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A BRIEF STUDY OF R.C.C. OVER HEAD WATER TANK AS PER IS CODE

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Abstract : Water tanks are an important public service and industrial structure. The design and construction methods used for reinforced concrete are influenced by existing building processes, the physical appearance of the material and the climatic conditions. Prior to taking the design, the most appropriate type of tank suspension and appropriate load balancing including structural proportions especially in relation to overlapping joints are performed. The design is done taking into account the possible combination of loads, times and shekels from direct loads and horizontal loads that work in any direction where the tank is full and empty. In this project by doing an analysis of the Intze tank, deviation formation due to hydrostatic pressure and stress, etc. it is analyzed.

Keywords: *Overlapping Joint, Reinforced concrete, Hydrostatic pressure, Inlet Tank*

I. INTRODUCTION

1.1. General

Storage dams and overhead tank are used to store water, liquid petroleum, petroleum products and similar liquids. The structures are made of stone, steel, reinforced concrete and pre-reinforced concrete. In this case, stone and metal tanks are used for less skill. The cost of steel tanks is high and that is why they are rarely used to store water. Reinforced concrete tank is high and therefore rarely used to store water. Reinforced concrete tanks are very popular because, apart from the construction and designs they are simple, inexpensive, and naturally monolithic and can be leaked proof. Generally, no cracks are allowed to occur in any part of the R.C.C tank structures that store liquids and make water solid by using a rich mixture (not less than M20) of concrete. In addition, waterproofing materials are sometimes used to make tanks stronger. The durability of concrete is directly related to the water content of cement. The combination that should be used with vibrators should be done to achieve non-corrosion. Cement content from 330 Kg / $m3$ to 530 Kg / $m3$ is recommended to keep the weight down.

Leaks have a high head and it has been noted that a head up to 15m does not cause a leak problem. It is recommended that the use of the 415 grade disabled barriers be constructed to construct fluid storage structures. However soft metals are also used. Proper placement of reinforcement, use of smaller sizes and the use of disabled bars lead to distinct cracks. Split width of 0.1mm is accepted as the allowable value for liquid storage structures. When designing fluid storage structures the recommendations of the "Liquid Code Practice Code- IS3370 (Part I to IV)" should be considered.

1.1. Classification of R.C.C Water Tank

1.1.1. Resting on Ground

These are used for freshwater storage areas, seating tanks, ventilation tanks etc. These tanks sit directly on the ground. The walls of these tanks are under water pressure from the inside and the foundation is under water pressure inside and the soil reaction under the foundation. The tank may be open at the top or roof. The groundwater tank is made of carbon steel, it can get water from a water source or surface water that allows a large amount of water to be placed on the inventory and used during cycles of high demand.

1.1.2. Elevated Water Tank

These tanks are based on a stage that may have stone walls, an R.C.C tower or an R.C.C column attached together. The walls are under water pressure from the inside. The foundation is under water weight, the weight of the walls and the weight of the roof. The stage should carry all tanks throughout the water and face air loads.

1.1.3. Underground Water Tank

These tanks are built below ground level, like the filters of water treatment plants and septic tanks. The walls of these tanks are exposed to water pressure from the inside and earth pressure from the outside. The bottom of the tanks is exposed to water pressure from the inside and earth pressure from the outside. The bottom of the tanks is exposed to water pressure from the inside and soil reaction from below. They are always covered at the top

1.1.4. Circular Tank

Generally, circular tanks rest on the ground or are elevated. Underground circular reservoirs are also constructed. Circular tanks can be designed with either a flexible connection of the bottom to the wall or a rigid connection between the walls and the bottom, in the first case expansion and contraction of the side walls is possible, but in the second case the walls are monolithic with the base. The walls of the tank are subjected to hydrostatic pressure, which is maximum at the base and zero at the top. Typically, for the design of circular tanks, the thin cylinder theory is used to design the wall thickness and to calculate the maximum loop stress.

1.1.5. Rectangular Tank

For smaller capacities, circular tanks are uneconomical and their formwork expensive. Rectangular tanks are designed where small capacity tanks are required. These can rest on the ground, elevated or underground. Tanks should preferably have a square plan and it is desirable that the larger side is not more than twice the smaller side and for rectangular tanks. Tank walls, either resting on the ground or elevated, are subjected to water pressure from the inside, and underground they are subjected to internal water pressure and external earth pressure.

1.1.6. Intze Type Tank

This is a very special type of elevated tank used for very large capacities. Round tanks for very large capacities prove uneconomical when a flat bottom plate is provided. The Intze type tank consists of an upper dome supported by a ring beam that rests on a cylindrical wall. The walls are supported by a ring beam and a cone plate. A lower dome will also be provided, which will also be supported by a ring beam. The cone and lower dome are made so that the horizontal pull from the cone base is balanced by the pull from the lower dome.

II. GENERAL CONSIDERATION

IS 3370(Part 1) recommends the following precautions to be considered before construction of water tank –.

1.2. Cement content

The concrete used for the tank should be at least M20 to provide not only strength but also a higher density to prevent seepage. The cement content should not be less than 300 kg/$m3$ to achieve watertightness and not more than 530 kg/$m3$ to prevent cracking due to concrete shrinkage. A well-graded aggregate with a water-cement ratio of less than 0.5 is recommended for the production of impermeable concrete.

1.3. Permissible steel requirement

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, fst In shear, f_{sv}	 125 125	 190 175
Compression in column subjected to direct load	125	175

1.4. Permissible Stresses in Concrete

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

1.5. Cover of reinforcement

The minimum clear cover or nominal cover of the main reinforcement in direct tension shall be 20mm rod diameter, whichever is larger. The minimum nominal coverage is increased to 25 and 30 mm for tensile bending and alternating wetting and drying environments, but the minimum coverage should be 40 mm for the surface in contact with water.

1.6. Minimum Steel

Minimum amount of steel shall be provided in two main directions to minimize cracking due to shrinkage, temperature etc. Minimum HYSD reinforcement in walls, floors and roofs should be 0.35% of surface zone cross section in both right-angle directions.

1.7. Water proofing material

In addition, the primary consideration for water tanks is the strength of the watertightness of the tank. Complete waterproofing can be achieved by using high-strength concrete. In addition, waterproofing materials can be used to further increase water tightness. Internal waterproofing or waterproof linings are often used to make concrete impermeable or waterproof. Admixtures are used in the internal waterproofing method

III. DESIGN COMPONENTS OF INTZE TYPE TANK

3.1. Tank Portion

The components of an upper circular tank R.C.C. The various components of an elevated tank are as follows:

3.1.1. Upper Roof Dome

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

3.1.2. Ring Beam

The ring beam is necessary to resist the horizontal component of the dome's thrust. The ring beam will be dimensioned to induce the hoop stress.

3.1.3. Circular Wall

This must be designed for the hoop pull caused by the horizontal water pressure and resist the bending moment induced on the wall by the liquid load.

3.1.4. Bottom Plate

It will be designed for the total load above it. The board will also be designed for the total load above it. The board will also be designed as a board spread in both directions.

3.1.5. Lower Beams

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

3.2. Staging Portion

3.2.1. Columns & Braces Columns

They should be sized for the total load that is transferred to them. Columns shall be braced at intervals and shall be designed for wind pressure and seismic loading as required. The braces are the elements connecting the columns at the mid-height of the columns. It is supplied in slim columns to increase the load capacity of the column.

3.2.2. Foundation

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

3.3. Domes

A dome can be defined as a thin shell formed by rotating a regular curve about one of its axes. The shape of the dome depends on the type of curve and the direction of the axis of rotation. Domes are used in various structures such as roofs of circular areas, circular tanks, hangars, exhibition halls, auditoriums and the bottoms of tanks, storage tanks and bunkers. Domes can be made of masonry, steel, wood and reinforced concrete. However, braced domes are most commonly used these days because they can be constructed over large spans. A membrane theory for the analysis of rotating shells can be developed by neglecting the effect of bending moment, torsional moment and shear, provided that the loads are fully carried by axial stresses. The meridional thrust and circumferential forces are calculated for the design of the domes. However, a minimum amount of 0.3% steel should be provided in both directions of the dome.

3.4. Cylindrical Wall

Circular wall tanks are generally more economical than tanks of other shapes. Tanks are subjected to a uniformly varying load due to hydrostatic pressure increasing from zero at the free water level to the water level to a maximum at the bottom. In a circular tank, lateral pressure causes wall stress. The magnitude of the loop stress depends on the nature of the connection between the wall and the bottom plate.

4. STAGING OF TANKS

Above-ground tanks are generally supported on a space frame consisting of reinforced concrete columns braced together by ring girders at the top and bottom and also at a number of places along the height by struts shown. The arrangement allows the effective height of the columns to be taken as the distance between the centers of adjacent stiffeners. Alternatively, the tower can be a thin-walled reinforced shaft, i.e. a cylindrical shell

4.1. Analysis of Wind Forces

In addition to gravitational forces, the tower and tank are subject to wind and seismic forces depending on the location of the tank. The wind pressure at the site is determined as per the provisions of IS : 875 part III. The wind force on the surface is the product of the pressure per unit area and the projected area perpendicular to the wind direction. Intze tanks offer relatively less resistance and a reduction factor of the order of 0.7 is used to achieve an effective pressure. The nature of the forces and the analysis procedure are discussed in the following sections.

4.1.1. Classification of Structure

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., with a maximum dimension (greatest horizontal or vertical dimension) of less than 20 m.

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., with a maximum dimension (greatest horizontal or vertical dimension) greater than 50 m

4.1.2. Terrain Category

There are four terrain categories. The terrain in which a specific building stands is evaluated as 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-dispersed obstacles generally between 1.5 and 10 m high.

Category 3 – terrain with numerous closely spaced obstacles of structure size up to 10 m in height with few or no isolated tall structures.

Category 4 – terrain with numerous large high obstacles.

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

$$V_Z = V_B\ K_1\ K_2\ K_3$$

4.1.4. 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 :

$$\alpha h = \beta\ I\ F$$

5. DESIGN

5.1. Design Data

5.1.1. Population Calculation

Population forecast for Kokrajhar Town

Table 1. The table presents the projection of population (PHED, Kokrajar)

Year	Population decadal (Souls)	(Increment)	Incremental	Rate of growth
1961	9489	-	-	-
1971	17060	7571	-	0.79
1981	21960	4900	(-) 267	0.29
1991	28240	6280	(+) 1380	0.29
2001	50433	22193	(+) 15193	0.79
Total		**40944**	**14622**	
Average		**x= 10236**	**4874**	**r_g = 0.48**

Design capacity of plant = 7225910 litre = 7225.91 m^3

Providing 8 water tank = 903 m^3

5.1.2. Dimension of Tank

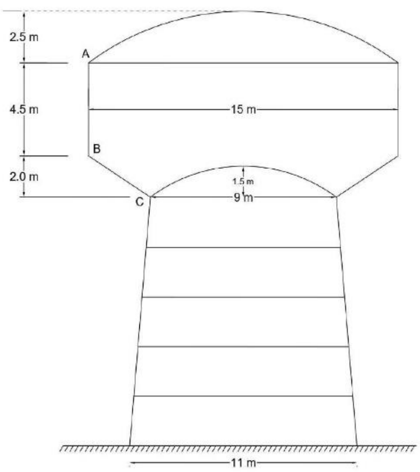

Figure 1. Dimension of Tank

5.1.3. Design of Top Dome

Provide a thickness of 150 mm for the roof dome

Total load (w) = 4485 N/m^2

Hoop stress at the level of springing = 91360.5 N/m^2 = 0.091 N/mm^2

Hoop stress at the crown = 186875 N/m^2= 0.18 N/mm^2

Provide 8 mm ϕ @ 110 mm c/c

5.1.4. Ring Beam at Top

Provide 6 bars 18 mm diameter (1526 mm^2)

Size of the ring beam

Provide 350 mm × 400 mm section

Shear reinforcement Provide 8 φ – 2 legged stirrups, Provide 8 φ– 2 legged vertical stirrups @ 250 mm c/c

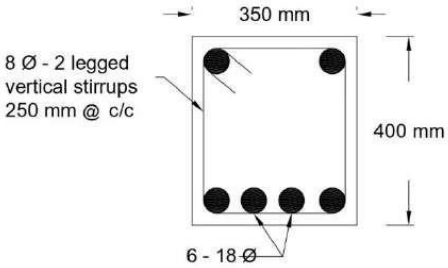

Figure 2. Ring Bean Top Reinforcement

5.1.5. Cylindrical Wall

Thickness of wall Provide t = 300 mm

Provide of 8 mm φ bars @ 100 mm c/c near each face.

5.1.6. Ring Beam at Bottom

Provide 14 bars of 24 mm diameter

Provide,750 mm × 950 mm section

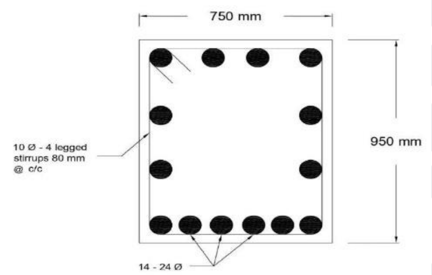

Figure 3. Ring Beam Bottom Reinforcement

5.1.7. Design of Conical Slab

Design for hoop tension

Length of sloping slab = 3.6055 m

Thickness of sloping slab = 300 mm.

Provide 35 bars of 20 mm diameter

Design for bending moment

Load per meter width of the conical slab = 176641 N

Maximum bending moment = 66240 Nm.

Axial compression = 100842 N.

provide 20 mm φ bars @ 170 mm c/c

5.1.8. The Bottom Dome

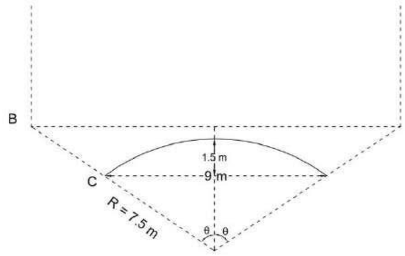

Figure 4. Bottom Dom

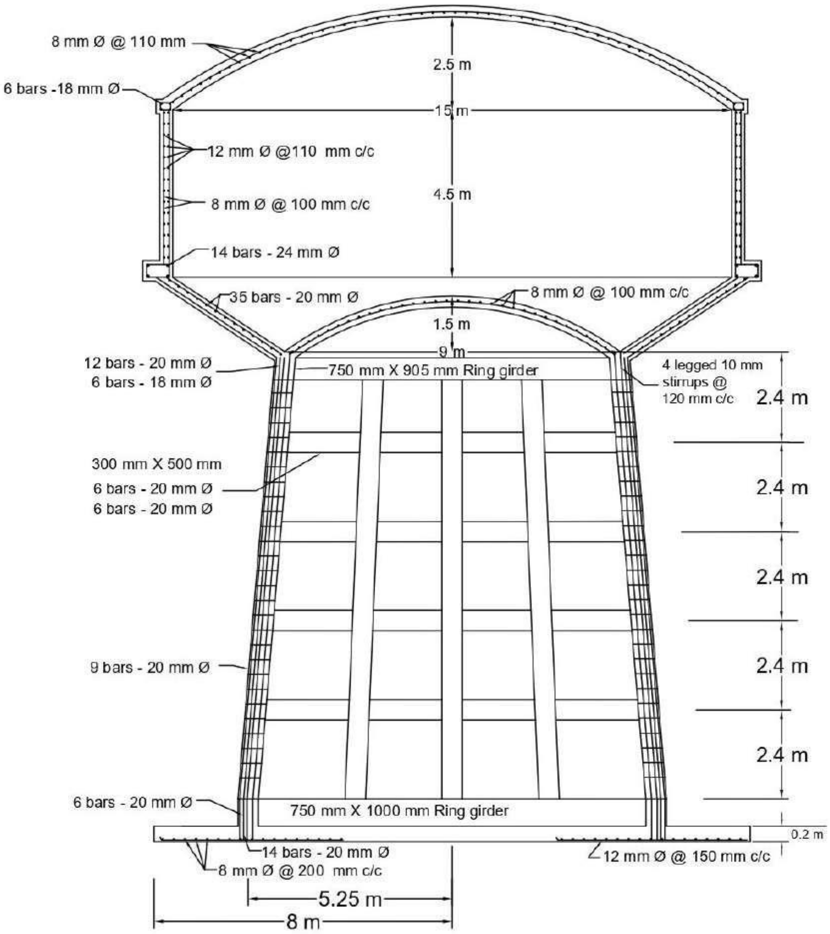

Figure 5. Details of reinforcement in Intze tank

VI. RESULT AND CONCLUSIONS

Water storage in the form of tanks for drinking and washing purposes, swimming pools for exercise and entertainment, and tanks for settling waste water is gaining more and more importance in today's life. For small capacities we choose rectangular water tanks, while for larger capacities we supply circular water tanks. The Intze tank is a modified circular tank. The design of the Intze water tank is a very lengthy method. The entire structure is designed by hand with M30 grade concrete in mind.

Thus overhead water tank with a capacity of 3,00,000 litres is planning, designed, and manually analysed all materials behaviour that are used for water storage and found that concrete thank. Detailed drawings were prepared in AutoCAD software, which are necessarily shown. The station was designed with maximum safety and the effects of seismic force and wind force are also taken into account.

So overall, this project can be implemented in the mentioned area, i.e. Kokrajhar

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