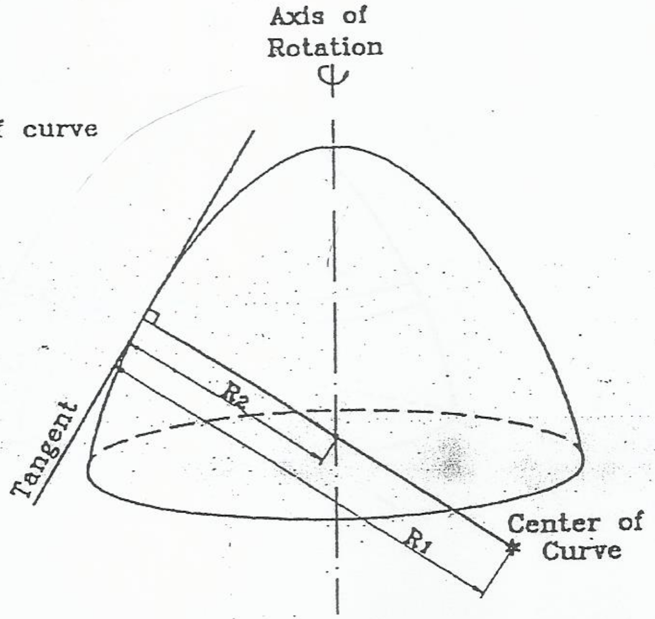
SURFACE OF REVOLUTION

It is surface resulted from rotation of curve around axis of rotation .

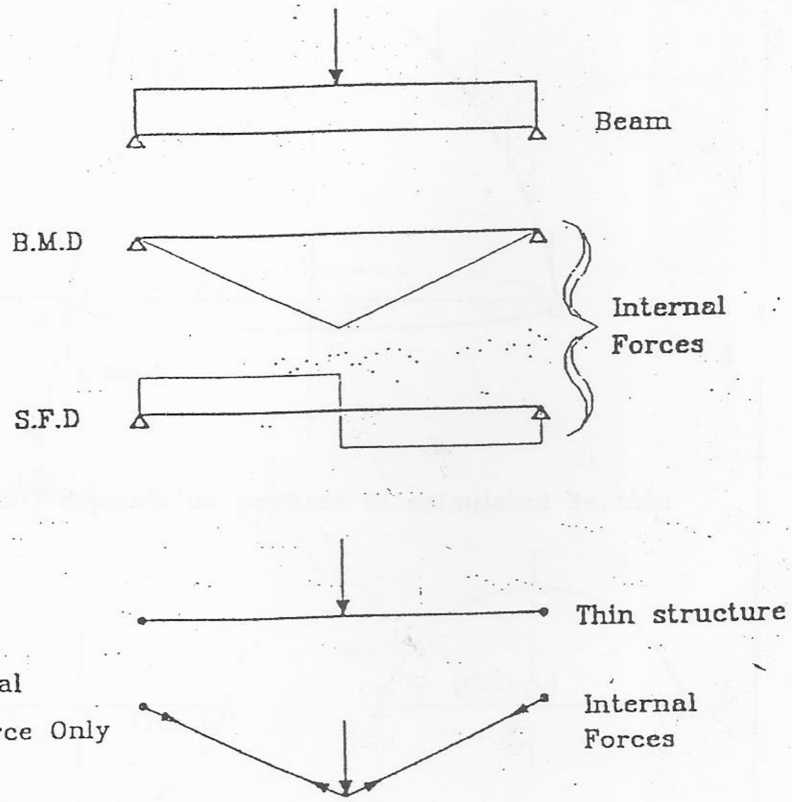
R_1 : radius of curve

R_2 : Length from tangent to axis of rotation



Membrane theory

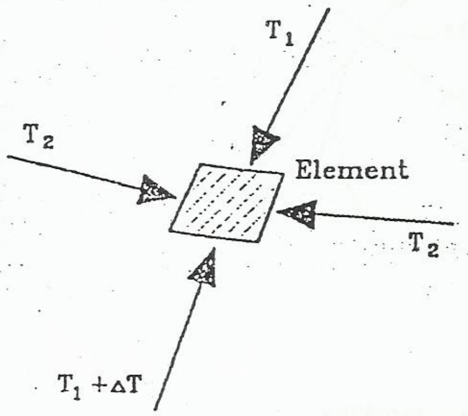
For thin structures the internal forces are axial force .

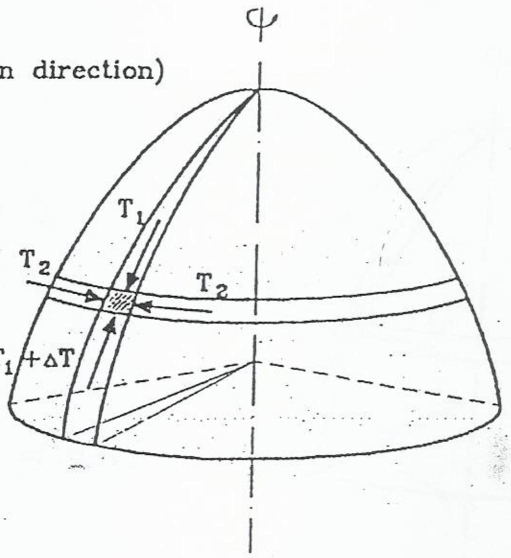


Internal Forces

T_1 : Maridiane Force (Force in meridian direction)

T_2 : Ring Force (Force in hl direction)





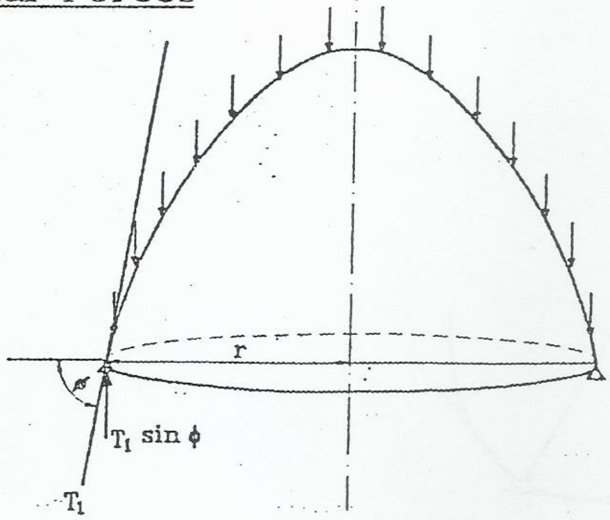
Calculation of Internal Forces

T1

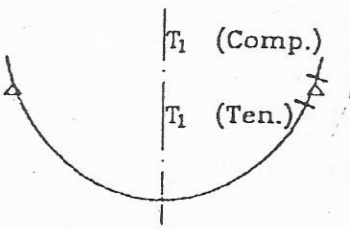
$\Sigma Y = 0$

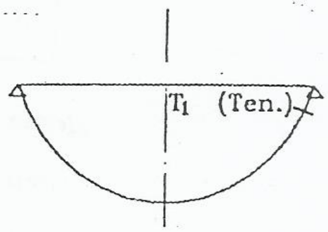
$W = T_1 \sin \phi$

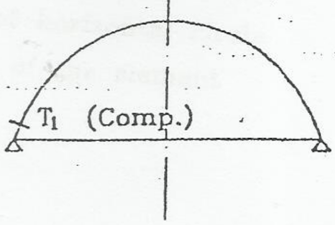
$$T_1 = \frac{W\phi}{(\sin \phi)\ 2 \pi r} \quad t/m$$



Type of T_1 (Compression or Tension) depends on position of calculated section due to support .



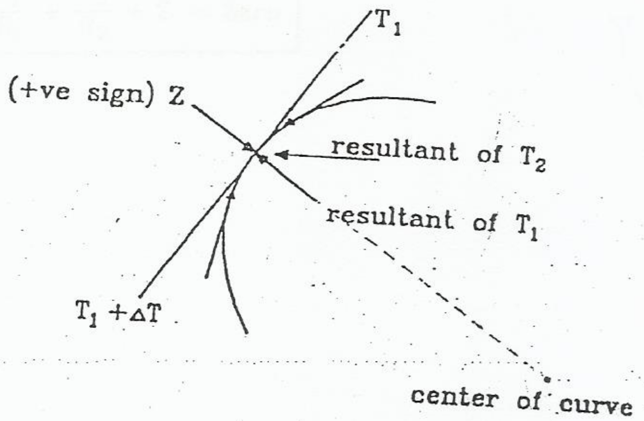


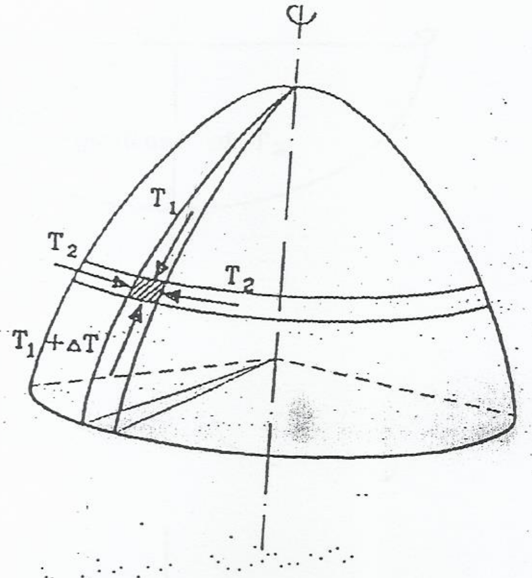


T_1 (Comp.) If calculated section over support

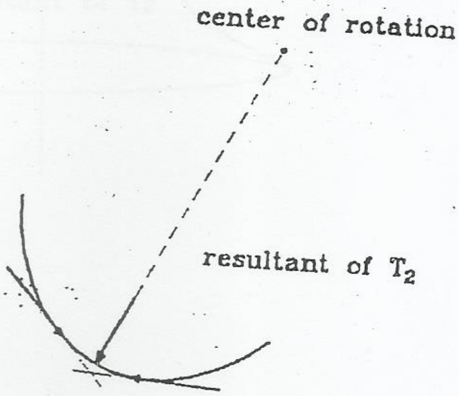
T_2 (Ten.) If calculated section under support

T2





vertical section
of vertical circle
of the element



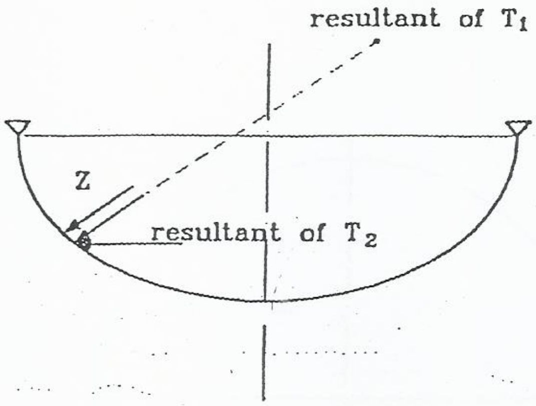
horizontal section
of horizontal circle
of the element

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = Z$$

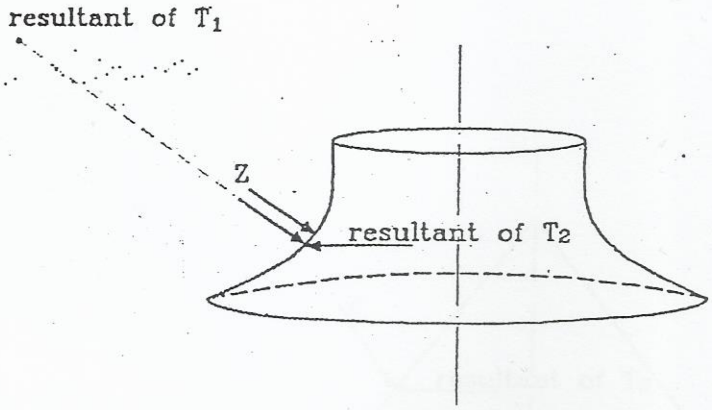
+ve sign means comp.

−ve sign means ten.

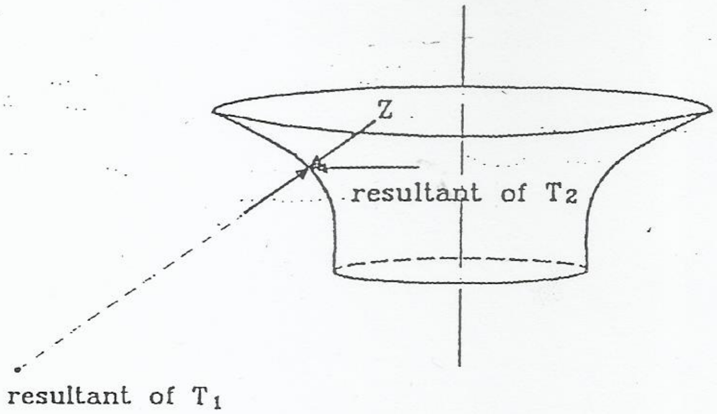
$$\frac{T_1}{R_1} + \frac{T_2}{R_2} + Z = Zero$$



$$\frac{T_1}{R_1} + Z = \frac{T_2}{R_2}$$

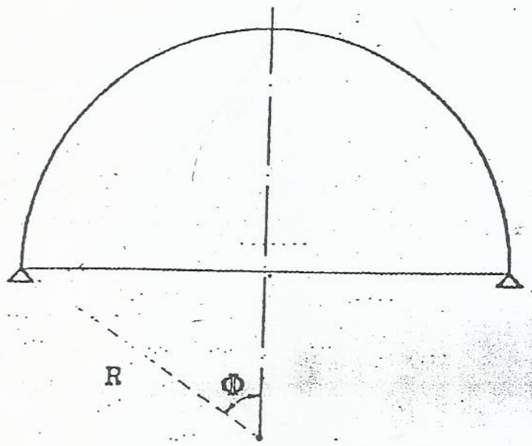


$$\frac{T_1}{R_1} = \frac{T_2}{R_2} + Z$$



Special Cases

(1) Sphere (Dome)



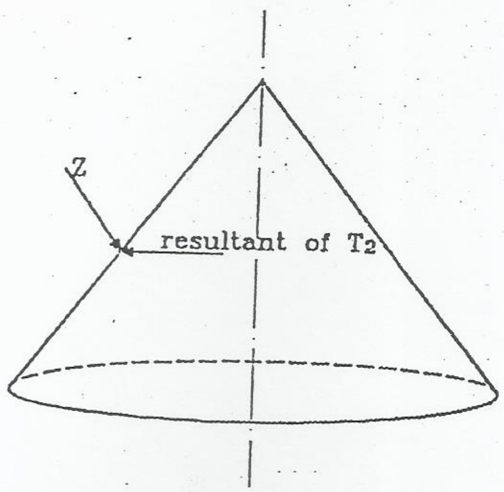
$$R_1 = R_2 = R$$

where R : radius of the sphere

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = Z$$

$$\boxed{T_1 + T_2 = R\,Z}$$

(2) Cone



$$R = \infty$$

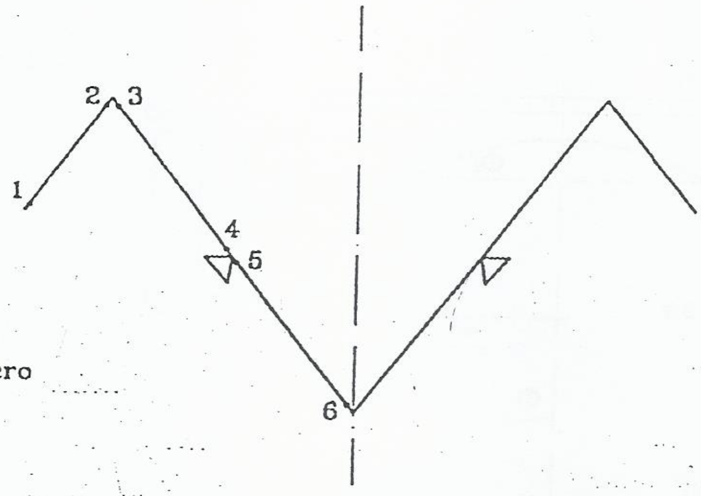
$$\frac{T_1}{R_1} = \text{Zero}$$

$$\frac{T_2}{R_2} = Z$$

$$\boxed{T_2 = R_2\,Z}$$

Example (1)

Determine type of forces on sections 1---6



sec. (1)

T_1 = Zero W_Φ = Zero

T_2 = Comp.

sec. (2)

T_1 = Ten.

T_2 = Comp.

sec. (3)

T_1 = Comp.

T_2 = Ten.

sec. (4)

T_1 = Comp.

T_2 = Ten.

sec. (5)

T_1 = Ten.

T_2 = Ten.

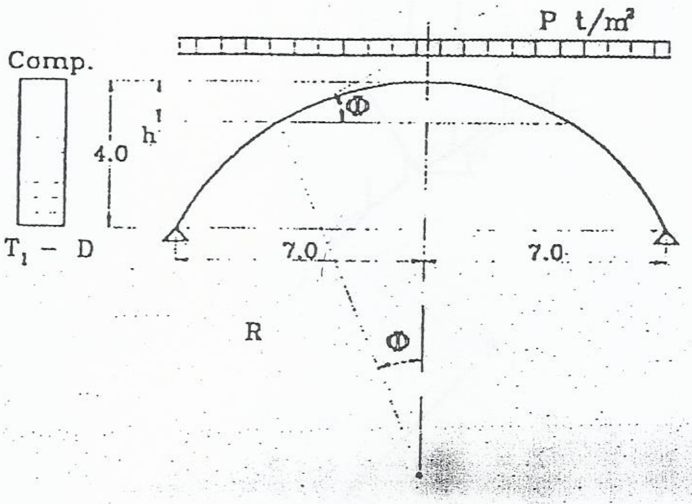
sec. (6)

T_1 = Zero W_Φ = Zero

T_2 = Zero R_2 = Zero

Example (2)

Draw T_1, T_2 Diagram Due to L.L



$$T_1 = \frac{W_\Phi}{2\pi r \sin\Phi}$$

$$W_\Phi = P\,(\pi r^2)$$

$$T_1 = \frac{P\,(\pi r^2)}{2\pi r \sin\Phi}$$

$$\sin\Phi = \frac{r}{R}$$

$$T_1 = \frac{P\,(\pi r^2)}{2\pi r \frac{r}{R}} = \frac{P\,R}{2}$$

$$R^2 = (7)^2 + (R-4)^2$$

$$= 49 + R^2 - 8R + 16$$

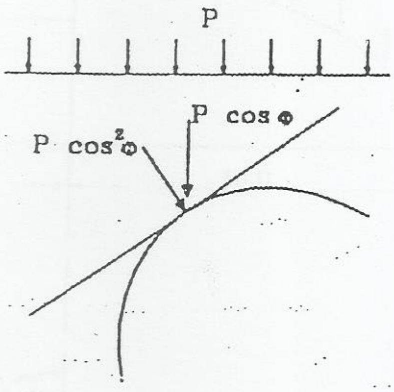
$$R = 8.125 \text{ m}$$

$$T_1 + T_2 = R\,Z$$

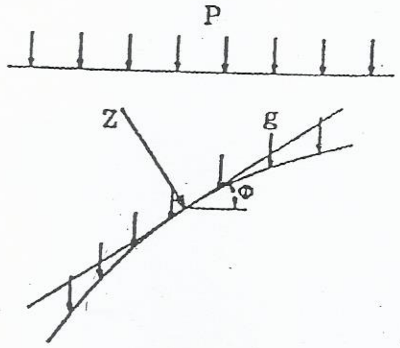
$$T_2 = R\,Z - T_1$$

$$T_2 = R\,P\cos^2\Phi - \frac{P\,R}{2}$$

$$T_2 = P\,R\left(\cos^2\Phi - \frac{1}{2}\right)$$

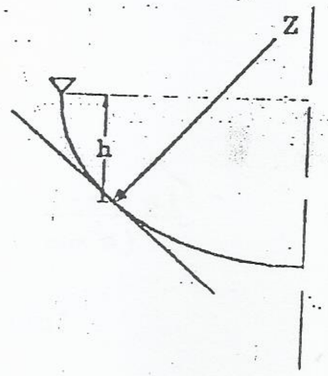


Calculation of Z



Z is the component of loads perpendicular to the tangent at certain point

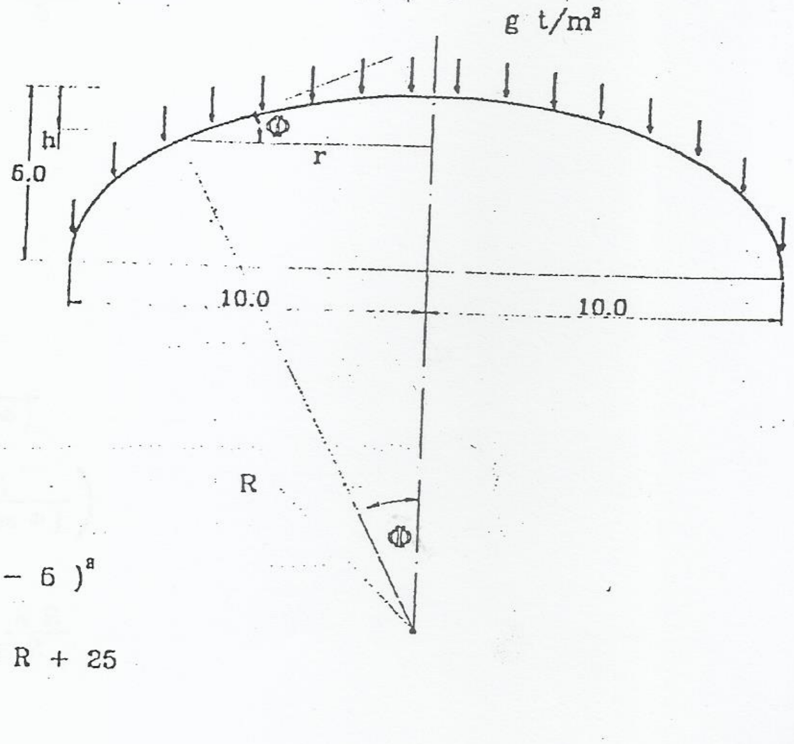
$$Z = g \cos\Phi + P \cos^2\Phi$$



$$Z = \gamma h + g \cos\Phi$$

Example (3)

Draw T_1, T_2 Diagram



$$R^2 = (10)^2 + (R-6)^2$$

$$= 100 + R^2 - 10R + 25$$

$$R = 12.5 \text{ m}$$

$W_\Phi = g * \text{surface area}$

$W_\Phi = g * 2\pi R h$

$$T_1 = \frac{W_\Phi}{2\pi r \sin\Phi}$$

$$T_1 = \frac{g * 2\pi R h}{2\pi r \sin\Phi}$$

$\sin\Phi = \frac{r}{R}$ $\qquad h = R - R\cos\Phi$

$r = R\sin\Phi$ $\qquad h = R(1-\cos\Phi)$

$$T_1 = \frac{g R R (1-\cos\Phi)}{R \sin\Phi * \sin\Phi} = \frac{g R (1-\cos\Phi)}{\sin^2\Phi} = \frac{g R (1-\cos\Phi)}{(1-\cos^2\Phi)}$$

$$= \frac{g R (1-\cos\Phi)}{(1-\cos\Phi)(1+\cos\Phi)} = \frac{g R}{(1+\cos\Phi)} \quad t/m'$$

at $\Phi = \text{zero}$ $\qquad T_1 = \frac{g R}{2}$

$T_1 + T_2 = R Z$

$T_2 = R Z - T_1$

$Z = g \cos\Phi$

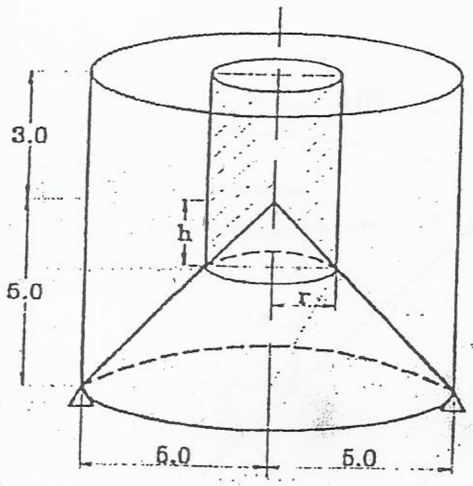
$$T_2 = R g \cos\Phi - \frac{g R}{(1+\cos\Phi)}$$

$$= R g \left(\cos\Phi - \frac{1}{(1+\cos\Phi)}\right)$$

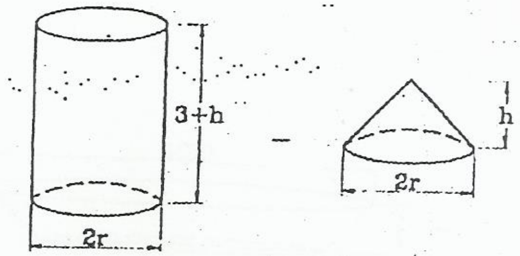
at $\Phi = \text{zero}$ $\qquad T_2 = \frac{g R}{2}$

Example (4)

Calculate T_1, T_2 for the Cone



$W_\Phi =$



$$W_\Phi = \pi r^2(3+h) - \frac{1}{3}\pi r^2(h)$$

$$T_1 = \frac{W_\Phi}{2\pi r \sin\Phi}$$

Φ is constant $\qquad \tan\Phi = \frac{h}{r}$

$$T_2 = R_2 Z$$

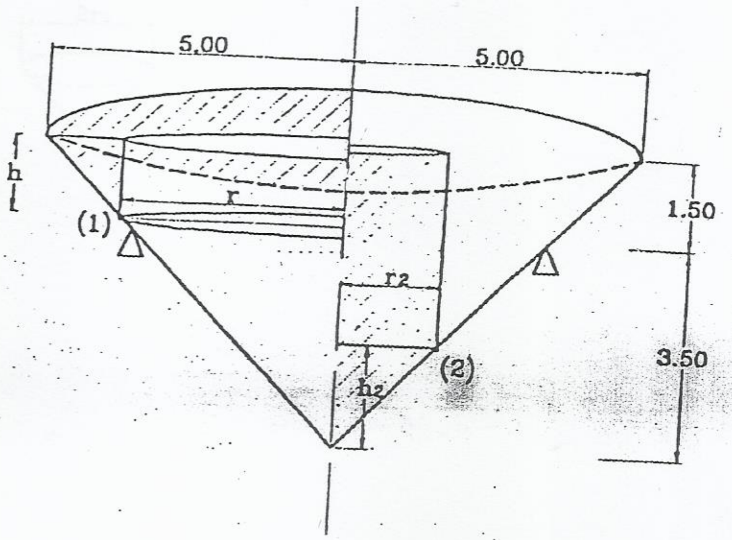
$$R_2 = \frac{r}{\sin\Phi}$$

$$Z = \gamma_w (h + 3)$$

$$T_2 = \frac{r}{\sin\Phi}(h + 3)$$

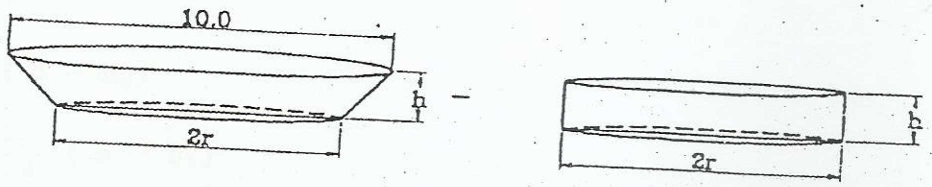
Example (5)

Calculate T_1, T_2 for the Cone full of water



sec. (1)

W_Φ =



$$T_1 = \frac{W_\Phi}{2\pi r \sin\Phi}$$

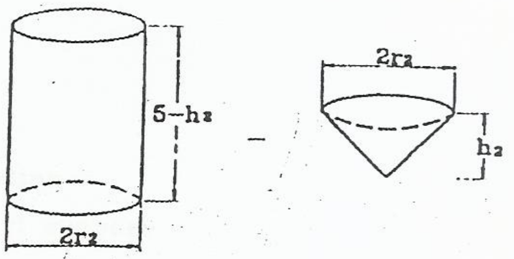
$$T_2 = R_2 \, Z$$

$$R_2 = \frac{r}{\sin\Phi} \qquad Z = \gamma_w \, h$$

W_Φ = Area of triangle * Premeter of c.g. circle

$$= \quad \ast \; 2 \left(r + \frac{5-r}{3} \right)$$

sec. (2)

$W_\Phi =$ 

$$W_\Phi = \pi r_2^2(5-h_2) + \frac{1}{3}\pi r_2^2(h_2)$$

$$T_1 = \frac{W_\Phi}{2\pi r_2 \sin\Phi}$$

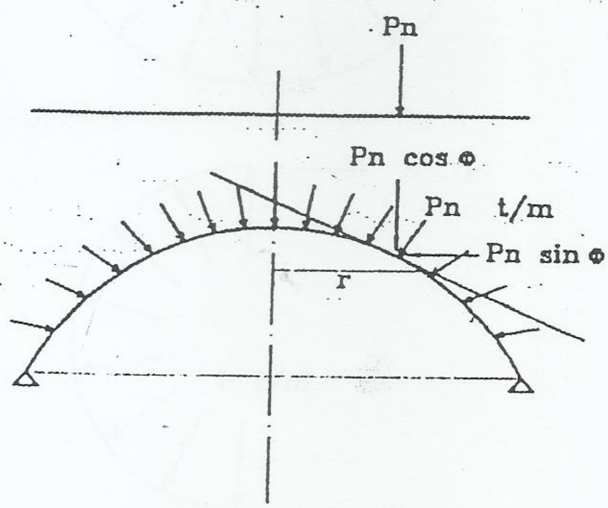
$$T_2 = R_2 \; Z$$

$$R_2 = \frac{r_2}{\sin\Phi}$$

$$Z = \gamma_W \;(5 - h_2)$$

$$T_2 = \frac{r_2}{\sin\Phi}\;(5 - h_2)$$

– W_Φ for case of load perpendicular to the tangent



W_Φ = Pn * area of hL projection

$= Pn * \pi r^2$

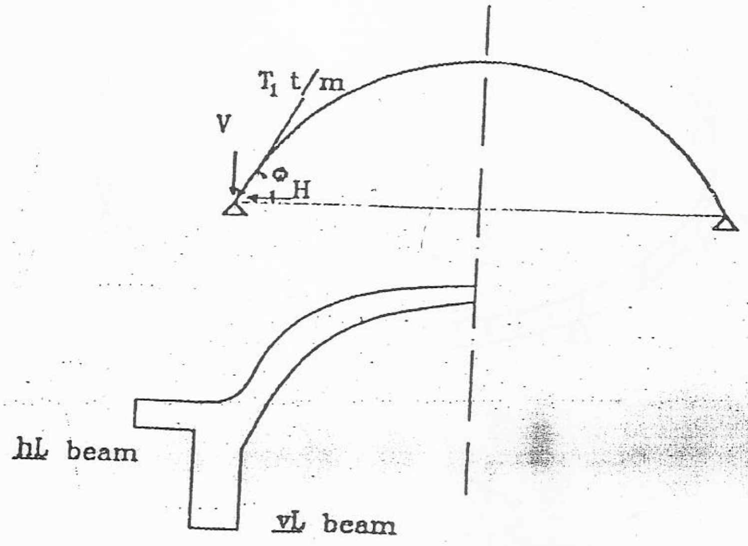
$Z = Pn$

supports of surface of revolution

$V = T_1 \sin \phi$

$H = T_1 \cos \phi$

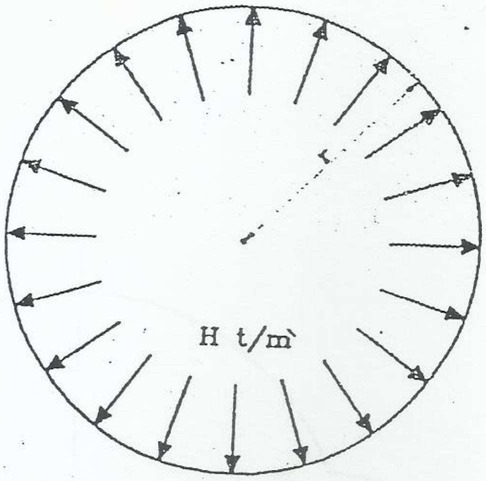
Surface of revolution
must have hl & vl support



(1) hL beam

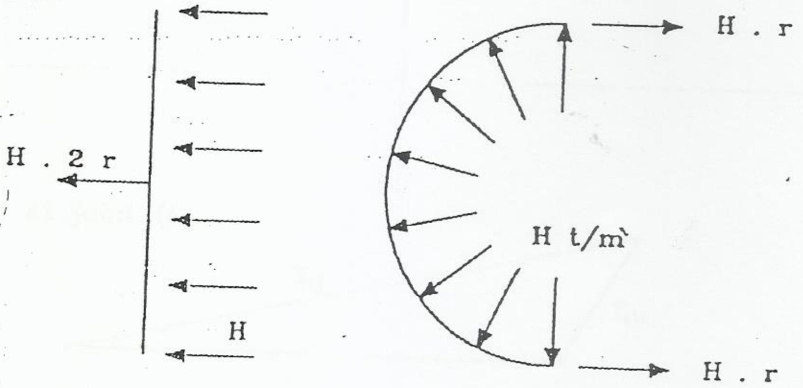
Internal Force is Axial Force

Axial Force = H . r   Tension

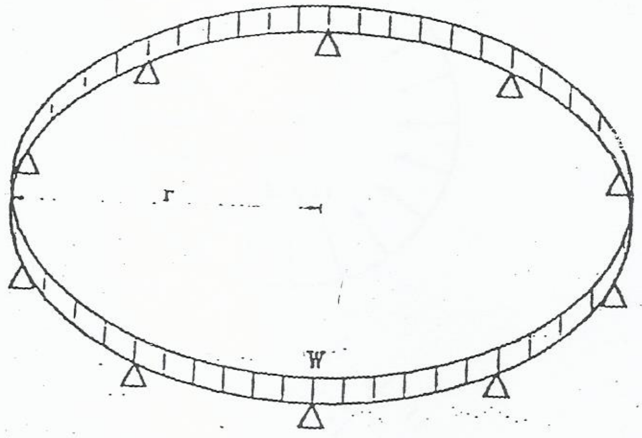


$As = \frac{Tu}{\frac{Fy}{\gamma s}}$

$Ac = (30 - 50)\ As$



(2) vL beam



w = V + o.w of hL beam

+ o.w of vL beam

from tables

Q = ...

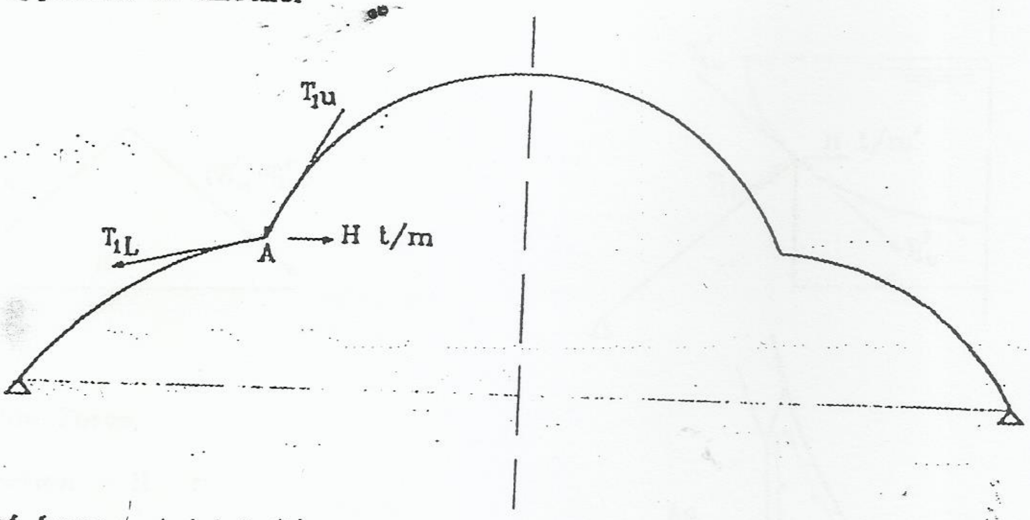
B.M (at Mid span) = ...

M_{-ve} (at support) = ...

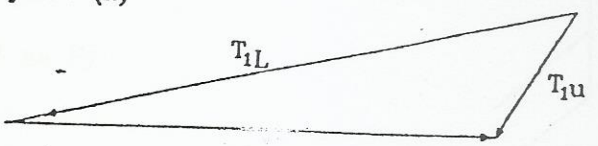
M_t = ...

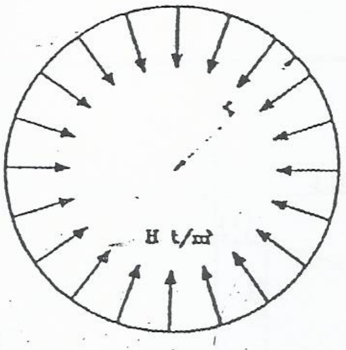
- Surface supported to another

(1)



Triangle of forces at joint (A)





Axial Force = H . r

Compression Force

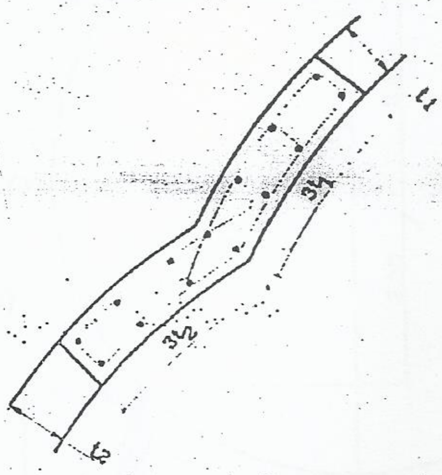
Design equation as column

$$Pu = 0.35\ Ac\ Fcu + 0.67\ As\ Fy$$

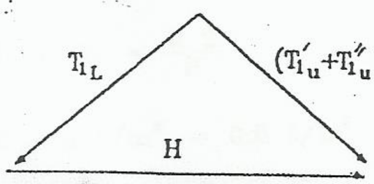
assume $Ac = 3\ t_1^2 + 3\ t_2^2$

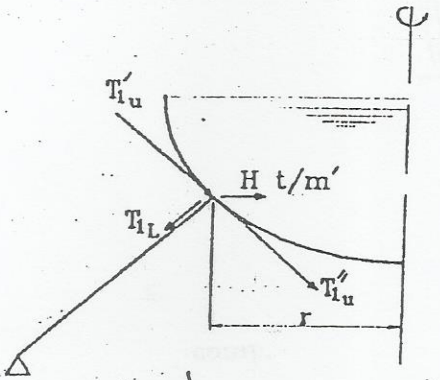
$\therefore$ As = ...

min (0.8 % Ac)



(1)

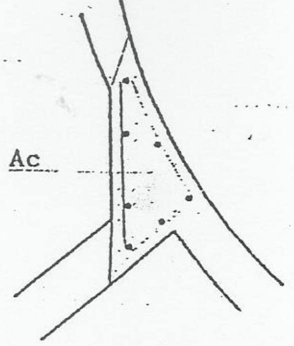




Compression Force

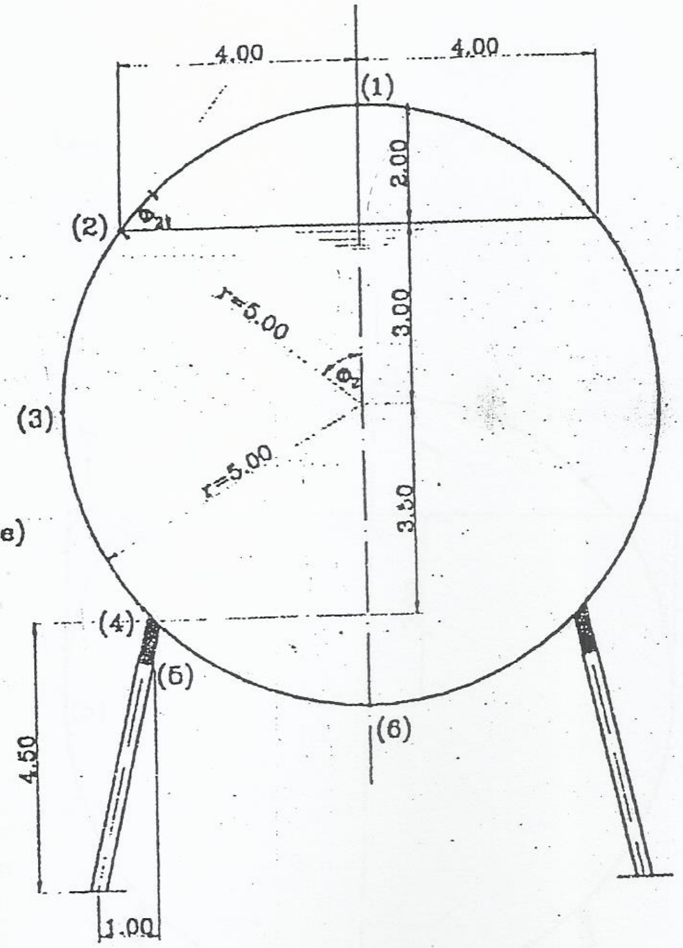
at intersection = H . r

$$Pu = 0.35\ Ac\ Fcu + 0.67\ As\ Fy$$



Example (6)

Calculate the internal forces at the shown sections .



assume t = 20 cm (water structure)

o.w of slab = 0.5 t/m^2

Sec. (1)

$$T_1 = T_2 = \frac{R\ Z}{2}$$

$$Z = g\ t/m^2 = 0.5\ t/m^2$$

$$T_1 = T_2 = \frac{5 * 0.5}{2} = 1.25\ t/m' \qquad \text{comp.}$$

Sec. (2)

$$W_\Phi = 0.5 * 2\pi * 5 * 2 = 31.42\ t$$

$$T_1 = \frac{W_\Phi}{2\pi\ r\ \sin\Phi}$$

$$r = 4.0 \qquad \Phi = \Phi_2 = \cos^{-1}\frac{3}{5} = 53.13^\circ$$

$$T_1 = \frac{31.42}{2\pi * 4 * \sin 53.13} = 1.56\ t/m' \qquad \text{comp.}$$

$T_1 + T_2 = R\ Z$

$Z = g \cos \Phi = 0.3\ t/m^2$

$1.56 + T_2 = 5 * 0.3$

$T_2 = -0.06\ t/m'$ ten.

Sec. (3)

$W_\Phi = o.w_{1-3} \downarrow + W_1 \uparrow$

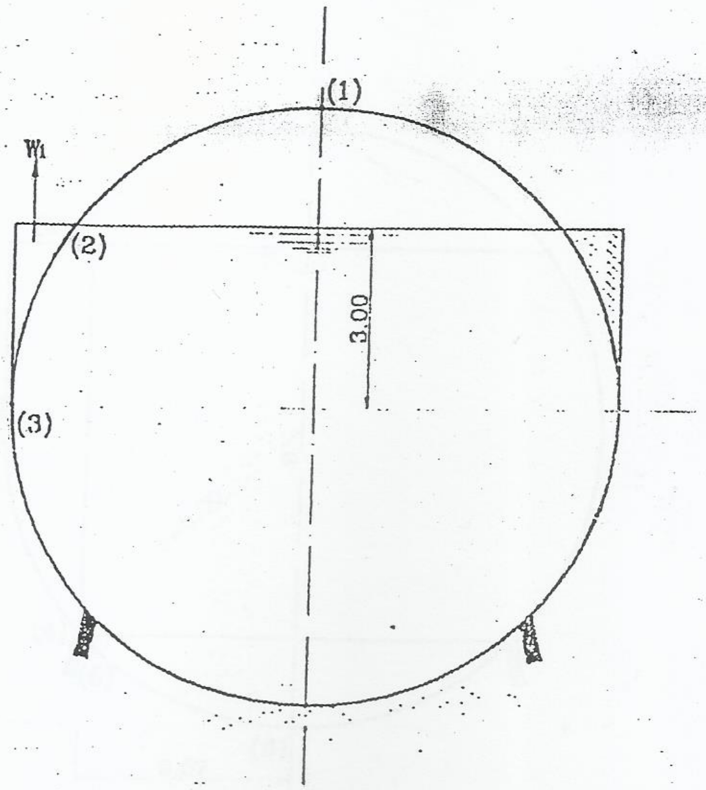
$W_\Phi = 0.5 * 2\pi * 5^2 -$
$- \{ \pi * 5^2 * 3 - \frac{\pi * 3}{6} (3 * 5^2$
$+ 3 * 4^2 + 3^2) \} = 50.27\ t$

$T_1 = \frac{W_\Phi}{2 \pi r \sin \Phi}$

$r = 5.0 \qquad \Phi = 90°$

$T_1 = \frac{50.27}{2\pi * 5 * \sin 90} = 1.6\ t/m$

comp.



– just before sec. (3)

$T_1 + T_2 = R\ Z$

$Z = \gamma h = 1 * 3 = 3\ t/m^2$

$1.6 + T_2 = 5 * 3$

$T_2 = 13.4\ t/m'$ comp.

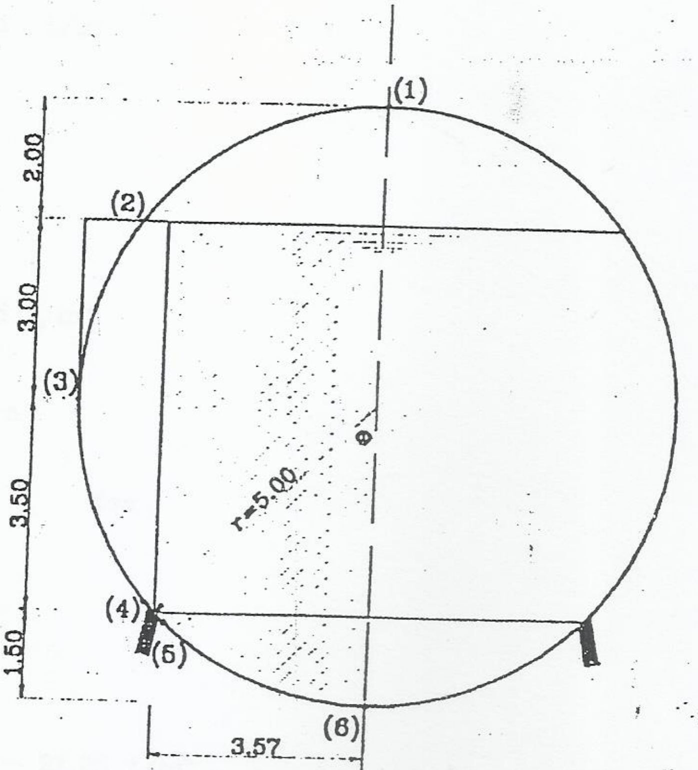
– just after sec. (3)

$T_1 + T_2 + R\ Z = \text{zero}$

$Z = \gamma h = 1 * 3 = 3\ t/m^2$

$1.6 + T_2 + 5 * 3 = \text{zero}$

$T_2 = -16.6\ t/m'$ ten.



Sec. (4)

$$W_\Phi = 0.5 \left\{ 2\pi * 5^2 + 2\pi * 5 * 3.5^2 \right\} + \left\{ \frac{\pi * 6.5}{6} \left(3 * 4^2 + 3 * 3.57^2 + 6.5^2 \right) - \pi * 3.57^2 * 6.5 \right\}$$

$$= 310.55\ t$$

$$T_1 = \frac{W_\Phi}{2\pi\ r\ \sin\Phi}$$

$r = 5.0$ $\sin\Phi = \frac{3.57}{5}$

$$T_1 = \frac{50.27}{2\pi * 5 * \frac{3.57}{5}} = 19.4\ t/m$$ comp.

$T_1 + T_2 + R\ Z = \text{zero}$

$Z = \gamma h + g\ \cos\Phi$

$= 1 * 6.5 + 0.5\ \cos\Phi = 6.85\ t/m^2$

$19.4 + T_2 + 5 * 6.85 = \text{zero}$

$T_2 = -53.65\ t/m'$ ten.

Sec. (5)

$$W_\phi = 0.5 * 2\pi * 5 * 1.5 + \pi * 3.57^2 * 6.5 +$$

$$+ \pi * 1.5^2 * \left(5 - \frac{1.5}{3.0}\right) = 315.63 \quad t$$

$$T_1 = \frac{W_\phi}{2\pi r \sin\phi}$$

$$r = 5.0 \qquad \sin\phi = \frac{3.57}{5}$$

$$T_1 = \frac{315.63}{2\pi * 3.57 * \frac{3.57}{5}} = 19.71 \quad t/m \qquad \text{ten.}$$

$$T_1 + T_2 + R\,Z = \text{zero}$$

$$Z = \gamma h + g \cos\phi$$

$$= 1 * 6.5 + 0.5 \cos\phi = 6.85 \ t/m^2$$

$$-19.71 + T_2 + 5 * 6.85 = \text{zero}$$

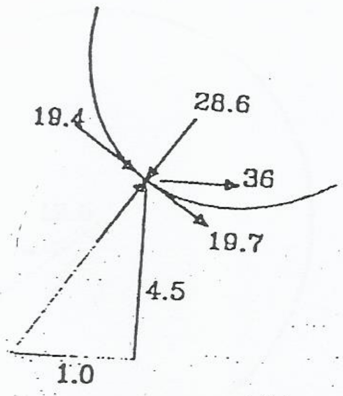
$$T_2 = -14.54 \quad t/m' \qquad \text{ten.}$$

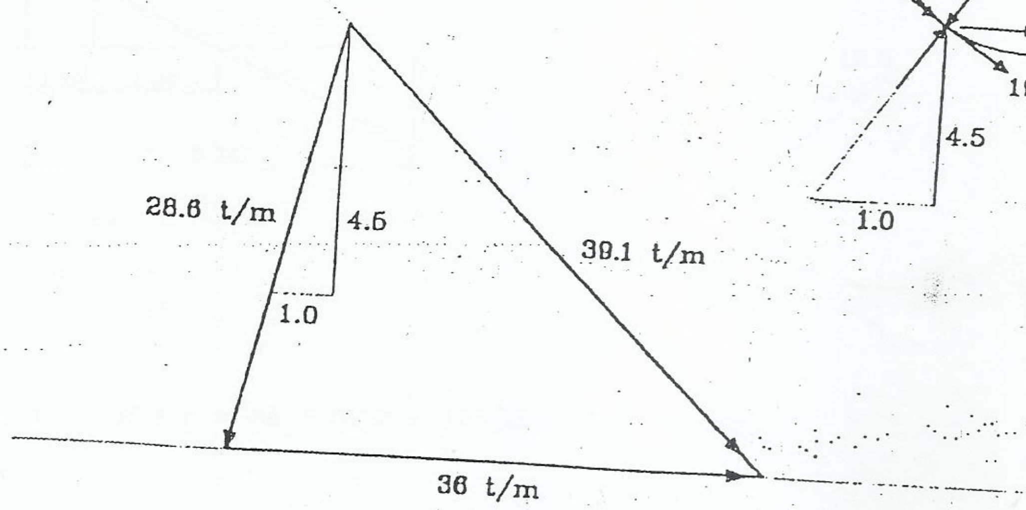
Sec. (6)

$$T_1 = T_2 = \frac{R\,Z}{2}$$

$$= -5 * \frac{(8 + 0.5)}{2} = -21.25 \ t/m' \qquad \text{ten.}$$

Design of Support





$W = 28.6 +$ component of o.w

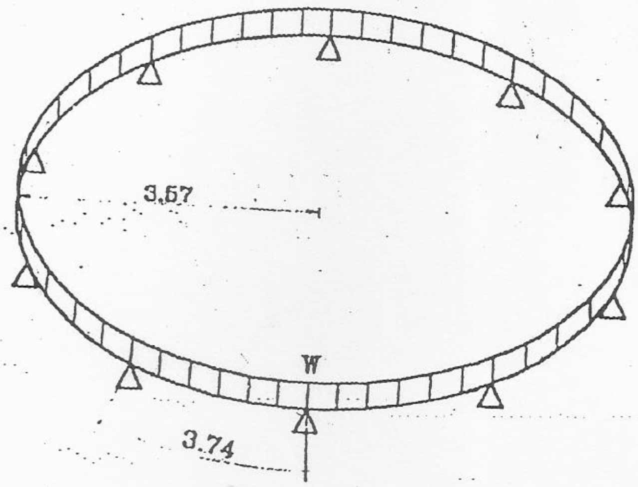
assume sec. $40 * 100$

$W = 28.6 + 0.4 * 1 * 2.5$

$= 29.6 \ t/m$

$P = 2\pi * 3.57 * 29.6 =$

$= 663.96$ ton



assume 6 column

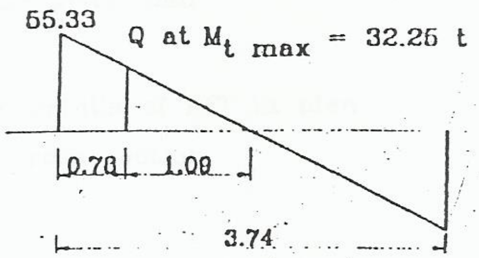
Load / col. $= \frac{P}{6} = 110.7$ ton

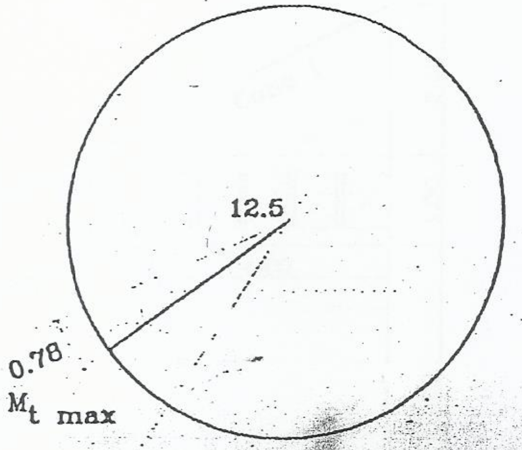
$Q_{max.} = \frac{P}{12} = 55.33$ ton

$M_{+ve} = 0.0075 * 663.96 * 3.57 = 17.8$ m.t

$M_{-ve} = -0.0148 * 663.96 * 3.57 = -35.1$ m.t

$M_t = 0.0015 * 663.96 * 3.57 = 3.6$ m.t



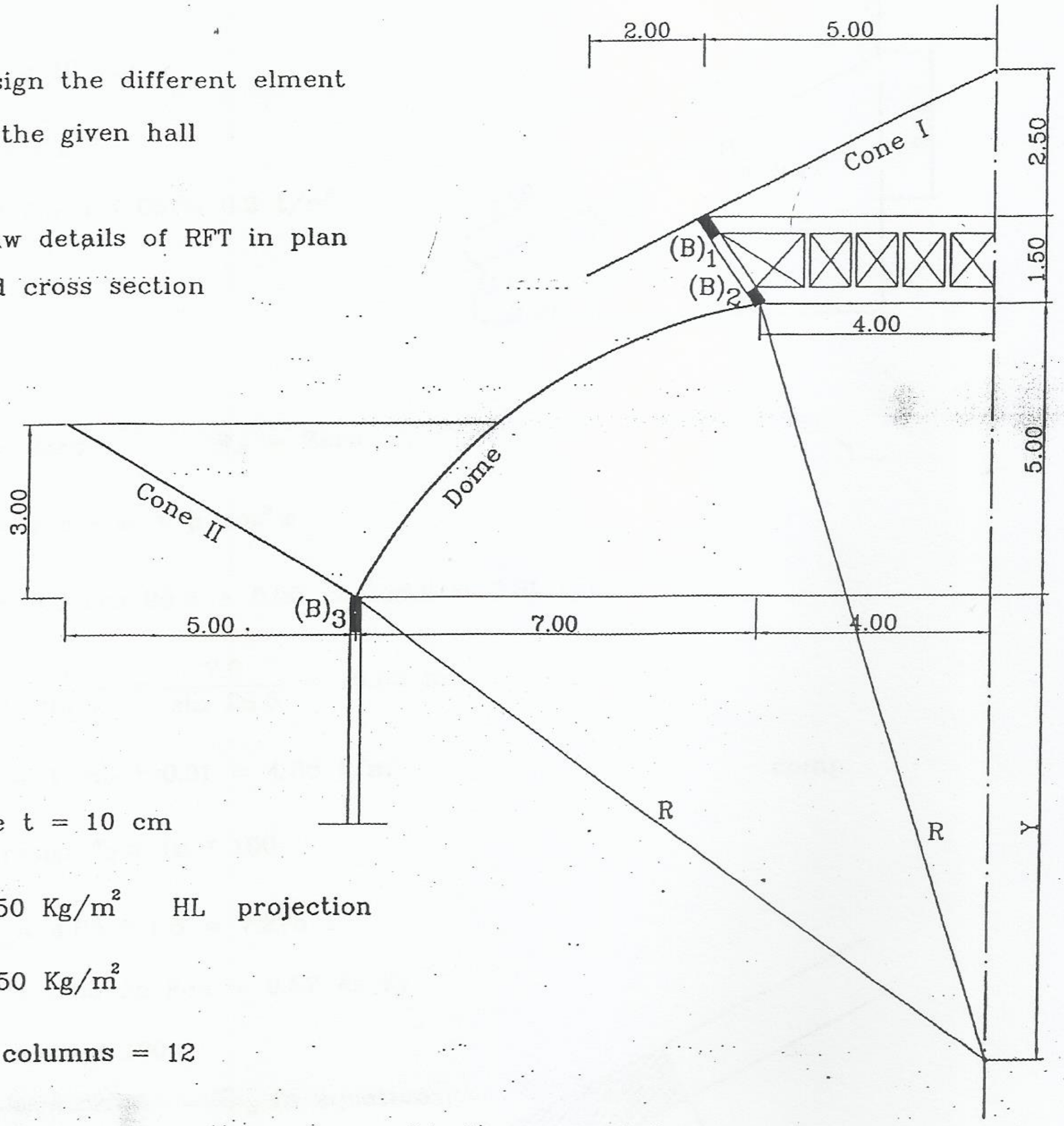


$N.F = H * r = 36 * 3.57 = 128.52$ t comp.

Example (7)

- Design the different elment of the given hall

- Draw details of RFT in plan and cross section



assume t = 10 cm

L.L = 50 Kg/m^2 HL projection

F.c = 50 Kg/m^2

no. of columns = 12

$$R^2 = (4)^2 + (5 + Y)^2$$

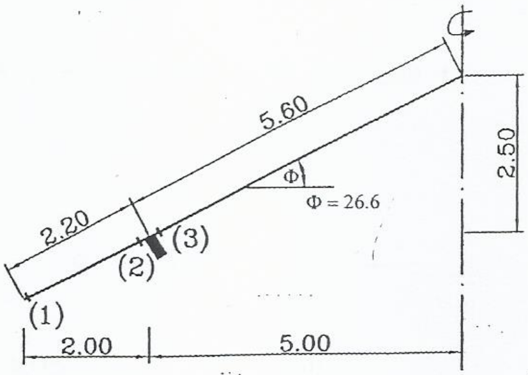
$$R^2 = (11)^2 + (Y)^2$$

$$16 + 25 + 10Y + Y^2 = 121 + Y^2$$

Y = 8.0 m

R = 13.6 m

Cone I



assume t = 10 cm

g = o.w + F.c

$g = 0.1 * 2.5 + 0.05 = 0.3\ t/m^2$

Sec. (1)

$T_1 = Zero \qquad W_\Phi = Zero$

$Z = g \cos\Phi + p \cos^2\Phi$

$= 0.3 \cos 26.6 + 0.05 \cos^2 26.6 = 0.31\ t/m^2$

$R_2 = \frac{r}{\sin\Phi} = \frac{7.0}{\sin 26.6} = 15.63\ m$

$T_2 = 15.63 * 0.31 = 4.85\ t/m`$ comp.

** sec resist $T_2 = 10 * 100$

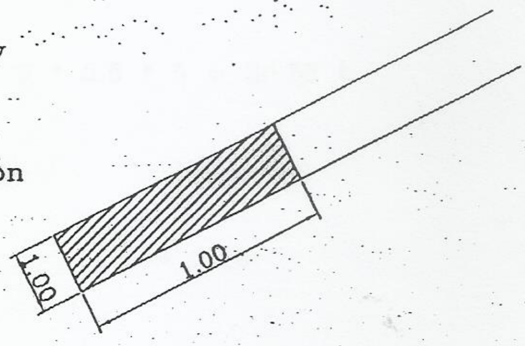
$T_{2u} = 4.85 * 1.5 = 7.275\ t$

$P_u = 0.35\ Ac\ Fcu + 0.67\ As\ Fy$

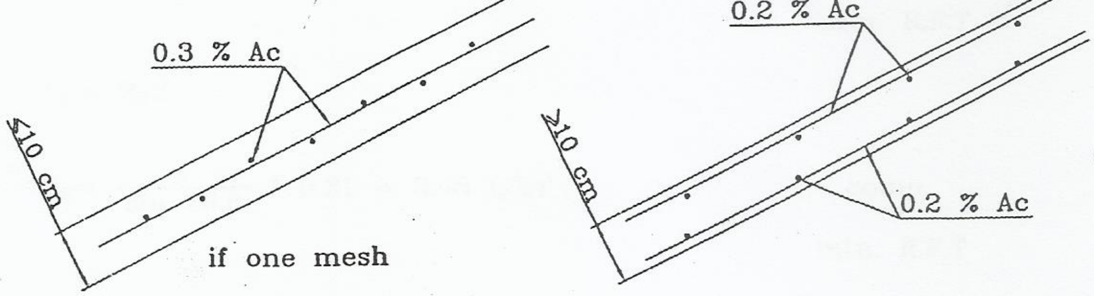
$A_c = 10 * 100$

take $P_u = 7.275\ t = T_{2u}$ in equation

A_s min =



Min RFT for surface of revolution



double mesh or
5ø8/m`

Sec. (2)

$$W_\Phi = 0.05 * \pi * (7^2 - 5^2) + 0.3 * \pi * 2.2 * (5 + 7) = 11.69 \ t$$

$$T_1 = \frac{W_\Phi}{2 \pi r \sin\Phi}$$

$r = 5.0 \qquad \Phi = 26.6$

$$T_1 = \frac{11.69}{2\pi * 5 * \sin 26.6} = 4.16 \quad t/m` \qquad \text{ten.}$$

$$T_1 u = 4.16 * 1.5 = 6.24 \ t/m`$$

$$As = \frac{T_1 u}{Fy/\gamma s} = \frac{6.24}{3.6/1.15} = 1.73 \ cm^2 = 5\phi8/m`$$

$$T_2 = R_2 Z$$

$$T_2 = \frac{5}{\sin 26.6} * 0.31 = 3.46 \ t/m` \qquad \text{comp.}$$

min. R.F.T

Sec. (3)

$$W_\Phi = 0.05 * \pi * (5^2) + 0.3 * \pi * 5.6 * 5 = 30.32 \ t$$

$$T_1 = \frac{W_\Phi}{2 \pi r \sin\Phi}$$

$r = 5.0 \qquad \Phi = 26.6$

$$T_1 = \frac{30.32}{2\pi * 5 * \sin 26.6} = 10.78 \quad t/m \qquad \text{comp.}$$

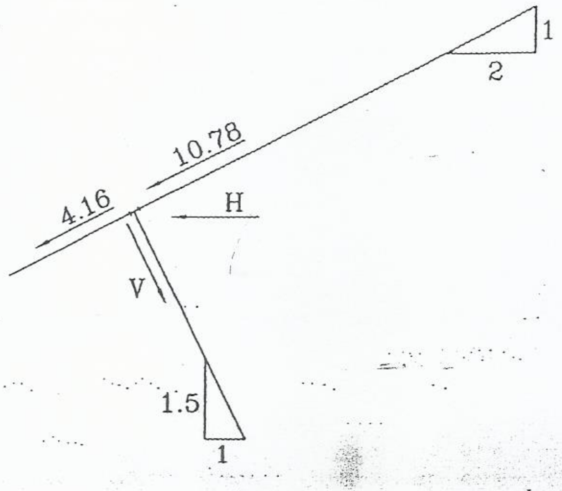
min. R.F.T

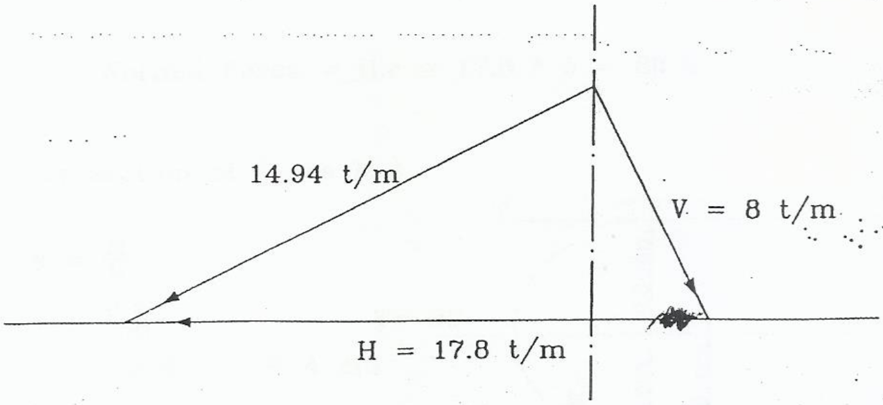
$$T_2 = R_2 Z$$

$$T_2 = \frac{5}{\sin 26.6} * 0.31 = 3.46 \ t/m` \qquad \text{comp.}$$

min. R.F.T

Design of B_1





assume sec. 20 * 40

o.w = 0.2 * 0.4 * 2.5 = 0.2 t/m`

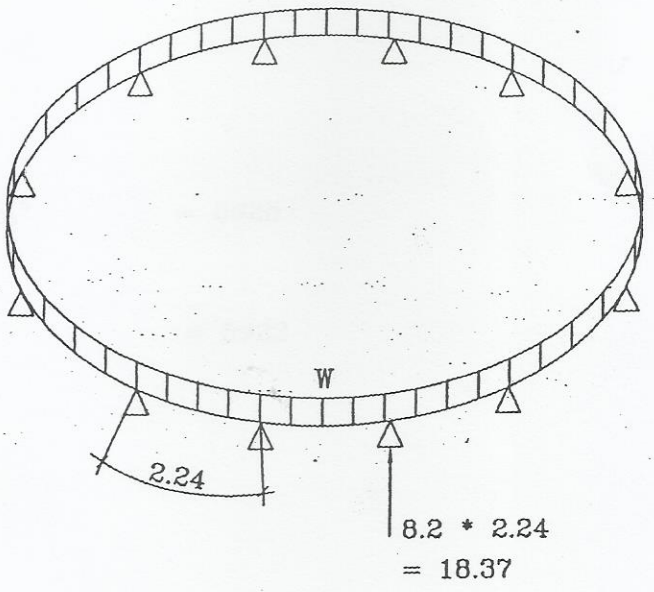
assume no. of posts = 14

no. of columns > 12

∴ neglect torsion

$$M_{+ve} = \frac{wL^2}{12}$$

$$M_{-ve} = \frac{wL^2}{24}$$



$w = V + \text{component of o.w} \quad (\simeq 0.2)$

$= 8.0 + 0.2 = 8.2 \ t/m`$

$$M_{+ve} = \frac{wL^2}{12} = \frac{8.2(2.24)^2}{12} = 3.42 \ m.t$$

$$M_{-ve} = \frac{wL^2}{24} = \frac{8.2(2.24)^2}{24} = 1.71 \ m.t$$

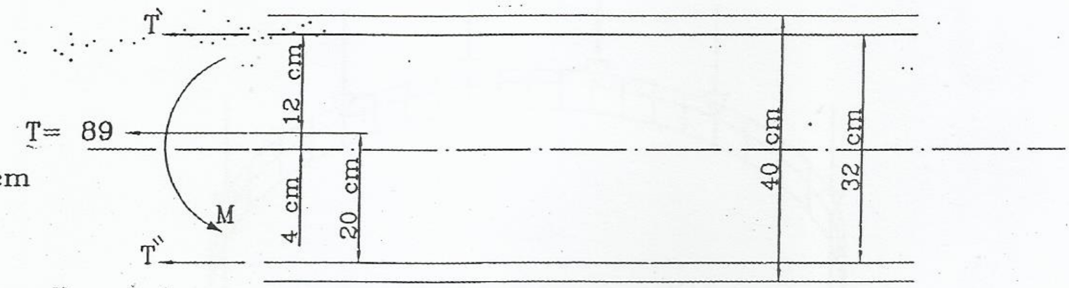
Normal Force = H.r = 17.8 * 5 = 89 t ten.

for section of (−ve M)

$e = \frac{M}{N}$

$= \frac{3.42}{89}$

$= 0.384 \quad \simeq 4 \ cm$



$e < (\frac{t}{2} - \text{cover})$ small ecc. ten.

$T` = 89 * \frac{20}{32} = 55.6 \ t$

$T`` = 89 * \frac{12}{32} = 33.4 \ t$

$$As_1 = \frac{T\grave{u}}{Fy/\gamma s} = \frac{55.6 * 1.5}{3.6/1.15} = 26.64 \ cm^2 \qquad = 6\phi 25$$

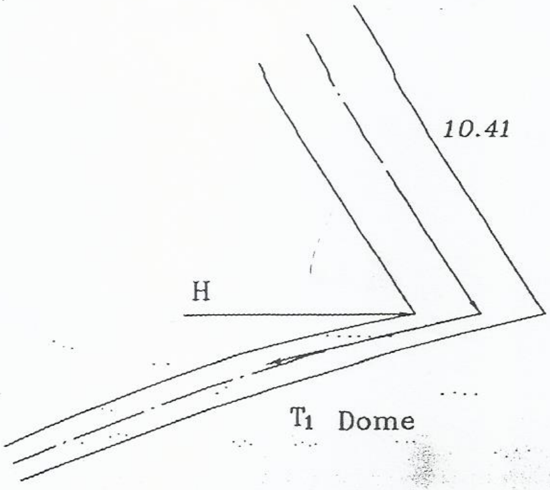
$$As_2 = \frac{T\grave{\grave{u}}}{Fy/\gamma s} = \frac{33.4 * 1.5}{3.6/1.15} = 16 \ cm^2 \qquad = 5\phi 22$$

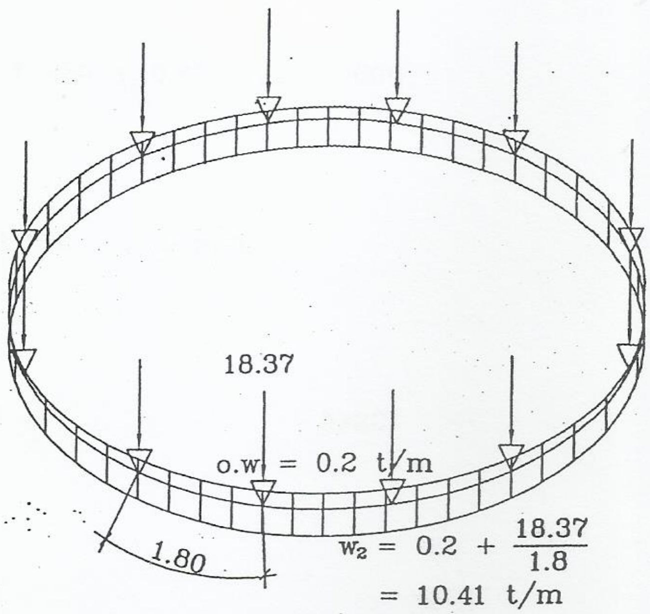
Post

P u = 18.37 * 1.5

assume sec. 20 * 20 4ø12

Design of B_2





$$w_2 = 0.2 + \frac{18.37}{1.8}$$

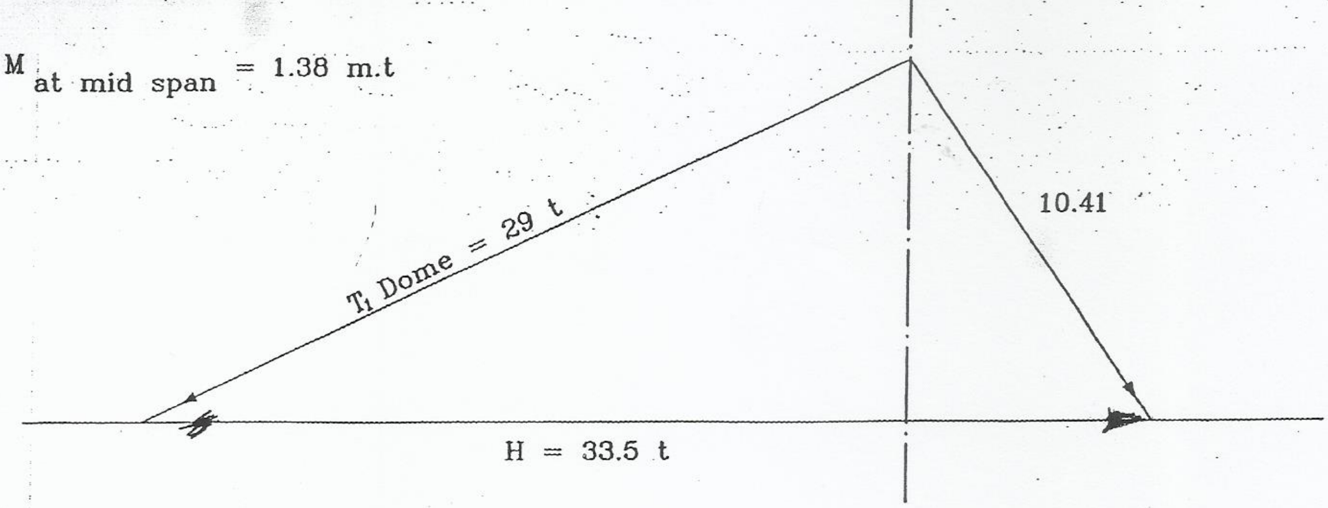
$$= 10.41 \ t/m$$

$$M_{at\ support} = \frac{wL^2}{12}$$

$$= \frac{(10.41-0.2)^2 * 1.8}{12}$$

$$= 2.76 \quad m.t$$

$$M_{at\ mid\ span} = 1.38 \ m.t$$



$N.F = 33.5 * 4 = 134 \ t$ comp.

$$e = \frac{M}{N} = \frac{2.76}{134} = 0.02 \ m$$

$$\frac{e}{t} = \frac{0.02}{0.40} = 0.05$$

$\therefore$ neglect M

$P_u = 0.35 \ Ac \ Fcu + 0.67 \ As \ Fy$

$A_c = 20 * 40$

$P_u = 134 * 1.5$

$134 * 1.5 * 10^3 = 0.35 * 20 * 40 * 250 + 0.67 * As * 3600$

$A_s = 54.3 \ cm^2$

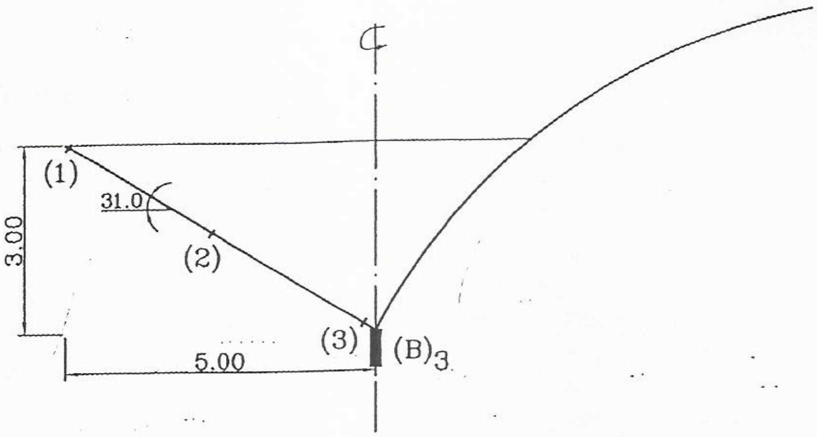
$$\mu = \frac{As}{Ac} = \frac{54.3}{20 * 40} * 100 = 6.8 \ \% \quad > 3 \ \%$$

take sec. 20 * 70

$\therefore \quad A_s = 32.54 \ cm^2 \qquad 9\phi22$

$\mu = 2.32 \ \%$

Cone II



$Z = g \cos \Phi + p \cos^2 \Phi$

$= 0.3 \cos 31 + 0.05 \cos^2 31$

$= 0.29 \ t/m^2$

Sec. (1)

$T_1 = \text{Zero}$ $\quad W_\Phi = \text{Zero}$

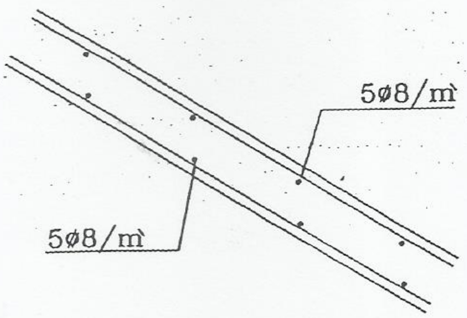
$T_2 = R_2 . Z$

$R_2 = \dfrac{r}{\sin \Phi} = \dfrac{16.0}{\sin 31.0} = 31.06 \ m$

$T_2 = 31.06 * 0.29 = 9.0 \ t/m'$ Tension

$As_1 = \dfrac{T\grave{u}}{Fy/\gamma s} = \dfrac{9.0 * 1.5}{3.6/1.15} = 4.31 \ cm^2$ two sides

$As/side = 2.155 \ cm^2 = 5\phi8/m$ each side



∴ T_2 of sec. (2) & (3)

is not required since

As_1 of $T_{2\,max}$ (at sec.(1)) min. R.F.T

double mesh or 5ø8/m`

Sec. (3)

$$W_\Phi = 0.5 * \pi * ((16)^2 - (11)^2) + 0.3 * \pi * 5.83 (16 + 11)$$

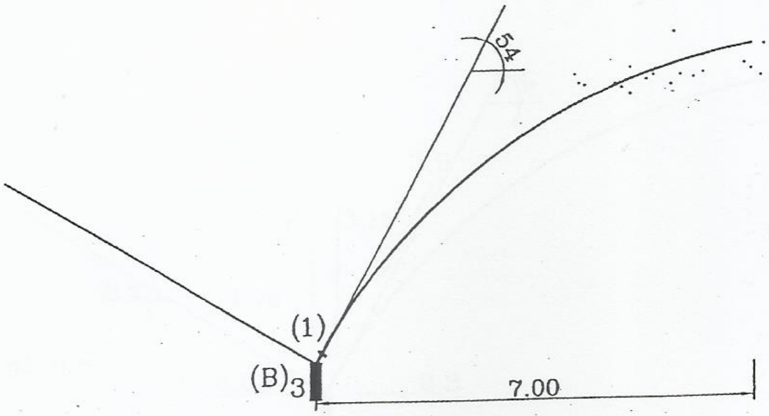
$$= 169.56 \text{ ton}$$

$$T_1 = \frac{W_\Phi}{2 \pi r \sin\Phi}$$

$r = 11$ $\Phi = 31.0°$

$$T_1 = \frac{169.56}{2\pi * 11 * \sin 31} = 4.76 \quad t/m` \qquad \text{comp.}$$

Dome



Sec. (1)

$$W_\Phi = 0.05 * \pi * 7^2 + 0.3 * \pi * 7.8 * 7.0$$

$$+ 0.2 * 2 * \pi * 5 + 0.2 * 0.2 * 0.5 * 2.5 * 14$$

$$+ 0.2 * 0.6 * 2.5 * 2 * \pi * 4 + 0.05 * \pi * (11 - 4)$$

$$+ 0.3 * 2 * \; * 13.6 * 5 = 218.35 \text{ t}$$

$$T_1 = \frac{W_\Phi}{2 \pi r \sin\Phi}$$

$r = 11$ $\Phi = 54$

$$T_1 = \frac{218.35}{2\pi * 11 * \sin 54} = 3.90 \quad t/m` \qquad \text{comp.}$$

$Z = g \cos \Phi + p \cos^2 \Phi$

$= 0.05 \cos 54 + 0.3 \cos 54 = 0.19 \ t/m^2$

$T_1 + T_2 = R \ Z$

$T_2 = 13.6 * 0.19 - 3.9$

$= -1.32 \ t/m$ ten.

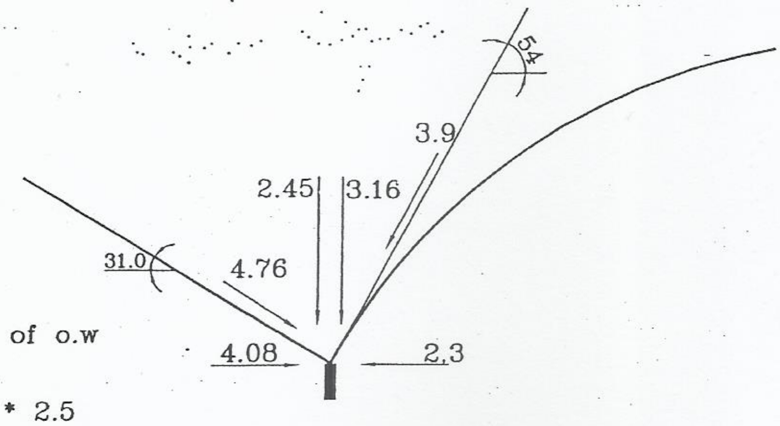
min. R.F.T 5ø8/m

Design of B3

assume no. of column

= 10

assume sec. 35 * 80



w = 3.16 + 2.45 + component of o.w

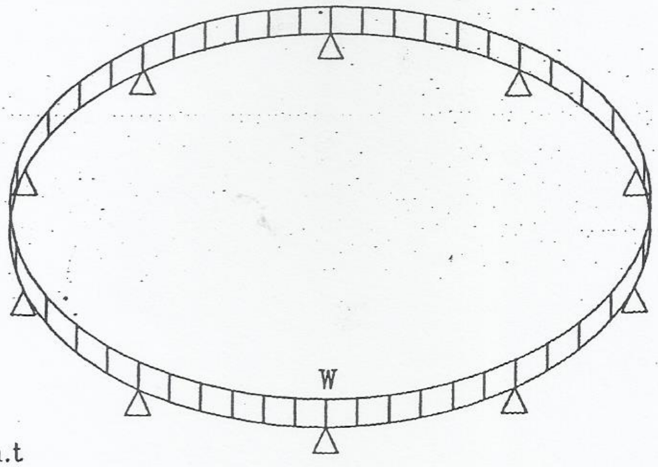
= 3.16 * 2.45 + 0.35 * 0.85 * 2.5

= 6.31 t/m

$P = w * 2 \pi * r$

$= 6.31 * 2 * \pi * 11$

= 436.12 t



Load / col. $= \frac{P}{10} = 43.61$ ton

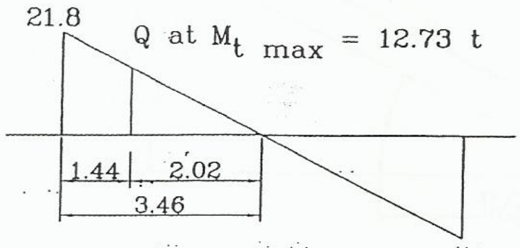
$Q_{max.} = \frac{P}{2*10} = 21.8$ ton

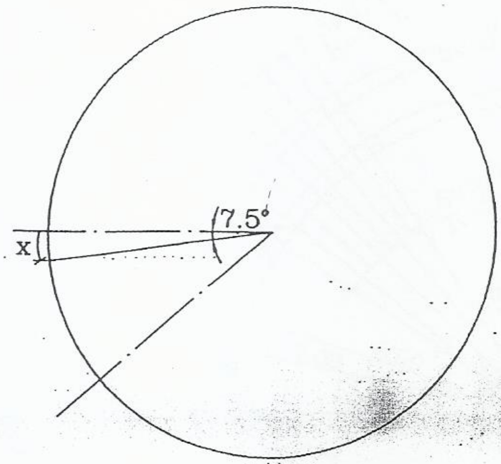
N = (4.08 − 2.3) * 11 = 19.58 t comp.

$M_{+ve} = 0.0032 * 436.12 * 11 = 15.35$ m.t

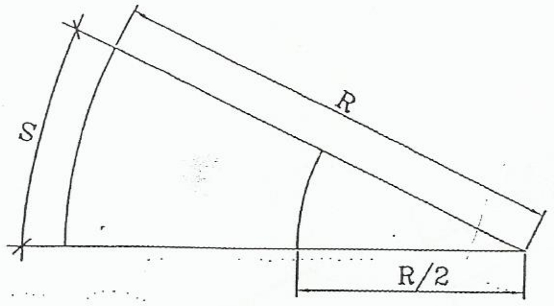
$M_{-ve} = 0.0052 * 436.12 * 11 = 24.95$ m.t

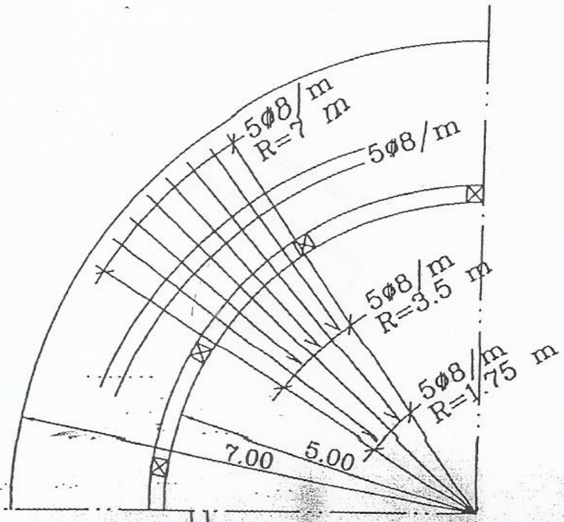
$M_t = 0.0004 * 436.12 * 11 = 1.92$ m.t

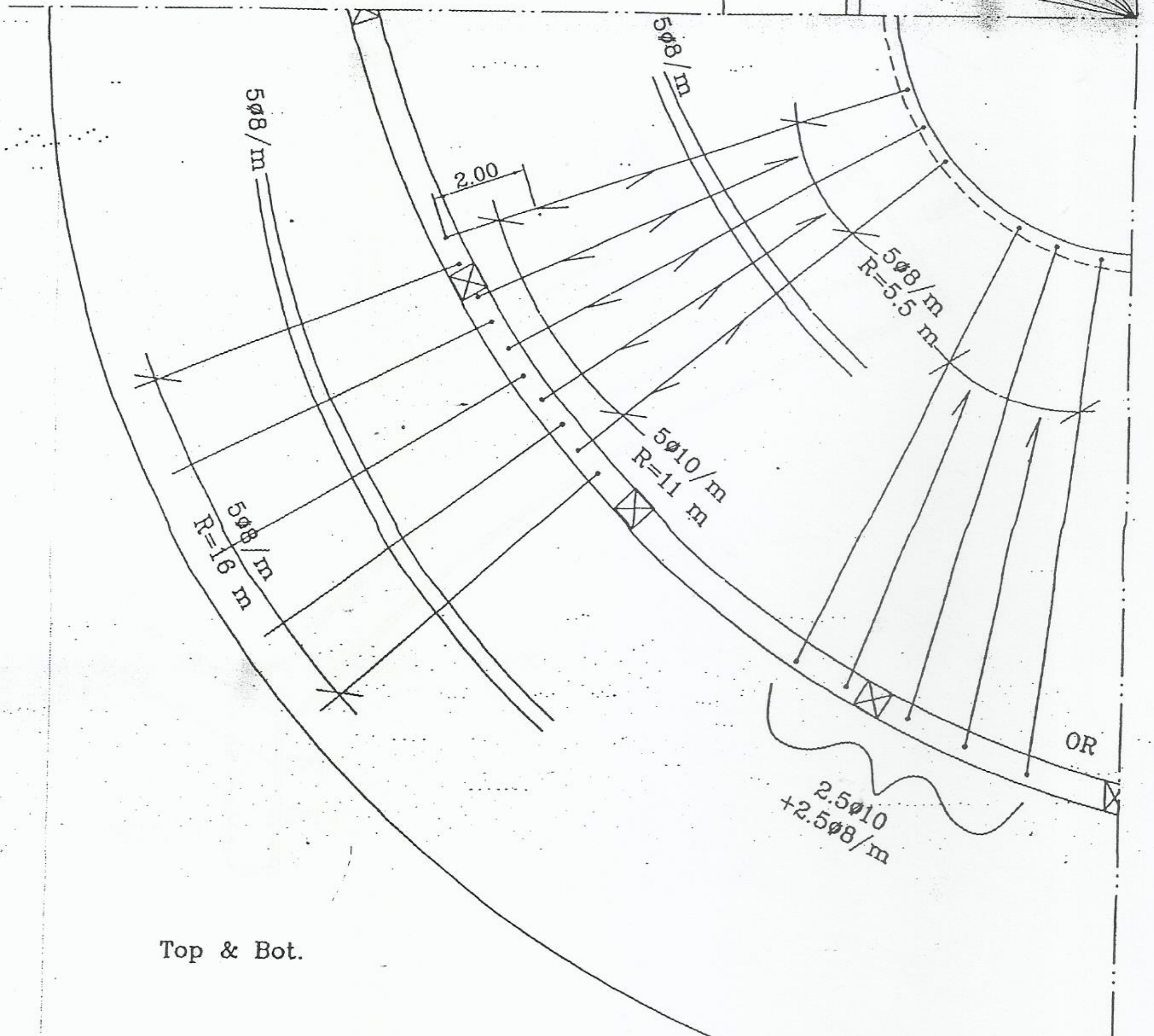

21.8
Q at M$_t$ max = 12.73 t
1.44
2.02
3.46

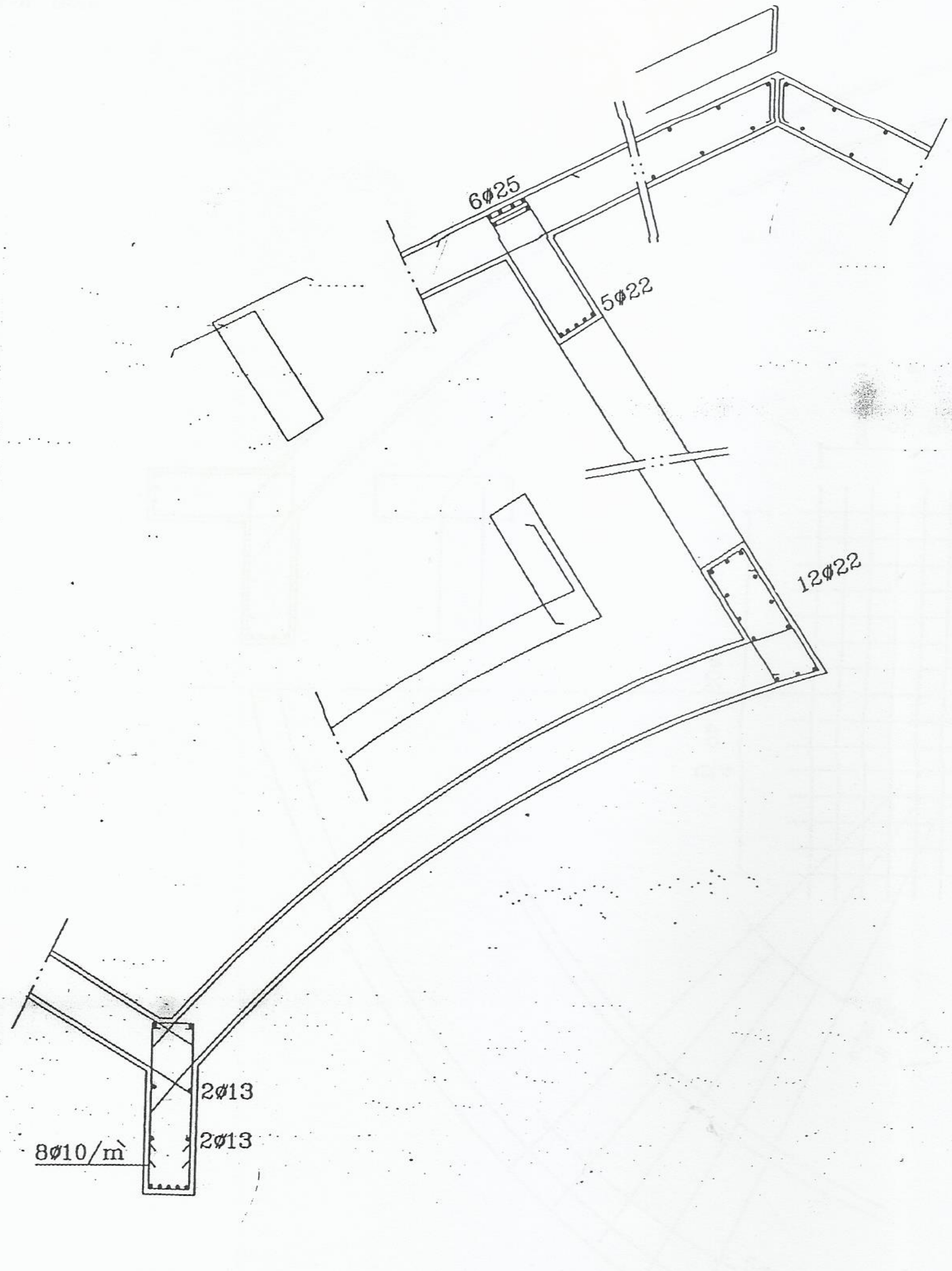

7.5°
x

Details of R.F.T

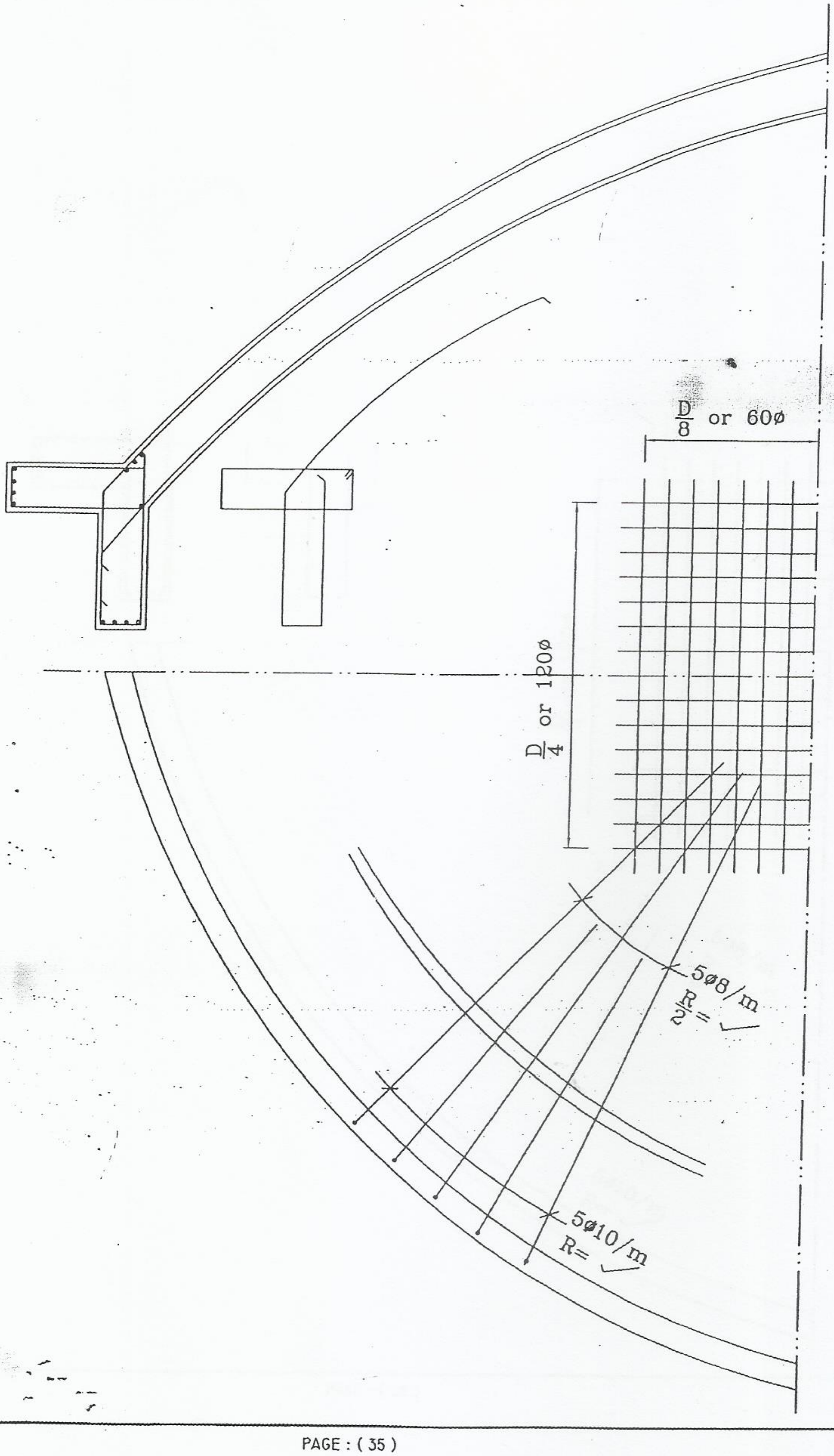




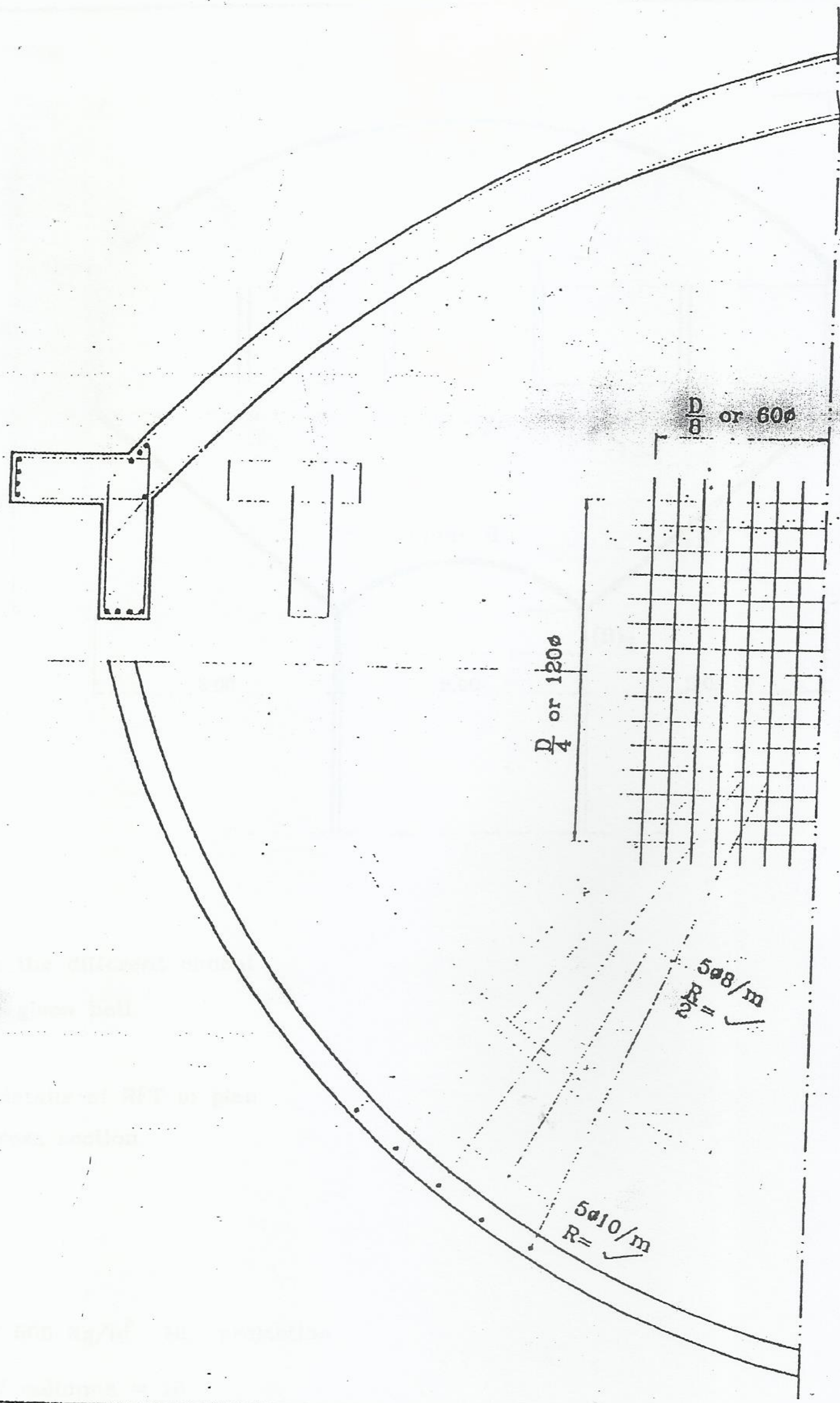



6Ø25
5Ø22
12Ø22
2Ø13
2Ø13
8Ø10/m`

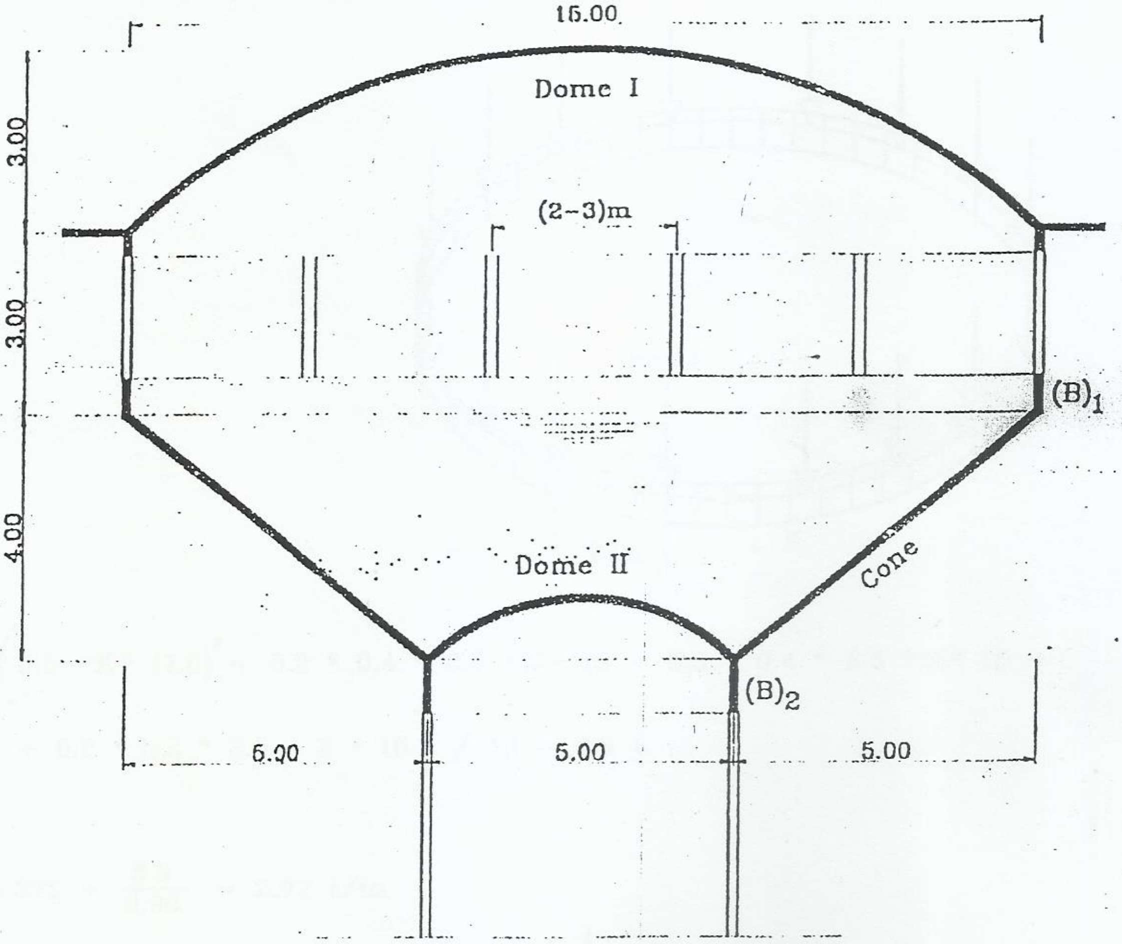
For Dome



For Dome



Example (8)



- Design the different elment of the given hall

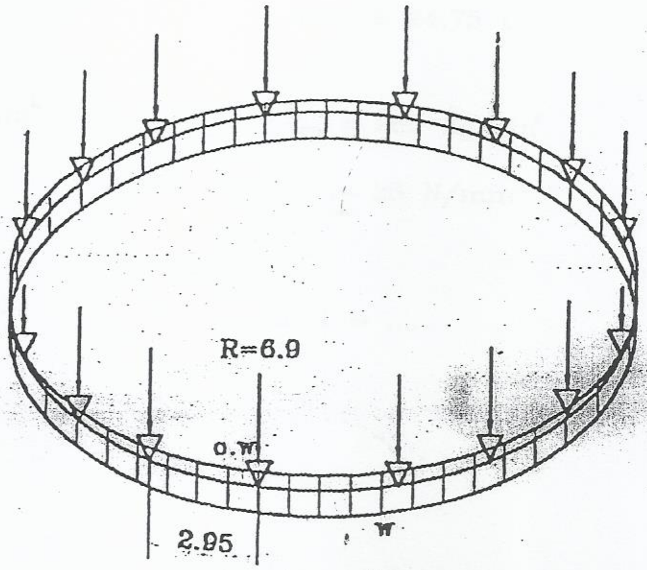
- Draw details of RFT in plan and cross section

assume

T.L = 500 Kg/m^2 HL projection

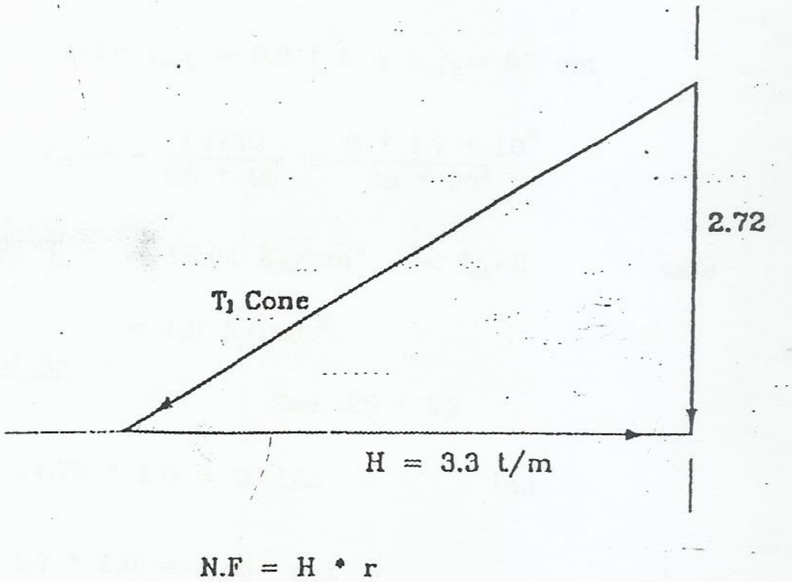
no. of columns = 16

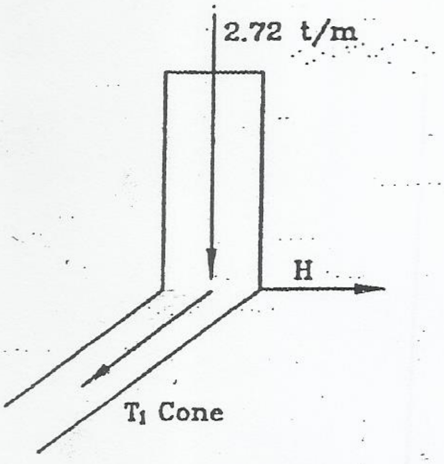
Design of B_1



$$R = \left(0.5 * \pi * (7.5)^2 + 0.2 * 0.4 * 2.5 * \pi * 15 + 0.2 * 0.4 * 2.5 * \pi * 15 + + 0.2 * 0.2 * 2.5 * 2 * 16\right) / 16 = 6.9 \text{ t}$$

$$w = 0.375 + \frac{6.9}{2.95} = 2.72 \text{ t/m}$$





$$N.F = H * r$$

$$= 3.3 * 7.5 = 24.75 \text{ t} \qquad \text{ten.}$$

$$M_1 = \frac{W_{net} (L)^2}{12} = \frac{(2.72 - 0.375) * (2.95)^2}{12} = 1.7 \text{ m.t}$$

Sec. of Beam B_2

$M = 1.7$ m.t

$N = +24.75$ t

$F_{ct\,all} = 17\ Kg/cm^2 = 1.7\ N/mm^2$

$F_{cu} = 250\ Kg/cm^2$

$= 25\ N/mm^2$

$$F_{ct\,all} = \frac{N}{A} + \frac{M}{Z}$$

$$= \frac{N}{b.t} + \frac{6\ M}{b.t^2}$$

$\therefore\ t = ...$

or neglect M

$$F_{ct\,all} = \frac{N}{A} = \frac{N}{b.t}$$

$$17 = \frac{24750}{25 * t_1}$$

$\therefore\ t_1 = 58$ cm

neglect N

$$F_{ct\,all} = \frac{M}{Z} = \frac{6\ M}{b.t^2}$$

$$17 = \frac{6 * 1.7 * 10^5}{25 * (t_2)^2}$$

$\therefore\ t_2 = 50$ cm

take $t_{act} = 0.8\ (\ t_1 + t\ )_2 = 90$ cm

$$F_{ct\,act} = \frac{24750}{25 * 90} + \frac{6 * 1.7 * 10^5}{25 * 90^2}$$

$= 16.04\ Kg/cm^2 \quad < F_{ct}$ all safe

$= 1.6\ N/mm^2$

Cal. of As

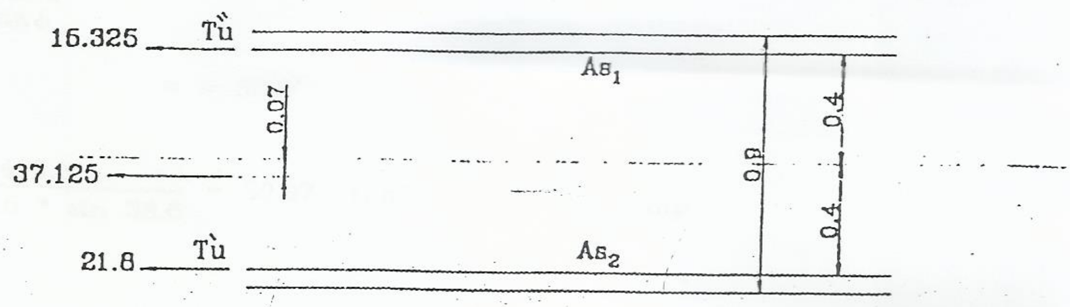
Sec. 25 * 90

$Nu = 24.75 * 1.5 = 37.125$ t ten.

$Mu = 1.7 * 1.5 = 2.55$ m.t

$$e = \frac{M}{N} = \frac{2.55}{37.125} = 0.07 \quad < \quad \frac{t}{2} - \text{cover}$$

Small ecc. Ten.



B = 0.75 H.T.S. (13 , 16)

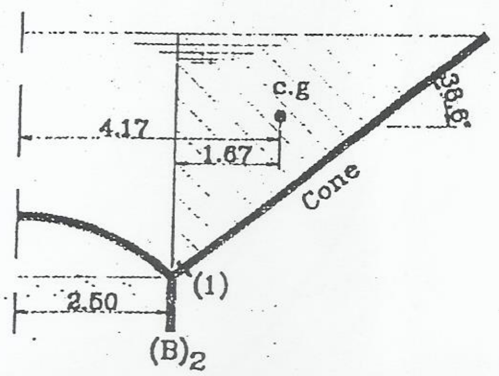
$$As_1 = \frac{T\grave{u}}{Fy/\gamma_s} = \frac{21.8}{0.75(3.6/1.15)} = 9.50 \text{ cm}^2 \qquad = 5\phi16$$

$$As_2 = \frac{T\grave{u}}{Fy/\gamma_s} = \frac{15.325}{0.75(3.6/1.15)} = 6.53 \text{ cm}^2 \qquad = 4\phi16$$

<u>Cone</u>

assume ts = 20 cm

$g = 0.5 \text{ t/m}^2$



<u>Sec. (1)</u>

$W_\phi = 0.5 * \pi * (7.5)^2$ Dome

$+ 0.2 * 0.4 * 2.5 * 2 * \pi * 15$ hL & vL

$+ 0.2 * 0.2 * 2.5 * 2 * 16$ Posts

$+ 0.25 * 0.9 * 2.5 * \pi * 15$ B_2

$+ 0.5 * \pi * 6.4 * (7.5 + 2.5)$ o.w

$+ 1/2 * 4 * 5 * 2 * \pi * 4.77$ Water

= 490.2 ton

$$T_1 = \frac{W_\Phi}{2\pi r \sin\Phi}$$

$r = 2.5$ $\Phi = 38.6°$

$$T_1 = \frac{499.2}{2\pi * 2.5 * \sin 38.6} = 50.97 \quad t/m'$$ comp.

$T_2 = R'_2 \, Z$

$$R_2 = \frac{r}{\sin\Phi} = \frac{2.5}{\sin 38.6} = 4.0 \quad m$$

$$Z = g \cos\Phi + \gamma h$$

$$= 0.5 \cos 38.6 + 1 * 4 = 4.39 \quad t/m^3$$

$T_2 = 4 * 4.39 = 17.6 \quad t/m'$ ten.

** Design of Sec.

Due to $T = 17.6$ t

Sec. $= t * 100$

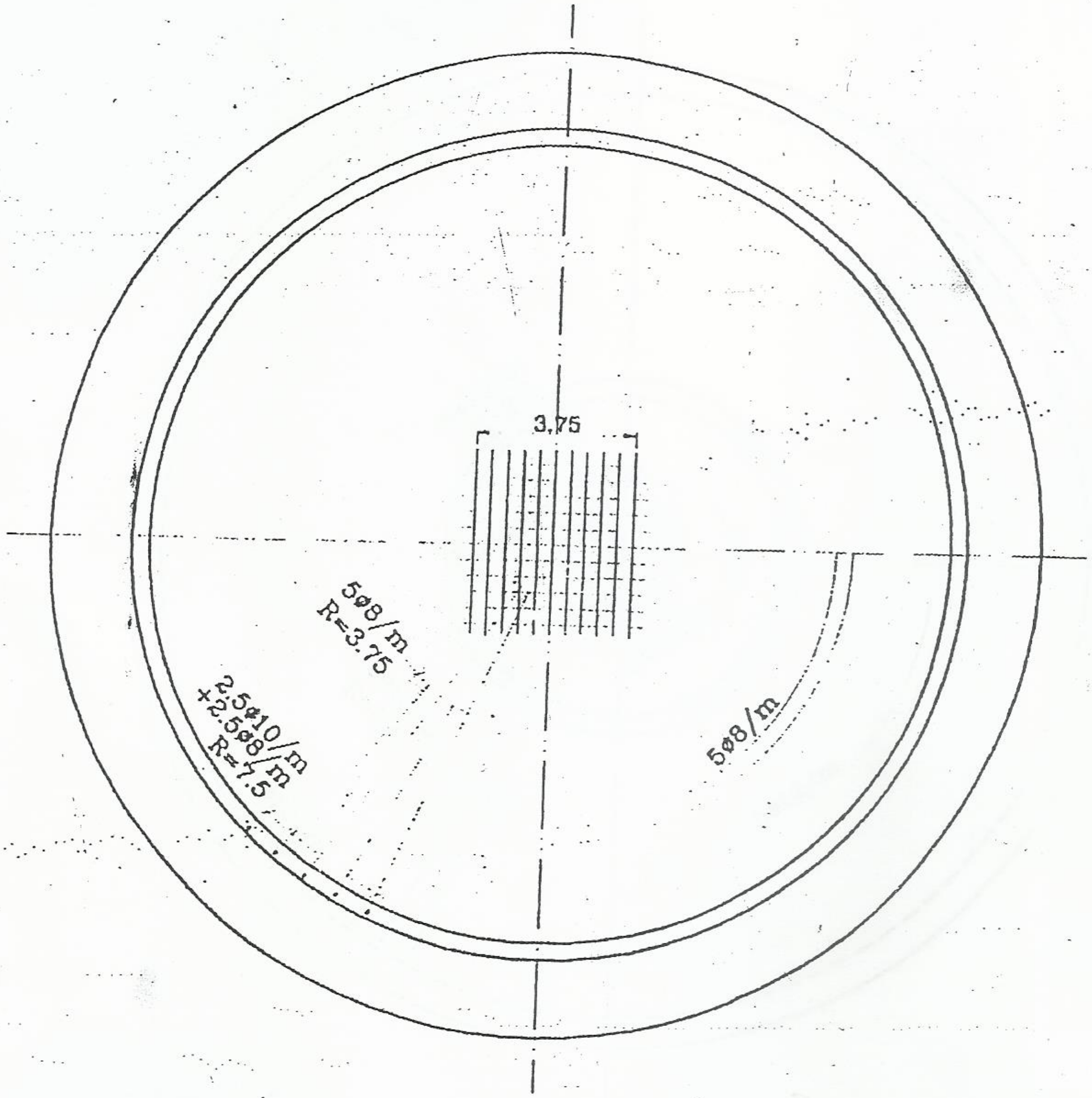
$t = K * T$

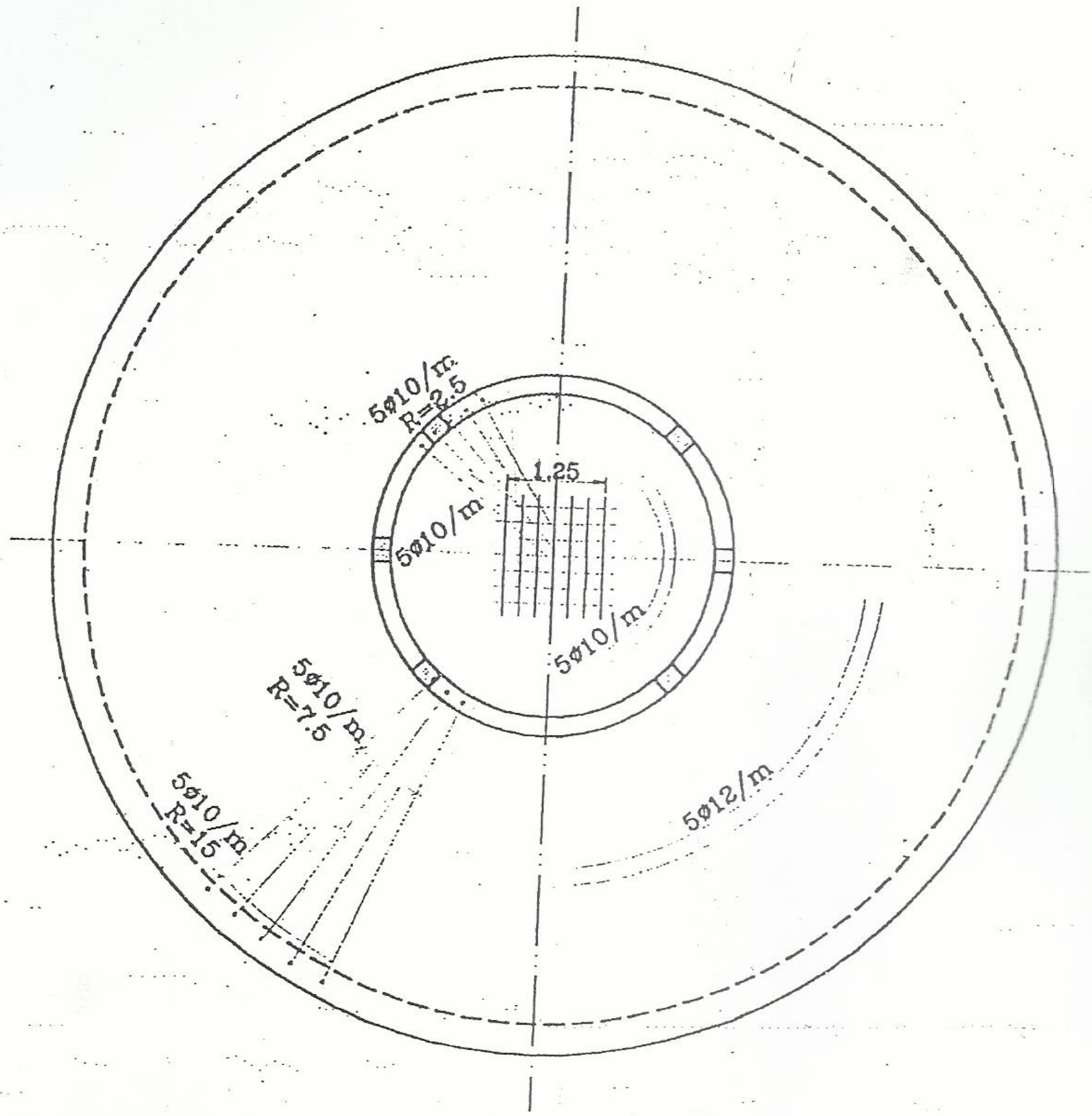
$= 0.59 * 17.6 = 10.384$ cm < 20 cm safe

$$As = \frac{Tu}{B_{cr}(Fy/\gamma_s)} = \frac{17.6 * 1.5}{0.75 * \left(\frac{3.6}{1.15}\right)} = 11.24 \ cm^2$$ 5ø12 each side

Details of R.F.T

Dome (1)




5ø10/m
R=2.5
1.25
5ø10/m
5ø10/m
5ø10/m
R=7.5
5ø10/m
R=15
5ø12/m