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# Seismic Analysis of Overhead Rectangular Water Tank with Varying Length to Width Ratio

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**ABSTRACT**

*During the Earthquake, many of the fluid containers are damaged badly. Also unrestrained fires and spillage of dangerous fluids due to a major earthquake may cause significantly more damage than the earthquake itself. The object of the present work is to compare the behaviour of overhead RCC water tank rectangular in shape with different ratio of length to width having same depth and staging height. For this research, the ratios of length to width considered are between 1.0 to 4.0. The depth of tank for the various seismic zone is kept as 3 m and tank capacity kept as 1 lakh litres. The total staging height for all the size of tanks is kept as 18 m. The models are analysed for seismic zones IV and V. The results are compared on the basis of parameters like displacement and base shear from the analysis, it shows that there is increase in displacement and Base shear from lower to higher zones because of the rise in the magnitude of intensity for higher zones. The displacement values shows sudden increase as the ratio of length to width increases from 2.5 to 3.0 and the value reaches the peak at L/B ratio of 4.0 for all the seismic zones.*

***Keywords:*** *Water tank, seismic zone, base shear, displacement, length to width, overhead, Rectangular.*

## I. INTRODUCTION

It is known that, some of the fluid containers are damaged in many earthquakes. Some unwanted events may cause such as shortage of drinking and utilizing water, uncontrolled fires and spillage of dangerous fluids which are due to damage or collapse of these structures. Water is human basic needs for daily life. In certain area sufficient water distribution depends on the design of a water tank. Water supply depends on overhead water tanks for storage in our country as the required pressure in water supply process is obtained by gravity in elevated tanks rather than the need of heavy pumping facilities. Due to natural disasters like earthquakes, draughts, floods, cyclones etc, Indian sub-continent is highly vulnerable. According to seismic code IS: 1893 (Part1)-2002, more than 60% of India is prone to earthquakes. During earthquake for the failure of elevated water tanks it is most critical consideration that huge water mass is at top of a slender staging. Since, the elevated tanks are frequently used in seismic active regions also hence their seismic behavior has to be investigated in detail.

## II. SCOPE OF THE STUDY

Water is human basic needs for daily life. In certain area sufficient water distribution depends on the design of a water tank. Water supply depends on overhead water tanks for storage inour country as the required pressure in water supply process is obtained by gravity in elevated tanks rather than the need of heavy pumping facilities. Due to natural disasters like earthquakes, draughts, floods, cyclones etc, Indian sub-continent is highly vulnerable. According to seismic code IS: 1893 (Part1)-2002, more than 60% of India is prone to earthquakes. During earthquake for the failure of elevated water tanks it is most critical consideration that huge water mass is at top of a slender staging. Since, the elevated tanks are frequently used in seismic active regions also hence their seismic behavior has to be investigated in detail.

From the shape point of view water tanks may be of several types:

1. Circular tanks
2. Circular tanks with conical bottoms
3. Rectangular tanks

Based on the location of tank in a building, tanks can be classified into three categories:

1. Tanks resting on ground

2. Underground tanks

Overhead tanks

## III. OBJECTIVE OF STUDY

The objectives of this study are as follows:

- ✓ To analyse the seismic behavior of overhead RCC water tanks rectangular in shape with variable length to width ratio and having constant depth and staging height.
- ✓ To study the response of overhead rectangular RCC water tanks for the earthquake forces.
- ✓ To evaluate the performance of elevated rectangular RCC water tanks in different seismic zones i.e., Zone III & IV.
- ✓ To compare the results of analysis on the basis of various parameters like base shear, displacement.

## IV. PROBLEM STATEMENT

The comparison of the seismic behavior for different length to width ratio for overhead water tank with constant depth and staging height is performed by considering the ratio of length and width as 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.5, 3.0 and 4.0. The depth of tank for all the ratios is kept as 3m and capacity of tank is considered as 1 lakh litres. Staging Height of staging for all the ratios is considered as 18m. All the models are analysed for zone III, zone IV and zone V using Staad.Pro v8i software. To study the seismic behavior of all the models the response parameters selected are lateral displacement and base shear.

Structural details of all the models are as follows:

Size of tank having L/B = 1.0 is 6.0m x 6.0m x 3.0m.

Size of tank having L/B = 1.2 is 5.5m x 6.6m x 3.0m.

Size of tank having L/B = 1.4 is 5.0m x 7.2m x 3.0m.

Size of tank having L/B = 1.6 is 4.75m x 7.6m x 3.0m.

Size of tank having L/B = 1.8 is 4.5m x 8.1m x 3.0m.

Size of tank having L/B = 2.0 is 4.25m x 8.5m x 3.0m.

Size of tank having L/B = 2.5 is 3.8m x 9.5m x 3.0m.

Size of tank having L/B = 3.0 is 3.5m x 10.5m x 3.0m.

Size of tank having L/B = 4.0 is 3.0m x 12.0m x 3.0m.

Thickness of wall is 300mm.

Size of columns is 500mm x 500mm.

Size of beams is 300mm x 500mm.

Grade of concrete is M-30.

Grade of steel is Fe-500.

## V. METHODOLOGY & MODELLING

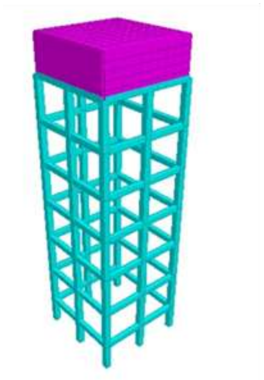

**Fig:1 Plan of water tank L/B 1.0**

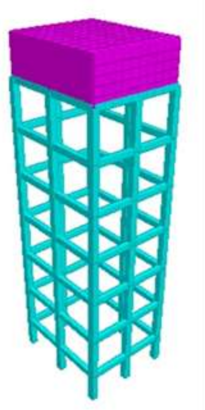

**Fig:2 Plan of water tank L/B 1.2**

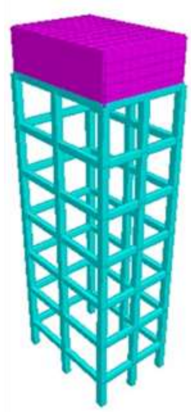

**Fig:3 Plan of water tank L/B 1.4**

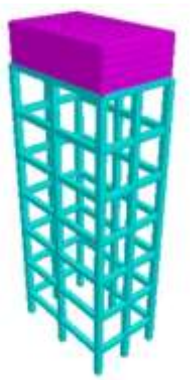

**Fig:4 Plan of water tank L/B 1.6**

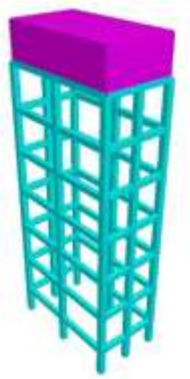

**Fig:5 Plan of water tank L/B 1.8**

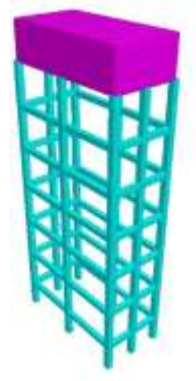

**Fig:6 Plan of water tank L/B 2.0**

**Fig:7 Plan of water tank L/B 2.5**

**Fig:8 Plan of water tank L/B 3.0**

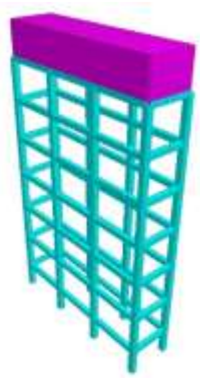

**Fig:9 Plan of water tank L/B 4.0**

## VI. RESULTS AND DISCUSSION

The performance of Overhead RCC water tanks is assessed for constant capacity and staging height varying length and width for earthquake zones IV & V. The results obtained from analysis are given in various tables and figures are as follows:

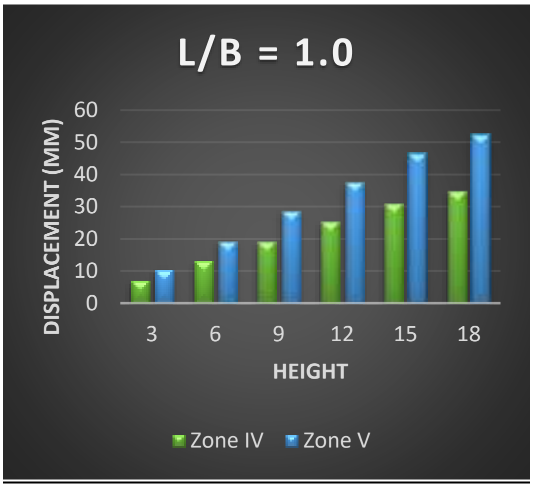


**Fig. 6.1 Displacements for L/B = 1.0**

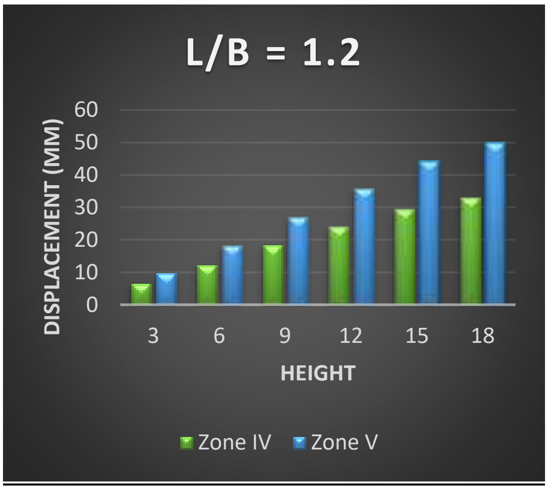


**Fig. 6.2 Displacements for L/B = 1.2**

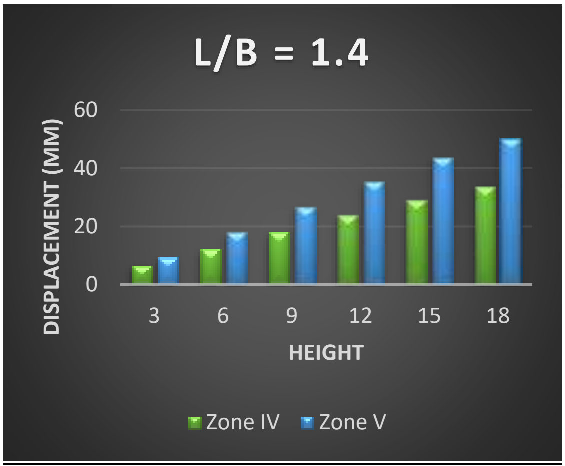


**Fig. 6.3 Displacements for L/B = 1.4**

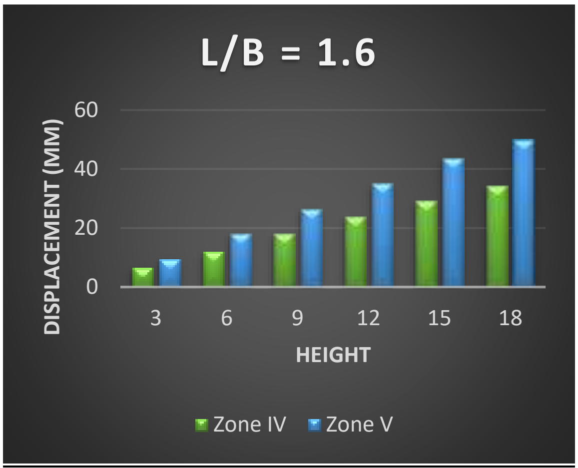


**Fig. 6.4 Displacements for L/B = 1.6**

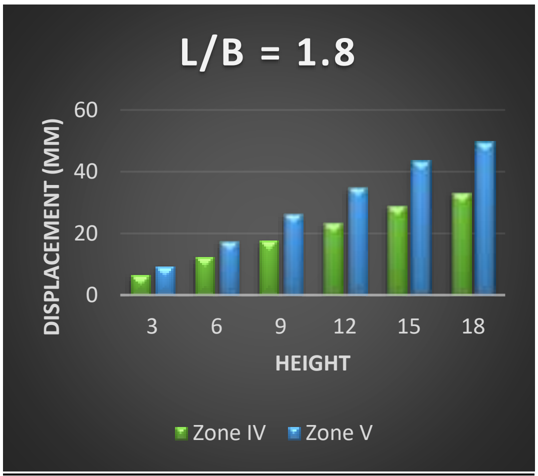


**Fig. 6.5 Displacements for L/B = 1.8**


**Fig. 6.6 Displacements for L/B = 2.0**

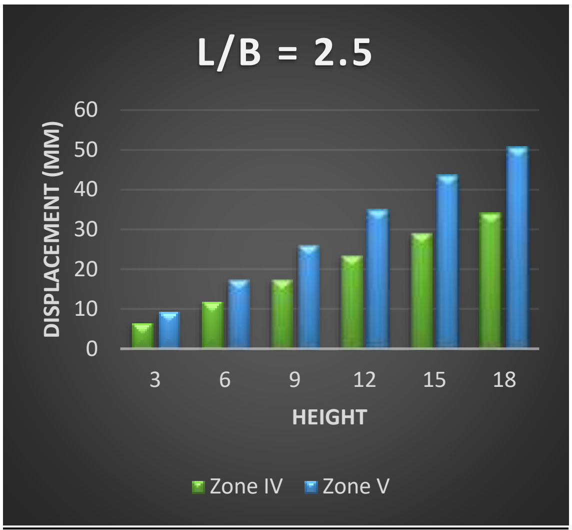


**Fig. 6.7 Displacements for L/B = 2.5**

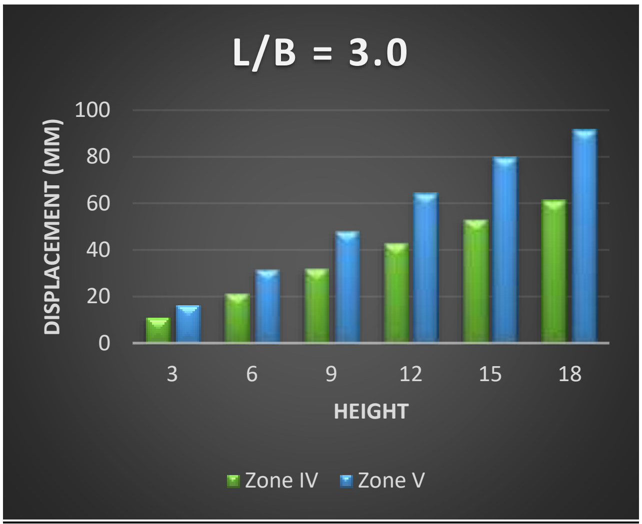


**Fig. 6.8 Displacements for L/B = 3.0**

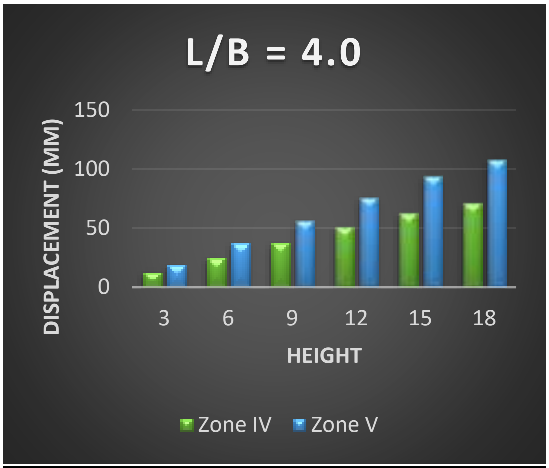


**Fig. 6.9 Displacements for L/B = 4.0**

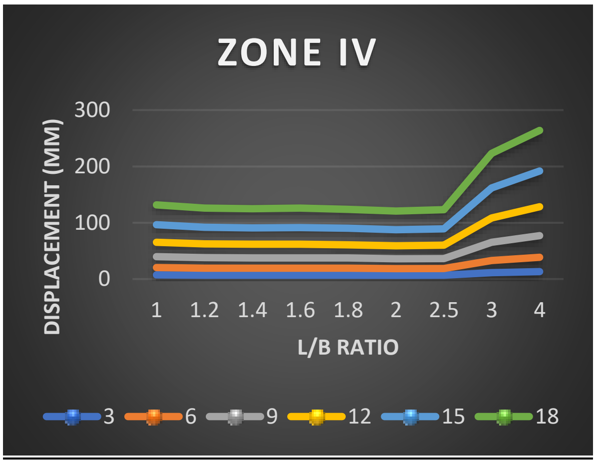


**Fig. 6.10 Displacements for Zone IV**

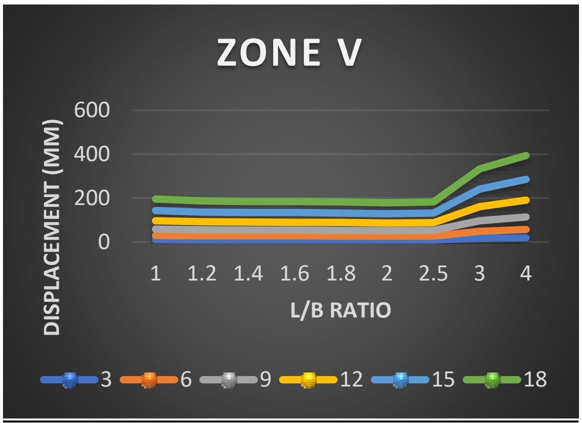


**Fig. 6.11 Displacements for Zone V**

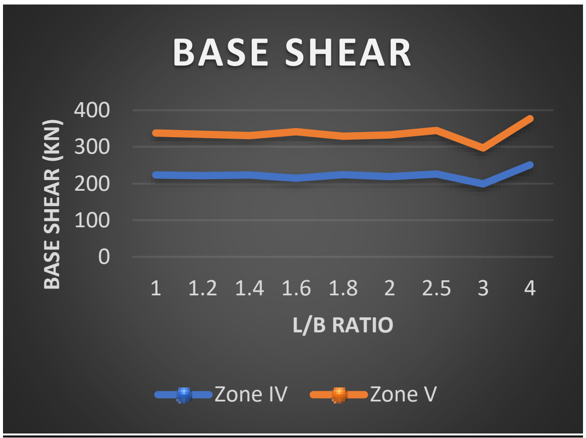


**Fig. 6.12 L/B Ratio Vs. Base Shear3**

## VII. CONCLUSION

Within the scope of present work, following conclusions are drawn form results:

Seismic effect on displacement:

The result shows the effect of earthquake zones on displacement by considering different length to width ratios for particular zone. From the results it is observed that by varying zone, the value of deflection successively increases from zone IV to zone V.

1. The displacement value increases for higher seismic zones at all height of stagings for all the L/B ratios from 1 to 4 due to increase in magnitude of the earthquake.

2. It is observed from the results that for all the L/B ratios from 1 to 4, the displacement values follow the same pattern, i.e., the value increases gradually along the staging height.

3. There is a sudden increase in displacement at all heights of stagings for the cases when L/B ratio of the tank is 3.0 and 4.0 in both the zones.

4. With increase in L/B ratio of tank from 1.0 to 2.5 the value of displacement slightly decreases but suddenly increases largely for ratio 3.0 and 4.0.

5. In zone IV, the value of displacement decreases from 35.04 mm to 33.1 mm in L/B ratio 1.0 to 2.0 and then slightly increases to 34.05 in L/B ratio 2.5. But suddenly increases to 61.32mm and 72.07 mm for L/B ratios 3.0 and 4.0 respectively at 18 m height of stagings.

6. In zone V, the similar pattern is observed as the value of displacement decreases from 52.48 mm to 49.84 mm in L/B ratio 1.0 to 2.0 and then slightly increases to 50.67 in L/B ratio 2.5. But suddenly increases to 91.59 mm and 108.50 mm for L/B ratios 3.0 and 4.0 respectively at 18 m height of stagings.

Seismic effect on base shear:

The result shows the effect of earthquake zones on base shear by considering different length to width ratios for particular zone. From the results it is observed that by varying zone, the value of base shear successively increases from zone IV to zone V.

1. It is observed here that in all the models the values of base shear are less for lower zones and it goes on increases for higher zones because the magnitude of intensity will be the more for higher zones.

2. For all the L/B ratios from 1.0 to 4.0, the base shear follows the zigzag pattern and possess the having maximum value at L/B ratio 4.0.

3. The tank with L/B ratio 3.0 experiences minimum base shear in both zones and maximum value in L/B ratio of 4.0.

4. In zone IV, the value of base shear varies unevenly from 223 KN to 226 KN from L/B ratio 1.0 to 2.5 then reaches the minimum value pf 199 KN in L/B ratio 3.0, and then peaks to 251 KN in L/B ratio 4.0.

5. In zone V, the value of base shear varies unevenly from 338 KN to 345 KN from L/B ratio 1.0 to 2.5 then reaches the minimum value pf 297 KN in L/B ratio 3.0, and then peaks to 377 KN in L/B ratio 4.0.

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