Seismic Analysis of RC Elevated Rectangular Water Tank Using STAAD Pro

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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 investigation different Length/width ratios considered are (1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.5, 3.0 and 4.0). The water tank is designed for 10000 liters capacity for 2.5m depth for all the L/B ratios. The height of RCC elevated water tank is 18 m. .Using Staad pro software the analysis of RCC water tank has been carried out for different seismic zone (Zone III, Zone IV & Zone V). Result parameters compare from this analysis are lateral displacement, base shear & Axial Force.*

***Keywords*: Axial Force, Base Shear, lateral displacement, Water Tank, Staad Pro**

I.INTRODUCTION

A large amount of water storage capacity is said to be an elevated water tank which is constructed for supply the water at definite height for the water distribution system. There are various types of storage of water such as underground, ground supported and overhead used broadly by municipalities and industries. So water tanks are mainly necessary requirement for public usefulness and for industrial structures.In various researches it is observed that earthquakes damaged some of the liquid storage container. Some unnecessarymeasures are caused such as lack of drinking water as well as utilizing water, uncontrolled fires and spillage of dangerous fluids which are due to damage or collapse of these structures.

II. OBJECTIVE

The objectives of the present research works are:

1. Evaluatedisplacement & base shear of seismic performance of elevated RCC water tanks having different L/Bratios.
2. To evaluate the outcomeparameter of different rectangular RCC water tanks having different L/B ratios with steady depth and capacity

MODELLING APPROACH

Modeling Approach

The analysis of rectangular water tank for different models & analysis has been carried out for different seismic zones.

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

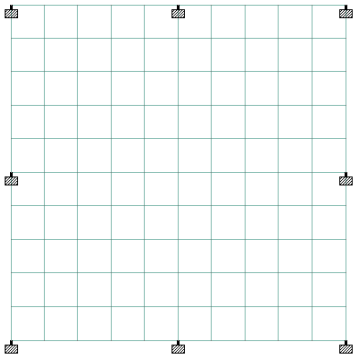

Fig:1Plan of water tank L/B 1.0

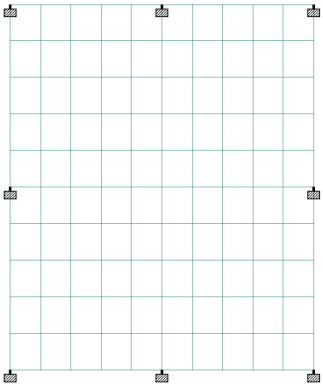

Fig:2Plan of water tank L/B 1.2

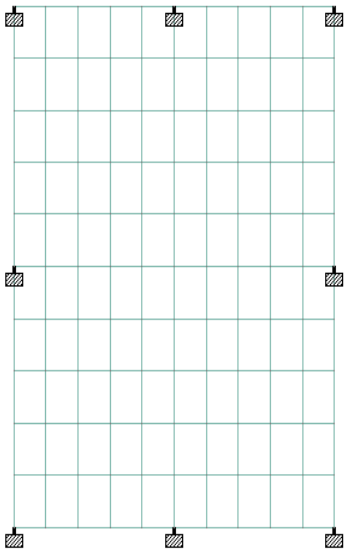

Fig:3Plan of water tank L/B 1.4

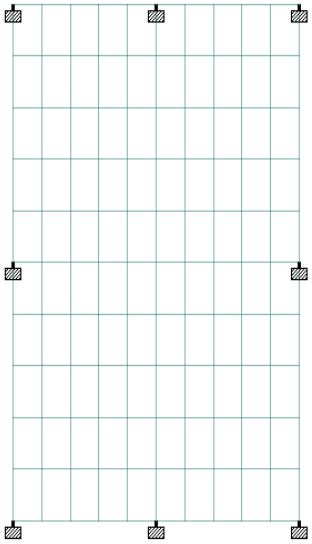

Fig:4Plan of water tank L/B 1.6

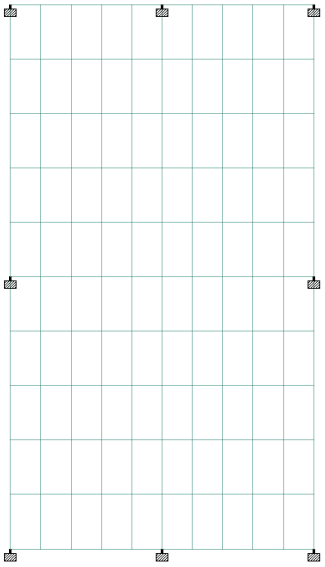

Fig:5Plan of water tank L/B 1.8

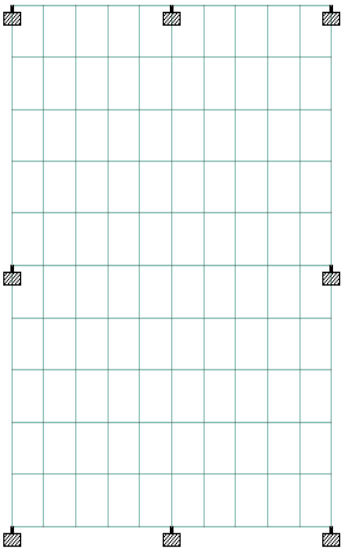

Fig:6 Plan of water tank L/B 2.0

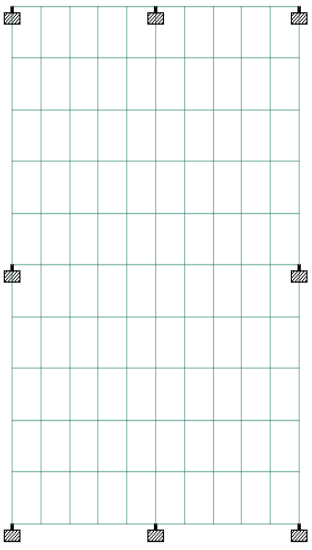

Fig:7Plan of water tank L/B 2.5

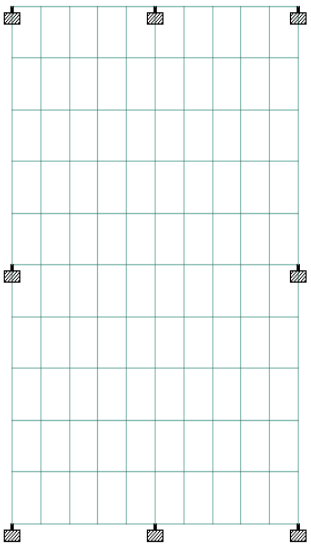

Fig:8Plan of water tank L/B 3.0

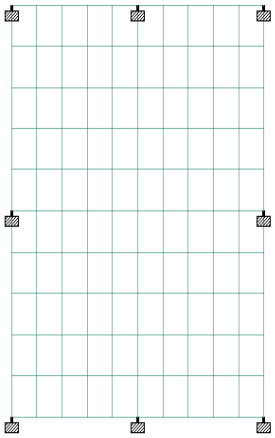

Fig:9 Plan of water tank L/B 4.0

IV. RESULTS AND DISCUSSION

The results obtained from analysis are given in various tables and figures are as follows

IV (A) **Results of Displacements:**

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

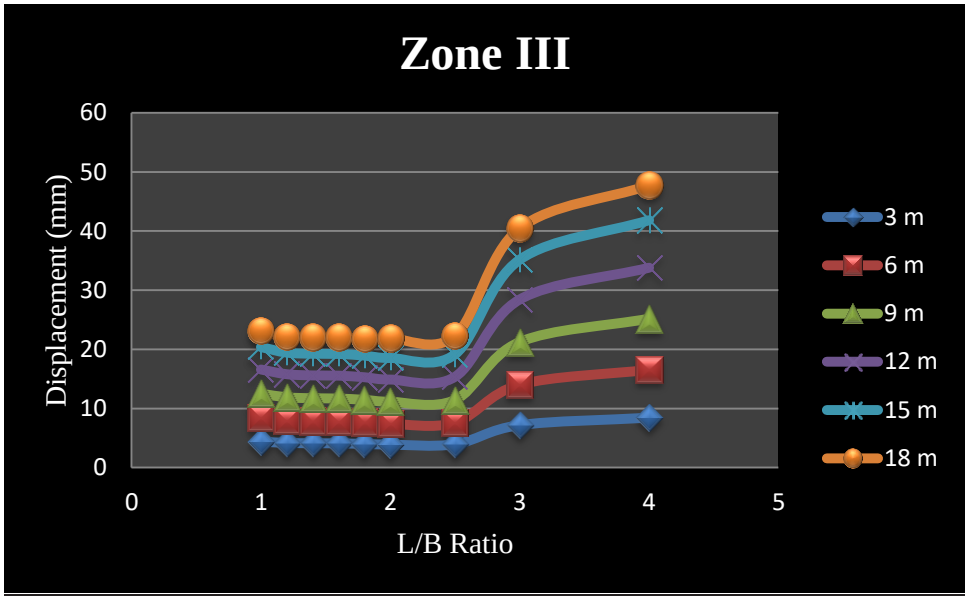

Fig. 10 Displacements for Zone III

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

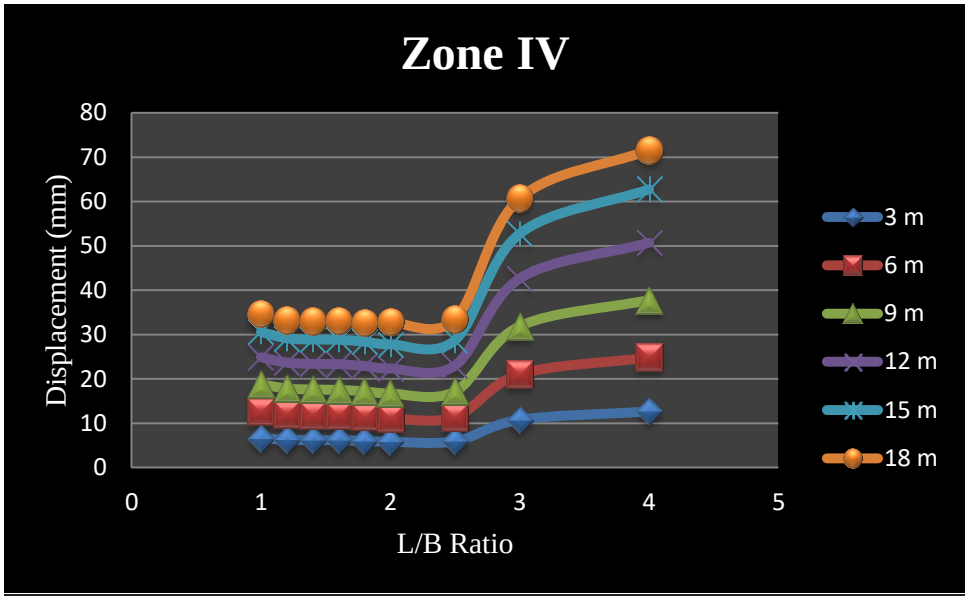

Fig. 11 Displacements for Zone IV

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

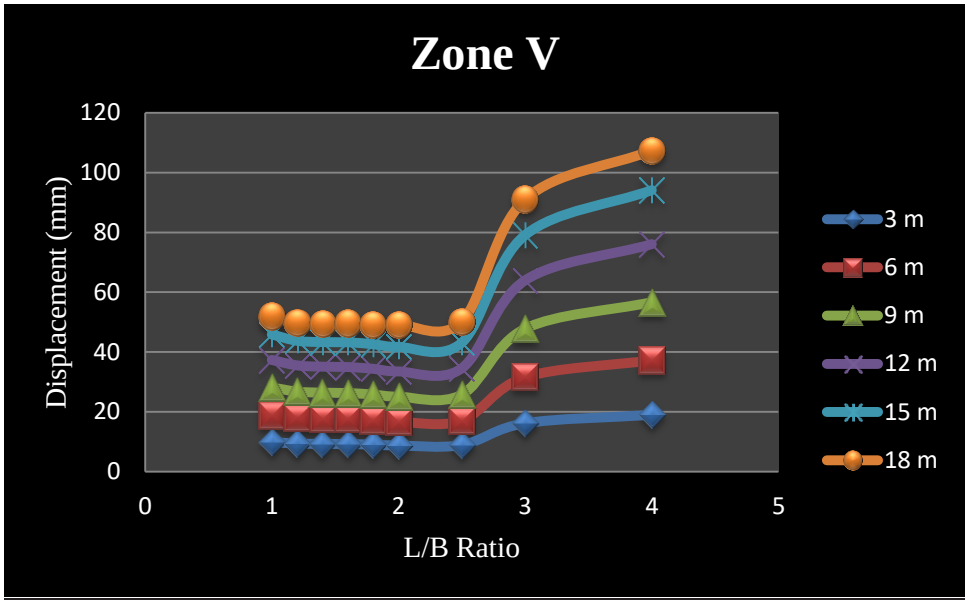

Fig. 12 Displacements for Zone V

Discussion: From the above graph it is very clear thatin zone III, Zone IV & 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 Length/width ratios 3.0 and 4.0 value of displacement rapidly increases

(B) Results of Base Shear:

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

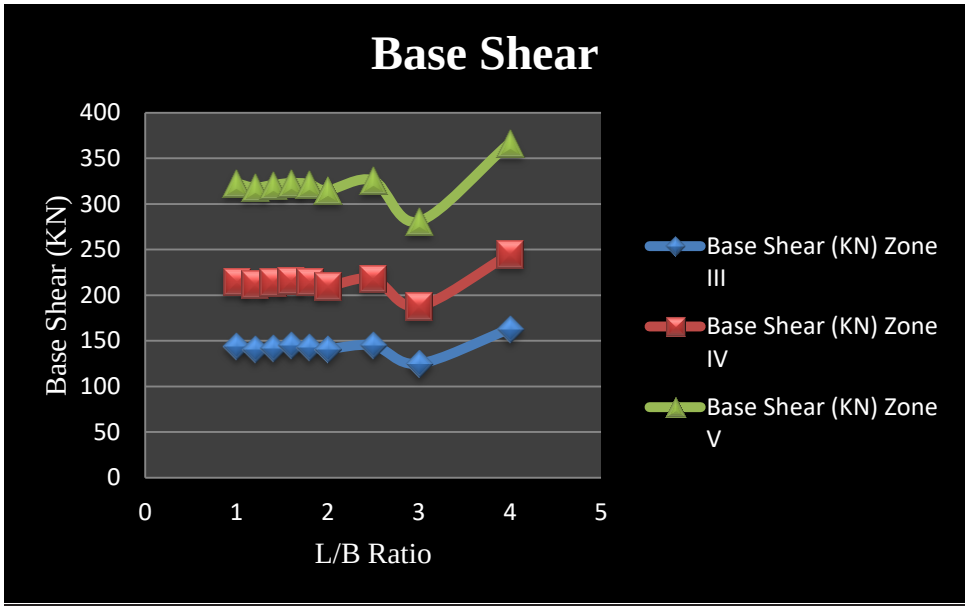

Fig. 13 L/B Ratio Vs. Base Shear

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

V. CONCLUSIONS

The conclusion of this research is as follows:

1. After analysis all the models of water tank the value of displacement & base shear decreases for lower seismic zone & increases for higher seismic zone.

2. 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.

3. When Length by width ratio 3.0 and 4.0 forZone II, Zone III, Zone IVwater tanks the maximum value of displacement achieved.

4. 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.

REFERENCES

[1] AmiyaRanjanPandit *, Kishore Chandra Biswal (2019): Seismic behavior of partially filled liquid tank with sloped walls Ocean Engineering PP:1-20

[2] M. Moslemi, A. Farzin, M.R. Kianoush(2019):Nonlinear sloshing response of liquid-filled rectangular concrete tanks under seismic excitation journal homepage: www.elsevier.com/locate/engstruct PP:564-577

[3] Mainak Ghosal1 (2019): Water Tank Analysis Using STAAD PRO International Transaction on Engineering & Science, Volume 1, Issue 2, January 2019 PP: 7-15

[4] M. Ravikanth1, V. Mallikharjuna Reddy2 ,S. Raja Ravindra Kumar3 ,Sk.Tabassum Afroze4 Ch.Rithvik5 ,G. Siva Sai6: Design And Analysis Of Hydraluic Water Tank By Using Staad Pro International Journal of Research in Advent Technology PP:436-440

[5] Joseph Asha1• Joseph Glory1 (2018) Dynamic Behaviour and Seismic Response of Ground Supported Cylindrical Water Tanks J. Inst. Eng. India Ser. A

[6] Abhyuday Titiksh1 (2018): Parametric study on cylindrical water tanks by varying their aspect Ratios Asian Journal of Civil Engineering https://doi.org/10.1007/s42107-018-0097-1 PP:1-10

[7] 2011, Konstantin Meskouris, Britta Holtschoppen, ChristophButenweg, Julia Rosin, **"Seismic Analysis of Liquid Storage Tanks".**

[8] 2012, Ayazhussain M. Jabar1, H. S. Patel, **"Seismic Behaviour of RC Elevated Water Tank Under Different Staging Pattern And Earthquake Characteristics".**

[9] 2013, L. KalaniSarokolayi, B. NavayiNeya, J. VaseghiAmiri and H. R. Tavakoli, **"Seismic Analysis of Elevated Water Storage Tanks Subjected to Six Correlated Ground Motion Components".**

[10] 2013, Syed SaifUddin, **"Seismic Analysis of Liquid Storage Tanks".**

[11] 2014, S. K. Jangave, Dr. P. B. Murnal, **"Structural Assessment of Circular Overhead Water Tank Based on Frame Staging Subjected to Seismic Loading".**

[12] 2015, Jay Lakhanakiya, Prof. Hemal J. Shah, **"A Parametric Study of an Intze Tank Supported On Different Stagings".**

[13] 2015, Pradnya V. Sambary, D.M. Joshi, **"Seismic Analysis of RC Elevated Water Tanks".**

[14] 2015, Rupachandra J. Aware, Dr. Vageesha S. Mathada, **"Seismic Analysis of Cylindrical Liquid Storage Tank".**

[15] 2016, Ankush N. Asati, Dr.MahendraS.Kadu, Dr. S. R. Asati,**"Seismic Analysis and Optimization of RC Elevated Water Tank Using Various Staging Patterns".**