Internal Assessment Test III –Nov. 2018

Sub:	DESIGN OF RC STRUCTURAL ELEMENTS				Sub code:	15CV5 1	Branch:	CIVIL
Date:	11/20/2018	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 two full questions	Marks	CO	RBT
1 (a)	Design a slab for a room of clear dimensions 3mX5m supported on wall of 300mm thickness with the corners held down. Two adjacent sides of the slab are continuous and the other discontinuous. Live load on the slab is $3kN/m^2$ Assume the floor finish as $1kN/m^2$. Use M20 grade concrete and Fe415 steel. Sketch the reinforcement details.	[25]	CO 4	L3
2 (a)	The main stair of an office building has to be located in stair case room measuring 2.5m X 5.6m. The vertical distance between the floors is 3.7m. Live load on stairs is 5 kN/m^2. Design the flight slab using M20 and Fe 415 if the landing slab span in the same direction.	[25]	CO 4	L3

1) a) $L_x = 3m$

$L_y = 5m$

$\frac{L_y}{L_x} = \frac{5}{3} = 1.666 < 2$ (Twoway slab)

Step 1 :- Fixing the dimensions :-

Assume it as simply supported slab

$\frac{L}{d} = 35 \times 0.8$ (from Code book IS 456:2000, pg No 39)

$\frac{3000}{35 \times 0.8} = d$

$d = 110mm$

Assume $d' = 20mm$ $\therefore$ $D = d + d' = 130mm$

Step 2 :- effective length = 3m (Consider shorter span length)

Step 3 :- Load calculation :-

$DL = 1 \times 0.13 \times 25 = 3.25 \; kN/m^2$

$LL = 3 \; kN/m^2$

$FF = 1 \; kN/m^2$

$TL = 7.25 \; kN/m^2$

$W_u = 7.25 \times 1.5 = 10.875 \; kN/m^2$

Step 4 :- Mu & Vu

$Mu_x = \alpha_x W_u \times l_{eff}^2$

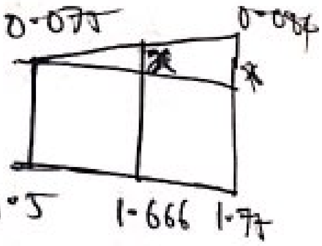
$Mu_y = \alpha_y W_u l_{eff}^2$

{from IS 456:2000, pg No-91 Table No 26} ⇒ clause 24.4.1

M_{ux} for (-ve moment) $= \alpha_x \times w_u \times l_{eff}^2$

$= 0.0761 \times 10.875 \times 3^2$

$= 7.4482$ kNm



M_{ux} for (+ve moment) $= 0.057 \times 10.875 \times 3^2$

$= 5.578$ kNm

$\frac{0.009}{1.25} = \frac{x}{0.166}$

M_{uy} for (-ve moment) $= 0.047 \times 10.875 \times 3^2$

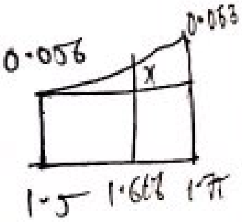
$= 4.600$ kNm

$x = 1.195 \times 10^{-3}$

M_{uy} for (+ve moment) $= 0.035 \times 10.875 \times 3^2$

$= 3.4256$ kNm

for $1.666 = 0.0761$



$V_u = \frac{w_u l_{eff}}{2} = 16.3125$ kN

<u>step 5:- check for depth</u>

$\frac{x}{0.166} = \frac{0.007}{1.25}$

$d = \sqrt{\frac{M_u}{0.138 f_{ck} b}} = \sqrt{\frac{7.4482 \times 10^6}{0.138 \times 20 \times 1000}}$

9.296×10^{-4}

for $1.666 = \alpha_x = 0.057$

$d_{req} = 51.94$ mm $\simeq 55$ mm

$d_{provided} = 110$ mm

$\therefore d_{req} < d_{provided}$ <u>Hence safe</u>

<u>step 6:- Ast calculation:-</u>

i) <u>Ast calculation in l_x direction</u> :- (-ve)

$M_u = 0.87 f_y A_{st} d \left(1 - \frac{A_{st} f_y}{f_{ck} b d}\right)$ { pg No. 96, IS 456:2000 clause G-1.1

$$7.4482\times10^6 = 0.87\times415\times Ast\times110\times\left(1-\frac{Ast\times415}{1000\times110\times20}\right)$$

$\therefore Ast_{req} = 195\ mm^2$

$$\boxed{Ast_{min} = \frac{0.12}{100}\times \overset{\times100}{0.13}\times1000 = 156\ mm^2}$$

$$Spacing = \frac{\frac{\pi}{4}\times10^2}{195}\times1000 = 402.768\ mm$$

ii) 300 mm

iii) $3d = 330\ mm$

$$Ast\ provided = \frac{\frac{\pi}{4}\times10^2}{300}\times1000 = 260\ mm^2$$

{In l_x direction $\therefore$ Since for $M_u(+ve)$ ⇒ Ast will be Coming lesser than $M_u(-ve)$ so we consider Ast provided for M_u-ve value}

provide 10 mm dia bars @ 300 mm c/c as Main reinforcement in l_x direction

ii) Ast Calculation in l_y direction:-

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

$$4.6\times10^6 = 0.87\times415\times Ast\times110\times\left(1-\frac{Ast\times415}{20\times1000\times110}\right)$$

$Ast_{req} = 120\ mm^2$ $\left\{\therefore Ast_{min} = \frac{0.12}{100}\times1000\times130 = 156\ mm \simeq 155\ mm\right\}$

$$spacing = \frac{\pi/4\times10^2}{155}\times1000 = \cancel{654.49\ mm}\ 506.7\ mm$$

{Since Ast req is less than Astmin we take Astmin as Astreq}

ii) 300 mm

ii) $3d = 330\ mm$

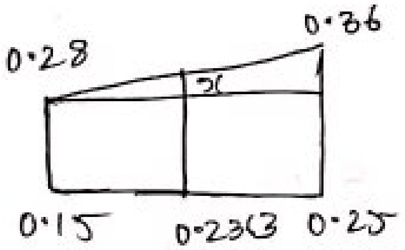
$$Ast\ provided = \frac{\pi/4\times10^2}{300}\times1000 = 260\ mm^2$$

provide 10mm dia bars @ 300mm c/c as Main reinforcement in l_y direction

Check for shear:-

$$\tau_v = \frac{V_u}{bd} = \frac{16.3125 \times 10^3}{1000 \times 110} = 0.1482$$

$$\tau_c = \frac{100\, A_{st\,pro}}{bd} = \frac{100 \times 260}{1000 \times 110} = \boxed{0.2363 = P_t}$$



$$\Rightarrow \frac{0.08}{0.1} = \frac{x}{0.0863} \Rightarrow x = 0.06904$$

$$\tau_c = 0.06904 + 0.28 = 0.349$$

$\boxed{\therefore \tau_v < \tau_c}$ Hence safe.

Before that Area of torsion reinforcement

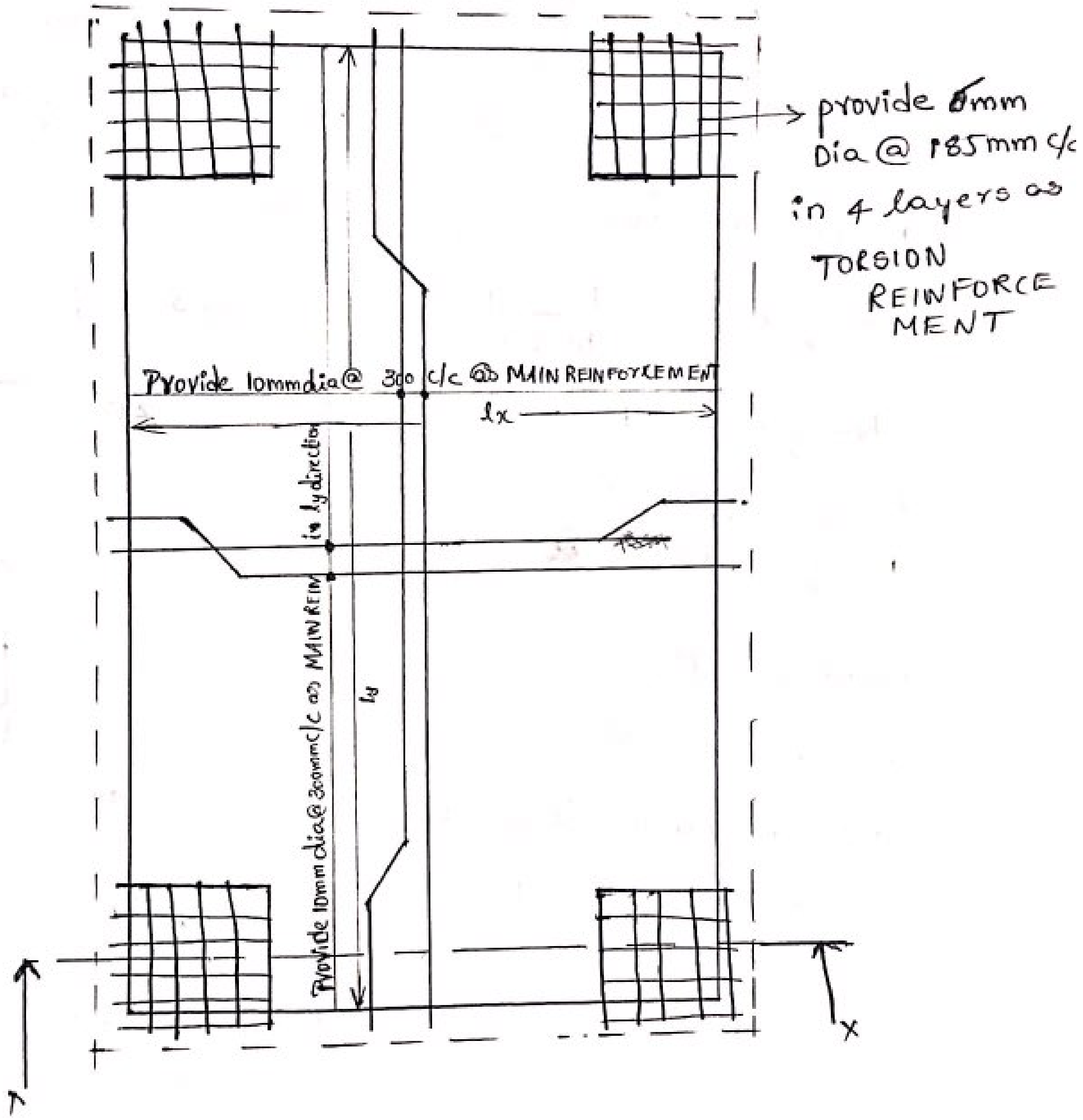
$$\Rightarrow A_{st\,tor} = \frac{3}{4} A_{st\,req} = \frac{3}{4} \times 195 = \cancel{145}\ 150\, mm^2$$

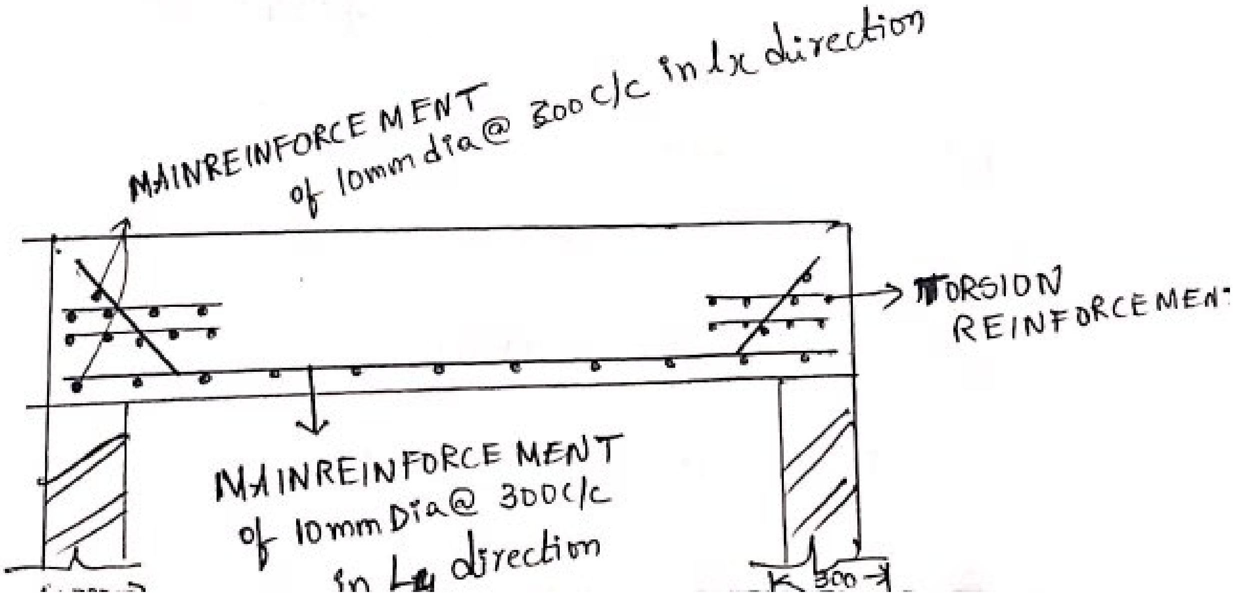
$$\text{Spacing} = \frac{\pi/4 \times 6^2}{150} \times 1000 = 185\, mm$$

~~Ast provided =~~ $\frac{l_x}{5} = \frac{3000}{5} = 600$

provide 6mm dia bars @ 185mm c/c in 4 layers at 600mm length as torsion reinforcement.

Detailing:-


provide 8mm Dia @ 185mm c/c in 4 layers as TORSION REINFORCEMENT
Provide 10mmdia@ 300 c/c as MAIN REINFORCEMENT
lx
Provide 10mm dia@ 300mm c/c as MAIN REIN in ly direction
ly
X


MAINREINFORCEMENT of 10mm dia@ 300 c/c in lx direction
TORSION REINFORCEMENT
MAINREINFORCEMENT of 10mm Dia@ 300c/c in Ly direction
300

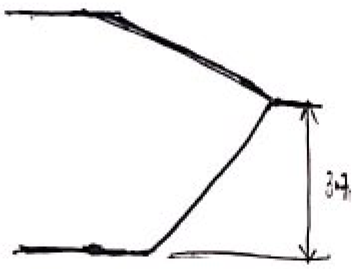
2) Given 2.5m × 5.6m Assume D = 150mm, … $\frac{…}{2}$ = 125mm

FL ht = 3.7m Assume rise = 150mm

Thread = 0.25mm

LL = 5 kN/m^2 Assume landing width = 1.45m

Assume FF = 0.6 kN/m^2 T.S = 280mm



Assume the stair as dog legged stair:-

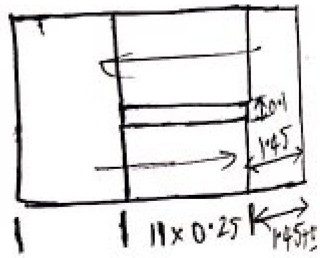
$$\text{No. of rises} = \frac{\text{Floor ht}}{\text{ht of 1 rise}} = \frac{3700}{150} = 24.36 \simeq 24$$

No. of rises = 12 + 12

$$1 \text{ rise} = \frac{3700}{24} = 150$$

No. of threads = 11 + 11

No. of landings = 2



$1.4 + \frac{0.23}{2} = 2.75$

= 1.515

5.83m

Load Calculation:-

Load on flight

DL on waste slab = 0.15 × 25 = 3.75 kN/m^2

$$\text{for Horizontal} \Rightarrow DL = \frac{3.75 \times \sqrt{T^2 + R^2}}{T}$$

$$= \frac{3.75 \times \sqrt{0.25^2 + 0.15^2}}{0.25}$$

$$= 4.373 \text{ kN/m}^2$$

LL = 5 kN/m^2

FF = 0.6 kN/m^2

DL from slab = $\frac{R}{2} \times 25 = 1.875$ kN/m^2

Total load = 11.848 kN/m^2

w_u = 11.848 × 1.5 = 17.772 kN/m^2

Load on landing :-

$DL = 0.15 \times 25 = 3.75$

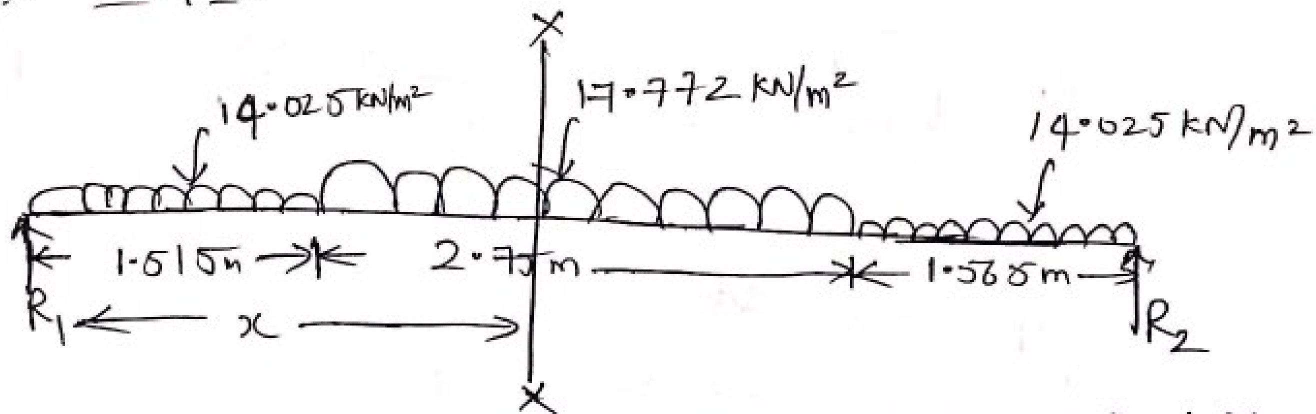
$LL = 5$

$FF = 0.6$

$9.35\ kN/m^2$

$w_u = 9.35 \times 1.5 = 14.025\ kN/m^2$

$\Rightarrow$ step 3 :- M_u & V_u :-



$V_u = R_1 + R_2 = 14.025 \times 1.515 + 17.772 \times 2.75 + 14.025 \times 1.565$

$R_1 + R_2 = 76.92\ kN \simeq 77\ kN$

$\Sigma M_A = 0 \Rightarrow -R_2 \times 5.83 + 14.025 \times 1.565 \times \left(\frac{1.565}{2} + 2.75 + 1.515\right) +$

$= 17.772 \times 2.75 \times \left(\frac{2.75}{2} + 1.515\right) + 14.025 \times \frac{1.515^2}{2}$

$\boxed{R_2 = 46\ kN}$

$\boxed{R_1 = 31\ kN}$

$\boxed{V_u = 77\ kN}$

$V_{u\,x-x} = R_1 = 14.025 \times 1.515 + 17.72 \times (x - 1.515)$

$\therefore x = 2.065 \simeq 2.1$

$\boxed{x = 2.1}$

Scanned with CamScanner

$M_{u\,x-x} =$

$$R_1 \times x - 14.025 \times 1.515 \times \left(\frac{1.515}{2} + (x - 1.515)\right) - 17.779 \times \frac{(x-1.515)^2}{2}$$

By sub $x = 2.1$

$$\boxed{M_{u\,x-x} = 30.432\,\text{kNm}}$$

Step 5 :- $d_{req} = \sqrt{\frac{\cancel{0.138}}{f_{ck}\, b}}$ check for depth

$$d = \sqrt{\frac{M_u}{0.138 f_{ck} b}} = \sqrt{\frac{30.432 \times 10^6}{0.138 \times 20 \times 1000}} = 105$$

$d_{req} = 105\,\text{mm}$

$d_{provided} = 125\,\text{mm}$

$\therefore d_{req} < d_{provided}$ Hence safe.

Ast calculation:-

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

$$30.432 \times 10^6 = 0.87 \times 415 \times 125 \times A_{st} \left(1 - \frac{415 A_{st}}{125 \times 1000 \times 20}\right)$$

$A_{st\,req} = 770\,\text{mm}^2$ $\qquad A_{st\,min} = \frac{0.12}{100} \times 150 \times 1000 = 180\text{m}$

$$\text{Spacing} = \frac{\pi/4 \times 10^2}{770} \times 1000 = 101.34\,\text{mm} \simeq 100\,\text{mm}$$

ii) $3d = 3 \times 125 = 375\,\text{mm}$

iii) $300\,\text{mm}$

$$\therefore A_{st}\ \text{provided} = \frac{\pi/4 \times 10^2}{100} \times 1000 = 785\,\text{mm}^2$$

∴ provide 10mm dia @ 100mm c/c as Main reinforcement

Distribution reinforcement :-

$$\frac{0.12}{100} \times 150 \times 1000 = 180\,mm^2$$

$$\text{Spacing} = \frac{\pi/4 \times 8^2}{180} \times 1000 = 280\,mm$$

ii) 5d = 625mm

iii) 450mm

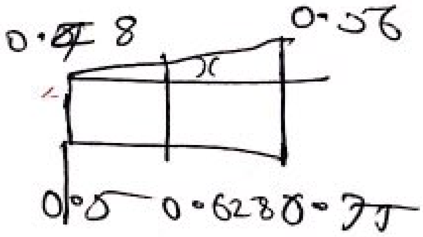
provide 8mm dia @ 280 c/c as Distribution reinforcement

Check for shear :-

$$\tau_v = \frac{V_u}{bd} = \frac{77 \times 10^3}{1000 \times 125} = 0.616$$

$$\tau_c = \frac{100\,A_{st\,pro}}{bd} = \boxed{0.628 = P_t}$$

$$\cancel{x} = \cancel{p}\ \boxed{\tau_c = 0.52}$$



∴ $\tau_v < \tau_c$ Hence Safe

~~x = 0.5 + 0.48~~

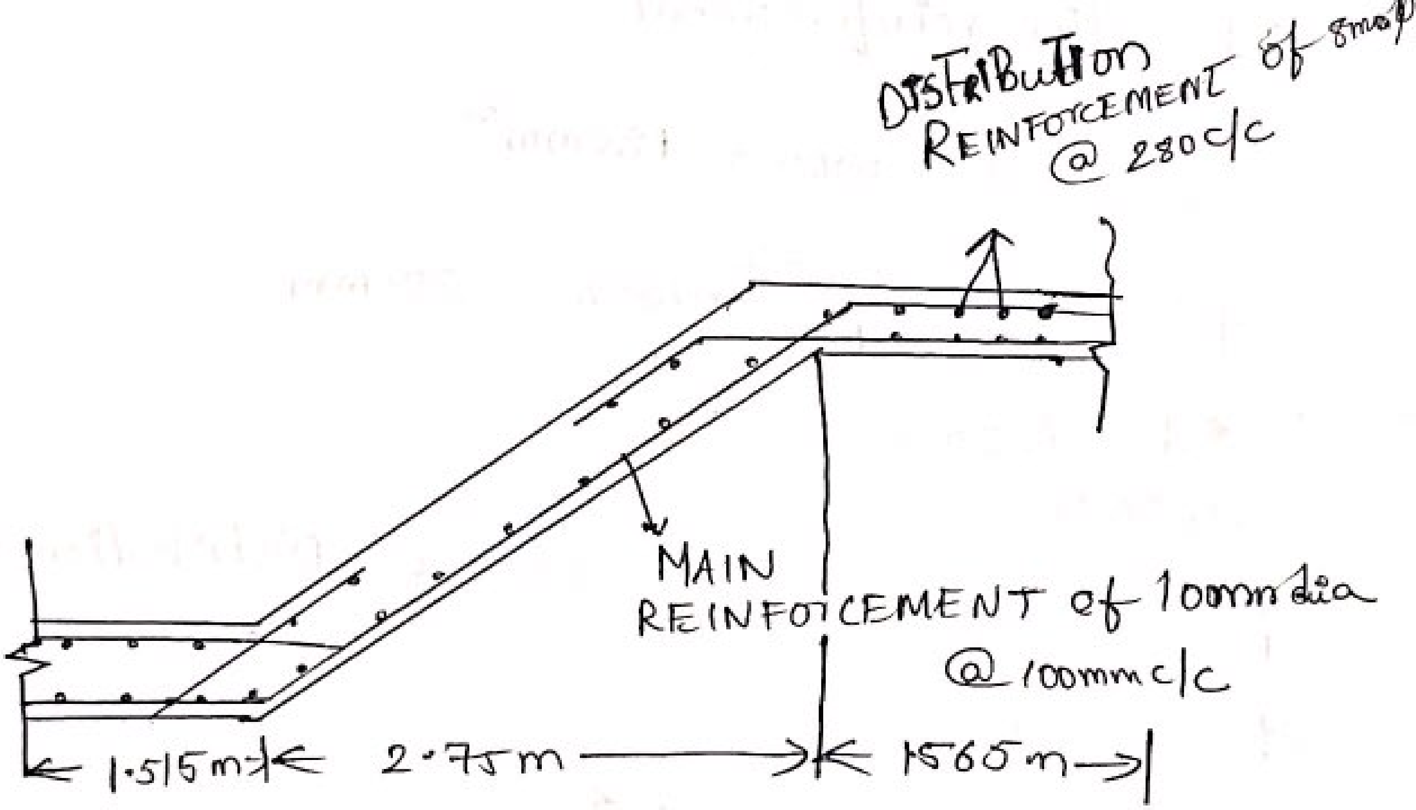
∴ ~~Assume x~~

$$\frac{0.08}{0.25} \times \frac{x}{0.12}$$

$$x = 0.0384$$

Reinforcement details

↳ 6


DISTRIBUTION
REINFORCEMENT of 8mmϕ
@ 280 c/c
MAIN
REINFORCEMENT of 10mm dia
@ 100mm c/c
1.515m
2.75m
1.560m