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Comparative Seismic Analysis of Ground Supported Circular Water Tank Using Codal Provision

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ABSTRACT

The seismic analysis of ground supported circular water tank resting on soft soil, medium soil and hard soil consisting of mass tank wall, mass of water and mass of base slab is carried out. "In this paper a parametric study on spring mass model, time period in impulsive and convective mode, base shear, bending moment, overturning moment, pressure due to vertical excitation, maximum hydrodynamic pressure due to impulsive and convective mass of water is considered. The seismic analysis of ground supported circular water tank performed using IS 1893 part 2: 2014 and IS 1893 part 1: 2016."

Keywords: Ground Rested Tank, Spring Mass Modal, D/H Ratio, Base Shear, Bending Moment, Overturning Moment, Hydrodynamic Pressure.

I. INTRODUCTION

Water is the primary source of living for the human being. It is necessary to deal with the storage as properly as possible. Many new ideas and innovation are being made for the storage of water and other liquid material in different forms and fashions. There are many different ways for the storage of liquid such as underground, ground supported, elevated etc. As the population is increasing and due to the big society water requirements have increase to a larger level. Thus to compete the demand with supply, large storage tanks are required for storage of water and other liquids.

The seismic performance of the circular and rectangular reservoir is matter of special importance. Without a water supply, uncontrolled fires occurring as a result of major earthquake may cause more damage than the earthquake itself. If the out brake of the disease that follows the earthquake is to be avoided, then it is essential that the safe supply of water is available. There are many recorded failures of circular tank under seismic effects.

Liquid storage tank are used for storage of different types of materials such as water, oil, nitrogen, high pressure gas and petroleum. Damaged tanks containing petroleum or other hazardous chemicals could cause irreparable environmental pollution. Sloshing frequency of liquid in tank, hydrodynamic pressure on wall and proper analysis of fluid-structure interaction under seismic excitation is required for evaluating the performance of storage tanks.

II. METHODS AND DATA PROBLEM

Two mass modal for tank was proposed by housner (1963) which is more appropriate and is being commonly used in most of the international codes including IS 1893 (part 2). The pressure generated within the fluid due to the dynamic motion of the tank can be separated into impulsive and convective parts. When a tank containing liquid with a free surface is subjected to horizontal earthquake ground motion, tank wall and liquid are subjected to horizontal acceleration. The liquid in the lower region of tank undergoes sloshing motion. This mass is termed as convective liquid mass and it exerts convective hydrodynamic pressure on wall and base. Thus, total liquid mass gets divided into two parts- impulsive mass and convective mass. In spring mass modal of tank-liquid system, these two liquid masses are to be suitably represented. Figure 1 represents the spring mass modal and description of hydrodynamic pressure distribution on tank wall.

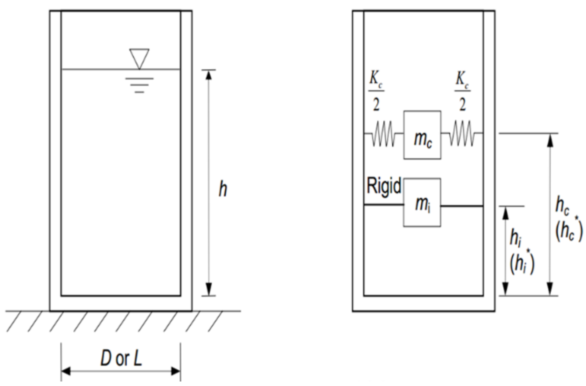

Fig. 1 spring mass modal

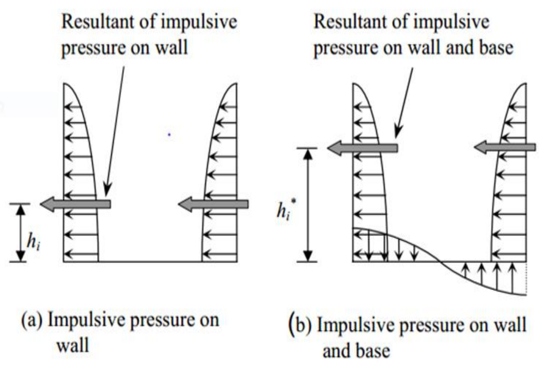

Fig. 2 impulsive and convective hydrodynamic pressure

Problem data

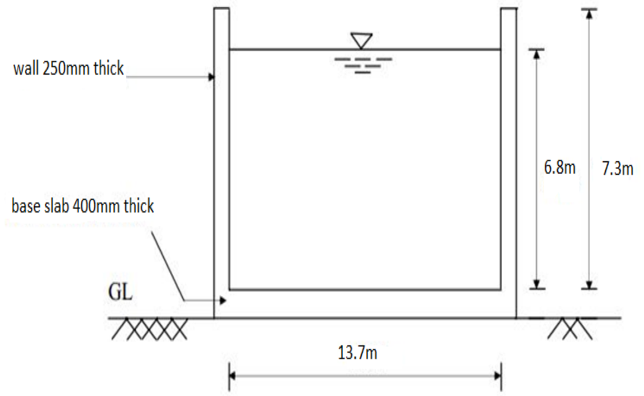

Fig. 3problem data of circular water tank

Table 1 problem description

Free board	0.5 m
Wall thickness	250 mm
Thickness of base slab	400 mm
Grade of concrete	M 30
Soil type	Hard soil, medium soil, Soft soil
Zone	IV

Table 2 dimension of circular water tank

dimension	D/h				
	2	2.5	3	3.5	4
Diameter (m)	13.7	14.7	15.6	16.5	17.2
height of water (m)	6.8	5.9	5.2	4.7	4.3
height of wall (m)	7.3	6.4	5.7	5.2	4.8

III. RESULTS AND DISCUSSION

A. Impulsive time period

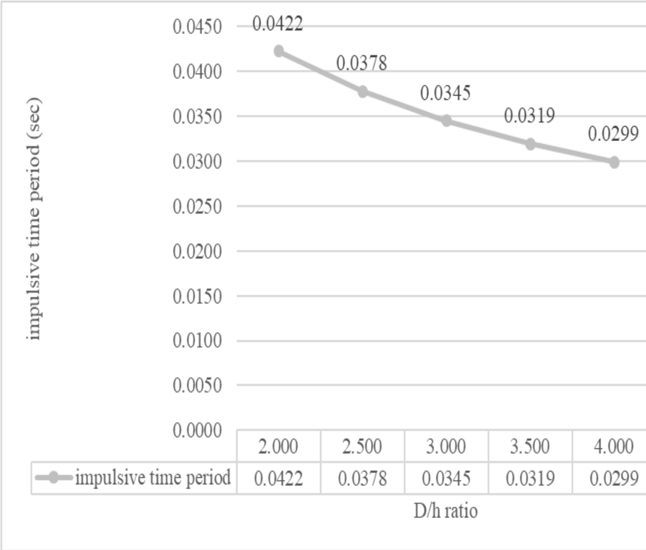

Fig.4 impulsive time period vs D/h ratio

B. Convective time period

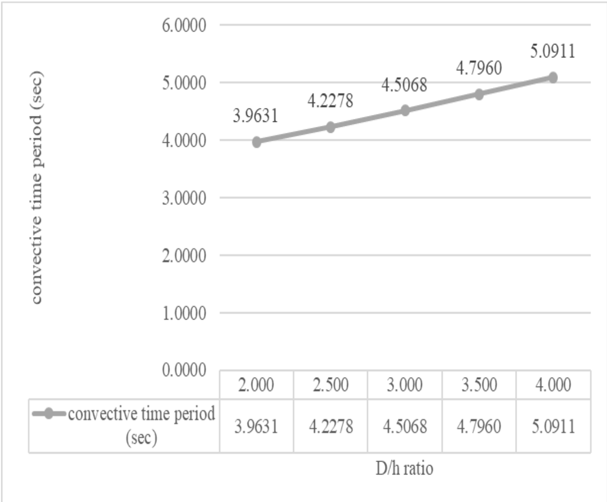

Fig. 2 convective time period vs D/h ratio

C. Total base shear

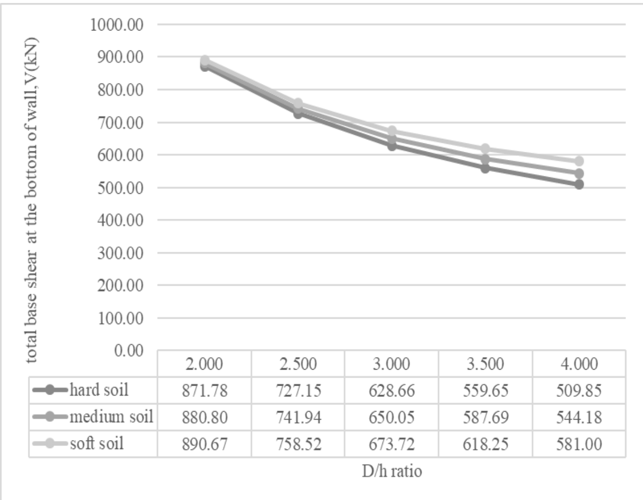

Fig. 3 total base shear vs D/h ratio

D. Total moment at bottom of wall

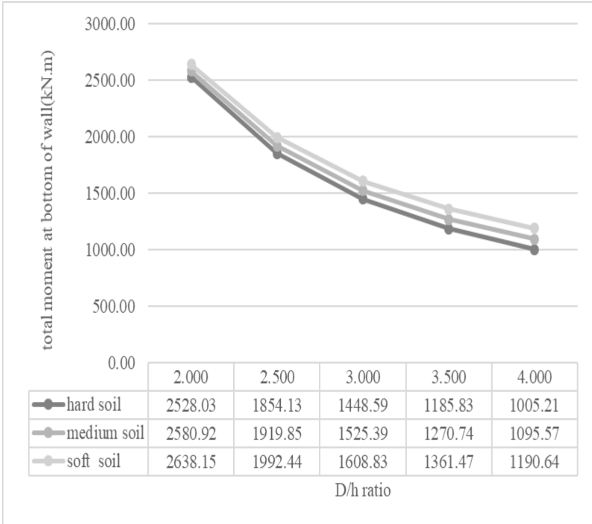

Fig. 4 total moment at bottom of wall vs D/h ratio

E. Overturning moment

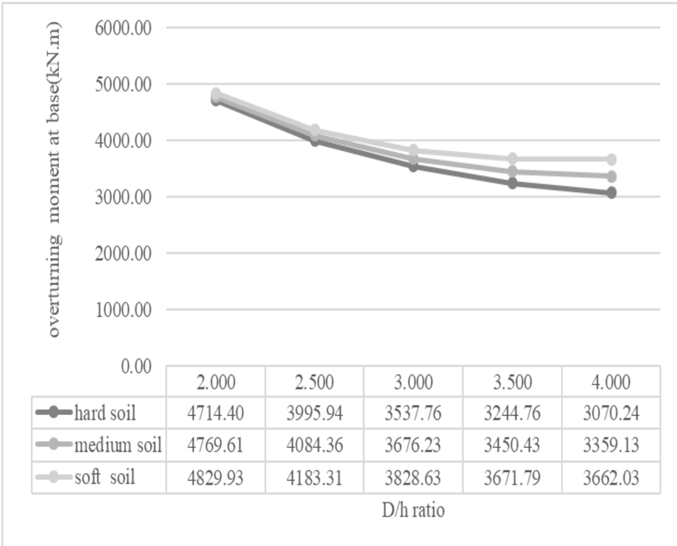

Fig. 5 overturning moment vs D/h ratio

F. Pressure due to vertical excitation

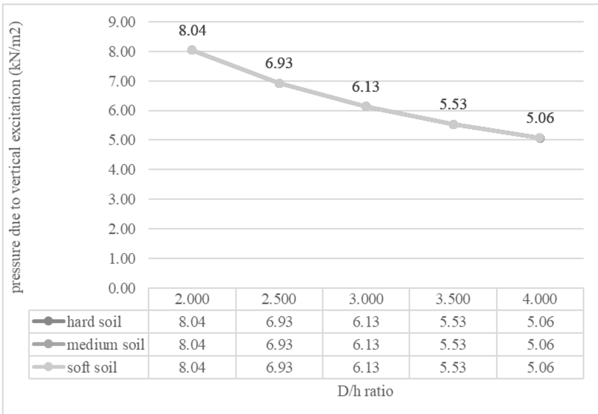

Fig. 6 pressure due to vertical excitation vs D/h ratio

G. Maximum hydrodynamic pressure

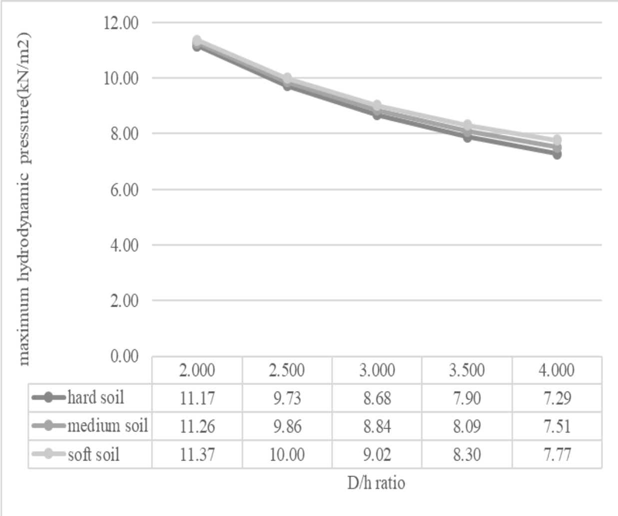

Fig. 7 maximum hydrodynamic pressure vs D/h ratio

IV. CONCLUSION

The observation made from the comparative analysis of various circular tanks with different geometrical properties while evaluating their seismic responses are summarized as follows:

The D/h ratio increases, the decrement in impulsive time period T_i is less and convective time period T_c increases considerably.

Total base shear decreases with increment in d/h ratio. The value of D/h = 2, now for total base shear is quite similar for soft soil, medium soil and hard soil but as D/h ratio increases, then the value of total base shear seems very much varying for soft soil, medium soil and hard soil.

Total base moment decreasing while increasing the d/h. comparatively, the value of total moment at bottom of wall for soft soil is greater than medium soil and hard soil. Similarly, the value of medium soil is greater than hard soil and less than soft soil. At last, the value of hard soil is less than soft soil and medium soil.

Total overturning moment at base decreases with increases d/h ratio. For D/h = 2, all the calculated values for soft soil, medium soil and hard soil is nearly same, but as the D/h ratio increases we can find considerable change in the calculated values.

Pressure due to vertical excitation and maximum hydrodynamic pressure decreases while increasing d/h. The value of maximum hydrodynamic pressure for soft soil, medium soil and hard soil are quite nearly.

Sloshing wave height increases with increase in D/h ratio. Taking D/h = 2 to 4, sloshing wave height of soft soil is greater than medium soil and hard soil. Whereas the same sloshing wave height for medium soil is greater than hard soil and its less than soft soil. Sloshing wave height for hard soil is less than soft soil and medium soil.

V. REFERENCES

[1] Dr. Suchita Hirde, Ms. Asmita Bajare, Dr. Manoj Hedaoo, "Seismic performance of elevated water tank" International Journal of Advanced Engineering Research and Studies Vol.1 issue 1 October. - December. 2011/78- 87.

[2] P. Deepak Kumara, Aishwarya Aloka, P. R. Maitib. "Comparative Study of Dynamic Analysis of Rectangular Liquid Filled Containers Using Codal Provisions." ELSEVIER,12th International Conference on Vibration Problems, ICOVP 2015.

[3] O.R. Jaiswal, D.C. Rai, S.K. Jain, Review of code provisions on seismic analysis of liquid storage tanks: a review, Report No. IITKGSDMAEQ-04-V1.0, Indian Institute of Technology, Kanpur (2004).

[4] P.K. Malhotra, T. Wenk, M. Wieland, "Simple procedure for seismic analysis of liquid storage tanks", Structural Engineering, IABSE, 2000, Vol. 10, No. 3, pp. 197-201.

[5] IITK-GSDMA: Guidelines for seismic design of liquid storage tank, Provisions with commentary on the Indian seismic code, Indian standard

[6] M. Moslemi, M.R. Kianoush. "Parametric study on dynamic behavior of cylindrical ground supported water tanks." ELSEVIER, Engineering Structures.

[7] J.Z. Chen, M.R. Kianoush. “Generalized SDOF system for seismic analysis of concrete rectangular liquid storage tanks.", ELSEVIER, Engineering Structures.

[8] C. Chougule, P. A. Chougule, S. A. Patil. “Study of Seismic Analysis of Water Tank at Ground Level” International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056 ,2017.

[9] IS:3370(Part IV)-1967. “Code of practice for concrete structures for the storage of liquids”. Bureau of Indian Standard, New Delhi.

[10] IS: 1893(Part-I)-2016 “Criteria for Earthquake Resistant Design of Structures”. Bureau of Indian Standard, New Delhi.

[11] IS 1893(Part II):2014. “Criteria for earthquake resistant design of structures” Bureau of Indian Standard, New Delhi.

[12] R.o.ruize & et al. (2015) . “An efficient computational procedure for the dynamic analysis of liquid storage tanks” ELSEVIER, Engineering structure 85 (2015) 206-218