# Analysis And Design Of RCC And Pre-stressed Concrete Elevated Storage Water Tank 

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#### Abstract

$\boldsymbol{A} \boldsymbol{b s t r a c t}$ : Each and every design comes out when we encounter problems. These designs can be used to solve the current problems. Specially people in some regions where there is scarcity of water, don't get enough flow and speedy discharge exceptionally for those living in elevated floors in a multi-storied buildings. In this way people suffer some lack of water due to insufficient supply of water for their basic needs. Instant solution for this type of problem is to construct or develop water storage projects. We need to have the knowledge of structural aspects as well as all the practical knowledge in terms of experience, bye-laws and design codes. The motive of this standard is to ensure safety and steadiness in economy. Therefore, the water storage tank should be constructed in proper maintenance and care. By conducting normal designs and calculations it requires more time than expected time so, we adopted different softwares to obtain the results. For this reason analysis and design of water tank is carried out by "STAAD.Pro V8i". Comparison of RCC circular water tank and RCC intze water is carried out in the following paper. In the last, we have compared RCC circular water tank and PSC circular water tank.


Key words - Problem, design, tank.

## I. INTRODUCTION

## Elevated Storage Tank

An elevated water tank is constructed for the purpose of holding water supply at certain height to pressurization in water distribution system. Water tanks are classified into two types based on position and shapes of tanks:

1. Based on position- Underground water tanks, tanks resting on ground, elevated overhead water tanks.
2. Based on shapes- Circular tanks, rectangular tanks, intze tanks, square tanks.

We have selected elevated water tank ie. INTZE water tank. Water tanks are used to provide storage of water. It can be used in many applications such as:

- Drinking water
- Irrigation and agriculture
- Fire suppression
- Chemical manufacturing
- Food preparation and so on.

Water tank parameters include the general design of the tank, choice of construction materials, linings etc. Water tanks are an efficient way to help developing countries to store clean water. A variety of materials can be used to construct a typical water tank; steel and reinforced or pre-stressed concrete are most often used (with wood, fiber glass, or brick also in use). Water tanks are tall and are often placed on high ground, so that they can provide sufficient pressure to deliver water to homes in case of an emergency. While elevated tanks provide the best pressure, they are far more expensive and generally, only used where supply is in high demand.

## II. COMPARISON BETWEEN PSC AND RCC WATER TANK

| PSC | RCC |
| :---: | :---: |
| More durable | Less durable |$|$| No tensile cracks | Tensile cracks are unavoidable |
| :---: | :---: |
| As high strength concrete is used, <br> dead weight of PSC member is less | Dead load of RCC member is <br> more |
| Material cost is less | Material cost is more |
| Deformation of PSC member is less | Deformation of RCC member is <br> more |
| Fatigue strength is very good | Fatigue strength is bad |

Table 1.1: Comparison between PSC and RCC Water Tank

## III. METHODOLOGY



## A. Data Collection

Various methods can be adopted for estimating future populations. I have chosen Geometric Increase Method to calculate the population forecast. The formula used to calculate population forecast is:
where,
$\mathrm{Pn}=$ population forecast
$\mathrm{P}=$ present population
$\mathrm{Ig}=$ present growth
$\mathrm{n}=$ number of decades

## B. Modelling

The modelling is done by using STAAD.Pro V8i software.


Fig 2.1: 3D Model of Intze Water Tank


Fig 2.2: 3D Model of Circular water Tank

## C. Description of Models For Analysis of Elevated Storage Water Tank

NOTE:- Design is done for the population of 1400 .

| Sr. <br> No. | Description | Circular Water Tank | Intze Water Tank |
| :---: | :---: | :---: | :---: |
| 1. | Diameter of the column | 550 mm | 550 mm |
| 2. | Staging height | 12 m | 12 m |
| 3. | Height of wall | 3 m | 3 m |
| 4. | Hopper height | NA | 2 m |
| 5. | Bracings | $300 * 600 \mathrm{~mm}$ | $300 * 600 \mathrm{~mm}$ |
| 6. | Thickness of roof slab | 300 mm | 300 mm |
| 7. | Floor slab thickness | 550 mm | 550 mm |
| 8. | Material | M20 grade concrete and | M 20 grade concrete and |
|  | Fe 415 steel | Medium steel |  |
| 9. | Medium soil | Normal |  |
| 10. | Normal | $25 \mathrm{KN} / \mathrm{m}^{3}$ |  |
| 11. | Unit weight of concrete | $25 \mathrm{KN} / \mathrm{m}^{3}$ | 2 m |
| 12. | Bottom diameter of tank | 10 m | 10 m |
| 13. | Diameter of water tank | 10 m | 8 m |
| 14. | Diameter of ring beam | 2 m | 2 m |
| 15. | Height of conical dome | 1.8 m | 1.8 m |
| 16. | Rise of top dome | 1.6 m | 1.6 m |
| 17. | Rise of bottom dome |  |  |

Table 1.1: Description for RCC Circular Water Tank and RCC Intze Water Tank

| Sr. <br> No. | Description | Circular Water Tank |
| :---: | :---: | :---: |
| 1. | Volume of tank | $378 \mathrm{~m}^{3}$ |
| 2. | Height of tank | 12.5 m |
| 3. | Depth of wall | 3.15 m |
| 4. | Grade of concrete | M 40 |
| 5. | Allowable tensile strength | $13 \mathrm{~N} / \mathrm{mm}^{2}$ |
| 6. | Soil type | Medium |

Table 1.2: Description for PSC Circular Water Tank

## IV. RESULT AND DISCUSSION

## TOP DOME:

| Tank | Dimensions (mm) | Reinforcement Details |
| :---: | :---: | :---: |
| Intze Water Tank | 100 | 8 mm dia bars @ $160 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ in both directions |
| Circular Water Tank | 100 | 8 mm dia bars @ 160 mm c/c in both directions |
| TOP RING BEAM: |  |  |
| Tank | Dimensions (mm) | Reinforcement Details |
| Intze Water Tank | $360 * 400$ | Main reinforcement- 4nos. 20 mm dia bars Stirrups- 8 mm dia bars @ <br> $200 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ |


| Circular Water Tank | $360 * 400$ | ```Main reinforcement- 4nos. 20mm dia bars Stirrups- 8mm dia bars @ 200mm c/c``` |
| :---: | :---: | :---: |
| CYLINDRICAL WALL: |  |  |
| Tank | Dimensions (mm) | Reinforcement Details |
| Intze Water Tank | 260 (Avg) | Main reinforcement: Upto 2 m from top12 mm dia @ $170 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ <br> From 2 m to $4 \mathrm{~m}-12 \mathrm{~mm}$ dia @ $80 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ Distribution Steel: 8 mm dia bars <br> @ $150 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ |
| Circular Water Tank | 100 | Main reinforcement: |
|  |  | Upto 2 m from top- 16 mm dia @ $280 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ From 2 m to $5 \mathrm{~m}-16 \mathrm{~mm}$ dia @ $110 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ Distribution Steel: 8 mm dia bars @ $150 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ |
| BOTTOM RING BEAM: |  |  |
| Tank | Dimensions (mm) | Reinforcement Details |
| Intze Water Tank | $100 * 600$ | Main reinforcement: 6 nos. of 30 mm dia bars with nominal stirrups 8 mm dia bars @ $200 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ |
| Circular Water Tank |  |  |
| CONICAL DOME: |  |  |
| Tank | Dimensions (mm) | Reinforcement Details |
| Intze Water Tank |  | Main reinforcement: Provide 20 mm dia bars @ $250 \mathrm{~mm} \quad \mathrm{c} / \mathrm{c} \quad$ in both directions Distribution Steel: $12 \mathrm{~mm} \text { dia bars @ } 170 \mathrm{~mm} \text { c/c }$ |
| Circular Water Tank | 500 (Slab) | Radially at top- 20 mm dia @ $100 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ at bottom- 20 mm dia @ 200 mm c/c in both directions |
| BOTTOM DOME: |  |  |
| Tank | Dimensions (mm) | Reinforcement Details |
| Intze Water Tank | 250 | 12 mm dia bars @ $160 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ in both directions |


| Circular Water Tank | - | - |
| :---: | :---: | :---: |
| BOTTOM CIRCULAR BEAM: |  |  |


| Tank | Dimensions (mm) | Reinforcement Details |
| :---: | :---: | :---: |
| Intze Water Tank | 700*1200 | Main reinforcement: <br> At support- 8 nos. 25 mm dia bars <br> At top- 8 nos. 25 mm dia bars <br> At bottom- 4 nos. 25 mm dia bars <br> Transverse Reinforcement: At support- 4L <br> 12 mm dia bars@170mm c/c <br> At mid span-4L 12mm dia bars@300mm c/c |
| Circular Water Tank |  |  |
| COLUMN: |  |  |
| Tank | Dimensions (mm) | Reinforcement Details |
| Intze Water Tank | $700$ | Main reinforcement: 12 nos. 30 mm dia bars Stirrups: <br> 12 mm dia bars @ 250 mm c/c |
| Circular Water Tank | 700 | Main reinforcement: 12 nos. 30 mm dia bars Stirrups: <br> 12 mm dia bars @ 250 mm c/c |
| BRACINGS: |  |  |
| Tank | Dimensions (mm) | Reinforcement Details |
| Intze Water Tank | 300*750 | Main reinforcement: <br> 4 nos. 20mm dia bars @ top and bottom Transverse Reinforcement: 2L 12 mm dia bars @ 230mm c/c |
| Circular Water Tank | 300*750 | Main reinforcement: |
|  |  | 4 nos. 20 mm dia bars @ top and bottom Transverse Reinforcement: 2L 12 mm dia bars @ $230 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ |

Table 2.1: Comparison between RCC Circular and Intze Water Tank

| RCC Circular Water Tank | PSC Circular Water Tank |
| :---: | :---: |
| Diameter of tank $=10 \mathrm{~m}$ | Diameter of tank $=12.5 \mathrm{~m}$ |
| Height of the tank $=5 \mathrm{~m}$ | Height of the tank $=3.15 \mathrm{~m}$ |
| Thickness $=100 \mathrm{~mm}$ | Thickness $=80 \mathrm{~mm}$ |


| Top dome: <br> $100 \mathrm{~mm}, 8 \mathrm{~mm}$ dia bars @ 160 mm c/c in both directions | Circumferential wire winding $=32$ wires $/ \mathrm{m}$ ( 5 mm diameter wire) |
| :---: | :---: |
| Top ring beam: $360 * 400 \mathrm{~mm}$, Main reinforcement- 4nos. 20 mm dia bars Stirrups- 8 mm dia bars @ 200mm c/c | Vertical spacing of cables $=610 \mathrm{~mm}(8 \mathrm{~mm}$ dia, 12 wires) |
| Cylindrical wall: <br> $260 \mathrm{~mm}, 16 \mathrm{~mm}$ diameter @ 110 mm c/c | - |
| Slab: <br> 550 mm , Radially at top- 20 mm dia @ $100 \mathrm{~mm} \mathrm{c} / \mathrm{c}$ at bottom- 20 mm dia @ 200 mm c/c in both directions | - |

Table 2.2: Comparison Between RCC and PSC Circular Water Tank

## V. CONCLUSION

1. The geometric progression method provides qualitative support to design the water tanks.
2. Compare to RCC circular water tank we can reduce the percentage of steel in the RCC intze tank at bottom slab (dome). The steel requirement for other components are almost same. Hence for the required demand RCC intze tanks are more economical.
3. Water tanks are analysed and designed for the same capacity then seen that thickness of RCC circular water tank is more than pre-stressed concrete circular water tank and other design details are different.
4. By the following results PSC circular water tanks is economic when compared RCC circular water tank.
5. For material cost, Steel has the greatest effect on tank and supporting structure while concrete has the greatest effect on foundation.
6. RCC Circular water tank is more economic than RCC Intze water tank.
7. Under wind loading Intze water tank is recommended.

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