DESIGN OF OVERHEAD CIRCULAR WATER TANK USING RCC

Project Report submitted in partial fulfillment of the Degree of

Bachelor of Technology

In

Civil Engineering

Under the Supervision of

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To

विद्या तत्व ज्योतिसमः

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CERTIFICATE

This is to certify that project report entitled "**DESIGN OF OVERHEAD CIRCULAR WATER TANK USING RCC**", submitted by **ABHINAV WADHWA, PARSHANT BHARDWAJ, NAMAN SINGHAL** in partial fulfillment for the award of degree of Bachelor of Technology in Civil Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision. This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date: **Supervisor's Name**

Mr. SAURAV

ACKNOWLEDGEMENT

We take this opportunity to express our profound gratitude and deep regards to our guide, **Mr. SAURAV KUMAR** for his exemplary guidance, monitoring and constant encouragement throughout the course of this project . The blessing, help and guidance given by her time to time shall carry us a long way in the journey of life on which we are about to embark.

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ABSTRACT

Water tanks are used to store water and are designed as crack free structures, to eliminate any leakage. In this project, design of circular water tank resting on ground is presented. Both reinforced concrete (RC) and pre-stressed concrete (PSC) alternatives are considered in the design and are compared considering the total cost of the tank. These water tank are subjected to the same type of capacity and dimensions. As an objective function with the properties of tank that are tank capacity, width & length etc. A computer program has been developed for solving numerical examples using the Indian std. Indian Standard Code 456-2000, IS-3370-I, II, III, IV & IS 1343-1980. The paper gives idea for safe design with minimum cost of the tank and give the designer the relationship curve between design variable thus design of tank can be more economical, reliable and simple. The paper helps in understanding the design philosophy for the safe and economical design of water tank.

Storage reservoirs and overhead tank 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 limit state method.

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SYMBOLS

- A = Total area of section
- Ab = Equivalent area of helical reinforcement.
- Ac = Equivalent area of section
- Ah = Area of concrete core.
- Am = Area of steel or iron core.
- Asc = Area of longitudinal reinforcement (comp.)
- Ast = Area of steel (tensile.)
- Al = Area of longitudinal torsional reinforcement.
- Asv= Total cross-sectional are of stirrup legs or bent up bars within distance Sv
- Aw =Area of web reinforcement.
- AΦ= Area of cross –section of one bars.
- a = lever arm.
- ac = Area of concrete.
- B =flange width of T-beam.
- b = width.
- br =width of rib.

- C =compressive force.
- c = compressive stress in concrete.
- c'= stress in concrete surrounding compressive steel.
- D = depth
- d = effective depth
- dc = cover to compressive steel
- ds= depth of slab
- dt= cover to tensile steel
- e = eccentricity.
- = compressive steel depth factor (=dc/d).
- F =shear force characteristic load.
- Fd= design load
- Fr = radial shear force.
- f= stress (in general)
- fck= characteristic compressive stress.
- Fy= characteristic strength of steel.
- H = height.
- I = moment of inertia.

- Ie=equivalent moment of intertia of stress.
- j= lever arm factor.
- Ka=coefficient of active earth pressure.
- Kp=coefficient of passive earth pressure.
- k = neutral axis depth factor (n/d).
- L=length.
- Ld=devolopment length.
- l = effective length of column; length; bond length.
- M = bending moment; moment.
- Mr=moment of resistance; radial bending moment.
- Mt=torsional moment.
- Mu= bending moment (limit state design)
- Mθ=circumferential bending moment
- m = modular ratio.
- n = depth of neutral axis.
- nc=depth of critical neutral axis.
- Pa=active earth pressure.
- Pp= passive earth pressure.

- Pu= axial load on the member(limit state design).
- P = percentage steel.
- P'= reinforcement ratio.
- Pa=active earth pressure indencity.
- Pe=net upward soil pressure.
- Q= shear resistance.
- q = shear stress due to bending.
- q'=shear stress due to torsioN
- R= radius.
- s= spacing of bars.
- sa= average bond stress.
- sb= local bond stress.
- T=tensile force.
- Tu= torsional moment.
- t= tensile stress in steel.
- tc= compressive stress in compressive steel.
- Vu= shear force due to design load.
- Vus=strength of shear reinforcement.

- W= point load.
- X= coordinate.
- x_u= depth of neutral axis.
- Z= distance.
- α = inclination.
- β = surcharge angle.
- γ = unit weight of soil
- γ_f=partial safety factor appropriate to the loading.
- γ_m= partial safety factor appropriate to the material.
- σ_{cc} = permissible stress in concrete.
- σ_{cbc}= permissible compressive stress in concrete due to bending.
- σ_{sc}= permissible compressive stress in bars.
- σ_{st}= permissible stress in steel in tension.
- σ_{st}= permissible tensile strss in shear reinforcement.
- σ_{sy}= yield point compressive stress in steel.
- μ = co efficient of friction.

CHAPTER: - 1

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 .The decrease in water cement ratio will therefore be desirable to decrease the permeability, but very much reduced water cement ratio may cause compaction difficulties and prove to be harmful also. Design of liquid retaining structure has to be based on the avoidance of cracking in the concrete having regard to its tensile strength. 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.

Storage reservoirs and over head 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. In general there are three kinds of water tanks-tanks resting on ground Underground tanks and elevated tanks. Here we are studying only the tanks resting on ground like clear water reservoirs, settling tanks, aeration tanks etc. are supported on ground directly. The walls of these tanks are subjected to pressure and the base is subjected to weight of Water.

CHAPTER: - 2

LITERATURE REVIEW

2.1 GENERAL DEFINITIONS

WATER TANKS

A water tank is a container for storing water. The need for a water tank is as old as civilized men, providing storage of water for drinking water, irrigation agriculture, fire suppression, agricultural farming, both for plants and livestock, chemical manufacturing , food preparation as well as many other applications. Water tank parameters include the general design of the tank, and choice of construction materials. Various materials are used for making a water tank: plastics (polyethylene, polypropylene), fiberglass, concrete, stone, steel (welded or bolted, carbon, or stainless), Earthen ponds function as water storage.

COLUMNS

Column or pillar in architecture and structural engineering is a structural element that transmits, through compression, the weight of the structure above to other structural elements below. In other words, a column is a compression member. The term column applies especially to a large round support with a capital and base and made of stone or appearing to be so. A small wooden or metal support is typically called a post, and supports with a rectangular or other non-round section are usually called piers. For the purpose of wind or earthquake engineering, columns may be designed to resist lateral forces. Other compression members are often termed "columns" because of the similar stress conditions. Columns are frequently used to support beams or arches on which the upper parts of walls or ceilings rest.

DOME

A dome is an element of architecture that resembles the hollow upper half of a sphere. Dome structures made of various materials have a long architectural lineage extending into prehistory. A dome may be defined as a thin shell generated by the revolution of a regular curve about one of its axes. The shape of the dome depends on the type of the curve and the direction of the axis of revolution. In spherical and conidial domes, surface is described by revolving an arc of a circle. The centre of the circle may be on the axis of rotation (spherical dome) or outside the axis (conidial dome). Both types may or may not have a symmetrical lantern opening through the top. The edge of the shell around its base is usually provided with edge member cast integrally with the shell. Domes are used in variety of structures, as in the roof of circular areas, in circular tanks, in hangers, exhibition halls, auditoriums, planetarium and bottom of tanks, bins and bunkers. Domes may be constructed of masonry, steel, timber and reinforced concrete. However, reinforced domes are more common nowadays since they can be constructed over large spans

Membrane theory for analysis of shells of revolution can be developed neglecting effect of bending moment, twisting moment and shear and assuming that the loads are carried wholly by axial stresses. This however applies at points of shell which are removed some distance away from the discontinuous edge. At the edges, the results thus obtained may be indicated but are not accurate.

OVERHEAD WATER TANKS

Overhead water tanks of various shapes can be used as service reservoirs, as a balancing tank in water supply schemes and for replenishing the tanks for various purposes. Reinforced concrete water towers have distinct advantages as they are not affected by climatic changes, are leak proof, provide greater rigidity and are adoptable for all shapes.

2.2 PAPERS CONSULTED

One of the papers we have consulted is “Economics of R.C.C. Water tank Resting over Firm Ground visa- vis Pre-stressed Concrete Water Tank Resting over Firm Ground” by” Ms. Snehal Metkar sent University of MAHARASHTRA)”. In the paper there were details of joints in the water tank.

The second was the paper with title “Design of RCC overhead Tank” by “Department of Civil Engineering Gokaraju Rangaraju Institute of Engineering and Technology Hyderabad”.

2.3 BOOK CONSULTED

The books consulted for the project are “Design of RCC Structure by C.V Ramanutham” “Structure Analysis” by B.C Punmia “Design of RCC structure” by Pillai and Menon. All these books contain the details regarding the reinforcement in water tank and in the columns. These also contain the details of loading.

CHAPTER:-3

OBJECTIVES

- To make the study about the analysis and design of water tank.
- To study the guidelines for the design of liquid retaining structure According to IS code.
- To know about design philosophy for safe design of water tank.
- To design the reinforcement details manually.
- To know economical design of water.

WATER QUANTITY ESTIMATION

The quantity of water required for municipal uses for which the water supply scheme has to be designed requires following data: Water consumption rate (Per Capita Demand in litres per day per head)Population to be served.

Quantity= Per demand x Population

CHAPTER:-4

DESIGN PHILOSOPHY

4.1 Permissible stresses in concrete:-

- *For resistance to cracking*:-

Design of liquid retaining structure is different from R.C.C. structures. As it requires that concrete should not crack and hence tensile stresses in concrete should be within permissible limit. A reinforced concrete member of liquid retaining structure is design on the usual principle ignoring tensile resistance of concrete in bending. Accordingly it should be ensure that tensile stresses on the liquid retaining face of the equivalent concrete section do not exceed the permissible tensile strength of concrete.

Grade Of Concrete	***Permissible Stresses***		***Shear***
	Direct Tension	Tension Due To Bending	
M15	1.1	1.5	1.5
M20	1.2	1.7	1.7
M25	1.3	1.8	1.9
M30	1.5	2	2.2
M35	1.6	2.2	2.5
M40	1.7	2.4	2.7

- *For strength calculation*:-

In strength calculations the permissible Concrete stresses shall be in accordance with above Table. Where the calculated shear stress in concrete a lone exceeds the permissible value, reinforcement acting in conjunction with diagonal compression in the concrete shall be provided to take the whole of the shear.

4.2 Permissible Stresses In Steel :-

- *For resistance to cracking.*

When steel and concrete are assumed to act together for checking the tensile stress in concrete for avoidance of crack, the tensile stress in steel as in table 2will be limited by the requirement that the permissible tensile stress in the concrete is not exceeded so the tensile stress in steel shall be equal to the product of modular ratio of steel and concrete, and the corresponding allowable tensile stress in concrete.

- *For strength calculations*

In strength calculations the permissible stress shall be as given

Grade Of Concrete	***Permissible Stresses***	
	Mild Steel Bars	HYSD Bars
Tensile stresses in the members under direct Tension	115	150
Tensile stress in members in bending On Liquid Face	115	150
Tensile stress in members in bending On face of away from liquid for members less than 225mm	115	150
On face away from liquid for members 225mm or more in thickness	125	190
Tensile stresses in shear reinforcement For members less than225mm in thickness	115	150
For members 225mm or more in thickness	115	175

4.3 Design Requirement:

Generally M30 grade of concrete should be used Design Mix (1:1*1/2:3) Steel reinforcement should not less than0.3% of the gross section shall be provided in each direction Floors:-floor may be constructed of concrete with nominal % of reinforcement smaller than provided in table 1.they are cast in panels with sides not more than 45m and with contraction or expansion joints in between..In such cases a screed or concrete layer(M10) not less than 75mm thick shall placed first on the ground and covered with a sliding layer of bitumen paper to destroy the bond between the screed and the floor.

Minimum Cover: - 35mm (both the faces).

Minimum Reinforcement:-Overall .24% of total cross section should be provided.

CHAPTER:-5

DESIGN STEPS

- Assumed suitable thickness
- Calculate designed constants
- Calculate hoop tension, maximum bending moment by using IS 1370 part IV.
- Calculate hoop steel(provide in the form of rings per meter height)
- Check the assume thickness with given permissible values of tensile stresses of concrete in direct tension for the given grade of concrete.
- Check of thickness for bending
- Provide vertical steel
- Design base slab and draw details

CHAPTER:-6

DESIGN DETAILS

6.1 Minimum Reinforcement:-

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.

6.2 Minimum Cover to Reinforcement:-

For liquid faces of parts of members either in contact with the liquid the minimum cover to all reinforcement should be 25mm or the diameter of the main bar whichever is grater.

6.3 Forces On Walls Of Tank:-

T_1, T_2- Tangential Forces Acting on the Dome

V_1, V2- Vertical Force acting along the side of the cylindrical wall

V_3, V4- Vertical forces resisted by columns of the water tank

H_1, H2- Horizontal forces acting on joints

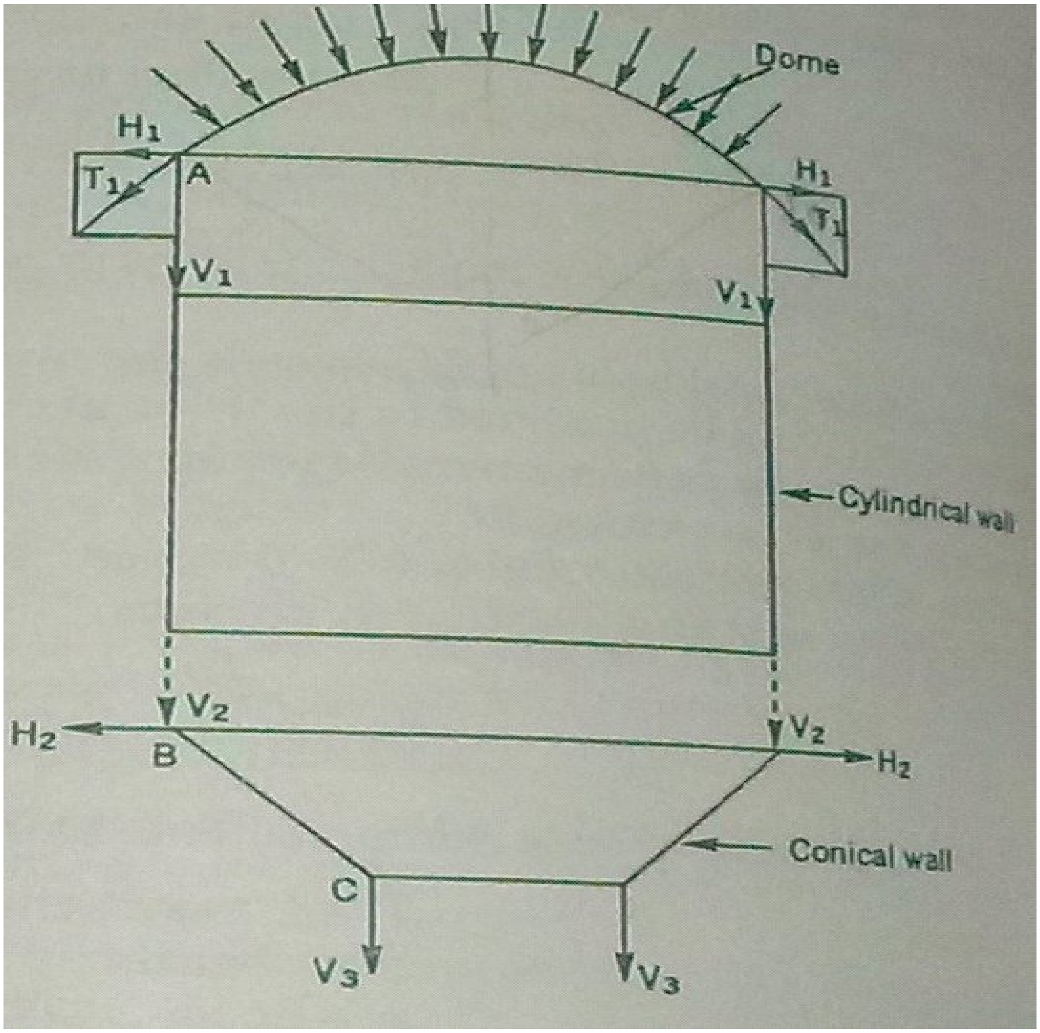


Fig1: PLAN OF WATER TANK WITH FORCES ACTING

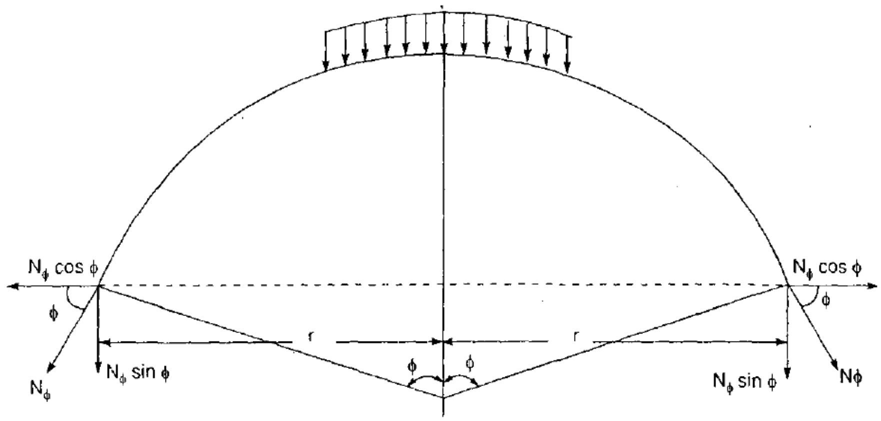


Fig2: FORCES ON SHELL OF THE TANK

Nϕ - Forces along the circumference Or Meridonial Stresses

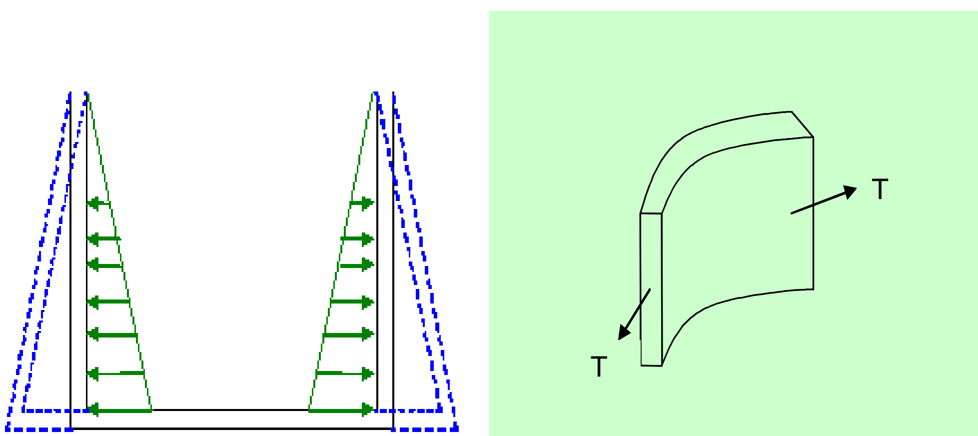


Fig3: FORCES ON WALLS OF TANK

CHAPTER:-7

DESIGN

Design of an intez tank for a capacity of 250,000lts

Assuming height of tank floor above G.L 12m

Safe bearing capacity of soil 100kn/m^2

For M20 σ_{cbc} = 7N/mm^2, σ_{cc} = 5N/mm^2

Direct tension σ_{st} = 5N/mm^2

Tension in bending = 1.70 N/mm^2

Modular ratio $m = 13$

For Steel stress,

Tensile stress in direct tension = 115 N/mm^2

Tensile stress in bending on liquid face = 115 N/mm^2 for t < 225 mm

Taking the volume as 0.585 D^3 for proportion given in Fig.

D = 7.50 m. The dimension of the Tank is shown in fig.

7.1 Design of Roof Dome:

Considering a rise of 1.50 m, radius of the roof dome is given from

$1.50(2R-1.50) = (3.75)^2$

R = 5.4375m.

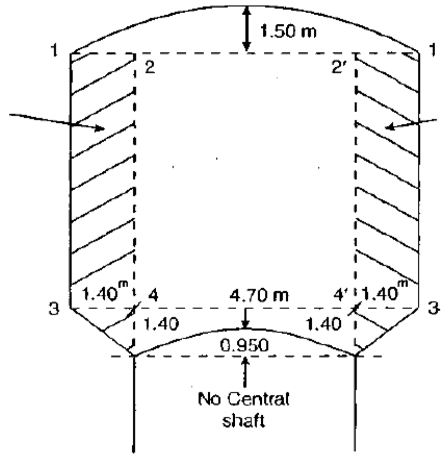
$\cos\phi = (5.4375 - 1.50)/5.4375 = 0.7241$

And $\phi = 43.602 < 51.8°$

Hence no tension

Assuming t = 100mm.

Self wt. = 2400N/m^2



Equivalent of wind load, accidental and live load = 5000N/m^2

Meridian stresses at edge of dome

No = -wR/(1+cosϕ)

= - 50000(5.4375)/

= 157669.10 N

And Meridian Stress = 15769.10/1000(100) = -0.1577N/mm^2 (compressive)

Maximum hoop stress at crown = -wR/2t = -5000(5.4375)/2(100)(1000)

= -0.136 N/mm^2

Use nominal R/f = 0.3% = 300mm2

Use 8mm bars @160mm c/c both ways.

***<u>7.2 Design of ring beam at top</u>*:-**

Horizontal component of Nϕ = Nϕcosϕ

= 15769.10(0.7421)

= 11418.41 N

Hoop Tension in ring = 11418.41(7.5/2) = 42819.10N

Steel required for hoop tension = 42819.10/115

= 372.33mm^2

Use 4 Nos. 12mm bars at corners.

Area of cross section of ring beam considering concrete only

= 42819.10/1.20

= 35682.58 mm^2

Use a ring beam 225mm*160mm

Area provided = 36000mm^2 > 35682.58mm^2

Use 6mm dia bars for nominal stirrups @ 100mm c/c

Shear stress along the edge = N□sin□ = 15769.10

Steel required for hoop tension = 42819.10/115

= 372.33mm2

Use 4 Nos.12 mm bars at corners.

Area of cross section of ring beam considering concrete only

= 42819.10/1.20

= 35682.58mm2

Use a ring beam 225mmX160mm

Area provided = 36000mm2 > 35682.58mm2

Use 6mm dia nominal stirrups @ 100mm c/c.

Shear stress along the edge = N□ sin□ = 15769.10 (0.690) = 10880.68N

Shear stress = 10880.68/100(1000) = 0.1088N/mm2 –very low.

***<u>7.3 Design of cylindrical wall</u>*:-**

Height of the wall = 5.0 m

Pr = 10000(5) = 50000N/m2

N□ = 50000(7.50/2) = 187500N

Area of steel required = 187500/115 = 1630.43mm2

Use 12 mm bars @ 135mm c/c on both faces.

With A_s = 1675.52m2

Thickness of concrete required $\frac{187500+60\,(1675.52)}{1.2}$

Considering A = Ac + (m-1) As = Ac+ (12) (1675.52) = Ac + 20106.24 = 240026

Ac = 219919.76mm2

Use t = 230mm at bottom, tapered to 200mm at top

Minimum Ast = 0.30-0.10 (130) / 350 = 0.2629%

Maximum Ast = 604.57mm2

Hence 12mm φ @135 c/c. at both faces adequate

***<u>7.4 Cantilever beam</u>*:-**

From table 1, for H_2/D_t = 14.493

Cantilever B.M. 0.0090 (wH^3) = 0.0090 (10000) (5)3 = 11250Nm/m

For no crack t = 230mm adequate.

Use vertical steel And $A_{st} = \frac{1000}{115(0.853)(200)} = 573.42mm^2$

Use 12 mm □ vertically @150 mm c/c. as both faces.

Roof load = (2πR) h1 (w_{d+l})

= 2πR2 (1+cos□) w_{d+l}

= 2π (5.4375)2 (1-0.7241) (5000) = 256271.38N

Wt. of ring beams = (0.225) (0.160) (π) (7.725) (24000)

= 20968.25N

Wt. of side wall = $\frac{(7.715)(0.215)(5)(25000)}{902564.22}$= 625324.59N

Direct compressive stress = $\frac{902564.22}{\pi(7.715)(1000)(230)}$ = 0.162 N/mm2

Hence ok

7.5 Design of ring beam at bottom of cylindrical wall and top of conical slab **:-**

From top ΣW = 902564.22N

Self Wt. of ring beam = 80000.00N

Total weight = 982564.22N

Inclined thrust at top of conical portion = $\frac{982564.22}{\pi(7.725)\sin\theta}\pi$= 57256.10N/m

Where θ = 45°

Horizontal component = 57256.10(cos45°) = 40486.18N/m

Hoop tension in ring beam = 40486.18 (7.50/2) = 151823.16N

Pressure of water at ring level = 10000 (5) = 50000N/m

Hoop tension due to this on the ring beam

50000(7.5/2) (width of the ring beam) = 56250N

Taking width as 300mm

Total hoop tension = 151823.16+ 56250 = 208073.16

Steel required = 208073.16/115 = 1809.33mm2

Use 6 nos. 20 mm Ø bars

Ac + (m-1)Ast = Ac+12(1884.96)

Hence Ac = 208073.16-12(1884.33) = 154551mm^2

Use ring size 520mmX300mm

Use 12 mm 2 legged stirrups in ring beam @ 150c/c.

7.6 Design of conical slab **:-**

Wt of side wall and dome = 902564.22N

Wt of conical bottom assuming 250 mm thick

= π (97.50+4.70) (1.40√2)/2

= 250/1000(24000) = 227653.345N

Wt. of water on dashed part in fig

= $\pi/4((7.50)^2-(4.70)^2)$ (5.00) (10000)+π(1.40)/12

= $((7.50)^2+(4.70)^2+(7.50)(4.70))$ (10000)-$\pi/4(4.70)^2(1.40)$ (10000)

= 1514896.92N/2645114.48N

Meridian force N□ = 2645114.48√2/ π(4.70) = 253344.65N/m

Compressive stress = 253344.65/(1000) (250) = 1.013 N/mm2

Hoop tension N_θ

Diameter of conical dome at ht 'h'

Above base = 4.70 + (7.50-4.70) h /2 = 4.70+2h

Intensity of water pressure there = (5+1.40-h) (10000) = 64000-10000h

Self Wt. = 250/1000 *24000 = 6000N/m2

N_θ = ((6.40-h) 10000 + 6000/√2) ((4.70+2h) √2)/2

= (10000√2 (6.40-h) +6000) (4.70+2h)/2

N_θ from $N\varphi/r1 + N\theta/r2 = -Pr$

r_1 = infinity r_2 = (4.70+2h)/2

At h = 0, N_θ = 2226797.72N

h = 0.70, N_θ = 264161.028N

h = 1.40, N_θ = 287665.05N

Maximum A_{st} = 287665.05/115 = 2501.44mm2

Use 16 mm Øbars on each face @ 160 mm c/c.

Checking thickness,

$A_{eq} = A_c + (m-1)A_{st}$ = Ac +12(2513.27)

Thickness reqd = 1/1000[(287665.05)/1.2 – 12(2513.27)] ~210mm

Hence t = 250mm in adequate

***7.7 Design of inclined slab of conical Dome*:-**

Total *W* on top of Inclined slab = 2645114.48 *N-m*

Wt. of side wall and done. = 2645114.48-902564.22 = 1742550.26N

Vertical load on slab /m = 174255026/ (π(7.50+4.70)/2) = 90929.67 N/m

B.M. = 90929.67(1.40)/8 = 15912.70 Nm

With partial fixity B.M. = 12730.16 Nm

Axial compression = 902564.22 N = 37238.50 N/m.

Resulting B.M. = 15912.70 +37238.50√2 [(0.210-0.125)]= 20389.07Nm

Ast = 20389.07(1000)/ 115 (0.853) (210) = 989.76 mm2

Minm Steel = 0.30- (0.10/350)(150) = 0.257% *i.e.,* = 642.86 mm2

Use 12 mm Ø @ 110 mm c/c on both faces.

***7.8 Design of Bottom dome*:-**

Span of the dome = 4.70 m.

Rise of the dome = 0.950 m.

Radius of the dome from 0.950 (2R - 0.950) = (4.70/2)2

Hence R =3.3816m

Angle subtended by the dome = 2θ

Sinθ = (4.70/2)/3.3816 = 0.695

And θ = 44.02°; Cos θ = 0.71

Take thickness of dome as 200 mm

Loading

D.L. of dome = 0.200 (24000) = 4800 N/m2

Wt. of water on dome = 10,000 [π/4(4.70)2 (6.40) –π/6(0.950) (3 x2.352 +0.9502)]

= 1023465.44 N

Area of dome surface = 2 n (3.3816) (0.950) = 20.185 m2

= 2 π (3.3816) (0.950) = 20.185 m2

Load intensity = (1023465.44/20185) +4800 = 55504.26N/m2

Meridian thrust at springing level =wR/(1+cosθ) = 55504.26(3.3816)/1.719 = 109187.43N/m

Meridian compressive stress = 109187.43/1000(200) = 0.546N/m2

Hoop stress = wR/t[cosθ-(1/1+cosθ)

Maximum at θ = 0, where Max hoop stress = 0.469N/mm2

Stresses are low and provide 0.30 % steel.

Use 8 mm Ø bars @ 80 mm c/c.

***7.9 Design of Circular Girder*:-**

Assume size of girder as 400 x 600 (deep) Center to center of Girder = 4.70 + 0.400 = 5.10m.

Check for Hoop Stress on Ring Beam

From inclined conical slab with φ0 = 45°

Nφ0 = 253344.65N

Horizontal component = 253344.65 cosφ0 = 179141.72N

From bottom of Dome Nφ1 = 109187.43 N/m

With φ1 = 44.02°

Horizontal component = 78505.76 N

Hoop stress as Ring Beam = (179141.72 -78505.76)(5.10/2) = 256621.70N

Hoop stress (compression) = 256621.70/(1000(400)) = 0.642N/mm^2

Total loads on the circular girder are:

Weight of water = 1514896.92+ 1023465.06 N = 2538362.06 N

Wt. of Top dome and side slab = 902564.22 N

Wt. of Conical wall = 227653.34 N

Wt. of Lower dome = (4800) (20.185) = 96888.0 N

Wt. of Circular girder with a size of 400 x 600 = 78200.0 N

Total Wt. = 3843667.62 N

With D = 4.70 + 0.400 = 5.10, W = 239897.53 N/m

Provide Six Columns.

From Mφ = (θ cosφ-1)WRsinθ

Tφ = [(θ/sinθ)sinφ-θ]WR

Vφ = WRφ

For the case 2θ = 60°; With 6 Columns

Considering column of diameter 600 mm (531.74 mm eq. square)

φ = 24° on face of column from center of span

φ = 0° at center.

φ = 17.27° from center for Tmax

Design negative BM on face of column = [(π/6)/0.50)cos24º](239897.53)(2.55) = 67603.52Nm

Maximum +Ve BM at φ = 0,

B.M. = [(π/6)/0.50)cos0º](239897.53)$(2.55)^2$ = 73625.05Nm

Maxm. Torsion Moment at φ = 17.27° from center

Tmax = [(π/6) sin17.27º- (17.27)(π)] (239897.53)$(2.55)^2$0.05 180 = 14769.97Nm.

Tφ = [(π/6) sin24º- (24)(π)] (239897.53)$(2.55)^2$0.05 180 = 11004.70 Nm

S.F. at distance d = 560 mm from face of support

Where φ = 11.44º

V = wRφ = (239897.53)(2.55) (π)(11.44) = 122143.22N

S.F on face of column Ve = V + 1.6(TR/b) = 122143.22+1.6 (11004.70/0.400) = 166162N

τve = 166162/(400)(560) = 0.742<τmax , i,e., 1.80 N/mm2

Shear reinforcement necessary,

Design moment at face of column = M+Mt = 67670.52+(11004.70/1.70)(1+600/400)

= 83853.90M

Hence section is under reinforced

Ast = 83583.90(1000)/ 115(0.853)(550) = 1526.47 mm2

Use 5 Nos. 20 mm *§* at top in one layer

As *Mt* < *M*, longitudinal reinforcement on flexural compression face not necessary.

For positive B.M.

Ast = 73625.05(1000)/ 115(0.853)(560) = 1526.47 mm2

Use 5 Nos. 20 mm at bottom.

SF at a distance d = 56mm from face of column where = 11.44°

And SF there = 166162.42 = Ve

τve there = 0.742 N/mm2 < 1.80 N/mm2

Shear reinforcement is necessary.

At the location of Tmax.

Ve = *184389.28* + 1.6+ (14769.97/0.40)

τve = 1.087 N/mm2 < τmax

100(Ast/bd) = 0.70 and τc = 0.340N/mm^2

Transverse reinforcement to be not less than

Asv = (τve –τc)b.Sv/ Sv = = [(1.087-0.340) 400(Sv)]/125

For two legged 12 mm stirrups *Sv* @ 95 mm c/c.

Also As = (T Sv/b1d1σsv) +V Sv/2.5 d1 σsv

b_1 = 400-2(25+ 12+10) = 306mm

d_1 = 600 -2(25 +12 +10) = 506mm

Asv = [(14769.97 (1000)Sv)/ (306) (506) (125)]+[(184389.28 Sv/2.5 (506) (125)]

= 0.76313 Sv+1.16610 Sv = 1.92923 Sv

With 2 legged 12 mm stirrups

Sv = 117 mm c/c. Use Sv = *95* c/c.

***7.10 Design of Columns*:-**

Six columns of 600 mm diameter to be symmetrically place at 60° c/c.

Length of column = 12 + 1 = 13 m. Consider column to have a batter of 1 in 20,

α = 2.862° and cos α = 0.999; sin α = 0.050

Total load:

Load from Top = 3843667.62 N

Self wt. of 6 columns = 529300.00 N

Wt. of Bracing = 60000.00N

Total = 4432967.62 N

Load on each column due to W = 738828 N

Thrust on each column = 739567.50 N

Diameter at base = 5.10+ (12/10) = 6.30m

Wind Loading Considering *Vb* - 50 m/sec.

Vz = Vbk1k2k3 = 0.90Vbk2k3

Taking k1 as 0.90 for 25 yrs. life.

Taking k2 and k3 both as unity.

Pz = 0.60 v2 = 0.60 $(45)^2$ = 1215 N/m2

P_1 = [7.5+0.450)(5.0(7.69)(2/3)(1.60)+(7.69+5.10)(1.60)/2]

= (1215) (0.70)

= 49915N

Taking shape factor as 0.70

This acts at a height = 12 +1/2(1.60 + 5 +1.6)

P2 = Due to column, Bracing and circular Girder

= [(5.50) (0.600) + *Vi* (0.60) (4.0) (6.0)] (1215) (0.70)+(5.50) (0.300) (1215) (0.70)

= 10333.58N at l2m above G.L.

P3 = on column and Bracing

= [6 (0.600) (4) + (5.80) (0.300)] (1215) (0.70)

= 13727 Nat 4 m. above G.L

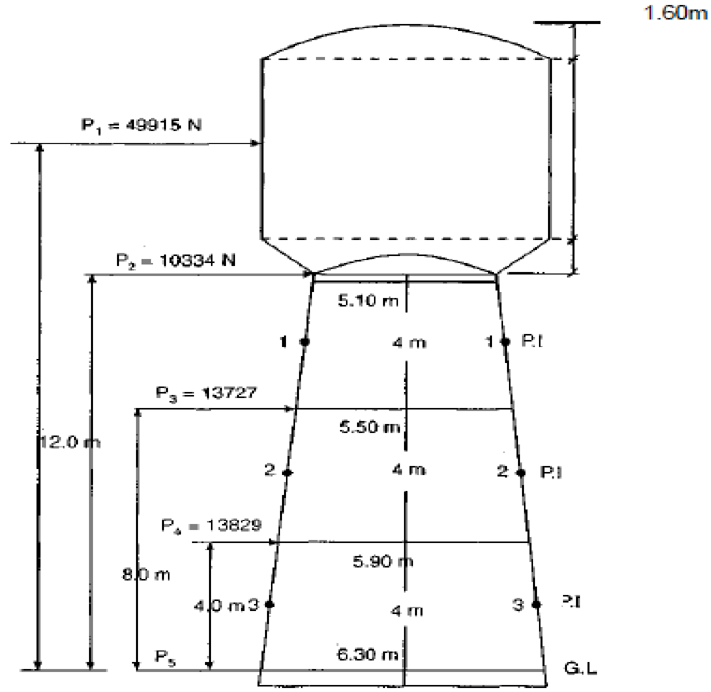
P4 = [6(0.600) (4) + (6.20) (0.300)](1215) (0.70)

= 13829 *N at* 4 m above G.L.

Consider column fixed at base

Considering P.I. at mid height of column

Levels	Shear(N)	Moment(Nm)
1-1	49915+10334 = 60249	49915(4.10+2)+10334(2) = 325149.50
2-2	60249+13727 = 73976	49915(6.10+4)10334(6)+13727(2) = 667575.50
3-3	73976+13829 = 87805	49915(14.10)+13727(6)+10334(10) +13829(2) = 917161.50



Referring to fig.

For XX axis

Σy^2 = 4(D*√3) ^2/8 = 3/4d^2

For YY axis

Σx^2 = 2(D/2) ^2+4(D/4) ^2 = 3/4D^2

For bending about XX axis, due to wind loading, Referring line 3-3

$V_1 = V_4 = 0$

And $V_2 = V_3 = V_5 = V_6$ = ±917161.50/ (3/4(6.10) ^2 (√3/4(6.10) = ± 86807.12M

For bending about YY axis, $V_1 = V_4$ = (916171.50*6.10)/ ¾(6.10) ^2

V2 = V4 = V5 = V6 = ± 50118.1N

Maxim. Thrust in column = 739567.50+100236.23/0.999 = 83994N

At point 3-3,

On each column H = 878.5/6 = 14634.17N

Vertical load at (3) due to W.L. = 100236.23N

B.M on column = 14634.17(2)-100236.23N = 19244.72Nm

Design of column can be done by limit state method M20 concrete Fe415 steel.

Self wt of column = 81530N

Axial force = 839904N + 81530N

Case 1; M_{yy} = 19244.72Nm

Case 2; M_{xx} = 2058.64Nm

Safety factor to be used is 1.20

Case 1; P_u = 1105720.80N

Muyy = 23093.664Nm

Case 2; P_u = 1089589.38N

Mu_{xx} = 24705.17N

With 600φ column,

$P_u/ (f_{ck}d^2)$ = 0.154 for case 1 and 0.151 for case 2

M_u / (f_{ck} D^3) = 0.0053 for case 1 and 0.0057 for case 2

d/D = (40+8)/0.08

Use d/D = 0.10

Min steel = 0.80% i.e., p/f_{ck} = 0.04

$Mu_{xx} \sim Mu_{yy}$ = 0.06(20) (600) ^3

Hence column is adequate.

Use 8 Nos. 20 mm dia bars as longitudinal bars; Ties 10mm @ 300c/c.

Design of Foundation:

Consider bottom of foundation at 2 m below G.L. Vertical load:

Tank full = 3843667.62 + 274826.52 + 75000 =4193494.15 N Tank Empty = 1305305.56 + 274826.52 + 75000 = 1655132.08 N

Moment at bottom of Foundation :

For Tank fulI = 219975.52(18.10) = 3981556.91Nm For Tank Empty 113753.152(18.10) =

2058932.05Nm, with A_h = 0.08 (for safety maximum value of A_h taken);

Diameter at base c/c. of columns = 6.40 m.

Consider an outside diameter of Foundation as 9.60 m and 3.20 m. inside diameter. Area = $\pi(4.80^4 - 1.60^2)$ = 64.33982 m^2

$I = \pi/4\,(4.80^4 - 1.60^4) = 411.77483\ m^4$

Considering 10% as the approximate Wt. of

Foundation P = $\underline{1.10(4193494.15)}$ = 71.695 KN/m^2 < 100 kN/m^2 64.33982

For Tank full:

p_{max} = 118.1074392 kN/m^2

P_{min} =25.2825661 kN/m2< 1.25 (100) *i.e.,* 125 kN/m^2

For Tank Empty:

p_{max} = 56.24325 kN/m^2

P_{min} =8.241 kN/m^2

No Tension and Base is adequate. Assume a Ring girder of Size 450 x 700. Design on basis of $p_{ne(}$ = 65.177 kN/m^2

Supported on six column of 450 mm diameter eq. square = 400 mm and

0 = 30°On face of column φ = 25.50° Location of Maxm. T, φ = 7.27°

For S.F at distance d =620 mm from Location of maximum. T, φ = 15.32˚

Load on ring beam =65.177(3.20) = 208.567 kN/m As self wt. acts toward.

Maximum -V_e BM on face of column = 117.0696 kN/m T_φ at the location =12.3257kN/m

Maximum + V_e BM at center = 100.801kNm T_{max} at φ = 17.27˚= 20.22176kNm

SF at φ =17.27˚ =201.171 kN

<u>Design by limit state method.</u>

As only vetical (D.L+L.L) considered load factor =1.50

with M-20 concrete and Fe 415 steel

Mu, limit = 0.138(20)(450)(620)2 = 477.425kNm Section is under reinceforced

At face of column Mu= 1.50 [117.0696+$\underline{12.3257(}$1+(700/450)] =203.3976kNm 1.70

Lever arm j = 0.927 and A_{st} =980.18mm^2

Use 5nos. 16mm at bottom ; minimum A_{st} =572 mm^2

For +V_e BM =100.801 kNm

No torsion occurs there,

$$Mu = 1.50(100.801) = 151.2015 kNm$$

$$J = 0.947 \text{ and } A_{st} = 713.25\ mm^2$$

Use 4Nos.16mm φ at top.

At of T_{max}

SF V_e =201.171+1.6(20.22176/0.450) =273.071kN

V_{ue} = 1.50(273.071) = 409.606kN

$\tau_{ve} = 409.606(10)^3/450(620) = 1.468 < \tau_{cmax}$.

$100(A_{st}/bd)$ =[100(4)π/4 $(16)^2$] / (450)(620) =0.288%

τ_c = 0 .378 N/m m^2

minim um transverse reinforcement

$$A_{sv} = (\tau_{ve} - \tau_c) bS_v/0.87f_y = 1.35854$$

$$d_1 = 700-2(40+12+8) = 580 \text{ mm}$$

and A_{sv}=1.0153 S_v –this gives smaller spacing

Use 12 mm φ @ 150 c/c.

For side face reinforcement use 0.10% of web area

$$= 0.10/100(500)(450) = 225\ mm^2$$

Half on each face i.e. Use 12 mm 0 bar longitudinally.

Design of bottom slab :

Use 400 mm thick slab Projection =1.60(0.450/2) =1.375 m

Designed for variation of bearing pressure considering effect of Moment Downward load from top due to slab and soil = 40 kN/m^2 Referring to Fig.

Maximum BM=[$(104.81-40)(1.375)^2/2$]+13.297[$(1.375)^2$ /3] =69.4556kNm

Maximum SF at distance d = 3 50 from face of beam

= [½(108.20 +118.107) -40] (1.375 -0.350) = 74.982 KN

$$\tau_v = 1.5(74.962)(10)^3/1000(350) = 0.321\ N/mm^2$$

$100A_{st}/be$ required = 0.202%

For BM. M_u=1.50(69.4556) = 104.1834kNm J = 0.948 , A_{st} =869.67mm^2

Use 12mmφ @125 c/c

$100(A_{st}/bd) = 0.258\%$ hence it is adequate

Check for stability:

Sliding - Due to seismic loading

V= 244237.52 N

W=4193494.15 + Wt. of base + Circular Bear

=4193494.15 + 617662.25 + 65144.06 =4876300.56 N

FS against sliding μW/244237.52 = 9.98>2 OK

FS against overturning = 4876300.56(4.80)/244237.52(18.10)

=5. 295>2 OK

For e mpty condition = W = 1655132.08 + 617662.25+65144.06= 2337938. 39

FS agains t sliding = μW/V

V = 120424.4 5N =9.707 > 2.0

F.S ag ainst over turning =2 337938.3 9(4.80)/ 120424.45(18.10) = 5.15>2.0

CHAPTER:-8

ESTIMATION

Detailed estimation:

Detailed estimate is an accurate estimate and consists of working out the quantities of each item of works, and working the cost. The dimensions, length, breadth and height of each item are taken out correctly from drawing and quantities of each item are calculated, and abstracting and billing are done.

The detailed estimate is prepared in two stages:

Details of measurement and calculation of quantities.

The details of measurements of each item of work are taken out correctly from plan and drawing and quantities under each item are calculated in a tabular form named as details of measurement form.

Abstract of estimated cost:

The cost of each item of work is calculated in a tabular form the quantities already computed and total cost is worked out in abstract estimate form. The rates of different items of work are taken as per schedule of rates or current workable rates for finished item of work.

Detailed estimation

S.No.	DECRIPTION OF WORK	NOS	L m	B m	A m^2	D m	QTY m^3	REMARKS
1	EARTH WORK IN EXCUVATION	1			64.32	2	128.64	L =2πR = 2π*2.55 = 16.022m,R =5.1/2 = 2.55m
2	EARTH WORK IN FILLING	1					100.198	L =2πR = 2π*3.75 = 23.56m,R =7.5/2 = 3.75m
3	RCC WORK IN FOUNDATION (1:1.5:3)	1			64.32	0.4	25.728	L =2πR = 2π*3.75 = 23.56m,R =7.5/2 = 3.75m
4	RCC WORK IN COLOUMNS BELOW G.L (1:1.5:3)	6			0.282	1.6	2.714	Sa = 2πhRc =π (h2 + r2) =π (1.5^2+5.4375^2) =99.95m^2,h =1.5m,r = 5.4375
5	RCC WORK IN COLOUMNS ABOVE G.L UPTO 4M HT (1:1.5:3)	6			0.282	4	6.785	Davg =(7.5+5.1)/2 = 6.3m,R=6.3/2= 3.15m,Sa =πr(r+h) = π*3.15(3.15+1.6) = 47.006m^2
6	RCC WORK IN COLOUMNS FROM 4M TO 8M HT(1:1.5:3)	6			0.282	4	6.785	R = 3.3816m,Sa = 2πhRc =π (h2 + r2) =π (0.950^2+3.3816^2) =
								38.760m^2
7	RCC WORK IN COLOUMNS FROM 8M TO 12M HT (1:1.5:3)	6			0.282	4	6.785	D = (0.23+0.2) =.215m,Sa =2πR h= 2π*3.75*5 = 117.80m
8	TOTAL RCC WORK IN COLOUMNS (1:1.5:3)						23.069	QTY = 2*6*0.3*0.3*0.6 =0.648m^3
9	RCC WORK IN BRACING AT 4m HT (1:1.5:3)	1	18.535	0.3		0.3	1.668	QTY = 23.609 - 0.648 = 22.961m^3
10	RCC WORK IN BRACING AT 8m HT (1:1.5:3)	1	17.278	0.3		0.3	1.555	QTY =25.728+2.714+3*6.785+22.961+1.668+1.555+3.845+3.675+0.848+9.995+11.751+7.752+25.327=138.174m^3
11	RCC WORK IN CIRCULAR GIRDER (1:1.5:3)	1	16.022	0.4		0.6	3.845	,R=6.3/2= 3.15m,Sa =πr(r+h) = π*3.15(3.15+1.6) = 47.006m^2

12	RCC WORK IN RING BEAM AT BOTTOM OF THE CL WALL (1:1.5:3)	1	23.56	0.3		0.52	2.675	R=6.3/2+0.5= 3.65m,Sa =πr(r+h) = π*3.65(3.65+1.6) = 60.2m^2
13	RCC WORK IN RING BEAM AT TOP OF THE CL WALL (1:1.5:3)	1	23.56	0.16	99.95	0.225	0.848	R = 3.3816m,Sa = 2πhRc =π (h2 + r2) =π (0.950^2+3.3816^2) = 38.760m^2
14	RCC WORK IN DOMED ROOF(1:1.5:3)	1				0.1	9.995	Sa = 2πhRc =π (h2 + r2) =π (1.5^2+5.4375^2) =99.95m^2,h =1.5m,r = 5.4375
15	RCC WORK IN CONICAL SLAB (1:1.5:3)	1			47.06	0.25	11.751	Davg =(7.5+5.1)/2 = 6.3m,R=6.3/2= 3.15m,Sa =πr(r+h) = π*3.15(3.15+1.6) = 47.006m^2
16	RCC WORK IN CONICAL DOME (1:1.5:3)	1			38.76	0.2	7.752	R = 3.3816m,Sa = 2πhRc =π (h2 + r2) =π (0.950^2+3.3816^2) = 38.760m^2
17	RCC WORK IN CYLINDRICAL WALL (1:1.5:3)	1		0.215	117.8	5	126.35	D = (0.23+0.2) =.215m,Sa =2πR h= 2π*3.75*5 =
								117.80m
18	DEDUCTIONS IN RCC WORK IN BRACINGS IN COLOUMNS	2*6	0.3	0.3		0.6	0.648	QTY = 2*6*0.3*0.3*0.6 =0.648m^3
19	T0TAL RCC WORK IN COLOUMNS AFTER DEDUCTIONS						22.901	QTY = 23.609 - 0.648 = 22.961m^3
20	TOTAL RCC WORK (1:1.5:3)						138.174	QTY =25.728+2.714+3*6.785+ 22.961+1.668+1.555+3.8 45+3.675+0.848+9.995+1 1.751+7.752+25.327=138 .174m^3
21	PLASTERING IN C M (1:2) FOR INNER SURFACE OF CONIVAL SLAB (12MM)	1			47.06		47.006	,R=6.3/2= 3.15m,Sa =πr(r+h) = π*3.15(3.15+1.6) = 47.006m^2
22	PLASTERING IN				60.2		60.2	R=6.3/2+0.5= 3.65m,Sa

	C M (1:6) FOR OUTER SURFACE OF CONICAL SLAB (12MM)							=πr(r+h) = π*3.65(3.65+1.6) = 60.2m^2
23	PLASTERING IN C M (1:2) FOR INNER SURFACE OF CONICAL DOME (12MM)	1			38.76		38.76	R = 3.3816m,Sa = 2πhRc =π (h2 + r2) =π (0.950^2+3.3816^2) = 38.760m^2
24	PLASTERING IN C M (1:6) FOR OUTER SURFACE OF CONICAL DOME (12MM)				43.135		43.135	R = 3.3816+0.2m = 3.5816,Sa = 2πhRc =π (h2 + r2) =π (0.950^2+3.3.5816^2) = 43.135m^2
25	PLASTERING IN C M (1:2) FOR INNER SURFACE OF CYLINDRICAL WALL (12MM)				117.8		117.8	D = (0.23+0.2) =.215m,Sa =2πR h= 2π*3.75*5 = 117.80m
26	PLASTERING IN C M (1:6) FOR OUTER SURFACE OF CYLINDRICAL WALL (12MM)				125.03		125.03	D = (0.23+0.2) =.215m,R=3.75+.23 =3.98m,Sa =2πR h= 2π*3.98*5 = 125.03m
27	PLASTERING IN C M (1:2) FOR INNER SURFACE OF DOMED ROOF (12MM)				96.5		96.556	Sa = 2πhRc =π (h2 + r2) =π (1.5^2+5.3375^2) =96.56m^2,h =1.5m,r = 5.3375
28	PLASTERING IN C M (1:6) FOR OUTER SURFACE OF DOMED ROOF (12MM)				99.95		99.95	Sa = 2πhRc =π (h2 + r2) =π (1.5^2+5.4375^2) =99.95m^2,h =1.5m,r =
								5.4375
29	PLASTERING IN C M (1:6) FOR COLUMNS (12MM)	6			45.23		271.433	P =2πRh =2π*.6*12 = 45.23m^2
30	PLASTERING IN C M (1:6) FOR CIRCULAR GIRDER (12MM)	1	16.022			0.6	91.732	L =2πR = 2π*2.55 = 16.022m,R =5.1/2 = 2.55m
31	PLASTERING IN C M (1:2) FOR RING BEAM AT TOP (12MM)		23.56	0.16			18.213	Sa =2*23.56*0.225+2*0.225 *0,16+2*0.16*23.56 = 18.213m^2
32	PLASTERING IN C M (1:2) FOR RING BEAM AT BOTTOM (12MM)		23.56	0.3		0.225	38.95	Sa =2*23.56*0.52+2*0.52*0 .3+2*0.3*23.56 = 38.950m^2

33	PLASTERING IN C M (1:6) FOR BRACING AT 4M HT (12MM)		18.535	0.3		0.52	22.422	Sa =2*18.535*0.3+2*0.3*0.3+2*0.3*18.535 = 22.422m^2
34	PLASTERING IN C M (1:6) FOR BRACING AT 8M HT (12MM)		17.278	0.3		0.3	20.936	Sa =2*17.278*0.3+2*0.3*0.3+2*0.3*17.278 = 20.936m^2
35	TOTAL PLASTERING IN CM (1:2) 12MM THICK					0.3	357.289	QTY = 47.006+38.76+117.8+96.56+18.213+38.95 = 357.289m^2
36	TOTAL PLASTERING IN CM (1:6) 12MM						652.838	QTY = 60.2+43.135+125.03+99.95+271.433+9.732+22.422+20.936 = 652.838m^2
37	THICK WATER PROOF CEMENT PAINTING FOR TANK PORTION						647.174	QTY =47.006+60.2+38.76+43.135+117.8+125.03+96.56+99.95+18.213+0.52=647.174m^2
38	WHITE WASHING FOR COLUMNS	6			45.23		271.433	P =2πRh =2π*.6*12 = 45.23m^2
39	TOTAL WHITE WASHING						918.607	QTY =647.174+271.433 = 918.607m^2

ABSTRACT

S.NO	DESCRIPTION OF WORK	QTY OR NOS	RATE RS PS	COST RS PS
1	Earth work in excuvation	**28.30cumec**		
2	Beldars	**5nos**	**215.00**	**1075.00**
3	Mazdoors	**4nos**	**215.00**	**860.00**
4	Total			**1935.00**
5	Total earth work in Excavation for 128.64cumec	**128.64/28.30** **=4.6*1935** **=8901**		**8901.00**
6	Earth work in filling In foundation	**28.30**		
7	Beldar	**3**	**215.00**	**645.00**
8	Bhisthi	½	**260.00**	**130.00**
9	Total			**775.00**
10	Total earth work in Filling 100.198 cumec	**100.198/28.30** **=3.6*775** **=2790**		**2790.00**
11	Disposal of surplus earth in a lead 30m			
12	Mazdoor		**215.00**	**645.00**
13	Total			12336**.00**

DATA SHEET

RCC M- 20 Nominal mix (Cement:fine aggregate: coarse aggregate) corresponding to Table 9 of IS 456 using 20mm size graded machine crushed hard granite metal (coarse aggregate) from approved quarry including cost and conveyance of all materials like cement

FOUNDATION				
A. MATERIALS:	UNIT	QTY	RATE RS	AMOUNT RS
20mm HBG graded metal	Cum	0.9	1405.04	1264.54
Sand	Cum	0.45	509.92	229.46
Cement	Kgs	400	5.42	2169.60
1st Class Mason	Day	0.133	285.00	37.91
2nd Class Mason	Day	0.267	260	69.42
Mazdoor (Both Men and Women)	Day	3.6	215	774.00
Concrete Mixer 10 / 7 cft (0.2 / 0.8 cum) Capacity	Hour	1	248.40	248.40
Cost of Diesel for Miller	Liters	0.133	45	5.99
Cost of Petrol for Vibrator	Liters	0.667	68	45.36
Water (including for curing)	Kl	1.2	77.00	92.40
Add 20% in Labour (1st Floor)				176.27
Add MA 20%				211.52
Add TOT 4%				212.99
BASIC COST per 1 cum				**5538.00**

Description	**Unit**	**Quantity**	**Rate Rs.**	**Amount Rs.**
COLUMNS				
20mm HBG graded metal	Cum	0.9	1405.04	1264.54
Sand	Cum	0.45	509.92	229.46
Cement	Kgs	400	5.42	2169.60
1st Class Mason	Day	0.167	285.00	47.60
2nd Class Mason	Day	0.167	260	43.42
Mazdoor (Both Men and Women)	Day	4.7	215	1010.50
Labour for centering	Cum	1	971	971.00
Material hire charges for centering	Cum	1	89	89.00
Concrete Mixer 10 / 7 cft (0.2 / 0.8 cum) Capacity	Hour	1	248.40	248.40
Water (including for curing)	Kl	1.2	77.00	92.40
Add 20% in Labour				432.304
Add MA 20%				500.96
Add TOT 4%				283.96
BASIC COST per 1 cum				**7383.144**
RCC RING BEAM AT TOP	**UNIT**	**QTY**	**RATE RS**	**COST**

20mm HBG graded metal	cum	0.9	1405.04	1264.54
Sand	cum	0.45	509.92	229.46
Cement	Kgs	400	5.42	2169.60
1st Class Mason	day	0.067	285.00	19.10
2nd Class Mason	day	0.133	260	34.58
Mazdoor (Both Men and Women)	day	2.5	215	537.50
Labour for centering	Cum	1	1002	1002.00
Material hire charges for centering	Cum	1	893	893.00
Concrete Mixer 10 / 7 cft (0.2 / 0.8 cum) capacity	hour	0.267	248.40	66.32
Water (including for curing)	kl	1.2	77.00	92.40
Add 20% in Labour				497.24
Add MA 20%				358.08
Add TOT 4%				286.56
BASIC COST per 1 cum				**7450.37**

RCC Domed roof 100 mm thick				
20mm HBG graded metal	cum	0.9	1405.04	1264.54
Sand	cum	0.45	509.92	229.46
Cement	Kgs	400	5.42	2169.60
1st Class Mason	day	0.067	285.00	19.10
2nd Class Mason	day	0.133	260	34.58
Mazdoor (Both Men and Women)	day	2.5	215	537.50
Labour for centering	Sqm	10	1843	18430
Material hire charges for centering	Sqm	10	1915	19150
Concrete Mixer 10 / 7 cft (0.2 / 0.8 cum) capacity	hour	0.267	248.40	66.32
Water (including for curing)	kl	1.2	77.00	92.40
Add 20% in Labour				7634.236
Add MA 20%				9161.09
Add TOT 4%				2351.56
BASIC COST per 1 cum	day			**61,141**

C0NE SHAPED DOMICALSLAB AND INCLIND SLAB 200 mm thick				
m HBG graded metal	cum	0.9	1405.04	1264.54
	cum	0.45	509.92	229.46
Ent	Kgs	400	5.42	2169.60
lass Mason	day	0.067	285.00	19.10
Class Mason	day	0.133	260	34.58
oor (Both Men and Women)	day	2.5	215	537.50
ur for centering	Sqm	5	1498	7490
rial hire charges for centering	Sqm	5	1915	9575
rete Mixer 10 / 7 cft (0.2 / 0.8 cum) capacity	hour	0.267	248.40	66.32
r (including for curing)	kl	1.2	77.00	92.40
20% in Labour				1616.23
MA 20%				1939.48
TOT 4%				
IC COST per 1 cum	day			**25035**

Description	Unit	Quantity	Rate Rs.	Amount Rs.
RCC CYLINDRICAL WALL				
20mm HBG graded metal	Cum	0.9	1405.04	1264.54
Sand	Cum	0.45	509.92	229.46
Cement	Kgs	400	5.42	2169.60
1st Class Mason	Day	0.167	285.00	47.60
2nd Class Mason	Day	0.167	260	43.42
Mazdoor (Both Men and Women)	Day	4.7	215	1010.50
Labour for centering	Cum	1	896	896.00
Material hire charges for centering	Cum	1	89	89.00
Concrete Mixer 10 / 7 cft (0.2 / 0.8 cum) Capacity	Hour	1	248.40	248.40
Water (including for curing)	Kl	1.2	77.00	92.40
Add 20% in Labour (1st Floor)				399.50
Add MA 20%				479.40
Add TOT 4%				278.79
BASIC COST per 1 cum				**7249.00**

RCC RING BEAM AT BOTTOM OF CYLINDRICAL WALL				
20mm HBG graded metal	cum	0.9	1405.04	1264.54
Sand	cum	0.45	509.92	229.46
Cement	Kgs	400	5.42	2169.60
1st Class Mason	day	0.067	285.00	19.10
2nd Class Mason	day	0.133	260	34.58
Mazdoor (Both Men and Women)	day	2.5	215	537.50
Labour for centering	Cum	1	1113	1113.00
Material hire charges for centering	Cum	1	1276	1276.00
Concrete Mixer 10 / 7 cft (0.2 / 0.8 cum) capacity	hour	0.267	248.40	66.32
Water (including for curing)	kl	1.2	77.00	92.40
Add 20% in Labour				341
Add MA 20%				409.036
Add TOT 4%				302.10
BASIC COST per 1 cum				**7854.636**

RCC CIRCULAR GIRDER				
20mm HBG graded metal	cum	0.9	1405.04	1264.54
Sand	cum	0.45	509.92	229.46
Cement	Kgs	400	5.42	2169.60
1st Class Mason	day	0.067	285.00	19.10
2nd Class Mason	day	0.133	260	34.58
Mazdoor (Both Men and Women)	day	2.5	215	537.50
Labour for centering	Cum	1	751	751.00
Material hire charges for centering	Cum	1	893	893.00
Concrete Mixer 10 / 7 cft (0.2 / 0.8 cum) capacity	hour	0.267	248.40	66.32
Water (including for curing)	kl	1.2	77.00	92.40
Add 20% in Labour (1st Floor)				268.44
Add MA 20%				322.12
Add TOT 4%				265.92
BASIC COST per 1 cum				**6914.00**

RCC BRACING AT 4M HEIGHT				
20mm HBG graded metal	cum	0.9	1405.04	1264.54
Sand	cum	0.45	509.92	229.46
Cement	Kgs	400	5.42	2169.60
1st Class Mason	day	0.067	285.00	19.10
2nd Class Mason	day	0.133	260	34.58
Mazdoor (Both Men and Women)	day	2.5	215	537.50
Labour for centering	Cum	1	875	875.00
Material hire charges for centering	Cum	1	1276	1276.00
Concrete Mixer 10 / 7 cft (0.2 / 0.8 cum) capacity	hour	0.267	248.40	66.32
Water (including for curing)	kl	1.2	77.00	92.40
Add 20% in Labour (1st Floor)				293.23
Add MA 20%				351.88
Add TOT 4%				288.35
BASIC COST per 1 cum				**7497.22**

RCC BRACING AT 8M HEIGHT				
20mm HBG graded metal	cum	0.9	1405.04	1264.54
Sand	cum	0.45	509.92	229.46
Cement	Kgs	400	5.42	2169.60
1st Class Mason	day	0.067	285.00	19.10
2nd Class Mason	day	0.133	260	34.58
Mazdoor (Both Men and Women)	day	2.5	215	537.50
Labour for centering	Cum	1	954	954.00
Material hire charges for centering	Cum	1	1276	1276.00

Concrete Mixer 10 / 7 cft (0.2 / 0.8 cum) capacity	hour	0.267	248.40	66.32
Water (including for curing)	kl	1.2	77.00	92.40
Add 20% in Labour (1st Floor)				309.036
Add MA 20%				370.84
Add TOT 4%				292.93
BASIC COST per 1 cum				**7616.30**

Plastering with CM (1:3), 12 mm thick - 10 Sqm				
Cement Mortor (1:3)	cum	0.15	3191.00	478.65
Mason 1st class	day	0.6	285.00	171.00
Mazdoor (unskilled)	day	0.96	215	206.40
Add MA 20%				75.48
Add TOT 4%				37.26
Grand Total				**969.00**

Plastering with CM (1:6), 12 mm thick - 10 Sqm				
Cement Mortor (1:6)	cum	0.15	1889.00	283.35
Mason 1st class	day	0.6	285.00	171.00
Mazdoor (unskilled)	day	0.96	215	206.40
Add MA 20%				75.48
Add TOT 4%				29.45
Grand Total				**766.00**

CHAPTER:-9

CONCLUSION

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.

Design of water tank is a very tedious method. Without power also we can consume water by gravitational force.

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$_H2$ *DT*	Co efficient at points						
	0.2 H	*0.3 H*	*0.4 H*	*0.5 H*	*0.6 H*	*0.7 H*	*0.8H*
0.4	+ 0.0014	+ 0.0021	+ 0.0007	- 0.0042	-0.0150	-0.0302	-0.0529
0.8	+ 0.0037	+ 0.0063	+ 0.0080	+ 0.0070	+ 0.0023	+ 0.0068	-0.0024
1.2	+ 0.0042	+ 0.0077	+ 0.0103	+ 00112	+ 0.0090	+ 0.0022	-0.0108
1.6	+ 0.0041	+ 0.0075	+ 0.0107	+ 0.0121	+ 0.0111	+ 0.0058	-0.0051
2.0	+ 0.0035	+ 0.0068	+ 0.0099	+ 0.0120	+ 0.0115	+ 0.0075	-0.0021
3.0	+ 0.0024	+ 0.0047	+ 0.0071	+ 0.0090	+ 0.0097	+ 0.0077	+0.0012
4.0	+ 0.0015	+ 0.0028	+ 0.0047	+ 0.0066	+ 0.0077	+ 0.0069	+0.0023
5.0	+ 0.0008	+ 0.0016	+ 0.0029	+ 0.0046	+ 0.0059	+ 0.0059	+0.0028
6.0	+ 0.0003	+ 0.0008	+ 0.0019	+ 0.0032	+ 0.0046	+ 0.0051	+0.0029
8.0	+ 0.0001	+ 0.0002	+ 0.0008	+ 0.0016	+ 0.0028	+ 0.0038	+0.0029
10.0	+ 0.0000	+ 0 0001	+ 0.0004	+ 0.0007	+ 0.0019	+ 0.0029	+0.0028
12.0	+ 0.0000	+ 0.0001	+ 0.0002	+ 0.0003	+ 0.0013	+ 0.0023	+0.0026
14.0	0.0000	0.0000	0.0000	+ 0.0001	+ 0.0008	+ 0.0019	+0.0023
16.0	0.0000	-0.0001	- 0.0002	-0.0001	+ 0.0004	+ 0.0013	+0.0019