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Seismic Evaluation of RC Elevated Rectangular Water Tank

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ABSTRACT:

To study the seismic behavior of all the models the response parameters selected are lateral displacement and base shear. Observation shows that with large increase in L/B ratio, displacement also increases largely. From the analysis, result parameters displacement and base shear of the water tanks increases from lower to higher zones because the magnitude of intensity will be more for higher zones. Present work provides good information on the result parameters displacement and base shear in the water tanks having different L/B ratios with constant depth, staging height and capacity.

Keywords**:** Water tank, seismic, displacement, base shear, length to width ratio.

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. Since, the elevated tanks are frequently used in seismic active regions also hence their seismic behavior has to be investigated in detail.

Types of Water Tank:

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

1. Tanks resting on ground
2. Underground tanks
3. Overhead tanks

The tanks resting on ground like clear water reservoirs, settling tanks etc. are supported on the ground directly. The walls of these tanks are subjected to pressure and the base is subjected to weight of water and pressure of soil. The tanks may be covered on top.

The examples of underground tanks are as septic tanks, purification tanks, Imhoff tanks, and gas holders. The walls of these tanks are subjected to water pressure from inside and the earth pressure from outside. The base is subjected to weight of water and soil pressure. At the top these tanks are covered.

Elevated or overhead water tanks are supported on staging which might consist of masonry walls, R.C.C. tower or R.C.C. columns braced together. The walls are subjected to water pressure. The base has to carry the load of water and tank load. The staging has to carry load of water and tank. The staging is also designed for wind forces.

II. METHODOLOGY

General Design Requirements:

Plain Concrete Structures:

Plain concrete member of reinforced concrete liquid retaining structure may be designed against structural failure by allowing tension in plain concrete as per the permissible limits for tension in bending. This will automatically take care of failure due to cracking. However, nominal reinforcement shall be provided, for plain concrete structural members.

Permissible Stresses in Concrete:

a. **For resistance to cracking:** For calculations relating to the resistance of members to cracking, the permissible stresses in tension (direct and due to bending) and shear shall confirm to the values specified in Table 3.1. The permissible tensile stresses due to bending apply to the face of the member in contact with the liquid. In members less than 225mm. thick and in contact with liquid on one side these permissible stresses in bending apply alsoto the face remote from the liquid.
b. **For strength calculations:** In strength calculations the permissible concrete stresses shall be in accordance with Table 3.1. Where the calculated shear stress in concrete alone exceeds thepermissible value, reinforcement acting in conjunction with diagonal compression in the concrete shall be provided to take the whole of the shear.

Table 3.1 Permissible concrete stresses

Grade ofconcrete	**Permissible stress Grade of concrete in KN/m^2 tension**		**shear**
	Direct	**Bending**	
M-15	**1.1**	**1.5**	**1.5**
M-20	**1.2**	**1.7**	**1.7**
M-25	**1.3**	**1.8**	**1.9**
M-30	**1.5**	**2.0**	**2.2**
M-35	**1.6**	**2.2**	**2.5**
M-40	**1.7**	**2.4**	**2.7**

Permissible Stresses in Steel:

a. **For resistance to cracking:** When steel and concrete are assumed to act together forchecking the tensile stress in concrete for avoidance of crack, the tensile stress in steel will belimited by the requirement that the permissible tensile stress in the concrete is not exceeded so the tensile stress in steel shall be equal to the product of modular ratio of steel and concrete, and the corresponding allowable tensile stress in concrete.
b. **For strength calculations:** In strength calculations the permissible stress shall be as follows:
   1. Tensile stress in member in direct tension 1000 kg/cm^2
   2. Tensile stress in member in bending on liquid retaining face of members or face away fromliquid for members less than 225mm thick 1000 kg/cm^2
   3. On face away from liquid for members 225mm or more in thickness 1250 kg/cm^2
   4. Tensile stress in shear reinforcement, For members less than 225mm thickness 1000 kg/cm^2 For members 225mm or more in thickness 1250 kg/cm^2
   5. Compressive stress in columns subjected to direct load 1250 kg/cm^2

III. RESULTS AND DISCUSSION

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

(A) Results of Displacements:

Table 3.1 Displacements for L/B = 1.0

Height (m)	Displacement (mm)		
	Zone III	Zone IV	Zone V
3	4.39	6.59	9.88
6	8.39	12.59	18.88
9	12.52	18.78	28.16
12	16.59	24.89	37.34
15	20.38	30.58	45.87
18	23.09	34.63	51.95

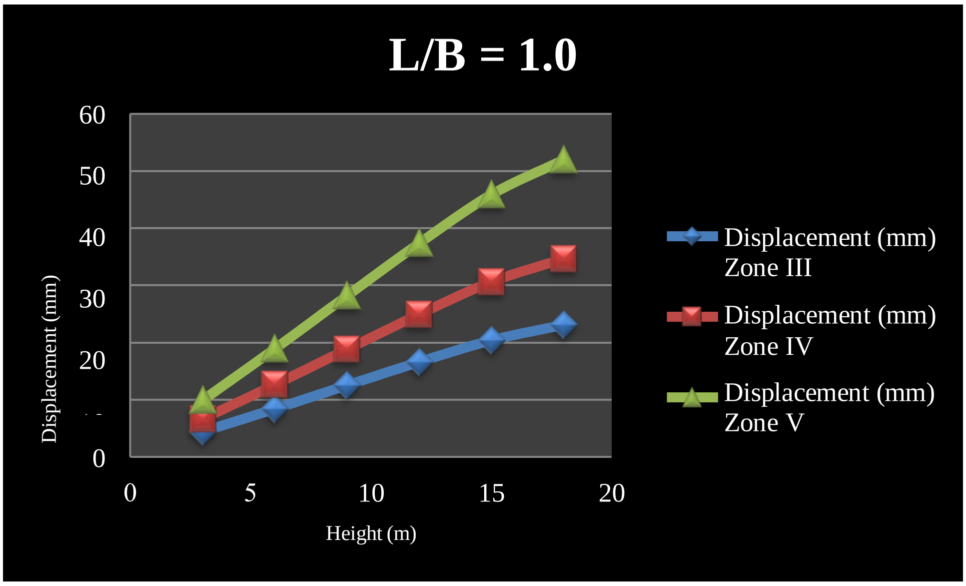

Fig. 1 Displacements for L/B = 1.0

Table 3.2 Displacements for L/B = 1.2

Height (m)	Displacement (mm)		
	Zone III	Zone IV	Zone V
3	4.18	6.27	9.4
6	7.97	11.95	17.93
9	11.89	17.84	26.76
12	15.79	23.68	35.52
15	19.44	29.16	43.75
18	22.14	33.21	49.82

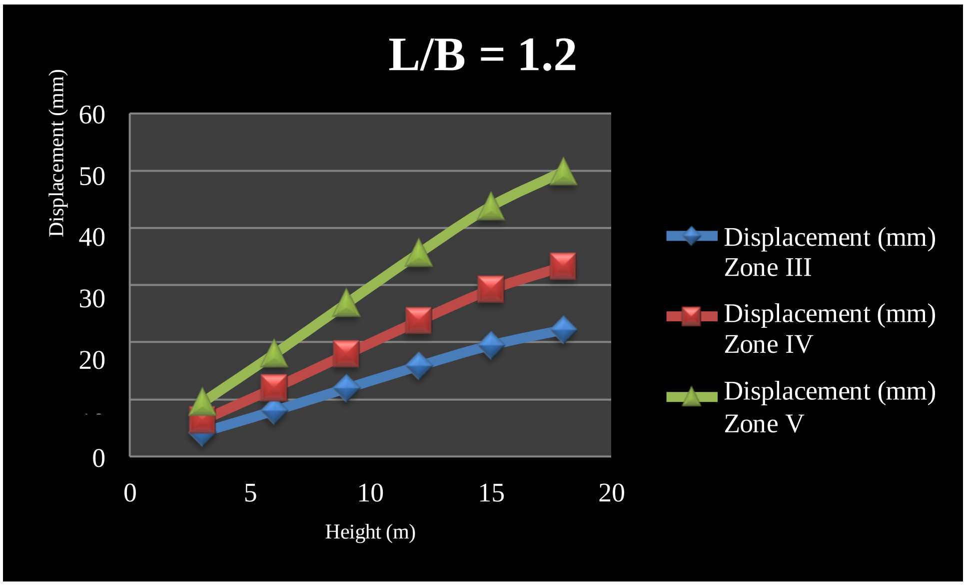

Table 3.3 Displacements for L/B = 1.4

Height (m)	**Displacement (mm)**		
	Zone III	**Zone IV**	**Zone V**
3	**4.12**	**6.18**	**9.27**
6	**7.85**	**11.78**	**17.67**
9	**11.73**	**17.6**	**26.4**
12	**15.59**	**23.39**	**35.09**
15	**19.25**	**28.87**	**43.31**
18	**22**	**33**	**49.5**

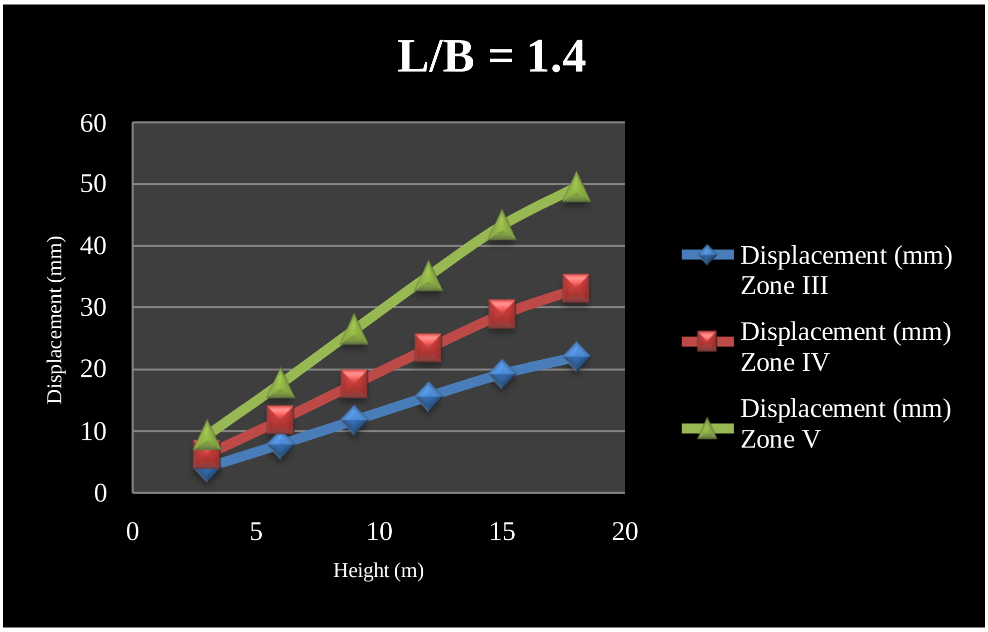

Fig. 3 Displacements for L/B = 1.4

Table 3.4 Displacements for L/B = 1.6

Height (m)	Displacement (mm)		
	Zone III	Zone IV	Zone V
3	4.1	6.15	9.22
6	7.81	11.72	17.58
9	11.68	17.52	26.28
12	15.55	23.32	34.98
15	19.22	28.83	43.24
18	22.04	33.05	49.58

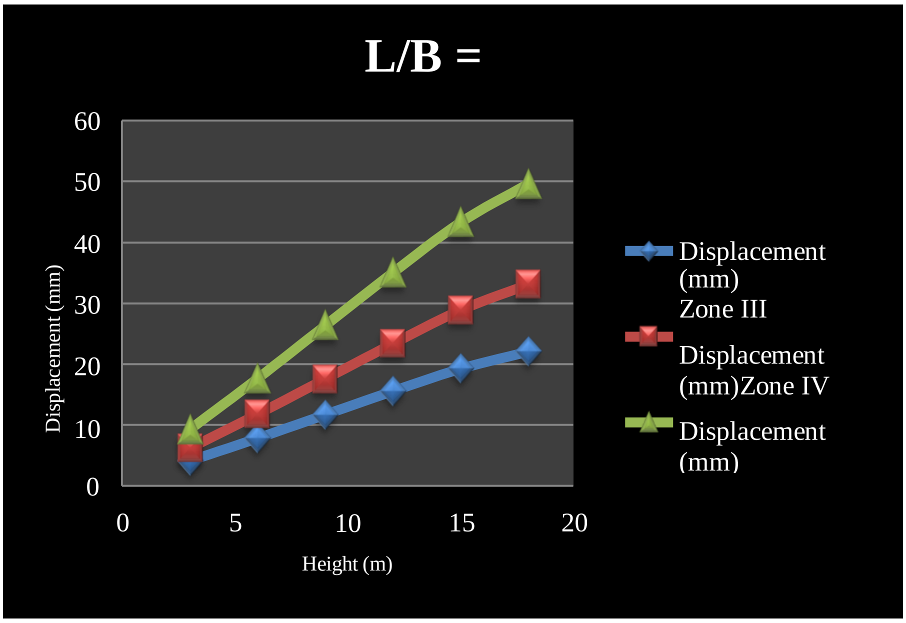

Fig. 4 Displacements for L/B = 1.6

Table 3.5 Displacements for L/B = 1.8

Height (m)	Displacement (mm)		
	Zone III	Zone IV	Zone V
3	4.01	6.01	9.02
6	7.65	11.48	17.21
9	11.46	17.19	25.78
12	15.28	22.92	34.38
15	18.94	28.4	42.61
18	21.8	32.69	49.04

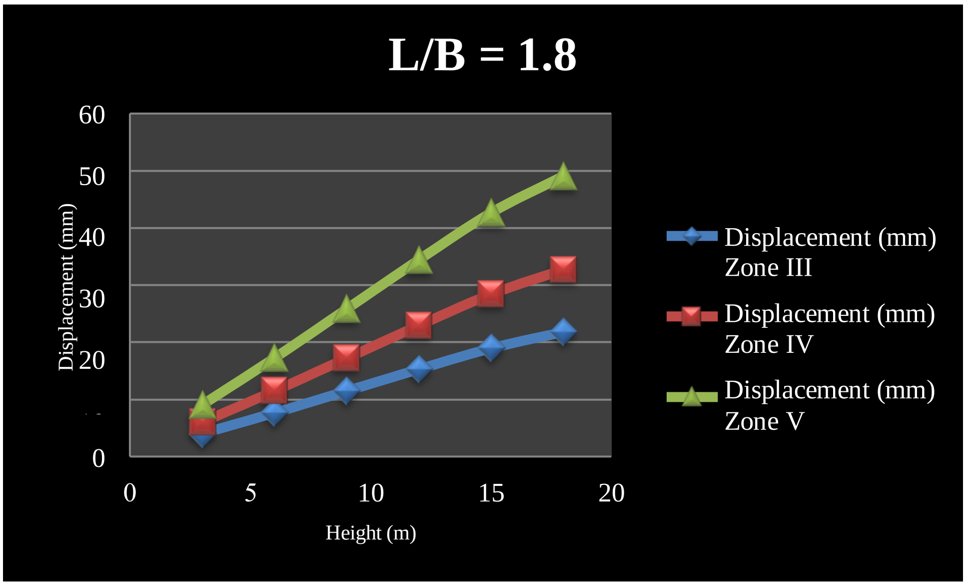

Fig. 5 Displacements for L/B = 1.8

Table 3.6 Displacements for L/B = 2.0

Height (m)	Displacement (mm)		
	Zone III	Zone IV	Zone V
3	3.89	5.83	8.74
6	7.42	11.13	16.7
9	11.14	16.71	25.07
12	14.89	22.34	33.5
15	18.54	27.81	41.71
18	21.88	32.82	49.23

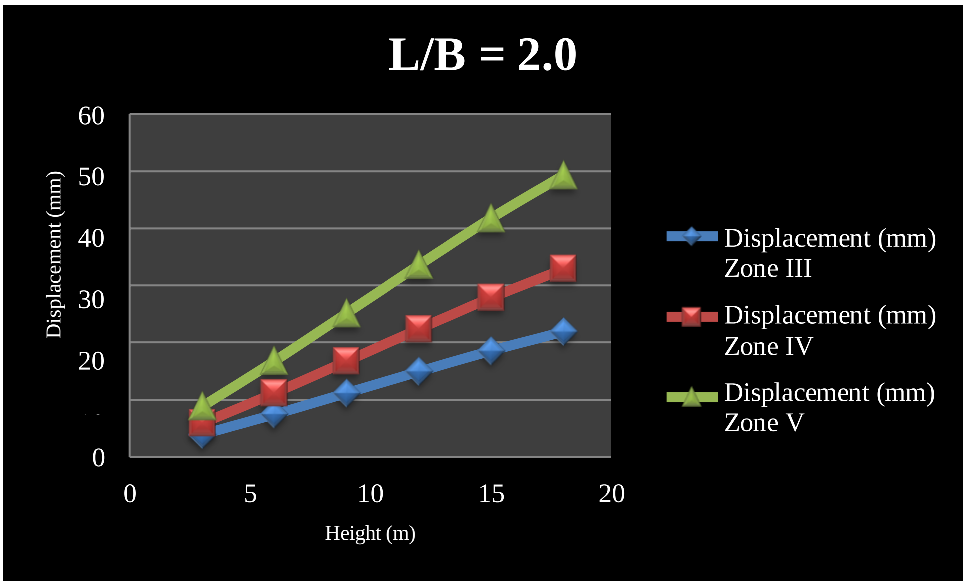

Fig. 6 Displacements for L/B = 2.0

Table 3.7 Displacements for L/B = 2.5

Height (m)	Displacement (mm)		
	Zone III	Zone IV	Zone V
3	3.96	5.94	8.9
6	7.59	11.38	17.07
9	11.44	17.16	25.74
12	15.36	23.03	34.55
15	19.16	28.74	43.11
18	22.28	33.43	50.14

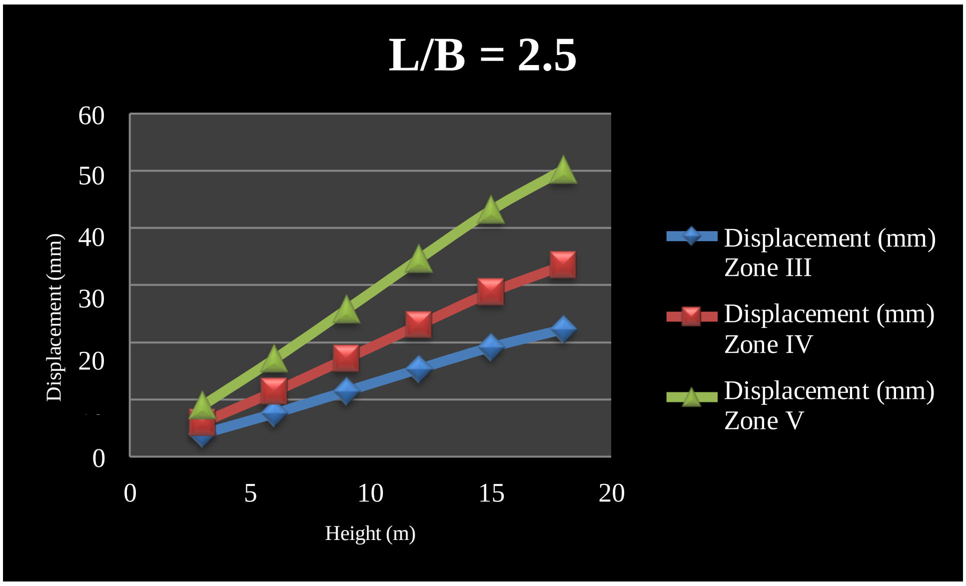

Fig. 7 Displacements for L/B = 2.5

Table 3.8 Displacements for L/B = 3.0

Height (m)	Displacement (mm)		
	Zone III	Zone IV	Zone V
3	7.19	10.78	16.18
6	14.03	21.05	31.57
9	21.24	31.87	47.8
12	28.43	42.64	63.96
15	35.16	52.73	79.1
18	40.47	60.71	91.07

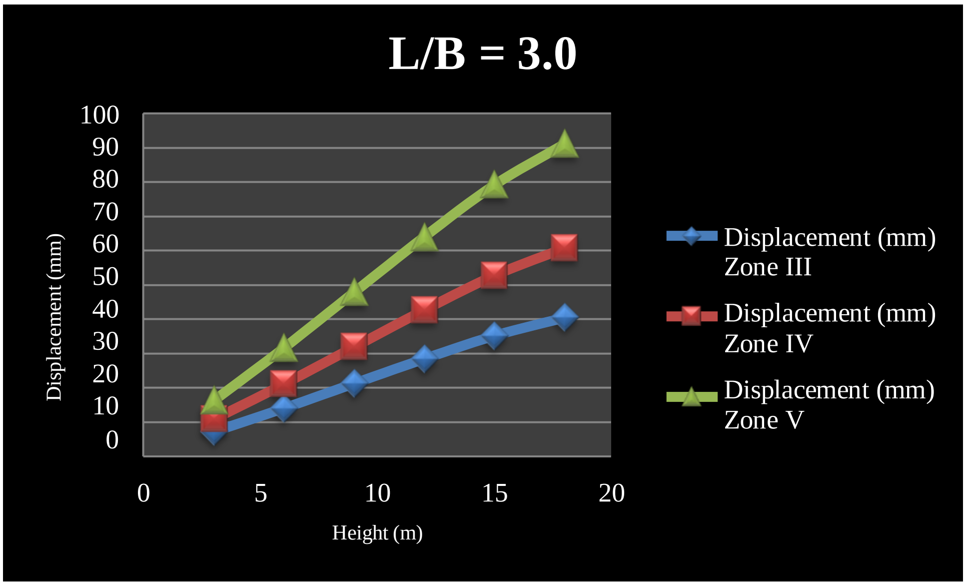

Fig. 8 Displacements for L/B = 3.0

Table 3.9 Displacements for L/B = 4.0

Height (m)	**Displacement (mm)**		
	Zone III	**Zone IV**	**Zone V**
3	**8.44**	**12.66**	**18.99**
6	**16.55**	**24.83**	**37.24**
9	**25.19**	**37.78**	**56.67**
12	**33.81**	**50.72**	**76.08**
15	**41.84**	**62.76**	**94.14**
18	**47.72**	**71.58**	**107.36**

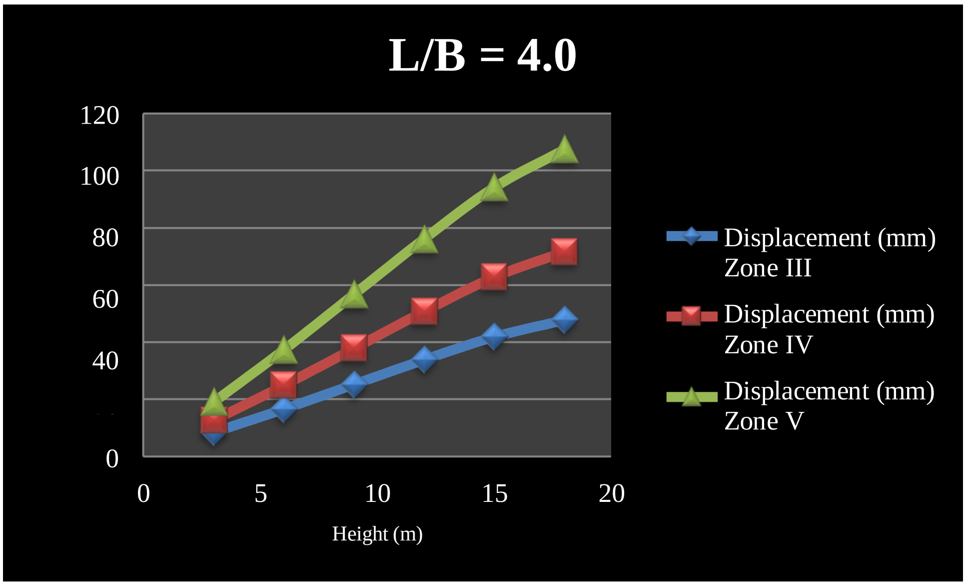

Fig. 9 Displacements for L/B = 4.0

V. CONCLUSIONS

Within the scope of present work following conclusions are drawn:

1. It is observed here that in all the models displacement values 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. From the results it is observed that the tank having L/B ratio 3.0 and 4.0 experiences maximum displacement values in all the zones.

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