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Comparative Analysis of Various Geometrical Shape Water Tanks Resting Over Ground for Same Capacity with Different Support Conditions

Allen Aghamkar[1], Dr. A. R. Gupta[2]
[1]*M.E Student, Department Of Structural Engineering, College Of Engineering And Technology Akola, India.*
[2] *Guide, Department Of Structural Engineering, College Of Engineering And Technology Akola, India.*
Sant Gadge Baba Amravati University.

Abstract: ***Water is one the most important source for humans to live. The need of water is serious and its storage is must. Water tanks are used to provide storage of water for use in many application of our day to day life. So, an appropriate analysis of these water tanks must be done. This paper concerns the study of comparative analysis between circular, square and rectangular reinforced concrete water tanks resting over ground for same capacity. The report will include the study of analysis of various shapes of water tank using Staad-Pro and comparative analysis of circular, square and rectangular water tank with different support conditions on the basis of their post processing results taken from Staad-Pro. The above mentioned points will be studied in this report and conclusion will be made on the basis of the results.***
Keywords: Water Tank resting over ground, Support Conditions, Analysis, Staad-Pro

I. INTRODUCTION

"Water is Life", as we all know this popular phrase from which we can make out the seriousness of water in our life. Thus, high demand for harmless and fresh water is increasing day by day as one cannot live without water. Considering this serious need and demand of water necessity of storing water is very important. A water tank is a container for storing liquid. These water tanks are to be designed as economical and stable water tanks for all over convenience. So in this paper it is studied that by using Staad pro the comparative analysis of different geometries of water tanks resting over ground with different support conditions can be done. Thus, a stable water tank can be designed from this comparison.

II. LITERATURE REVIEW

Mainak Ghosal et.al [1] every design comes out when there is a problem. A design is created to solve the existing problems. People in the region where there is scarcity of water, don't get enough flow or speed or discharge especially those living on the upper floors in a multi-storied building.

As a consequence people suffer from lack of water due to insufficient supply for compensating their daily needs. As a first solution of this problem, one needs to develop a water storage project as has been designed with the help of STAAD principles, known as Overhead Water Reservoir. The present study reports the analysis and design of an elevated circular water tank using STAAD Pro V8i. The design involves load calculations manually and analyzing the whole structure by STAAD Pro V8i. The design method used in STAAD Pro analysis is Limit State Design and the water tank is subjected to wind load, dead load, self – weight and hydrostatic load due to water.

Manjusha Chute et.al [2] the need for a water tank is as old as a civilization, to provide storage of water for use in many applications. Design and cost estimation of water tanks is a time consuming task, which requires a great deal of expertise. This project therefore studies the efficiency of rectangular or circular tanks of different capacities were used in order to draw reasonable inferences on tank shape design effectiveness, relative cost implications of tank types and structural capacities. From the analysis results concluding about the influence of shape factor in design loads and how shapes of the tanks play predominant role in the design and in stress distribution and overall economy.

The result of design and estimation revealed that circular tank consumed lesser materials as compared to rectangular tank. Hence circular tank is more economical than the rectangular tank for large quantity.

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III. TO STUDY THE ANALYSIS OF VARIOUS SHAPES OF WATER TANK USING STAAD PRO.

A. *Shapes of water tank to be studied.*

There are different shapes of water tank as we have seen in our previous study. Following are the types of water tanks for our study:

1) Circular water tank
2) Square shaped water tank
3) Rectangular water tank

B. *Geometry of shapes of water tank.*

1) *Circular Water Tank:* Considering the radius of circular water tank as 6.77199177 m and height of the tank as 6 m and then calculating the volume of circular water tank by the formulae $V = \pi r^2 h$ where 'r' is the radius of the circular tank and 'h' is the height of the circular tank, we get the total volume of the water tank as 864 m^3. So the total capacity of the circular water tank is 864000 litres or 864 m^3.
2) *Square Shaped Water Tank:* Considering the side of the square shaped water tank as 12m and height of the water tank as 6 m, the total volume of the square shaped water tank can be derived by the formulae $v = a^2 \times h$ where 'a' is the side length and 'h' is the height of the tank. So the total volume derived is 864000 litres or 864 m^3. So the total capacity of the square shaped water tank is 864000 litres or 864 m^3.
3) *Rectangular Water Tank:* Considering the length of rectangular water tank as 16m, the width as 9m and height as 6m, the total volume of the rectangular shaped water tank can be derived by the formulae $v = l \times b \times h$ where 'l' is the length, 'b' is the width and 'h' is the height of the tank. So the total volume derived is 864000 litres or 864 m^3. So the total capacity of the rectangular water tank is 864000 litres or 864 m^3.

All the above water tanks are to be designed for the same capacity i.e. 864000 litres.

C. *Analysis of water tanks in Staad pro.*

Considering the capacity of all the above water tanks as 864000 litres, the analysis of these water tanks can be done in Staad Pro. Following are the steps performed in Staad Pro for analysis of water tank resting over ground:

1) Inserting the decided geometrical parameters of the water tank in command of run structure wizard in Staad Pro and also assigning the plates to all the required sides of the water tank.
2) Selecting proper supports for the water tank and applying the loads acting on the water tank resting over ground.
3) After application of loads run analysis command is to be given.
4) The analysis we have performed should give the result of zero errors, zero warnings and zero notes.
5) When we see zero errors, zero warnings and zero notes in our analysis we can further enter into the post processing mode.
6) In the post processing mode we can know the displacements, reactions and deflections produced in the water tank.
7) Performing the same process for analysis of the desired shapes and support conditions, comparison between the values of displacements, reactions and deflections produced in the water tank can be done.
8) The above comparison gives us the excepted result from the analysis done.

All the above steps give the complete analysis of water tank resting over ground for the required capacity. Same analysis has to be performed for all the three tanks with different support conditions and by comparing their displacements, reactions and deflections, a perfect shape of water tank depending on the conditions, can be derived.

IV. TO COMPARE THE ANALYSIS OF CIRCULAR, SQUARE AND RECTANGULAR WATER TANK WITH DIFFERENT SUPPORT CONDITIONS.

A. *Comparison of Maximum Absolute Stress values*

The comparison of maximum absolute stress values of the water tanks are done by assigning two different supports i.e. fixed support and hinged support separately to all the three shapes of the water tanks. Thus, comparison can be made from the varying maximum absolute stress values of the water tanks.

1) Comparison of maximum absolute stress values of circular, square and rectangular water tanks for fixed support:

Table I: Maximum Absolute Stress Values of Water Tanks for Fixed Support

Comparative Maximum Absolute Stress values of water tanks for Fixed support		
Sr. no	Type of water tank	Maximum Absolute Stress values in N/mm^2
1)	Circular (Fixed)	0.301 N/mm^2
2)	Square (Fixed)	0.362 N/mm^2
3)	Rectangular (Fixed)	0.405 N/mm^2

For Fixed support, after applying the same loads to all the three tanks and looking at the values of the above table it can be said that the circular type of water tank resists more stresses as compared to the other shaped water tanks, the square shaped water tank resists more stresses as compared to the rectangular type water tank and the rectangular type of water tank resists the least amount of stresses as compared to the other two water tanks. From the analysis done, it is seen that for a fixed support the circular water tank has least number of Max. Absolute Stress value i.e. 0.301 N/mm^2.

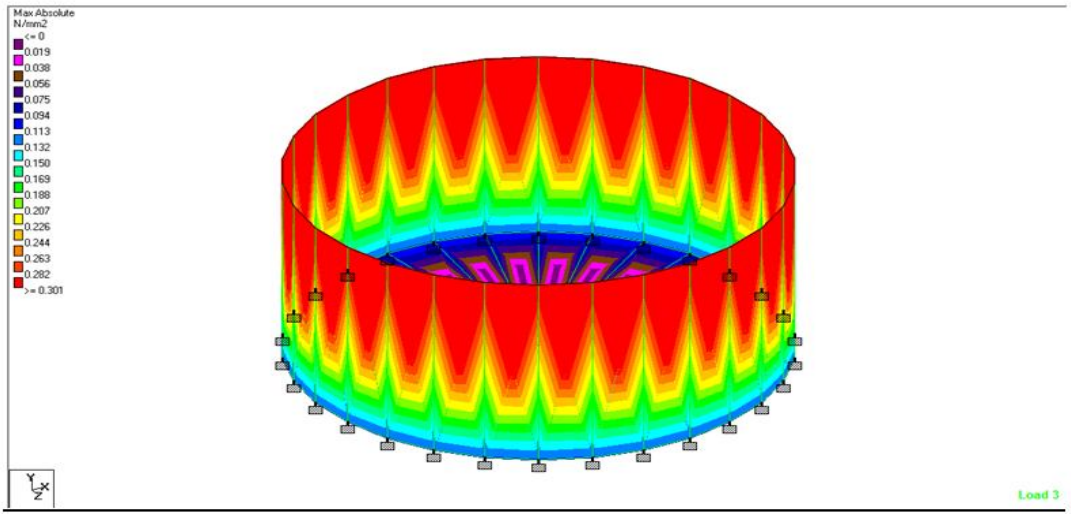

Fig 1: Max. Absolute Stress Value of circular water tank (Fixed)

2) Comparison of maximum absolute stress values of circular, square and rectangular water tanks for hinged support:

Table II: Maximum Absolute Stress Values of Water Tanks for Hinged Supports

Comparative Maximum Absolute Stress values of water tanks for Hinged support		
Sr. no	Type of water tank	Maximum Absolute Stress values in N/mm^2
1)	Circular (Hinged)	1.78 N/mm^2
2)	Square (Hinged)	0.721 N/mm^2
3)	Rectangular (Hinged)	0.669 N/mm^2

For Hinged support and same loads to all the three tanks and looking at the values of the above table it can be said that the rectangular type of water tank resists more stresses as compared to the other shaped water tanks, the square shaped water tank resists more stresses as compared to the circular type water tank and the circular type of water tank resists the least amount of stresses as compared to the other two water tanks. From the analysis done, it is seen that for a hinged support the rectangular water tank has least number of Max. Absolute Stress value i.e. 0.669 N/mm^2.

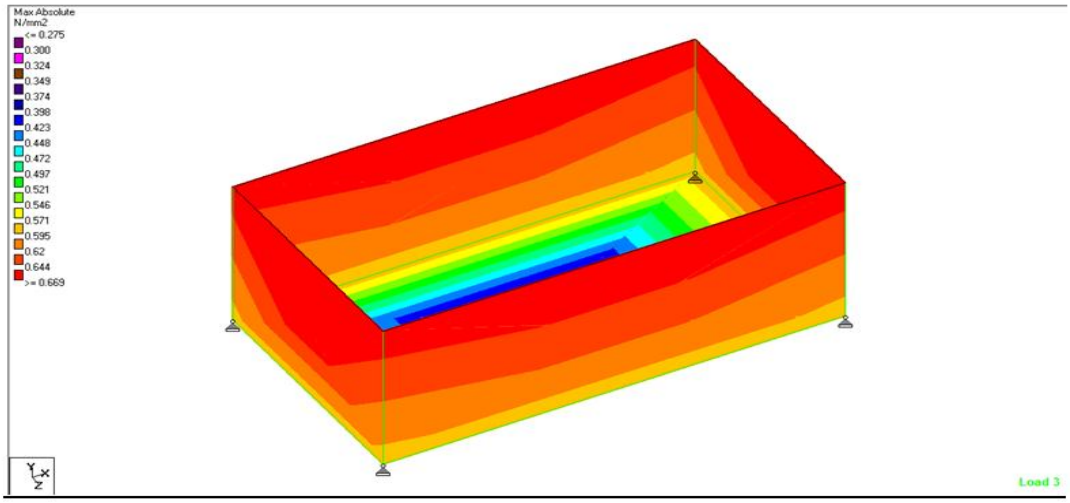

Fig 2: Max. Absolute Stress Value of Rectangular water tank (Hinged)

V. CONCLUSION

The Report summarises the study of analysis of various shapes of water tank for same capacity with changing support conditions in Staad pro, depending on various objectives that have been fulfilled according to our study.

In this report, the capacity of all the 3 tanks is kept same i.e. 864000 litres analysis is done over various shapes of water tank by changing their support conditions. For Fixed support, applying the same loads to all the three tanks and looking at the values of the above table it can be said that the circular type of water tank resists more stresses as compared to the other shaped water tanks, the square shaped water tank resists more stresses as compared to the rectangular type water tank and the rectangular type of water tank resists the least amount of stresses as compared to the other two water tanks. So from the analysis done, it can be said that for a fixed support the circular water tank is more stable as compared to the other two water tanks as the circular water tank has least number of Max. Absolute Stress value i.e. 0.301 N/mm^2.

For Hinged support applying same loads to all the three tanks and looking at the values of the above table it can be said that the rectangular type of water tank resists more stresses as compared to the other shaped water tanks, the square shaped water tank resists more stresses as compared to the circular type water tank and the circular type of water tank resists the least amount of stresses as compared to the other two water tanks. So from the analysis done, it can be said that for a hinged support the rectangular water tank is more stable as compared to the other two water tanks as the rectangular water tank has least number of Max. Absolute Stress value i.e. 0.669 N/mm^2.

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[2] Manjusha Chute 1, Vijaya Bhagadkarr 2, Buddhapriya Ramteke 3, Aman Shende4, Rupali Singh 5, Rameez Raza 6. 1,2,3,4 Student, Department of Civil Engineering, WCEM, Nagpur, India. 5,6 Professor, Department of Civil Engineering, WCEM, Nagpur, India International Journal of Research in Engineering, Science and Management Volume-2, Issue-3, March-2019 www.ijresm.com | ISSN (Online): 2581-5792.

[3] Dhritiman Mondal Assistant Professor, Dream Institute of Technology E-mail : dhritimanmondal8@gmail.com J.C. Guha Professor, Narula Institute of Technology International Journal of Innovative Research & Studies Volume 8, Issue IV, APRIL/2018 ISSN NO : 2319-9725492 http://ijirs.in/.

[4] Thalapathy.M[1], Vijaisarathi.R.P[1], Sudhakar.P[1], Sridharan.V[1], Satheesh.V.S[2] [1]UG student, Department of Civil Engineering, Adhiyamaan College of Engineering, Hosur, Tamilnadu, India. thalapathy1595@gmail.com [2]Assistant professor, Department of Civil Engineering, Adhiyamaan College of Engineering, Hosur, Tamilnadu, India. IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 3, March 2016. www.ijiset.com ISSN 2348 – 7968.

[5] Vaseem Akhtar 1, Shaik Rehman 2, S Zubeeruddin 3 1 P.G. Scholar, 2 Guide, Assistant Professor, 3 Head Of Department 1,2,3 Branch : Structural Engineering 1,2,3 Geethanjali College of Engineering and Technology, Kurnool Email: 1 vaseemakhtarce@gmail.com, 3avrsvr_ec@rediffmail.com p-ISSN: 2348-6848 e-ISSN: 2348-795Xs Volume 08 Issue 03 March 2021.

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[7] Jay R. Dholariya 1, Paresh V. Patel 2 International Journal of Emerging Technology and Advanced Engineering (E-ISSN 2250–2459, UGC Approved List of Recommended Journal, Volume 7, Special Issue 2, December 2017) 1 Postgraduate Student, 2 Professor, Department of Civil Engineering, Institute of Technology, Nirma University, Ahmedabad, India 1. dholariyajay31@gmail.com, 2. paresh.patel@nirmauni.ac.in.

[8] Payal Chavhan 1, Sneha Dorle 2, Ashish Bendwar 3, Amol Kumar Jangere4, Rupali Singh 5, Rameez Raza 6 1,2,3,4 Student, Department of Civil Engineering, WCEM, Nagpur, India 5,6 Professor, Department of Civil Engineering, WCEM, Nagpur, India International Journal of Research in Engineering, Science and Management Volume-2, Issue-3, March-2019 www.ijresm.com | ISSN (Online): 2581-5792.

[9] Sunita Ahuja Department of civil Engineering Sanghvi institute of management and science indore, Madhya Pradesh, India. 2 Sourabh Dashore Department of civil Engineering Sanghvi institute of management and science indore, Madhya Pradesh, India International Journal of Scientific Research & Engineering Trends Volume 5, Issue 6, Nov-Dec-2019, ISSN (Online): 2395-566X.

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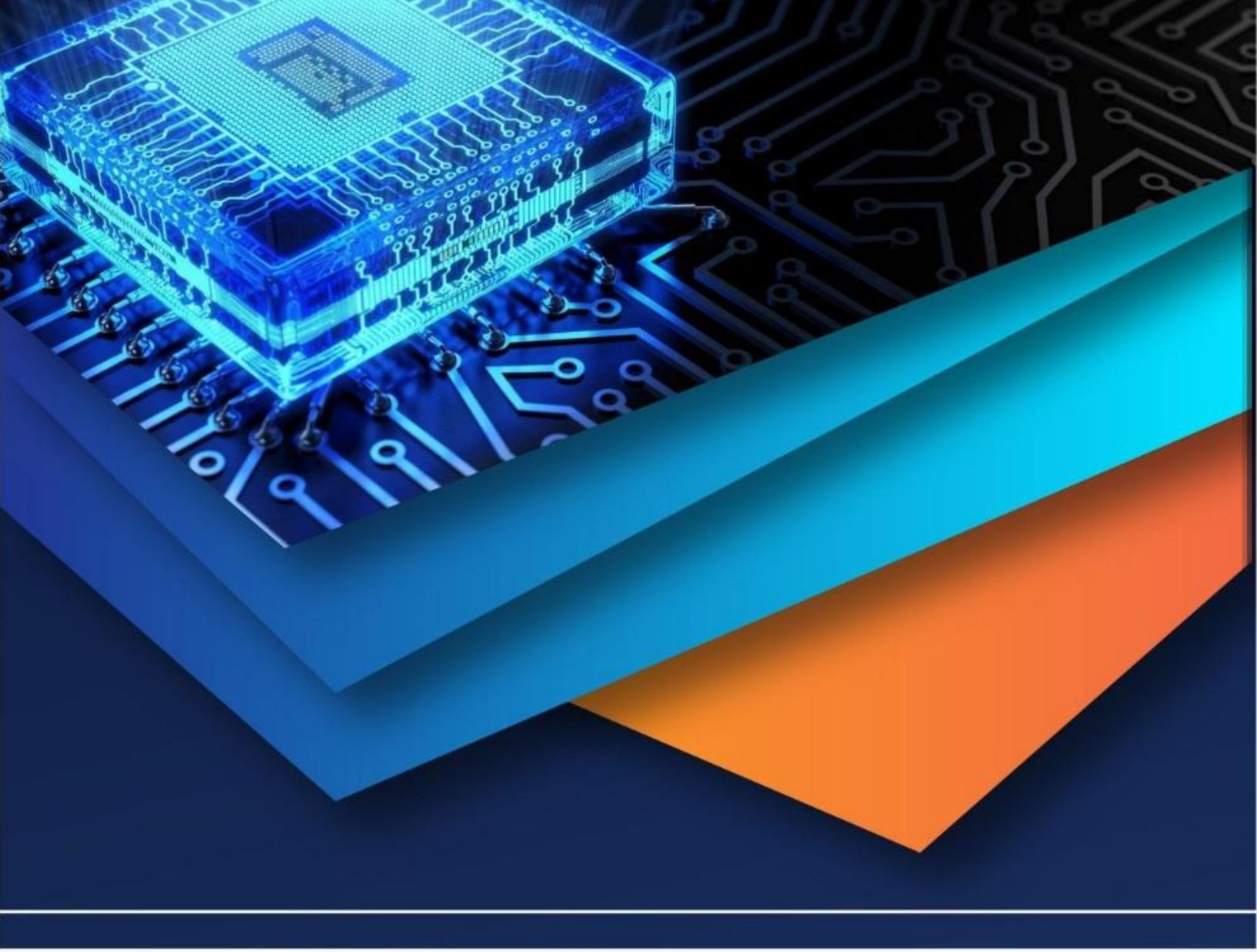

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