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Seismic Analysis of Rectangular Water Tank with Different Length by Width Ratio

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ABSTRACT:

The main objective of this research is to evaluate the seismic performance of elevated rectangular RCC water tanks having different L/B ratios with constant depth. In this research L/B width ratios considered are (1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.5, 3.0 and 4.0). The depth considered 2.5m used for all the ratios and capacity of tank is considered as 100000 litres. Height of staging for all the ratios is considered as 18m. The analysis of water tank for zone III, zone IV and zone V using Staad.Pro v8i software. In this research we have to calculate lateral displacement and base shear.

Keywords: Elevated Water tank, Base Shear, Displacement, Staad Pro

I. INTRODUCTION

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.

II. OBJECTIVE

The objectives of the present research works are to study the performance of elevated rectangular RCC water tanks under seismic forces. To compare the seismic behavior of elevated rectangular RCC water tanks having different length to width ratios with constant depth and height of staging. To compare the result parameters of different rectangular RCC water tanks having differentlength to width ratios with a constant depth and capacity.

III .PROBLEM FORMULATION

The object of the present work is to compare the seismic behavior of elevated rectangular RCC water tanks having different length to width ratios with constant depth and height of staging. For this purpose L/B ratios considered are 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 2.5m and capacity of tank is considered as 1 lakh litres. Height of staging for all the ratios is considered as 18m. All the models are analyzed 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 6.4m x 6.4m x 2.5m.
Size of tank having L/B = 1.2 is 5.8m x 7.0m x 2.5m.
Size of tank having L/B = 1.4 is 5.4m x 7.6m x 2.5m.
Size of tank having L/B = 1.6 is 5.1m x 8.2m x 2.5m.
Size of tank having L/B = 1.8 is 4.75m x 8.55m x 2.5m.
Size of tank having L/B = 2.0 is 4.5m x 9.0m x 2.5m.
Size of tank having L/B = 2.5 is 4.0m x 10.0m x 2.5m.
Size of tank having L/B = 3.0 is 3.7m x 11.1m x 2.5m.
Size of tank having L/B = 4.0 is 3.2m x 12.8m x 2.5m.
Thickness of wall is 200mm.
Size of columns is 400mm x 400mm.

Size of beams is 300mm x 400mm.
Grade of concrete is M-30.
Grade of steel is Fe-500.

IV. MODELLING APPROACH

Modeling Approach

The modeling approach includes types of cases considered for analysis of rectangular RCC water tank, the development, analysis of models and details of models. After then analysis has been carried out for Zone III, IV & V for rectangular RCC water tank.

Table 1 below shows the details of various building models (Model-1 to Model-9) for different L/B ratio (from 1.0 to 4.0)

Table 1: Details of various building models

Model	L/B Ratio
Model 1	1.0
Model 2	1.2
Model 3	1.4
Model 4	1.6
Model 5	1.8
Model 6	2.0
Model 7	2.5
Model 8	3.0
Model 9	4.0

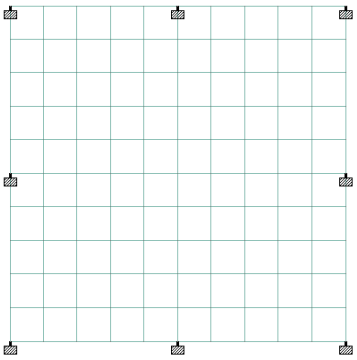

Figure:1 Plan of water tank L/B 1.0

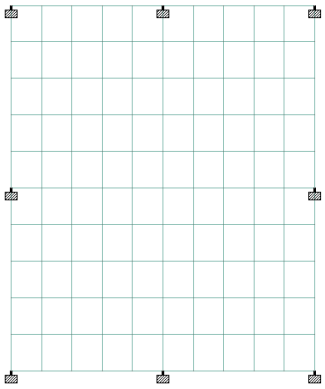

Figure:2 Plan of water tank L/B 1.2

Figure 1 shows the plan of rectangular RCC water tank when length/Breadth ratio 1.0. The ends of this rectangular RCC water tank are fixed base. In this figure size of tank is 6.4m x 6.4m x 2.5m.

Figure 2 shows the plan of rectangular RCC water tank when length/Breadth ratio 1.0. The ends of this rectangular RCC water tank are fixed base. In this figure size of tank is 5.8m x 7.0m x 2.5m.

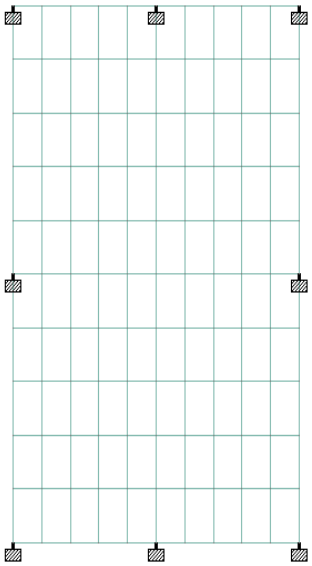

Figure:3 Plan of water tank L/B 1.4

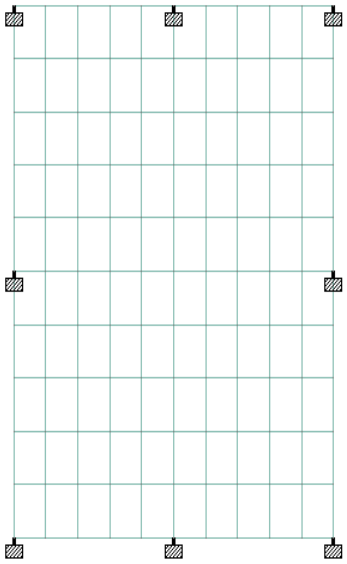

Figure:4 Plan of water tank L/B 1.6

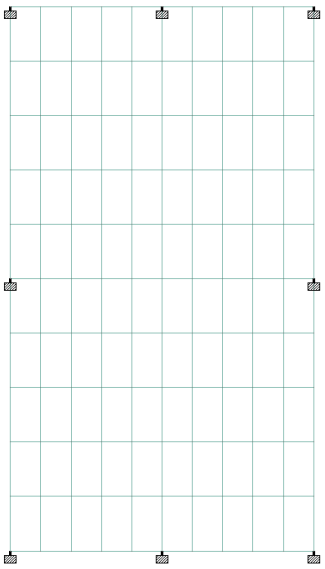

Figure:5 Plan of water tank L/B 1.8

Figure 3 shows the plan of rectangular RCC water tank when length/Breadth ratio 1.4. The ends of this rectangular RCC water tank are fixed base. In this figure size of tank is 5.4m x 7.6m x 2.5m.

Figure 4 shows the plan of rectangular RCC water tank when length/Breadth ratio 1.6. The ends of this rectangular RCC water tank are fixed base. In this figure size of tank is 5.1m x 8.2m x 2.5m.

Figure 5 shows the plan of rectangular RCC water tank when length/Breadth ratio 1.8. The ends of this rectangular RCC water tank are fixed base. In this figure size of tank is 4.75m x 8.55m x 2.5m.

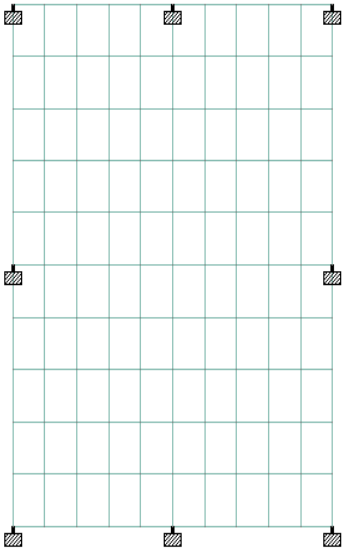

Figure:6 Plan of water tank L/B 2.0

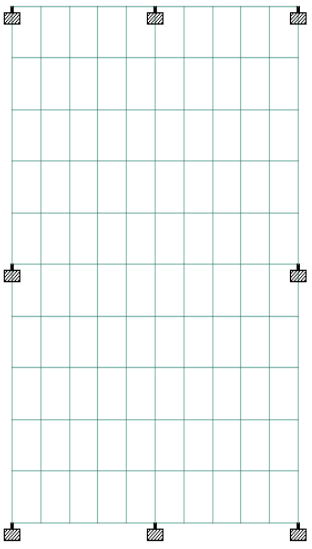

Figure:7 Plan of water tank L/B 2.5

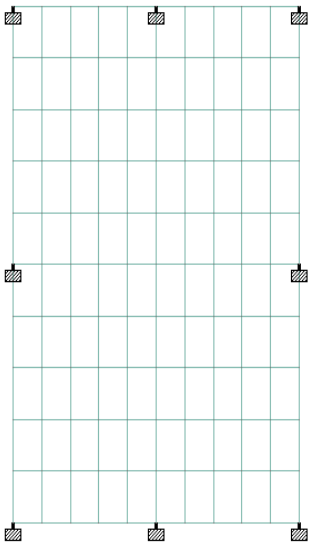

Figure:8 Plan of water tank L/B 3.0

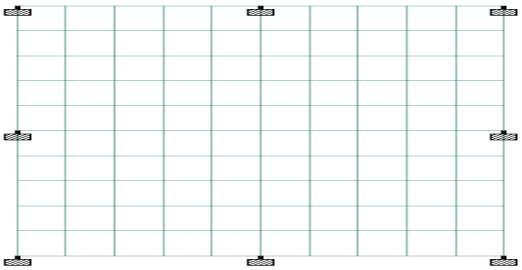

Figure: 9 Plan of water tank L/B 4.0

Figure 6 shows the plan of rectangular RCC water tank when length/Breadth ratio 1.4. The ends of this rectangular RCC water tank are fixed base. In this figure size of tank is 4.5m x 9.0m x 2.5m..

Figure 7 shows the plan of rectangular RCC water tank when length/Breadth ratio 1.6. The ends of this rectangular RCC water tank are fixed base. In this figure size of tank is 4.0m x 10.0m x 2.5m.

Figure 8 shows the plan of rectangular RCC water tank when length/Breadth ratio 1.8. The ends of this rectangular RCC water tank are fixed base. In this figure size of tank is 3.7m x 11.1m x 2.5m.

Figure 9 shows the plan of rectangular RCC water tank when length/Breadth ratio 1.8. The ends of this rectangular RCC water tank are fixed base. In this figure size of tank is 3.2m x 12.8m x 2.5m

IV. RESULTS AND DISCUSSION

The various results obtained from the analysis by software Staad pro are given in various tables and figures are as follows.Table 2 below shows the displacement in mm for Zone-III for different L/B (1.0 to 4.0) ratio for different heights (3m to18m)

Table 2 Displacements for Zone III

Displacement (mm), Zone III						
L/B ratio	Height (m)					
	3	6	9	12	15	18
1	4.39	8.39	12.52	16.59	20.38	23.09
1.2	4.18	7.97	11.89	15.79	19.44	22.14
1.4	4.12	7.85	11.73	15.59	19.25	22
1.6	4.1	7.81	11.68	15.55	19.22	22.04
1.8	4.01	7.65	11.46	15.28	18.94	21.8
2	3.89	7.42	11.14	14.89	18.54	21.88
2.5	3.96	7.59	11.44	15.36	19.16	22.28
3	7.19	14.03	21.24	28.43	35.16	40.47
4	8.44	16.55	25.19	33.81	41.84	47.72

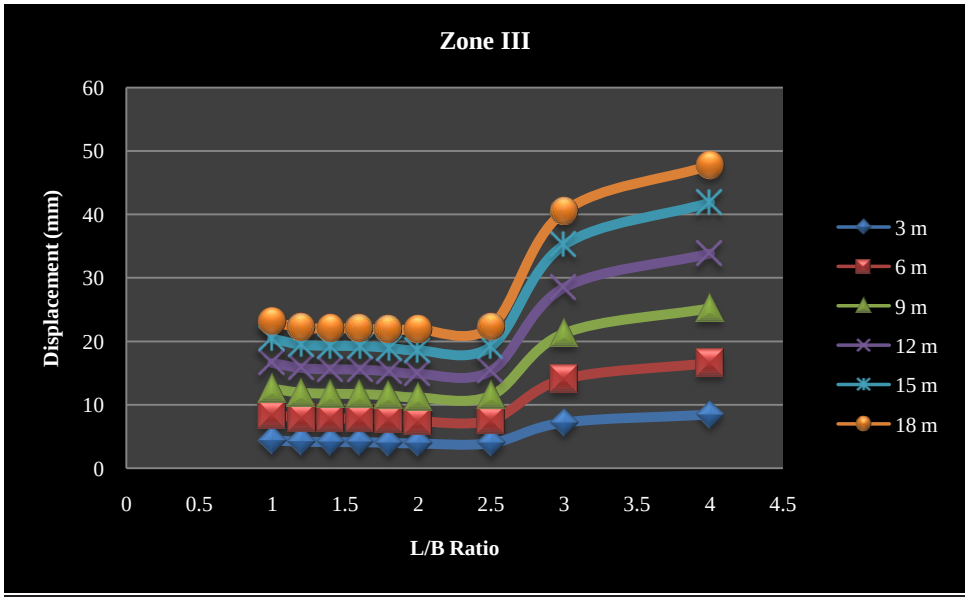

Figure. 10 Displacements for Zone III

Figure 10 shows the displacement of water tank having different L/B ratio for seismic zone-III. In this figure it is very clear that in zone III, the value of displacement decreases in L/B ratio 1.0 to 2.0 then in L/B ration 2.5 it slightly increases. But in L/B ratios 3.0 and 4.0 value of displacement suddenly increases

Table 3 below shows the displacement in mm for Zone-IV for different L/B (1.0 to 4.0) ratio for different heights (3m to18m)

Table 3 Displacements for Zone IV

Displacement (mm), Zone IV						
L/B ratio	Height (m)					
	3	6	9	12	15	18
1	6.59	12.59	18.78	24.89	30.58	34.63
1.2	6.27	11.95	17.84	23.68	29.16	33.21
1.4	6.18	11.78	17.6	23.39	28.87	33
1.6	6.15	11.72	17.52	23.32	28.83	33.05
1.8	6.01	11.48	17.19	22.92	28.4	32.69
2	5.83	11.13	16.71	22.34	27.81	32.82
2.5	5.94	11.38	17.16	23.03	28.74	33.43
3	10.78	21.05	31.87	42.64	52.73	60.71
4	12.66	24.83	37.78	50.72	62.76	71.58

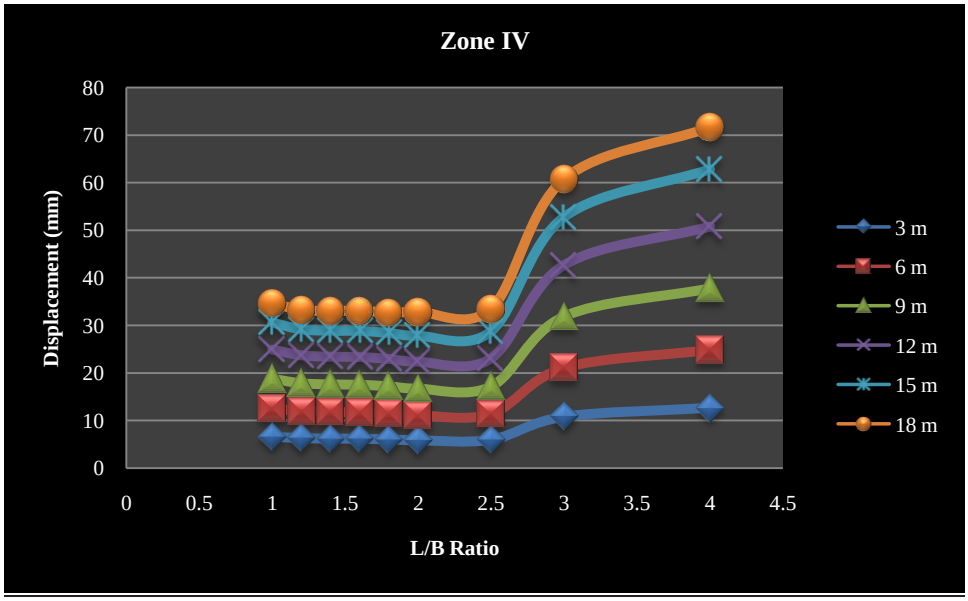

Figure. 11 Displacements for Zone IV

Figure 11 shows the displacement of water tank having different L/B ratio for seismic zone-IV. In this figure it is very clear that in zone IV, the value of displacement decreases in L/B ratio 1.0 to 2.0 then in L/B ration 2.5 it slightly increases. But in L/B ratios 3.0 and 4.0 value of displacement suddenly increases.

Table 4 below shows the displacement in mm for Zone-V for different L/B (1.0 to 4.0) ratio for different heights (3m to18m)

Table 4 Displacements for Zone V

Displacement (mm), Zone V						
L/B ratio	Height (m)					
	3	6	9	12	15	18
1	9.88	18.88	28.16	37.34	45.87	51.95
1.2	9.4	17.93	26.76	35.52	43.75	49.82
1.4	9.27	17.67	26.4	35.09	43.31	49.5
1.6	9.22	17.58	26.28	34.98	43.24	49.58

1.8	9.02	17.21	25.78	34.38	42.61	49.04
2	8.74	16.7	25.07	33.5	41.71	49.23
2.5	8.9	17.07	25.74	34.55	43.11	50.14
3	16.18	31.57	47.8	63.96	79.1	91.07
4	18.99	37.24	56.67	76.08	94.14	107.36

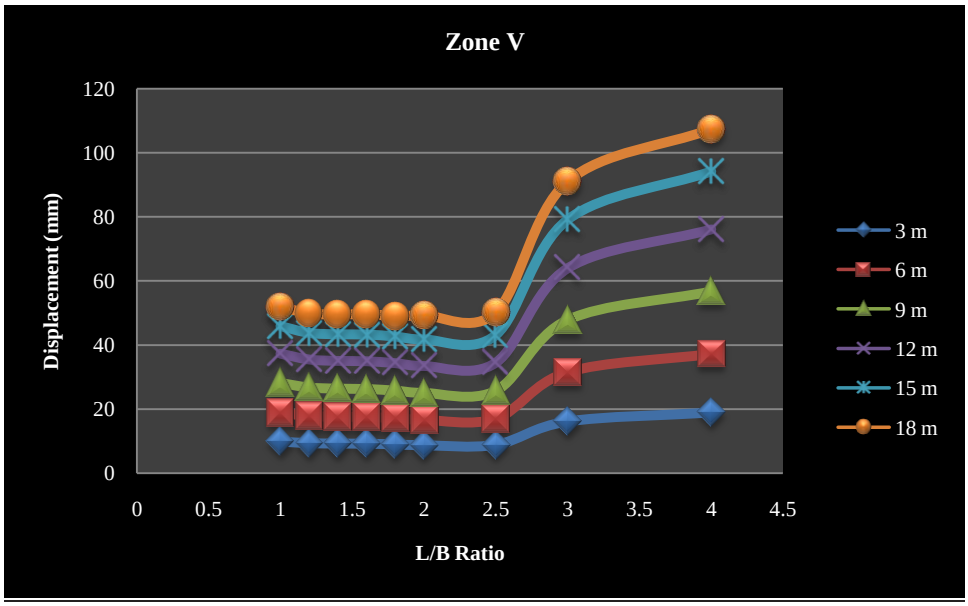

Figure. 12 Displacements for Zone V

From the above figure 12 it is very clear that in Zone V the value of displacement decreases in L/B ratio 1.0 to 2.0 then in L/B ration 2.5 it slightly increases. But in L/B ratios 3.0 and 4.0 value of displacement suddenly increases

(B) Results of Base Shear:

Table 5 below shows the base shear in KN for Zone-III, Zone-IV & Zone-V for different L/B (1.0 to 4.0) ratio for different heights (3m to18m)

Table 5 Base Shear

L/B Ratio	Base Shear (KN)		
	Zone III	Zone IV	Zone V
1	144	215	323
1.2	141	212	318
1.4	142	214	321
1.6	145	216	323
1.8	143	215	322
2	141	210	315
2.5	145	218	326
3	125	188	281
4	163	245	367

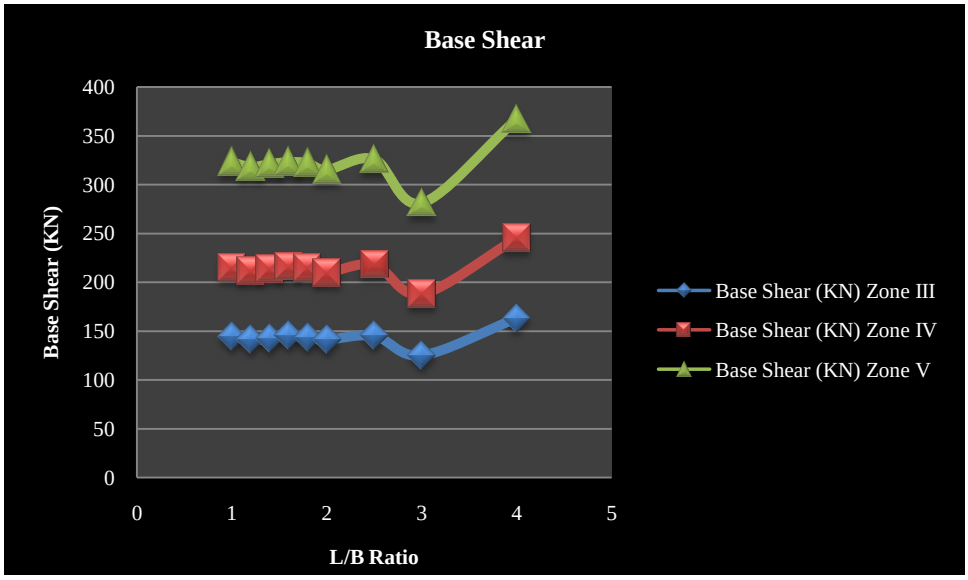

Figure. 13 L/B Ratio vs. Base Shear

From the figure 13 it is clear that in zone III, Zone IV & Zone V the value of base shear maximum in L/B ratio 1.0 to 2.5. When L/B ratio 3.0 the minimum value of base shear is achieved.

V. CONCLUSIONS

After analysis all the models of water tank the value of displacement & base shear decreases for lower seismic zone & increases for higher seismic zone. When length by width ration increases the value of displacement decreases up to length by width ratio is 2.5 in Zone II, Zone III & Zone IV. When Length by width ratio 3.0 and 4.0 for Zone II, Zone III, Zone IV water tanks the maximum value of displacement achieved. When Length by width ratio 3.0 the minimum base shear is value is achieved and for Length by width ratio 4.0 maximum value of base shear is achieved for Zone II, Zone III, Zone IV.

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