CMR
INSTITUTE OF
TECHNOLOGY

USN

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Improvement test – June 2017

Sub:	Design and Drawing Of RCC Structural Elements							Code:	10CV62
Date:	02/6/17	Duration:	90 Min.	Max Marks:	50	Sem:	6	Branch:	CV

Note: **Use of IS 456:2000 code is permitted. Assume the missing data suitably.**

Q	Part-A		OBE	
Answer any one full question:		Marks	CO	BTL
1.	Draw the Longitudinal section, cross section and prepare bar bending schedule of a rectangular simply supported RCC beam with the following data: Clear span =3.5m, Width of beam = 220mm, Overall depth of beam = 300mm, Bearing width at support = 200 mm, Main reinforcement = 5 Nos -12 mm diameter bars with 2 bars bent up at L/7 from centre of support, Anchor/hanger bars= 2-10 mm diameter, 2 legged Stirrups = 8 mm diameter @ 200 mm c/c., Materials : Mild steel, M20 grade concrete	10	CIV602.4	L3
2	A RCC dog legged stair case as the following details Staircase hall 3.5 X 3.7m central portion with two semicircular landing portion on either side Floor to floor height 3.8m, Rise 150mm, Tread 300mm, Waist slab 150mm, Width of stair is 1.6m, Bearing 300mm throughout, Main steel# 12 @180, Dist steel # 8 @200, Material M 20 concrete FE 415 steel. Two landing beam are provided whose overall size 400 X500mm deep with 3-12mm dia at top and bottom 2L-8MM dia @ 200mm c/c stirrups through out a. Draw to a suitable scale. b. Plan of stair Sectional elevation from Ground Floor landing to first floor details of landing beam c/s l/s.	10	CIV602.4	L3

Part-B			OBE	
Answer any one full question:		**Marks**	**CO**	**BTL**
1.	Design a Counter-fort retaining wall to retain soil for a height of 4m above the ground level The back fill is horizontal. Assume the following details. Density of back fill=18 kN/m^3 SBC of soil below wall= 150 kN/m^2 Angle of repose=30 Co efficient of friction =0.55 M20 concrete and Fe415 steel are used Draw to suitable scale 1) c/s of retaining wall, 2) l/s of stem and base slab showing all steel for about 3m length and Sectional plan showing the reinforcement details in toe and heel slab.	40	CIV602.2	L3

IMPROVEMENT TEST.

PART-B.

Given :- Density of back fill = 18 KN/m³.

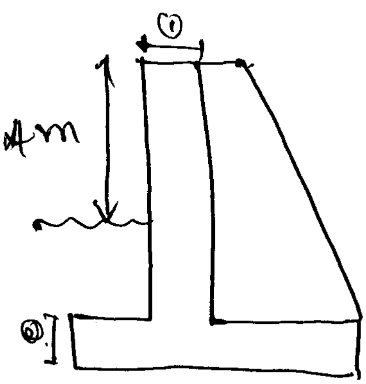
P = SBC = 150 KN/m².

$\phi = 30°$.

$\mu = 0.55$.

$f_{ck} = 20$ N/mm²

$f_y = 415$ N/mm²



Step 1 :- Depth of stem from G.L.

$$D = \frac{P}{\gamma}\left(\frac{1-\sin\phi}{1+\sin\phi}\right)^2 = \frac{150}{18}\left(\frac{1-\sin 30}{1+\sin 30}\right)^2$$

$$= 0.92 \text{ m}.$$

$\therefore$ H = 4m + 0.92 = 4.92 m.

Step 2 :- Spacing of counter fort.

$$l = 3.35\left(H/\gamma\right)^{1/4}$$

$l = 3.35\left(\frac{4.92}{18}\right)^{1/4} = 2.42\,m < 3m.$

Hence provide 3m c/c of counterfort.

Step 3 :- Retaining wall Dimensions.

(a) Base of retaining wall, $b' = 0.7H$.

$b' = 0.7 \times 4.92$

$b' = 3.4\ m.$

(b) Toe projections, $= b'/4 = 3.4/4 = 0.85\ m \approx 1\,m.$

(c) Depth of base slab $= 20 \times H \times l.$

$= 20 \times 4.92 \times 3 = 295.2\ mm$

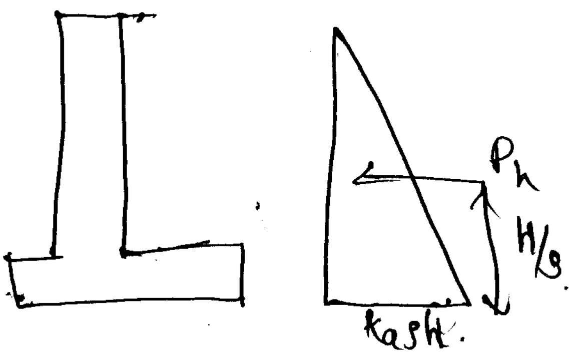
$= 300\ mm.$

(d) height of stem, $h = 4.92 - 0.3 = 4.62\ m.$

(e) Thickness of stem,

$$K_a = \frac{1-\sin\phi}{1+\sin\phi}$$

$$K_a = \frac{1-\sin 30}{1+\sin 30} = 1/3$$



The $\quad M_u = \frac{w_u l^2}{12}$ $\qquad w_u = k_a \gamma H$

$= 1/3 \times 18 \times 4.62$

$= 27.44$ KN.

$$M_u = \frac{27.44 \times 1.5 \times 3^2}{12}$$

$M_u = 30.87$ KN-m.

<u>check for depth</u>

$$d = \sqrt{\frac{M_u}{0.138 f_{ck} b}} = \sqrt{\frac{30.87 \times 10^6}{0.138 \times 25 \times 1000}}$$

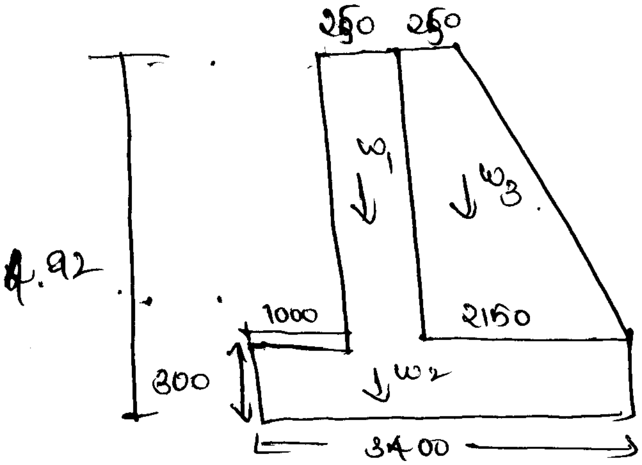
$d = 94.59 \approx 100$ mm,

Provide $d = 200$mm for safe against shear.

$\therefore \quad d = 200$mm, $\quad d' = 50$mm.

$D = 250$mm.

(i.f) Length of heel. $= 3.4 - 0.25 - 1 = 2.15$ m.



step 4 :- stability analysis.

Components	lever arm (m)	Moment (M_R)
1) stem $w_1 = 0.2 \times 4.62 \times 25$ $= 23.1$	~~1/2 = 0.5~~ ~~1/2~~ $1 + 0.25/2$ $= 1.12$	25.87
2) Base $w_2 = 3.4 \times 0.3 \times 25$ $= 25.5$	~~1/2~~ $3.4/2$ $= 1.7$	43.35
3) Back fill $w_3 = 4.62 \times 2.15 \times 18$ $= 178.79$	$1.2 + 2.15/2$ $= 2.27$	405.85
$\Sigma W = 227.39$ kN		$\Sigma M_R = 475.07$

FOS against sliding $= \frac{\mu \Sigma W}{P_H} = \frac{0.55 \times 227.39}{71.89}$

$= 1.7 > 1.4$ Hence safe.

$P_H = 1/2 \times 0.33 \times 18 \times 4.92 \times 4.92 = 71.89$ kN.

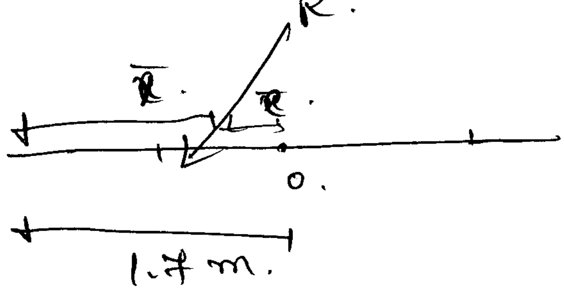
$M_0 = P_H \times H/3 = 71.89 \times 4.92/3 = 117.89$.

FOS against overturning $= \dfrac{\Sigma M_R}{\Sigma M_o}$

$= \dfrac{474.61}{117.89} = 4.02 > 1.6$

Safe //.

step 5 :- Eccentricity g column.



$\bar{x} = \dfrac{\Sigma M_R - \Sigma M_o}{\Sigma W}$

$= \dfrac{474.61 - 117.89}{227.39}$

$\bar{x} = 1.457 m.$

$\therefore e = 1.7 - \bar{x} = 1.7 - 1.457 = 0.13$ ~~0.25~~ m.

6) upward pressure calculation.

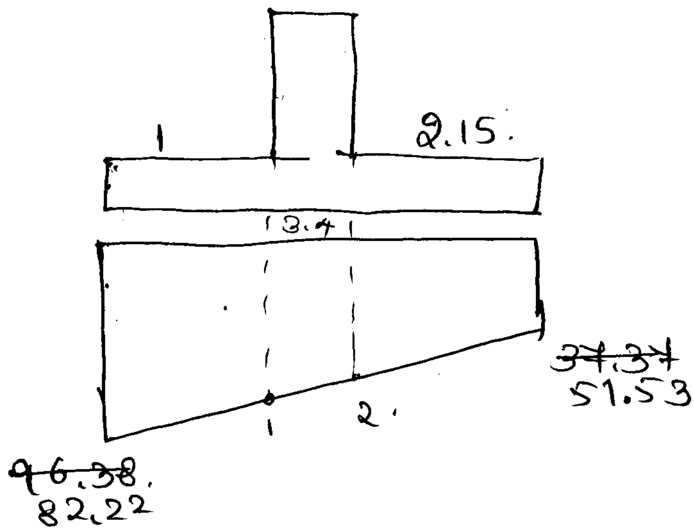
τ_{max} (or) $\tau_{min} = \dfrac{\Sigma W}{b'}\left[1 \pm \dfrac{6e}{b'}\right]$

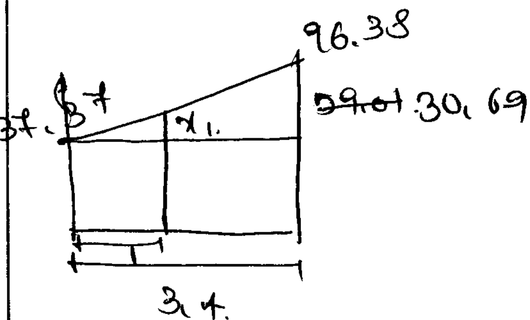
$\tau_{max} = \dfrac{227.39}{3.4}\left[1 + \dfrac{6 \times 0.13}{3.4}\right]$

τ_{max} = ~~96.38~~ 82.22. kN/m^2

$$\tau_{min} = \frac{227.39}{3.4}\left[1 - \frac{6 \times 0.25}{3.4}\right]$$

$= \sim\sim 37.37 \sim\sim$ 51.53 kN/m².



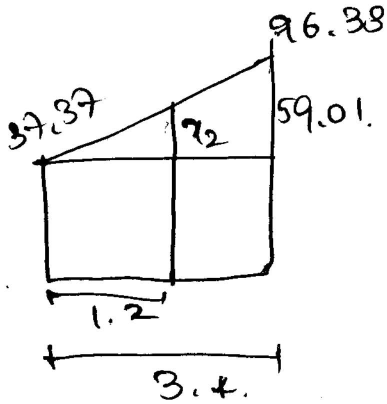


$$\frac{x_1}{1} = \frac{\sim\sim 59.01 \sim\sim \; 80.69}{3.4}$$

$x_1 =$ ~~17.35~~ 9.02

∴ $y_1 =$ ~~$x_1 +$~~

$y =$ ~~87.036~~ 73.2 kN/m²



$$\frac{x_2}{1.2} = \frac{59.01}{3.4}$$

$x_2 = 20.83$

$y_2 =$ ~~74.56~~ 41.39 kN/m²

Step 7:- Design of Stem

$M_u = 30.87$ KN-m.

$D = \sout{200}$ 250 mm, $d = 200$mm.

$$M_u = 0.87 f_y A_{st} d \left[1 - \frac{f_y A_{st}}{f_{ck} b d}\right]$$

$$30.87 \times 10^6 = 0.87 \times 415 \times A_{st} \times 200 \left[1 - \frac{415 \times A_{st}}{25 \times 1000 \times 200}\right]$$

$A_{st} = 443.85 \text{ mm}^2$.

$$\text{Spacing} = \frac{a_{st}}{A_{st}} \times 1000$$

$$= \frac{\pi/4 \times 12^2}{443.85} \times 1000 = 254.80 \text{ c/c.}$$

Hence provide 12 ϕ @ 250 c/c as main reinforcement.

$A_{st\,prov} = 452.38 \text{ mm}^2$

Distribution steel = 0.12 % bD.

$$= \frac{0.12}{100} \times 1000 \times 250$$

$= 300 \text{ mm}^2$.

$$\text{spacing} = \frac{\pi/4 \times 8^2}{300} \times 1000 = 670.20 \text{ c/c}$$

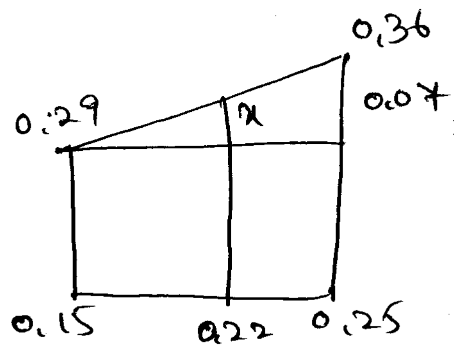
provide 8 φ @ 300 mm c/c as distribution steel

<u>check for shear</u>

$$\tau_v = \frac{V_u}{bd} = \frac{41.16 \times 10^3}{1000 \times 200} = 0.20 \text{ N/mm}^2$$

$$P_t = \frac{100 A_{st}}{bd} = \frac{100 \times 452.38}{1000 \times 200} = 0.22$$

τ_c =



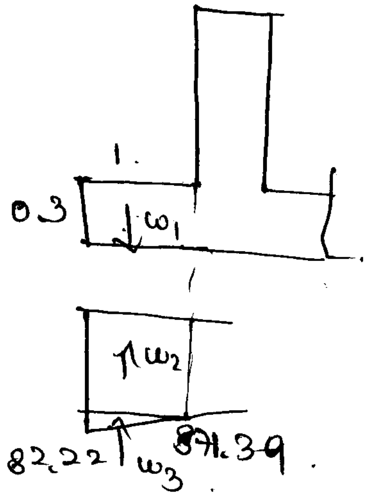
$$\frac{x}{0.07} = \frac{0.07}{0.1}$$

$$x = 0.049$$

$$\therefore \tau_c = 0.29 + 0.049 = 0.33 \text{ N/mm}^2$$

Hence $\tau_c > \tau_c$ safe //

Step 8 :- Design of Toe



$w_1 = 1 \times 0.3 \times 25$
$= 7.5$ KN.

w_2 $x_1 = 1/2 = 0.5$ m.

$w_2 = 87.36 \times 1$
$= 87.36$ KN.

$x_2 = 1/2 = 0.5$ m.

$w_3 = 1/2 \times 1 \times 10.83 = 5.41$ KN, $x_3 = 1/3 = 0.33$ m.

$M_1 = -7.5 \times 0.5 = -3.75$ KN-m.
$M_2 = 43.68$ KN-m
$M_3 = 1.78$ KN-m.

$M = 43.49$ KN-m.

$M_u = 65.24$ KN-m.

Ast Calculation

$$M_u = 0.87 f_y A_{st} d \left[1 - \frac{f_y A_{st}}{f_{ck} b d}\right]$$

$$65.24 \times 10^6 = 0.87 \times 415 \times A_{st} \times 250 \left[1 - \frac{415 A_{st}}{25 \times 1000 \times 250}\right]$$

$A_{st} = 761.26\ mm^2$.

$$\text{spacing} = \frac{a_{st}}{A_{st}} \times 1000 = \frac{\pi/4 \times 12^2}{761.26} \times 1000$$

$$= 148.56\ mm.$$

provide 12 mm ϕ @ 140 c/c as main.

$$A_{st\ prov} = \frac{\pi/4 \times 12^2}{140} \times 1000 = 807.83\ mm^2.$$

Distribution steel = 0.12 % bD

$$= \frac{0.12}{100} \times 1000 \times 300$$

$$= 360\ mm^2.$$

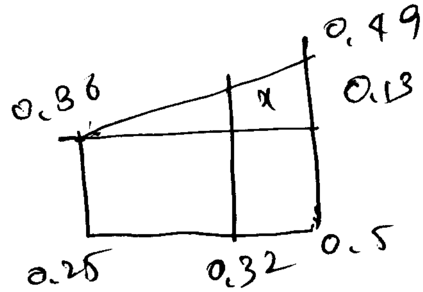
$$\text{spacing} = \frac{\pi/4 \times 8^2}{360} \times 1000 = 139.62\ mm.$$

provide 8 mm ϕ @ 130 mm c/c as Distribution

<u>check for shear</u>

$$\tau_v = \frac{V_u}{bd} = \frac{85.27 \times 10^3 \times 1.5}{1000 \times 250} = 0.51\ N/mm^2$$

$$P_t = \frac{100 A_{st}}{bd} = \frac{100 \times 807.83}{1000 \times 250} = 0.32$$



$$\frac{x}{0.07} = \frac{0.13}{0.25}$$

$$x = 0.036.$$

$$\tau_c = 0.39 \ N/mm^2$$

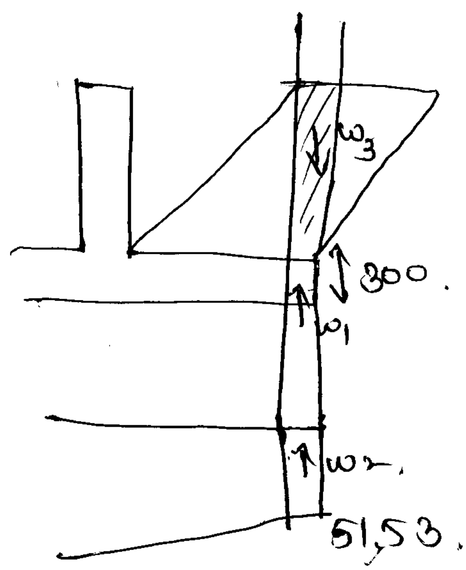
$\tau_c < \tau_v$ safe but provide depth as

$$\tau_v = \frac{V_u}{bd} = \tau_c.$$

$$\frac{127.9 \times 10^3}{1000 \times \sout{200}\, d} = 0.39$$

$$d = 327.94 \simeq 330 \ mm \ //.$$

Step 9:- Design of heel



$w_1 = 1 \times 1 \times 0.3 \times 25$
$= -7.5$ kN.

$w_2 = -1 \times 1 \times 51.53 = -51.53$ kN

$w_3 = 1 \times 1 \times 4.62 \times 18$
$= +83.16$ kN.

pressure on counter fort = $1/2 \times 0.33 \times 18 \times 4.92 \times 4.92 \times 3$.

$= 215.67$

$M_{u} = P_H \times H/3$

$= 235.80$ KN-m.

~~235.80 × 10^6 =~~

$d_{req} = \sqrt{\frac{235.80 \times 10^6}{0.138 \times 25 \times 3000 \times}} = 477.31 < d_{prov}$

Hence safe.

$A_{st} = 337.81 \text{ mm}^2$.

Minimum steel =, $A_{st} = \frac{0.85 b d}{f_y}$

$A_{st} = \frac{0.85 \times 300 \times 1952}{415}$

$A_{st} = 1199.42 \text{ mm}^2$.

~~spac~~ no of # $= \frac{1199.42}{\pi/4 \times 16^2} = 5.9 \approx 6$ #.

provide ~~16 φ @~~ 6 # of 16 φ.

Step 11 :- Horizontal ~~&~~ links

Take $V_u = 41.16 \times 10^3$ N.

$M_u = \frac{W_u l^2}{12} = \frac{41.16 \times 3^2 \times 10^3}{12} =$

Area of steel $= \frac{\text{force}}{\text{stress}} = \frac{w_u \times l}{0.85 f_y}$.

$= \frac{41.16 \times 10^3 \times 3}{0.85 \times 415} = 350.04\ mm^2$

2L - of 8mm ϕ.

spacing $= \frac{2 \times \pi/4 \times 8^2}{350.04} \times 1000$

$= 287.19\ mm^2 \simeq 280\ mm^2$

provide 8mm ϕ @ 280 mm c/c.

Step 12 :- Vertical links.

take $V_u = 36.19$ KN.

Area of steel $= \frac{w_u \times l}{0.85 \times f_y} = \frac{36.19 \times 10^3 \times 3}{0.85 \times 415}$

$= 307.78\ mm^2$.

$w = 24.13$ KN.

$w_u = 36.19$ KN.

$$M_u = \frac{w_u l^2}{12} = \frac{36.19 \times 3^2}{12} = 27.14 \text{ KN-m}.$$

Ast calculation

$$M_u = 0.87 f_y A_{st} d \left[1 - \frac{A_{st} f_y}{b d f_{ck}}\right]$$

$$27.14 \times 10^6 = 0.87 \times 415 \times A_{st} \times 250 \left[1 - \frac{415 \times A_{st}}{1000 \times 250 \times 25}\right]$$

$A_{st} =$ ~~1175.70~~ 306.93 mm^2

$$\text{Spacing} = \frac{\pi/4 \times 12^2}{306.93} \times 1000 = 368.47.$$

provide 12mm ϕ @ 360 mm as main reinforcement

Distribution steel $= 0.12\%$ bD

$$= \frac{0.12}{100} \times 1000 \times 300$$

$= 360$ mm.

provide 8 mm ϕ

$$\text{spacing} = \frac{\pi/4 \times 8^2}{360} \times 1000 = 139.62$$

provide 8mm ϕ @ 130 mm c/c.

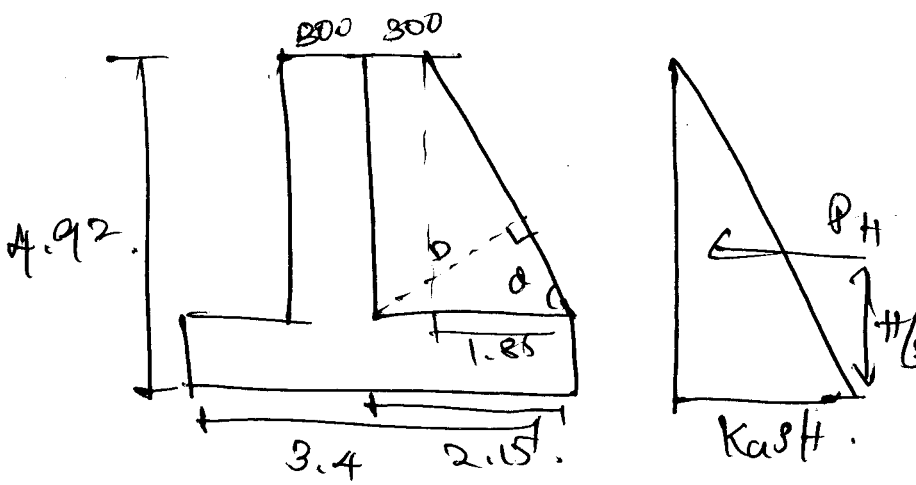
check for shear

$$\tau_v = \frac{V_u}{bd} = \frac{36.19 \times 10^3}{1000 \times 250} = 0.14 \text{ N/mm}^2$$

$$P_t = \frac{100 A_{st}}{bd} = \frac{100 \times 314.15}{1000 \times 250} = 0.12\%$$

$\tau_c = 0.29$ N/mm² Hence safe.

step 10 :- Design of counterfort



$$\tan\theta = \frac{4.92}{1.85}$$

$$\theta = 69.39°$$

$$\sin\theta = \frac{D}{2.15}$$

$D = 2.012$m

$\therefore d' = 60$ mm

$\therefore d = 1952$ mm

$$\text{spacing} = \frac{2 \times \pi/4 \times 8^2}{307.78} \times 1000 = 326.63 \text{ mm.}$$

provide 8 mm ϕ @ 320 mm c/c as vertical links //.

Given :- Clear span = 3.5 m.

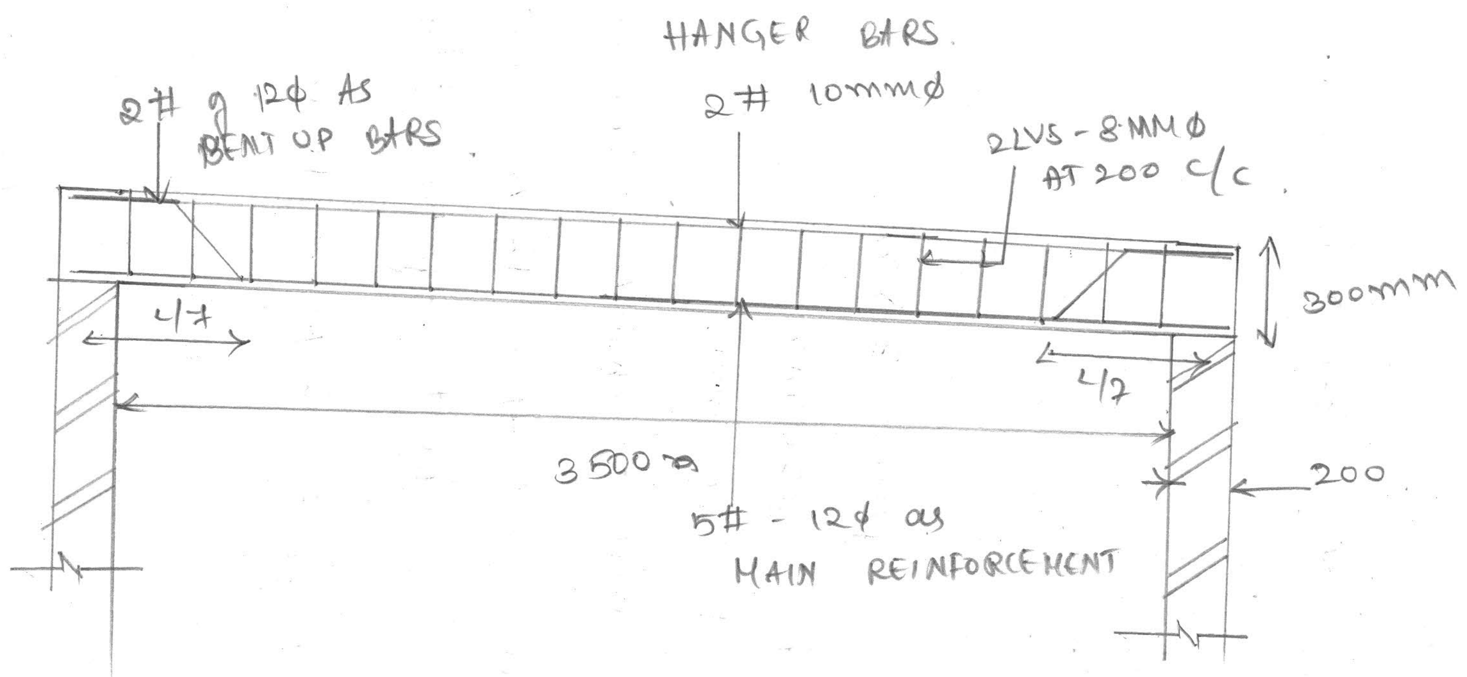
b = 220 mm

D = 200 mm.

wall thickness = 200 mm.

main = 5 # - 12 ϕ. with 2 bars bent up to L/7 from c/c

Hanger = 2 # - 10 mm ϕ.



LONGITUDINAL SECTION

ALL DIMENSSIONS ARE IN MM.