Design and Analysis of Intze Water Tank

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ABSTRACT: Due to enormous need by the public, water has to be stored and supplied according to their needs. Water demand is not constant throughout the day. It fluctuates hour to hour. In order to supply constant amount of water, we need to store water. So, to meet the public water demand, water tank needs to be constructed.

Storage reservoirs and overhead tanks are used to store water, liquid petroleum, petroleum products and similar liquids. The force analysis of the reservoirs or tanks is about the same irrespective of the chemical nature of the product. All tanks are designed as crack free structures to eliminate any leakage.

This project gives in brief, the theory behind the design of liquid retaining structure (Elevated circular water tank with domed roof and conical base) using working stress method. Elements are design in working stress method.

KEYWORDS: Upper dome, bottom dome, ring beam, conical slab, circular girder.

I. INTRODUCTION

A water tank is used to store water to tide over the daily requirement. In the construction of concrete structure for the storage of water and other liquids the imperviousness of concrete is most essential.

The permeability of any uniform and thoroughly compacted concrete of given mix proportions is mainly dependent on water cement ratio. The increase in water cement ratio results in increase in the permeability.

Cracks can be prevented by avoiding the use of thick timber shuttering which prevent the easy escape of heat of hydration from the concrete mass the risk of cracking can also be minimized by reducing the restraints on free expansion or contraction of the structure.Design of liquid retaining structure has to be based on the avoidance of cracking in the concrete having regard to its tensile strength.

II. MATERIALS USED

1.Aggregate: To be used in work should be hard, durable and clean. The aggregate should be completely free fromlumps of clay, organic and vegetable matter. Fine dust etc. the aggregate should be uniformly graded.

2.Sand: It should have less silt container. which attract moisture from atmosphere.

3.Cement: Ordinary Portland cement having 43 grades can be used, 53 grade ordinary Portland cement develops crackin early stages and also after construction because of heat of evaluation. These 43 grades develop strength slowly. Ultimately it reaches the same strength as 53 grades.

4.water: Water used should not have salts as it caused efflorescence. water available for potable purpose is only used in construction and during cursing purpose

5.Steel: High yield strength of steel be used in construction such as fe415 gives good strength.

III.WATER CONSUMPTIONFOR VARIOUS PURPOSE

	Types of Consumption	Normal Range (lit/capita/day)	Average	%
1	Domestic Consumption	65-300	160	35
2	Industrial and Commercial Demand	45-450	135	30
3	Public including Fire Demand Uses	20-90	45	10
4	Losses and Waste	45-150	62	25

IV.DESIGN PERIOD

❖ Useful life of the component, considering obsolescence, wear, tear etc.
❖ Expandability aspect.
❖ Anticipated rate of growth of population, including industrial, commercial Developments & migration-immigration.
❖ Available resources.
❖ Performance of the system during initial period.

V.DESIGN OF THE TANK

The design of the tank will involve the following:

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

(2) Ring beam supporting the dome: The ring beam is necessary to resist The horizontal component of the thrust of the dome. The ring beam will be designed for the hoop tension induced.

(3) Cylindrical walls: This has to be designed for hoop tension caused due To horizontal water pressure.

(4) Ring beam at the junction of the cylindrical walls and the conical wall: This ring beam is provided to resist the horizontal component of the reaction of the conical wall on the cylindrical wall. The ring beam will be designed for the induced hoop tension.

(5) Conical slab: This will be designed for hoop tension due to water pressure. The slab will also be designed as a slab spanning between the ring beam at top and the ring girder at bottom.

(6) Floor of the tank: The floor may be circular or domed. This slab is supported on the ring girder.

(7) The ring girder: This will be designed to support the tank and it Contents. The girder will be supported on columns and should be designed for Resulting bending moment and Torsion.

(8) Columns: These are to be designed for the total load transferred to them. The columns will be braced at intervals and have to be designed for wind pressure or seismic loads whichever govern.

(9) Foundations: A combined footing is usual provided for all supporting columns. When this is done it is usual to make the foundation consisting of a ring girder and a circular slab. Suitable proportions for the Intze.

for case(1) suggested by Reynolds. Total volume ~0.585D3
for case(2), the proportion was suggested by Grey and Total Volume is given by

V1 = pd24×H= 0.39D3. for H = D/2.
V2 = $ph12$×(D2 +d2+d) = 0.102D3.
V3 =$ph16$ (3r2+ $h12$) = 0.017D3.
With h1 = 3/25D and r = 0.0179D3.
Volume V = 0.4693D3.
With h1 = D/6 and r = 3/10D.
Volume V = 0.493D3

VI. DESIGN REQUIREMENT OF CONCRETE

In water retaining structure a dense impermeable concrete is required therefore, proportion of fine and course aggregates to cement should be such as to give high quality concrete. Concrete mix lesser than M20 is not used. The minimum quantity of cement in the concrete mix shall be not less than 30kN/m3.Cracking may be caused due to restraint to shrinkage, expansion and contraction of concrete due to temperature or shrinkage and swelling due to moisture effects. Such restraint may be caused by.

❖ The interact ion between reinforcement and concrete during shrinkage due to drying.

❖ The boundary conditions.

❖ The differential conditions prevailing through the large thickness of massive concrete Use of small size bars placed properly, leads to closer cracks but of smaller width. The risk of cracking due to temperature and shrinkage effects may be minimized by limiting the changes in moisture content and temperature to which the structure as a whole is subjected.

VII.GENERAL DESIGN REQUIREMENTS (I.S.I)

Plain Concrete Structures:

Plain concrete member of reinforced concrete liquid retaining structure may be designed against structural failure by allowing tension in plain concrete as per the permissible limit s for tension in bending.

Permissible Stresses in Concrete

❖**For resistance to cracking**: For calculations relating to the resistance of members to cracking, the permissible stresses in tension

❖ **For strength calculations**: Where the calculated shear stress in concrete alone exceeds the permissible value, reinforcement acting in conjunction with diagonal compression in the concrete shall be provided to take the whole of the shear.

Floors:
Floors of tanks resting on ground: If the tank is resting directly over ground, floor may be constructed of concrete with nominal percentage of reinforcement provided that it is certain that the ground will carry the load without appreciable subsidence in any part and that the concrete floor is cast in panels with sides not more than 4.5m.

WALLS
Pressure on Walls.
❖ In liquid retaining structures with fixed or floating covers the gas pressure developed above liquid surface shall be added to the liquid pressure.

❖ When the wall of liquid retaining structure is built in ground, or has earth embanked against it, the effect of earth pressure shall be taken into account.

VIII.LOADING

Field covers of liquid retaining structures should be designed for gravity loads, such as the weight of roof slab, earth cover if any, live loads and mechanical equipment. They should also be designed for upward load if the liquid retaining structure is subjected to internal gas pressure. A superficial load sufficient to ensure safety with the unequal intensity of loading which occurs during the placing of the earth cover should be allowed for in designing roofs. The engineer should specify a loading under these temporary conditions which should not be exceeded. In designing the roof, allowance should be made for the temporary condition of some spans loaded and other spans unloaded, even though in the final state the load may be small and evenly distributed.

IX.WATER TANK WITH SPHERICAL BOTTOM

GENERAL:

Referring to the tank in Fig.(a), supported along the circumference as shown, the magnitude of Na may be obtained from consideration of equilibrium. If it is required to obtain Na at section1-1 from calculation of the total downward load, there are two possibilities. The downward load may be taken to be the weight of water and tank of the annular part i.e. W1 shown in Fig.(b)
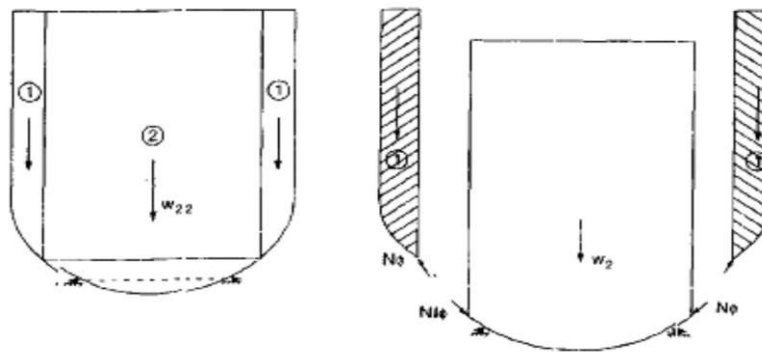

Fig (a)   Fig (b)

FIG: WATER TANK WITH SPHERICAL BOTTOM

Alternatively, the downward load may be calculated from the weight of water and tank bottom of the part i.e. W2 less upward react ion of the support as shown in Fig. For section which cuts the tank bottom inside the support, the reaction has to be considered with the weight of water and tank of the annular part.

### X.DESIGN OF REINFORCED CONCRETE DOMES

GENERAL

The requirements of thickness of dome and reinforcement from the point of view of induced stresses are usually very small. However, a minimum of 80 mm is provided so as to accommodate two layers of steel with adequate cover. Similarly, a minimum of steel provided is 0.15% of the sectional area in each direct ion along the meridians as well as along the latitudes. This reinforcement will be in addition to the requirements for hoop tensile stresses.

The reinforcement is provided in the middle of the thickness of the dome shell Near the edges usually some ring beam is provided for taking the horizontal component of the meridian stress. Some bending moment develops in the shell near the edges. As shown in Fig. it is normal to thicken the shell near the edges and provide increased curvature.

When shrinkage stresses are considered it is necessary to check the thickness for no crack.

Minimum reinforcement of each of two directions at right angles shall have an are of 0.3% for 100 mm thick concrete to 0.2% for 450 mm thick concrete wall. In floor slabs, minimum reinforcement to be provided is 0.15%. The minimum reinforcement as specified above may be decreased by 20%), if high strength deformed bars are used.

XI. CONCLUSION
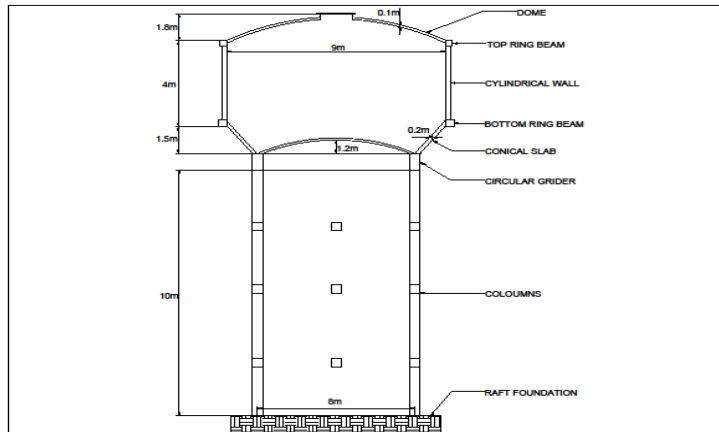
PLAN OF THE WATER TANK

Storage of water in the form of tanks for drinking and washing purposes, swimming pools for exercise and enjoyment, and sewage sedimentation tanks are gaining increasing importance in the present-day life. For small capacities we go for rectangular water tanks while for bigger capacities we provide circular water tanks. The intze elevated towers, when the horizontal angle of conical part is increased from 30 degree to 60 degree, then the stress along that section is reduced by 50%. It is not feasible when the angle is less than 30 degree. The intze elevated towers, when the horizontal angle is maintained in between 40 to 50 degree, the optimum cost is reduced by 6% of total cost compared with the 60-degree tank.

For intze tanks the foundation cost decreases by 5.5% and tank cost increases by 4% when bearing capacity increases from 100 to 150 KN/m^2. While in cylindrical tanks foundation cost decreases by 3 % and supporting structure and tank cost increases by 1% and 2% respectively. Increase of wind speed from 38 to 53.5 m/s has an effect on foundation cost increases by 0.7% and tanks cost decreases by approx. 1% for intze tank. Supporting structure cost remains approximately constant for the wind speed increment. In cylindrical tanks all the elementary cost remains constant.

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