DR. B. C. ROY ENGINEERING COLLEGE, DURGAPUR

Laboratory : STRUCTURAL ENGINEERING DESIGN PRACTICE

SUBJECT CODE : CE 891

Title : STRUCTURAL ENGINEERING DESIGN PRACTICE

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Department : CIVIL ENGINEERING (CE-1-Y) ROLL NO 12001315128

Semester : 8th

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REPORT

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Signature

Date of Experiment

RECTANGULAR WATER TANK
(RESTING ON FIRM GROUND)

Design a rectangular water tank of size 5m × 4m × 3m deep resting on firm ground. use M25 concrete and mild steel.

size of the tank = 5m × 4m × 3m

Grade of concrete M25

$$\sigma_{cbc} = 8.5 \text{ N/mm}^2$$

$$m = \frac{280}{3 \times 8.5} = 11$$

$$\sigma_{st} = 11.5 \text{ N/mm}^2$$

Design constants are.

$$n = \frac{m\sigma_{cbc}}{m\sigma_{cbc} + \sigma_{st}}$$

$$= \frac{11 \times 8.5}{11 \times 8.5 + 11.5} = 0.448$$

$$J = 1 - n/3 = 1 - \frac{0.448}{3} = 0.850$$

$$K = 1/2\, \sigma_{cbc} \times j \times n$$

$$= \frac{1}{2} \times 8.5 \times 0.850$$

$$= 1.619$$

In this problem,

$$L/H = 5/4 = 1.25 < 2$$

Horizontal frame action:-

The critical section is at a height $h = \frac{H}{4}$ at 1m wherever more, Hence in this time = 1m.

$$P_x = \gamma(H-1) = 9.81(3-1) = 19.6 \ kN/m^2$$

∴ Fixed end moments are :-

$$= \frac{P_x l^2}{12} = \frac{19.6 \times 5^2}{12}$$

$= 40.83$ KN-m is long wall

$$= \frac{P_x B^2}{12} = \frac{19.6 \times 4^2}{12} = 26.133 \ KN\text{-}m$$ in short wall

Since thickness of short and long walls are maintained same, distribution factors are shown.

Member	Stiffness	Total stiffness	Distribution
Short wall	$\frac{4EI}{4} = EI$	1.8EI	0.556
Long wall	$\frac{4EI}{5} = 0.8EI$		0.444

Due to symmetry are balancing wall take care of moment distribution as shown in table below.

Short wall			Long wall
	0.556	0.444	
	−26.133	40.883	
	−8.20	−6.55	
	−34.33	34.333	

Correct moment = 34.333 KNm section outside effective thickness required for balance section

$$d = \sqrt{\frac{M}{K\,b}} = \sqrt{\frac{34.33 \times 10^6}{1.1619 \times 1000}} = 146 \text{ mm}$$

section is to be sufficiently under reinforced. Hence let us keep overall thickness of 200mm. with effective cover of 35mm.

$$d = 200 - 35 = 165 \text{ mm}$$

Direct pull on long and short wall are given by

$$T_L = P_x \times \frac{B}{2} = 19.6 \times \frac{4}{2} = 39.2 \text{ KN}$$

$$T_B = P_x \times \frac{L}{2} = 19.6 \times \frac{5}{2} = 49 \text{ KN}$$

and, Eccentricity of reinforcement from centre of wall.

$$x = \frac{200}{2} - 35 = 65 \text{ mm}$$

Design moment at corner $= M - Tx = 34.33 - 39.2 \times 0.065$

$= 31.785$ KN-m

Hence at corner, horizontal reinforcement required for bending resistance.

$$A_{st} = \frac{M'}{\sigma_{st} J d} = \frac{31.785 \times 10^6}{11.5 \times 0.850 \times 165}$$

$= 1970 \text{ mm}^2$

using 20mm Bars direct tension.

$$A_{st} = \frac{T_1}{\sigma_{st}} = \frac{39.28 \times 1000}{115} = 341 \text{ mm}^2$$

Total $A_{st} = 2311 \text{ mm}^2$

Using 20mm bars, spacing required as

$$S = \frac{\pi/4 \times 20^2}{2311} \times 1000$$

$= 136$ mm

Provide 20mm bars at 130mm c/c. It is to be provided on water face.

Reinforcement at middle of long walls.

Bending moment $= \dfrac{P_x\, l^2}{8}$ − Moment at corner

$$= \frac{19.6 \times 5^2}{8} - 34.33$$

$$= 26.917 \text{ KN-m}$$

Design moment $= M - T_L$

$$= 26.917 - 39.2 \times 0.065$$

$$= 24.369 \text{ KN-m}$$

$$Ast_1 = \frac{24.369 \times 10^6}{11.5 \times 0.850 \times 16.5}$$

$$= 1511 \text{ mm}^2$$

$$Ast_2 = \frac{39.2 \times 1000}{11.5} = 341 \text{ mm}^2$$

$$Ast = Ast_1 + Ast_2$$

$$= 1852 \text{ mm}^2$$

using 20mm bars, spacing

$$S = \pi/4 \times \frac{20^2}{1852} \times 1000$$

$$= 169 \text{ mm.}$$

Hence, also bars may be provided at 130 mm c/c, so that bars may be bent and used.

Reinforcement for short wall

$M = 34.333 - T$

$= 34.33 - 49 \times 0.065$

$= 31.198$ KN-m

$Ast_1 = \frac{31.198 \times 10^2}{11.5 \times 0.850 \times 165}$

$= 1931\ mm^2$

$Ast_2 = \frac{49 \times 1000}{15} = 926\ mm^2$

$Ast = Ast_1 + Ast_2 = 2357\ mm^2$

using 20mm bars at 130mm c/c

Bending moment at centre of wall

$= \gamma (H - h) \frac{4^2}{8}$ - moment at ends

$= 9.8 (3 - 1) \times \frac{4^2}{8} - 34.333 = 4.867$ KNm

Reinforcement in vertical direction.

Cantiliver moment $= \gamma H \frac{h^2}{6} = 9.8 \times 3 \times \frac{1^2}{6}$

$= 4.9$ KN-m.

$Ast = \frac{M}{\sigma_{st}\ j d} = \frac{49 \times 10^2}{11.5 \times 0.85 \times 165} = 304\ mm^2$

minimum reinforcement $= \frac{0.3}{100} \times 200 \times 1000$

$= 600\ mm^2$

Provide 304 mm^2 area on each face so that

using 10mm bars = $\frac{\pi/4 \times 10^2}{304} \times 1000$

= 258 mm

Provide 10 mm bars at 250 mm c/c on both face,

Base slab :- Provided Base slab of thickness 150mm with 8mm bars at 220 mm c/c in both direction at top and ~~bottom~~ section of slab. A lean concrete bed of 100 mm may be provided on which bottom slabs.