit state method mainly considering two aspects. Firstly it limits the stresses in steel so that concrete is not stressed and in the second aspect it limits the cracking width. The author concluded that large capacity and flat bottom need large reinforcement at the ring beam, to overcome this in the tank, providing a conical bottom and another spherical bottom reduces the stresses in-ring beams and it is more economical.

Mareddy Arun Kumar et al. (2018)Studied "Planning, analysis and design of an overhead circular water tank in n.b.k.r.i.s.t using Staad Pro software" the principal objective of this paper is to plan, analysis and design a Circular Overhead Tank of 15 lakh liters capacity at N.B.K.R. Institute of Science and Technology, Vidyanagar. In this paper, all structural elements of the circular water tank are analyzed and designed by using STAAD. Pro software. The author concludes that the design of the tank is safe from the software design concerning loads applied for small capacities we go for rectangular water tanks while for bigger capacities we provide circular water tanks.

Jindal Bharat Bhushan et al. (2012) Studied "Comparative study of the design of water tank regarding IS: 3370" in this study an Intz type of tank was designed as per IS: 3370 (2009) which included these aspects as well as working stress method. The tank was chosen as per the guidelines of this new edition. The tank was also designed considering the working stress method. The results were then compared and it was found that the area of steel required approximately the same when the stresses in steel were kept less than 130 MPa and under a limit state of collapse there was a considerable decrease in the required steel. It was found that the provisions of reinforcement through the surface zones in IS: 3370 (2009) provides economical and more effective reinforcement.

P. Deepak Kumar et al. (2016) Studied on "Comparative study of dynamic analysis of rectangular liquid-filled containers uses codal provisions" in this study the main objective of the author is to determine hydrodynamic pressure distribution on rectangular tanks of various geometries considering impulsive and convective of the liquid mass. A comparative study of Draft IS 1893 Part 2, ACI 350.3 and Eurocode 8 for the rectangular-shaped tank has been performed. Further, the differences in the magnitude of shear and moment at the base as obtained from static (IS 3370 IV) and dynamic (Draft IS 1892 Part 2) analysis of rectangular-shaped tanks have been evaluated. It was found that the values obtained as per Draft IS 1893 Part 2 are considerably higher than those obtained by IS 3370 IV -1967 highlighting the need for us to revise the old code to a newer code that is more accurate and reliable.

P.L.N. Sarojaet al. (2016) study and analyze the elevated water tank and comparing the forces created on an elevated water tank in different seismic zones due to earthquake The analysis of elevated water tank is performed on impulsive mode and convective mode using the code IS 1893 (part 2) 2002 and also had considered forces in both tank full condition and tank empty condition. Study results that by comparing the seismic forces and wind forces, the weight per unit height is more due to seismic for than wind forces. Also, Horizontal forces are higher at the bottom level due to the seismic effect and it is decreased from bottom to top.

H. Shakib et al. (2017) studied the effect of earthquake site-source distance on the dynamic response of concrete elevated water tanks. The objective of the proposed study is considering base fixed, to compare the base shear, base moment, and sloshing responses under different near and far-field ground motions and simultaneous effects of their horizontal and vertical components. It is to be found out that the dynamic behavior of the considered system is highly sensitive to the site-source distance of the earthquake records.

Sandip T D et al. (2017) studies the performance of two types of elevated water tanks with varying heights under seismic and wind-induced dynamic loads. Wind loads are considered as per IS 1911-1967, IS 875(part3): 1987 and seismic load as per IS 1893(part1):2002. The FEM analysis of elevated water tanks involves modal analysis, equivalent static, response spectrum, and wind analysis with gust factor. According to the obtained results, the Response spectrum analysis result shows displacement increases as the height increases in both square and circular, and when compared to the square tank, circular tanks show minimum displacement. It indicates a circular tank is more effective than a square tank. Also, Wind analysis result shows that displacement increases as the height increases in both square and circular.

3. CONCLUSION

As of now, limited researches have been done on the effect of the seismic zones and the change of geometry. The present study focuses on the area which had been unfocused in past researches. The present study is an attempt to focus on the various aspects of the study for dynamic analysis of elevated water tanks which are still not taken as a matter of interest. Based on the literature review it is observed that the analytical study was carried out and the results determine that the elevated water tanks are more vulnerable to seismic activities due to earthquakes. The conclusions of some studies are limited by the fact that only a circular shape for an overhead water tank is considered. In some of the research, the variation in the geometry is not considered as circular shape and rectangular shape behave completely different in stress distribution manner. It is found that the H / R ratio is not taken into account as the time period of the structure changes with varying H / R ratio for varying geometry. The effect of the cyclonic wind on the tank is not taken into account as the new factor is introduced in IS 875-Part 3 to calculate wind intensity.

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