Displacement &Cost Analysis of Bottom Ring Beam and Foundation of R.C.C over Head Tank for Various Earthquake Zones

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Abstract - *Many researchers have worked on the behavior, analysis, and seismic design of tanks, especially tanks on the ground, while only a few of these investigators have to do with reinforced concrete tank. The present study reports the analysis and design of an R.C.C. Over head tank using STAAD. ProV8i. The design method used in the STAAD. Pro analysis is that the water tank is subject to active load, dead load, own weight and seismic loads. The seismic load calculations are performed according to IS 1893-2000.The aim of this study is to understand the behavior of Displacement & Cost Analysis of Bottom Ring Beam & Foundation of R.C.C Overhead Tank for Various Earthquake Zones. Different models are used for calculating nodal displacements for bottom ring beam & whole structure over head tank for various earthquake zones & work out the variation of cost of foundation for various earthquake zones. The document gives an idea for a secure design with a minimum cost of the base and provides the relationship curve between the designer and the design variable. Therefore, the design of the base can be more economical, reliable and simple.*

***Key Words*: Static analysis, Seismic analysis, Node displacements, Estimate and Rate analysis, STAAD-Pro.**

1. INTRODUCTION

Water tanks are used to store water. The cost, shape, dimensions and construction materials used to build the water tanks are influenced by the capacity of the water tank. The shape of the water tank is an important design parameter because the nature and intensity of the stresses are based on the shape of the water tank. In general, for a given capacity, the circular shape is preferred because the stresses are uniform and lower than other shapes. Less stress means less amount of material required for construction that reduces the cost of building water tanks. The design of the liquid retention structure should be based on avoiding cracking in the concrete taking into account its tensile strength. The cracks can be prevented by avoiding the use of thick wooden formworks that prevent the easy escape of heat from the hydration of the concrete mass. The raised water tank is a large high water storage container constructed to maintain a water supply at a height sufficient to pressurize a water distribution system. In large cities, the main supply pattern is enhanced by the individual supply systems of industrial institutions and industrial areas for which raised tanks are an Integral part. These structures have a configuration that is particularly vulnerable to horizontal forces due to the large total mass concentrated in the upper part of the thin support structure. The damage to important lifeline services such as high water tanks often causes considerable difficulties even after the disaster occurs, sustaining human losses and economic losses in the built environment. The survey on the effects of seismic wind has been recognized as a necessary step to understand the natural risks and their risk for the long-term society. Water tanks the strength of these tanks against the side forces, such as those caused by the wind, requires special attention.

1.1 LITERATURE REVIEW

G.P. Deshmukh, Ankush. S. Patekhede (2015) Investigated this study is to understand the behavior of different staging, under different loading conditions and strengthening the conventional type of staging, to give better performance during earthquake. Equivalent Static Analysis, for five different types of bracing systems, applied to the staging of elevated circular water tank in zone IV, is carried out using STAAD Pro. Comparison of base storey shear and nodal displacements of the container of circular water tank for empty, half filled and full condition is done .[17]

Miss. Neeta K.Meshram, Dr. P.S.Pajgade (2015) Investigated Detailed analysis and design is done. Working drawings are prepared for all conditions. For understanding the financial implications quantities for concrete and steel were calculated. Exact amount of steel required is calculated for each case as per working drawings. It was observed that in case of limit state design cost required is less. Obviously circular water tank is more economical compare to square tank. [4]

1.2 OBJECTIVE OF THE STUDY

The aim of this work is to study the design analysis and estimation of the storage tank and to understand the philosophy for the safe and economic design of the water tank according to the guidelines for the design of the liquid retention structure according to the code IS.

1. Calculate the forces and displacement of the node acting on the Intze water storage tank.

2. Conduct a study on the guidelines for designing the liquid retention structure based on the code.

3. Design and analyze the structure of the water tank using STAAD pro software.

4. To work out the variation of cost of foundation for various earthquake zone.

5. To find out the displacement of bottom ring of over head tank for various earthquake Zone.

6. To work out the Comparison of quantity of steel of Isolated Footings in different seismic zone.

2. METHODOLOGY

1. First of all we are constructing an Intze water tank model using STAAD-Pro
2. Provide the geometric properties of the water tank; create a model of Water tank.
3. Provide members with the properties of the water tank.
4. Provide the material properties of the water tank.
5. Provide loads as dead, live and earthquake loads in the water tank.
6. Run the analysis and then provide the design command based on the Code in STAAD-Pro.
7. Calculate the displacement of the node acting on the Intze water Storage tank.
8. To find out the displacement of bottom ring of over head tank for Various earthquake Zone.
9. Design and analysis Isolated footing of intze water tank with different Seismic zone using STAAD-Pro.
10. Detailed Estimate is prepared in two stages: Details of measurement and calculation of quantities.
11. To work out the variation of cost of isolated footing for various Earthquake zones.
12. To work out the Comparison of quantity of steel of Isolated Footings in different seismic zone.

3. PARAMETERS OF ELEVATED WATER TANK

Parameters	Values
size of top slab	350 mm thick
size of bottom slab	350 mm
size of top ring beam	450x450 mm
size of bottom ring beam	450x450 mm
size of column	Circular columns of 500mm dia.
size of braces	450x450 mm
density of concrete	25 kN/sq.m
Diameter of tank	14 m
Height of cylindrical portion tank	6 m
Depth of conical dome	2 m
Height of staging	12 m
Number of columns	12
Zone	I,II,III,IV(0.1,0.16,0.24,0.36)
Response reduction factor	5 (SMRF)
Importance factor	1 for water tank

4. 3-D MODELS AND POSITION OF NODES

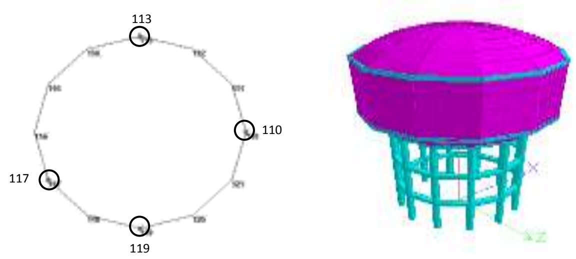


Fig -1: Intze Water Tank Model and Selected Nodes

5. PARAMETERS OF ISOLATED FOOTING

Parameters	Values
Footing Thickness (Ft)	305.000 mm
Footing Length - X (Fl)	1000.000 mm
Footing Width - Z (Fw)	1000.000 mm
Column Shape	Circular
Column Dia.	0.500m
Unit Weight of Concrete	25.000 kN/m3
Strength of Concrete	25.000 N/mm2
Yield Strength of Steel	415.000 N/mm2
Minimum Bar Size	Ø6
Maximum Bar Size	Ø32
Minimum Bar Spacing	50.000 mm
Unit Weight of soil	22.000 kN/m3
Soil Bearing Capacity	100.000 kN/m2
Coefficient of Friction	0.500

6. PLAN OF ISOLATED FOOTING

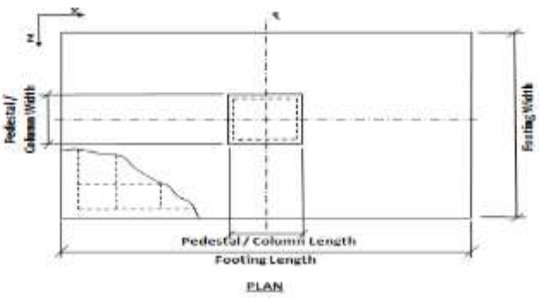


Fig -2: Plan for Isolated Footing

7. ESTIMATING OF ISOLATED FOOTING: Detailed Estimation

Detailed estimate is an accurate estimate and consists of working out the quantities of each item of works, and working the cost. The

dimensions ,length, breadth and height of each item are taken out correctly from drawing and quantities of each item are calculate, and abstracting and billing are done.

The detailed estimate is prepared in two stages:

Details of measurement and calculation of quantities: The details of measurements of each item of work are taken out correctly from plan & drawing and quantities under each item are calculated of isolated footing of different seismic zone II, III, IV, V.

Abstract of estimated cost: The cost of each item of works calculated the quantities already computed and total cost is worked out in abstract estimate (Rate analysis) form. The rates of different items of work are taken as per schedule of rates or current workable rates for finished item of work.

8. RESULTS AND DESCUSSION

Results of Node Displacement for different seismic zones:

S.NO.	ZONE	DISPLACEMENTS(mm)			
		Node no.110	Node no.113	Node no.117	Node no.119
1	II	9.302	9.245	9.33	9.358
2	III	11.66	11.59	11.7	11.74
3	IV	14.974	14.881	14.974	15.052
4	V	20.131	20.022	20.183	20.234

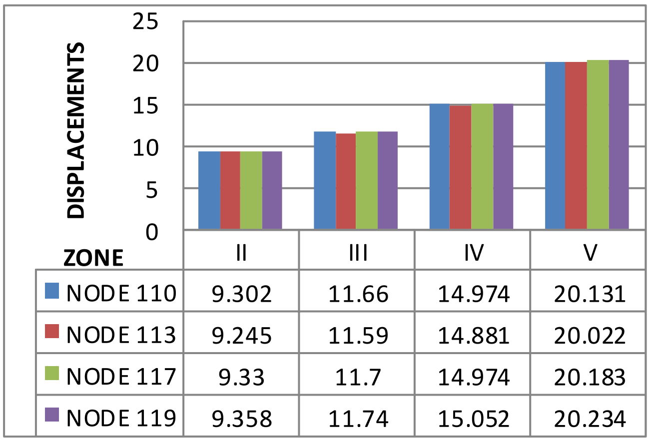


Chart -1: Average Node Displacement

Displacement value at Node 110 is 22.51% increased zone II to III, 24.85% increased zone III to IV, 29.38 %increased zone IV to V.

Displacement value at Node 113 is 22.56 % increased zone II to III, 24.86 % increased zone III to IV, 29.45 % increased zone IV to V.

Displacement value at Node 117 is 22.54 %increased zone II to III, 24.54 % increased zone III to IV, 29.63 % increased zone IV to V.

Displacement value at Node 119 is 22.58 %increased zone II to III, 24.72 % increased zone III to IV, 29.37 increased zone IV to V.

Results of cost analysis for different seismic zones

S.NO.	ZONE	COST	% INCREASE
1	II	8398653.75	-
2	III	8580845.22	2.123
3	IV	8580920.08	0.001
4	V	8604911.82	0.279

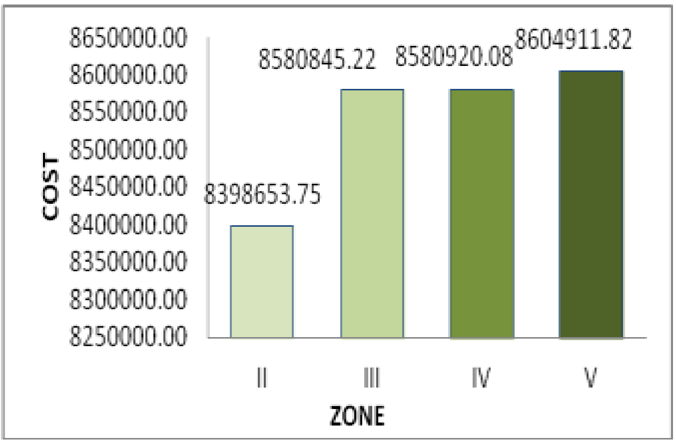


Chart -2: % Cost variation in different zone

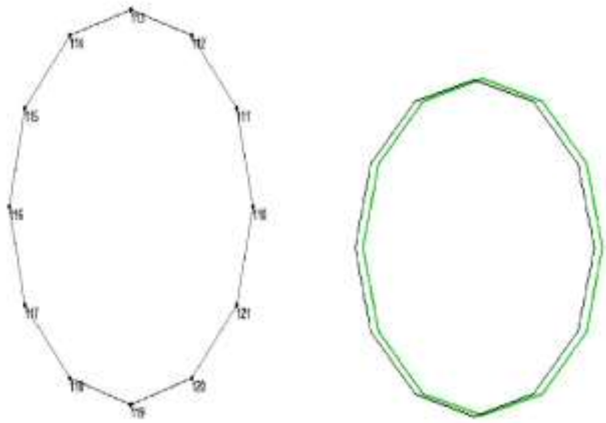
2.123% increase zone II to III, 0.001 % increase zone III to IV, 0.279 % increase zone IV to V.

Total Rate Analysis of isolated footing of zone II is Rs. 8398653.75/-

Total Rate Analysis of isolated footing of zone III is Rs. 8580845.22/-

Total Rate Analysis of isolated footing of zone IV is Rs. 8580920.08/-

Total Rate Analysis of isolated footing of zone V is Rs. 8604911.82/-



Displacement of the Bottom Ring Beam

Results of Comparison of quantity of steel of Isolated Footings in different seismic zone

ZONE	F1 & F25	F5 & F21	F9 & F17	F13	F29 & F45	F33 & F41	F37
	kg	kg	kg	kg	kg	kg	kg
II	5962.8	5989.05	6026.69	3013.33	5909.67	5909.67	2915.86
III	5962.8	6026.72	6064.39	2899.93	5867.17	5867.17	2885.76
IV	5962.8	6064.39	6171.14	2820.48	5831.75	5831.75	2885.74
V	5962.8	6114.63	6233.93	3154.63	5771.51	5771.50	2885.74

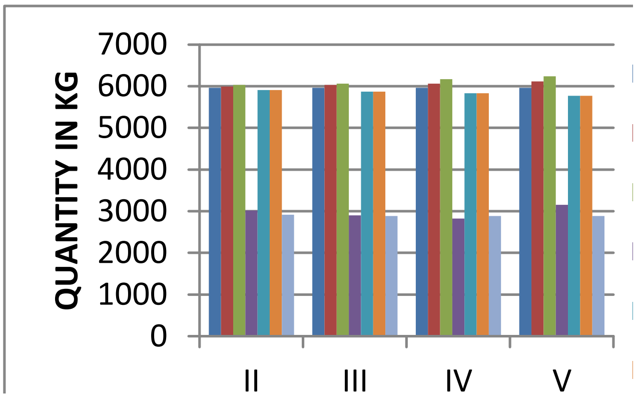


Chart -3: Reinforcement Variations at Different Zone

Quantity of steel 9.41 % increased zone II to III, 0 % increased zone III to IV, 0 % increased zone IV to V

Quantity of steel 0.63 %increased zone II to III, 0.625 % increased zone III to IV, 0.83% increased zone IV to V

Quantity of steel 0.625 %increased zone II to III, 1.76 % increased zone III to IV, 1.01 % increased zone IV to V

Quantity of steel 3.76 %increased zone II to III, 2.74 % increased zone III to IV, 11.84 % increased zone IV to V

Quantity of steel -0.719% decreased zone II to III, -0.603 % decreased zone III to IV, - 1.02 % decreased zone IV to V

Quantity of steel -0.719 % decreased zone II to III, -0.603 % decreased zone III to IV, -1.02 % decreased zone IV to V

Quantity of steel -1.03 % decreased zone II to III, -0.000693 %decreased zone III to IV, 0 % increased zone IV to V

3. CONCLUSIONS

The above study provides a useful design and help to improve the Life of Water tank structure. From the above results, from our study of various seismic zone we have observed that the Average Node Displacements of bottom ring beam found on water tank with different seismic condition is maximum i.e. average node displacement at node 119 zone V is 20.234 mm. We conclude that node 119 is unsafe for zone V and minimum Average node displacement at node 113 zone II is 9.245 mm and node 113 is safe for zone II.

We have compared the average node displacement with selected node 110,113,117 and 119. Maximum node displacement at node 119 is 20.234 mm and Minimum node displacement at node 113 is 9.245 mm. We are concluding that node 119 is unsafe for seismic condition and node 113 is safe for seismic condition.

From our study we have design an isolated footing with different seismic zone.

- Minimum cost analysis of isolated footing of zone II is Rs 8398653.75/- and Maximum cost analysis of isolated footing of zone V is Rs. 8604911.82/- .

- The percentage increase of minimum cost analysis of zone II to zone III is 2.13 %, zone III to IV is 0.001 % and zone IV to V is 0.279 %.

Comparison of quantity of steel of isolated footing in different seismic zone will be minimum at footing F13 is 2820.48 kg zone III and Maximum at footing F9 and F17 is 6233.93 kg zone V.

From the above study work the following conclusions are made:

- It can be seen that for respective seismic levels, it shows variation in displacement for corresponding nodes.
- In various seismic zones we have observed variation in displacements in the structures.
- From the obtained results we have compared relatively average node displacement, Cost analysis and Quantity of steel with different seismic zone.
- Staad-pro software can be used efficiently to determine the effect of node displacement with different seismic zone.

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