International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 06 | June 2022 www.irjet.net p-ISSN: 2395-0072

RESPONSE OF ELEVATED WATER STORAGE TANKS UNDER SEISMIC EVENTS

I.V.H.P. YASASSWI [1], Dr. B. KESAVA RAO[2]

[1]M. Tech Student, [2]Assistant Professor,
[1,2]Department of Civil Engineering, RVR & JC College of Engineering, Chowdavaram, Guntur, Andhra Pradesh, 522 019

Abstract – *The current analysis and designs of elevated overhead tanks are extremely weak under adjacent forces due to an earthquake zone. In the past earthquakes, it has ensued found that the reinforced concrete elevated over-head tanks under lateral earthquake loads were suspectable where in some cases the structure has experienced collapse. Whereas the water works as an important role in the day-to-day life of a human being the elevated tanks should be designed as per the code provisions so that to avoid the failures of the structure and for the life of the structure. The study and creation of the elevated overhead tanks are done in ETABS software according to Indian Standards Codes. The reinforced concrete elevated water storage tank and the steel elevated water storage tanks have been designed for a full tank condition and the response spectrum plots and the time-history plots are also generated along with displacements & drifts. The columns and beams of the reinforced concrete storage tank are designed in accordance with IS456:2000 and the steel water tank is designed in accordance with IS800:2007. The designed structure is analyzed to check the reaction of the structure under the seismic events and the time history analysis is also being analyzed from the previous records.*

Key Words: **ETABS, Elevated Over-Head Water Tanks, Reinforced concrete & Steel Elevated Over-Head Water Tank, Response Spectrum, Time -History Analysis.**

1. INTRODUCTION

The elevated water storage tank remains built which is used for the storage and distribution of the water to the villages, towns & cities because the water is the most crucial part of human life and the trenches are used to stock the drinking water are out of shortage and the elevated tanks are built for storing and distributing the water. In the construction of these tanks, it has been very easy to store and distribute the water but after the structure is exposed to the natural calamities such as earthquakes and others calamities and after the structure is exposed to these and it has started to collapse due to lack of resistance towards lateral loads. So, by analyzing and designing the structure for resistance to the lateral forces and lateral loads which occur during the earthquake. By analyzing & designing, the structure will withstand collapsing due to the lateral loads. So respective cases taken and fixed focused upon the seismic actions of the elevated water storage tanks by considering the past earthquake records to design the structure in view of safety and durability (Livaoglu and Dogangun 2006 [1] Dogangun and Livaoglu 2007 [2]; Santhosh, Vangaveti Sai, Susanta Kumar Sethy, and A. N. Shankar 2008 [3]; Hirde, Suchita, Ms. Asmita Bajare, in addition, Manoj Hedaoo.2011 [4]; M. R.Kianoush, and W. Pogorzelski 2011[5]; Jabar, Ayazhussain M., also H. S. Patel in 2012 [6]; Sathyanarayanan, Sridhar, and Seshu MR Adluri 2013[7]; Harsha, Kaviti, KS K. Karthik Reddy, and Kondepudi Sai Kala, Kumar 2015 [8]; Patil, Nishigandha R., and Rajashekhar S. Talikoti; Ronad, Urmila, K. S. Raghu, and T. N. Guruprasad 2016 [9]; Kumbar, Ishwar, M. R. Suresh, and N. Shashikanth 2019 [10]; Hitesh, also Sandip Kumar Saha 2021 [11]. Compared to the trenches, the elevated water storage tanks give a better response to the seismic behavior by resisting the later loads that occurred due to earthquakes.

2. METHODOLOGY

The structural analysis modes are categorized into five classifications they are –

i. Equivalent Static Analysis
ii. Response Spectrum Analysis
iii. Linear Dynamic Analysis
iv. Non-Linear Dynamic Analysis
v. Non-Linear Static Analysis

2.1 EQUIVALENT STATIC ANALYSIS

The analysis performed upon the structure resembling the impact of seismic activity motions is usually defined with a response spectrum. This one assumes that the structure reacts around its primary modes and it's true that the construction has to be low-rise in addition to it should not twist ominously when the ground moves.

2.2 RESPONSE SPECTRUM ANALYSIS

The method approves the various methods of the response of the structure to be procured into analysis and these modes can also be a combination of some specific modes. The computer analysis can be done to resolve these methods meant for the structure for each mode a response is to be delivered commencing the design spectra. The full response of the structure is provided and estimated based on the modal frequencies and mass of the modal. In this, we can compute the magnitude of the force in all directions (X, Y, Z). So, the result of the response spectrum investigation utilizing the response spectrum from earth motion is naturally unlike after that which should be computed right from the linear dynamic analysis by means of the ground motion directly. In cases where the structure is irregular (or) too tall the response spectrum is approached no longer suitable for the complex study.

2.3 LINEAR DYNAMIC ANALYSIS

In this analysis, the structure is patterned as the multi-degrees of freedom with linear elastic stiffness matrix also equal viscous damping ratio. The response of a structure to earth movement is determined using the time domain from previous records in linear dynamic analysis.

2.4 NON-LINEAR DYNAMIC ANALYSIS

It makes use of the sequences of ground movement data by a detailed structural pattern therefore it is efficient to generate solutions by comparatively low uncertainty and in this, the non-linear dynamic analysis of the detailed structural representation which is subjected to the ground motion record predicts that each component deformation to every freedom degree within the modal. But the analyzed response can remain extremely subtle to the features of the specific earth movement used as per seismic input.

2.5 NON-LINEAR STATIC ANALYSIS

Overall, the linear procedure remains appropriate after the structure is predicted to persist approximately in the elastic form used for the parallel to the ground movement (or) while the design outcomes stay approximately for equal distribution of non-linear response all over the structure. This is similarly called “Pushover Analysis” where the arrangement of forces is useful to a structural pattern that contains non-linear properties. These can be combined with the acceleration-displacement response spectrum (ADRS) and also it moderates the problematically to a single degree of freedom (SDOF).

3. STRUCTURAL DATA OF REINFORCED CONCRETE & STEEL ELEVATED OVERHEAD WATER TANKS

Table -1: Structural Data of Reinforced concrete elevated over a head water tank

Height of storey Height of top storey	3m 5m
External Beam Size Internal Beam Size	450mm X 400mm 400mm X 300mm
Column Size	450mm X 450mm 400mm X 400mm
Characteristic Strength of Concrete (fck)	30MPa
Thickness of Slab	150mm

Table -2: Structural Data of Steel elevated overhead water tank

Height of storey Height of top storey	3m 5m
Beam Size	ISWB-600-1
Column Size	ISA200 X 200 X 25
The thickness of steel plate	120mm

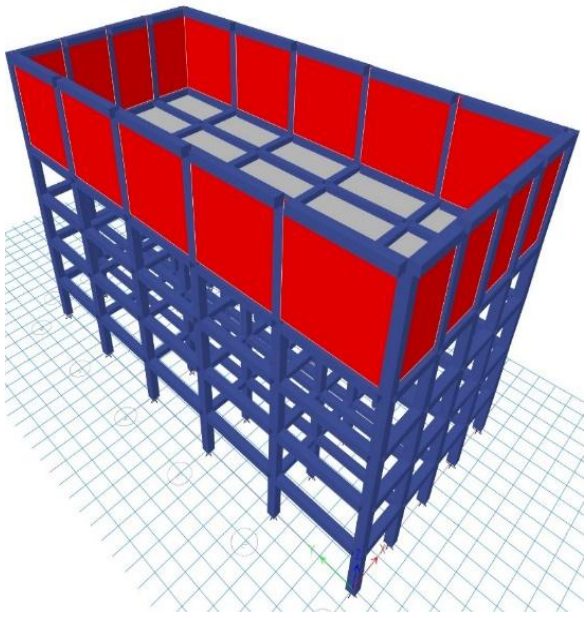

Fig -1: Reinforced Concrete Elevate Over-Head Water Storage Tank

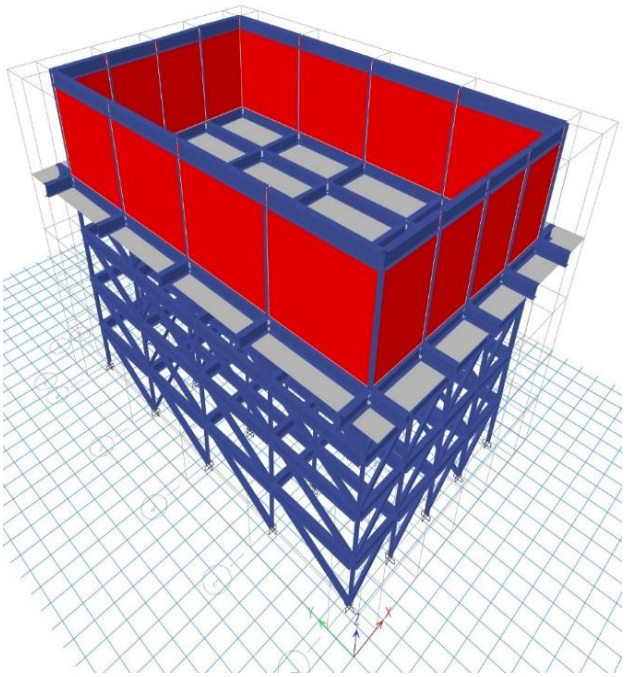

Fig -2: Steel Elevated Over-Head Water Storage Tank

4. RESULTS

The reinforced concrete & steel elevated over-head water storage tanks are subjected to the seismic events in ETABS software.

4.1 Storey Displacements

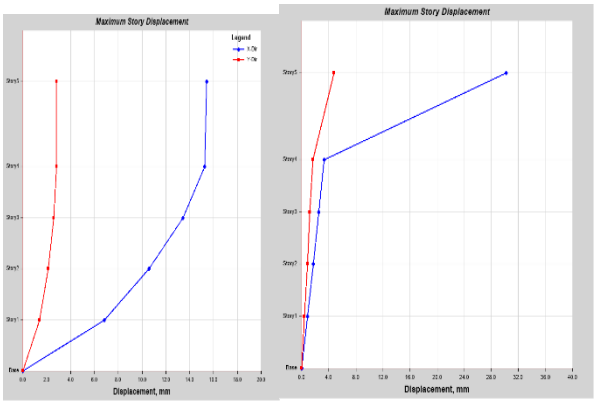

Fig-3 Fig-4

Fig-3: Storey displacements of reinforced concrete elevated overhead water storage tank.

Fig-4: Storey displacements of steel elevated overhead water storage tank.

4.2 Storey Drifts

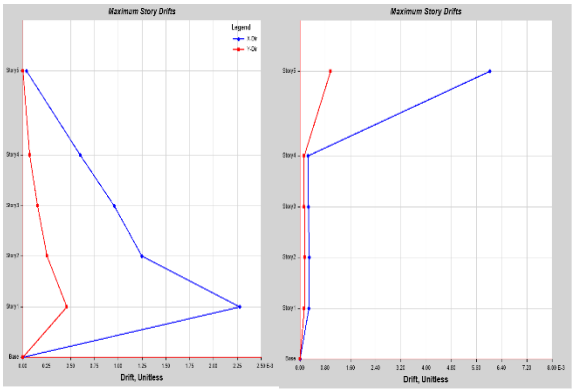

Fig-5 Fig-6

Fig-5: Storey drifts of reinforced concrete elevated overhead water storage tank

Fig-6: Storey drifts of steel elevated overhead water storage tank

4.3 Time History Response Values

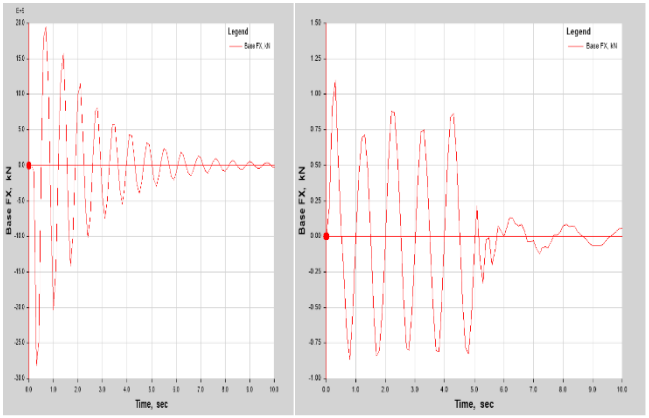

Fig-7 Fig-8

Fig-7: Time history response values of reinforced concrete elevated overhead water storage tank

Fig-8: Time history response values of steel elevated overhead water storage tank

4.4 Time History Analysis Response Spectrum Plots

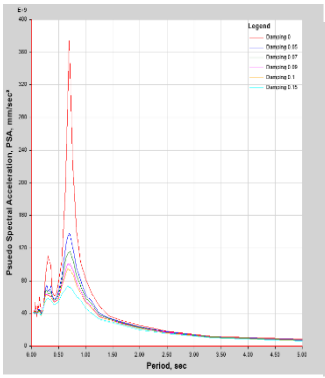

Fig-9

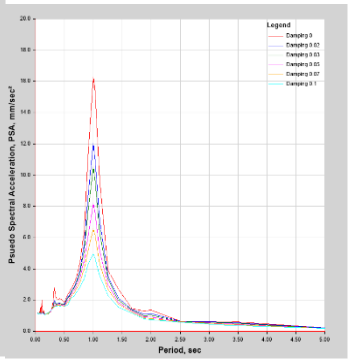

Fig-10

Fig-9: Time history study of reinforced concrete elevated overhead water storage tank response spectrum plots

Fig-10: Time history study of steel elevated overhead water storage tank response spectrum plots

5. CONCLUSIONS

This presents a method of analysis based on spectrum. Response spectrum analysis (RSA) for predicting the forces generated by the earthquake in the elevated over-head tanks. In a response spectrum study, a linear response spectrum is integrated into the time history analysis (THA) approach to consider the linear combination impact of vibration modes in the seismic response of the elevated overhead water tanks.

The above findings show that elevated water storage tanks are built by using a variety of materials like reinforced concrete and also steel by using standard codal provisions which are subjected to the seismic events and generate the displacements, and drifts, and also generated the response spectrum and time history curves so that it shows the variation between the plots and curves of both reinforced concrete elevated over-head water tank and steel elevated over-head water tank so the structures are designed to resist the seismic induced forces from the previous records and also resist the lateral loads which are done using the ETABS software.

REFERENCES

[1] Livaoglu, R. in addition A. Dogangun. "Effect On Foundation Embedment on Seismic Performance of Elevated Water Storage Tanks Considering Fluid–Structure-Soil Interaction." Soil Dynamics and Earthquake Engineering, vol. 27, No.9, pp. 855-863, 2007.

[2] Livaoğlu, R., in addition Adem Doğangün. " Seismic Analysis Procedures for Elevated Water Storage Tanks Considering Fluid-Structure–Soil Interaction." Journal of fluids and structures, vol. 22, No.3, pp. 421-439, (2006).

[3] Santhosh, Vangaveti Sai, Susanta Kumar Sethy, and A. N. Shankar. "Seismic Analysis of Overhead Water Storage Tank Using Indian, American, and British Codal Provisions." (2008).

[4] Hirde, Suchita, Ms. Asmita Bajare, and also Manoj Hedaoo. "Seismic Performance of Elevated Water Storage Tanks." International Journal of Advanced Engineering Research to Studies vol.1, No.1, pp. 78-87, (2011).

[5] Moslemi, M., M. R. Kianoush, and also W. Pogorzelski. "Seismic response of liquid-filled elevated water storage tanks." Engineering structures vol.33, No.6, pp. 2074-2084 (2011).

[6] Jabar, Ayazhussain M., and H. S. Patel. "Seismic Behavior of RC Elevated Water Tank under different Staging Pattern and Earthquake Characteristics." International journal of advanced engineering research and studies, IJAERS 1 (2012).

[7] Sathyanarayanan, Sridhar, and Seshu MR Adluri. "Incorporation of Friction Coefficient in the Design Equations for Elevated Temperature Tanks." Journal of Pressure Vessel Technology vol.135 No.2, (2013).

[8] Harsha, Kaviti, KS K. Karthik Reddy, and Kondepudi Sai Kala. "Seismic Analysis and Design of INTZE Type Water Tank." International Journal of Science Technology and Engineering, ISSN (2015).

[9] Patil, Nishigandha R., and Rajashekhar S. Talikoti. "Seismic Behavior of Elevated Water Tank." International Journal of Research in Engineering and Technology 4 pp. 131-135, (2011).

[10] Kumbar, Ishwar, M. R. Suresh, and N. Shashikanth. "Lateral Stability Improvement designed for Elevated Steel Water Storage Reservoir in Severe Wind in addition to Earthquake Zone using Etabs." Lateral vol.3, No.5, (2019).

[11] Kumar, Hitesh, and Sandip Kumar Saha. " The Seismic Performance of Base-Isolated Elevated Liquid Storage Tanks by Considering the Soil–Structure of Interaction." Practice Publication of Structural Design and Construction vol.26, No.1 Trans., 04020062, (2021).