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Seismic Analysis and Design of INTZ Type Water Tank for Storage Water

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ABSTRACT

Liquid Storage structures are generally constructed with reinforced concrete. Such structures must have adequate strength and be in compliance with serviceability requirement with respect to crack widths. In this study an attempt is made to understand the differences in structural behavior of intz type water tank with two types of idealization for foundation such as rigid with half-filled and full capacity of water. This paper deals with FE analysis of intz type tanks supported on rigid foundation. Few verification problems are also solved for software familiarization purposes. Structural components of the elevated water tank are designed by using the semi-automation features available in EXCEL.

Key words: Shear stress, Lateral force, Wind and Earthquake, intz Tank, FE analysis

1. INTRODUCTION

Liquid Storage structures are generally constructed with reinforced concrete. Such structures must have adequate strength and be in compliance with serviceability requirement with respect to crack widths. Conceptually the design of liquid retaining structures is different from usual RC structures in the sense that concrete should not crack. This important design requirement is achieved by limiting the tensile stresses in concrete to be within permissible limits as specified in codes of practice. The design of elevated water tanks has yet another important design check to be performed so as to ensure stability with respect to lateral loads generated due to wind and earth quake.

1.1 Elevated Intz Tanks

Elevated intz type water tanks are supported on staging which may consist of masonry walls, RC. Tower or RC columns braced together. The walls are subjected to water pressure. The base has to carry the load of water and tank load. The staging has to carry load of water and tank. The staging is also designed for earthquake force and also wind force.

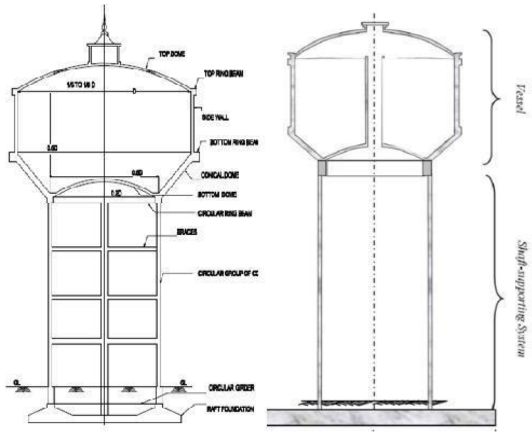


Fig. 1: Structural Element of Intz Type Water Tank

2. OBJECTIVES

1. The object is to have a good understanding of behavior of water tank and to ensure the structural integrity and safety of the structure.
2. The modeling of elevated intz type water tank and analysis for different load combinations.
3. To make the study about guide lines for the design of liquid retaining structure according to IS-code.
4. To know about the design criteria for the economical and safe design of intz type water tank.
5. To study the concept of design of intz type of water tank.
6. To validate the results what we have got from manual and software calculations.
7. To compare the results of manual calculation and staad.Pro.vsi calculations.
8. To study about the concept of rigid and flexible base intz type water tank.
9. To create an excel sheet manual design and design results tabular format.
10. Design of elevated intz type water tank using excel as per IS 456:2000, IS 3370-2009.

3. METHODOLOGY

1. The structure of elevated intz type water tank is modeled in STAAD and analyzed for all loads and load combinations.
2. The structure is analyzed for different cases of gravity loads such as dead load and live load, the lateral load such as earth quake and wind load and primary load cases as per IS 875 (part-1,2&3) and IS 1893(part-1)2002.
3. Material properties, physical property and boundary conditions are assigned.
4. Performance and analysis for water tank for different load conditions. Results are compared for the rigid and flexible base of foundation.
5. Analysis is carried out for two cases namely, tank full and zero level condition considering the hydro static pressure.

Table 1: Physical Properties of Intz Water Tank

Columns	0.6M diameter
Bracing	0.5x0.5M
Circular ring beam	0.6x1.2 M
Bottom ring beam	0.6x1.2M
Top ring beam	0.3x0.3M
Plate Thickness	
Raft foundation	1M
Bottom dome	0.3M
Conical dome	0.6M
Cylindrical wall	0.4M
Top dome	0.1M

Table 2: Material Properties of Intz Water Tank

Density of concrete	2500kg/ m^3

Poison's ratio	0.2
Young's modulus	2000 N/mm^2 (M20)
Grade of concrete	M20

3.1 Isometric view of the structures

Fixed boundary conditions are assumed at the foundation level. Structural analysis and design are performed using STAAD.Pro software.

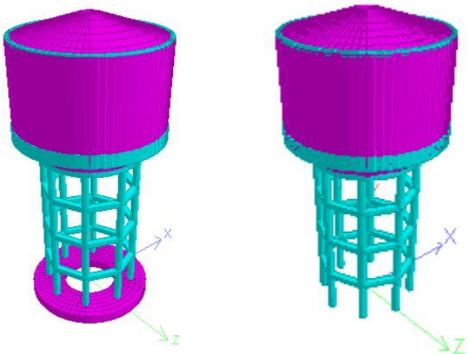
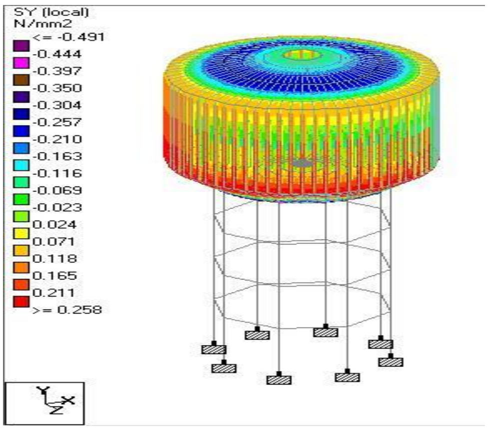


Fig. 2 Isometric view of the structures for Flexible Base and Rigid Base

For Empty DL Case



For full DL Case

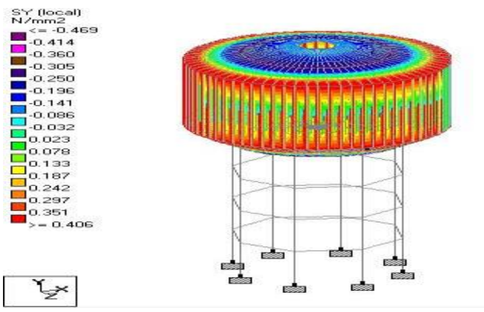
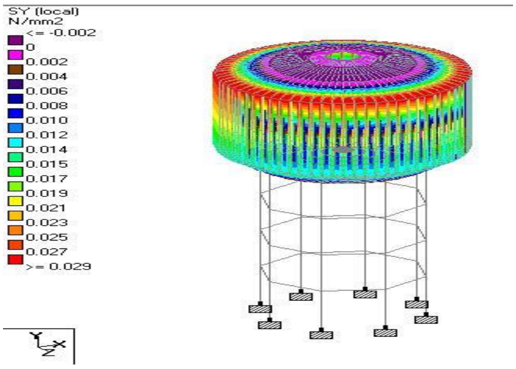


Fig 3 Stress contour obtained for Flexible foundation

For Empty LL Case



For full LL Case

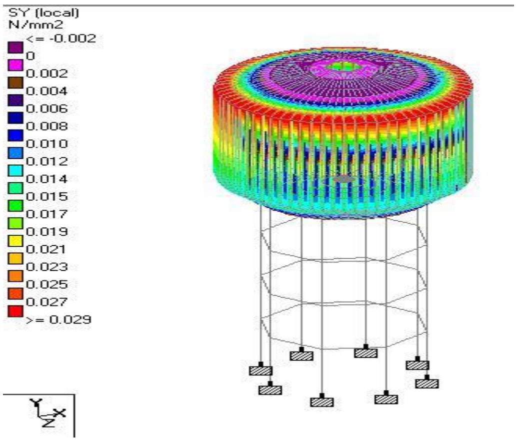


Fig. 4 Stress contour obtained for Flexible foundation

4. RESULTS AND DISCUSSIONS

The conclusion that we come to know after the comparison of intz type water tank for flexible and fixed case is as follows.

1. Flexible pavement or supports are differs from rigid Supports in terms of load distribution. In flexible pavements load distribution is primarily based on layered system that means load is distributed step by step in the form of layer. While, in case of rigid pavements most of the load carries by slab itself and slight load goes to the underlying strata of the water tank.
2. Flexible pavement depends on the description of every single layer below the water tank. While, the structural capacity of rigid pavements is only dependent on the characteristics of mesh tank. This is so, because of low bearing soil capacity of underlying soil.
3. Load intensity decreases with the increase in depth. Because of the distribution of loading in each single layer. While, in case of rigid pavement maximum intensity of load carries by Tank itself, because of the weak underlying layer.
4. In flexible pavement deflection basin is very deep, because of its dependence on the underlying layers. While in case of rigid pavement, deflection basin is shallow, this is because of independency of rigid pavement on the underlying layers.
5. Flexible pavement has very low modulus of elasticity (less strength). Modulus of elasticity of rigid pavement is very high, because of high strength concrete and more loads bearing capacity. Than compared to that of the flexible pavements.
6. In flexible pavements, underlying layers play very prominent role. Therefore, more roles are playing only underlying layers. In case of rigid pavements, slight function of fundamental layers. Maximum

role is playing by the top layer (that is slab) by itself. Therefore, minute part is taking by sub layers of the water tank.

5. CONCLUSIONS

1. Significant differences are found in the structural behavior with Full and Zero Filed Case idealizations.
2. Semi automation tools developed in the present study for the design of structural components can be used for preliminary design purposes to fix the element properties for detailed FE analysis.
3. It is found that the maximum stress contour for the structural component in the empty dead load case is 0.258 N/mm^2 and it is found that maximum stress contour for the structural component in full dead load case is 0.406 N/mm^2 Since there is no water in the tank the only load coming is its self-weight so the empty case the value is 0.258 N/mm^2. where as in the case of full load self-weight and water load is also coming to the foundation of the water tank i.e. 0.406 N/mm^2
4. It is found that the maximum stress contour for the structural component in the empty live load case is 0.029 N/mm^2 and it is found that maximum stress contour for the structural component in full live load case is 0.162 N/mm^2.

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