Study of Design of Water Tankwith New Provision By Response Spectrum Method

Parag R. Chopade[1], Dr..P. O. Modani[2]
[1]PG Student, Department of Civil Engineering,
[2]Asst. Prof. Department of Civil Engineering,
[1,2],PankajLathad Institute of Technology and Management Studies, Buldana, India

Abstract- *Water is considered as the source of every creation and is thus a very crucial element for humans to live a healthy life. High demand of Clean and safe drinking water is rising day by day as one cannot live without water so design of water tank is safe. Design of water tank by using Response Spectrum Method.For Response Spectrum Analysis three different numbers of columns are used i.e. 8 column (rectangular shape), 8 columns (octagonal shape) and 12 columns having three different conditions water tank was full, half and empty conditions.*

Keywords- SAP 2000,RSM

I. INTRODUCTION

In response spectrum method, the response of a structure during an earthquake is obtained directly from the earthquake response (or design) spectrum. This method gives an approximate peak response, which is quite accurate for structural design applications. Time period of structure is determined on the basis of the lateral stiffness of structure. From the time period, the responses of structure is determined using modal combination methods such as complete quadratic combination (CQC), square root of sum of squares (SRSS), or absolute sum (ABS) method. Earthquake response spectrum is the most popular tool in the seismic analysis of structures. There are computational advantages in using the response spectrum method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves the calculation of only the maximum values of the displacements and member forces in each mode of vibration using smooth design spectra that are the average of several earthquake motions. The procedure to compute seismic responses using IS: 1893-1984.

For Response Spectrum Analysis three different numbers of columns are used i.e. 8 column (rectangular shape), 8 columns (octagonal shape) and 12 columns having three different conditions water tank was full, half and empty conditions. The water tank used for analysis are as follows. Their displacement & storey drifts results for various number of columns has been computed.

II. OBJECTIVE

1. To check about design philosophy for safe design of water tank Using RSM.
2. To check economical design of water tank.
3. To make the study about the analysis and design of water tank.

III. DYNAMIC ANALYSIS OF WATER TANK

The dynamic analysis of water tank by two different methods i.e. Response Spectrum Method and Time History Analysis. Water tank is analysed by using sap2000.

3.1 Response Spectrum Method

In response spectrum method, the response of a structure during an earthquake is obtained directly from the earthquake response (or design) spectrum. This method gives an approximate peak response, which is quite accurate for structural design applications. Time period of structure is determined on the basis of the lateral stiffness of structure. From the time period, the responses of structure is determined using modal combination methods such as complete quadratic combination (CQC), square root of sum of squares (SRSS), or absolute sum (ABS) method. Earthquake response spectrum is the most popular tool in the seismic analysis of structures. There are computational advantages in using the response spectrum method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves the calculation of only the maximum values of the displacements and member forces in each mode of vibration using smooth design spectra that are the average of several earthquake motions. The procedure to compute seismic responses using IS: 1893-1984.

For Response Spectrum Analysis three different numbers of columns are used i.e. 8 column (rectangular shape), 8 columns (octagonal shape) and 12 columns having three different conditions water tank was full, half and empty conditions. The water tank used for analysis are as follows. Their displacement & storey drifts results for various number of columns has been computed.

a) This is the water tank model with 8 columns in Rectangular shape. Water tank analysed by RSM using SAP 2000.

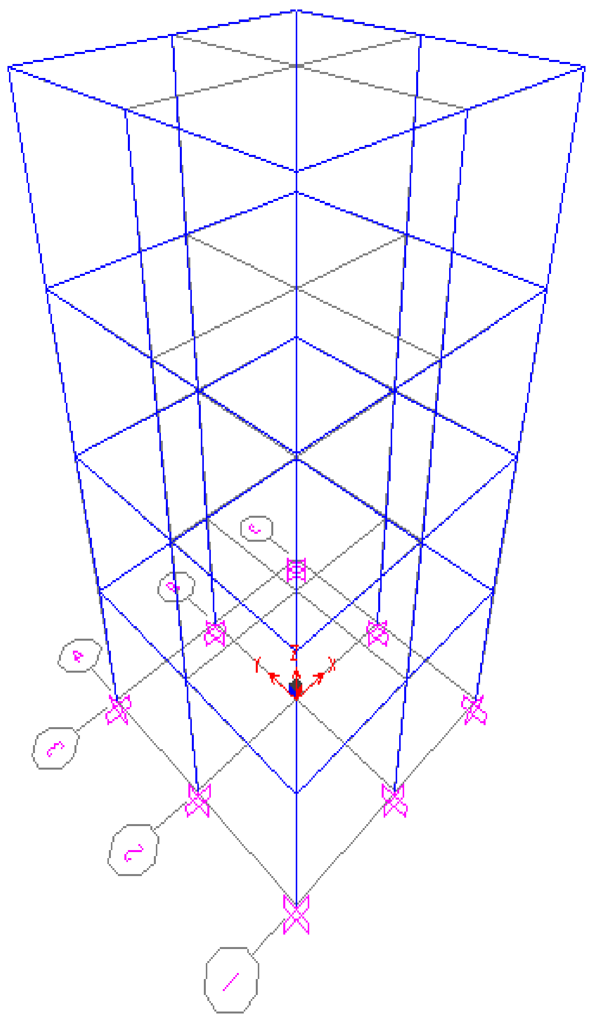


Fig. 3.1 Sap model Water Tank 8 column (Rectangular)

For full tank condition, volume = area x h

= 8 x 8 x 4 = 256 m^3

Weight of water = volume x unit wt. of water

= 256 x 10 = 2560 kN

Udl on tank = $\frac{2560}{8+8+8+8}$ = 80 kN/m

Wt. of Wall = 25 x 4 x 0.3 = 30 kN/m

For half tank condition,

Udl on tank= 40 kN/m

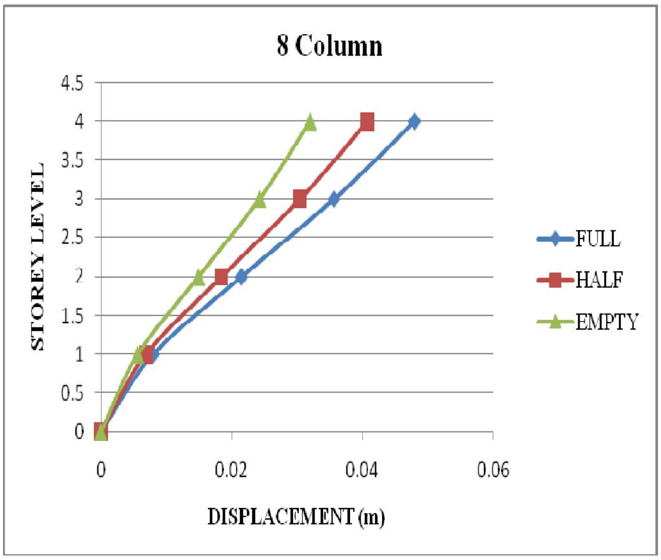
Wt. of Wall = 25 x 4 x 0.3 = 30 kN/m

For empty tank condition,

Udl on tank = 0

Wt. of Wall = 25 x 4 x 0.3 = 30 kN/m

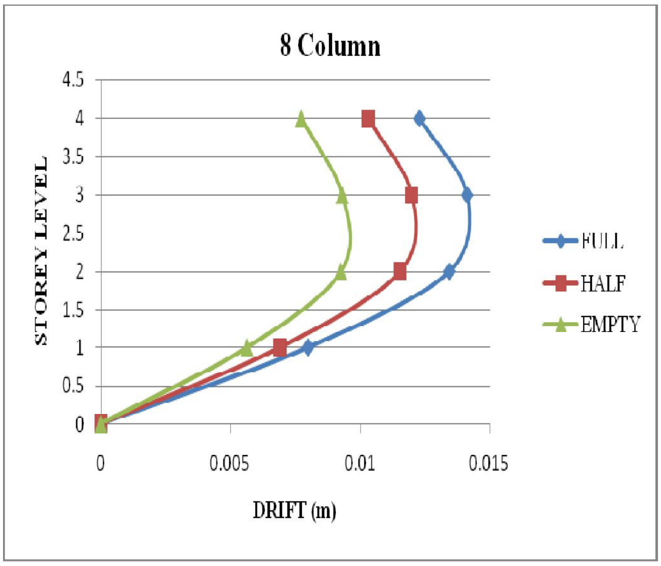
Displacement graphs



Graph 3.1.1 Displacement vs Storey level

The above graph shows displacement in X- axis and storey level on Y- axis. The variation in displacement value for full, half and empty conditions. Empty condition gives the less displacement than full and half condition.

Drift graphs



Graph 3.1.2 Drift vs Storey level

The above graph shows displacement in X- axis and storey level on Y- axis. The variation in drift value for full, half and empty conditions. Empty condition gives the less drift than full and half condition.

This is the water tank model with 8 columns in Octagonal shape. Water tank analysed by RSM using SAP 2000.

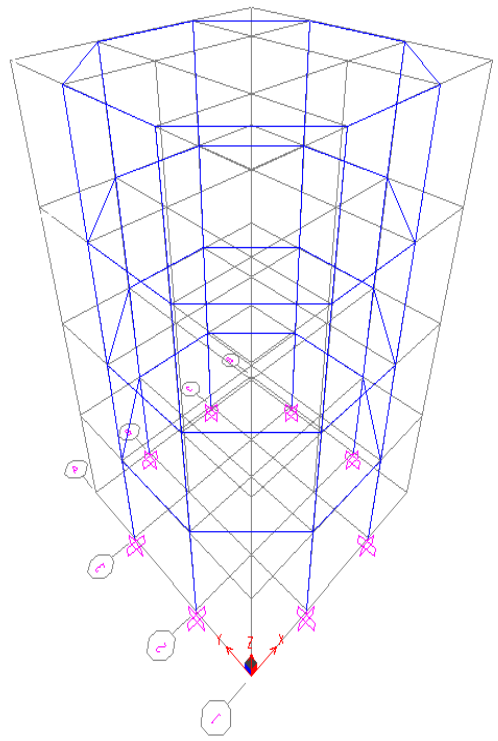


Fig. 3.2 Sap model Water Tank 8 column (Octagonal)

For full tank condition, volume $= \frac{\pi}{4} \times D^2 \times h$

$= \frac{\pi}{4} \times 11^2 \times 4 = 380\ m^3$

Weight of water = volume x unit wt. of water

= 380 x 10 = 3800 kN

Udl on tank $= \frac{3800}{32.96} = 115.3$ kN/m

Wall load $= \frac{\pi}{4} \times (D^2 - d^2) \times h \times 25$

$= \frac{\pi}{4} \times (11^2 - 0.3^2) \times 4 \times 25$

= 9496.25 kN

Wt. of Wall $= \frac{9496.25}{32.96} = 288$ kN/m

For half tank condition,

Udl on tank= 57.65 kN/m

Wt. of Wall $= \frac{9496.25}{32.96}$

= 288 kN/m

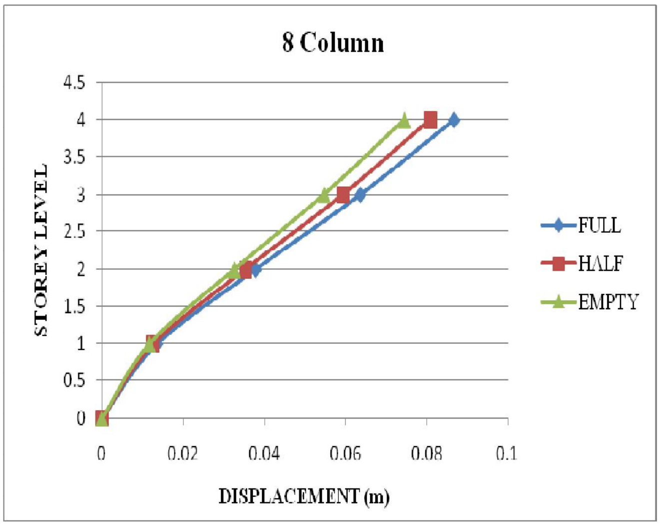
For empty tank condition,

Udl on tank = 0

Wt. of Wall $= \frac{9496.25}{32.96}$

= 288 kN/m

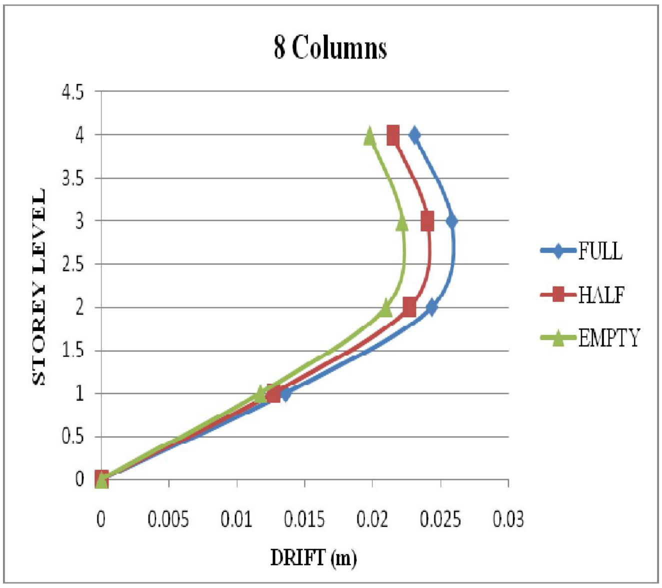
Displacement graph



Graph 3.2.1 Displacement vs Storey level

The above graph shows displacement in X- axis and storey level on Y- axis. The variation in displacement value for full, half and empty conditions. Empty condition gives the less displacement than full and half condition.

Drift graph



Graph 3.2.2 Drift vs Storey level

The above graph shows displacement in X- axis and storey level on Y- axis. The variation in drift value for full, half and empty conditions. Empty condition gives the less drift than full and half conditionThis is the water tank model with 12 columns. Water tank analysed by RSM using SAP 2000.

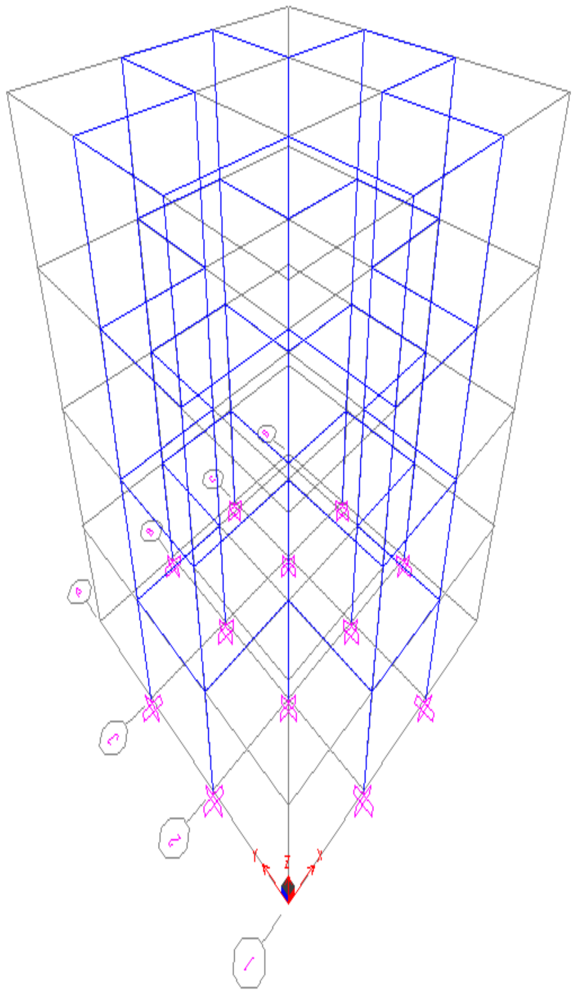


Fig. 3.3 Sap model Water Tank 8 column (12 Columns)

For full tank condition, volume = D^2 x h

= 12^2 x 4 = 576 m^3

Weight of water = volume x unit wt. of water

= 576 x 10 = 5760 kN

Udl on tank = $\frac{5760}{12+12+12+12}$ = 120 kN/m

Wall load = h x 0.3 x 25

=4 x 0.3 x 25

= 30 kN

For half tank condition,

Udl on tank= 60 kN/m

Wt. of Wall = h x 0.3 x 25

=4 x 0.3 x 25

= 30 kN

For empty tank condition,

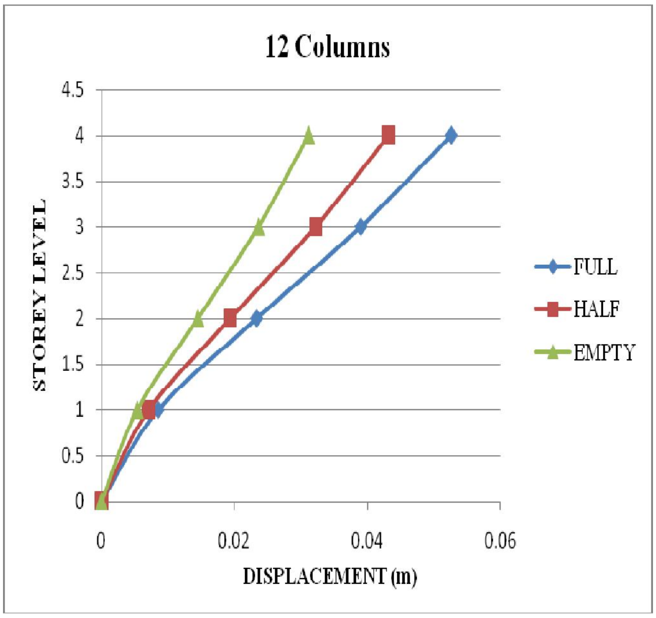
Udl on tank = 0

Wt. of Wall = h x 0.3 x 25

=4 x 0.3 x 25

= 30 kN

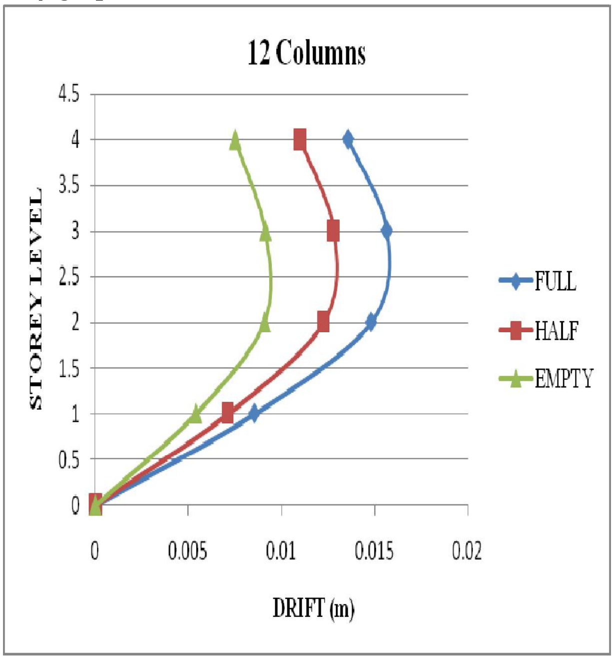
Displacement graph



Graph 3.3.1 Displacement vs Storey level

The above graph shows displacement in X- axis and storey level on Y- axis. The variation in displacement value for full, half and empty conditions. Empty condition gives the less displacement than full and half condition.

Drift graph



Graph 3.3.2 Drift vs Storey level

The above graph shows displacement in X- axis and storey level on Y- axis. The variation in drift value for full, half and empty conditions. Empty condition gives the less drift than full and half condition

IV. CONCLUSION

The dynamic analysis of water tank For response spectrum analysis analysis 8 and 12 three different numbers of columns are used with different conditions tank was full, half and empty conditions. In RSM results graphs are shown in between storey displacement and storey drifts. As per this graph shows displacement is more in full tank condition, moderate in half tank condition and less in empty tank condition. Drifts are also same more in full tank condition, moderate in half tank condition and less in empty tank. 12 columns water tank gives the less displacement and less drift. If the deformation is less safe in earthquake. So empty tank is always preferred than half and full water tank in earthquake zone.

REFERENCES

[1] M Bhandari and Karan deep Singh, "Comparative Study of Design of water Tank with Reference to IS: 3370", IJETAE Publication, Vol-4,Issue-11, November 2014.

[2] Ranjit Singh, Dr.Abhay Sharma and Dr.VivekGarg, "Design of Intze Tank in Perspective of Revision of IS: 3370,"IJSET Publication, Vol-3, Issue-09,1September2014.

[3] R.V.R.K.Prasad, AkshayaB.Kamdi, "Effect of Revision of IS 3370 on Water Storage Tank", International Journal of Engineering Research and Applications 2(5), 2012.

[4] Dr.SuchitaHirde, AsmitaBajare and Dr. Manoj Hedaoo, "Seismic performance of Elevated Water Tank", International Journal of Advanced Engineering Research and Studies Vol.I, 2011.

[5] IITK-GSDMA guidelines for seismic design of liquid storage tanks.

[6] Durgesh C. Rai and Bhumika Singh, "Seismic Design of Concrete Pedestal Supported Tanks" 13th World Conference on Earthquake Engineering Vancouver, B.C, Canada August 1-6, 2004

[7] Ayazhussain M. Jabar and H. S. Patel, "Seismic Behavior of RC Elevated Water Tank under Different Staging Pattern and Earthquake Characteristics".International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974, IJAERS, Vol. I, Issue III, April-June, 2012 293-296

[8] Mohammad TaghiAhmadi, AfshinKalantari, "Modeling of Elevated Water Tank Under Seismic Excitation Considering Interaction of Water and Structure", Structural Engineering Forum of India, 2002.

[9] Praveen K. Malhotra, Thomas Wenk, Martin Wieland, "Simple Procedure for Seismic Analysis of Liquid Storage Tank", Structural Engineering International 3/2000, 197-201.

[10] G.P.Deshmukh and Ankush.S.Patekhed, "Analysis of Elevated Water Storage Structure using Different Staging System", IJRET Publication Vol-4, Issue-4, April 2015.

[11] Pawan S. Ekbote, Dr.Jagdish G. Kori, "Seismic Behaviour of RC Elevated Water Tank Under Different Types of Staging Pattern".Journal of Engineering, Computers & Applied Sciences, 2(8), 23-29.

[12] IS 3370 (Part 1) and (Part 2):1965 "Concrete Structure For Storage Of Liquids- Code of Practice", Bureau of Indian Standard, New Delhi.

[13] IS 3370 (Part 4):1967 "Concrete Structure For Storage Of Liquids-Code of Practice", Bureau of Indian Standard, New Delhi.

[14] IS 3370 (Part 1) and (Part 2):2009 "Concrete Structure For Storage Of Liquids-Code Of Practice", Bureau of Indian Standard, New Delhi.

[15] IS 456:2000 "Plain And Reinforced Concrete – Code Of Practice", 4th revision, Bureau of Indian Standard, New Delhi.

[16] IS: 1893-2002 (Part II) "Criteria for Earthquake Resistant Design of Structure (Liquid Retaining Tanks)", Bureau of Indian Standards, New Delhi.

[17] RCC Designs by Dr. B C Punmia, Ashok Kumar Jain and Arun Kumar Jain, tenth edition ,Laxmi Publication.

[18] "Advance Reinforced Concrete Design" 2nd Edition N. Raju

[19] Sneha S. Shende, Sanjay Bhadke, Amey R. Khedikar"Comparative study of design of water tank with new provision", International Journal of Current Trends in Engineering & Research (IJCTER) e-ISSN 2455–1392 Volume 2 Issue 4, April 2016 pp. 481 - 485