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Design of Elevated Water Tank Container

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ABSTRACT: Water tanks are containers using for storage of water; these tanks are usually storing water for human consumption. Water is needed for the survival of human, mammals and other living things and plants. The water tank provides means for storing drinking water, for irrigation, for agriculture, agricultural farming, fire suppression, manufacturing of chemicals, food preparation and several other applications. A lot of materials are used for constructing water tanks; plastic, fiberglass, poly-ethane, polypropylene, concrete, steel. "Groundwater tank" is made of lined carbon steel, it may receive water from wells or from the surface of the ground, allowing a huge volume of water to be stored and used during peak time. The increase in elevation creates a distribution pressure at the tank outlet. In the current an elevated water tank container is designed keeping the stress and forces within permissible limits.

KEYWORDS: Elevated water tank, Forces, container design, INTZE,

I. INTRODUCTION

Water tanks are containers using for storage of water; these tanks are usually storing water for human consumption. Water is needed for the survival of human, mammals and other living things and plants. The water tank provides means for storing drinking water, for irrigation, for agriculture, agricultural farming, fire suppression, manufacturing of chemicals, food preparation and several other applications. A lot of materials are used for constructing water tanks; plastic, fiberglass, poly-ethane, polypropylene, concrete, steel. "Groundwater tank" is made of lined carbon steel, it may receive water from wells or from the surface of the ground, allowing a huge volume of water to be stored and used during peak time. The increase in elevation creates a distribution pressure at the tank outlet. The profile of water tanks begins with the application parameters; thus, the type of materials used and the design of variables:

1. Water tank locations can be indoors, outdoors, above ground or underground.
2. The volume of the water tank needs to hold.
3. What will the water be used for?
4. The temperature of the area where will be stored, concern for freezing.
5. The pressure required delivering water.
6. How the water reaches to a water-tank.
7. Forces due to wind and earthquake are the major criteria for design. which allows water tanks to survive seismic and high wind events.

Wood, ceramic and stones have been used as water storage for hundreds of years. These were naturally occurring and manmade, and some tanks are still in service. There are several custom configurations that include various rectangular cubes shaped tanks, circular tanks, cone bottom and special shapes for specific design requirements. A functional water tank/container should do not harm the water. It is susceptible to a number of ambient negative influences, including bacteria, viruses, algae, changes in pH, and accumulation of minerals. Correctly designed water tank systems work to mitigate these negative effects. Elevated water tank is necessary for pressurizing the water for supplying or distribution of potable water and also to provide fire protection. It is also call ed INTZE. A water tower is

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built based on the Intze Principle. It has a brick shaft on which the water tank sits. The base of the tank is fixed with a ring anchor made of iron or steel and the design is such that the only vertical forces are transferred to the tower. No horizontal force is generated. Due to the lack of horizontal forces the tower shaft does not need to be built as solid. Figure 1 shows the parameters of the intze container.

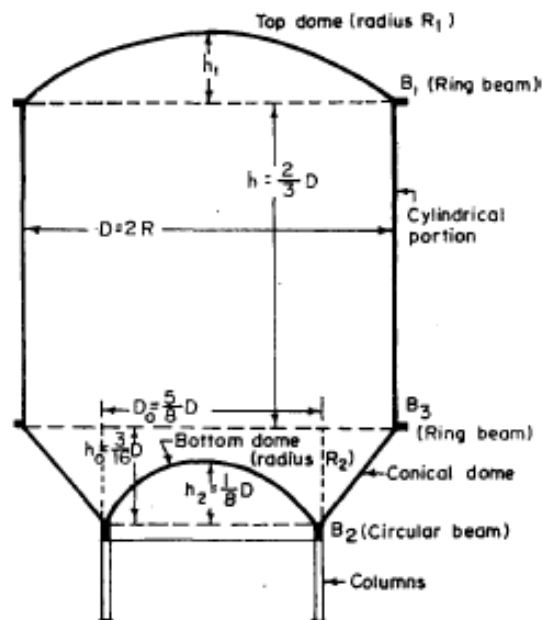


Figure1. Container Parameters

II. LITERATURE REVIEW

Ahmed M. (2015) et al, presented that, the steel fluid stockpiling tanks inside the state of truncated cones are regularly used as regulation vessels for water conveyance or putting away compound substances. Various disappointments were recorded in the past couple of decades for metallic fluid tanks and storehouses underneath wind stacking [1]. Kumar B. D. (2010) et al., presented that, the wind streams with respect to the surface of the ground and produces the stack on the status of the framework on the ground. The impact of the breeze on the structures is of prime significance. The vast majority of the creators remember the static effect of twist on the structure. In any case, for all frameworks, the breeze interfaces with the structure [2]. Thorat Yogesh (2017) et al., presented that, water tanks and Storage repositories are used to store water, oil-based goods, and fluid, equivalent some different fluids. The weight investigation of their tanks is set the indistinguishable of the compound idea of the item. All tanks are outlined as free frameworks from split to dismiss any spillage. This undertaking offers the entire evaluation of the layout of the dissolved securing structure [3]. Asari F. P. (2012) et al., had evaluated the seismic reaction of lifted water tanks, using of friction damper. The RCC hoisted conduct water tank is examined using rubbing damper (FD). For FD machine, the major stage is to decide the slip load. In nonlinear dynamic inspect, the reaction of structure for three seismic tremor time history has been performed to gain the estimations of tower drift base shear [4].

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III. APPROACHES

The past most of the circular water tanks with flat bottom slab were used because they were easy to construct. In the flat bottom slabs, the thickness and reinforcement is heavy so that they are economical. In case of large diameter tanks and economical alternative would be to reduce its diameter at its bottom by conical dome such tank is known as Intze tank. Volume of the container is calculated by the formula:

$$V = (\pi/4) * D^2 h + (\pi h_0 / 12) * (D^2 + D_0^2 + D * D_0) - (\pi h_2^2 / 3) * (3R_2 - h_2), \text{ Where,}$$

D = Diameter of the cylindrical portion

h = Height of the cylindrical portion which is calculated by above formula or thumb-rule is two third of the diameter, h_0 = Height of the conical dome = $3 \times D / 16$, D_0 = Diameter of the staging = $5 \times D / 8$, h_1 = Rise of top spherical dome = $D / 8$, h_2 = Rise of bottom spherical dome = $D / 8$, R_1 = Diameter of the staging = $5 \times D / 8$, R_1 = Height of the conical dome = $3 \times D / 16$.

Meridian thrust at the edge of the top spherical dome is given by

$$T_1 = P * R_1 / (1 + \cos \phi_1)$$

Maximum hoop stress at the centre of the top spherical dome is calculated by

$$(P * R_1 / t) * [\cos \phi_1 - 1 / (1 + \cos \phi_1)], \text{ Meridian thrust at edge is } 31.615 \text{ kN}$$

Top ring beam hoop tension is calculated as

$$P_1 = T_1 * \cos \phi * D / 2,$$

Hoop tension of the conical dome is calculated by

$$P_0' = (P / \cos \phi_0 + q * \tan \phi_0) D' / 2$$

Hoop stress of the bottom dome is calculated by $P_2 R_2 / 2t_0$ Where, R_2 is radius of curvature of the bottom dome and it is calculated as

$$R_2 = (0.25 * D_0^2 + h_2^2) / 2h_2$$

Maximum hoop stress at centre of the bottom dome is calculated as

$$P_2 R_2 / 2t_0$$

Vertical stress on the circular shaft is given by

$$\sigma_{cv} = (W / 2\pi r t) * (1 + 2e/r), \text{ Where, } e = \text{eccentricity, } r = \text{radius of the shaft}$$

IV. RESULTS

The tank design should be such that it can survive in case of earthquake or in wind blow conditions. The top container takes the water load and self weight so equal distribution forces are required. The staging strength is strong enough to take the weight of the container. Table 1 shows the result of the forces on the different parts of the container.

Table 1. Forces and area of the container components

S.No.	Structure	Forces, kN	Reinforcement Area, mm ²
1	Top dome	31.6	300
2	Top ring beam B1	200	1519.76
3	Cylindrical wall	384	2658.84
4	Middle ring beam B3	700	4948
5	Conical dome	615	2115.78
6	Bottom spherical dome	292.620	650
7	Bottom ring beam B2	277	2537
8	Column	1256	4019.2

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V. CONCLUSION

The review of the literatures uncovers that a lot of investigative research work has been done to investigate the convenience and adequacy of intze sorts of tanks in water containing tank.

Generally, the construction material-outputs for all water tank capacities would be based on the choice of the design considerations, with the sizes of their structural elements. Hence, there exists the possibility of having an equal-capacity and similar geometrically shaped water tanks but with some measurable difference in material requirements. In this paper the design of container is considered. In this design the stress and forces of the different components of the container are within the permissible limits. The study is useful for designing the intze with a maximum capacity of 1000kilo litre.

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