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An Analytical study of overhead water tank subjected to seismic load

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Abstract:-

In this research paper, the effect of seismic load for overhead water tank, the water is the most essential element to a life on the earth. There is two different types of tank, of same capacity but having different height and different diameter of the overhead water tank in seismic zone (zone IV and V), this study on displacement of tank, time period, base shear and base moment cofficient of different height and diameter of overhead water tank, seismic plays an important in design of tank structure because of dynamic nature. Effect of seismic is predominant on tank structure, height of the struture in this paper the compression of the tank their height and its different diameter on tank for analysis of seismic loads on tanks

Keyword:- Seismic analysis, seismic zone iv and v, water tank, stagging, water tank seismic code IS 1893 Part II

1.0 INTRODUCTION:-

There are a large number of storage tanks around the world, most of which are used as storage of water and oil facilities, There are several different ways of storing water such as underground, on ground and above ground tank An elevated water tanks consists of a container at the top supported on a staging to transfer the load of container to the foundation .These tank are particularly at risk of damage due to vibrations caused by earthquake because the tanks consist of a huge mass of water acting in the top of the staging, A large number of elevated water tanks damaged during the past earthquake histories, majority of them were shaft type while some were in the frame type stagin Water tank are used for agriculture , firefighting, drinking. Failure of water tank has a negative impact on a performance of water network. Earthquake is the major cause of failure of water tank so. Structure should be design in such a way that it have the ability to withstand against the seismic force. In this review paper we will study intz tank for different type of staging i.e. Frame staging & shaft staging. The aim of design of this tank to have seismic resistance propose . Comparative study of frame staging &shaft staging will be done . In this paper we will study the behaviors of different staging under different loading condition, this can be done using Staad-Pro software

1.1 TOTAL SEISMIC RESPONSE:-

The total seismic response of a tank structure should be analysed in terms of natural periods of vibrations, base shear force and overturning moments. As already mentioned, these quantities will be determined in accordance with the provisions of Eurocode 8. The modal properties of a tank structure should be determined at the beginning of the analysis. The natural periods of the impulsive and the convective modes are calculated by the Eqns. 1 and 2, respectively

$$T_i = \square\square \frac{H\sqrt{P}}{\sqrt{\frac{s}{R}}\sqrt{R}} \qquad (1)$$

$$T_c = C_c\sqrt{\square} \qquad (2)$$

here s represents equivalent uniform thickness of the tank wall (in the case of a wall with constant thickness, s is equal to the wall thickness), E is the modulus of elasticity of tank material and ρ is mass density of the liquid. The total base shear force is calculated by the

$$\square = (\square\square + \square\square + \square\square)\square\square(\square\square) + \square\square\square\square(\square\square) \qquad (3)$$

Where m_w, represent the mass of the tank wall, m_r, represent the mass of the tank roof Se(Ti) is the impulse spectral acceleratio

1.2 SEISMIC WAVES:-

Seismic waves are waves of energy that travel through Earth's layers, and area result of earthquakes, volcanic eruptions, magma movement, large landslides and large manmade explosions that give out low-frequency acoustic energy. Many other natural andanthropogenic sources create low-amplitude waves commonly referred to as ambient vibrations.Seismic waves are studied by geophysicists called seismologists. Seismic wave fields arerecorded by a seismometer, hydrophone (in water), or accelerometer.

2.0 SCOPE OF THE STUDY:-

To know design philosophy for safe and economical design of circular water tank.To study seismic response of circular water tank for various zone of earthquake (Zone IV,V) the performance was studied in terms of mode period, base shear, story displacement. The modelling, analysis, and design were carried out by STAAD PRO Vi8 software

3.0 OBJECTIVE OF THE STUDY:-

1. To study the seismic performance of overhead tank with different filled up condition of tank and different height of tank which located on seismic zone IV and V on medium soil under seismic loads.

2. To evaluate and comparison of same capacity but having different height and diameter of the overhead water tank in seismic zone (zone IV and V) by their dynamic response result like time period ,deflection ,displacement and base shear.

4.0 Methodology :-

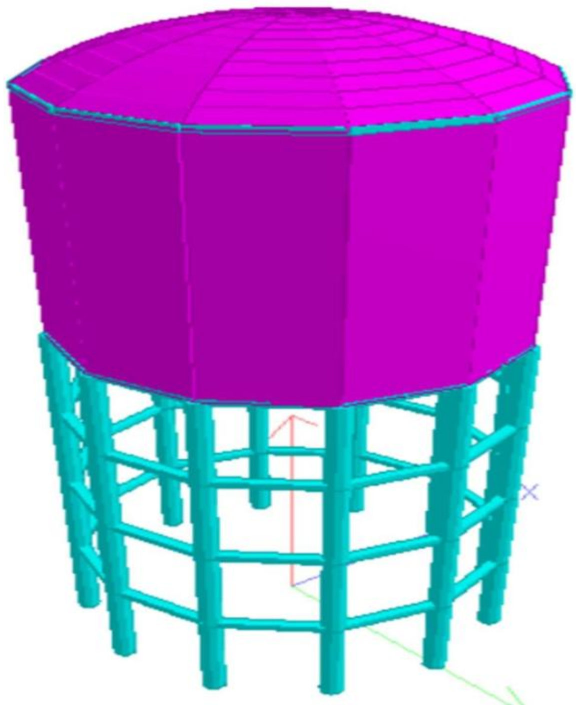

Fig.2. 3D staad pro model

6.0 loading pattern:-

As the test models are generated inSTAAD Pro Vi8 . In order to model and analyze them, various methods can be used. But I have used a certain method in order to maintain simplicity in calculation. The following points will elaborate

- As the test models will undergo seismic analysis for comparative study in term of time period, Base Shear, Storey Displacement, similar loading patterns are used throughout the model, the following points will elaborate.

    1. The live loads and dead loads will be similar in all the models as well at various levels in the structure.

7.0 RESULT AND DISCUSSION:-

7.1.1 Time Period –

Natural Period 'T' of a water tank is the time taken by it to undergo one complete cycle of oscillation

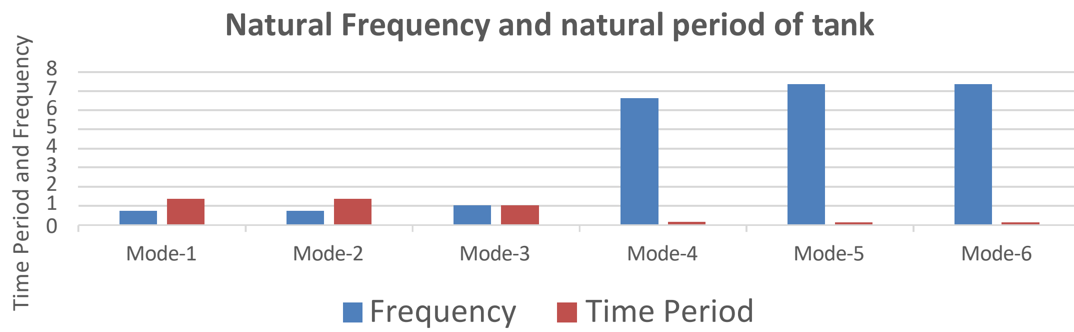

Table.1. Natural Frequency and natural period of tank

Mode	Natural frequency	Natural period
6	7.366	0.135

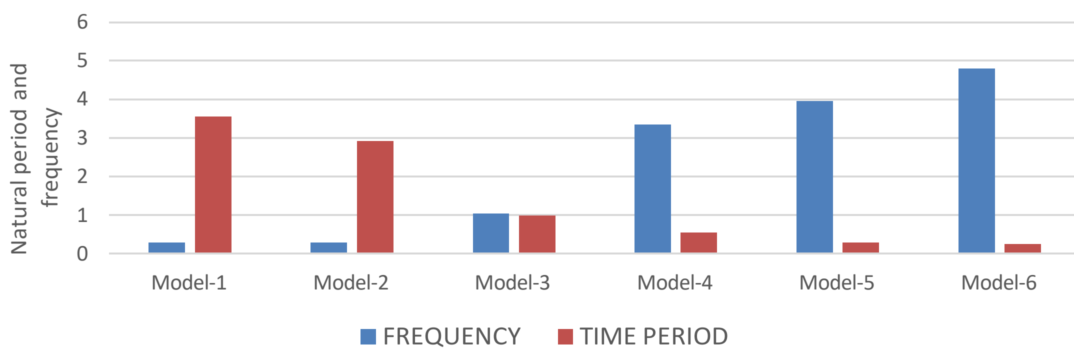

Table.2. Natural Frequency and natural period of tank

Mode	Natural frequency	Natural period
6	4.791	0.2542

7.1.2. BASE SHEAR :-

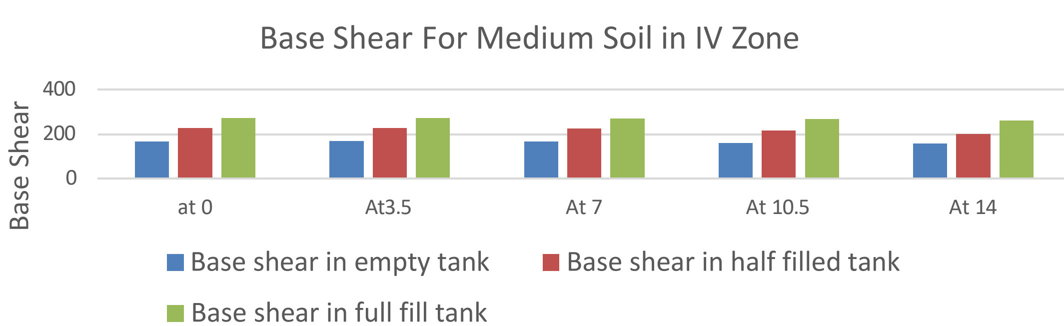

Table.3. Base shear in zone IV for medium soil

Empty tank	Half filled tank	Full filled tank
165.58	228.27	273.12

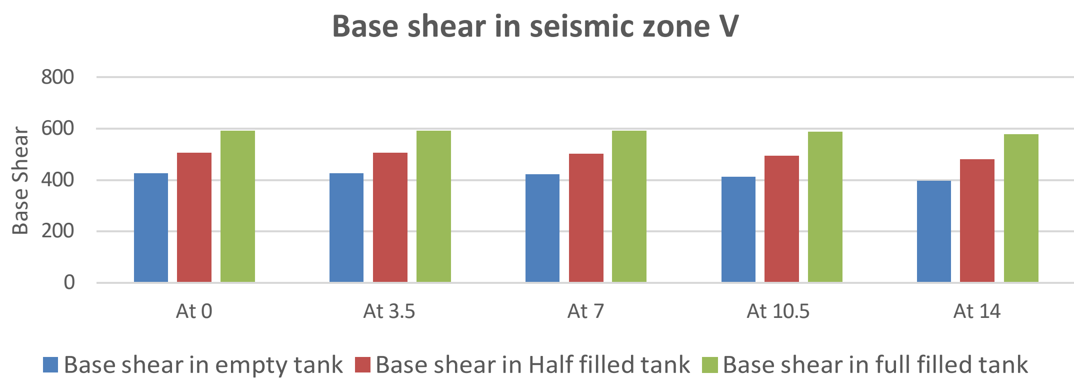

Table.4. Base shear in zone V for medium soil

Empty tank	Half filled tank	Full filled tank
425.8	505.41	593.11

7.1.3. MODEL .2:-

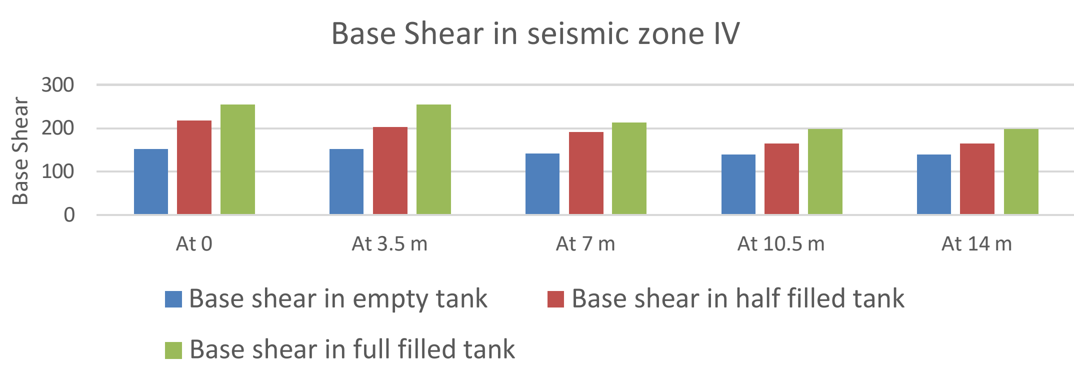

Table.5. Base shear in zone IV for medium soil

Empty tank	Half filled tank	Full filled tank
153.21	217.17	254.63

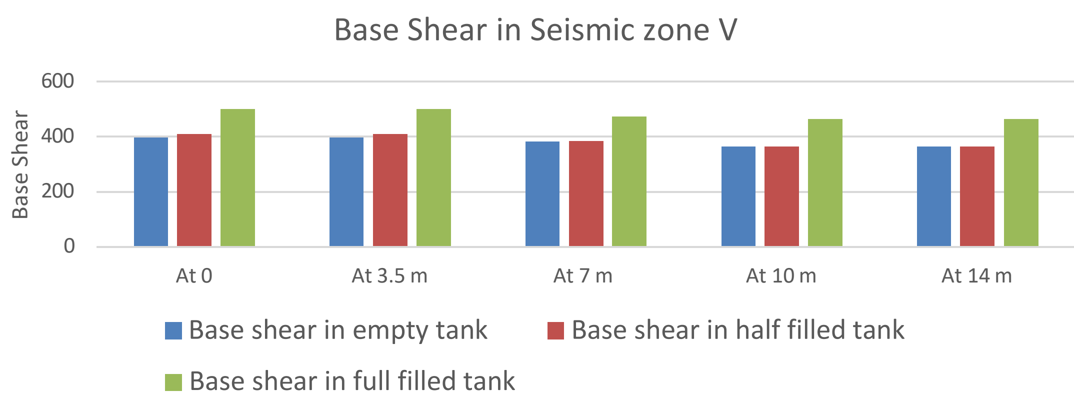

Table.6. Base shear in zone IV for medium soil

Empty tank	Half filled tank	Full filled tank
396.81	409.42	498.52

7.1.4. STORY DISPLACEMENT:-

7.1.5. model 1 –

The displacement of all models has been analysis. all displacement of all models is tabulated in the form of graph for different level for transverse direction

Displacement in seismic zone IV

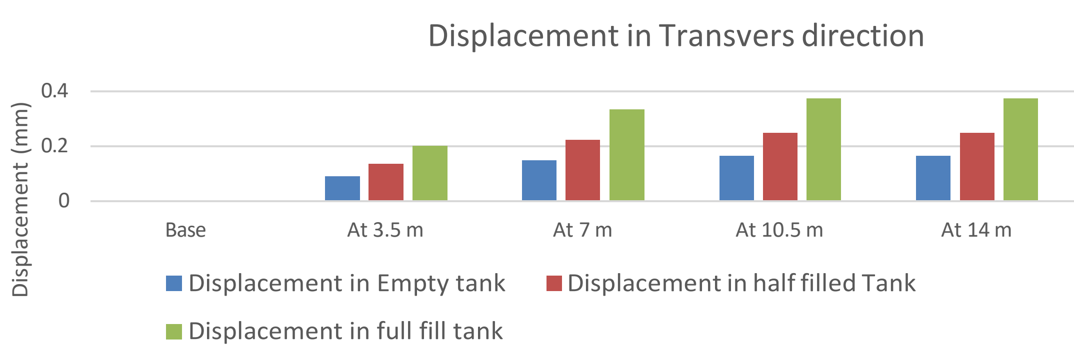

Table.7.Displacement in zone IV for medium soil

Different level of tank	Empty tank	Half filled tank	Full filled tank
At 14 m	0.165	0.248	0.372

Displacement in seismic zone V

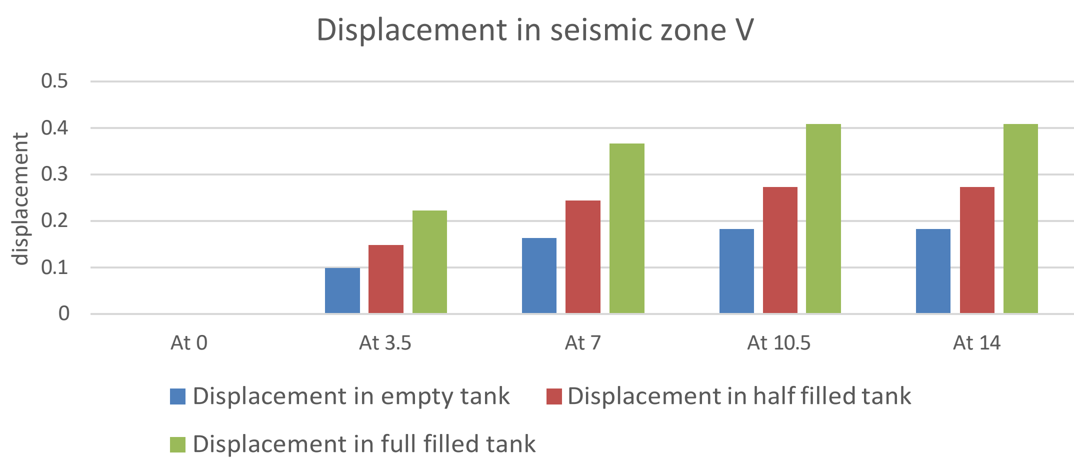

Table.8.Displacement in zone V for medium soil

Different level of tank	Empty tank	Half filled tank	Full filled tank
At 14 m	0.182	0.273	0.409

7.1.6. model.2.

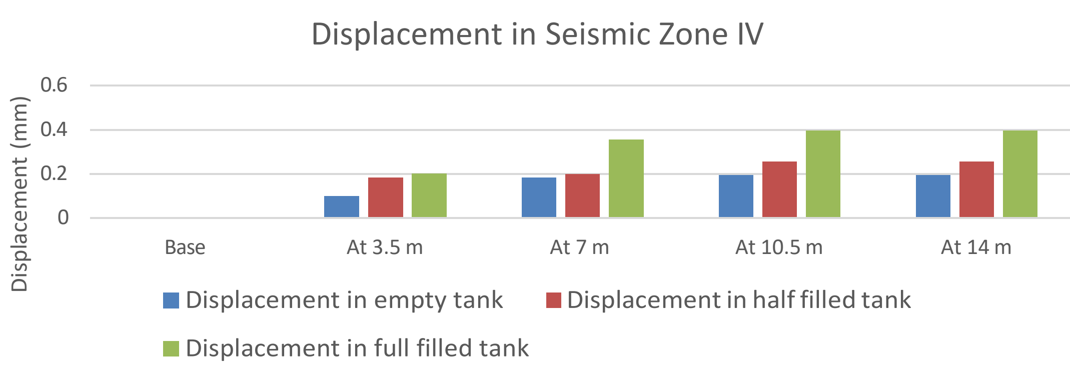

Table.9.Displacement in zone IV for medium soil

Different level of tank	Empty tank	Half filled tank	Full filled tank
At 14 m	0.196	0.256	0.396

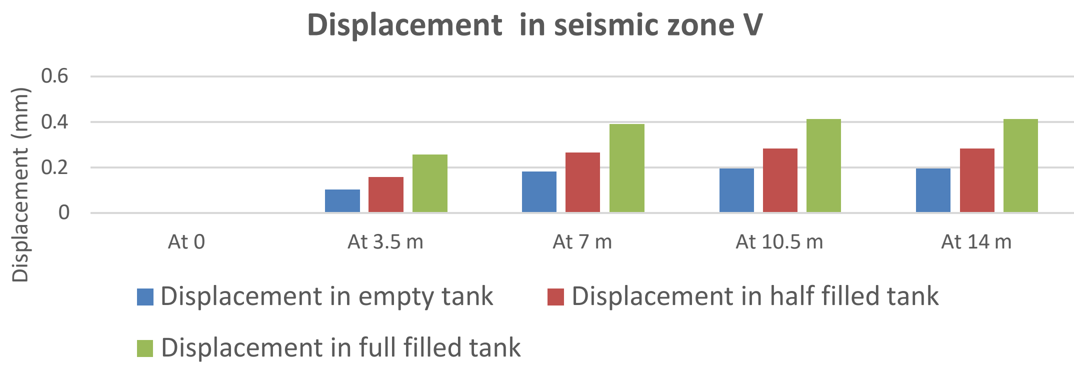

Table.10.Displacement in zone V for medium soil

Different level of tank	Empty tank	Half filled tank	Full filled tank
At 14 m	0.196	0.0.283	0.412

8.0 CONCLUSION:-

A seismic analysis of overhead circular tank on same capacity and varying height of tank is presented in seismic zone IV and V for the medium soil. Further conclusions are listed below:

a) As the mode shape tank is increase then time period is decrease and in Model-1 having the less time period as 61.46% from Model-2.

b) Maximum displacement and base shear is found in full fill tank but minimum displacement and base shear is found in empty tank.

c) When the height of the overhead tank is increase then the displacement is increase and base shear is decrease but in the case of seismic zone V having the maximum displacement and base shear than seismic zone IV.

d) The displacement of Model-2 is more than 6.06% in seismic zone IV and 0.73% in seismic zone V from Model-1 in the case of the full fill tank.

e) The base shear of Model-2 is less than 6.77% in seismic zone IV and 15.95% in seismic zone V from Model-1 in the case of full fill tank.

f) The displacement of Model-2 is more than 15.82% in seismic zone IV and 7.14% in seismic zone V from Model-1 in the case of the half filled tank.

g) The base shear of Model-2 is less than 7.46% in seismic zone IV and 6.81% in seismic zone V from Model-1 in the case of half filled tank.

h) The displacement of Model-2 is more than 3.125% in seismic zone IV and 3.53% in seismic zone V from Model-1 in the case of the empty tank.

The base shear of Model-2 is less than 4.862% in seismic zone IV and 18.99% in seismic zone V from Model-1 in the case of empty tank

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Reference

1. M.K. Shrimali and R.S. Jangid, “Earthquake Response of Isolated Elevated Liquid Storage Tank” (2003).
2. J. Z. Chen and M. R. Kianoush, “Response of concrete liquid containing structures in different seismic zones”,13th world conference on earthquake engineering, (2004).
3. R. Livaoglu, “Investigation of seismic behaviour of fluid rectangular tank-soil/foundation systems in frequency domain “, Soil dynamics and earthquake engineering- ELSEVIER, (2008).
4. Halil Sezen and Livaoglu et al. “Dynamic analysis and seismic performance evaluation of above ground liquid- containing tanks”, Engineering structuresELSEVIER, (2008).
5. R. Livaoglu and A. Dogangun, “Effect of foundation embedment on seismic behaviour of elevated tanks considering fluid- structure –soil interaction”, Soil dynamics and earthquake engineering- ELSEVIER, (2007).
6. Suchita Hirde and Manoj Hedaoo, “Seismic performance of elevated water tanks”, International Journal of Advanced Engineering Research and Studies, (2011).
7. M. Moslemi and M.R. Kianoush, “Parametric study on dynamic behavior of cylindrical ground supported tanks”, Engineering structures- ELSEVIER, (2012).
8. M.V Waghmare and S.N Madhekar, “ Behavior of elevated water tank under sloshing effect”, International Journal of Advanced Techno.
9. Uma Chaduvulaa and Deepam Patela et al, “Fluidstructure- soil interaction effect on seismic behaviour of elevated water tanks”, Procedia engineeringELSEVIER, (2013), (84-91).
10. V.M Naveen and Sanya Maria Gomez, “Study of hydrodynamic effect on RC elevated water tanks under seismic excitation”, International journal of engineering and research, (2015)

11. K.J Dona Rose and Sreekumar M et al, " A study of overhead water tanks subjected to dynamic loads", International journal of engineering trends and technology,(2015),(344-348).

12. Neeraj Tiwari and M. S. Hora, "Transient analysis of elevated intze water tank- fluid-soil system", ARPN Journal of Engineering and Applied Sciences, (2015), Vol.10 (2), (869-882).

13. Rupachandra J. Aware and Vageesha et al, "Effect of container height on base shear of elevated tank", International Journal of Science and Research, (2015), Vol.4 (12), (2123-2128).

14. Yonghui Wang and J.Y. Richard Liew et al, "Structural performance of water tank under static and dynamic pressure loading", International journal of impact engineering- ELSEVIER, (2015), (110-123).

15. A.I Gareane and Algreane et al, "Behavior of elevated concrete water tank subjected to artificial ground motion", Electronic journal of geotechnical engineering, (2008), Vol.16, (387-406).

16. A.R Ghanemmaghami and M.R Kianoush, "Effect of wall flexibility on dynamic response of concrete rectangular liquid storage tanks under horizontal and vertical ground motions", Journal of Structural Engineering-ASCE, (2010), Vol. 136(4), (441-45