SEISMIC ANALYSIS OF OVERHEAD WATER TANKS A REVIEW PAPER

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ABSTRACT

This review paper provides the structural stability and behavior of different shapes and sizes of reinforced concrete cement overhead water tanks during the penetrable force like earthquake. Water is essential for human beings, thus, water tanks are very important components for the life line of any city or locality. In India, the earthquake had damaged or collapsed reinforced concrete cement overhead water tanks due to causes like improper design of the size, shape, unsuitable design of supporting system, mistakes during selection of supporting system, improper arrangement of reinforcement, underestimated demand of water, overestimated strength etc. Consequently, the objective of this study is to understand the shapes of water tanks as per different seismic zones II, III, IV and V in India.The modelling will be done by using advanced design software STAAD Pro (Structural Analysis and Designing Professionally) which is an advanced design software.

Keywords-water tanks;overhead water reservoir;seismic effect ; STAAD Pro

I. INTRODUCTION

"Water Tank" generally used to store water to provide the daily requirement for humans to live healthy life. High demand of fresh and safe drinking water and washing purposes, swimming pools for exercise and enjoyment and sewage sedimentation tanks is rising day by day. Water Tanks are designed as crack free structure to avoid any leakage. In order to avoid leakage and to provide higher strength concrete of grade M20 and above is recommended for liquid retaining structures. Overhead water tanks are used to distribute water directly through gravity flow and are normally of smaller capacity. As the overhead water tanks are open to public view, their shape is influenced by the aesthetic view in the surroundings.

In general, the classification of water tanks on the basis of their shape-

- Circular Tank
- Rectangular Tank
- Spherical Tank
- Intze Tank
- Funnel Tank

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. Water storage tanks are designed as per the provisions of IS 3370:2009.

II. PROBLEM FORMULATION

In order to carry out the structural analysis, overhead water tanks of circular, rectangular, square, Intze shapes, which are commonly adopted by designers, were considered for the study. Water tank of each shape was designed for capacities of 200 kl and each shape is analyzed on different seismic zones II, III, IV and V. Only the tank portion was considered in this study. The design of all water tanks was done by the designing software STAAD Pro.

III. LITERATURE SURVEY

Pavan S. Ekbote and Dr. Jagadish G. Kori (2013), Elevated water tanks were profoundly smashed or collapsed during earthquake. Due to the liquid structure interactions, the seismic behaviour of elevated water tanks has the characteristics of intricate 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 systems such as cross and radial bracing were studied.

R.V.R.K. Prasad and Akshaya B. Kamdi (2012), Storage elevated water tanks are used to store water. BIS has brought out the revised version of IS 3370 (part-1&2) after a long time from its 1965 version in year 2009. This revised code is mainly drafted for the liquid storage tank. In this revision important is that limit state method is incorporated in the water tank design. This paper gives in brief, the theory behind the design of circular water tank using WSM and LSM. Design of water tanks by LSM is most economical as the quantity of material required is less as compared to WSM. Water tank is the most important container to store water therefore, Crack width calculation of water tank is also necessary.

Ramaiah and Gupta, the factor such as size of columns, braces, number of panels and initial tension of bracing rods, affecting seismic design of water towers. The lateral shear force and stress in the rods are higher for towers with more panels. With increase in size of bracing rods, the period was found to decrease, while the lateral force and seismic coefficient increased. As per IS 1893-1984, an elevated water tank may be modelled by a single degree of freedom system. However, research indicates that the single degree of freedom idealization is approximate only for closed tanks, which are completely filled with liquid.

Shepherd presented the two-mass idealization of elevated water tanks. Jain and Sameer proposed approximate methods to estimate the lateral stiffness of the tank staging.

Asari Falguni & Prof. M.G. Vanza (2012) has thrown light onthe results of an analytical investigation of the seismic response of elevated water tanks using damper. In This paper, the behaviour of RCC elevated water tank isstudied with using friction damper (FD). For FD system, the main step is to determine the slip load.

Ayazhussain M. Jabar and H. S. Patel (2012), has investigated to be aware of the deeds of supporting system which is more effective under different earthquake time history is carried out with SAP 2000software. As known from very upsetting experiences, elevated water tanks were heavily damaged or collapsed during earthquake. This was might be due to the lack of knowledge regarding the proper behaviour of supporting system of the tank again dynamic effect and also due to improper geometrical selection of staging patterns.

Hasan Jasim Mohammed (2011), studied 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 slab thickness, as design variables.

Merlecha S.K. (2002) studied on “Analysis of Water tank on Sloping ground”. The author analyzed water tanks on level as well as on sloping ground. Four column staging is used for two heights of staging one of which is 9m high and another is 12m high. Six models for each staging height are studied for different level difference. For 9m height staging interval is kept 3m and for 12m height staging interval is kept 4m. Earthquake forces are calculated for each model as per I.S 1893-1984 and the models are analyzed. Variation in forces for different components of tank like base beam, column and bracing beam is studied for all 12 models.

IV. SUMMARY

Generally, when earthquake occur major failures of elevated water tank take place due to failure of tank walls, as they are to take care for seismic forces. Therefore, tank wall of elevated water tanks are extremely vulnerable under lateral forces due to an earthquake. Looking to the above literature study, it can be summarizing that there was no prior research paper publish to analyse the structure of water tank at different seismic zones and also of different shapes and sizes. A reviewed literature demonstrates the considerable change in seismic behaviour of elevated tanks with consideration of responses like displacement, base shear, base moment, sloshing, torsional vulnerability etc. when supporting system is used with appropriate modifications.

V. SCOPE AND CONCLUSION

Limit State Method was found to be most economical for design of water tanks as the quantity of steel and concrete needed is less as compared to working stress method. There was no change in size of members for working stress method by IS: 3370 (1965) and IS: 3370 (2009). However, steel requirement increased in IS: 3370 (2009) for overhead circular type, overhead square type and for underground rectangular water tanks, as the allowable stresses in steel were lower.

As the capacities increase, the amounts of materials for the structure also increase. But, a rather non-perfect proportionality resulted; that is, a proportional increase in the capacity would not, necessarily lead to a proportional increase in any of the materials required. The quantities of materials needed for the rectangular water tank were constantly more than those needed for square tank which is more than the quantity required for the circular water tank, at each varied capacity. Generally, the construction material-outputs for all water tank capacities would be based on the choice of the design considerations and from the results obtained here points out that the circular shaped tank is the most economical among other two shapes considered for study as per IS3370 – 2009 adopting limit state method of design.

Apart from that, it is required to identify suitable modified water tank staging system by determining what improvements or added features are necessary for staging part of water tank for better performance during earthquake. Also, alternate or innovative configurations are also required to put in practice. The comparison must be done among the analysis results, practical results and critical calculations for the better performance.

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