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Seismic Analysis and Comparison of Overhead Intze Water Tank, CircularWater Tank and Rectangular Water Tank and Response Spectrum Analysis

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ABSTRACT

Elevated WTs are used to store water in the public water supply system and they play a significant role in the seismic areas. The flaw in WTs might be due to a lack of water or problem with people to suppress the flames during seismic activity. The seismic activity caused various breakdowns such as the breakdown Protection of ground and lack of support to the stages. The aim of this paper is a Reaction spectrum analysis, seismic analysis and comparison of overhead Intze WT, circular WT, and rectangular WTs with unfilled, ½ filled and complete in earthquake 3rd & 5th field is done by implementing in STAAD Pro V8i SS6. These three categories of high circular, rectangular & Intze WTs of 450000 liters capacity holds up on RCC frame stages height 27 m under seismic activity loads according to outline code section 2 of IS 1893:2002.

Keywords: overhead Intze WT, circular WT and rectangular WT, base shear, lateral displacement.

INTRODUCTION

The Indian continent is in the grip of natural disasters such as seismic activity, tropical storm and so on. These natural disasters, specially seismic activity is a sudden shaking movement ofthe surface of the earth. Seismic activity can range in weak site and harm the population in this site and demolish all the towns . The frequency of seismic activity at an experienced site during time interval is known as seismic activity in that area. Seismic activity results in surface faulting, tsunamis, soil liquid factions, ground resonance, landslide, ground failure, destruction and damage of constructed, natural environments, loss of life, failure of infrastructure, psychological fear of the region also a decline in economic growth of the area. Therefore, Learning to stay alongside of this incident is essential. Seismic code based on IS 1893 (Part I): 2002. The high reservoir structure for water use is commonly used for supply safe drinking water, industrial facilities, fire fighting system, swimming bath, sewage sedimentation. Their safety performance during a severe seismic activity is alarming. The failure of these structures may threaten citizens as a result of a shortage of water or a fire during the seismic activity. Storage tanks are built for storing water, liquid petroleum, petroleum product and similar liquids. Fluid depot tanks, mostly comprise of 2 categories: underground storage tank & high reservoir. These tanks are mounted on Reinforce cement concrete, steels structure, stonework foundation. The high reservoir is at an elevation of 27 meters. This kind of structure should not only have enough power, but should be free of any vent. The purpose of this article is to recognize the behavior of high WTs in seismic regions by taking into consideration and modeling reservoirs by the Staad Pro V8i SS6 software and by the corresponding IS code.

Explaination Of Models:

Circular, rectangular & intze WTs models are used with a capacity of 450,000 litres, which are mounted on a reinforced cement concrete frame of 27 meters height and 8 columns with ahorizontal surface. Overhead water reservoirs are in the middle soil in the III and V regions. The M30 grade and Fe415 steel grade are used. The seismic evaluation, comparison of all the models and the spectral reaction study technique are done in Staad Pro v8i SSS6.

Circular Overhead Water Reservoir

Table 1 Parameters of elevated circular water reservoir

Parameter	Dimension
The depth of peak dome	0.1m
Rise of peak dome	2.25m
Radius of peak dome at base	6m
Dimension of peak dome ring beam	0.34*0.3m
Cylindrical wall diameter	12m
Cylinder wall height	3.8m
Cylindrical wall depth	0.2m
Base slab depth	0.4m
Size of base ring girder	0.75*0.7m
No. Of columns	8
No. Of bracing levels	7
Distance between bracing	3.85m
Size of bracing	0.35*0.3m
Size of columns	0.6m

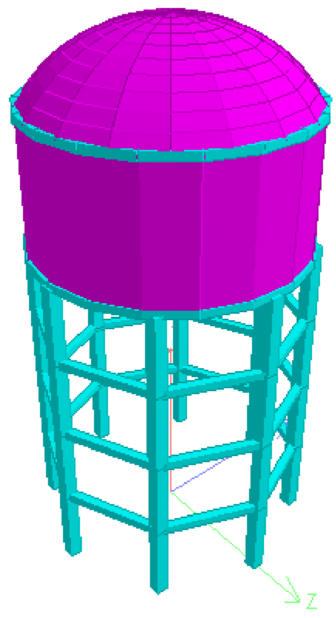

Figure 1 3D elevated circular WT

RECTANGULAR OVERHEAD WATER TANK

Table 2 parameter of elevated rectangular WT

Size of rectangular WT	Dimension
Depth of wall	0.2m
Size of peak slab	0.1m
Size of peak ring beam	0.35*0.3m
Size of wall	3.5m
Size of base slab	0.4m

Size of base ring beam	0.75*0.7m
No. Of columns	8
Size of columns	0.7m
No of bracing	7
Size of bracing	0.4*0.35m

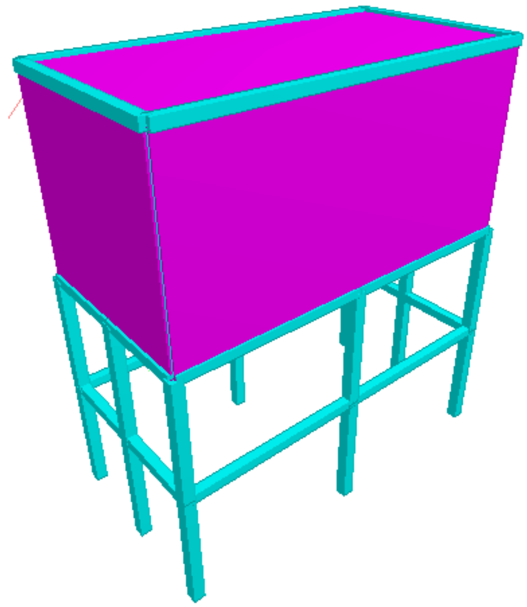

Figure 2 3D elevated Rectangular WT

Intze Overhead Water Tank

Table 3 Parameters of elevate units WT

Parameter	Dimension
The depth of peak dome	0.1m
Rise of peak dome	2.25
Size of peak ring beam	0.35x0.3m
Cylindrical wall diameter	12m
Cylinder wall height	3.8m
Cylindrical wall depth	0.2m
the middle ringbeam	0.35x0.3m
Elevation of conical dome	2.5m
neter of the cone,dome	12m
Conical dome depth	0.45m
Base dome height	
Base dome radius	6m
Base dome depth	2.25m
Size of the base circle girder	0.75*0.5m
No. Of columns	8
No.Of bracing levels	7
Space between middle braces	3.85m
Range of bracing	0.4*0.35m
Size of columns	0.6m

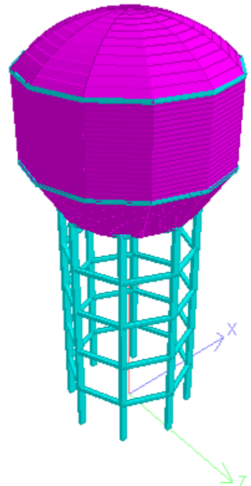

Figure 3 3D elevated Intze WT

METHODOLOGY

This method involves selecting the category of WT, modifying the size of the selected tank component, and executing a linear dynamic study by IS:1893-2002 (part 1) & IS1893-2002 (part 2) outline code. The seismic evaluation, comparison of all the models and the spectral reaction are analyzed with the below given data with peripheral soils in earthquake regions 3^{rd} & 5^{th}.

Live load: 0.75 KN/m2 Load on peak dome, which is usually considered for maintenance work.

Seismic load: Factors such as seismic load, field factor, import factor and decrease in reaction factor are used to match the reaction spectrum and physical factors used in seismic zones III and V were 0.16 and 036, respectively, in code IS1893: 2002. Importance in reservoir 1.5 To store drinking water, non volatilizable materials, flammable organic compound, etc. used for agency services such as the fire service. The response coefficient depends on the category of frame used. For a frame that does not fit with sheet detail, In this category of frame, the resistance reaction time of 1.8 times is used in the field III. To a frame consistent with a sheet extension, is considered to be a resister reaction factor of 2.5. This range of frames is used in field V.

DISCUSSION AND RESULT:

In current study all the models have been analysed by linear equivalent static method and linear response spectrum method. Response spectrum base shear scaled up at least by 85% ofit total static base shear. Base shear, time period and lateral deflection of all models have been founded for seismic zone three and five for full, half and full condition of water in the water tank. Base shear, lateral deflection and time period of all models have been compared with each other and optimized.

Base Shear (BS): Base shear value for circular, rectangular & unit models are attained byresponse spectrum method by using staad pro.

Table 4 BS value for Region-III

Water level in tanks	Circular fx (in KN)	Rectangular fx (KN)	The Intze fx (KN)
Discharged tank level	268.24	243.4	324.23
Half tank level	326.38	383.49	456.3
Full tank level	397.13	319.4	562.21

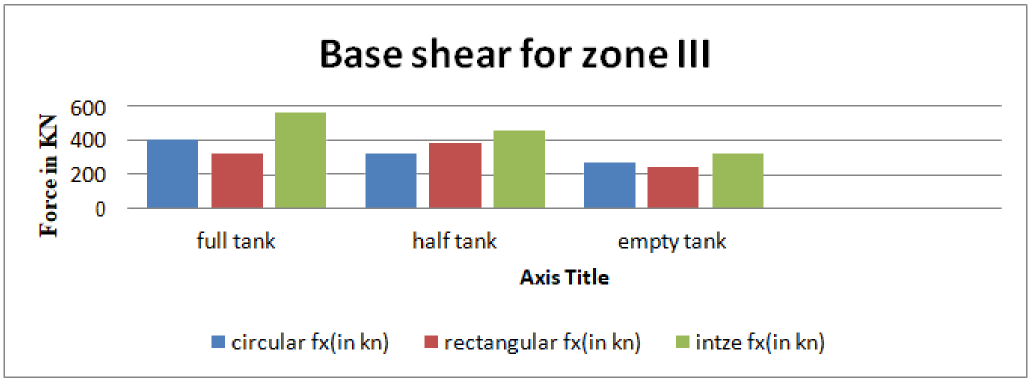

Figure 4 base shear of zone III

Table 5 Base shear value of Zone-V

Water level in tanks	Circular fx (in KN)	Rectangular fx (KN)	The Intze fx (KN)
Discharged tank level	366.92	391.6	324.23
Half tank level	522.2	552.88	568.15
Full tank level	712.64	895.13	843.32

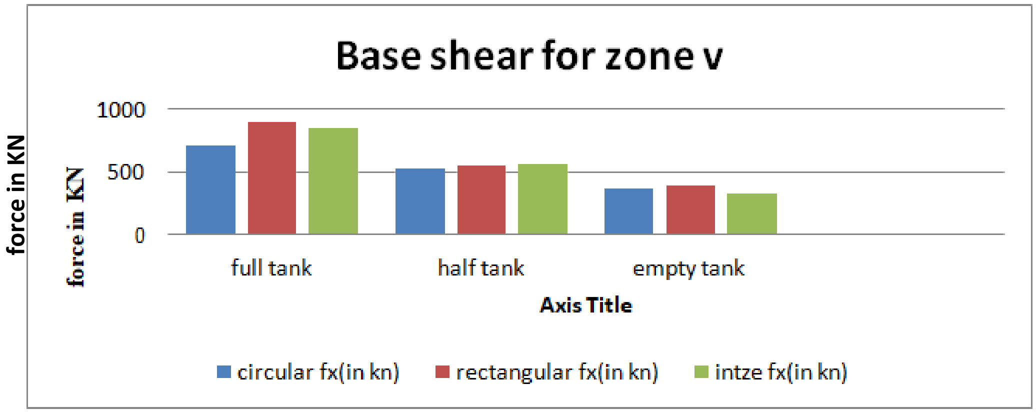

Figure 5 base shear in zone v

Discuss the value of base shear of all models:

1. Bottom shear for rectangular category is much greater than Intze and circularcategory for complete reservoir conditions in seismic region V.
2. The base shear for the circular category of the tank increases 1.8 times, when theregion III changes to the full V reservoir state.
3. The base shear is 2.86 times higher for a rectangular category when the region IIIchanges in V region of the complete state of the reservoir model.
4. The base shear for the Intze category tank increases 1.5 times when the region IIIbecomes V of the complete state of the reservoir model.

Displacement:

The displacement value of circular, rectangular & Intze schemes are attained from thespectrum study by staad.pro for different levels of water in seismic regions III and V.

Discussion about displacements on the models:

1. The maximum displacement usually occurs at peak most nodes and a minimum at thebottom supports node for all models irrespective of shape.
2. The displacement increases 2.2 times for the circular tank in full tank condition whenZone III changes to Zone V.

3. When region III is switched to Zone V, the displacement of the Intze tank in the fulltank position increases 1.5 times.
4. When region III changes to zone V, the displacement for a rectangular tank in thefull tank position increases 2.2 times.
5. The displacement of a circular category reservoir over the category of Intze reservoirand a rectangular category for a complete reservoir in the seismic region V.

Table 6 Displacement of Elevated WTs

Seismic zone v			
	Circular tank	Rectangular tank	Intze tank
Full tank	438.4 mm	276.5 mm	358.176 mm
Half tank	248.975 mm	210.61 mm	235.26 mm
Empty tank	168.58 mm	144.199 mm	125.76 mm

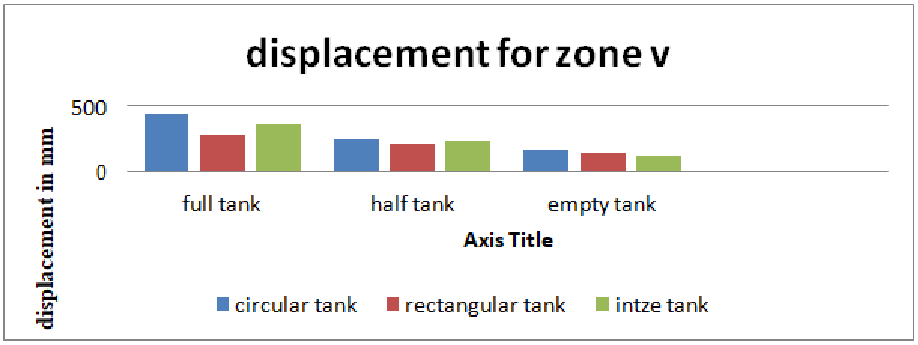

Figure 6 Displacement for zone V

Table 7 Lateral displacement of elevated WTs

Seismic zone III			
	Circular tank	Rectangular tank	Intze tank
Full tank	199.33 mm	123.268 mm	239 mm
Half tank	156.1 mm	104.239 mm	189.834 mm
Empty tank	123.6 mm	85.1 mm	125.756 mm

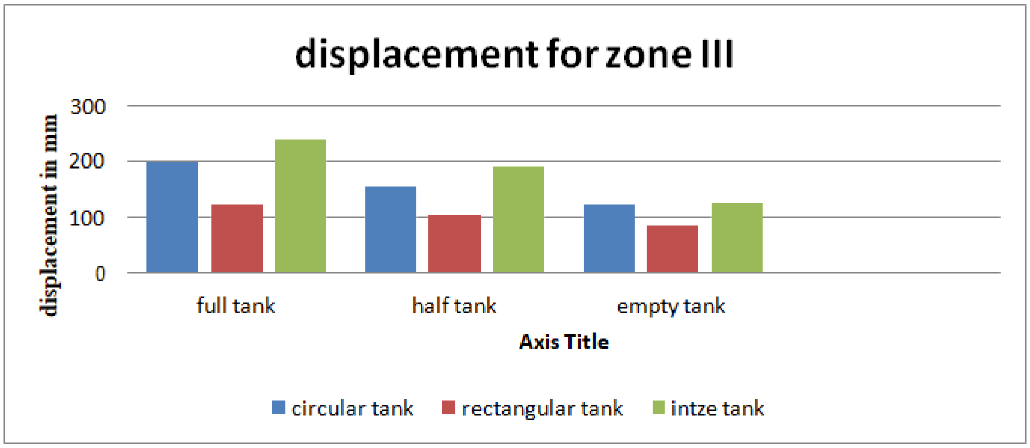

Figure 7 Displacement for zone III

Discussion on the time period of the models:

1. The time period of elevated water tanks is independent of seismic zones and isobtained same for Zone III and Zone V.
2. The duration for a rectangular category tank is less than the category Intze of thereservoir and the category of the circular for the full reservoir in the seismic region V.
3. The duration of the circular category reservoir and Intze are approximately the sameas the full reservoir condition in both seismic zone III-V.
4. Time for circular category reservoir and Intze category more than rectangular reservoir for complete seismic zone III.

Table 8 Time period in second

Seismic zone v			
	Circular tank	Rectangular tank	Intze tank
Full tank	3.74 Sec	2.975 Sec	3.767 Sec
Half tank	2.978 Sec	2.577 Sec	2.95 Sec
Empty tank	2.278 Sec	2.1 Sec	1.865 Sec

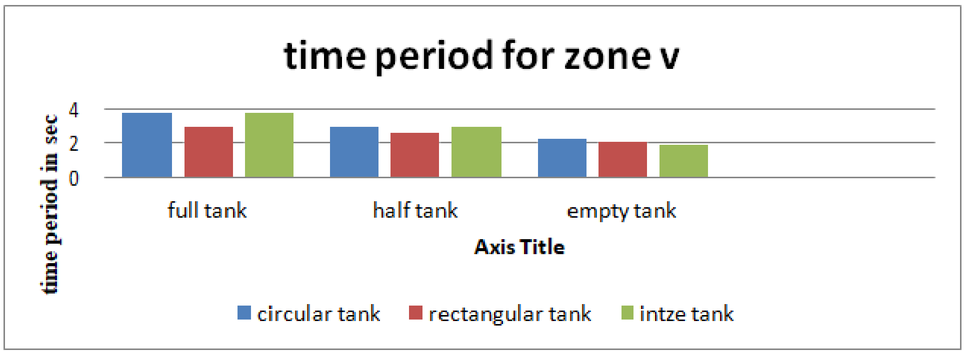

Figure 8 Time period for zone V

Table 9 Time period in second

Seismic zone III			
	Circular tank	Rectangular tank	Intze tank
Full tank	3.788 Sec	2.97 Sec	3.767 Sec
Half tank	2.978 Sec	2.577 Sec	2.955 Sec
Empty tank	2.28 Sec	2.0415 Sec	1.865 Sec

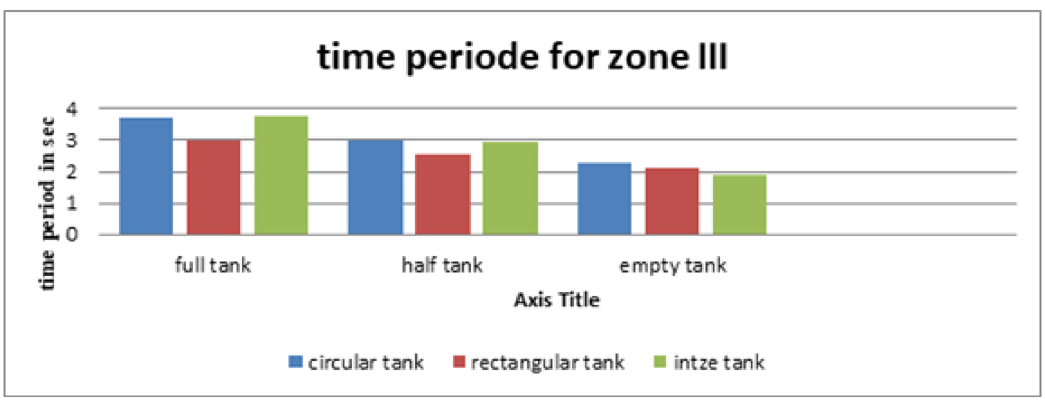

Figure 9 Time period for zone III

CONCLUSIONS

1. The total base shear in complete reservoir conditions is greater than the conditions inthe empty and semi-filled reservoir in both seismic zones III and seismic zone V for three Intze, rectangular and circular category of the tank. Hence design is governed by full tank condition.
2. The increment in the base shear is very large with change in zone III to Zone V in three circular, rectangular and Intze category of WTs.
3. From the analysis results it is seen that maximum displacement occurs at backmost node and is maximum in the Intze category of WT.
4. The maximum displacement occurs in Intze tank, rectangular tank and circular tank in comparison with both seismic zones III and seismic zone V.
5. The maximum displacement in circular, rectangular and Intze tank occurs in full tank condition and displacement value increases in zone V in comparison to zone III.
6. The increment in displacement from empty condition to full tank condition for Intze, circular tanks is more in comparison to the rectangular WT in both seismic zones III and seismic zone V.
7. The time period is more for Intze, circular tanks in full-filled condition in comparison to rectangular tank and is independent of zones.
8. Design of elevated water tank is very complex, which involves a lot of mathematical calculations and time consuming. Hence Staad pro gives all parameters which are useful in design of elevated water tank.

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