iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** VI **Month of publication:** June 2019

DOI: http://doi.org/10.22214/ijraset.2019.6077

Comparative Analysis of Elevated Water Storage Structure using different Bracing Pattern in Staging

Vishal Rokade[1], Shriram Salunkhe[2], Pranay Shinde[3],Dhanraj Tawhare[4], Nikhil Yokar[5]
[1, 2, 3, 4, 5]*Department of Civil Engineering Dr. D. Y. Patil Institute of Technology, Pune, Maharashtra, India*

Abstract: The energy released due to earthquake as seismic wave is propagated from the epicenter to the earth surface. This seismic wave causes the ground shaking which in turn causes severe damages to the structure overlying on the surface. During the propagation of this wave it has to travel through rock and soil types having different properties and of variable depth. According to the Indian standard for Earthquake resistant design (IS: 1893), the seismic force depends on the zone factor (Z) and the average response acceleration coefficient (Sa/g) of the soil types at thirty meter depth with suitable modification depending upon the depth of foundation. As per IS 1893, only three types of soils (soft, medium and hard) is considered without any consideration for the site specific soil parameters. In the present study an attempt has been made to generate response spectra using site specific soil parameters for some sites in seismic zone V, i.e. Arunachal Pradesh and Meghalaya and the generated response spectra is used to analyze some structures using commercial software STAAD Pro.
Keywords: Hydrodynamic pressure , Elevated Water Tank , STAAD Pro V8i. Base shear , Maximum Bending Moment

I. INTRODUCTION

Liquid storage tanks are essential structures in water, oil and gas industrials and the behaviour of them during earthquake is more important than the economic value of the tanks and their contents. It is important that utility facilities remain operational following an earthquake to meet the emergency requirements such as fire fighting water or meet the public demands as a source of water supply. For these reasons, serviceability becomes the prime design consideration in most of these structures. A good understanding of the seismic behaviour of these structures is necessary in order to meet safety objectives while containing construction and maintenance costs. One of the problems that are important in analysis and designing of these structures is the interaction between fluid and structure. Prediction of analytical response of coupled field systems is very complex and approximately no available. So most of investigations are concerned about numerical methods such as finite element method. In this paper Numerical analysis of elevated concrete water tanks with central shaft is performed by using of finite element software which fluid- structure interaction is considered. Elevated tanks should remain functional in the post-earthquake period to ensure water supply is available in earthquake-affected regions. Never the less, several elevated tanks were damaged or collapsed during past earthquakes Due to the fluid–structure–soil/foundation interactions, the seismic behaviour of elevated tanks has the characteristics of complex phenomena. Therefore, the seismic behaviour of elevated tanks should be known and understood, and they should be designed to be earthquake-resistant. Some general programs have been carried out, which cover large amounts of data; these programs include STAAD PRO etc.

II. LITERATURE REVIEW

In this chapter, the survey of all the past researches is done. This past research has guided us in carrying out this investigation. The various methods used in the previous works has been of great help.

III. METHODOLOGY

A. Design Of Water Tank

1) *The Top Dome And Top Ring Beam:* The dome and ring beam are assumed to be freely connected to the cylindrical wall of the tank with the help of shear key. We shall design the top dome and its ring beam on membrane analysis, considering these to be independent of the tank wall which is assumed to be free at top.
2) *The Cylindrically Wall:* Let the diameter of tank be D and the height of cylindrical portion be H. The walls are assumed to be free at top and bottom. Due to this, tank walls will be subjected to hoop tension only without any B.M. Maximum hoop tension

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VI, June 2019- Available at www.ijraset.com

will occur at base, its magnitude being equal to W.h.d/2 per unit height. The tank walls are adequately reinforced with horizontal rings provided at both faces. In addition to this, vertical reinforcement is provided on both the faces in the form of distribution reinforcement.

3) *Design Of Ring Beam At The Junction Of The Cylindrical Wall And Conical Dome:* Find hoop tension in the beam by the formula $H = H_1 * d/2 + H_2 * d/2$ Where, H_1- horizontal component of the thrust T, due to w_1. w_2 being the load transmitted through the tank wall at the top of the conical dome. The value of H_1 is given by $H_1 = w_1 \tan(\beta)$ H_2 - horizontal force due to water pressure at the top of the conical dome and its value is given by $H_2 = w * h * d$ Where, d - Assumed depth of the beam h - is the depth of water up to the centre of beam. Having calculated H, the beam can be designed in a similar manner as the top ring beam. It is desirable to keep the depth of the beam less, so as to get more width, which may serve as walkway or inspection gallery around the tank. Design of conical dome: The steps to be followed in the design are: Find the weight of water on the conical dome by taking average diameter and the corresponding depth of water. To this value add the self-weight of the conical dome slab and the load (w_1) transmitted through the tank wall at the top of the conical dome. Divide the total load obtained above by the perimeter of the conical dome at base, to get load per meter run at the conical dome base. Find Meridional thrust in the slab due to (w_2) by the formula $T = W2 / \cos\beta$
4) Find hoop tension due to water pressure and self-weight of the conical dome slab, we know that the water pressure will act, normal to the inclined slab surface. Let the intensity of water pressure at a depth h meter above conical dome base be "P" and let, Dh be the diameter of the conical dome at this depth. Hoop tension is then given by a general formula, $H = (\rho/\cos\beta + q.\tan\beta)\, Dh/2$ Where, q - weight of the conical slab per square meter of the surface area.
5) With the help of the above formulae, find the value of hoop stress at bottom, mid height and top of the inclined conical dome slab and provide necessary hoop reinforcement.
6) *Design Of Bottom Spherical Dome:* The bottom dome is designed in the similar manner as the top dome, except that the load of the water above the dome is added to the self-weight of the dome slab to get design load for the dome.
7) *Design Of Bottom Ring Beam:* The steps to be followed in the design are: Find the net horizontal force (P) on the ring beam given by the formula, $P = T_1 \times \cos\alpha \sim \cos\gamma$ If $T_1 \cos\alpha > \cos\gamma$, the result will be net inward force per meter i.e. the force will be compressive in nature. Find hoop stress given by,=PD/2 * 1/bd (compressive) Being compressive in nature and normally very small in magnitude, its effect can be neglected. (In a well-proportioned tank the net horizontal force should be much less.) Find vertical load per meter run, given by $= T_1 \cos\beta * T_2 \sin\gamma$ Alternatively: Vertical load per meter can also be found by dividing the total vertical loads by the perimeter of the bottom ring beam.
8) *Design of Staging:* Let W be the total vertical load (including live loads) due to tank and its contents above the staging. If n be the number of columns in the staging: Total load on each column = W/η . Add to this the vertical force $P\omega$ due to wind to which the column will be subjected to. When the wind blows, the windward columns on leeward side experience downward forces. The neutral axis can be considered a line passing through the centre of the group of column circle and at right angles to the direction of wind. Let, Mw = Moment due to wind about the bottom of columns and let „r‟ be the distance from any column to the neutral axis. Σr^2 = Sum of the square of the distances of all the columns from N.A. The vertical force in any column at a distance r from N.A. is given by the formula $Pw = Mw * r / \Sigma r^2$
9) *Alternatively:* The maximum force in the remotest or the extreme column can also be calculated from the following formula $Pw = 2Mw/n*R$ Where, R = radius of the column circle. It is obvious that the farthest column or the extreme column on the leeward side will govern the design of columns. The column should be designed for a. Maximum bending moment given by the equation B.M. =1/2 * Max. Horizontal shear * Distance between the bracing; and b. Total vertical Load = P + Pw

IV. APPROPRIATE SELECTION OF SOFTWARE

STAAD.Pro.v8i is the most popular structural engineering software product for 3D model generation, analysis and multi-material design. It is user-friendly GUI, visualized tools, powerful analysis and design facilities and seamless integration to several other modelling and design software products. For static as well as dynamic analysis of bridges, containment structures, embedded structures (tunnels and culverts), pipe racks, steel, concrete, aluminium or timber buildings, transmission towers, stadiums or any other simple or complex structure, STAAD-Pro has been the choice of design professionals around the world for their specific analysis needs.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VI, June 2019- Available at www.ijraset.com

V. COLLECTION OF DATA AND COMPUTATION PROCEDURE

WATER TANK NO. 1
LOCATION – PIMPLE GURAV

WATER TANK NO. 2
LOCATION - SANGVI

VI. PROBLEM STATEMENT

A reinforced elevated circular water tank with fixed base frame type tank with 500 m3 capacity is considered for present study. It is supported on RC staging consisting of 8 columns. Tank is located on medium soil. Grade of staging concrete is M25and Fe 415, Density of concrete is 25 KN/m3.

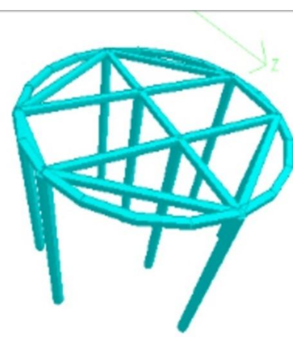
Sr .No	component	size
1	Roof slab	200 mm
2	Wall	200 mm
3	Floor slab	200 mm
4	Floor beam	350 * 365 mm
5	Braces	350 * 365 mm
6	Column diameter	600 mm
7	Inner diameter of tank	16500 mm
8	Outer diameter of tank	16100 mm
9	Height of tank	7500 mm

Table no 1: sizes of various component of water tank

VII. TYPES OF BRASSING SYSTEM USED:

Cross Bracing

Hexagonal Radial Bracing



Hexagonal Cross Bracing

VIII. RESULT

	Cross Pattern			Radial Pattern			Hexagonal Cross Pattern		
	Full	Half	Empty	Full	Half	Empty	Full	Half	Empty
MBM	379.88	187.98	28.93	128.987	88.37	29.315	98.33	65.23	28.9
Base shear	65.92	58.73	30.88	49.121	33.22	21.121	24.33	22.98	21.06

IX. CONCLUSION

A. Radial configuration has more stiffness than cross and normal and deflection vice versa.

B. In radial configuration though base shear is more, roof displacement is less than cross and normal configurations for all zones. Hence performance of radial configuration is better

C. Base shear increases as the level of bracing increases because, bracing system put on additional mass to the structure, which results into increase in base shear value.

D. Similarly base moment is found to be increased as the level of bracing increases

E. Base shear in full condition tank is slightly higher than empty tank due to absence of water or Hydrostatic pressur

REFERENCES

[1] Nitesh j Singh1, Mohammad Ishtiyaque2 "Design Analysis & Comparison Of Intze Type Water Tank For Different Wind Speed And Seismic Zone As Per Indian Codes"in2015.

[2] R.S. Jangid, M.K. Shrimali "Seismic Analysis Of Base –Isolated Liquid Storage Tanks".

[3] El Damatty, A.A.,Korol, R.M.(1997A), ''Stability Of Imperfect Steel Conical Tanks under Hydrostatics Loading", Journal Structural Engineering,123(6),pp.703-712".

[4] Kelly JM. "Aseismic base isolation :review and bibliography .Soil Dynamic and Earthquake Engineering 1986;13:202-16".

[5] Mor Vyankatesh K, More Varsha T. "Dynamic analysis of RC elevated water tank frame staging supported".

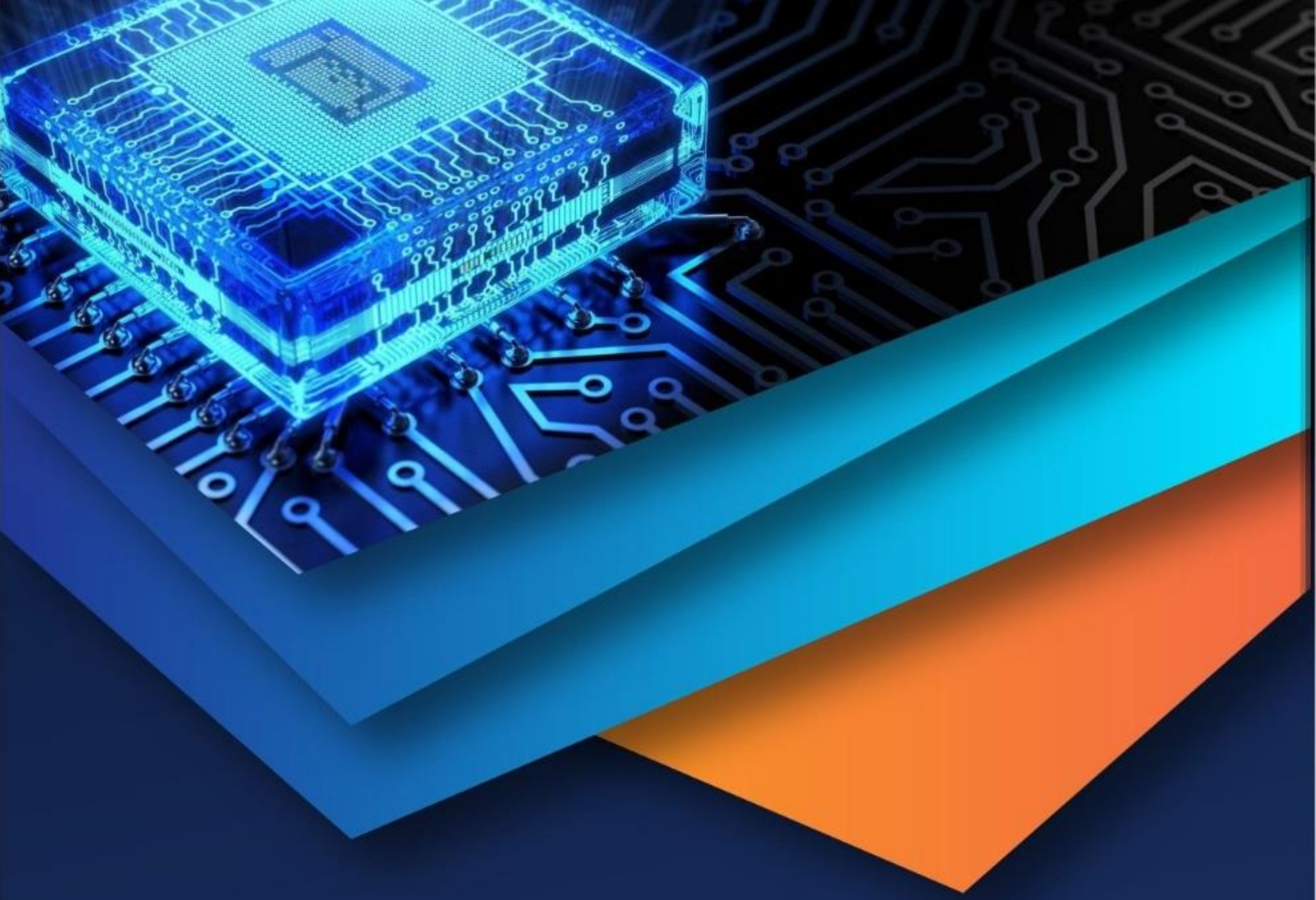
[6] P. S. Nemade, Dr. A. M. Pande "Parametric studies in design of staging configuration for elevated service reservoir for seismic consideration".

[7] Sonali M. Pole1, Amey R. Khedikar "Seismic investigation of RC elevated water tank for different type of staging system."

[8] Ankush N. Asati, Dr. Mahendra S.Kadu "Seismic behaviour of RC elevated water tank under different staging pattern and earthquake characteristics ".

[9] Ayazhussain M. Jabar1, H. S. Patel "Seismic behaviour of RC elevated water tank under different staging pattern and earthquake characteristics."

[10] Dhiraj virkhare, Prof. Laxmikant vairagade, Vikrant nair "Pushover analysis of water tank staging



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY