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# ANALYSIS AND DESIGN OF INTZE TANK

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*Abstract :* A water tank is a storage container for water for domestic and industrial purposes. Water tanks come in many different shapes and sizes. They can be lying on the ground, in an underground location, or in a tall, thin shape with a rectangular shape. The circular and intze shape is characteristic of this object.Concrete is the best material for constructing storage tanks for water and other liquids, since it is very impervious to water. Overhead tanks are the most effective way to store water for domestic or industrial purposes. In order to make this project as economical as possible, an overhead tank of intze shape is designed that can hold a total of 1000000 liters.By using staad pro software and manual design by using IS CODES.

***IndexTerms* - Water, Intze Water Tank, STAAD Pro, analysis, Design as per IS codes.**

## I. INTRODUCTION:

Storage reservoirs and overhead tanks are used to store water, liquid petroleum, petroleum products, and similar liquids. These structures are made of different materials, such as masonry, steel, reinforced concrete, and prestressed concrete. Masonry and steel tanks are most commonly used for smaller capacities. The high cost of steel tanks means they are seldom used for water storage.Reinforced concrete tanks are very popular because they are cheap, monolithic, and can be made to be leakproof. Under normal circumstances, no cracks are allowed in any part of the structure of the liquid storage concrete tank, and rich concrete (not lower than M20) is used for waterproof treatment. In addition, waterproof materials are sometimes used to make the tank watertight.The permeability of concrete is directly related to the water cement ratio. To achieve impermeable, it must be properly compressed using a vibrator. The cement content of the material ranges from 330 kg/m3.

## II.CLASSIFICATION OF R.C.C WATER TANK:

| Based on heads | Based on shape of tank |
|---|---|
| 1.Resting on ground | 1. Circular |
| 2.Underground | 2. Rectangular |
| 3.Elevated | 3. Intze |

## III.DESIGN REQUIRMENT ON CONCRETE:

In water retaining structure a dense impermeable concrete is required.
Therefore, proportion of fine and coarse aggregates to cement should be such as to give high quality concrete.
Concrete mix weaker than M20 is not used. The minimum quantity of cement in the concrete mix shall be not less than 30 $kN/m^3$.
The design of the concrete mix shall be such that the resultant concrete is sufficiently impervious. Efficient compaction preferably by vibration is essential.
The permeability of the thoroughly compacted concrete is dependent on water cement ratio and increase in water cement ratio, increases permeability, while concrete with low water cement ratio is difficult to compact.
Other causes of leakage in concrete are defects such as segregation and honey combing.
All joints should be made water-tight as these are potential sources of leakage.

## IV.MINIMUM REINFORCEMENT:

(a)The minimum reinforcement in walls, floors and roofs in each of two directions at right angles shall have an area of 0.3 per cent of the concrete section in that direction for sections up to 100mm, thickness. For sections of thickness greater than 100mm, and less than 450mm the minimum reinforcement in each of the two directions shall be linearly reduced from 0.3

percent for 100mm thick section to 0.2 percent for 450mm, thick sections. For sections of thickness greater than 450mm, minimum reinforcement in each of the two directions shall be kept at 0.2 per cent.
In concrete sections of thickness 225mm or greater, two layers of reinforcement steel shall be placed one near each face of the section to make up the minimum reinforcement.

(b)In special circumstances floor slabs may be constructed with percentage of reinforcement less than specified above. In no case the percentage of reinforcement in any member be less than 0°15% of gross sectional area of the member.

## V. DIMENSIONS:

Dimensions are derived from the capacity of the tank, after we conduct population forecasting using one of the methods of population forecasting and we get the population estimation.
As per IS code, 135 litres are needed for daily use per person per day. Breakup of the IS assumptions:

- Drinking – 5 litres
- Cooking – 5 litres
- Bathing & Toilet – 85 litres
- Washing Clothes & Utensils – 30 litres
- Cleaning House – 10 litres

Hence assuming the design capacity of 1000000 litres,the total Family beneficial from this tank will be 10,00000/675 liters for 5 persons family =1481 Familie's.

So, in order to get the dimensions of water tank, we need to mention or assume at least one dimension.

## VI. METHODOLOGY:

DESIGN CRITERIA AS PER IS CODES:

The Analysis and Design of Intze Tank can be done in two way's one by manual calculations and another by using a software's.So here in this research work we had done design and analysis in both the ways by using IS CODES for manual design and STAADPRO Software for Software design.
1) Dome: On top, it is usually 100mm to 150mm thick with reinforcement along the longitude and latitude. Rise
Usually 1/5 of the span.
2) Ring beam supporting the dome: The ring beam is needed to resist the horizontal thrust of the dome. The ring beam will be designed to withstand the hoop tension caused by the structure.
3) Cylindrical Wall: This should be designed for hoop tension caused by horizontal water pressure.
4) The ring beam is designed to resist the horizontal force caused by the interaction between the cylindrical wall and the conical wall.
5) Conical slab: This cone-shaped slab will be designed to withstand the weight and pressure of water.The slab will span between the ring beam at the top and the ring girder at the bottom.
6)The floor could be circular or domed. The slab is supported by the ring girder.
7) The ring girder: The ring girder will be specifically designed to support the tank and its contents. The girder will be supported on columns, and should be designed to withstand the resulting bending moment and torsion.
8) Columns: Columns should be designed to withstand the total load being transferred to them, either from wind pressure or seismic forces.
9) Foundations: Columns are typically provided with a combined footing for stability. When this is done, the foundation will typically include a ring beam and a circular slab.

MANUAL DESIGN:

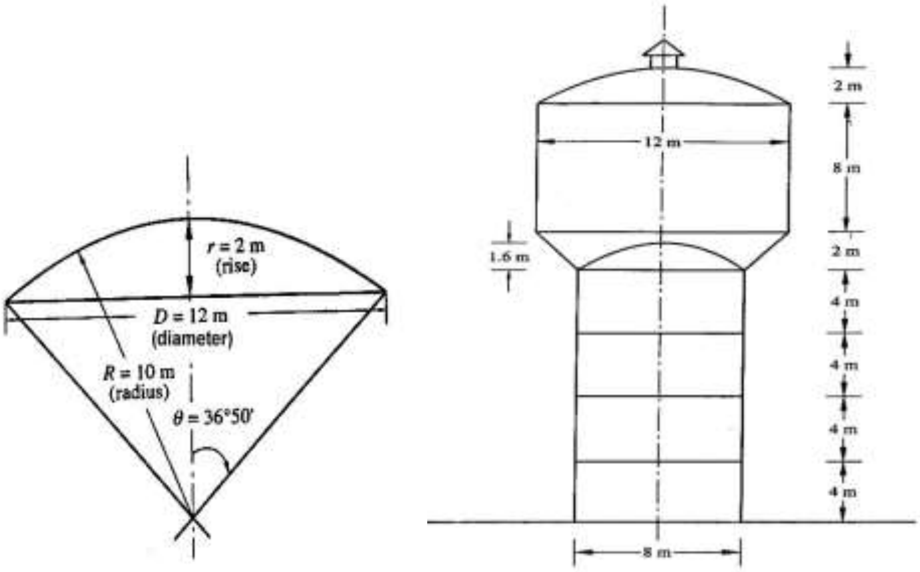


Fig-1 Dimensions of tank

## VII .RESULTS OF THE MANUAL DESIGN OF THE ELEVATED TANK :

Height of the tank – 28m
Staging height (linear) –18 m
Top Diameter of tank 12.00m
Height of Cylindrical Wall 8m
Thickness of Cylindrical Wall 300mm
Thickness of dome 300mm
Height of staging 16m
Number of columns 8 nos.
Column type Rectangular Bracings 1.2mx0.6mm

TOTAL VOLUME OF CONCRETE = 118.5 CU.METER

| BAR DIA (in mm) | WEIGHT (in Newton) |
|---|---|
| 8 | 19016 |
| 10 | 5700 |
| 12 | 34740 |
| 16 | 7961 |
| TOTAL= | 6720 |

VIII. DESIGN BY STAADPRO:

Below are the following results that came after Staadpro Design.

Table:1. Reaction summary

| | Node | L/C | Horizontal FX (kN) | Vertical FY (kN) | Horizontal FZ (kN) | Moment MX (kNm) | MY (kNm) | MZ (kNm) |
|---|---|---|---|---|---|---|---|---|
| Max FX | 251 | 2:LIVE | **1.441** | 182.222 | 0.327 | 0.479 | -0.016 | -2.853 |
| Min FX | 269 | 1:DEAD | **-1.404** | 211.368 | -0.222 | -0.318 | -0.000 | 2.009 |
| Max FY | 255 | 2:LIVE | -0.936 | **1.99E+3** | 1.147 | 1.670 | -0.061 | 0.732 |
| Min FY | 269 | 2:LIVE | 0.019 | **12.368** | 0.102 | 0.152 | 0.016 | -0.781 |
| Max FZ | 278 | 1:DEAD | -0.222 | 211.368 | **1.404** | 2.009 | -0.000 | 0.318 |
| Min FZ | 260 | 1:DEAD | 0.222 | 211.368 | **-1.404** | -2.009 | -0.000 | -0.318 |
| Max MX | 278 | 1:DEAD | -0.222 | 211.368 | 1.404 | **2.009** | -0.000 | 0.318 |
| Min MX | 260 | 1:DEAD | 0.222 | 211.368 | -1.404 | **-2.009** | -0.000 | -0.318 |
| Max MY | 260 | 2:LIVE | -0.479 | 110.735 | -0.926 | -1.351 | **0.103** | -0.039 |
| Min MY | 278 | 2:LIVE | -0.704 | 83.854 | 0.496 | 0.720 | **-0.103** | 0.289 |
| Max MZ | 269 | 1:DEAD | -1.404 | 211.368 | -0.222 | -0.318 | -0.000 | **2.009** |
| Min MZ | 251 | 2:LIVE | 1.441 | 182.222 | 0.327 | 0.479 | -0.016 | **-2.853** |

Table:2. Beam end force summary

| | Beam | Node | L/C | Axial Fx (kN) | Shear Fy (kN) | Fz (kN) | Torsion Mx (kNm) | Bending My (kNm) | Mz (kNm) |
|---|---|---|---|---|---|---|---|---|---|
| Max Fx | 299 | 234 | 2:LIVE | **2.09E+3** | 4.624 | -3.576 | 0.134 | 4.600 | 10.420 |
| Min Fx | 223 | 222 | 2:LIVE | **-30.100** | 0.351 | 0.352 | -0.060 | -0.383 | 0.033 |
| Max Fy | 295 | 247 | 2:LIVE | 19.096 | **38.972** | 0.155 | -10.636 | -0.215 | 70.164 |
| Min Fy | 287 | 229 | 2:LIVE | 18.589 | **-38.525** | -0.143 | 10.482 | 0.310 | -78.363 |
| Max Fz | 307 | 256 | 1:DEAD | 69.131 | -1.937 | **12.147** | -0.001 | -29.930 | -4.774 |
| Min Fz | 339 | 274 | 1:DEAD | 69.131 | 1.937 | **-12.147** | -0.001 | 29.930 | 4.774 |
| Max Mx | 287 | 229 | 2:LIVE | 18.589 | -38.525 | -0.143 | **10.482** | 0.310 | -78.363 |
| Min Mx | 295 | 247 | 2:LIVE | 19.096 | 38.972 | 0.155 | **-10.636** | -0.215 | 70.164 |
| Max My | 339 | 274 | 1:DEAD | 69.131 | 1.937 | -12.147 | -0.001 | **29.930** | 4.774 |
| Min My | 307 | 256 | 1:DEAD | 69.131 | -1.937 | 12.147 | -0.001 | **-29.930** | -4.774 |
| Max Mz | 295 | 247 | 2:LIVE | 19.096 | 38.972 | 0.155 | -10.636 | -0.215 | **70.164** |
| Min Mz | 295 | 234 | 2:LIVE | 19.096 | 38.972 | 0.155 | -10.636 | 0.379 | **-78.975** |

The signs of the forces at end B of each beam have been reversed. For example: this means that the Min Fx entry gives the largest tension value for an beam.

Table:3. Beam end displacement summary

Displacements shown in italic indicate the presence of an offset

| | Beam | Node | L/C | X (mm) | Y (mm) | Z (mm) | Resultant (mm) |
|---|---|---|---|---|---|---|---|
| Max X | 320 | 266 | 1:DEAD | **0.216** | -1.354 | 0.034 | 1.372 |
| Min X | 319 | 265 | 2:LIVE | **-11.426** | -0.079 | -0.011 | 11.426 |
| Max Y | 223 | 222 | 2:LIVE | -11.301 | **0.375** | 0.002 | 11.307 |
| Min Y | 232 | 232 | 2:LIVE | -11.254 | **-23.999** | 0.015 | 26.506 |
| Max Z | 283 | 243 | 2:LIVE | -5.780 | -13.790 | **0.244** | 14.954 |
| Min Z | 296 | 252 | 2:LIVE | -5.654 | -15.750 | **-0.221** | 16.736 |
| Max Rst | 232 | 232 | 2:LIVE | -11.254 | -23.999 | 0.015 | **26.506** |

Table:4 Node displacement summary

| | Node | L/ C | X (mm) | Y (mm) | Z (mm) | Resultant (mm) | rX (rad) | rY (rad) | rZ (rad) |
|---|---|---|---|---|---|---|---|---|---|
| Max X | 266 | 1:DEAD | **0.216** | -1.354 | 0.034 | 1.372 | -0.000 | 0.000 | 0.001 |
| Min X | 201 | 2:LIVE | **-44.509** | -11.899 | -0.005 | 46.072 | -0.000 | 0.000 | 0.002 |
| Max Y | 216 | 2:LIVE | -17.513 | **2.857** | 0.001 | 17.745 | 0.000 | -0.000 | 0.002 |
| Min Y | 16 | 2:LIVE | -37.153 | **-26.616** | -0.013 | 45.703 | -0.000 | 0.000 | 0.002 |
| Max Z | 243 | 2:LIVE | -5.780 | -13.790 | **0.244** | 14.954 | -0.001 | -0.000 | 0.001 |
| Min Z | 252 | 2:LIVE | -5.654 | -15.750 | **-0.221** | 16.736 | 0.001 | 0.000 | 0.002 |
| Max rX | 274 | 1:DEAD | -0.002 | -1.543 | 0.045 | 1.544 | **0.003** | 0.000 | 0.001 |
| Min rX | 256 | 1:DEAD | 0.002 | -1.543 | -0.045 | 1.544 | **-0.003** | 0.000 | -0.001 |
| Max rY | 275 | 2:LIVE | -5.849 | -0.568 | -0.075 | 5.877 | 0.000 | **0.000** | 0.002 |
| Min rY | 257 | 2:LIVE | -5.889 | -0.753 | 0.180 | 5.940 | -0.001 | **-0.000** | 0.002 |
| Max rZ | 265 | 1:DEAD | -0.045 | -1.543 | -0.002 | 1.544 | -0.001 | 0.000 | **0.003** |
| Min rZ | 247 | 1:DEAD | 0.045 | -1.543 | 0.002 | 1.544 | 0.001 | 0.000 | **-0.003** |
| Max Rst | 116 | 2:LIVE | -42.563 | -20.144 | -0.007 | **47.089** | -0.000 | 0.000 | 0.002 |

IX. RESULTS OF THE STAADPRO DESIGN OF THE ELEVATED TANK:

TOTAL VOLUME OF CONCRETE = 118.5 CU.METER

| BAR DIA (in mm) | WEIGHT (in Newton) |
|---|---|
| -------- | -------- |
| 8 | 19016 |
| 10 | 5700 |
| 12 | 34740 |
| 16 | 7961 |
| | ------------ |
| TOTAL= | 6720 |

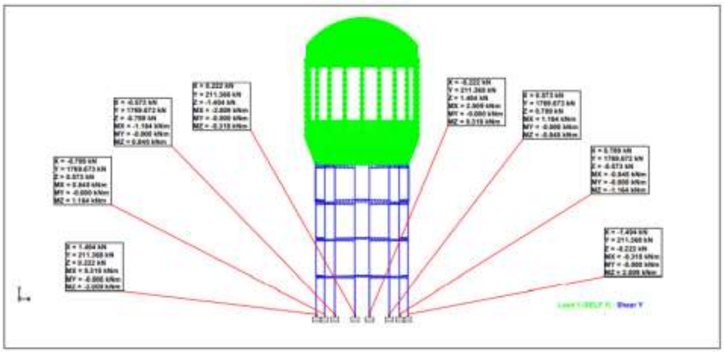

Fig: 2. Whole structure(sfd) with reactions.

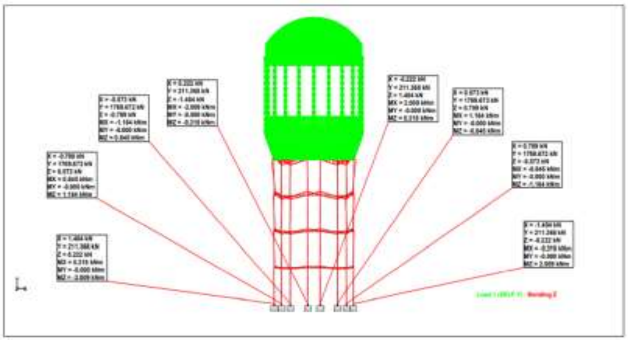

Fig: 3. Whole structure(bmd) with reactions.

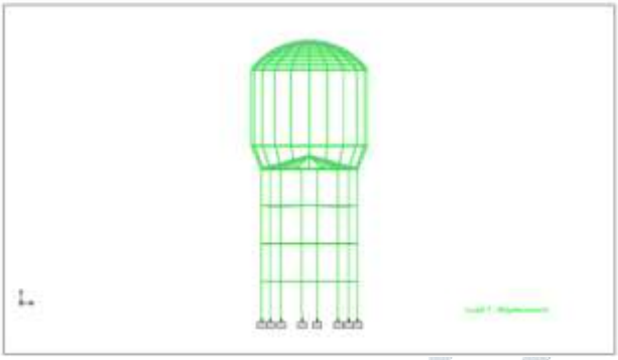

Fig: 4. Whole structure(displacement)

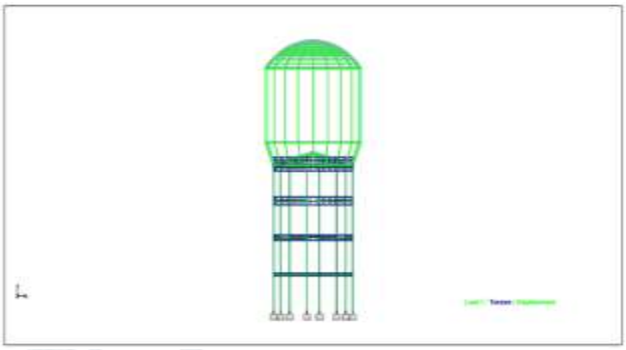

Fig:5. Whole structure(torsion)

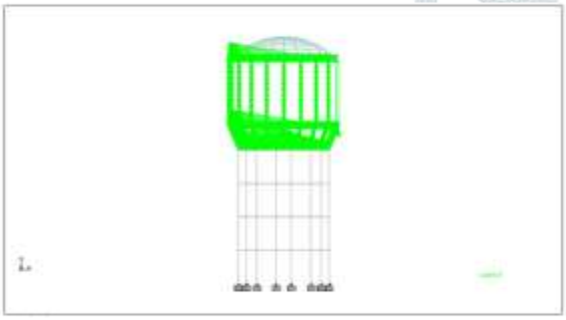

Fig: 6. Whole structure(Water loads)

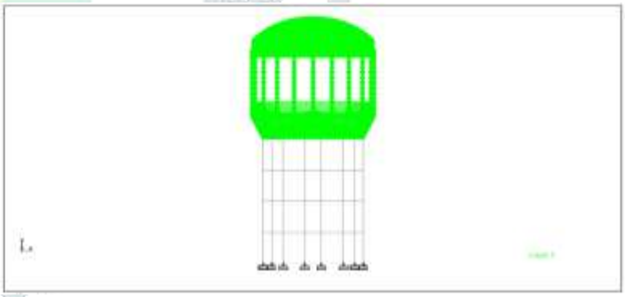

Fig:7. Whole structure(Dead loads)

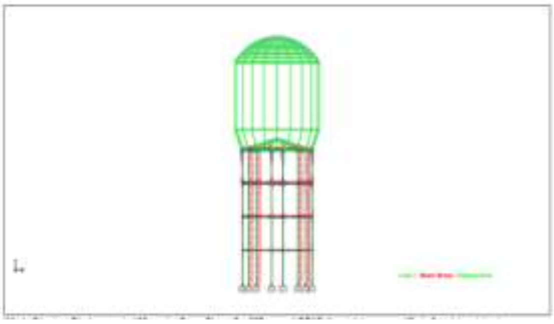

Fig: 8. Beam Streses.

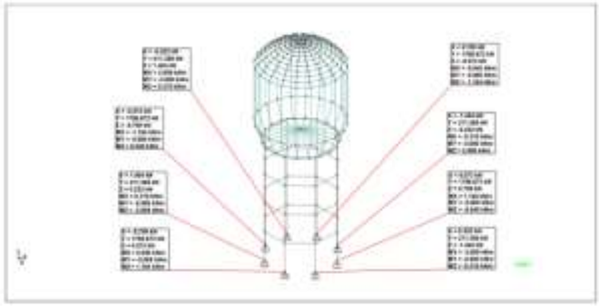

Fig: 9. Whole structure(Reactions)

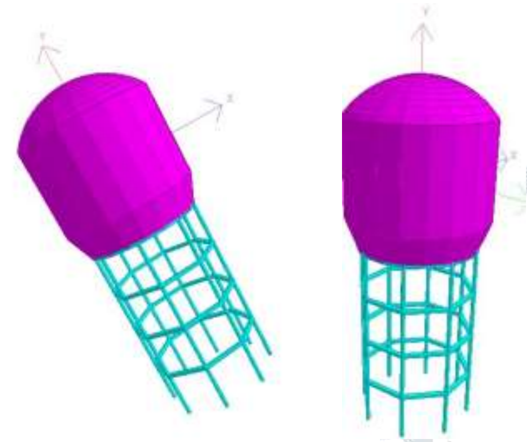

Fig: 31..3D Structure

## CONCLUSION

Storage of water for drinking, washing, swimming, and sewage disposal is becoming increasingly important in modern life. For small water tanks, we go with rectangular tanks. For larger tanks, we provide circular tanks. The Intze tank is a circular tank that is designed to reduce the cost of a project.The low dome in this construction resists the horizontal thrust, which is a factor that can add to the cost of a project. The design of a water tank can be quite time-consuming. The design of an Overhang water tank involves a lot of mathematical calculations. It takes a lot of time to do. The program provides a solution to the problems described above.There is a small difference in the design values of the program and the manual calculation. The program provides minimal value to the design. Designers should not provide less than the values we get from the program. In theory, the designer of a calculation should initially be familiar with the problem they are trying tosolve.

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