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CMRIT

Internal Assessment Test III – DEC. 2020

Sub:	DESIGN OF RC STRUCTURAL ELEMENTS				Sub code:	17CV51	Branch:	CIVIL
Date:	10/12/2020	Duration:	90 min's	Max marks: 50	Sem / sec:	5TH SEM / A & B	OBE
Note	**Use of is 456:2000 is permitted** **Assume any missing data suitably**						

	Answer all the three full questions	MARKS	CO	RBT
1 (a)	Design the longitudinal reinforcement for the beam of clear span 6m to support a design working live load of 12kN/m. Adopt M25 grade concrete and Fe 415 HYSD bars. Also Show the detailing of reinforcements.	[15]	CO 3	L3
2 (a)	Design a RC slab simply supported of 7m X 3m. Live load acting is 2kN/m^2 and the floor finish is 0.6 kN/m^2. Use M20 grade concrete and Fe 415 grade steel.	[15]	CO 4	L3
3 (a)	Deign a slab for a room of size 4m by 6m with discontinuous on all four sides and simply supported edges all the sides with corners prevented from lifting and supporting a service load of 4kN/m2.Adopt M-20 grade and Fe-415 HYSD bars	[20]	CO 4	L3

① A Reinforced Concrete Beam 400mm x 700mm is Simply Supported over a clear span of 8m. It carries a UDL of 48KN/m including the self weight. The Section is Reinforced with 6bars of 20mm ϕ take effective Cover of 40mm & use M20 Concrete & Mild Steel Calculate the shear reinforcement required if
(a) only Vertical Stirrups are used
(b) Two bars are bent up @ 45 near each support

Given data:

b = 400mm

d = 700mm

L = 8mm

ϕ = 20mm

$A_{st} = 6 \times \frac{\pi}{4} \times 20^2 =$ ~~2513.27 mm²~~ 1884.95 mm²

→ factored shear force

= UDL × 1.5

= 48 × 1.5

= 72 KN/m = 72×10^3 N/m

factored shear force = $\frac{Wul}{2} = \frac{72 \times 10^3 \times 8}{2}$

= 288000 N

→ Nominal shear force τ_v

$\tau_v = \frac{V_u}{bd} = \frac{45000}{400 \times 700}$

$\tau_v = 0.16$

Ⓡ <u>Calculation</u> for <u>area</u> of steel:-

$$Mu = 0.87 \times fy \times Ast \times d \left(1 - \frac{Ast \times fy}{b \times d \times fck}\right)$$

$$109.89 \times 10^6 = 0.87 \times 415 \times Ast \times 450 \left(1 - \frac{Ast \times 415}{250 \times 450 \times 25}\right)$$

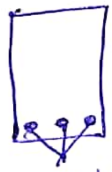
$$Ast = 762.05\ mm^2$$

The bar will be in the dia of 18, 20, 22mm²

$$\text{No of bars} = \frac{Ast}{\frac{\pi d^2}{4}} = \frac{762.05}{\frac{\pi}{4}(20)^2} = 3\ nos$$

Provide 3nos of 20mm dia bars.

$$\text{actual } Ast = \frac{3}{4} \times \pi d^2 = \frac{3}{4} \times \pi (20)^2 = 942.47\ mm^2$$



$$T_v = \frac{Vu}{bd} = \frac{70.61}{250 \times 450} = 0.63\ N/mm^2$$

$$T_c = \frac{100 Ast}{b \cdot d} = \frac{100(942.47)}{250 \times 450},\ T_c = 0.837\ N/mm^2$$

0.75 → 0.57
0.83 → ?
1 → 0.64

$$\frac{0.57 \times 0.64}{0.57 \times x} = \frac{0.75 \times 1}{0.75 \times 0.33}$$

$$x = 0.53 = T_c$$

for stirrups provide 2-legged 8mm Ø bars.

$$A_{sv} = 2 \times \frac{\pi}{4} \times d^2 = 2 \times \frac{\pi}{4} \times 8^2 = 100.53\ mm^2$$

$$Vu = (Vu - T_c bd) = \frac{0.87 \times fy \times Asv \times d}{Sv}$$

$$Sv = \frac{0.87 \times 415 \times 100.53 \times 450}{70.61 - 0.53(250 \times 450)}$$

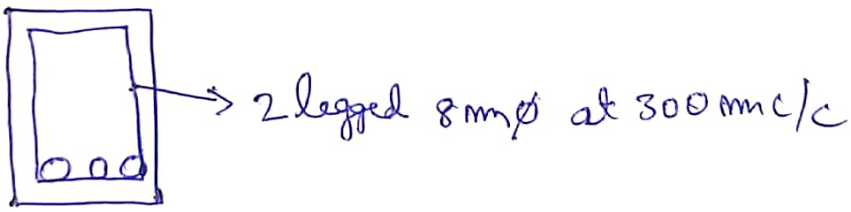
$S_v = 1486.88$ mm.

$S_v = 0.75 \times d$

$= 0.75 \times 450.$

$S_v = 337.5$ mm

hence provide 2-legged 8mm ϕ bars at 300 mm c/c.



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(2)

(*) **Check for oneway or twoway slab:-**

$$\frac{l_y}{l_x} = \frac{7}{3} = 2.33 > 2 \qquad \therefore \text{ one way slab.}$$

(*) **Effective depth :-**

$$20 = \frac{L}{d} \quad , \quad d = \frac{3000}{20} = 150\,mm.$$

Assuming overall as = 145 mm

∴ Assume effective cover as 25 mm.

$$d = 145 - 25 = 120\,mm.$$

(*) **Design load (W_u):**

b = 1m = 1000 mm.

D.L = 0.145 × 1 × 25 = 3.625 KN/m

LL = 1×2 = 2 KN/m.

F.F = 1×0.6 = 0.6 KN/m

Total load = 6.225 KN/m.

W_u = 6.225 × 1.5 = 9.33 KN/m.

(*) **Effective Span:**

$$c/c \text{ distance} = \frac{0.23}{2} + 3 + \frac{0.23}{2} = 3.23\,m.$$

Clear span + Eff depth = 3 + 0.12 = 3.12 m.

take least = l = 3.12 m

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⊛ moments & shear :-

factored moment = $\frac{W_u l^2}{8} = \frac{9.33 \times 3.12^2}{8}$ = 11.35 KN/m

Shear force = $V_u = \frac{W_u l}{2} = \frac{9.33 \times 3.12}{2}$ = 14.55 KN/m.

⊛ Check for depth :-

$d_{req} = \sqrt{\frac{M_u}{R_u \times b}}$ ∴ $R_u = 2.75$

$= \sqrt{\frac{11.35}{2.75 \times 1000}}$

d_{req} = 64.24m < assuming under reinforced.

∴ hence OK.

⊛ Area of tension steel :-

$M_u = 0.87 f_y \cdot A_{st} \left(1 - \frac{A_{st} \cdot f_y}{f_{ck} \cdot b \cdot d}\right)$

$11.35 \times 10^6 = 0.87 \times 415 \times A_{st} \left[1 - \frac{A_{st} \times 415}{20 \times 1000 \times 120}\right]$

$11.35 \times 10^6 = 43326 A_{st} - 7.491 A_{st}^2$, $A_{st} = 275.04 \ mm^2$

⊛ Spacing at # 10mm = $\frac{\frac{\pi}{4} \times 10^2}{A_{st}} \times b = \frac{\frac{\pi}{4} \times 10^2}{275.04} \times 1000$ = 285.55mm

∴ provide 10ϕ @ 285.55mm c/c.

⊛ Area of distribution bars :-

Area = 0.15% BD = $\frac{0.15}{100} \times 1000 \times 145$ = 217.5 mm²

Spacing at 8mm ϕ = $\frac{\pi/4 \times 8^2}{217.5} \times 1000$ = 231.1mm

∴ provide 8ϕ @ 231.1mm c/c.

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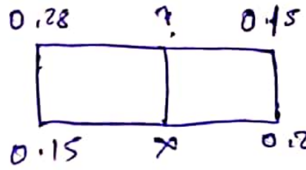
* Check for shear :-

$$\tau_v = \frac{V_u}{bd} = \frac{14.55 \times 10^3}{1000 \times 120} = 0.121 \ KN/mm^2$$

$$P_t = 100 \cdot \frac{Ast}{b \cdot d} = \frac{100 \times 275.04}{1000 \times 120} = 0.22.$$



$\therefore \tau_c = 0.336$. from table 19. SP.16

$$\frac{0.25 - 0.15}{0.36 - 0.28} = \frac{0.25 - 0.22}{0.36 - x}$$

$0.036 - 0.1x = 0.0026$

$x = 0.336.$

$\therefore$ The shear design is OK.

(3)

Sol :- Given $LL = 4 \ KN/m^2$

$F_{ck} = 20 \ N/mm^2$, $f_y = 415 \ N/mm^2$, assuming $FF = 1 \cdot KN/m$.

(1) $\frac{l_y}{l_x} = \frac{6}{4} = 1.5 < 2$ $\therefore$ Two way slab.

(2) Assumption of $D = 160 + 15 + \frac{10}{2} = 150mm.$

Eff depth along long span

$d_y = d_x - \phi = 160 - 10 = 150mm.$

Effective span l_x = least of following $\therefore$ assuming bearing = 230mm

(i) l_x = clear span + bearing $= 4 + 0.23 = 4.23m$

(ii) l_x = clear span + Eff depth $= 4 + 0.200 = 4.2mm.$

$l_e = 4.2mm$ = x-direction

$l_e = 6.2mm$ = y - direction.

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$20.01 \times 10^6 = 5776\, Ast - 7.481 \times Ast^2 = Ast = 363.52\ mm^2$.

Spacing at 8 mm $\phi = \frac{\pi/4 \times 8^2}{363.52} \times 1000 = 138.27$ mm.

∴ Provide # 8 mm ϕ for 138 mm c/c

Check for Ast, $Ast_{min} = \frac{0.12}{100} \times bd = 192$ mm.

∴ provide 8mm is at 138mm c/c

(*) Y-direction :- width of middle strip = 3/4 . l_x = 3.15 mm

$M_{uy} = 0.87 \times f_y \times Ast \times d_x \left(1 - \frac{Ast\, f_y}{f_{ck}\, bd}\right)$

$12.59 \times 10^6 = 57768\, Ast - 7.491\, Ast^2$.

$Ast = 224.47\ mm^2$

Spacing @ 8mm $\phi = \frac{1000 \times 50.3}{138} = 364.49$ mm

(*) Check for Spacing shear :

$\tau_v = \frac{V_u}{b \cdot d} = \frac{26.77 \times 10^3}{1000 \times 180} = 0.167\ N/mm^2$.

$P_t = \frac{100 Ast}{b \cdot d} = 0.22$ ∴ $\tau_c = 0.33\ N/mm^2$.

from clause 40.2.1.1, $\tau_c = 0.33 \times K_t$, $K_t = 1.24$.

∴ $\tau_c' = 0.33 \times 1.24 = \tau_c = 0.41\ N/mm^2$

(*) Torsional reinforcement at corner :-

mesh size = $\frac{l_x}{5} = \frac{4.2}{5} = 0.84 = 840$ mm.

Area of torsional reinforcement = $\frac{3}{4} \times 364 = 273\ mm^2$.

using 8mm ϕ bars = $\frac{\pi}{4} \times 8^2 = 50.3\ mm^2$

Spacing = $1000 \times \frac{50.3}{273} = 184.24$ mm

∴ Provide 8mm mesh @ 184 mm c/c.

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