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(1SJ19CV011) (1SJ19CV016)

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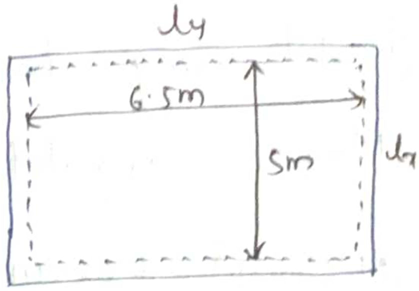
DEPARTMENT OF CIVIL ENGINEERING
Think pair share problem solving

Subject Code: 18CV53

Subject: Design of RC Structural Elements
Date:-6/01/2022
Sem & Section: 5th A

NOTE: *1. Answer All Questions from the following.*
2. Use of IS 456-2000 permitted.
3. Missing Data if any, may be assumed suitably

1. Design a RC slab for a hall measuring 6.5 m x 5 m. The slab is cast monolithically over the beams with corners held down. The bearing is 250 mm. The slab caries superimposed load of 3 kN/m². Use M20 concrete and Fe 415 steel. Sketch the details of steel.



Solution

(a) $\frac{ly}{lx} = \frac{6.5}{5} = 1.3m < 2$

Assume $D = 120mm$, $f' = 20mm$, $d = 100mm$
$b = 1000mm$

(b) Effective span (le)

(1) le span along shorter distance.

(i) le_x = clear span + $\frac{wall}{2}$ + $\frac{wall}{2}$
$= 5 + 0.25/2 + 0.25/2 = 5.25m$

(ii) le_x = clear span + d = 5 + 0.1 = 5.1m

(2) le - span along longer distance.

(i) ley = Clear span + wall/2 + wall/2
$= 6.5 + 0.25/2 + 0.25/2 = 6.75m$

(ii) ley = clear span + d = 6.5 + 0.1
= 6.6m

(c) load calculation.

(i) DL of slab = 0.12 × 1 × 25 = 3kN/m

(ii) LL on slab = 3kN/m²

(iii) ff on slab = 1kN/m

Total load (W) = DL + LL + fL
3 + 3 + 1 = 7kN/m

$Wu = 1.5W = 1.5 \times 7$
$10.5 kN/m$

$\frac{ley}{lex} = \frac{6.6}{5.1} = 1.29 \approx 1.3$

$Mux = \alpha_x \, Wu \, lex^2$
$= 0.079 \times 10.5 \times (5.1)^2$

$Mux = 21.57 kN\text{-}m$

$Muy = \alpha_y \, Wu \, lex^2$
$= 0.056 \times 10.5 \times (5.1)^2$

$Muy = 15.29 kN\text{-}m$

(d) check for depth.

$$M_{ux} = 0.36 \frac{x_{u,max}}{d}\left(1-0.42\frac{x_{u,max}}{d}\right) b d_{req}^2 f_{ck}$$

$$21.57\times10^6 = 0.36\times0.48\,(1-0.42\times0.48)\,1000\times d_{req}^2\times20$$

$d_{req}\,(88.42) < d_{prov}\,(100)$

(safe)

(e) Area of steel.

(i) Ast along shorter distance

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

$$21.57\times10^6 = 0.87\times415\times A_{st}\times100\left(1-\frac{A_{st}\times415}{1000\times100\times20}\right)$$

$A_{st} = 698.73\,mm^2$

spacing main Reinforced (Use 10ϕ) $= \dfrac{\frac{\pi\times10^2}{4}}{698.73}\times1000$

$= 112.40\,m \simeq 110\,m$

Provide Main Reinforced #10mm at 110 mm c/c along shorter distance

(ii) Ast along longer distance.

$$M_{uy} = 0.87 f_y \times A_{st}\, d\left(1-\frac{A_{st} f_y}{b d f_{ck}}\right)$$

$$15.29\times10^6 = 0.87\times415\times A_{st}\times100\left(1-\frac{A_{st}\times415}{1000\times100\times20}\right)$$

$A_{st} = 469.16\,mm^2$

provide Main Reinforced

Spacing main Reinforced (Use 8ϕ) $= \dfrac{\frac{\pi\times8^2}{4}}{469.16}\times1000$

$107.08 \simeq 100\,m$

provide main Reinforced #8mm at 100mm c/c along longer distance.

$$V_{ux} = \frac{w_u l_{ex}^2}{8} = \frac{10.5\times(5.1)}{8} = 34.13\,kN$$

(i) Normal shear stress $(\tau_v) = \frac{V_u}{bd} = \frac{34.13\times10^3}{100\times1000} = 0.34\,N/mm^2$

(ii) Permissible shear stress (τ_c) $0.65\,N/mm^2$ $\quad \frac{100\,A_{st}}{bd} = \frac{100\times144}{100\times1000} = 0.144$

$\tau_v < \tau_c$ safe

Distribution Reinforced = 0.12% of c/c Area of slab

$= \frac{0.12}{100}\times1000\times120$

$A_{st\,Dis} = 144\,mm^2$

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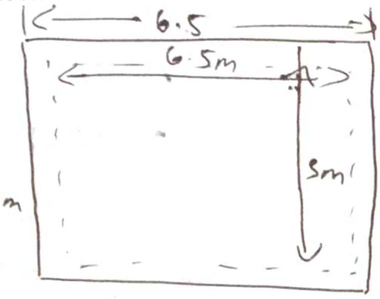


a) $\frac{l_y}{l_x} = \frac{6.5}{5} = 1.3 < 2$ (2 way slab)

Assume $D = 120$ mm, $\phi' = 20$mm, $d = 100$, $b = 1000$mm

b) Effective span

(i) $l_{ex} = c/s + \frac{W}{2} + \frac{W}{2}$

$= 5 + \frac{0.25}{2} + \frac{0.25}{2} = 5.25$

$l_{ex} = cs + d = 5 + 0.1 = 5.1$

$\boxed{l_{ex} = 5.1}$

(ii) $l_{ey} = cs + \frac{W}{2} + \frac{W}{2}$

$= 6.5 + \frac{0.25}{2} + \frac{0.25}{2} = 6.75$

$l_{ey} = 6.5 + 0.1 = 6.6$

$\boxed{l_{ey} = 6.6}$

c) Load calculations

DL on ~~beam~~ slab $= 1 \times 0.12 \times 25 = 3$ KN/m

LL on slab $= 3 \times 1 = 3$ KN/m

FF on slab $= 1 \times 1 = 1$ KN/m

7 KN/m

$\frac{l_{ey}}{l_{ex}} = \frac{6.6}{5.1} = 1.29$

$W_u = 1.5 \times W$

$= 1.5 \times 7$

$\boxed{W_u = 10.5}$

$\alpha_{x} = 0.0783$

$M_{ux} = \alpha_x W_u l_x^2$

$= 0.0783 \times 10.5 \times (5.1)^2$

$\boxed{M_{ux} = 21.38 \text{ KN m}}$

$\alpha_y = 0.056$

$M_{uy} = \alpha_y W_u l_x^2$

$= 0.056 \times 10.5 \times (5.1)^2$

$M_{uy} = 15.29\ KNm$

d) Check for depth

$M_{u\,lim} = 0.138 f_{ck}\, b d_{req}^2$

$21.38 \times 10^6 = 0.138 \times 20 \times 1000 \times d_{req}^2$

$d_{req} = 88.01 < 100$ (depth provided 100mm is safe)

e) Area of steel

(i) Area of the steel along shorter direction

$M_{ux} = 21.38\ KN\text{-}m$

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

$21.38 \times 10^6 = 0.87 \times 415 \times A_{st} \times 100 \left(1 - \frac{A_{st} \times 415}{1000 \times 100 \times 20}\right)$

$A_{st} = 691.33\ mm^2$

spacing (10mm) $= \frac{\frac{\pi}{4} \times 10^2}{691.33} \times 1000 = 113.60\ mm$

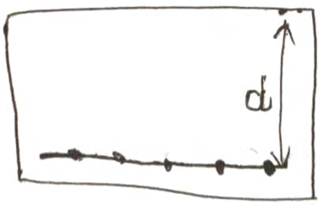
(ii) Area of the steel along longer direction

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

$15.29 \times 10^6 = 0.87 \times 415 \times A_{st} \times 100 \left(1 - \frac{A_{st} \times 415}{1000 \times 100 \times 20}\right)$

$A_{st} = 469.16\ mm^2$

Spacing (8mm) $= \frac{\frac{\pi}{4} \times 8^2}{469.16} \times 1000 = 107.13\ mm$



d : ~~Area of steel along longer direction~~

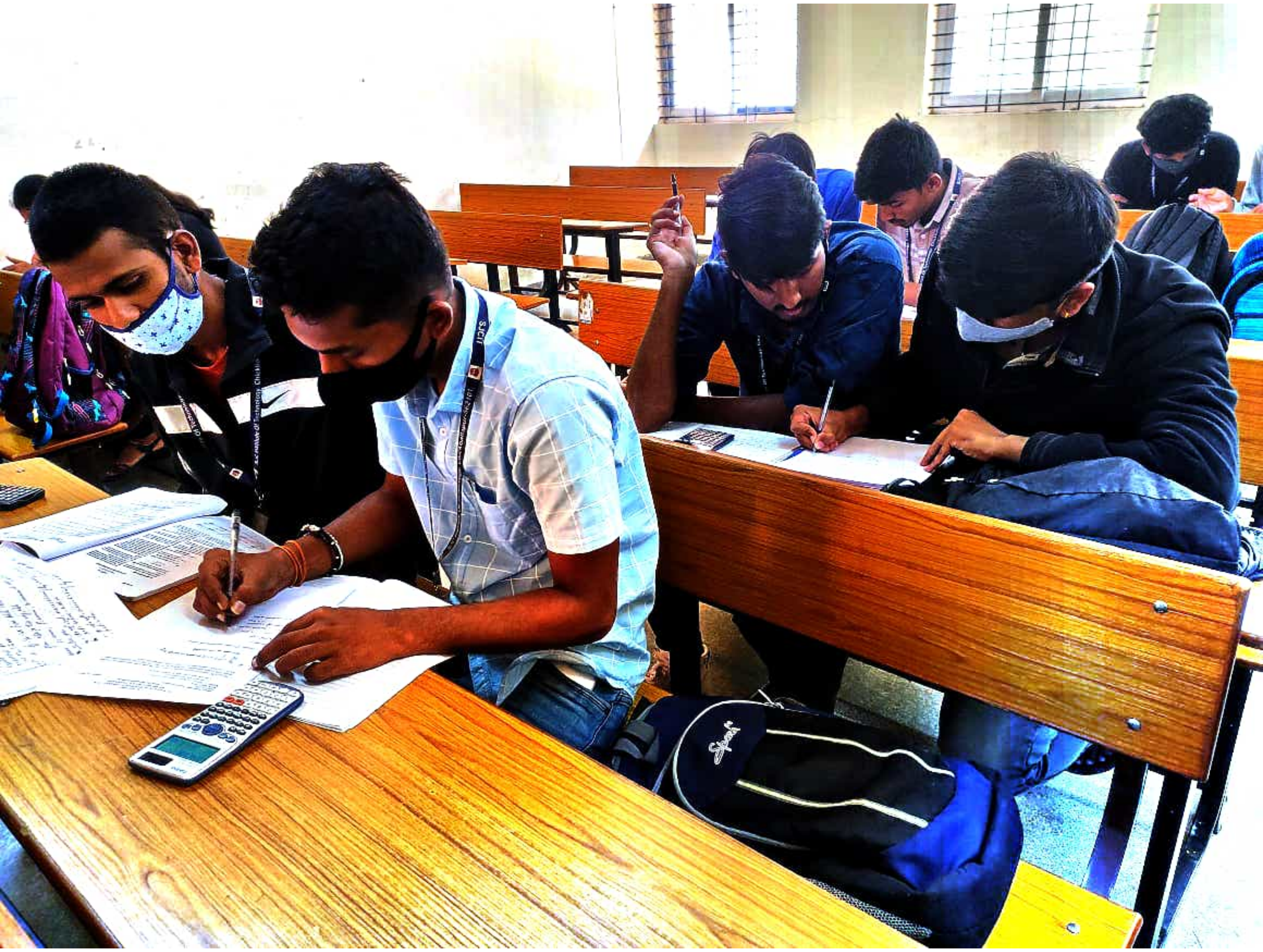
$\tau_v = \frac{V_u}{bd} = \frac{136.55 \times 10^3}{1000 \times 100}$ $V_u = 136.55 \times 10$

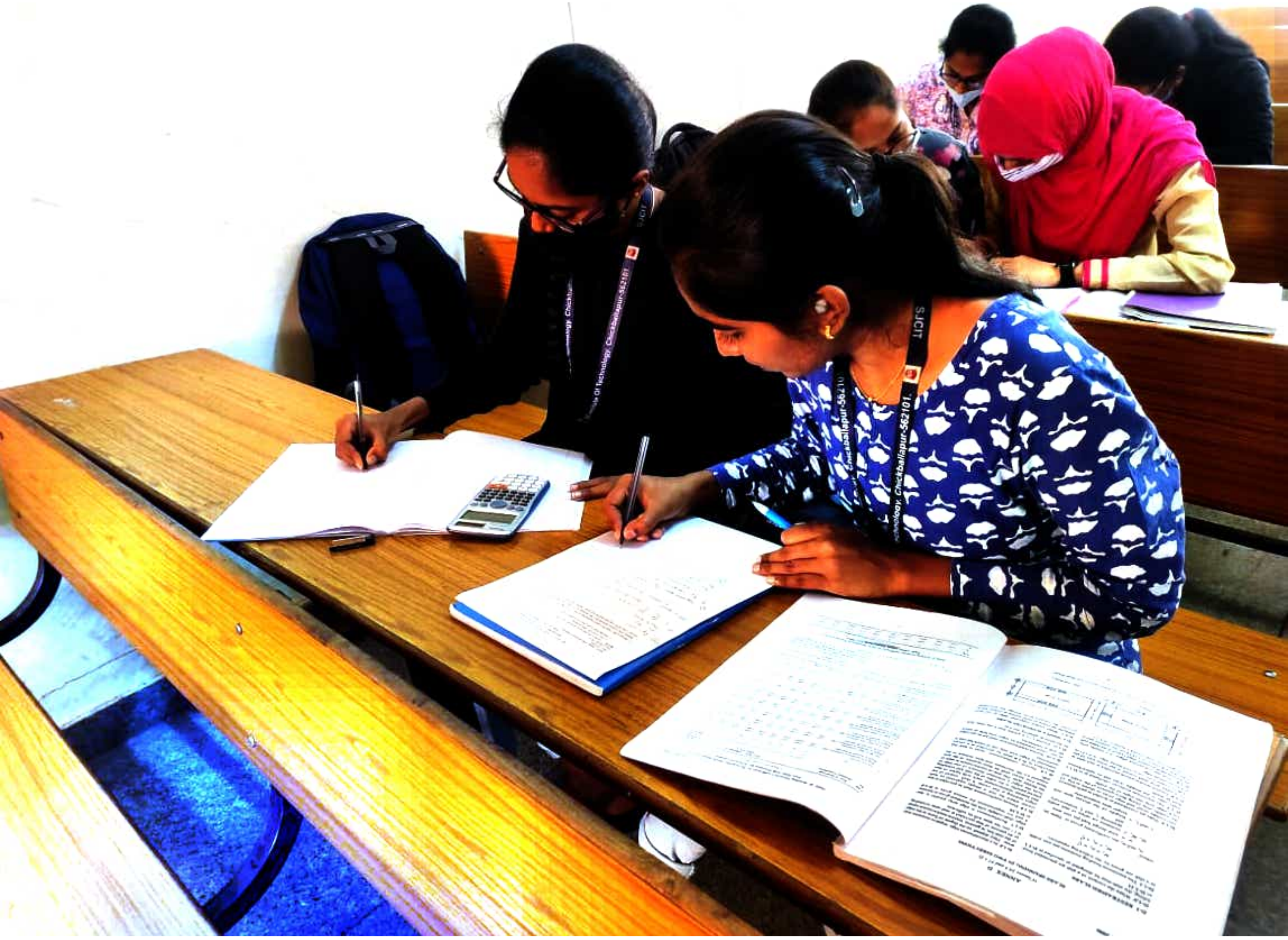
$\tau_v = 1.36\ N/mm^2$

$\tau_c = \frac{100 A_{st}}{bd} = \frac{100 \times 691.33}{1000 \times 100} = 0.69\ N/mm$

$\tau_v > \tau_c$

$\therefore$ It is safe

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