

▪ **Lay out and concrete dimension**

$$R = 11.5 \text{ m}$$

$$\text{hole radiuce} = 3 \text{ m}$$

$$t = 150 \text{ cm}$$

▪ **Load**

$$L.L = \text{water}$$

$$D.L = 1.5 * 2.5 = 3.75 \text{ t/m}^2$$

▪ **Straining action**

$$40 \quad 33.3 \text{ m.t}$$

Upper face of shell

| Load type | Case of loading | Radian moment | Tangential moment | Tension force |
|-----------|-----------------|---------------|-------------------|---------------|
| All load | Ultimate | -90 | -33 | +45 |
| All load | Working | -62 | -22 | +30 |

Design section under moment ant tension

Section 1

$$M_w = -62 \text{ m.t}$$

$$b = 100 \text{ cm}$$

$$t = 150 \text{ cm}$$

$$T = 30 \text{ t}$$

Water section

1- Working stage

Check stress

$$F_{Ct-N} = \frac{N_w}{A}$$

$$F_{Ct-N} = \frac{30 * 10 * 10^3}{1000 * 1500} = .2 \text{ Mpa}$$

$$F_{Ct-M} = \frac{6 * M_w}{b * t^2}$$

$$F_{Ct-M} = \frac{62 * 6 * 10 * 10^6}{1000 * 1500^2} = 1.653 \text{ Mpa}$$

$$F_{Ct-total} = F_{Ct-N} + F_{Ct-M}$$

$$F_{Ct-total} = 1.653 + .2 = 1.853 \text{ Mpa}$$

$$t_v = t * \left[1 + \frac{F_{Ct-N}}{F_{Ct-M}} \right]$$

$$t_v = 1500 * \left[1 + \frac{.2}{1.65} \right] = 1681.81 \text{ mm} > 600 \text{ mm} \rightarrow \eta = 1.7$$

$$F_{ctr} = .6 * \sqrt{F_{cu}}$$

$$F_{ctr} = .6 * \sqrt{30} = 3.286 \text{ Mpa}$$

$$\frac{3.286}{1.7} = 1.933 > F_{Ct-total} \quad \text{section is safe}$$

Ultimate stage

Concrete cover

From table 4-13 $d_c = 25 \text{ mm}$

$$e = \frac{M_u}{N_u}$$

$$e = \frac{90 * 10^5}{45 * 10^3} = 200 \text{ cm} > t/2 \quad \text{bigg ecc}$$

$$e_s = e + cover - \frac{t}{2}$$

$$e_s = 200 - \frac{150}{2} + 2.5 = 127.5 \text{ cm}$$

$$M_{us} = e_s * N_u$$

$$M_{us} = 45 * \frac{127.5}{100} = 57.37 \text{ t.m}$$

$$d = c_1 * \sqrt{\frac{M_{us}}{f_{cu} * b}}$$

$$150 - 2.5 = c_1 * \sqrt{\frac{57.37 * 10^5}{300 * 100}} \quad c_1 = 9.2 \quad \therefore j = .826$$

$$A_s = \frac{M_{us}}{f_y * j * d * \beta_{crack}} + \frac{N_u}{\frac{f_y}{\gamma_s} * \beta_{crack}}$$

assume used $\emptyset 18$ $\beta_{crack} = .75$

$$A_s = \frac{57.37 * 10^5}{3600 * .826 * 147.5 * .75} + \frac{45 * 10^3}{\frac{3600}{1.15} * .75} = 36.606 \text{ cm}^2 \quad \text{used } 15\emptyset 18$$

Tangential moment

$$M_w = -22 \text{ m.t}$$

$$b = 100 \text{ cm}$$

$$t = 150 \text{ cm}$$

Water section

Working stage

Safe

Ultimate stage

Concrete cover

From table 4-13 $d' = 25 \text{ mm}$

$$M_u = 33 \text{ m.t}$$

$$d = c_1 \sqrt{\frac{M_u}{F_{cu} * b}}$$

$$150 - 2.5 = c_1 * \sqrt{\frac{33 * 10^5}{300 * 100}} \quad \therefore c_1 = 12.17 \quad \rightarrow J = 0.826$$

$$\beta_{crack} = .75 \quad \text{form coad table 4 - 15}$$

$$A_s = \frac{M_u}{F_y * J * d * \beta_{crack}}$$

$$A_s = \frac{33 * 10^5}{3600 * .826 * 147.5 * .75} \quad A_s = 10.03 \text{ cm}^2 \ll A_{s-min} = 22.13$$

used 9Ø18 /m

Lower steel

9Ø18 in tow direction