iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 9 **Issue:** X **Month of publication:** October 2021

**DOI:** https://doi.org/10.22214/ijraset.2021.38616

# Seismic Analysis of Circular Elevated Water Tank Designed by Indian Standard and European Standard Code

Siddhnath Verma[1], Ganesh Jaiswal[2]
[1]PG Student, Department of civil engineering, Institute of Engineering and Technology, Lucknow, Uttar Pradesh, India
[2]Assistant Professor, Department of civil engineering, Institute of Engineering and Technology, Lucknow, Uttar Pradesh, India

***Abstract: Elevated water tank is used for storage of water which is used for distribution to the public at certain pressure head. In high seismic zones the safety of water tank becomes point of great concern which in case of failure becomes very hazardous for public because of deficiency of water for public use and difficulty in putting fire away caused by earthquake. The water tank must be designed as much strong so that it can perform during and after earthquake without failing. The aim of this study is to design the elevated water tank as per Indian standard code and European standard code on ETABS software. In this study an elevated circular water tank of 35 m$^3$ capacity is being designed in seismic zone III as per IS code and spectrum zone II as per Euro code for hard soil, medium soil and soft soil conditions. During analysis of tank the values of base moment, base shear, storey displacement and storey drift is being obtained and compared in both seismic zones for hard soil, medium soil and soft soil.***
***Keywords: base shear, base moment, ETABS, elevated water tank.***

## I. INTRODUCTION

Water tank are widely used for the storage of water which can be for consuming, fire preventing or for different domestic, business and institutional purposes.

Water plays an important function in day by day lifestyle; as a result water garage is extremely important. An extended water tank could be a large water reservoir made for the aim of keeping water at specified height to supply water at pre defined water pressure in the water distribution system. Elevated water tanks has large water mass at the top of a slim staging which are most critical attention for the failure of the tank at some point of earthquakes. Elevated tank are vital and strategic system and damage of those structures all thorough earthquakes might also endanger drinking water supply, motive to fail in preventing huge fires and massive cost efficient loss.

Since, the elevated water tank are frequently made in seismic prone areas additionally for this reason, the seismic behavior of these water tank must be the element of analysis of water tank. Due to lack of awareness of assisting gadget a number of the water tank are collapse or heavily damages during strong earthquakes. So there is need for recognition of seismic protection of lifeline of water tank structure during usage of tank.

The failure of these structures may cause some hazard for health of town due to shortage of water or trouble in putting out fire at some stage in vital situations. During recent years, many observations on soil- structure interactions on the seismic response have been made. Due to soil structure interaction it was found that even at same magnitude of earthquake in the same regions, the structural damages in the buildings or any other structure are not of same pattern.

A water tank also serves as a reservoir to help with water needs all through the maximum demand time of the day. Water tank should be designed such that it can fulfill the requirement of water for maximum public demand and also the fire demand. A water tower is a structure built at top of frames at sufficient height to pressurize water through distribution system for potable and other usage in daily life. Water tank helps in delivery of water at some specified pressure even in case of outages of power due to destruction of infrastructure during earthquake.

The aim of this study is earthquake analysis of tank as per Indian standard code and European standard code provisions. The equivalent static analysis of tank is done as per IS 1893(Part 2):2014. The response is also checked at hard soil, medium soil and soft soil conditions as per both codal provisions.

## II. METHODOLOGY

Because the raised water tanks are rarely entirely filled during their use, two mass idolizations are more appropriate than one. The two-mass model is the most frequent in all international and Indian codes, including IS 1893(part 2):2014. The impulsive and convective modes of fluid pressure created by earthquake-induced dynamic motion can be distinguished.

The elevated circular water tank in this paper is designed according to IS 3370:2009 and European standard code. The seismic analysis is carried out in accordance with Indian standard code IS 1893(Part 2):2014 and European standard EN 1998(Part 4):2006. Both codal provisions are used to calculate the seismic response of the base moment, base shear, storey displacement, and storey drift. ETABS software is used to simulate the dynamic response of a water tank.

### A. Model Description

| | |
|---|---|
| Capacity of tank | $35m^3$ |
| Thickness of top dome | 150 mm |
| Wall size | 230mm×300mm |
| Top ring beam size | 230mm×300mm |
| Bottom ring beam | 300mm×600mm |
| Column size | 400mm×400mm |
| Number of columns | 6 |

Parameters $m_i$, $m_s$, $m_c$, $M_i^*$, $M_c^*$, $m_c$, $h_i$, $h_c$, $h_i^*$, $h_c^*$ and $k_c$ are calculated based upon h/D ratio as per IS 1893(part 2):2014.

Where $m_s$ = Mass of empty container which includes mass of members like roofs, wall, tank floor, floor beams etc of elevated tank and one third of mass of staging.

or

$m_s$ =weight of container $+{}^1/_3\,(weight\ of\ staging)$

Live load: 1.5KN/m2 of load acting on the Top Dome, which is often used for maintenance. For response spectrum analysis in seismic loads, parameters such as zone factor, importance factor, and response reduction factors are used.

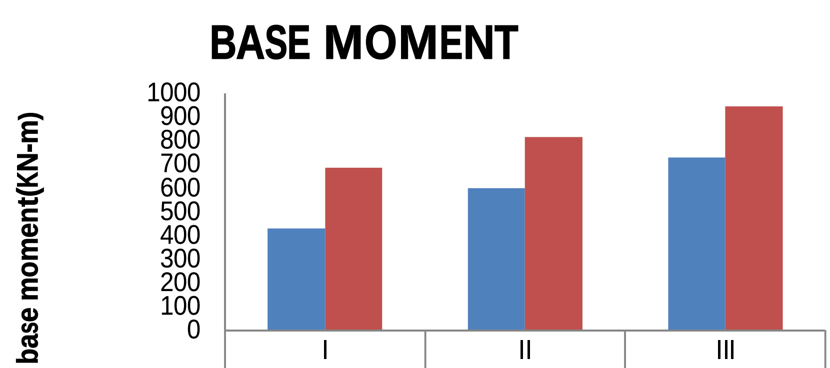
According to IS Code 1893:2016, the zone factors for seismic zones III are 0.16. Tanks used to store drinking water, non-volatile materials, low inflammable petrochemicals, and emergency services such as firefighting services have an importance factor of 1.0.

A special moment resistant response reduction factor of 2.5 is proposed for frames that correspond to ductile detailing.

## III. RESULT AND CONCLUSION

During the earthquake, a WATER tank is examined using two separate code criteria. For example, base shear, displacement, drift, and bending moments for the tank has been calculated. In this chapter, data representation in form of chart and table is discussed.

### A. Base Moment

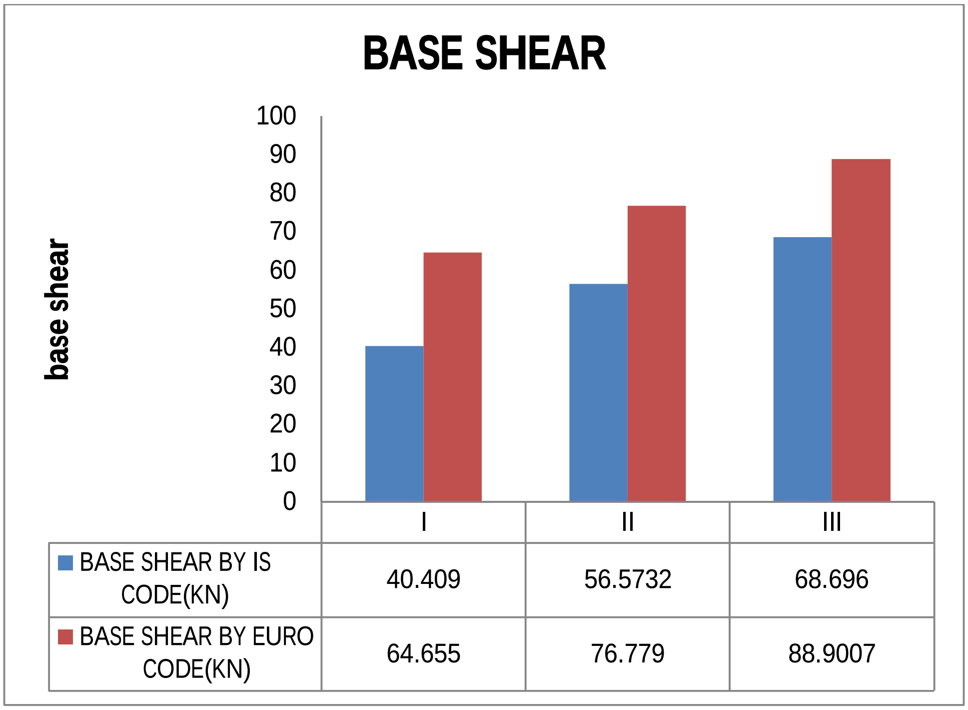



| | I | II | III |
|---|---|---|---|
| BASE MOMENT BY IS CODE(KN-m) | 429.5847 | 601.4009 | 730.26 |
| BASE MOMENT BY EURO CODE(KN-m) | 687.3009 | 816.1712 | 945.033 |

Chart-1 variation of base moment in different soil conditions

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429*
*Volume 9 Issue X Oct 2021- Available at www.ijraset.com*

*B. Base Shear*

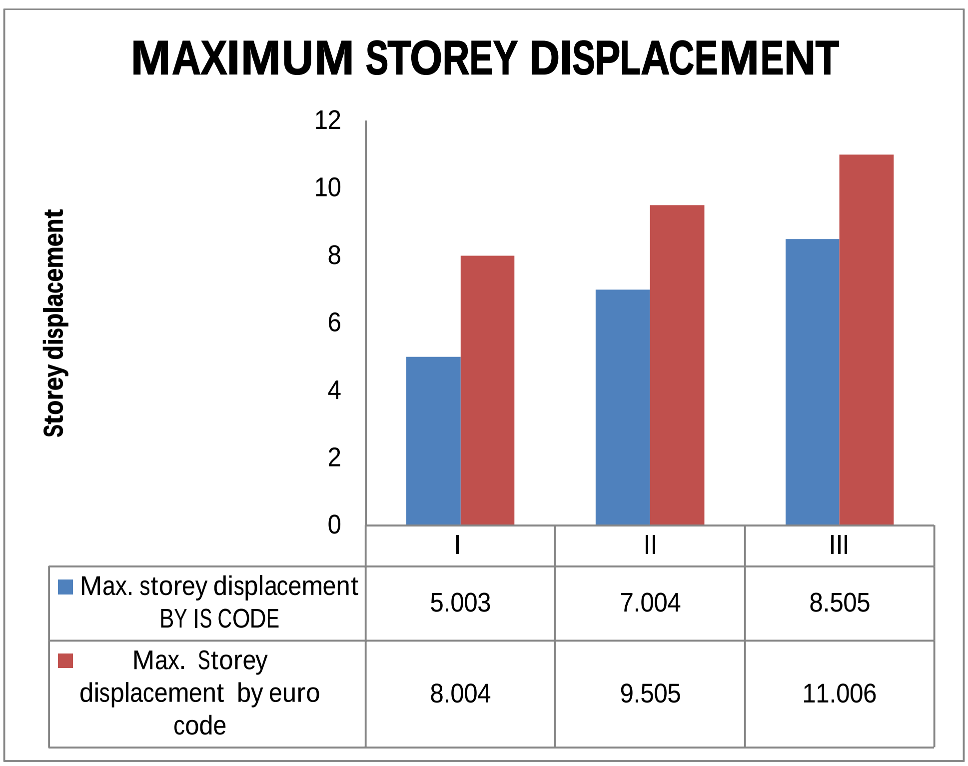



| | I | II | III |
|---|---|---|---|
| BASE SHEAR BY IS CODE(KN) | 40.409 | 56.5732 | 68.696 |
| BASE SHEAR BY EURO CODE(KN) | 64.655 | 76.779 | 88.9007 |

Chart 2 Base Shear for different seismic zone

*C. Storey Displacements*

Maximum Storey displacement as mentioned in European code is taken as **H/250. (**Where H is height of storey of water tank from ground level).




| | I | II | III |
|---|---|---|---|
| Max. storey displacement BY IS CODE | 5.003 | 7.004 | 8.505 |
| Max. Storey displacement by euro code | 8.004 | 9.505 | 11.006 |

Chart 3 storey displacement variations

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429*
*Volume 9 Issue X Oct 2021- Available at www.ijraset.com*

*D. Storey Drift*

The maximum allowable value of storey drift as per codal provisions is **0.004h.** where h is the height of storey for which drift is to be calculated.

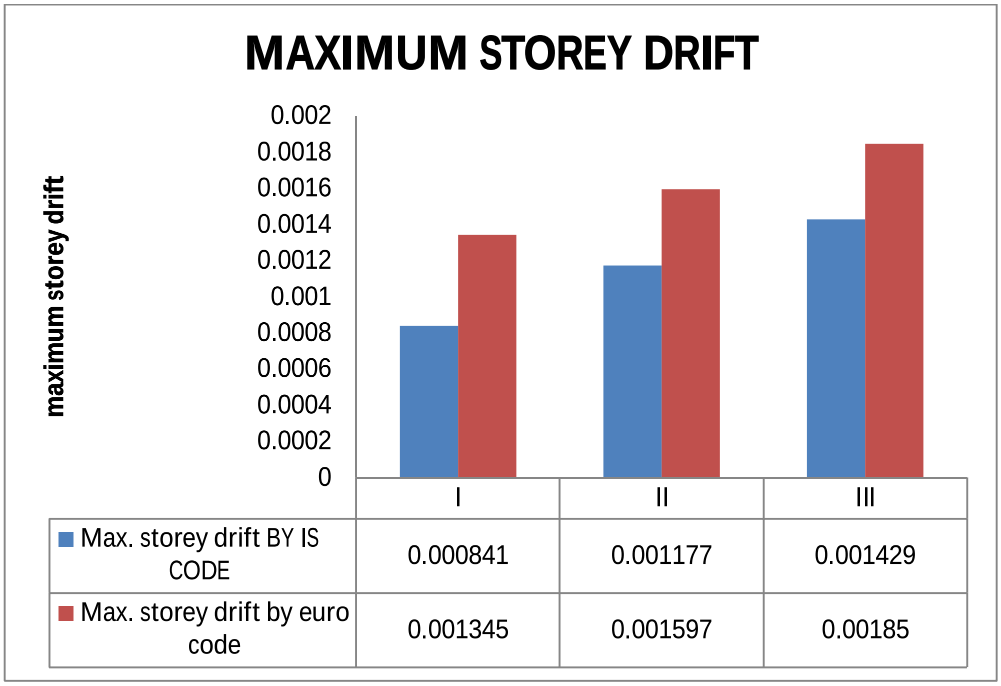



Chart-4 storey drift values as per Indian and euro codes

## IV. CONCLUSIONS

The conclusions from the above table and charts are as follows-

*A.* Chart 1 demonstrates that in water tanks developed according to European standard code, the maximum base moment for type I, type II, and type III soils is more than in water tanks designed according to Indian standard code. When comparing the results, it's clear that soft soil has the highest base moments compared to hard and medium soils.

*B.* When a water tank is developed according to Indian standard code, the base shear is lower than when it is designed according to European standard code. Chart 2 further demonstrates that type-III soils have the highest base shear compared to type-I and type-II soils.

*C.* In both Indian and European codal instances, the maximum storey displacement is largest for the top storey of the water tank. Chart 3 further reveals that type-III soils has more displacement than type-I and type-II soils in both circumstances.

*D.* In European standard design, the storey drift value is larger than in Indian standard design. Drift grows in value as you progress from hard to medium to soft soils.

## REFERENCES

[1] IS 1893 (Part-1):2016 criteria for earthquake resistant design of structures- General provisions and building.
[2] IS-1893 (Part-2):2016 criteria for earthquake resistant design of structures -Liquid retaining tank.
[3] IS 3370 (Part-I, II, III, IV):2009 Concrete structures for storage of liquid.
[4] IITK-GSDMA guidelines for seismic design of liquid storage tank. (Provisions with Commentary and Explanatory Examples).
[5] Effect of soil condition on seismic response of isolated base buildings, Hasan, Pal.
[6] Seismic analysis of circular elevated water tank, Urmila, Raghu, guruprasad.