# Review on Seismic Analysis of Elevated Water Tanks with different shape and Supports System

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**Abstract -** *Water is life so the storage of water is essential for daily use. An elevated water tank is one of the technique or method to store water above the ground level. Due to slenderness in structure and large mass concentration, such water tank are vulnerable to earthquake forces. Many research has been an attempt to study the characteristics of elevated water tank under the seismic load to minimize the collapse and damage of the water tank. Various finite element software like STAAD PRO, ETABS, SAAP, etc. are using for the analysis under the earthquake load. The main objective of this review paper is to study the performance and behavior of different shape of elevated water tank having different staging configuration undertaking the parameter like base shear, base moment, top displacement, time period during empty, half-filled and full filled condition considering the different soil types and seismic zone*

***Key Words*: Elevated Water Tank, Response spectrum analysis, STAAD PRO, ETABS, Base shear, Base Moment, Displacement, Time period, hydrostatic forces staging pattern.**

## 1. INTRODUCTION

Water is one of the essential for every creatures that exists Water is one of the essential for every creature that exists in the Nature. Nowadays underground source of water is in decreasing mode due to high population growth and unsystematic urbanization in the cities. Hence for the regular supply of water, different water storage system that may be underground water storage tank, ground resting water tank and overhead elevated water tank is necessary to tide over the daily requirements. Elevated water tank is the large water container supports by slender staging that can be of RCC or steel which lies above the ground level and supply water to a long distance with sufficient static head to the desired location under the effect of gravitational force. On the basic of shape elevated water tank is classified as circular, Rectangular, Spherical, Intze type and Circular with conical dome water tank. Earthquake is one of the factors that create an effective impact on the elevated water tank which leads to heavily damage as well as collapse. A large number of overhead water tanks damaged during the past earthquake. Majority of them were shaft staging while a few were on frame staging type Elevated water tanks. During the design phase adequate knowledge of code provision and past experience should be considered so that the water storage tank should remain functional during and after the earthquake to ensure portable water supply.

## 2. LITERATURE REVIEW

**Miss Ankita R Patil et al. (2014** has studied the Effect of Different Staging Configurations on Seismic Performance of Circular Elevated Water Tank in zone II, III, and IV by response spectrum method using SAP2000 software. The different types of strut configuration are normal, radial, cross in octagonal plan with staging height 12m, 16m, and 20m. According to this paper stiffness, base shear and an overturning moment of radial strut configuration is more as compared to normal and cross strut with increasing the height in all three zones but the roof displacement is less as compared to cross and normal configurations for all zones. All parameters studied by the author increased with increasing height

**Neha N. Walde et al. (2015** made an effort on the study of seismic analysis of circular water tank considering the effect on time period. Stiffness analysis is carried out using SAP 2000 at staging height 12m, 15m, 18m, 21m, 24m and 27m in zone V having soft and medium soil condition. The capacity of the tank considered for the study was 50 cum and 250 cum. It was found that the Convective time period and Impulsive time period are independent of soil type and have same value at the same staging height for both 50m3 and 250m3. During tank full condition both 50m3 and 250m3 have constant base shear value since the convective time period depends on tank diameter which is constant although the height of staging increases. For both cases with increasing in stiffness the impulsive time goes on decreasing order whereas the convective time period is constant. With increasing the stiffness the overturning moment of the full tank will also increase but in case of the empty condition, it will decrease.

**Prasad S. Barve et al. (2015**) has studied the parametric study seismic behavior of intze tank supported on a shaft to analyze the effect of variation of height/diameter (h/d) ratio of tank container and tank capacities. This study is according to IS: 1893-2002 (part-2). During his study, the capacity of tank considered was 500 to 1000 m3 and height/diameter (h/d) ratio 0.4 to 0.8. Height of staging above ground level was 18m. The study was carried out for earthquake zone III and soil type is medium. It was found that time period for an impulsive mode of vibration is much less than that for convective mode. Base shear and base moment in impulsive mode increase with the increase in h/d ratio for all capacities while for convective mode it is opposite. Hydrodynamic pressure variation in impulsive mode increases with increase in h/d ratio whereas the hydrodynamic pressure variation in convective mode decreases with increase in h/d ratio. The maximum hydrodynamic pressure increases with an increase in h/d ratio.

**Urmila Ronad et al. (2016)** has studied the seismic analysis of circular elevated tank by response spectrum method and analysis using ETABS 9.7.1. Software as per IS 1893:2002. Studies were carried out for frame staging with the hexagonal plan during empty & full tank condition under soft, medium and hard soil condition & in zones II, III, IV, and V with zone factor 0.1, 0.16, 0.24, 0.36. The capacity of overhead tank considered was 900m3 with staging height 16m. IS 1893:2002 part II is considered for the calculation of Hydrodynamic forces. In this paper, authors concluded that base shear and base moment of the tank during full tank condition is much more than an empty condition in all zone and all type of soil condition. Authors also emphasized that the base shear is more in soft soil as compared to medium soil and hard soil and base moment is higher in zone V as compared to zone II, III and IV.

**Ayush et al. (2017** has studied the Performance study of Different Staging Patterns on Elevated Intze Tank having RCC frame and shaft staging in zone IV by response spectrum method and the behavior of these staging systems are analyzed as per IS 1893 (Part-II) 2014 and Seismic loads are assigned as per IS: 1893 (Part-I) in STAAD Pro V8i SS6 software for analysis. The capacity of overhead tank 500 cum. In this paper, for the same height of staging (16 meters) the authors illustrate that base shear for the shaft staging is higher as compared to frame staging system. Whereas in case of node displacement, the frame staging has higher nodal displacement as compared to the shaft type staging hence, frame type staging is more flexible than shaft type staging for returning to its original position after a large deflection from its mean position. The overturning moment for frame staging is less than that of tanks supported on shaft type staging, so primary importance should be given to overturning moment during the design of shaft staging type. In impulse mode time period of shaft type tank is less as compared to the framed type staging elevated water tank.

**Prashant A. Bansode et al. (2017)** has study the Seismic Analysis of Elevated Water Tank with and without bracing in frame staging. The different types of bracing are cross-bracing and diagonal bracing in zone III by response spectrum method as per IS 1893 (Part-II) 2014 and Seismic loads are assigned as per IS: 1893:2002 (Part-II) using STAAD Pro V8i 2007 software. The capacity of the overhead tank considered was 900 cum. In this paper, for same height of staging (16 meters) the authors enlist that the as the level of bracing increases, the base shear and base moment increases i.e. the base share and base moment for diagonal bracing is more as compared to cross bracing and frame type staging but the time period decreases with increasing the bracing level. Hence bracing systems increases the stiffness of structure, which reduces the lateral displacement and time period of vibration is considerable.

**Mr. Shivkumar Hallale et al. (2018**) has worked on the topic the Seismic Behavior of Overhead Circular Water Tank with Shear Wall using STAAD PRO software. During his study, he considers radial staging system, the double strut staging system and a shear wall on six sides during half-filled, full filled and empty condition along with various height 5m, 10m, and 20m.In this paper, the author concluded that during full, half and empty condition as the height increases the time period and deflection also increase but these parameters are minimum for a shear wall as compared to radial and double strut staging. Moments produce by a shear wall at height 10m is more than radial and cross strut during all conditions of watering but for height 5m and 20m the moments keeps decrease at some level and again increase in some amount. The base shear of shear wall is higher in 5m and 10m in all three conditions of watering but in case of 20m height the base shear of radial staging decrease and again increase in some amount than that of shear wall.

**Tokhi Ajmal et.al (2019**) has studied the seismic analysis and comparison of overhead intze water tank, circular water tank and rectangular water tank and having RCC frame staging in zone III and V during empty, half and fully filled condition by response spectrum method using STAAD Pro V8i SS6 software following IS: 1893-2002 (part 1) & IS1893-2002 (part 2).The capacity of the overhead tank is 450m3and height of staging is 27m. In this paper the author illustrated that the base shear of intze tank is greater then a rectangular tank and circular tank in zone III during all three condition (i. e empty, full and half) whereas in zone V base shear of rectangular water tank is more as compared to intze and circular water tank. He mentions the statement that the maximum design base shear is the governing factor to be consider for design of elevated tank which can be obtained during full filled condition. In zone III circular water tank have maximum displacement during a full filled condition whereas in Zone V intze tank have a maximum displacement during fill condition. The time period is more for Intze, circular tanks in full-filled condition in comparison to rectangular tank and is independent of zones. Author neglected base moment during his research.

## 3. CONCLUSION

From the above review, I have concluded that for the elevated water tank having bracing strut addition on frame system and share wall arrangement are advantageous though the base shear and base moment increases. For example, though the base shear and overturning moment in radial strut configuration staging are more, the higher stiffness and lower roof displacement parameter shows better performance in radial configuration staging as compared to normal and cross strut configuration with increasing height. Base shear and base moment also increase corresponding to higher seismic zone and according to soil condition the base shear and base moment changes. The sloshing effect observed during earthquakes is due to the convective mass of water. In terms of the time period, deflection and moment shear wall performance is better than other staging types in all condition of watering. For elevated water tank time period is independent of the zone but depends upon the staging type and height of elevated water tank.

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