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Review on Seismic Analysis of RC Elevated Rectangular Water Tank

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Abstract : As recognized from very offensive experience in many places of world collapse of tank and due to this heavy damages during earthquakes due to this reason many studies done for dynamic behavior of water containers, most of them are concern with cylindrical tanks. The economic lifetime of this RCC tanks are usually in the range of 40-70 years. Staging is responsible for lateral resistance of complete structure .The objectives of this is study to understand the behavior of different staging system under different tank conditions for different L/B ratio.

Keywords: Water tank, Seismic, RCC

I. INTRODUCTION

Water is human basic needs for daily life. In certain area sufficient water distribution depends on the design of a water tank. Water supply depends on overhead water tanks for storage in our country as the required pressure in water supply process is obtained by gravity in elevated tanks rather than the need of heavy pumping facilities. Due to natural disasters like earthquakes, draughts, floods, cyclones etc Indian sub-continent is highly vulnerable. According to seismic code IS: 1893 (Part1)-2002, more than 60% of India is prone to earthquakes. During earthquake for the failure of elevated water tanks it is most critical consideration that huge water mass is at top of a slender staging. Since, the elevated tanks are frequently used in seismic active regions also hence their seismic behavior has to be investigated in detail.

II. REVIEW OF LITERATURE

[1]AmiyaRanjanPandit et.al (2019): Reviewed on Six different ground motions classified on the basis of low, intermediate and high frequency contents are selected to determine the dynamic characteristics of liquid in sloped bottom tanks. The effect of different slope angle on the frequency contents of earthquakes are investigated. The liquid domain is discretized as the combination of three node triangular and four node quadrilateral finite elements. The individual contribution of impulsive and convective response components of hydrodynamic behavior in terms of base shear force and hydrodynamic pressure distribution along the walls of the containers are successfully measured. The efficacy of the developed numerical model is validated with the existing published results.

[2] M. Moslemiet.al (2019): The current study is mainly focused on nonlinear sloshing analysis of rectangular liquid storage tanks. The main response quantity of interest is free surface sloshing height. There are some key factors to be investigated in order to make a better understanding of the performance of liquid tanks under seismic loading. These includethree-dimensional geometry, corner sloshing, tank aspect ratio, bidirectional loading, and earthquake frequency content. The main focus of this work is to investigate these important parameters through a comprehensive parametric study using a rigorous finite element technique capable of accounting for nonlinear fluid-structure interaction effects. The validity of current code provisions in seismic analysis of such structures is then investigated by comparing the obtained numerical results with those recommended by current practice and important conclusions are drawn. The present paper suggests that the sloshing nonlinearity could have a significant effect on the seismic performance of liquid containing structures and failing to account for it properly could introduce a major concern with respect to their satisfactory performance for a certain group of tanks in particular shallow tanks.

[3] M. Ravikanth et.al (2019):This project is an application economy of the tank as an objective function with the properties of that optimization method to the structural Analysis and design of circular tank, water depth, unit weight of water and tank floor slab thickness, as design elevated water tanks, considering the total tank that are tank capacity, width and length. To considering dead load, live load, seismic load A computer program has been developed to solve numerical examples. The project is strictly in accordance with IS 456:2000 (plain and reinforced concrete), SP 16 (Design Aids for Reinforced Concrete), IS 801 (Design of cold formed steel) load calculations are done using STAAD Pro and Manual calculations are done through known data.The aim of the project is to apply seismic loading for different zones - II III, IV, V And assess the varying steel and concrete in seismic zones

[4] Mainak Ghosal1 (2019): The present study reports the analysis and design of an elevated circular water tank using STAAD.Pro V8i. The design involves load calculations manually and analyzing the whole structure by STAAD.Pro V8i. The design method used

in STAAD.Pro analysis is Limit State Design and the water tank is subjected to wind load, dead load, self – weight and hydrostatic load due to water.

[5] Joseph Asha1 et.al (2018): In this paper, the dynamic behaviour of cylindrical ground supported concrete water tanks with different aspect ratios is investigated using finite element software ANSYS. The natural frequencies and modal responses are obtained for impulsive and convective modes of vibration. The natural frequency of vibration of the tank is observed to be the lowest at maximum water depth. The fundamental impulsive frequency increases as water level reduces and for water level less than 1/3 of tank height, there is significantly no change in impulsive frequency. The effect of wall flexibility on dynamic behaviour of the tank is investigated by performing the modal analysis of flexible and rigid tanks. For a partially filled tank, the results of the present study are of significant relevance. The response of the tank to the transient loading as horizontal ground motion of El Centro earthquake is studied for various water heights. As the height of water on the tank increases, the ultimate maximum seismic response parameters are also observed to be increased. The location of maximum hoop stress varies in accordance with the variations in input ground motion and water fill condition whereas shear and bending moment are maximum at the base.

[6] Abhyuday Titiksh1 (2018): This study is carried out to analyze the cost of overhead water tanks of a fixed capacity, having different heights and diameters so as to determine the most economical height to diameter (H/D) ratio to be adopted in the design of the tank. To optimize the results and check the accuracy of design, six circular water tanks of 350 kL, with top and bottom dome pattern, were designed by varying H/D ratio from 0.50 to 0.75 in STAAD.Pro. After assuring the safety of all the structures, further analysis is done to calculate the cost-effectiveness of the structures by comparing the approximate total cost of materials. It was found that the aspect ratio (H/D) of 0.60 led to the most efficient design.

[7] Dr. Ramakrishna Hegde et.al (2018): Aim of this project deals with the optimum working needs of rectangular and circular water tanks. 21000 liters capacity tank is utilized for design in this project. This project may comparison between the circular water tank and rectangular water Tanks. Constructing water tank is useful for future by domestic and commercial uses.

[8] **Mr. Manoj Nallanathel et.al (2018):**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. In this paper, we had discussed about the design of water tanks of both overhead and underground tanks of shapes rectangular, square and circular shapes are designed and analyzed using Staad pro. From the analysis results concluding about the influence of shape factor in design loads and how shapes of the tanks play predominant role in the design and in stress distribution and overall economy

[**9] Thalapathy.M1 et.al (2016):**This project 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 ground and 3) Overhead water tank. The analytical design has been made with Microsoft Excel sheet. The paper gives idea for safe design with minimum cost of the tank and give the designer relationship curve between design variable. Thus design of tank can be more economical, reliable and simple. The paper helps in understanding the design philosophy for the safe and economical design of water tank.

[10] Chirag N. Patel et.al (2016): This paper presents comparative study of analytical and software based methods used for the analysis of on ground concrete circular water tank.An analytical methos consider as per IS 3370 and as given by pca(portland cement association),which are also compare with the result of FE analysis using software staadpro.Importance of the present study is to observe actual behaviour of tank subjected to static loading condition with special emphasis on IS:3370, PCATableand software STAAD.*Pro*. Different tanks has been considered for the analysis depending on the parameters like dimensional aspect ratio H2/Dt (i.e. 14, 8, 4, 0.8) and end conditions at bottom having free at top (i.e. Hinged and Fixed) having similar storage capacity of 1 lac liter. Analytical calculations has been carriedout by Excel spread sheet program and finite element models have been observed in STAAD.*Pro*having similar parameters. Result output of hoop tension and bending moment shows similarity in the considered analytical approach but significant advantage of software based approach due to finite element modeling. Also, it revels that, engineers can apply software based approach more flexibly and efficiently to fulfill the practical tasks of structure modeling and analysis in engineering to achieve economy.

[11] K. L. Kulkarni et.al (2016): This paper present the comparative equivalent static and time history analysis of elevated encased composite column water tank is during earthquake. The RCC column staging of elevated water tank can be replace by a encases composite column staging water tank, because the RCC water tank developed the cracks during earthquake, result in loss of their of strength and stiffness, so increase performance of elevated water tank during earthquake to study the behavior of composite elevated water tank. Therefore the parametric studies on mathematical model of six water tank are creating in ETABS software. These are both tank has been create models in an ETABS for a different height from ground level. The Indian draft code part II of IS 1893:2002 which has provision of elevated water tank. The equivalent analysis with regards time periods, base shear, storey stiffness, displacement against height and storey drift

[12] Dona Rose K J et.al (2015): The present study focuses on the response of the elevated circular type water tanks to dynamic forces. Overhead water tanks consist of huge water mass at the top of a slender staging which are most critical consideration for the failure of the tank during earthquakes. Tanks of various capacities with different staging height is modelled using ANSYS software. The analysis is carried out for two cases namely, tank full and half level condition considering the sloshing effect along with hydrostatic effect. The time history analysis of the water tank is carried out by using earthquake acceleration records of El Centro. The tanks withstood the acceleration with the displacements within the permissible limits. The peak displacements and base shear obtained from the analysis were also compared.

[**13] Anup Y Naik et.al (2015**): In this study a rectangular tank is analyzed for seismic forces in two of the principal direction and the variation of these forces for different level of water within the tank is investigated in this study. In this study a general processor is built to calculate seismic forces and results are tabulated according to Housners mechanical model.

III. CONCLUSION

Within the scope of present work following conclusions are drawn: Present study is attempted to focus on various aspect of study for dynamic analysis of elevated water tank which are still not taken as mater of interest. Based on literature review it is observed that the analytic study was carried out and the results determine that the elevated water tanks are more vulnerable to seismic activities due to earthquake.

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