|| Volume 5 || Issue 12 || June 2021 || ISSN (Online) 2456-0774

INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH & ENGINEERING TRENDS

Multidisciplinary Journal

Double-Blind Peer Reviewed Refereed Open Access International Journal

DESIGN & ANALYSIS OF INTZE TYPE WATER TANK

[1]SHAIK.SUBHANI, [1]T.SAI LATHA, [1]R.NAGA BABU, [1]P.RAKESH, [1]B.NAGA NARESH

[2]Sri. K.VENKATESWARA RAO, M.Tech (Ph.D),

[1]B.Tech students, Department of Civil Engineering, Gudlavalleru Engineering College, Gudlavalleru, Krishna District, Andhra Pradesh,

[2]Associate Professor, Department of Civil Engineering, Gudlavalleru Engineering College, Gudlavalleru, Krishna District, Andhra Pradesh,

1Subhanishaik0809@gmail.com, 2raokalyanapu@gmail.com

---***---

Abstract: Water tanks are important public utility and industrial structure. The design and construction methods used in reinforced concrete are influenced by the prevailing construction practices, the physical property of the material and the climatic conditions. Any design of Water Tanks is subjected to Dead Load + Live Load and Wind Load or Seismic Load as per IS codes of Practices. Most of the times tanks are designed for Wind Forces and not even checked for Earthquake Load assuming that the tanks was safe under seismic forces once designed for wind forces. In this study Wind Forces and Seismic Forces acting on an Intze Type Water tank for Indian conditions are studied. According to seismic code IS 1893(Part-1)more than 60% of India is prone to earthquakes. The analysis was conducted as per the specifications of IS 3370, IS 456, IS 800, IS 875, IS 1893. The Intze type water tank was designed for 10Lakh Litres capacity of water for the Agiripalli Town at Krishna District in Andhra Pradesh. Different loads such as Dead Load, Live Load, Wind load will be applied on STAAD.Pro model as well manual design at appropriate location as per codes used for Loading. All the results obtain from STAAD.Pro will be compared with the results of manual design.

--***--

I INTRODUCTION

1.1 GENERAL

Storage reservoirs and overhead tank are used to store water, liquid petroleum, petroleum products and similar liquids. These structures are made of masonry, steel, reinforced concrete and pre stressed concrete. Out of these, masonry and steel tanks are used for smaller capacities.

The cost of steel tanks is high and hence they are rarely used for water storages. Reinforced concrete tank is high and hence they are rarely used for water storages. Reinforced concrete tanks are very popular because, besides the construction and designs being simple, they are cheap, monolithic in nature and can be made leak proof. Generally no cracks are allowed to take place in any part of the structure of liquid retaining R.C.C tanks and they made water tight by using richer mix (not less than M20) of concrete.

In addition sometimes water proofing materials are also used to make tanks water tight. Permeability of concrete is directly proportional to water cement ratio. Proper compaction using vibrators should be done to achieve imperviousness. Cement content ranging from 330 Kg/$m3$ to 530 Kg/$m3$ is recommended in order to keep shrinkage low. The leakage is more with higher head and it has been observed that head up to 15m does not cause leakage problem. Use of high strength deformed bars of grade 415 are recommended for the construction of liquid retaining structures .However mild steel bars are also used. Correct placing of reinforcement, use of small sized and use of deformed bars lead to differential cracks. A crack width of 0.1mm has been accepted as permissible value in liquid retaining structures. While designing liquid retaining structures recommendation of " Code of Practice for the storage of liquids- IS3370 (Part I to IV)" should be considered.

1.2 CLASSIFICATION OF R.C.C WATER TANK

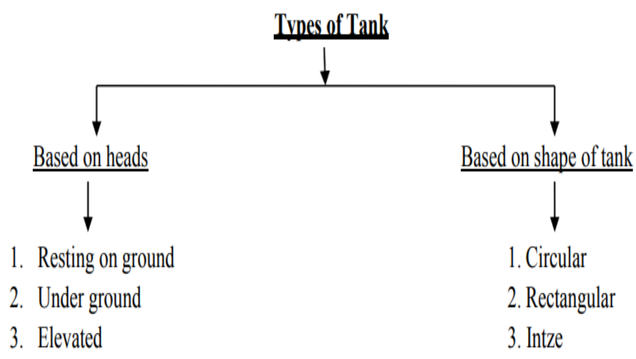


Figure 1 Classification of types of tank

|| Volume 5 || Issue 12 || June 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH & ENGINEERING TRENDS
Multidisciplinary Journal
Double-Blind Peer Reviewed Refereed Open Access International Journal

1.3 GENERAL CONSIDERATION

IS 3370(part 1) recommends the following measures to be considered before the construction of water tank

1. CEMENT CONTENT

The concrete used for tank should be minimum of M20 grade mix so as to provide not only the strength but also higher density to prevent seepage.

The cement content should not be lessthan 300Kg/$m3$ to get water tightness and not more than 530Kg/$m3$ to avoid cracking due to shrinkage of concrete.

A well graded aggregate with a water-cement ratio less than 0.5 is recommended for making impervious concrete.

2. PERMISSIBLE STEEL REQUIREMENT

Plain mild or HYSD steel reinforcement can be used in storage tanks.

The permissible stress in reinforcement is controlled by the strain and crack widths rather by the strength. In view of complexities associated with crack widths, a simplified approach through the reduced permissible stress is recommended. The permissible stress in steel is given below:

Types of stress in steel reinforcement	Mild steel bars (Mpa)	HYSD steel bars (Mpa)
Tensile stress in member under direct tension	115	150
Tension in steel bending or shear placed within 225mm from water face	115	150
Tension in steel placed beyond 225mm from water face; In bending, f_{st} In shear, f_{sv}	 125 125	 190 175
Compression in column subjected to direct load	125	175

Table 1.1: Permissible stress in steel

3. PERMISSIBLE STRESSES IN CONCRETE

To ensure uncracks condition, the permissible tensile stress in concrete in reinforcement concrete members should not exceed the values listed on table 2.2 on the liquid retaining face and also on the exterior face, for the members less than 225mm thick

Nature of stress	M20	M25	M30	M35
Direct tension, f_{ct}	1.2	1.3	1.5	1.6
Bending tension ,f_{cbt}	1.7	1.8	2.0	2.2
Shear Stress,τ_v	1.7	1.9	2.2	2.5

Table 1.2 Permissible stress in concrete

4. COVER OF REINFORCEMENT

The minimum clear cover or nominal cover to main reinforcement in direct tension shall be 20mm diameter of the bar, whichever is greater. The minimum nominal cover is increased to 25 and 30mm for the case of tension in bending, and in the environment of alternate wetting and drying, respectively, But minimum cover should be 40mm for the surface in contact with water.

5. MINIMUM STEEL

A minimum amount of steel shall be provided in two principle directions to minimize cracking due to shrinkage, temperature etc. The minimum HYSD reinforcement in walls, floors and roofs should be 0.35% of the surface zone cross section in either of direction of right angles.

6. WATER PROOFING MATERIAL

Primary consideration in water tanks, besides, strength is water tightness of tank. Complete water –tightness can be obtained by using high strength concrete. In addition, water proofing materials can be used to further enhance the water tightness. To make concrete leak proof or water tight, internal water proofing or water proofing linings are frequently used. In the method of internal water proofing, admixtures are used. The objects using them are to fill the pores of the concrete and to obtain a dense and less permeable concrete. Some of most commonly used admixtures are hydrated lime in quantity from 8 to 15%, by weight of cementof powdered iron fillings, which expands upon oxidation and fills in pores of concrete. Other agents like powdered chalk or talc, sodium silicate, zinc sulphate, calcium chloride etc. are also used. In water proofing linings, paints, asphalt, coal tar, waxes, resins, and bitumen are used. These materials have property to repel water.

1.4 JOINTS IN LIQUID RETAINING STRUCTURES MOVEMENT JOINTS:

There are four types of movement joints.

(i) CONTRACTION JOINT

It is a movement joint with deliberate discontinuity without initial gap between the concrete on either side of the joint. The

|| Volume 5 || Issue 12 || June 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH & ENGINEERING TRENDS
Multidisciplinary Journal
Double-Blind Peer Reviewed Refereed Open Access International Journal

purpose of this joint is to accommodate contraction of the concrete.

A contraction joint may be either complete contraction joint or partial contraction joint. A complete contraction joint is one in which both steel and concrete are interrupted and a partial contraction joint is one in which only the concrete is interrupted, the reinforcing steel running through as shown in Fig.(b)

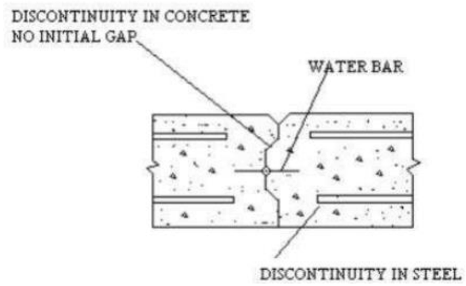


Figure 2 Partial Contraction Joint

(ii) EXPANSION JOINT

It is a joint with complete discontinuity in both reinforcing steel and concrete and it is to accommodate either expansion or contraction of the structure. This type of joint is provided between wall and floor in some cylindrical tank design.

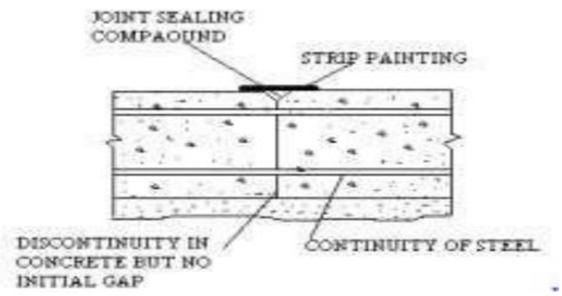


Figure 3 Expansion Joint

(iii) SLIDING JOINT

It is a joint with complete discontinuity in both reinforcement and concrete and with special provision to facilitate movement in plane of the joint. A typical joint is shown in Fig. This type of joint is provided between wall and floor in some cylindrical tank designs.

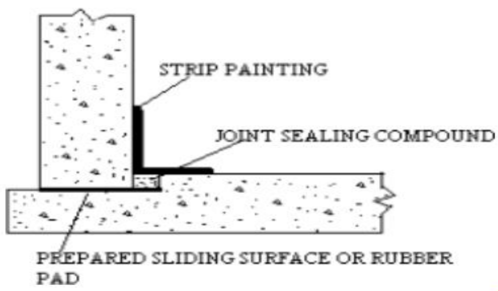


Figure 4 Sliding joint

(iv) TEMPORARY JOINTS

A gap is sometimes left temporarily between the concrete of adjoining parts of a structure which after a suitable interval and before the structure is put to use, is filled with mortar or concrete completely with suitable jointing materials. In the first case width of the gap should be sufficient to allow the sides to be prepared before filling.

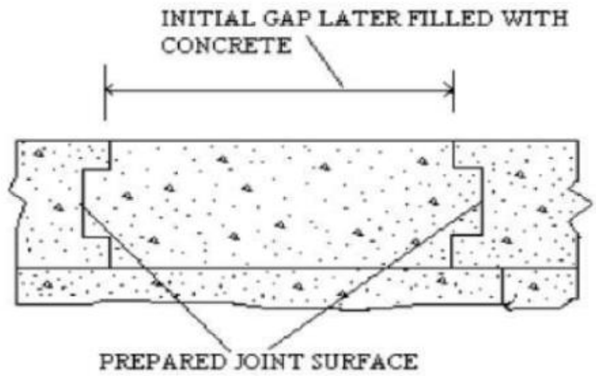


Figure 5 Temporary Joint

CHAPTER 2 LITERATURE REVIEW

A water tower built in accordance with the Intze Principle has a brick shaft on which the water tank sits.The base of the tank is fixed with a ring anchor (Ringanker) made of iron or steel, so that only vertical, not horizontal, forces are transmitted to the tower. Due to the lack of horizontal forces the tower shaft does not need to be quite as solidly built. This type of design was used in Germany between 1885 and 1905.The Intze Principle (German: IntzePrinzip) is a name given to two engineering principles, both named after the hydraulic engineer, Otto Intze, (1843–1904). In the one case, the Intze Principle relates to a type of water tower; in the other, a type of dam.Storage reservoirs and overhead tank are used to store water, liquid petroleum, petroleum products and similar liquids. These structures are made of masonry, steel, reinforced concrete and pre stressed concrete. Out of these, masonry and steel tanks are used for smaller capacities. Shape of the water tank is an important design parameter because nature and intensity of stresses are based on the shape of the water tank.In general, for a higher capacity, circular shape is preferred because stresses are uniform and lower compared to other shapes. INTZE type water tank is one such water tank which has circular shape with a spherical top and conical slab with spherical dome at the bottom. In this type of water tank, the inward forces coming from the conical slab counteract the outward forces coming from the bottom dome which result less stress on the concrete bottom slab of the water tank.Due to lesser stresses, the thickness of the concrete bottom slab reduces and reducing the amount of concrete required which has direct influence on the cost of the water tank.

|| Volume 5 || Issue 12 || June 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH & ENGINEERING TRENDS
Multidisciplinary Journal
Double-Blind Peer Reviewed Refereed Open Access International Journal

CHAPTER 3 DESIGN COMPONENTS OF INTZE TYPE TANK

3.1 TANK PORTION

The components of R.C.C overhead circular tank. The various components of elevated tank are as follows

1. Top Roof Dome

The dome at top usually 100mm to 150mm thick with reinforcement along the meridian and latitudes. The rise is usually 1/5th of the span.

2. Ring Beam

The ring beam is necessary to resist the horizontal component of the thrust of the dome. The ring beam will be designed for hoop tension induced.

3. Circular Wall

This has to be designed for hoop tension caused due to horizontal water pressure and to resist bending moment induced to wall by liquid load.

4. Bottom Slab

This will be designed for total load above it. The slab will also be designed for the total load above it. The slab will also be designed as a slab spanning in both directions.

5. Bottom Beams

The bottom beam will be designed as continuous beam to transfer all the load above it to the columns.

3.2 STAGING PORTION

1. Columns & Braces Columns

These are to be designed for the total load transferred to them. The columns will be braced atintervals and have to be designed for wind pressure and seismic loads whichever govern. Braces The braces are the members connecting the columns at intermediate height of columns. It is provided in slender columns to increase the column's load carrying capacity.

2. Foundation

As per is11682-1985, a combined footing or raft footing with or without tie beam or raft foundation should be provided for all supporting columns.

3.3 DOMES

A dome may be defined as a thin shell generated by revolution of a regular curve about one of its axis. The shape of dome depends on the type of the curve and the direction of axis of revolution. Domes are used in variety of structures, as in the roof of circular areas, in circular tanks, in hangers, exhibition halls, auditoriums and bottom of tanks, bins and bunkers. Domes may be constructed of masonry, steel, timber and reinforced concrete. However, reinforced domes are most commonly used nowadays, since they can be constructed over large spans. Membrane theory for analysis of shells of revolution can be developed neglecting effect of bending moment, twisting moment and shear assuming that loads are carried wholly by axial stresses. The meridional thrust and circumferential forces are calculated to design the domes. However, minimum amount of 0.3% of steel should be provided on both direction of the dome.

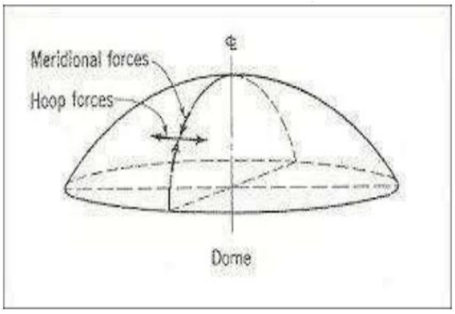


Figure 6 A typical shell of revolution

Force N^{φ} act tangentially to the surface all around the circumference whereas force Nθ act radially all around the circumference. The magnitude of hoop stress are meridional stress isobtained by:-

$\boldsymbol{N\theta}$ **= (1 cos ∅ − cos ∅)**

$\boldsymbol{N\varphi}$ **=** $\boldsymbol{WR}$ **1+cos∅**

Where W = Total load on the dome in KN/m2

R = Radius of curvature And,

∅ = cos R−1 R

CHAPTER 4 STAGING OF TANKS

The overhead tanks are generally supported on space frame staging consisting of reinforced concrete columns braced together by ring beams at top and bottom and also at a number of places along the height by braces shown. The arrangement enables effective height of columns to be taken as the distance between centre of adjacent bracings. Alternatively, the tower may be a thin walled reinforced shaft, i.e., cylindrical shell

• The design should be based on worst possible combination of loads, moments and shears arising from gravity and lateral loads in any direction when tank is full as well as empty.

• In case of lateral load due to seismic and wind action, the permissible stresses for columns of the staging are increased as per IS;456 provision. However, the increase is not allowed in the design of braces because seismic and wind loads are primary forces in them.

• In addition to the entire load of tank(gravity load), the column carry axial load, shear forces, and bending moment due to lateral forces exerted by the wind, earthquake and vibration.

• The axial force in the column due to lateral loads acting on all the part of the tanks as well as towers, should be calculated by equating the moments due to all lateral forces above the level under consideration to the restraining moment offered by axial forces in column.

• The vertical spacing rigidly connected horizontally bracings should not exceed 6m.

• For staging in seismic zones where horizontal seismic coefficient exceeds 0.05, twin diagonal vertical bracings of steel of R.C.C. in additional to horizontal bracing may be provided.

• For the tower situated in seismic zones where horizontal seismic coffecient is above in 0.05, all the columns are tied together by a ring beam at the base of the tower.

• The tower foundation is so proportioned that the combined pressure on soil due to gravity load(with tank full as well as empty) and lateral pressure is within safe bearing capacity, and in the critical direction the footing does not lift at any point.

4.1 ANALYSIS OF WIND FORCES

In addition to gravity forces the tower and the tank are subjected to wind and seismic forces depending upon the location of the tank.

The wind pressure at a site is determined as per IS : 875 Part III provision. The wind force on a surface is the product of pressure per unit area and projected area normal to the direction of wind. Intze tanks offer relatively smaller resistance and a reduction factor of the order 0.7 is used to arrive at effective pressure. The nature of forces and analysis procedure are discussed in the following sections.

1.1 CLASSIFICATION OF STRUCTURES

The structures are classified into the following three different classes depending upon their sizes;

Class A – Structures and/or their components such as glazing, cladding, roofing etc., having maximum dimension(greatest horizontal or vertical dimension) less than 20m.

Class B- Structures and / or their components such as glazing, cladding, roofing etc., having maximum dimension (greatest horizontal or vertical dimension) between 20m and 50m.

Class C- Structures and/or their components such as glazing, cladding, roofing etc., having maximum dimension (greatest horizontal or vertical dimension) greater than 50m.

4.1.2 TERRAIN CATEGORY

There are four terrain categories. Terrain in which a specific structure stands shall be assessed as being one of the following terrain categories:

Category 1- exposed open terrain with few or no objections in which the average height of any object surrounding the structure is less than 1.5m.

Category 2- open terrain with well scattered obstructions having heights generally between to 10m.

Category 3- terrain with numerous closely spaced obstructions having the size of structure upto 10m in height with or without a few isolated tall structures.

Category 4- terrain with numerous large high closely spaced obstructions.

4.1.3 WIND SPEED

Based on basic wind speed, there are six zones, zone 1 to zone VI. Basic wind speed shall be modified to include following effects to get design wind velocity at height for the chosen structure;

4.1.2.1 Risk level

4.1.2.2 Terrain roughness, height and size of structure 4.1.2.3 Local topography

The design wind speed at any height can be mathematically expressed as follows;

$$VZ= VbK1K2K3$$

Where, VZ = Design of wind speed at any height z

Vb= Basic wind speed in m/sec

K1 = Risk coefficient

K2 = Terrain height and structure factor

K3 = Topography factor For a given direction of wind, the maximum shear occurs in a brace connecting a column, while maximum bending moment occurs in a brace connecting a column, while maximum bending moment occurs in a brace.

4.2 ANALYSIS OF SEISMIC FORCES

The horizontal and vertical components of the seismic forces depend upon the total effective eight of the tank and stiffness of the staging . thus, the overhead tank located in seismically active areas should be analyzed and designed for seismic forces both under tank full and tank empty condition. When empty the effective weight of tank system used in the analysis Consist of dead weight of tank and one third weight of staging , When full the weight of contents is to be added to the weight under tank empty condition. The design horizontal seismic co efficient αh is computed as per the provision of IS : 1893 as follows :

$$\alpha h = \beta I F0\ sa\ g$$

Where ,

F0 = 0.4 (for seismic zone V)

|| Volume 5 || Issue 12 || June 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH & ENGINEERING TRENDS
Multidisciplinary Journal
Double-Blind Peer Reviewed Refereed Open Access International Journal

I = 1.5 (for water towers)

β = 1 (for raft foundation) sa

g = average acceleration coefficient

The average acceleration co efficient depends upon the period of free Vibration (T). And damping of concrete structure . For reinforced Concrete ,the damping is assumed to be 5%.

$$T = Ct \sqrt{[} Wh1\ EsAg$$

Ct = coefficient depending upon the slenderness ratio

, the slenderness Ratio, given in table 6 of IS : 1893

$h1$= height of structure above base

A = area of cross section of column

Es = modulus of elasticity of concrete

g = acceleration due to gravity

W = Weight of the structure above base

CHAPTER 5 DESIGN OF TANK

5.1 POPULATION CALCULATION

Total Population in Agiripalli = 7000

People Per Capita Demand of water per day 135 Litres

Design capacity of tank = (7000 × 135) = 945000 Litres

Total Required Capacity of Tank = 945000 Litres

Total Design Capacity of Tank = 1000000 Litres

5.2 DIMENSION OF TANK

Steel = Fe 415

Concrete grade = M30

Diameter of tank (D) = 15 m

Diameter of lower Ring Beam (D0) = 15 × 0.6 = 9m

Rise of top dome (h1) = 3.0m

Rise of bottom dome (h2) = 2.0m

Height of conical dome (h0) = 2.5m

Height of cylindrical portion :

Capacity of Tank:

$$= \pi\ 4 \times D\ 2 \times h + \pi\ 12 \times h0(D\ 2 + D0\ 2 + D \times D0) - \pi\ 3 \times h2\ 2\ (3R2 - h2)$$

$$R2 = (\ \ 2\ )\ 2 + h2\ 2\ 2h2\ s$$

$$R2 = 6.0625 \text{ m}$$

1000 $m3$= (π 4 × 152 × h) + π 12 × 2 × (152+9 2+ 15× 9) - π 3 ×1.5 2× (3×7.25 – 1.5)

⇒ h = 4.05 m Say ,

h = 4.5 m

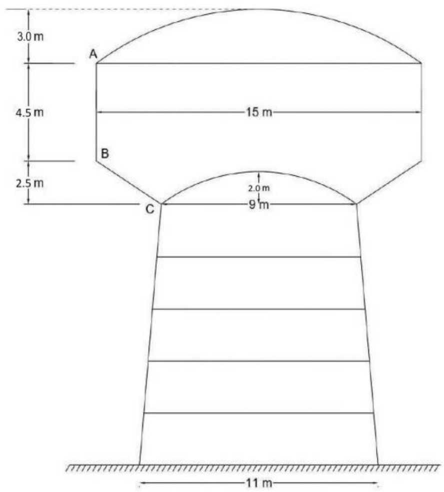


Figure 7 Dimension of water tank

5.3 DESIGN OF TOP DOME

Provide a thickness of 150 mm for the roof dome Let 2θ be the angle subtended by the dome of its centre

$$\therefore \sin\theta = \frac{d}{2R_1}$$

$$R_1 = \frac{(\frac{15}{2})^2 + 3^2}{2 \times 3}$$

$$R_1 = 10.875 \text{ m}$$

$$\theta = 43.6^0$$

5.3.1 LOADS

Dead load = 0.15 × 25000 = 3750 N/ $m2$

Live load of dome = 0.75 – 0.52 y 2 (from Table 2, IS : 875 part – 2)

Y = h1/ D = 3 15

Live load of dome = 735 N/$m2$

Total load (w) = 4485 N/$m2$

5.3.2 HOOP STRESS AT THE LEVEL OF SPRINGING

$$f = WR1\ t\ (\cos\theta - 1\ 1 + \cos\ )$$

$$f = 4485 \times 10.875\ .15\ (\cos 43.6 - 1\ 1 + \cos 43.6\ )$$

$$f = 0.047 \text{ N}/mm2$$

5.3.3 HOOP STRESS AT THE CROWN

∴ Sinθ = d 2$R1$

$R1$ = (15 2) 2+ 3 2 2 ×3

$R1$ = 10.875 m i.e , at θ = 0 0

$f = WR1\ t\ (1 - 1\ 1\ )$

f = 0.16 N/$mm2$

|| Volume 5 || Issue 12 || June 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH & ENGINEERING TRENDS
Multidisciplinary Journal
Double-Blind Peer Reviewed Refereed Open Access International Journal

Meridional thrust at the level of the springing , per meter run :

$T1 = WR1\ 1+\cos\theta$

$T1$ = 28288.58 N/m

∴ Meridional stress = 28288.5

150×1000 =0.189 N/$mm2$

These stresses are very small . Provide nominal reinforcement

∴ Provide nominal reinforcement (0.3%)

$$\text{Ast} = \frac{.30}{100} \times 1000 \times 150 = 450\ mm^2$$

$$\therefore Provide\ 8mm\ \emptyset\ @\ 110mm\ c/c$$

5.4 RING BEAM AT TOP

Horizontal component of T1 = T1 Cos θ

= 28288.58× cos 43.6

= 20485.8 N

Hoop tension in the ring beam = 20485.8 × 15 2

T = 153643.5 N

∴ Area of steel required for hoop tension = 153643.5 150 = 1024.28 $mm2$

∴ Provide 6 bars 16 mm diameter (1200 $mm2$)

5.5 ANALYSIS OF THE COLUMN SECTION

Radius of column circle = 5.5 m

Axial force in column due to gravity load tank full = 15003.700 KN

Overturning moment when tank is full = 145871.4 × 16.07 = 2344.154 KN-m

Maximum axial force on the remotest column staging,

When tank is full = 15003700 8 ± 2344154 Σ(x ×x) × R Where, ΣX 2 = 2R 2 + 4(r sin π 4) 2 = 121 = 15003700 8 ± 2344154 121 × 5.5 = 1982.015 KN = 19820015 0.995 = 1989.975 KN

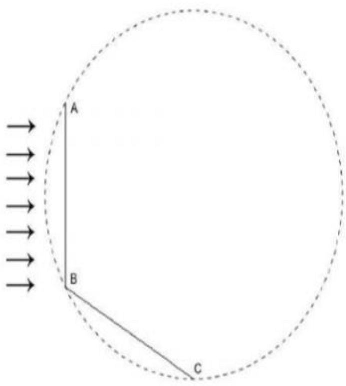


Figure 8 Wind pressure acting on brace AB

For the condition of maximum B.M. for the brace BC, seismic should act normal to an adjoining brace AB. Moment in brace BC = moment for the column × (sec 45̊) = 228270.4 ×√2 = 322.823 KN-m Providing (300 ×500) mm section and designing as doubly reinforcement beam with equal steel at top and bottom, Asc = Ast = 322822.5×1000 220×420 = 3493.75 $mm2$ Provide 6 bars of 20mm dia. at top and

5.6 DESIGN OF FOUNDATION

Total load on the columns when the tank is full = 1894365× 8 = 15154.927 KN

Approximate weight of foundation (10% of column load) = 1515.4927 KN

Total loads = 16670.420 KN Safe bearing capacity = 112.815 $KN/m2$ Area of foundation = 16670419.92 112815 = 147.76 $m2$

CHAPTER 6 STAAD Pro RESULTS

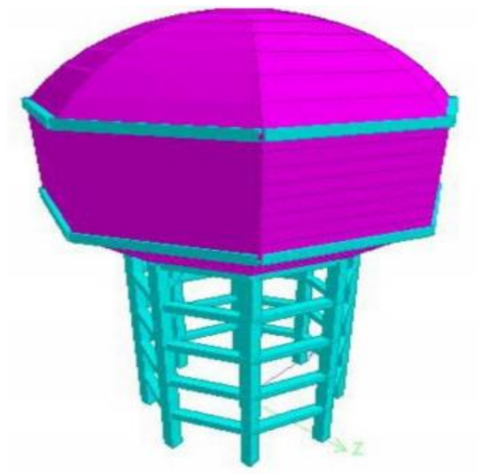
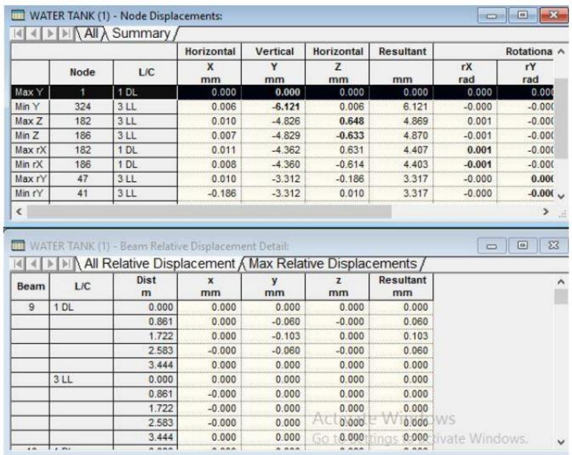


Figure 9 Intze tank 3D



WATER TANK (1) - Node Displacements:

All | Summary

	Node	L/C	Horizontal X mm	Vertical Y mm	Horizontal Z mm	Resultant mm	Rotational rX rad	rY rad
Max Y	1	1 DL	0.000	0.000	0.000	0.000	0.000	0.00(
Min Y	324	3 LL	0.006	-6.121	0.006	6.121	-0.000	-0.00(
Max Z	182	3 LL	0.010	-4.826	0.648	4.869	0.001	-0.00(
Min Z	186	3 LL	0.007	-4.829	-0.633	4.870	-0.001	-0.00(
Max rX	182	1 DL	0.011	-4.362	0.631	4.407	0.001	-0.00(
Min rX	186	1 DL	0.008	-4.360	-0.614	4.403	-0.001	-0.00(
Max rY	47	3 LL	0.010	-3.312	-0.186	3.317	-0.000	0.00(
Min rY	41	3 LL	-0.186	-3.312	0.010	3.317	-0.000	-0.00(

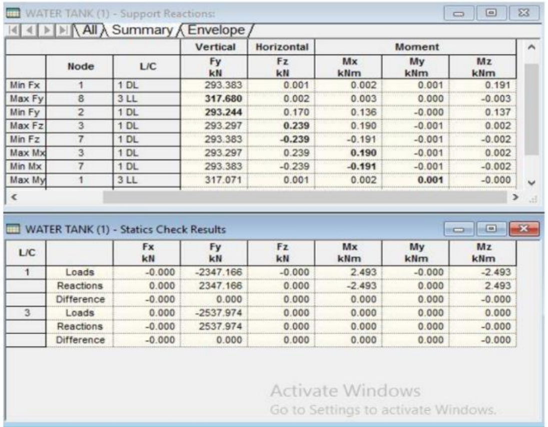
WATER TANK (1) - Beam Relative Displacement Detail:

All Relative Displacement | Max Relative Displacements

Beam	L/C	Dist m	x mm	y mm	z mm	Resultant mm
9	1 DL	0.000	0.000	0.000	0.000	0.000
		0.861	0.000	-0.060	-0.000	0.060
		1.722	0.000	-0.103	0.000	0.103
		2.583	-0.000	-0.060	-0.000	0.060
		3.444	0.000	0.000	0.000	0.000
	3 LL	0.000	0.000	0.000	0.000	0.000
		0.861	-0.000	0.000	0.000	0.000
		1.722	-0.000	0.000	0.000	0.000
		2.583	-0.000	0.000	0.000	0.000
		3.444	0.000	0.000	0.000	0.000

Figure 10 Relative Displacements

|| Volume 5 || Issue 12 || June 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH & ENGINEERING TRENDS
Multidisciplinary Journal
Double-Blind Peer Reviewed Refereed Open Access International Journal


WATER TANK (1) - Support Reactions:

All | Summary | Envelope

	Node	L/C	Vertical Fy kN	Horizontal Fz kN	Moment Mx kNm	My kNm	Mz kNm
Min Fx	1	1 DL	293.383	0.001	0.002	0.001	0.191
Max Fy	8	3 LL	317.680	0.002	0.003	0.000	-0.003
Min Fy	2	1 DL	293.244	0.170	0.136	-0.000	0.137
Max Fz	3	1 DL	293.297	0.239	0.190	-0.001	0.002
Min Fz	7	1 DL	293.383	-0.239	-0.191	-0.001	-0.002
Max Mx	3	1 DL	293.297	0.239	0.190	-0.001	0.002
Min Mx	7	1 DL	293.383	-0.239	-0.191	-0.001	-0.002
Max My	1	3 LL	317.071	0.001	0.002	0.001	-0.000

WATER TANK (1) - Statics Check Results

L/C		Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
1	Loads	-0.000	-2347.166	-0.000	2.493	-0.000	-2.493
	Reactions	0.000	2347.166	0.000	-2.493	0.000	2.493
	Difference	-0.000	0.000	0.000	0.000	0.000	-0.000
3	Loads	0.000	-2537.974	0.000	0.000	0.000	0.000
	Reactions	-0.000	2537.974	0.000	0.000	0.000	-0.000
	Difference	-0.000	0.000	0.000	0.000	0.000	-0.000

Figure 11 Support Reactions

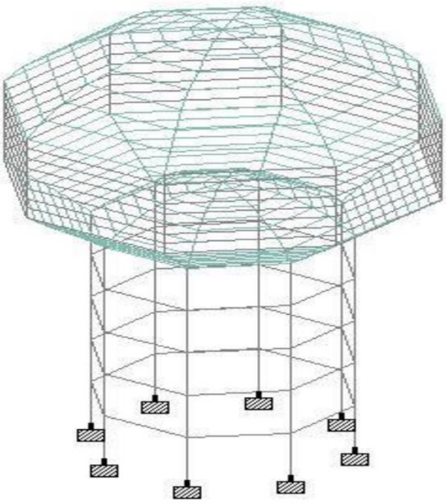


Figure 12 Intze tank 3D Wire Frame

CHAPTER 7 CONCLUSION

Both Manual Design and Staad Pro Designs are Compared for the same Loading conditions.

▪ First Manual Calculations are calculated and then these Dimensions are taken in Staad Pro Analysis.

▪ Results shown that members are not Fail and the Design is stable.

▪ The Reduction Factor for the Staad Pro Design is 1:3.

▪ The Maximum load from manual Design on the structure is 16670.419 KN and from the Staad pro is 4885.14 KN.

▪ Maximum Shear Force obtaining from manual design is 947.18 KN and obtained by Staad Pro Results is 317.68 KN.

▪ Maximum Bending from manual calculations is 691.822 KM-m and from the Staad Pro Results shows as 191 KN-m.

REFERENCES

•I.S 456:2000, “Code of Practice for Plain and Reinforced Concrete”, I.S.I., New Delhi.

• I.S 875 (Part II): 1987, “Code of Practice for Imposed Load”, I.S.I., New Delhi.

• I.S 875 (Part II): 1987, “Code of Practice for Wind Load” , I.S.I., New Delhi.

• I.S 1893: 2016, ”Criteria for Earthquake Resistant Design of Structures”, I.S.I., New Delhi.

• I.S 3370 (Part I): 2009, “Code of Practice for Concrete Structures for Storage of Liquid”, I.S.I., New Delhi.

• I.S 3370 (Part IV): 1967, “Code of Practice for Concrete Structures for Storage of Liquid”, I.S.I., New Delhi.

• 2018 18th edition of S. Ramamrutham, “Design of Reinforced concrete structures”, Dhanpat Rai Publications.