Analysis of Different Types of Water Tank using Etabs

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Abstract: **The present study investigates the behavior of elevated circular water tanks and intze water tanks by Response Spectrum Analysis on normal ground. It is carried out by considering various parameters like water storage capacity and staging height which are constant. By intercomparing each of these parameters two models of tank were created. All tank models have their locality in earthquake zone III. Dynamic response of elevated water tanks is hard to define, as the behavior of tank is unpredictable. All tank models are analyzed by Etabs software to study the effect of time periods, maximum displacement, baseshear and base moment.**

Keywords: **Elevated circular and intze water tanks, Response Spectrum Analysis, Tabs software.**

I. INTRODUCTION

Elevated water tanks are very important lifeline structures and should be designed considering the seismic forces. This project is concerned with the performance of two types of elevated water tank with normal ground under seismic and wind induced dynamic loads as shown below in the fig.1 and fig.2The overhead tanks are supported by the column which acts as stage. This elevated water tanks are built for direct distribution of water by gravity flow and are usually of smaller capacity. Most water supply systems in developing countries, such as India, depend on overhead storage tanks. The strength of these tanks against lateral forces such as those caused by earthquakes, needs special attention. General observations are pointing out the reasons towards the failure of supporting system which reveals that the supporting system of the elevated tanks has more critical importance than the other structural types of tanks. Most of the damages observed during the seismic events arise due to the causes like improper/unsuitable design of supporting system, mistakes during selection of supporting system, improper arrangement of supporting elements and/or underestimated demand or overestimated strength etc. Consequently, the aim of this study is to know the effectiveness of supporting systems of elevated tanks with different alteration. A reviewed literature demonstrates the considerable change in seismic behavior of elevated tanks with consideration of responses like displacement, base shear, base moment, sloshing, torsional vulnerability etc. Finally, study discloses the importance of suitable supporting configuration to remain withstands against heavy damage/failure of elevated water tanks during seismic events.

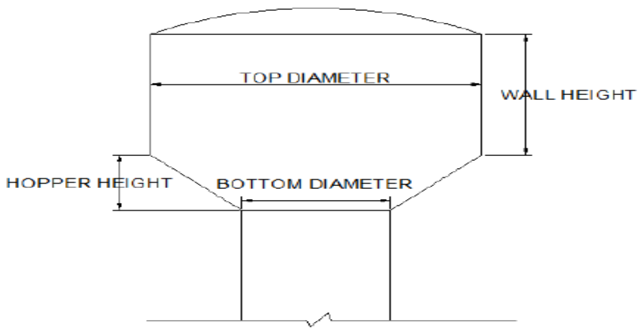

Fig. 1 General diagram of Intze water tank

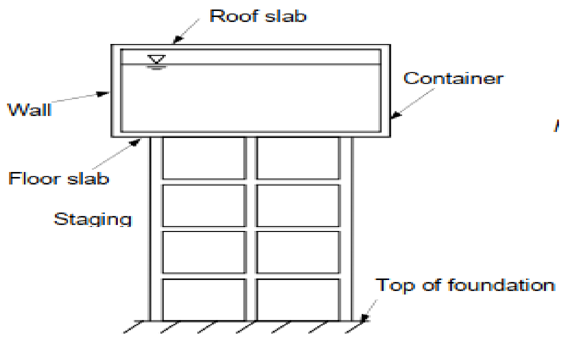

Fig.2 General diagram of Circular water tank

Objectives

This paper is to be presented to serve the following objectives-

1. To study the effectiveness of supporting system of elevated water tanks with different alteration and seismic response of tank on normal ground.
2. To carry out modeling and response spectrum analysis of circular and intze water tank on ground by using etabs Software.
3. Dynamic response of these elevated water tank in terms of base shear, base moment, time periods and maximum displacement are found out using response spectrum analysis on normal ground.

II. MATERIALS AND METHODS

Preliminary Data Required for Analysis of Elevated Water Tank

The current work is focused on the Comparative Study of circular and intze type of overhead water tanks. The configuration involves the same diameter and capacity of tanks but proposed on normal ground and in the same earthquake zone. It is carried out by considering various parameters like water storage capacity and staging height which is on normal ground and then, detailed analysis will be carried out in Etabs

The types of elevated water tank considering for analysis and modeling are as follows:
1. Circular water tank
2. Intze water tank

Table 1. Preliminary data required for analysis of Elevated Water Tank

Sr. No.	Description	Circular tank	Intze Tank
1.	Diameter of Column	450mm	450mm
2.	Height of wall (m)	3m	3m
3.	Hopper height (m)	NA	2m
4.	Height of Staging	12m	12m
5.	Bracings	225x300mm	225x300mm
6.	Thickness of Roof Slab	200mm	200mm
7.	Thickness of Floor slab	450mm	450mm
8.	Size of top beam	300x300 mm	300x300 mm
9.	Thickness of wall	300mm	300mm
10.	Size of bottom beam	450x800mm	450x800mm
11.	Staging level	4	4
12.	Type of soil	Medium soil	Medium soil
13.	No of Column	8	8
14.	Top diameter of tank	4m	4m
15.	Bottom diameter of tank	NA	2m
16.	Type of bracing	Normal	Normal,
17.	Unit Weights	Concrete = 25 KN/m^3	Concrete = 25 KN/m^3
18.	Material	M25 Grade Concrete & Fe415	M25 Grade Concrete & Fe415

Table 2. Loading according to IS 875-Part 1, Part2 and Part 3

Sr. No.	Parameter	Values
1.	Impose load	5 kN/m^2
2.	Super dead load	2.75 kN/m^2
3.	Basic wind speed (V_b)	33m/sec
4.	Windward coefficient c_p	0.8
5.	Leeward coefficient c_p	0.5
6.	Risk coefficient k_1	1
7.	Topography	1
8.	Importance factor (Wind)	1
9.	Surcharge load for circular water tank	$= \gamma_d$ =10x2.75 =27.5 kN/m^2
10.	Surcharge load for intze water tank	$= \gamma_d$ =10x4.75 =47.5 kN/m^2

Table 3. Seismic data required for analysis as per IS 1893 Part 1, Part 2

Sr. No	Parameter	Values
1	Seismic zone	III
2	Zone factor Z	0.16
3	Importance factor I(Earthquake)	1.5
4	Response reduction factor	1.8
5	Damping ratio	0.05
6	Type of soil	medium

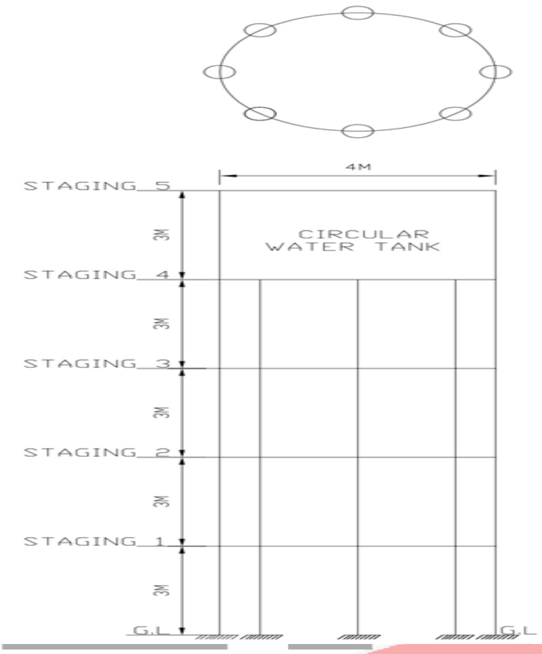

Fig. 3 Structure Elevation of circular water tank. Details input in Etabs Software on normal ground.

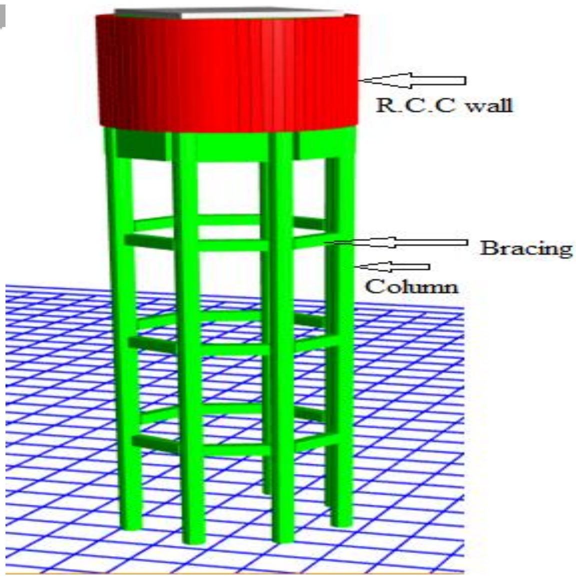

Fig. 4 Typical 3d Model Structure of circular water tank. Details input in Etabs Software on normal ground

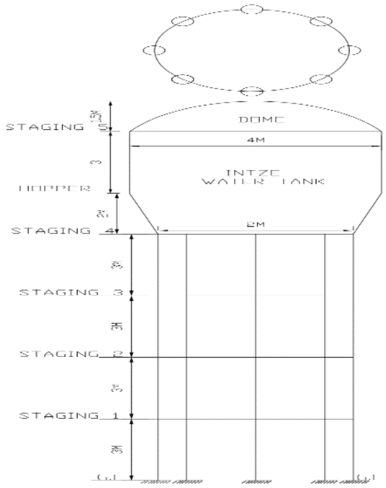

Fig.5 Structure Elevation of intze water tank. Details input in Etabs Software configurations of intze water

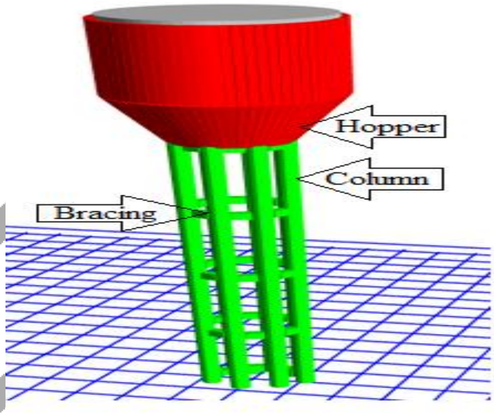

Fig.6 Typical 3d modelStructure of intze water tank.

III. RESULTS AND DISCUSSION

The maximum responses are determined for different parameters of elevated water tanks. Response spectrum analysis for the full tank condition in seismic zones III is carried out by using Etabs software. These responses include base shear force, base moment, maximum displacement and time periods.

Base Shear (in kN)

Base shear values for Circular and Intze models are obtained using Response spectrum analysis from the ETABS software

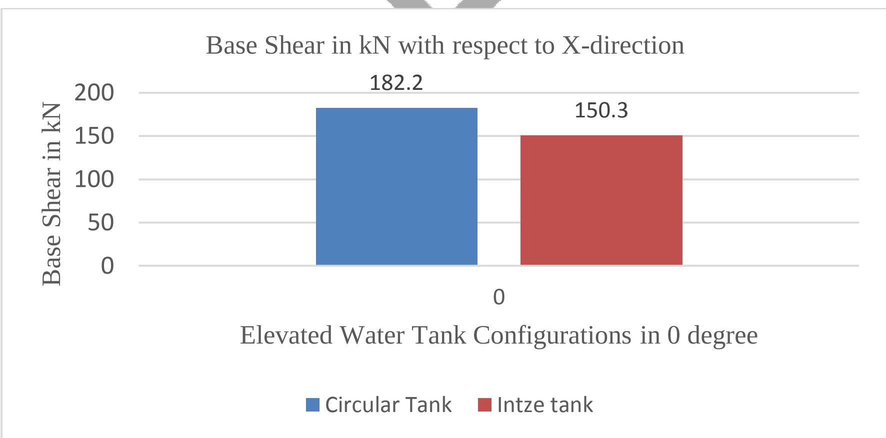

Fig.7 Base Shear in kN with respect to X-direction

Base Moment (in kN-m)

Base moment values for circular and Intze models are obtained using Response spectrum analysis from the ETABS software

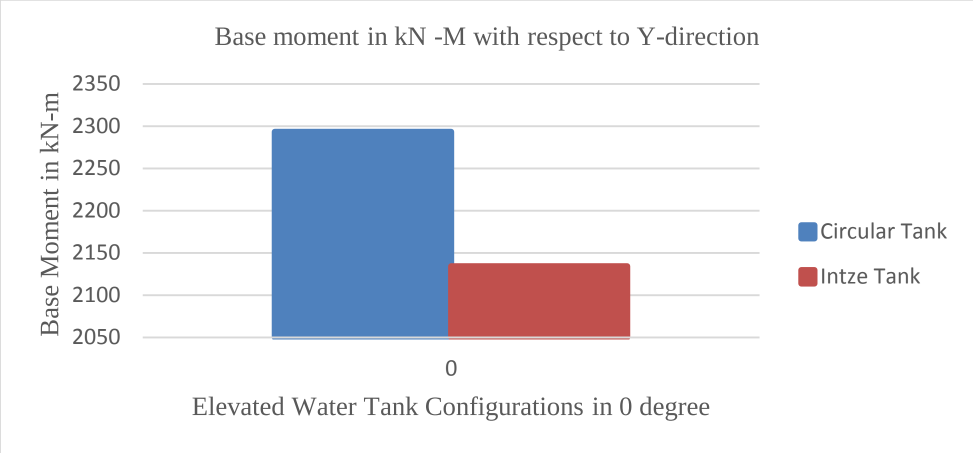

Fig.8 Base Moment in kN-m with respect to Y-direction

Maximum Displacements

Maximum Displacement values for circular and Intze models are obtained from Response spectrum analysis from the ETABS software under seismic zones III for Staging 5 levels of water.

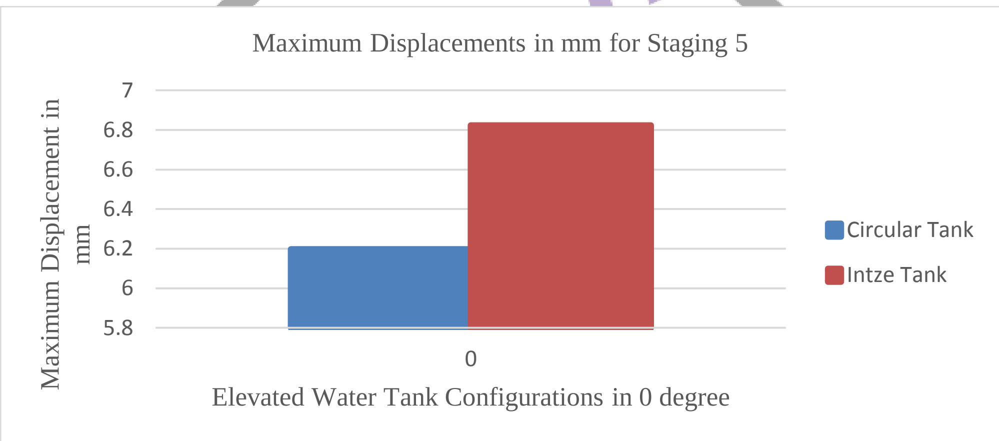

Fig.9 Maximum Displacements in circular tank and Intze tank

Time period:

The time period is calculated for convective mode where in the liquid mass in the upper region undergoes sloshing motion this mass is called as convective liquid mass and it exerts convective hydrodynamic pressure on the tank and the base.

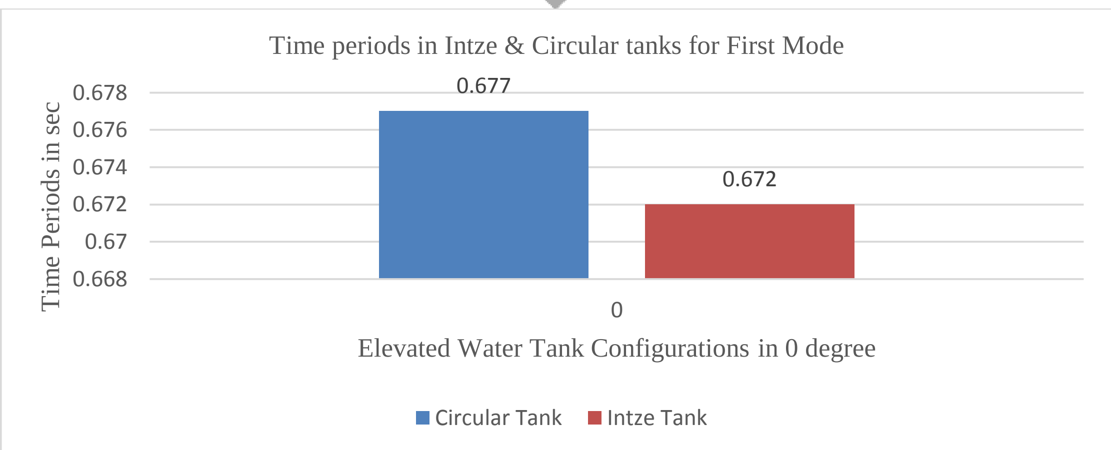

Fig.10 Time periods in Circular tank and Intze tank

IV. CONCLUSION

1. The base shear for Circular tank is 17.50% more than that of Intze type of tank for full tank condition in seismic zone III.
2. The base moment for Circular tank is 6.92% more than that of Intze water tank for seismic zone III.
3. The maximum displacement for Intze type of tank is 9.17 % more than that of circular tank for seismic zone III.
4. The time period for Circular tank is 0.74% more than that of Intze water tank for normal ground Configurations modal.
5. Design of water tank is a very tedious method. Particularly design of elevated cylindrical water tank involves lots of mathematical formulae and calculation. It is also time consuming
6. Large capacities circular water tanks are economical. On account of circular shape, it can make water tight easily as there as no sharp corners.
7. Intze water tank is constructed to reduce the project cost due to lower domes in this construction resist horizontal thrust

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