RCC WATER TANK – CIRCULAR

3.2 Design an RC circular tank

Example 2

Design an RC circular tank resting on the ground with a flexible base and a spherical dome for a capacity of 500000 litres. The depth of storage is to be 4m. Free board is 200mm, use M20 grade concrete and fe250 grade 1 steel. Permissible stress should be recommended in is 456 : 2000, draw the following views , Cross section of the tank showing reinforcement details in dome , tank walls and floor slab.

Step1 : Given data

Capacity of circular tank = 500000litres

depth of water = 4m

Free board = 200mm

fck =20N/mm^2

fy = 250N/mm^2

Step2 : permissible stress

IS 456 :2000

Page no.80

σct = 1.2 N/mm^2 (for tank walls)

= 2.8 N/mm^2 (for dome ring beam)

= 6.25 KN/m^2

σcc = 5 N/mm^2

σcbc = 7 N/mm^2

M = 280 / 3 x σcbc

= 13.33

Step3 : Dimension of tank wall

$(\pi \times D^2 / 4) \times h = 500000$ litres

$(\pi \times D^2 / 4) \times 4 = 500000 \times 1000$

$D^2 = (500000 \times 1000) / \pi$

$D^2 = 159.2 \times 10^6$

$D = 12618.8$mm

$= 12.6$m

Step4 : Design of spherical dome

Central rise of dome $= [(1 / 5) \times D]$

$= [(1 / 5) \times 12.6]$

$= 2.5$m

Radius of dome

$(R - 2.5)^2 = R^2 – 6.3^2$

$= 9.2$m

$\Theta = 43.2$

$\sin\Theta = 0.6847$

$\cos\Theta = 0.7289$

thickness $t = 100$mm

Radius of dome

$(R - 2.5)^2 = R^2 – 6.3^2$

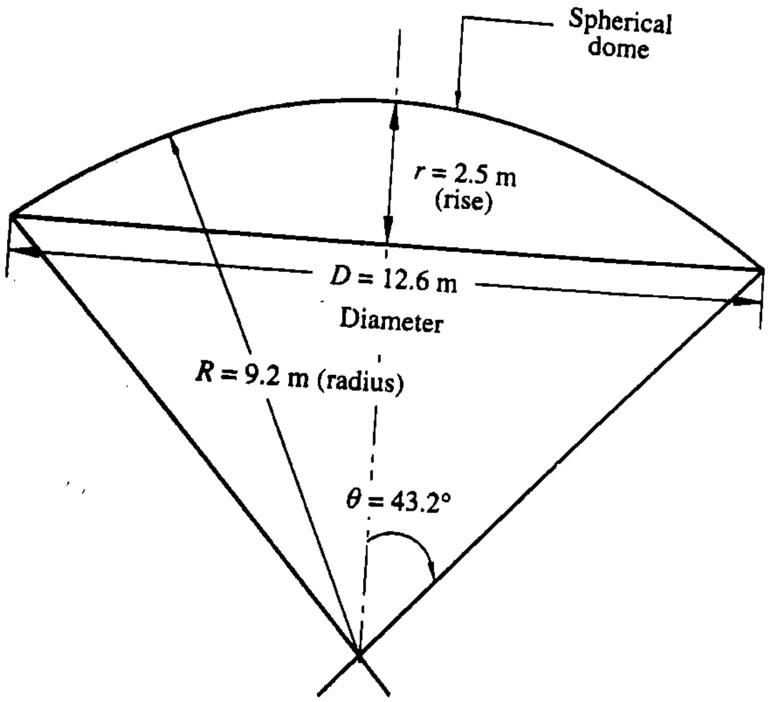
$= 9.2$m

$\Theta = 43.2$

sinϴ = 0.6847

cosϴ = 0.7289

thickness t = 100mm



(a) loads

self weight of dome = 0.1 x 24

= 2.4 KN/m^2

live load and floor finish = 2 KN/m^2

total load = 4.4 KN/m^2

(b) Stresses in dome

Meridional thrust T1 = [(w x R) / (1 + cosϴ)]

= [(4.4 x 9.2) / (1 + cos43.2)]

= 23.41 KN/m

Meridional compressive stress

=[(23.41 x 10^3) / (1000 x 100)]

= 0.2341 N/mm^2

Hoop stress

=[wR / t] (cosΘ - 1 / (1+ cosΘ)

= [4.4 x 9.2 / 0.1] (cos43.2- 1 / (1+ cos43.2)

= 60.72 KN/m^2

= 0.06072 N/mm^2

(c) Reinforced details in dome

Ast = 0.3 % of cross section area

= 0.3 / 100 x b x t

= (0.3 / 100) x [1000 x 100]

= 300 mm^2

spacing

Provide 8mm dia bars

Spacing = 1000 x [(πd^2 / 4) / Ast]

= 1000 x [(π x 8^2 / 4) / 300]

= 166mm

Provide 8mm dia bars at 160mm c/c

(d) Ring beam

horizontal component thrust =T1cosΘ

= 23.41 x cos43.2

= 17.06 KN/m

Hoop tension in ring beam

= (horizontal Thrust x dia of tank) / 2

=[(17.06 x12.6) /2]

= 107.47KN

Ast = hoop tension / σst

= 107.47 x 10^3 / 115

= 935mm^2

Provide 4nos of 20mm dia bars

ast = [(πd^2 / 4) x 4]

= [(π20^2 / 4) x 4]

= 1256mm^2

Find ‘Ac’ cross sectional area of ring beam

Ft / [Ac + (m-1)Ast] = allowable stress

107.47 x 10^3 / [Ac + (13.33-1) x 1256]

= 2.8

Ac = 23310mm^2

Adopt a ring beam of size 200mm x 200mm with 4nos of 20mm dia as hoop reinforcement and stirrups of 6mm dia at 150mm c/c

Step5 : Reinforcement in tank walls

Assume w = 10

Assume H = 4+0.2

= 4.2m

Max hoop tension = 0.5 x w x H x D

= 0.5 x 10 x 4.2 x 12.6

= 264.6KN

Tension reinforcement

Ast = max hoop tension / σst

= $264.6 \times 10^3 / 115$

= $2300 mm^2$

Spacing

Provide 16mm dia bars on both sides

Spacing = $1000 \times [(\pi d^2 / 4) \times 2 / Ast]$

= $1000 \times [(\pi \times 16^2 / 4) \times 2 / 2300]$

= 174mm

Provide 16mm dia bars at 170mm c/c on both face

Step6 : Thickness of tank walls

max hoop tension/ [1000t + (m-1)Ast] = σct

$264.6 \times 10^3 / [1000t + (13.33-1) \times 2300]$ = 1.2

$264.6 \times 10^3 / [1000t + 28359]$ = 1.2

264.6×10^3 = 1.2 [1000t + 28359]

264.6×10^3 = 1200t + 34030.8

1200 t = $264.6 \times 10^3 - 34030.8$

t = 177mm

t =190mm (adopt)

Step7 : curtailment of reinforcement of tank walls

Minimum reinforcement at top = 0.3% of cross section

Ast = $(0.3 / 100) \times 1000 \times 190$

$= 570mm^2$

Spacing

Provide 12mm dia bars on both sides

Spacing $= 1000 \times [(\pi d^2 / 4) \times 2 / Ast]$

$= 1000 \times [(\pi \times 12^2 / 4) \times 2 / 570]$

$= 396mm$

Provide 12mm dia bars at 300mm c/c at top of tank on both sides for height of 1m from top

Spacing at a depth of 2m below the top is given by

Ast $= [(0.5 \times w \times H \times D) / \sigma st]$

$= [(0.5 \times 10 \times 2 \times 12.6) \times 10^3 / 115]$

$= 1095mm^2$

Spacing

Provide 16mm dia bars on both sides

Spacing $= 1000 \times [(\pi d^2 / 4) \times 2 / Ast]$

$= 1000 \times [(\pi \times 16^2 / 4) \times 2 / 1095]$

$= 367mm$

Provide 16mm dia bars at 300mm c/c

Area of vertical reinforcement

area of vertical reinforcement $= 0.3\%$ of cross section

Ast $= (0.3 / 100) \times 1000 \times 190$

$= 570mm^2$

Spacing

Provide 10mm dia bars on both sides

Spacing $= 1000 \times [(\pi d^2 / 4) \times 2 / Ast]$

$= 1000 \times [(\pi \times 10^2 / 4) \times 2 / 570]$

$= 275mm$

Provide 10mm dia bars at 270m c/c

Step8 : Tank floor slab

Provide nominal thickness of 150mm for base slab

minimum area of reinforcement

= 0.3% of cross section

Ast $= (0.3 / 100) \times 1000 \times 150$

$= 450mm^2$

Provide half of reinforcement near each face

Ast $= 450/2$

$= 225mm^2$

Spacing

Provide 8mm dia bars

Spacing $= 1000 \times [(\pi d^2 / 4) / Ast]$

$= 1000 \times [(\pi \times 8^2 / 4) / 225]$

$= 220mm$

Provide 8mm dia bars at 220m c/c in both directions at top and bottom of tank floor