International Journal of Modern Developments in Engineering and Science
Volume 1, Issue 5, May 2022
https://www.ijmdes.com | ISSN (Online): 2583-3138

Comparative Analysis of Different Shapes of Underground Water Tank

Amruta Arvind Bhende[1*], Prajakta B. Jamale[2]
[1,2]*Department of Civil Engineering, Trinity College of Engineering and Research, Pune, India*

***Abstract*: The influences of different water tank shapes on thermal energy storage capacity and thermal stratification in the static mode of operation is investigated in this study under laminar natural convection. A new experimental apparatus is built, and a numerical model is developed to simulate the flow and heat transfer in the water tank. Computational results agree with the experimental data. Among the 10 different water tank shapes studied, the sphere and barrel water tanks are ideal for thermal energy storage capacity, whereas the cylinder water tank is the least favorable. The thermal energy storage capacity is closely related to the surface area of the water tank. According to the characteristics of the velocity and temperature fields, these shapes can be divided into three categories: shapes with sharp corners, those with hemispheres, and those with horizontal plane surface. Shapes with sharp corners have the highest degree of thermal stratification, whereas the shapes with horizontal plane surface possess the lowest That of the shapes with hemispheres lies in between these two degrees. The thermal stratification of different shapes is determined by the flow at the bottom of the water tank and the heat transfer from the fluid to the environment.**

***Keywords*: Tank, shapes, analysis, software, rectangular, circular.**

1. Introduction

In recent years, there has been much emphasis on water supply projects all over the world, which are very essential for the social and industrial development of the country. Water tanks can be of different capacity depending upon the requirement of consumption. Based on the location the water tanks are classified into three ways: i) Underground water tanks, ii) Tank resting on grounds, iii) Elevated or overhead water tanks. Also, the water tanks are classified based on shape: i) Circular tanks, ii) Rectangular tanks iii) Intz tanks, iv) Circular tank with conical bottom, v) Spherical tanks.

2. Objectives

i) To analyze the underground water tank using software, ii) To analyze water tank for the different shapes, iii) Comparison with the manual calculations, iv) To check the stresses in the water tank, v) To calculate the maximum moments and forces in the water tank.

3. Review of Literature

Imanishi, Y., et al [1] studied for above-ground vertical cylindrical storage tanks without any restraining element, such as anchor bolts or straps, to prevent any overturning moment, only the bending resistance due to the uplift of the rim of bottom plate exists. This recommendation shows how to evaluate the energy absorption value given by plasticity of the uplifted bottom plate for unanchored tanks, as well as the Ds value of an anchored cylindrical steel-wall tank. As the number of smaller under-ground tanks used for the storage of water and fuel is increasing in Japan, the Sub-committee has added them in the scope of the recommendation and provided a framework for the seismic design of under-ground tanks.

Nimade, A., et al [2] studied the recommendation has accordingly included a new response displacement method and a new earth pressure calculation method, taking into account the design methods adopted by the civil engineering fraternity. For silo design, additional local pressure which depends on eccentricity of discharge outlet, and equations which give approximate stress produced by this pressure are given in this 2010 publication.

Shakib, H. et al [3] studied idea for safe design with minimum cost of the tank and give the designer the relationship curve between design variable thus design of tank can be more economical, reliable and simple. The paper helps in understanding the design philosophy for the safe and economical design of water tank. The wall of tanks subjected to pressure and the base is subjected to weight of Water. In below paper, reinforced concert resting on ground monolithic with the base are design and their results are made optimum.

4. Modeling

- Model-VI: Rectangular water tank (7m X 11m) – 0.5m thickness
- Model-VII: Circular water tank (8m diameter) – 0.3 m thickness
- Model-VIII: Circular water tank (8m diameter) – 0.5 m thickness
- Model-IX: Circular water tank (10m diameter) – 0.3 m thickness
- Model-X: Circular water tank (10m diameter) – 0.5 m thickness

*Corresponding author: amrutabhende66@gmail.com

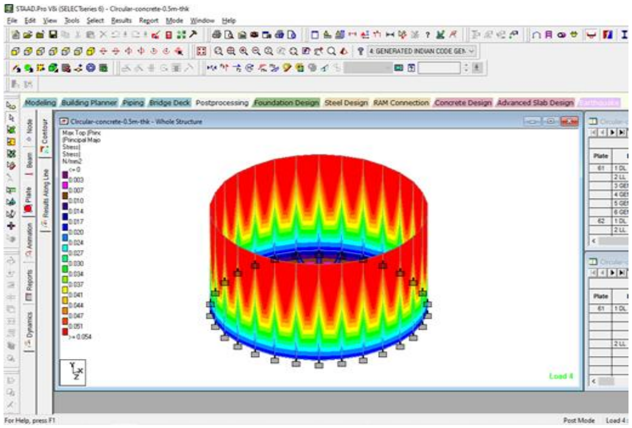

Fig. 1. Maximum absolute stress on the model-1

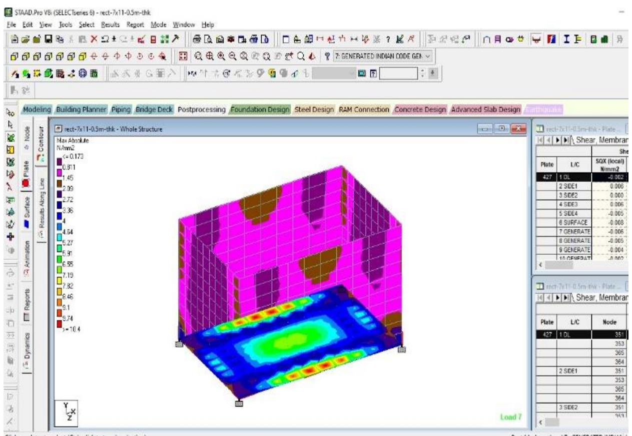

Fig. 2. Maximum absolute stress on the model-2

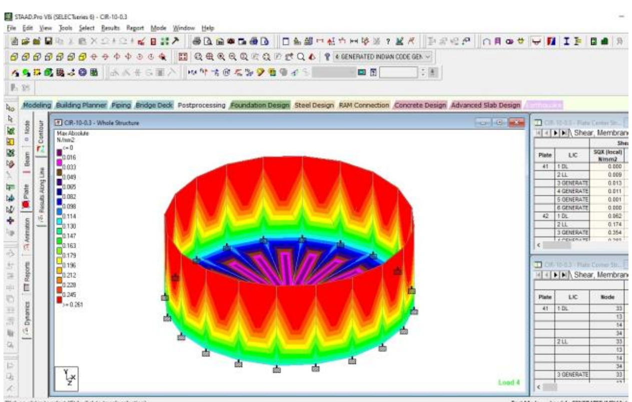

Fig. 3. Maximum absolute stress on the model-3

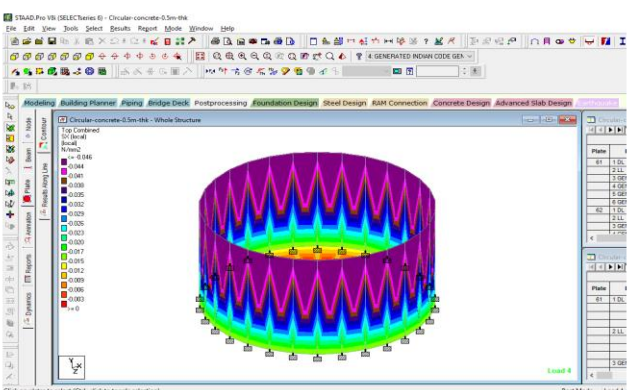

Fig. 4. Maximum absolute stress on the model-4

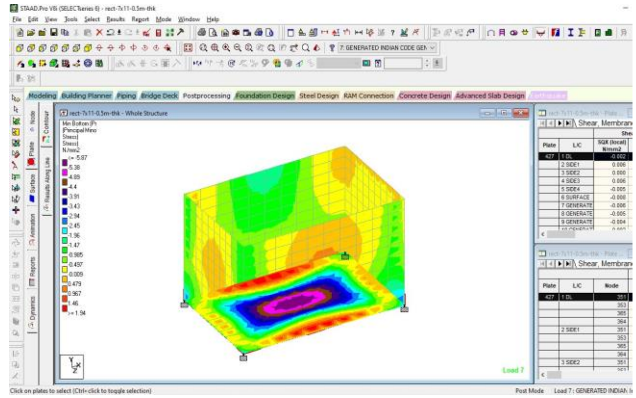

Fig. 5. Maximum absolute stress on the model-5

Table 1
Frequency of model-1

Mode	Frequency (Cycles/Sec)	Period (Sec)
1	16.081	0.06218
2	26.795	0.03732
3	39.953	0.02503
4	42.021	0.0238
5	48.278	0.02071
6	52.891	0.01891
7	54.34	0.0184
8	59.584	0.01678
9	69.834	0.01432
10	71.946	0.0139
11	79.514	0.01258
12	85.475	0.0117

5. Conclusion

1. The maximum principal stress (top and bottom) is found to be in the model-4 and the value obtained is 13.141 N/mm.
2. While the minimum principal stress (top and bottom) is observed in the model-10.
3. The maximum Von-Mis stress (top and bottom) is found to be in the model-1 and the value obtained is 13.963 N/mm^2 while the minimum Von-Mis stress (top and bottom) is observed in the model-10.
4. The maximum Tresca stress (top and bottom) is found to be in the model-1 and the value obtained is 15.235 N/mm^2 while the minimum Tresca stress (top and bottom) is observed in the model-10.
5. The models in the present work consists of the rectangular and circular shape water tank with different sizes.
6. As the size of the rectangular water tank increases the stresses on the plate are Parametric study of different shapes of underground water tank also increased.
7. The circular water tank gives the minimum stresses as compared to the rectangular water tank.
8. The frequency for the rectangular water is minimum as compared to the circular water tank.
9. The stresses of the rectangular and circular shape also depend upon the thickness of the water tank.

References

[1] IS: 3370 (Part 4th) – 1965, Code of Practice for Concrete Structures for the Storage of the Liquids. Parametric study of different shapes of underground water tank.
[2] IS:456-2000, Plain & Reinforced Concrete–Code of Practice.

[3] Issar Kapadia, Nilesh Dholiya, Purav Patel and Nikunj Patel “Parametric study of RCC staging (support structure) for overhead water tanks as per IS:3370”, IJAERD, Volume 4, Issue 1, January 2017.
[4] Kalyan Kumar Mandal, Damodar Maity, Investigation of sloshing in rectangular water tank. Procedia Engineering 144(2016) 11871194.
[5] Nibedita Sahoo, “Design Of water Tank”, May 2008.
[6] Nimade, A., Soni, N., Varma, G., Joshi, V. and Chaurasia, S., 2018. Parametric Study of Underground Water Tank using FEM. International Journal of Science Technology & Engineering, 4(9), pp. 94-98.
[7] Prashanth P, Anshuman S., Comparison of design results of a Structure designed using STAAD-PRO and ETABS Software, International Journal of Civil and Structural Engineering, Volume 2, No 3, 2012
[8] Prashanth P, Anshuman S., Comparison of design results of a Structure designed using STAAD-PRO and SAP Software, International Journal of Civil and Structural Engineering, Volume 2, No. 3, 2012.
[9] Ramamrutan S, “Design of Reinforce Concrete Structures,” New Delhi: Dhanpat Rai Publishing Company Pvt. Ltd. 2009.
[10] Sani, J.E., Nwadiogbu, C.P. and Yisa, G.L., 2014. Reliability Analysis of an Underground Reinforced Concrete Rectangular Water Tank. Journal of Mechanical and Civil Engineering, 11(1), pp. 58-68.
[11] Shakib, H. and Omidinasab, F., 2011. Effect of earthquake characteristics on seismic performance of RC elevated water tanks considering fluid level within the vessels. Arabian Journal for Science and Engineering, 36(2), pp. 227-243.
[12] Shi, H. and Liu, B., 2010. Design and seepage discharge analysis of artificial water curtains for water sealed underground petroleum storage caverns in rock. Chinese Journal of Geotechnical Engineering, 32(1), pp. 130-137.
[13] Soroushnia, S., Tafreshi, S.T., Omidinasab, F., Beheshtian, N. and Soroushnia, S., 2011. Seismic performance of RC elevated water tanks with frame staging and exhibition damage pattern. Procedia engineering, 14, pp. 3076-3087.
[14] Thalapathy, Vijaisarathi, Sudhakar and Sridharan, Satheesh, “Analysis and Economical Design of Water Tanks, International Journal of Innovative Science, Engineering & Technology, Vol. 3, Issue 3, March 2016.