International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue XI, Nov 2018- Available at www.ijraset.com

Analysis and Design of Post-Tensioned Elevated Rectangular Water Tank

Udit A. Chavda[1], Prof. N.B. Umravia[2], Dr. K.B. Parikh[3]
[1]*Pg student, Government engineering college, Dahod, Gujarat*
[2]*Assistant professor, Government engineering college, Dahod, Gujarat*
[3]*Associate professor, Government engineering college, Dahod, Gujarat*

***Abstract:** As known as elevated water tanks were heavily damages or collapsed during earthquake. This was might be due to the lack of knowledge regarding the proper behaviour of supporting system and mass of the tank against dynamic effect and also due to improper geometrical selection of staging patterns. Due to the fluid-structure interactions, the seismic behaviour of elevated tanks has the characteristics of complex phenomena. For later conditions water mass has been considered in two parts as impulsive and convective suggested by GSDMA guidelines. Tank responses including base shear, overturning moment and roof displacement have been observed, and then the results have been compared and contrasted. This research is based on analysis of water tank with post tension slab as post tension is beneficial with long lasting durable and low shrinkage cracks it is very useful to deals with water tank with water tightness. So the aim of the study is to provide post tension slab in elevated water tank and compare results with RC water tank by different loadings as well as difference in cost and material use for such a structure. For Analysis Response-spectrum analysis (RSA) which is linear-dynamic statistical analysis method is used by computer application SAP2000.*

***Keywords:** water tank, sap2000, analysis, design, seismic load*

I. INTRODUCTION

Civil Engineering is very oldest field in engineering field which is very important for development of the need of human requirements. In our day to day life we see many structures around us, which are very important to live easy and comfortable life, so civil engineering is gift for our human society.

Civil engineering is a professional engineering discipline that deals with the design, construction, and maintenance of the physical and naturally built environment, including works such as roads, bridges, water tanks, canals, dams, airports, sewerage systems, pipelines, and railways. Civil engineering is traditionally broken into a number of sub-disciplines. It is considered the second-oldest engineering discipline after military engineering, and it is defined to distinguish non-military engineering from military engineering. Civil engineering takes place in the public sector from municipal through to national governments, and in the private sector from individual homeowners through to international companies.

II. WATER TANK

A. Classification Of Water Tank

1) Based On Position

a) Tank resting on ground
b) Underground water tank
c) Elevated water tank

2) Based On Shape

a) Circular Tanks
b) Rectangular Tank
c) Intze Tanks
d) Spherical Tanks
e) Conical bottom Tanks
f) PSC Tanks

Fig. 1 Types of water-tank

III.DESIGN OF WATER TANK

A. Design Of Water Tanks

The design a water tank or container should do no harm to the water. Water is susceptible to a number of ambient negative influences, including bacteria, viruses, algae, changes in pH, and accumulation of minerals, accumulated gas. The contamination can come from a variety of origins including piping, tank construction materials, animal and bird feces, mineral and gas intrusion. A correctly designed water tank works to address and mitigate these negative effects. It is Imperative that water tanks be cleaned annually to preclude delivery of algae, bacteria and viruses to people or animals.

A safety based news article linked copper poisoning as originating from a plastic tank. The article indicated that rainwater was collected and stored in a plastic tank and that the tank did nothing to mitigate the low pH. The water was then brought into homes with copper piping, the copper was released by the high acid rainwater and caused poisoning in humans. It is important to note that since the plastic tank is an inert container, it has no effect on the incoming water. Good practice would be to analyze any water source periodically and treat accordingly, in this case the collected acid rain should be analyzed, and pH adjusted before being brought into a domestic water supply system.

The release of copper due to acidic water is monitored may be accomplished with a variety of technology, beginning with pH strips and going to more sophisticated pH monitors, indicate pH which when acidic or caustic, some with output communication capabilities. There is no "linkage" between the plastic tank and copper poisoning, a solution to the problem is easy, monitor 'stored rainwater' with 'swimming pool strips' cheap and available at, swimming pool supply outlets. If the water is too acidic, contact state/county/local health officials to obtain advice and precise solutions and pH limits and guidelines as to what should be used to treat rainwater to be used as domestic drinking water.

IV.LITERATURE REVIEW

AATISH KUMAR et al.(2013)“ Wind Effects on Overhead Tank under Different Soil Parameters” Large capacity elevated Intze tanks are used to store a variety of liquids, e.g. water for drinking and fire fighting, petroleum, chemicals, and liquefied natural gas. A water tank is used to store to tide over the daily requirements. Intze tank is a type of elevated water tank supported on staging. Intze tank is defined as bottom portion of circular tank is provided in flat shape, so in flat bottom, the thickness and reinforcement is found to be heavy. It is found in analysis that the bearing capacity increases for the same wind speed volume of concrete and quantity of steel both are decreased. Also, We have seen that in case of bearing capacity of soil 5 t/m2 and 10 t/m2 volume of concrete and quantity of steel are so high as compared to other. [1]

P.L.N. Saroja, et al.(2016) “Comparative Study of Analysis of Elevated Water Tank Due To Earth Quake from Different Zones of Earth Quake” The main aim of this study is to analyze the elevated water tank and comparing the forces created on elevated water tank in different seismic zones due to earthquake. Any civil engineering structures are conceived keeping in mind its intended use, the materials available, cost and aseptic, considerations. The analysis of elevated water tank is performed on impulsive mode and

convective mode using the code IS 1893 (part 2) 2002 and also we considered the forces in both tank full condition and tank empty condition. From this study the forces acting on elevated water tank due to seismic forces are calculated for all the zones and also the Base shear, Base moment values are compared from zone I to zone IV. The Horizontal forces due to seismic and wind effect are also calculated. Then finally the values are represented in the form of tables and graphs.[2]

F. Omidinasab, et al.(2008) "Seismic vulnerability of elevated water tanks using performance based-design" Liquid tanks and especially the elevated tanks are structures of high importance which are considered as the main lifeline elements that should be capable of keeping the expected performance. i.e. operation during and after earthquakes. Thus, researchers, in recent years, have focused on studying the seismic behavior of these tanks. Many researches have been done on the behavior, analysis, and design of seismic tanks, particularly ground tanks, while only a few of these researches have concerned with the elevated tanks and even less with the reinforced concrete elevated tanks. In this research, a sample of a reinforced concrete elevated water tank, with 900 cube meters under seven earthquake records have been studied and analyzed in dynamic time history and the tank's responses including base shear, overturning moment, tank displacement, and sloshing displacement under these seven record have been calculated, and then the results have been compared and contrasted.[3]

L. Kalani Sarokolayi, et al.(2008) "Dynamic analysis of water tanks with interaction between fluid and structure" Due to growing population and expansion of cities, the number of elevated water tanks supplying the demand urban water system is on the rise. As it has been mentioned in the Iranian code of practice for Earthquake /2800 because of the importance of sanitation and hygiene water tanks have been considered as important structures during the unexpected events such as earthquake. There is a great expectation not to see any phase out for their serviceability after the earthquake. Because of the presence of fluid with different behavioural properties of structures containing it and the most part of mass of tanks are located in a considerable distance from its foundation, the behaviour of these types of structures in compare with conventional structures are more complicated. In this research, cylindrical concrete water tanks, which have a central shaft, have been evaluated with considering the effect of the structure's interaction with water through precise implementation of boundary conditions on the interface between fluid and structure. Also considering the level of water in the tank and their behaviour under recorded acceleration of different earthquakes using finite element method. The results were then compared with suggested methods by Iranian code /2800, which the results show a relatively considerable difference between mentioned methods. [4]

Gloria Terenzi, et al.(2017)Seismic analysis and retrofit of the oldest R/C elevated water tank in Florence" The seismic performance of an elevated water tower with reinforced concrete staging structure—the oldest one in Florence—is analyzed in this paper. The tower, erected in 1905, is a major achievement by engineer Attilio Muggia, an Italian pioneer of reinforced concrete, and is now classified as modern heritage architecture. The structure is characterized by an atypical bracing layout, with all braces rising from the bottom left corner to the upper right corner at each bay of the three upper staging levels, and no braces on the first level. The time-history assessment study, carried out by a detailed finite element simulation of the water–tank dynamic interaction, shows unsafe response conditions of the first level columns starting from seismic action scaled at the basic design earthquake level. Based on these data, two retrofit measures are proposed, consisting either in integrating the existing reinforced concrete braces of the staging skeleton with additional steel braces, or incorporating a seismic isolation system, and namely a set of double curved sliders on top of the underground columns. From an architectural viewpoint, the former strategy meets the requirement of leaving the original staging elements exposed, whereas the latter causes no intrusion in the superstructure. The design criteria and technical installation details of the two systems are illustrated, along with the results of the seismic performance assessment analyses in both rehabilitated conditions, including the cost estimation of the interventions. [5]

V. CONCLUSIONS

As elevated water tank is very common structure and at region every corner of world it is required to fulfill the requirements so considering seismic zones it is necessary to make it earthquake resistant and durable so that it can be use year by year. Very less researches done on the water tank and it one of the important structure of mankind so, it is necessary to built water tank resistive as well as economical.

VI. ACKNOWLEDGMENT

I would like to thanks to My Parents for their everlasting love and financial support throughout my numerous academic years. Without their support, I would not have been able to accomplish my dreams.

I hereby seize the opportunity to express my sincere indebtedness and deep sense of gratitude to thank my guide Prof. N. B. UMRAVIA (Assistant Professor, Applied Mechanics Department, GEC Dahod) who took care of each and every facet of this work in congregation with personal attention and proper orientation. I am grateful to him for excellently tutoring and grooming me with

respect to professional ethics and real life normal values in order to face squarely this swift changing competitive world with compound nerve and verve. His approach and insight to the problem has helped me in presenting this thesis in its present form.

I am very much grateful to my co-guide Prof. K. B. PARIKH (Associate Professor, Applied Mechanics Department, GEC Dahod) who was always available to answer my questions and to provide me with the necessary information concerning the research work and also for his critical reflections on the work. Without his help and guidance it would not have been possible for me to present this thesis work in its present form.

I express sincere thanks to Head of Department Dr. KAUSHAL B. PARIKH Applied Mechanics Department, Government Engineering College, Dahod for giving us an opportunity to undertake this research study.

I would like to take this opportunity to thank my all Assistant Professors Applied Mechanics Department, Government Engineering College, Dahod, whose continues and persistent guidance has played a key role in making my dissertation a success.

I would also like to thank all My Friends and Staff of my college who have directly or indirectly provided their unerring support throughout the course of this dissertation work, without whom none of this would have been possible.

REFERENCES

[1] Aatish Kumar, R.K. Pandey, C.S. Mishra [1]“ Wind Effects on Overhead Tank under Different Soil Parameters”, International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-6, August 2013

[2] P.L.N. Saroja, Vanka. Srinivasa Rao [2] “Comparative Study of Analysis of Elevated Water Tank Due To Earth Quake from Different Zones of Earth Quake”, International Journal of Constructive Research in Civil Engineering (IJCRCE) Volume 2, Issue 1, 2016, PP 22-29

[3] F. Omidinasab and H. Shakib [3] “Seismic vulnerability of elevated water tanks using performance based-design”, The 14 World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China

[4] L. Kalani Sarokolayi, B. Navayineya, M. Hosainalibegi, J. Vaseghi Amiri[4] “Dynamic analysis of water tanks with interaction between fluid and structure”, The 14 World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China

[5] Gloria Terenzi, Elena Rossi[5] ,” Seismic analysis and retrofit of the oldest R/C elevated water tank in Florence”, Bull Earthquake Eng, December 2017

[6] Yonghui Wang , Hongyuan Zhou[6] ,“ Numerical study of water tank under blast loading”, Thin-Walled Structures 90 (2015) 42–48

[7] Smt.Dhotre Chandrakala(Ekbote S.S.), Prof. Jawalkar G.C[7] “Analysis on Overhead Circular water tank for various bearing capacity with sloping ground”, International Journal of Scientific & Engineering Research, Volume 6, Issue 5, May-2015

[8] Pallavi S. Dhamak, Prof. V. R. Rathi, Prof. Dr. K. B. Ladhane [8] ,” Dynamic Response of an Elevated Water Tank”, International Journal of Engineering Research & Technology (IJERT) ,Vol. 3 Issue 8, August - 2014

[9] Sai Kala Kondepudi , K. S. K Karthik Reddy , Harsha Kaviti [9] ,“ Analysis and Design of Elevated Intze Watertank and its Comparative Study in Different Wind Zones - using SAP2000”, IJSTE - International Journal of Science Technology & Engineering | Volume 2 | Issue 2 | August 2015

[10] SANDEEP T D[10] “A comparative studies on elevated water tank due to dynamic loading”, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 ,Volume: 04 Issue: 05 | May -2017

[11] Mr. Santosh Rathod, Prof. M. B. Ishwaragol [11],“ Analysis of overhead water tank with different staging height and base width” , International Research Journal of Engineering and Technology (IRJET) ,Volume: 05 Issue: 06 | June-2018

[12] Dhanya Johnson, Dr. M. Sirajuddin [12],“ Behaviour of Elevated Water Tank under Seismic Load - Review” , International Research Journal of Engineering and Technology (IRJET) ,Volume: 05 Issue: 05 | May-2018

[13] Pradnya V. Sambary, D.M. Joshi [13]“ Seismic Analysis of RC Elevated Water Tanks” , International Journal of Scientific & Engineering Research, Volume 6, Issue 12, December-2015

[14] Syed Shafahaduddin Quadri, R.M. Sawant [14],“ Seismic Behavior of RC Elevated Water Tank under the Impact of Liquid Sloshing” , Recent Trends in Civil Engineering & Technology ,Volume 7, Issue 3(2017)

[15] Mayank Gopal Manwani, Deepa P. Telang [15], “Review on Seismic Analysis of Elevated Water Tank with Variations of H/D Ratio and Container Shape”, International Journal of Computer Science and Mobile Computing, Vol. 6, Issue. 5, May 2017, pg.202 – 208

[16] Swati, Mr.Sumit [16] ,“ Effect of wind load on elevated water tank of intze type: an overview” , international journal of engineering sciences & research technology, 7(5): May, 2018

[17] Amr A. Abdelrahman[17] “Applications of sustainable post-tensioned concrete slabs “ , Innov. Infrastruct. Solut. (2017) 2:42

[18] Ehab Ellobody, Colin G. Bailey[18] ,“ Modeling of unbounded post-tensioned concrete slabs under fire conditions” , Fire Safety Journal 44 (2009) 159–167

[19] Gianluca Ranzi, Andrea Ostinelli [19],“ Ultimate behaviour and design of post-tensioned composite slabs” , Engineering Structures 150 (2017) 711–718

[20] Youssef F. Rashed[20], “Boundary element analysis of post-tensioned slabs”, Int J Adv Struct Eng (2015) 7:143–158