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Seismic Analysis of Circular Water Tank Designed by Indian Standard Code and Euro Code

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Abstract: Water tanks are widely used for storage of drinking water. Water tanks and especially the elevated water tanks are structures of high importance which are considered as main lifeline elements that should be capable of keeping the expected performance i.e. operation during and after earthquakes. In this research paper, the analysis of the seismic behaviour of the elevated circular water tank by Indian standard code and Euro code is carried being carried out. The analysis is carried out on 35 cubic meter capacity elevated circular water tank in zone III and spectrum zone II and on three different soil conditions i.e. hard soil, medium soil and soft soil using ETABS software as per Indian standard code and European standard code. The results of base shear, base moment, storey displacement and storey drift are obtained from both codal provisions.
Keywords: Elevated water tank, Seismic response, Etabs, Base shear, Base moment

I. INTRODUCTION

Water tank are widely used for the storage of water which can be used for drinking, fire fighting or for other domestic, industrial and institutional purposes. Water plays a necessary role in daily life, thus water storage is extremely necessary. An elevated tank could be a giant water storage instrumentation made for the aim of holding water at certain height to produce comfortable pressure within the water distribution system. Liquid storage tanks are also used for storage of flammable liquids and different chemicals. Industrial liquid tanks might contain extremely noxious and flammable liquids and these tanks should not lose their content throughout earthquake. According to code, hydrodynamic forces applied by fluids on tank wall shall be considered in the analysis in addition to hydrostatic forces. These hydrodynamic forces are assessed with the assistance of spring mass model of tanks. Because of concentration of loads at top, the water tanks are profoundly hazardous for lateral load imposed during earthquake. Therefore water tanks must be designed by considering the effect of earthquake. Elevated water tanks are strategic structure if damaged during earthquake, can cause shortage of drinking water, cause to unable to prevent any large fire etc. Two kinds of issues are identified to lifeline earthquake engineering. The first is to decide the normal earthquake ground motion for design, and the second is to decide the structural reaction. The degree of ground movement to be utilized in design can be determined severally. Code-based design utilizes comparable static formula, with a few boundaries joining the kind of structure, significance, soil conditions, and area comparative with seismic zones and blames. Codes make reference to more point by point examinations that utilization design spectra which join time with top ground acceleration increase or different techniques, for example, time narratives of ground movement in a dynamic investigation. Due to in-sufficient knowledge of supporting system, the water tanks during earthquake were damaged. So the supporting system must be sufficiently strong enough to withstand the lateral forces induced by ground due to earthquake. The aim of this work is analysis and design of water tank in different zone of earthquake and in different soil conditions.

II. METHODOLOGY

The methodology include the determination of the size of components of the water tank as per IS 456:2016 and IS 3370:2009. This work consist study of circular elevated tank of same capacity and same staging height in different seismic zone and different soil conditions. In this paper all the analysis are being done at full capacity of the tank. Seismic analysis of tank is being carried out as per IS 1893:2016(part 2) and EN 1998:2006 (part 4).

A. Model Description

Capacity of tank:	35 m^3
Top slab thickness:	150 mm
Bottom slab thickness:	300 mm
Cylindrical wall thickness:	230 mm
Column:	500mm×500 mm
Number of column:	6
Braces:	300mm ×600 mm

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B. Zones: III *Seismic Parameters*

, spectrum zone II

Zone factor: 0.16

Soil type: soft, medium, hard

Reduction factor: 5

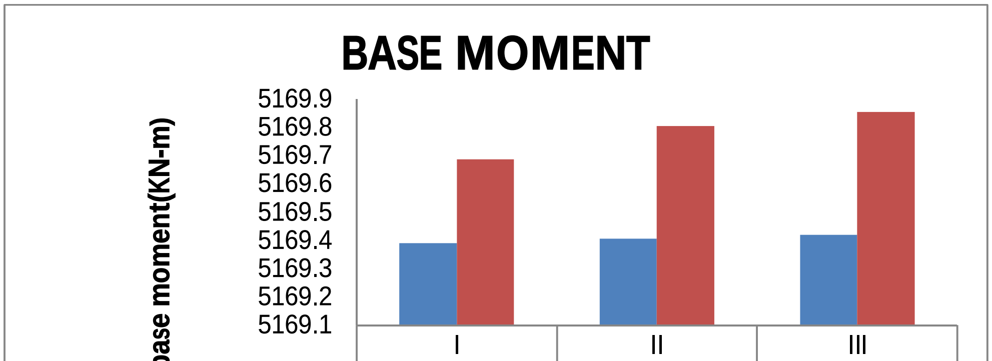
Importance factor: 1.0

During analysis of water tank, equivalent static method is considered. The seismic weight of the tank is taken as weight of empty tank plus (1/3) rd weight of staging. The tank is modelled in ETABS software.

III. RESULT AND CONCLUSIONS

In this study, elevated circular water tank have been designed using IS 3370:2009 and European standard code. Using ETABS software dynamic analysis has been carried for different soil conditions in seismic zone III and spectrum zone II. The results for base shear, base moment, storey displacement and storey drift are compared for both codes.

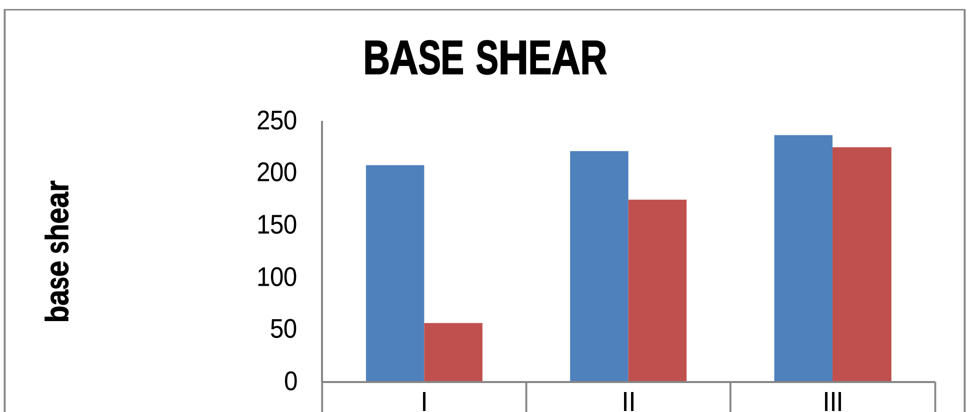
A. Base Moment



	I	II	III
BASE MOMENT BY IS CODE(KN-m)	5169.3917	5169.4071	5169.4204
BASE MOMENT BY EURO CODE(KN-m)	5169.6876	5169.8061	5169.8569

Table 1 base moment for hard, medium and soft soil

B. Base Shear



	I	II	III
BASE SHEAR BY IS CODE(KN)	207.992	221.352	236.867
BASE SHEAR BY EURO CODE(KN)	56.7344	174.579	225.0838

Table-2 base shear for hard, medium and soft soil

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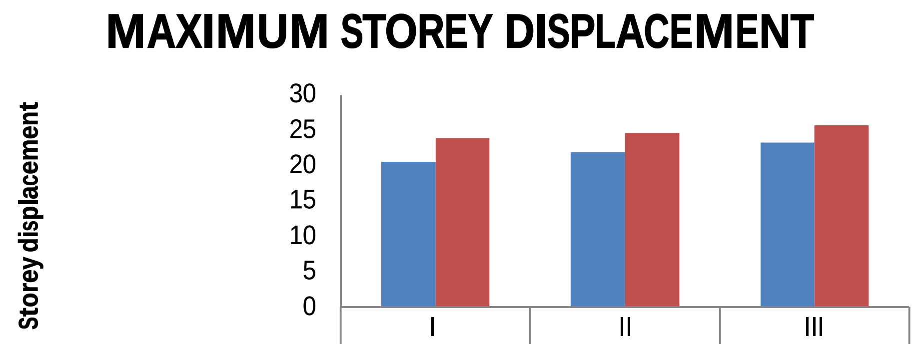
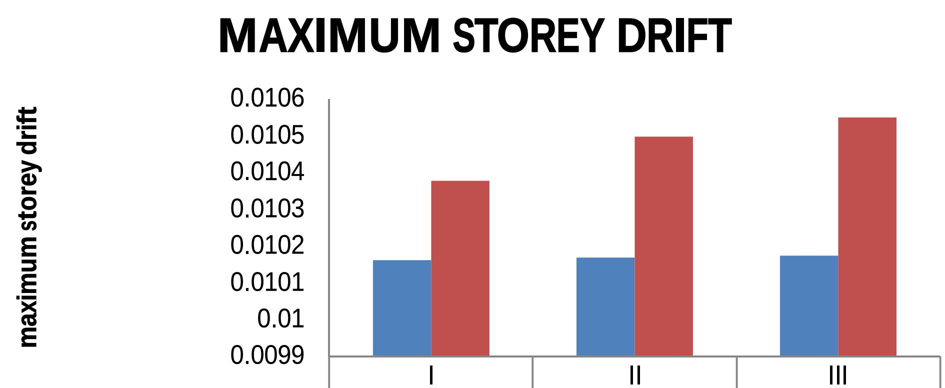
C. Storey Displacement



	I	II	III
Max. storey displacement BY IS CODE	20.507	21.875	23.274
Max. Storey displacement by euro code	23.907	24.646	25.673

Table 3 storey displacement for all three types of soils

D. Storey Drift



	I	II	III
Max. storey drift BY IS CODE	0.010162	0.010168	0.010174
Max. storey drift by euro code	0.010378	0.010497	0.01055

Table 4 storey drift for hard, medium and soft soils

IV. CONCLUSIONS

Following are the conclusions observed from above figures-

A. The table 1 shows that the maximum base moment for type-I, type-II and type-III soils comes more in water tank designed with European standard code as compared to Indian standard code. The comparison of results also reveals that base moments are maximum in type-III soil as compared to type-I and type-II soils.

B. The base shear comes higher for water tank designed with Indian standard code as compared to European standard code design. The table1 also shows that base shear is maximum for type-III soil as compared to type-I and type-II soils.

C. The maximum storey displacement is highest for top storey of water tank in both cases. Table 3 also shows that for type-III soil possesses higher displacement in both cases than type-I and type-II soils.

D. The storey drift value comes higher in European standard design than Indian standard design. Also the value of drift increases from type-I soil to type-II soil to type-III soil.

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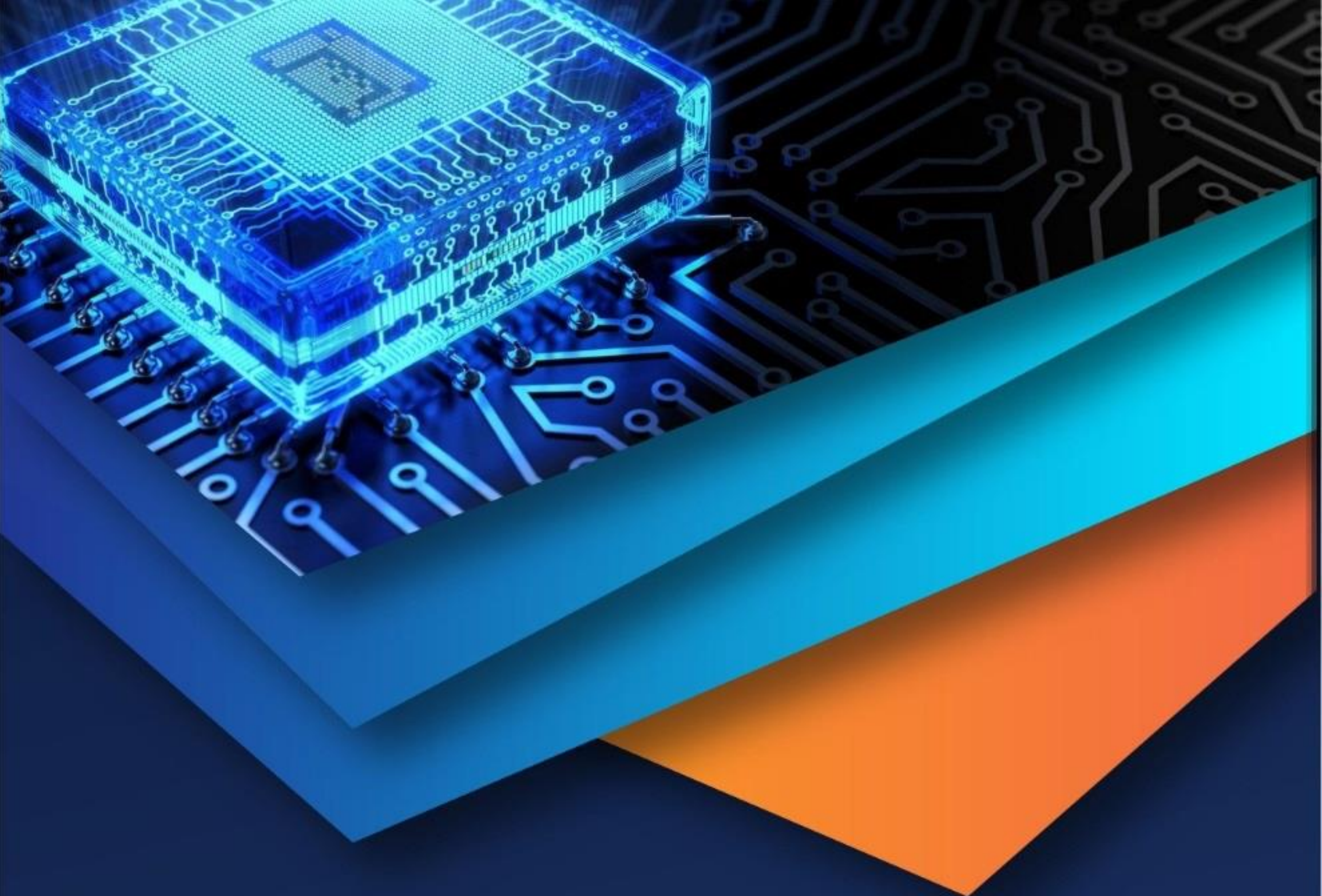

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