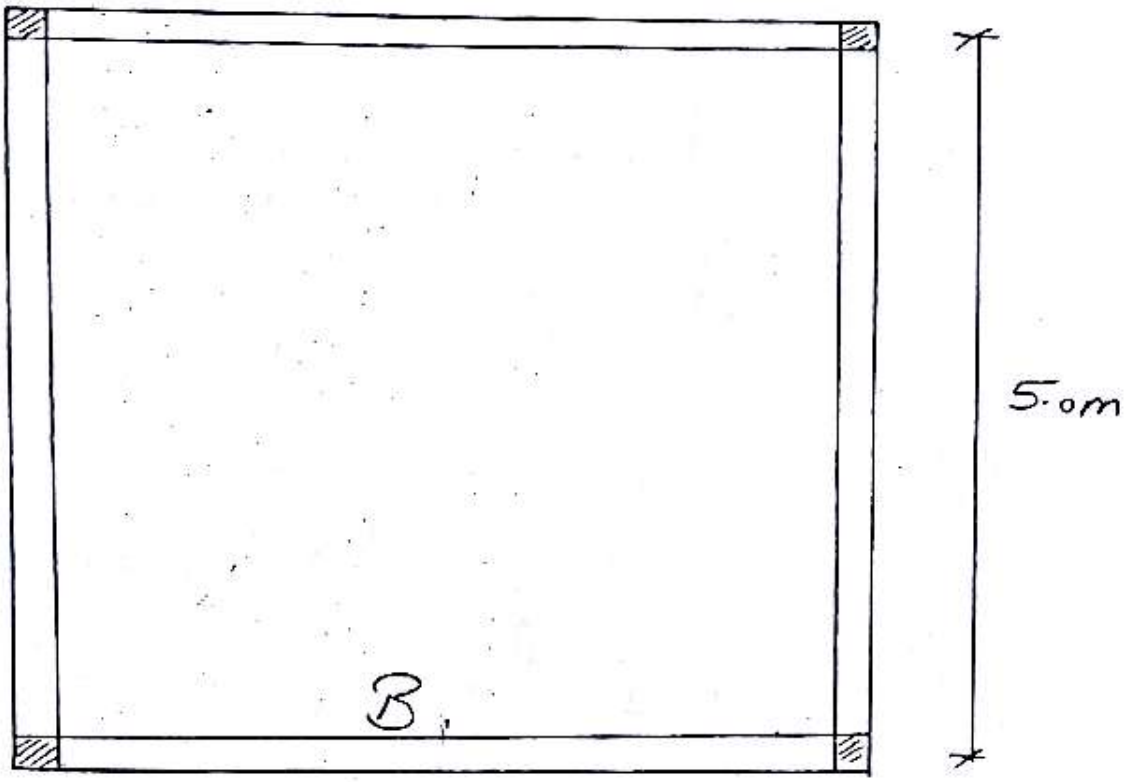
Reinforced Concrete

Design Of Beams

Solved Example (1)

Eng:Ahmed Yehia

Solved Example:-



For The given Plan if you Know That:-

→ (1) Data Given:

$f_{cu} = 25$ MPa

Steel grade 360/520

$\gamma_{wall} = 18$ KN/m^3

$h_{Floor} = 3.0$m

$t_s = 100$ mm

$b = 250$ mm

Floor Covering = 1.5 KN/m^2

Live load = 2 KN/m^2

→ it is Required To:-

(1) Calculate Loads acting on Beam (IS)

(2) Draw B.M.D & S.F.D

(3) Design Beam (IS) for flexure

(4) Design Beam (IS) for shear

(5) Check Deflection of Beam (IS)

(6) Check Cracking of Beam (IS)

(7) with Moment of Resistance Method

Draw Reinforcement Details for Beam (IS) showing The Curtailment of steel on Elevation and Draw The Cross section

① loads: ⟵ التعريف بالحمل

(1) $o.w = b(t - t_s)\gamma_{RC}$

Assume $t = 700\,mm$

$$o.w = 0.25\,(0.7 - 0.1) * 25 = 3.75\ Kn/m'$$

$$\longrightarrow \boxed{o.w = 3.75\ Kn/m'}$$

(2) $\omega_{wall} = \gamma_{wall} * h_{wall} * t_{wall}$

$t_{wall} = b = 250mm$

$\omega_{wall} = 18 * 0.25 * h_{wall}$

$h_{wall} = h_{Floor} - t$

$= 3.0 - 0.7 = 2.3\ m$

$\omega_{wall} = 18 * 2.3 * 0.25 = 10.35\ Kn/m'$

$$\longrightarrow \boxed{\omega_{wall} = 10.35\ Kn/m'}$$

③ Load from slab:

① Value
② Shape
③ التحويل

① Value:-

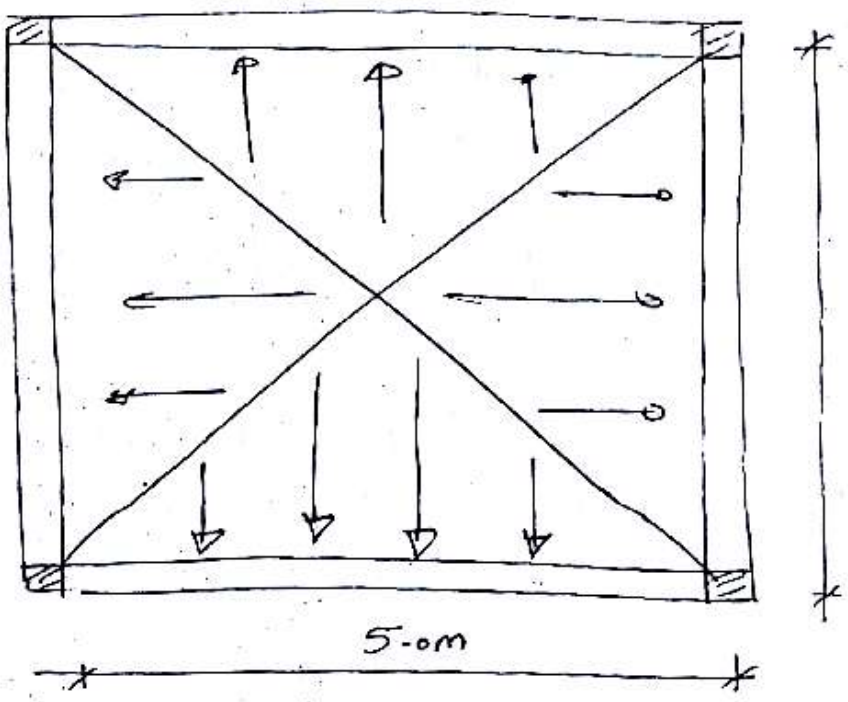
$$g_s = \frac{t_s}{1000} * 25 + F.C = \frac{100}{1000} * 25 + 1.5 = 4 \ KN/m^2$$

$$P_s = 2 \ KN/m^2 \quad \text{Given}$$

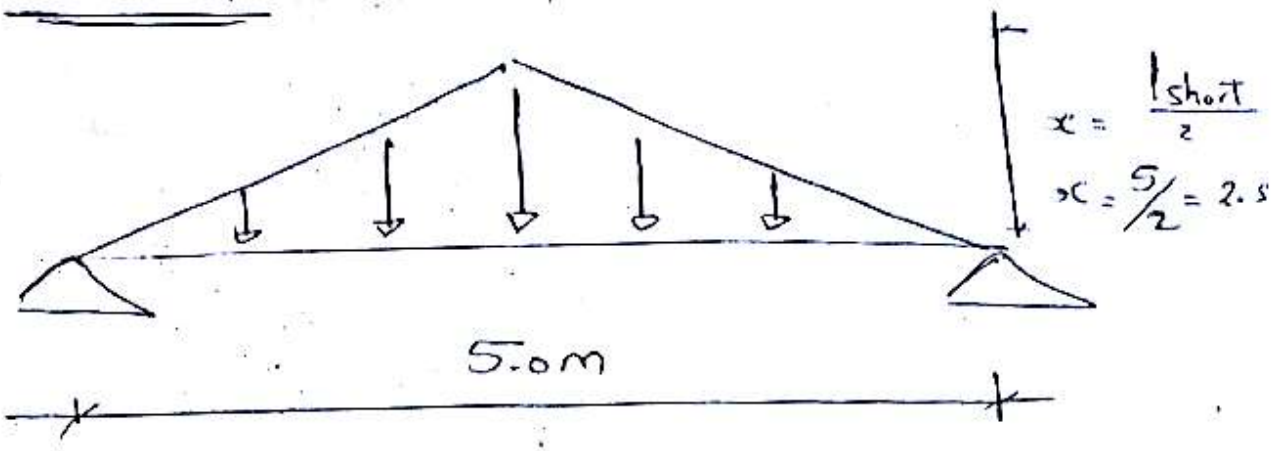
② Shape: ——o load Distribution (plan)

$$r = \frac{l_L}{l_s} = \frac{5}{5} = 1.0 < 2.0$$

Two way



② Shape :-



③ التحويل :-

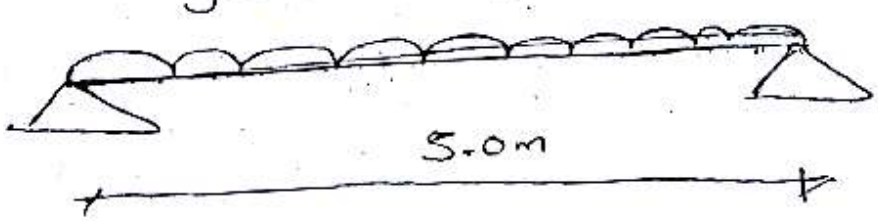
$$g_{mod} = g_s \times \frac{\Sigma Area}{span} = 4 \times \left(\frac{\frac{1}{2} \times 5 \times 2.5}{5}\right) = [illegible]$$

$$P_{mod} = P_s \times \frac{\Sigma Area}{span} = 2 \times \left(\frac{\frac{1}{2} \times 5 \times 2.5}{5}\right) = \underline{2.5}$$

$$\rightarrow g_{total} = \underbrace{g_w}_{3.75} + \underbrace{w_{wall}}_{10.35} + \underbrace{g_{mod}}_{5} = \boxed{19.1 \text{ K/m'}}$$

$$\rightarrow P_{total} = \boxed{2.5 \text{ K/m'}}$$

$g = 19.1 \quad P = 2.5$



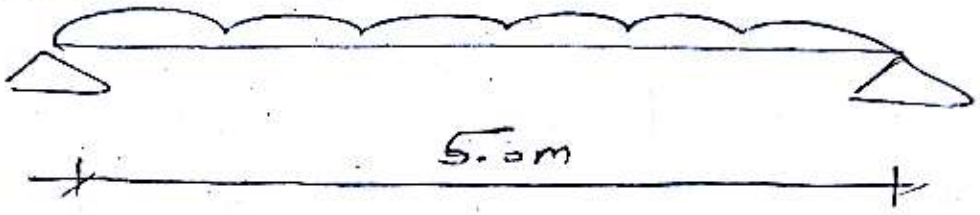
$w_u = 1.5(g+P)$

$w_u = 32.9$

(2) Straining actions: (Moment - Shear)

(1) Moment:-

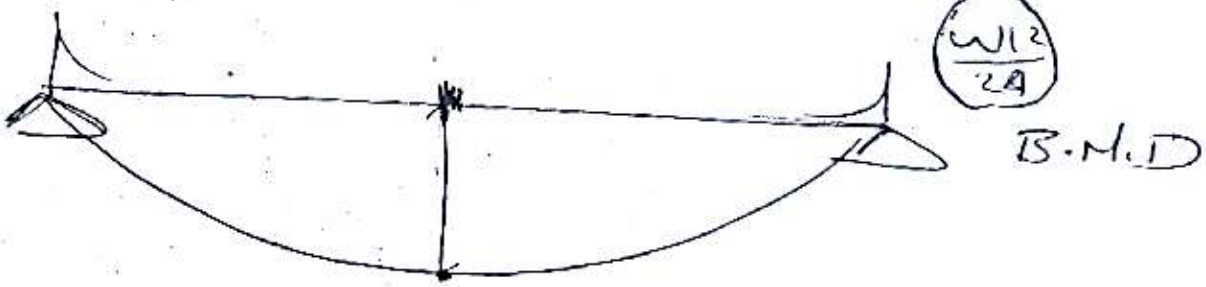
$W_u = 32.4$



$$P/g = 0.13 < 0.75$$

$$W_u = 1.5(P+g) = 32.4$$

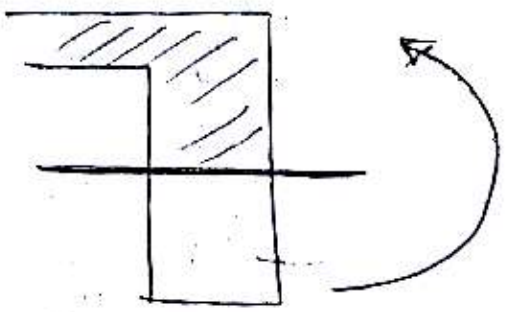
عزم التثبيت
حتى ٣م
كسبه



$$M_u = \frac{wl^2}{8} = \boxed{101.25}$$

(3) Design for Flexure:-(Moment)

نأخذ قطاع الكمرة (L-sec) ونظاهر فيه على الـ Plan



العزم السالب تحت
يبقى البيشد تحت
ويبقى فوق

الى انقطع هو شكل
(L-sec) يبقى هنحوم بطريقة
الـ (L-sec)

$$\therefore d = C_1 \sqrt{\frac{Mu * 10^6}{Fcu * B}}$$

B Min of:
- $6t_s + b = 6 \times 100 + 250 = 850mm$
- $\frac{l'}{10} + b = \frac{5000}{10} + 250 = \boxed{750mm}$
- $\frac{1}{2}(\text{⌀} - \text{⌀}) = 2500mm$

l_1 ⟵ simple Beam

$l' = l = 5.0m = 5000mm$

$d = t - 50 = 700 - 50 = 650mm$

$$650 = C_1 \sqrt{\frac{101.25 * 10^6}{25 \times 750}}$$

$\therefore C_1 = 8.84 \xrightarrow{\text{Table}} j = 0.826$.

أكبر حاجة في الجدول لأنه الـ (C_1) طلعه أكبر من الرقم في الجدول

$$A_s = \frac{M_u * 10^6}{F_y \, j \, d}$$

$$A_s = \frac{101.25 * 10^6}{360 \times 0.826 \times 650} = \boxed{523.89 \text{ mm}^2}$$

Check $A_{s\,min}$

- Max of
  - $\frac{0.225\sqrt{f_{cu}}}{F_y} bd = \boxed{507}$
  - $\frac{1.1}{F_y} bd = 495.9$
- Min of
  - $1.3\, A_{s\,req} = 680.9$
- Max of
  - $\frac{0.15}{100} bd = 243.75$

$\therefore A_s > A_{s\,min}$

$\therefore$ Take $A_s = 523.89 \text{ mm}^2$

$\therefore$ use $\boxed{5 \not\phi 12}$

$$A_s' = 0.2\, A_s = 104.7$$

$\therefore$ use $\boxed{2 \not\phi 10}$

① $M_R = \frac{A_s \text{ بعد التقريب}}{A_s \text{ قبل التقريب}} \times M_u$

$M_R = \frac{5 \times \frac{\pi (12)^2}{4}}{523.84} \times 101.25 = \boxed{109.2}$

② l_a Max of:

- $0.7d = 0.7 \times 650 = \boxed{455\ mm}$
- $10\phi = 10 \times 12 = 120mm$

③ $l_d = \frac{\alpha \beta 7\phi \, f_y/f_s}{4 f_{bu}}$ نكتب القانون

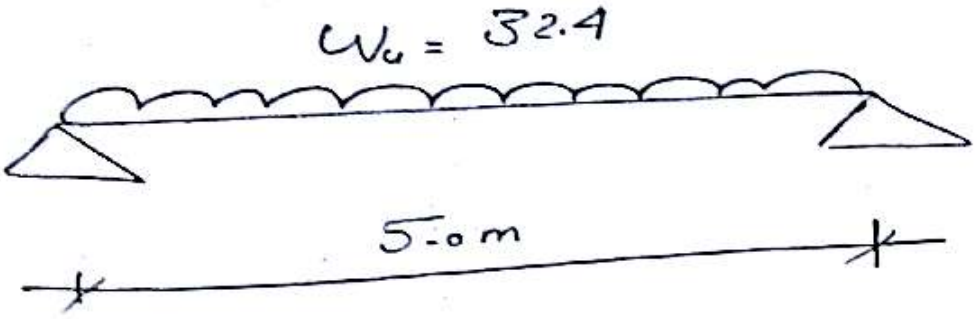
بس نخوض مع الأرقام الحسابية:

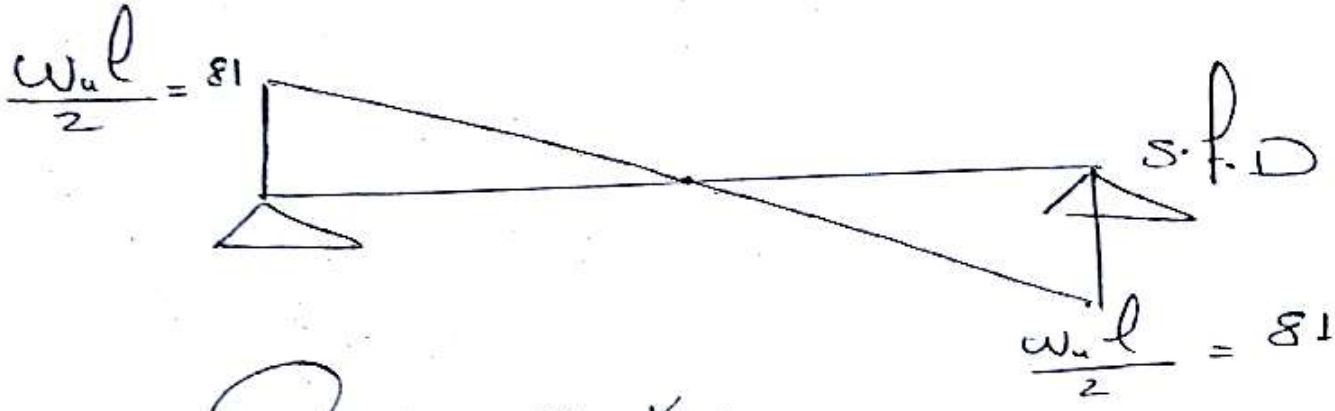
$l_d = 55\phi$ ← نكتب 7

$l_d = 55 \times 12 \times 1.0$ ← علشان الأسياخ سفلية

$\boxed{l_d = 660mm}$

(4) Design for Shear:





$$\therefore Q_{umax} = 81 \text{ kN}$$

$$\therefore (1)\ Q_{uC} = Q_{umax} - w_u \left[\frac{C}{2} + \frac{d}{2}\right]$$

Assume $C = 0.5m$

$$= Q_{uC} = 81 - 32.4 \left[\frac{0.5}{2} + \frac{0.65}{2}\right] =$$

$$Q_{uC} = \boxed{62.37 \text{ kN}}$$

$$(2)\ q_{sh} = \frac{Q_{uC} * 10^3}{b \times d} = \frac{62.37 * 10^3}{250 \times 650}$$

$\therefore q_{sh} = \boxed{0.38\ N/mm^2}$

$\therefore q_{cu} = 0.24\sqrt{\frac{f_{cu}}{\gamma_c}} = \boxed{0.98\ N/mm^2}$

$\therefore q_{sh} < q_{cu}$

$\therefore$ Safe

No need To use stirrups

but use $\sim$ Min stirrups

$\boxed{5\phi\ 8/m'}$

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Design Of Beams

Solved Example ②

Eng:Ahmed Yehia

Question IV **50%**

For the part of a structural plan of a residential building shown in Figure 3; It is required to:

1- Draw the load distribution of slabs on plan.

2- Calculate load on beam (G).

3- Draw the S.F.D and B.M.D due to ultimate total loads.

4- Design the critical sections of beam (G) for flexure and shear for the case of total loads.

5- Using moment of resistance diagram (MRD), show flexure and shear reinforcement details for the beam in elevation and cross sections to a convenient scale including cut off points of reinforcement.

6- Calculate and show on elevation the development and anchorage length.

Consider :

live load = 3.0 kN/m²

flooring cover = 1.50 kN/m²

f_{cu} = 25 N/mm²

steel 240/350

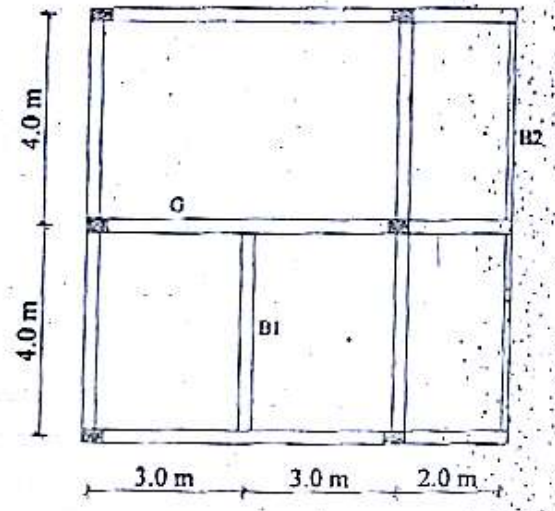
t_s = 120 mm

height of floor = 3.0 m

weight of brick walls = 4.0 kN/m²

column dimension =250×400 mm

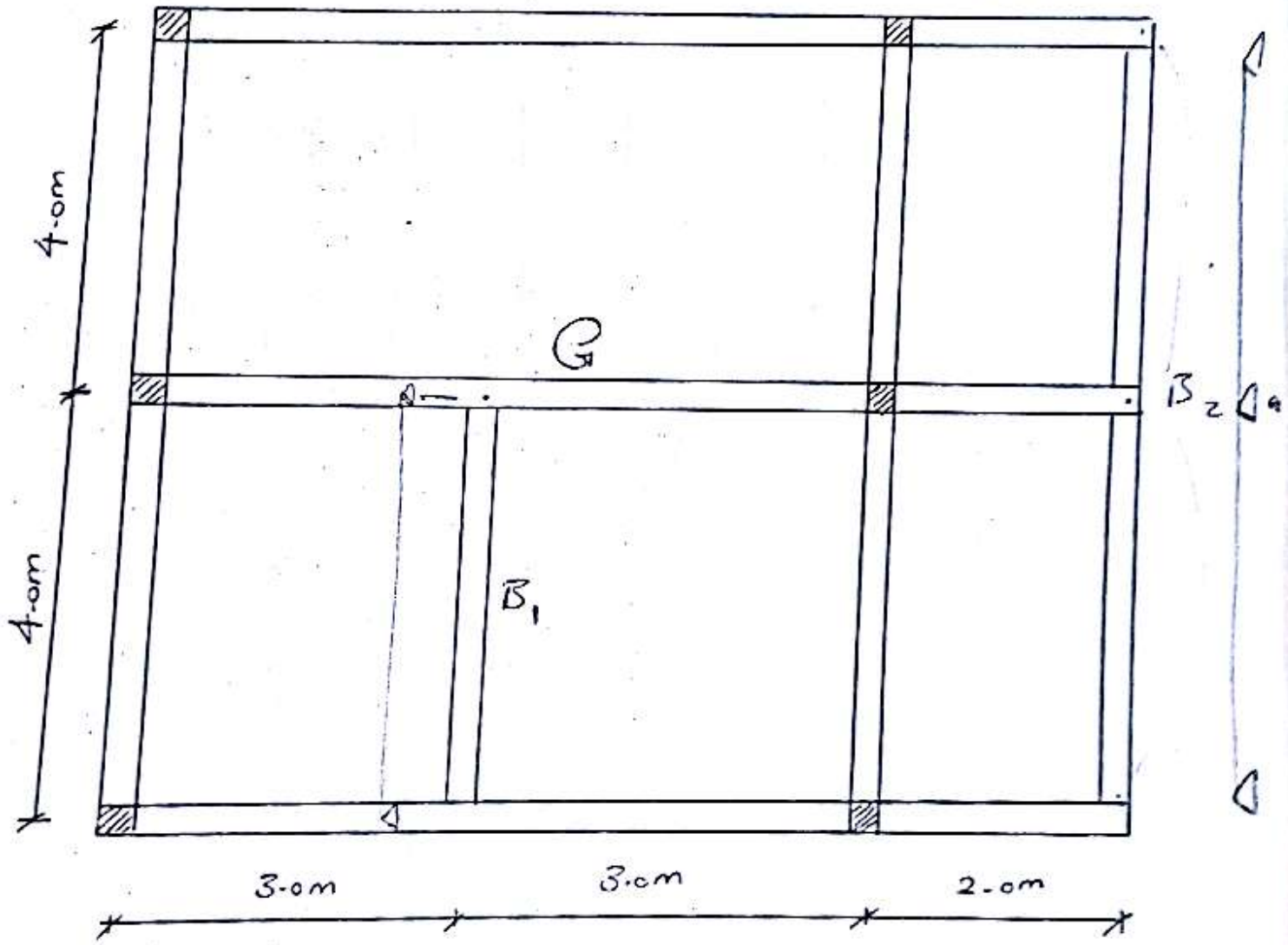
Total *depth of beam = 700 mm*



Reinforced Concrete

Solved Example

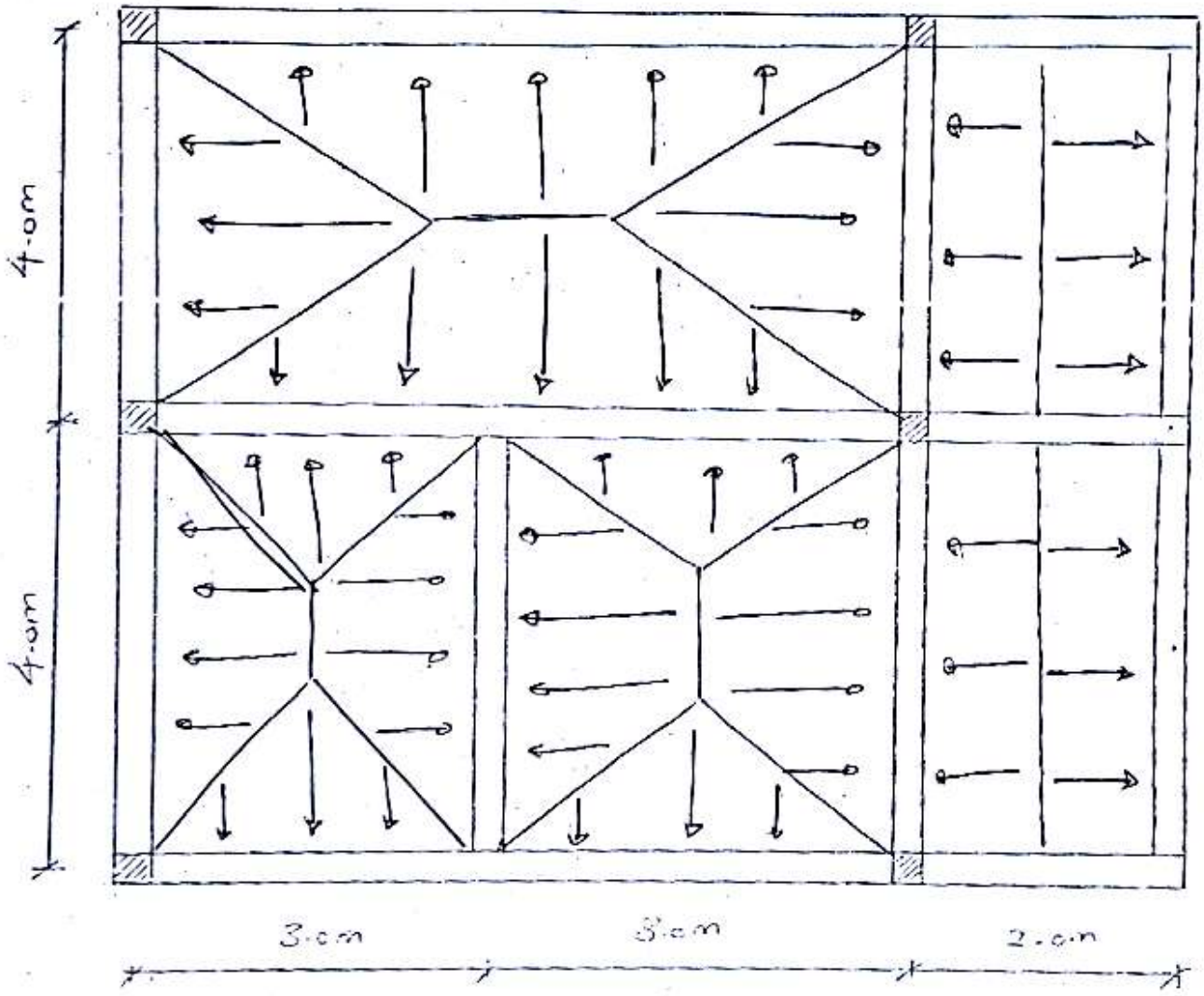
For the given structural plan, it's required to make complete design for the main girder (G), then draw the reinforcement details



Data Given:

- Live load = 3 Kn/m²
- Flooring Cover = 1.5 Kn/m²
- f_{cu} = 25 MPa
- steel grade 360/520
- t_s = 120 mm
- height of Floor = 3.0m
- weight of Brick wall = 9 Kn/m² (δ_{wall})
- Column Dimensions (250 x 400)
- depth of Beam = 700mm

$$t = 700mm$$


4.0m
4.0m
3.0m
3.0m
2.0m

For Beam (B_1) :-

⇒ Loads :-

① $o.w = b(t - t_s)\,\gamma_{R.C}$

$o.w = 0.25(0.7 - 0.12)\,25 =$ **8.625 Kn/m'**

② $\omega_{wall} = \gamma_w * h_{wall}$

$= 4 * (3 - 0.7) =$ **9.2 Kn/m'**

③ Load from Slab :-

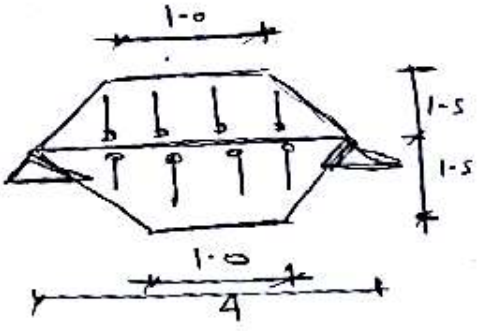
① Value :-

$g_s = t_s \times \gamma_{R.C} + F.C$

$= 0.12 * 25 + 1.5 = 4.5$ Kn/m²

$L_s = 3$ Kn/m²

② Shape :-



$$g_{mod} = g_s \times \frac{\Sigma Area}{span} = 4.5 \times 2 \left[\frac{\left(\frac{1+4}{2} \times 1.5\right)}{4} \right.$$

$$P_{mod} = P_s \times \frac{\Sigma Area}{span} = 3 \times //$$

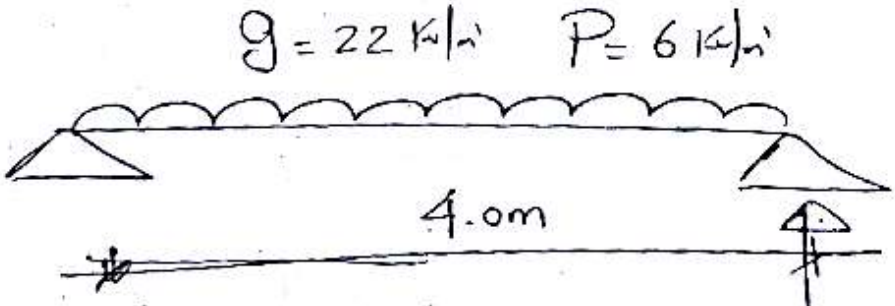
$$\therefore g_{mod} = \boxed{8.44 \text{ KN/m'}}$$

$$P_{mod} = \boxed{5.625 \text{ K/m'}}$$

$$\therefore g_{total} = \underbrace{0.}_{3.625} + \underbrace{g_{wall}}_{9.2} + \underbrace{g_{mod}}_{8.44} = \boxed{1.2}$$

$$\simeq \boxed{22 \text{ KN/m'}}$$

$$\therefore P_{total} = \boxed{5.625} \simeq \boxed{6 \text{ KN/m'}}$$



الحل ده هيتكلس حمل مركز في الكمره الرئيسيه

$R_g = 44$
$R_p = 12$

for Beam B_2 :-

(1) Loads :-

(1) O.W = 3.625 K/m'

(2) W_{wall} = 9.2 K/m'

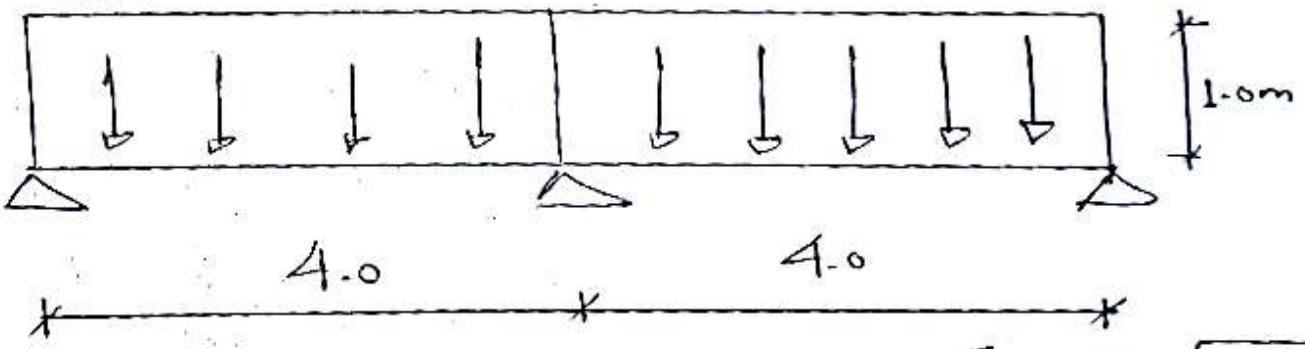
(3) Load from Slab :-

(1) Value :-

g_s = 4.5 K/m²

P_s = 3 K/m²

(2) Shape :-



$\therefore g_{mod} = g_s \times \frac{\Sigma Area}{span} = 4.5 \times \left[\frac{1 \times 8}{8}\right] = \boxed{4.5 K/m'}$

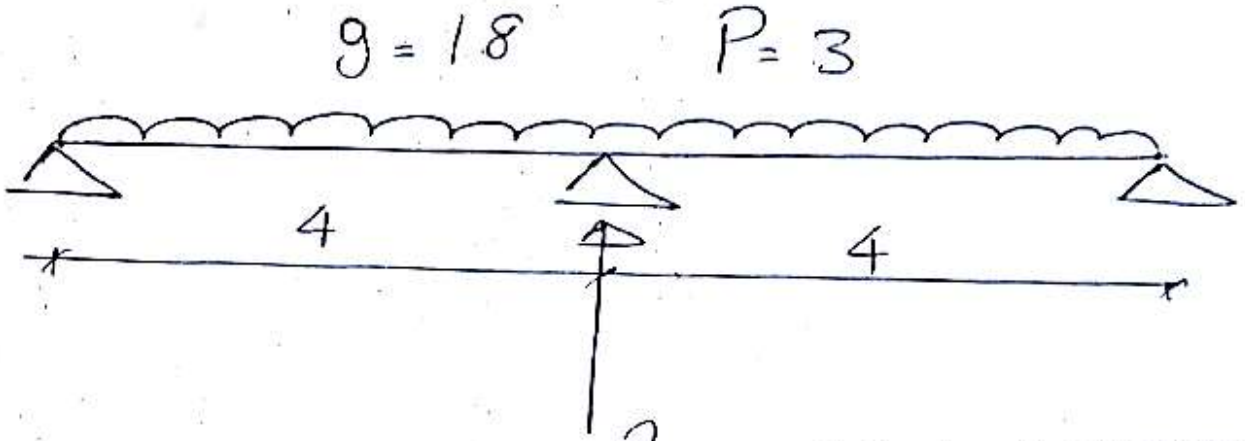
$P_{mod} = P_s \times \frac{\Sigma Area}{span} = 3 \times \left[\frac{1 \times 8}{8}\right] = \boxed{3 K/m'}$

$$\therefore g_{total} = g.w + w_{wall} + g_{mod}$$

$$3.625 + 9.2 + 4.5 = 17.3$$

$$\approx \boxed{18\ KN/m'}$$

$$P_{total} = P_{mod} = \boxed{3\ KN/m'}$$



$$R_g = 1.2 \times g \times L = 1.2 \times 18 \times 4 = \boxed{86.4}$$

$$R_p = 1.2 \times P \times L = 1.2 \times 3 \times 4 = \boxed{14.4}$$

الحمل ده هيتقلس حمل مركز ع الكمره الرئيسيه

for Main Girder (G):-

① Loads:-

① o.w = 3.625 Kn/m'

② w_{wall} = 9.2 Kn/m'

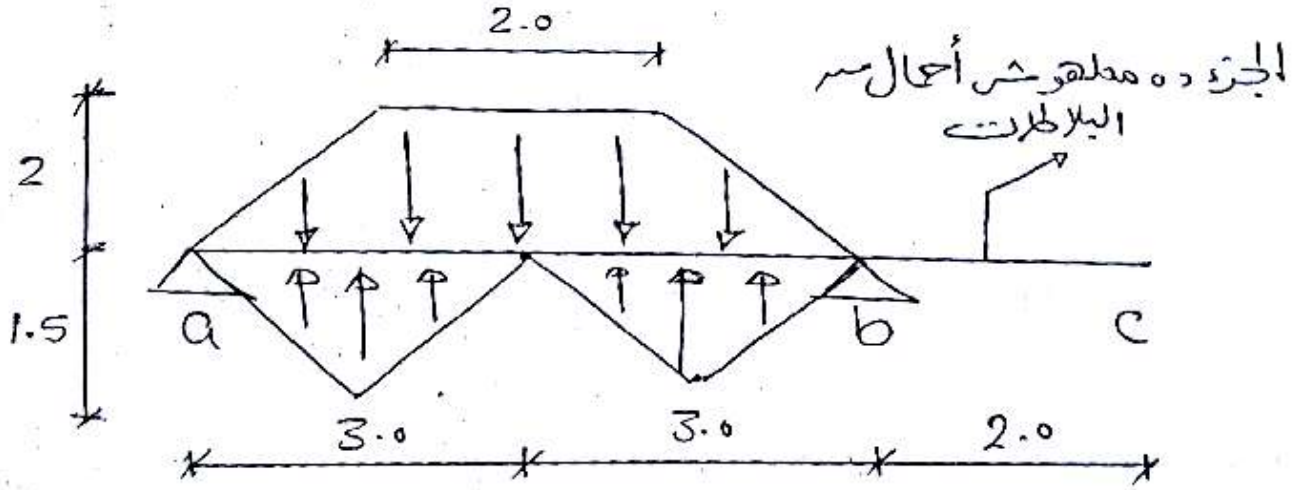
③ Load from Slab:-

① Value:-

g_s = 4.5 Kn/m²

P_s = 3 Kn/m²

② Shape:-



① for Part ab :-

$$g_{mod} = g_s \times \frac{\Sigma Area}{span} = 4.5 \times \left[\frac{\left(\frac{2+6}{2}\right)2 + 2 \times \frac{1}{2} \times 3 \times 1.5}{6}\right]$$

$$P_{mod} = P_s \times \frac{\Sigma Area}{span} = 3 \times \quad //$$

$$g_{mod} = 9.375 \simeq \boxed{10\ Kn/m'}$$

$$P_{mod} = \boxed{6.25\ Kn/m'}$$

$$\therefore g_{total} = \underbrace{22.8}_{\text{o.w + } w_{wall} + slab} \simeq \boxed{23\ Kn/m'}$$

$$P_{total} = P_{mod} = \boxed{6.25\ Kn/m'}$$

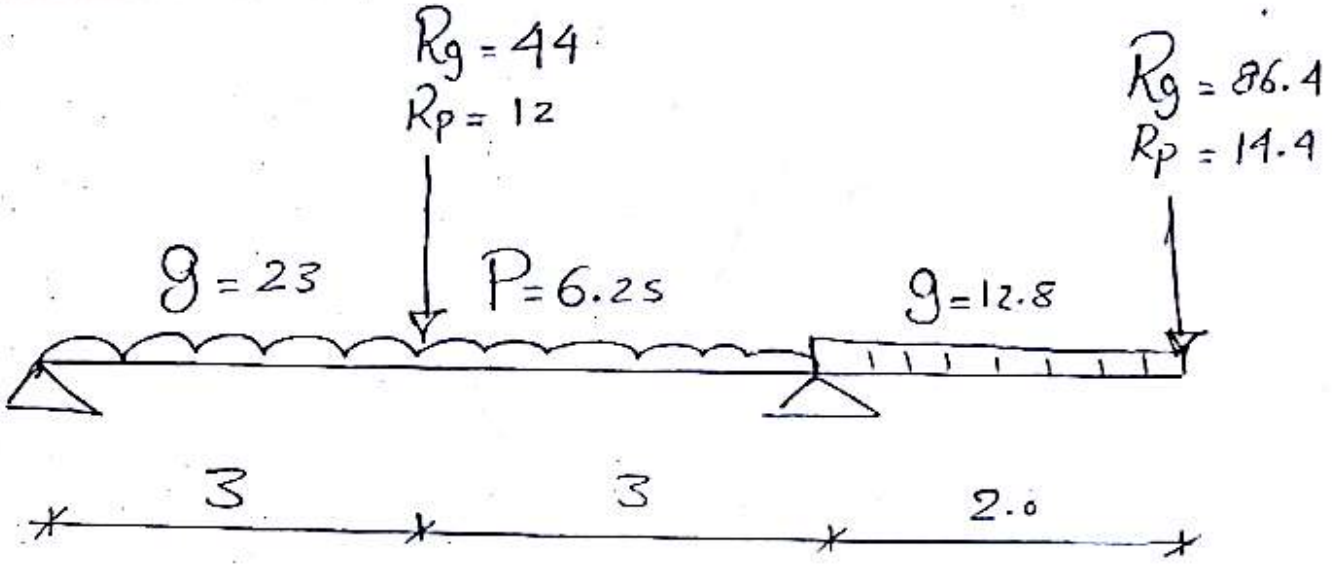
② for Part bc :-

بس کیونکہ صفیش کے اوپر دیوار ہے

$$g_{total} = o.w + w_{wall} = \boxed{12.8\ Kn/m'}$$

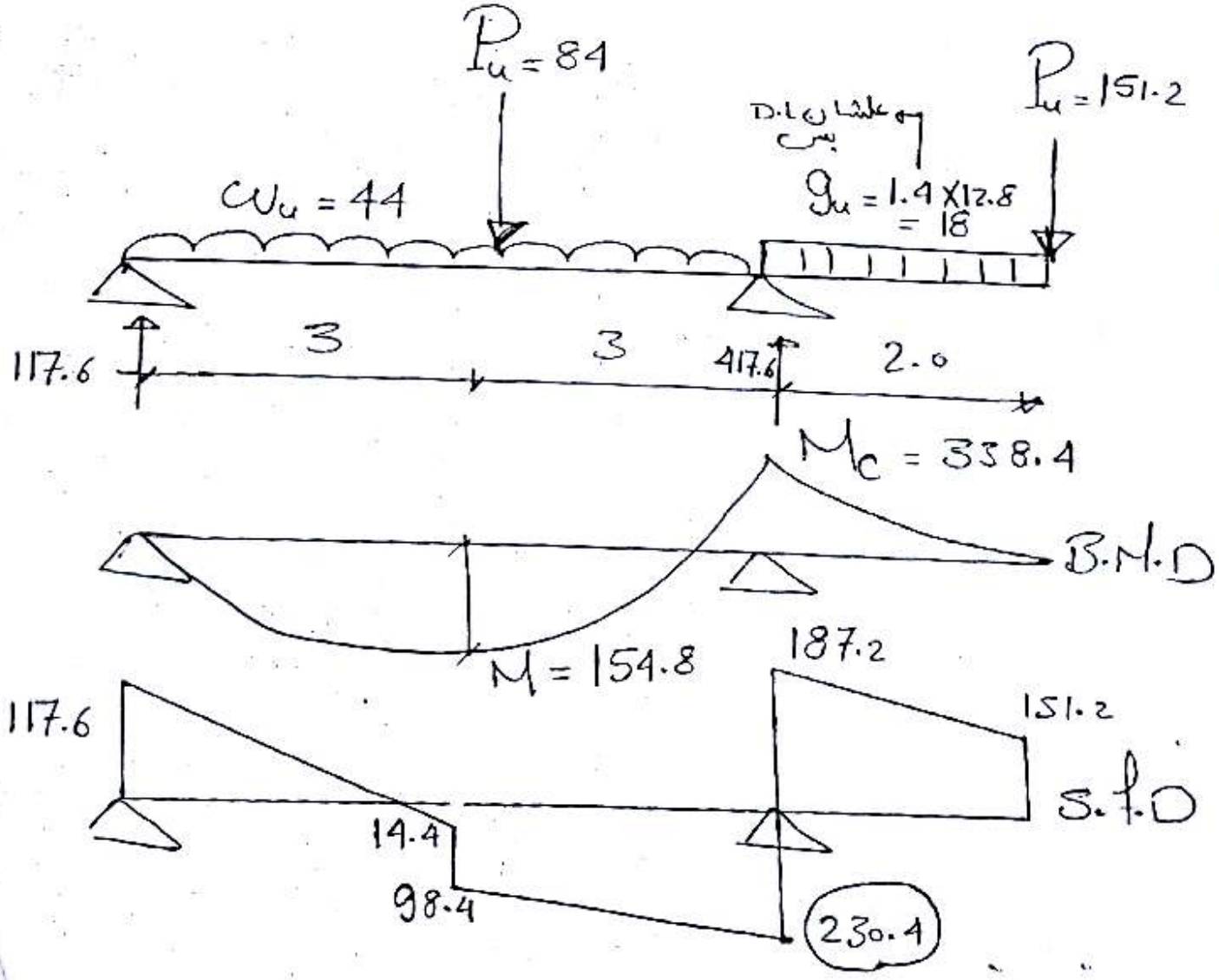
$$P_{total} = Zero \longrightarrow \text{صفیش پر لوڈ نہیں ہے}$$

live load

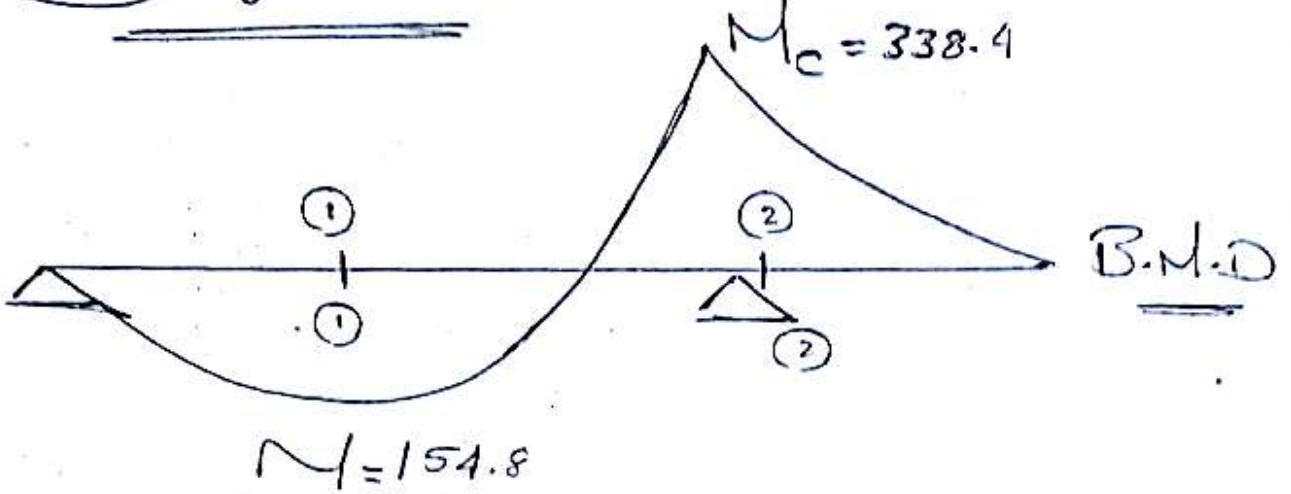


(2) Straining actions :-

ultimate Max ← هنختار الـ Max كلها بال



(3) Design for Flexure :-



(T-sec) (R.sec)

for Section (1-1) :- $M_u = 154.8$ KN.m

(T-sec) مقطع

B ← $\frac{M_{in}}{of}$ →
- $16t_s + b = 16 \times 120 + 250 = 2170$
- $\frac{l'}{5} + b = \frac{0.8 \times 6000}{5} + 250 = \boxed{1210}$
- ¢ - ¢

$$\therefore d = C_1 \sqrt{\frac{M_u * 10^6}{f_{cu} * B}}$$

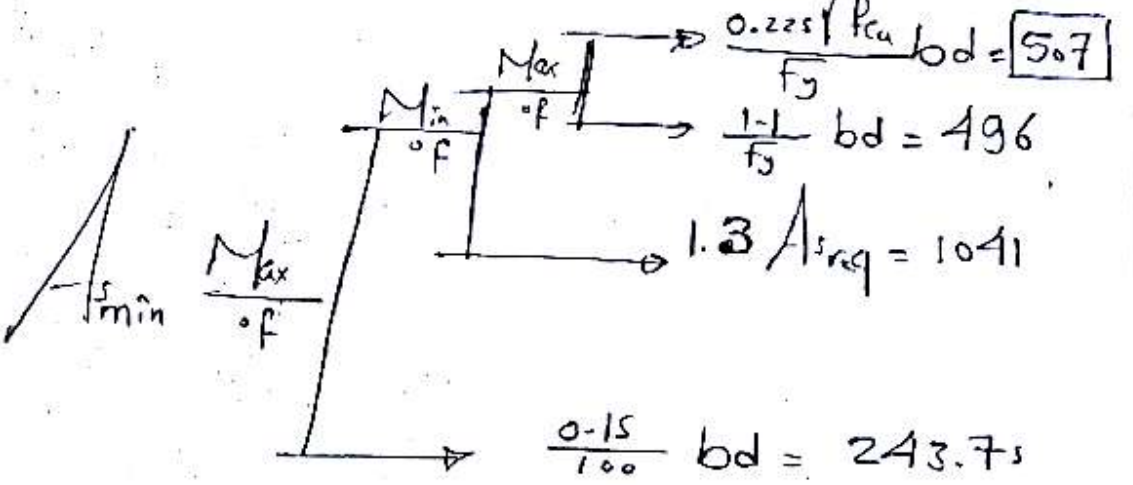
$$\therefore 650 = C_1 \sqrt{\frac{154.8 * 10^6}{25 \times 1210}}$$

$$\therefore C_1 = 9.09 \longrightarrow j = 0.826$$

$$\therefore A_s = \frac{M_u * 10^6}{F_y \, j \, d}$$

$$A_s = \frac{154.8 * 10^6}{360 \times 0.826 \times 650} = 800.9 \text{ mm}^2$$

Check $A_{s\,min}$



$$\therefore A_{s\,min} = 507 \text{ mm}^2$$

$$\therefore A_s > A_{s\,min}$$

use $A_s = 800.9 \text{ mm}^2$

use $\boxed{4 \not\# 16}$

$A_s' = 0.2 A_s$ use $\boxed{2 \not\# 10}$

① $M_{R_1} = \frac{4 \times 201}{800.9} \times \frac{M_{act}}{154.8} = \boxed{155.4}$

② l_{a_1} — $\frac{M_{ac}}{\phi f}$ → $0.7d = 0.7 \times 650 = \boxed{455}$.

→ $10\phi = 10 \times 16 = 160$

③ $l_{d_\perp} = \frac{\alpha \beta \gamma \phi \, f_y / f_s}{4 F_{ba}} = \boxed{880\ mm}$

for Section (2-2) :- $M_u = 338.4$

(R-Sec) فرضية

$$\therefore d = C_1 \sqrt{\frac{M_u * 10^6}{f_{cu} * b}}$$

$$= 650 = C_1 \sqrt{\frac{338.4 * 10^6}{25 \times 250}}$$

$$\therefore C_1 = 2.79 \xrightarrow{\text{Table}} j = 0.721$$

$$\therefore A_s = \frac{M_u * 10^6}{f_y \, j \, d}$$

$$A_s = \frac{338.4 * 10^6}{360 \times 0.721 \times 650} = 2005.76 \text{ mm}^2$$

Check $A_{s_{min}} = 507 \text{ mm}^2$

$\therefore A_s > A_{s_{min}}$

$\therefore$ use A_s ~~$A_{s_{min}}$~~ 2005.76 mm^2

use 5#25

$A_s' = 0.2 A_s$ use 2#16

① $M_{R_{②}} = \frac{5 \times 491}{2005.76} \times 338.4 = 414.2$ KN.m

② $l_{a_{②}}$ $\frac{M_{ax}}{\phi f}$ → $0.7d = \boxed{455 \text{ mm}}$

$10\phi = 10 \times 25 = 250$ mm

③ $l_{d_{②}} = \frac{\alpha \beta \gamma \phi f_y / \gamma_s}{4 f_{bu}} = 55\phi \times 1.3$ أسياخ علوية

$l_d = \boxed{1787.5 \text{ mm}}$

④ Design for Shear :-

$$Q_{umax} = 230.4 \text{ KN}$$

① $$Q_{uCr} = Q_{umax} - w_u \left[\frac{C}{2} + \frac{d}{2} \right]$$

$$= 230.4 - 44 \left[\frac{0.4}{2} + \frac{0.65}{2} \right]$$

$$= \boxed{207.3 \text{ KN}}$$

② $$q_{sh} = \frac{Q_{uCr} * 10^3}{b \times d}$$

$$= \frac{207.3 * 10^3}{250 \times 650} = \boxed{1.28 \text{ N/mm}^2}$$

③ $$q_{Cu} = 0.24 \sqrt{\frac{f_{cu}}{\gamma_c}} = \boxed{0.98 \text{ N/mm}^2}$$

$$\therefore q_{sh} > q_{Cu}$$

= unsafe

need to use stirrups

Calculation of stirrups :-

$$q_{rsh} = \frac{q_c}{2} + q_{rst}$$

$$1.28 = \frac{0.98}{2} + q_{st}$$

$$\therefore q_{st} = 0.79 \text{ N/mm}^2$$

$$\therefore q_{st} = \frac{n A_{st} \frac{f_{y,t}}{\gamma_s}}{b \times S}$$ assume ϕ_s = 10mm

$$0.79 = \frac{2 \times 78.5 \times \frac{240}{1.15}}{250 \times S}$$

$$\therefore S = 165.9 \text{ mm}$$

$$\therefore n' = \frac{1000}{S} = 6.02$$

عدد الكانات / متر

$\therefore$ use 7 ϕ 10/m'

Reinforced Concrete

Design Of Beams

Solved Example ③

Eng:Ahmed Yehia

Question III 40%

For the part of a structural plan of a residential building shown in Figure 3; It is required to:

1- Draw the load distribution of slabs on plan.

2- Calculate load on beam (B) on axis 1-1.

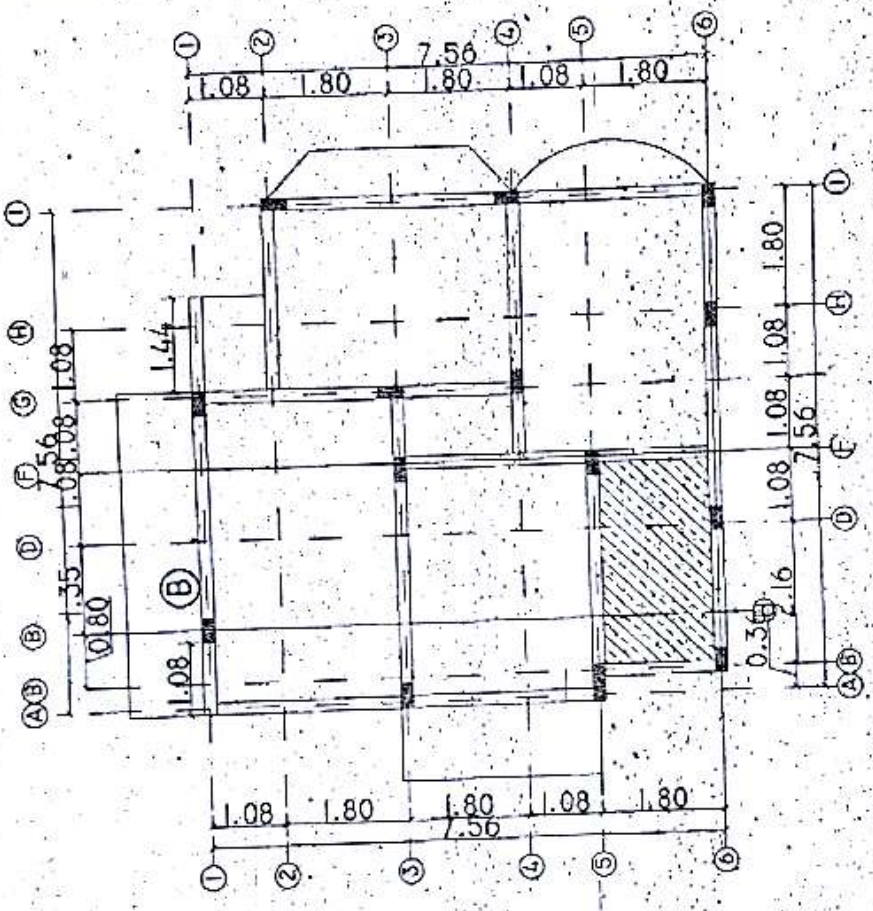
3- Draw the S.F.D and B.M.D due to ultimate total loads.

4- Design the critical sections of beam (B) for flexure and shear for the case of total loads.

5- Using moment of resistance diagram (MRD), show flexure and shear reinforcement details for the beam in elevation and cross sections to a convenient scale , including cut off points of reinforcement.

6. *Calculate development and anchorage lengths and then show it on the reinforcement elevation section.*

consider slab thickness = 140 mm, width of all beams = 250 mm, roof flooring = 2.0 kN/m², live load = 2.50 kN/m² and walls exist over all beams with intensity of 3 kN/m² as well as over outer blacony's with height of 1.2m, floor height 3.10m and total beam thichness 650m, column dimensions 250×400mm.

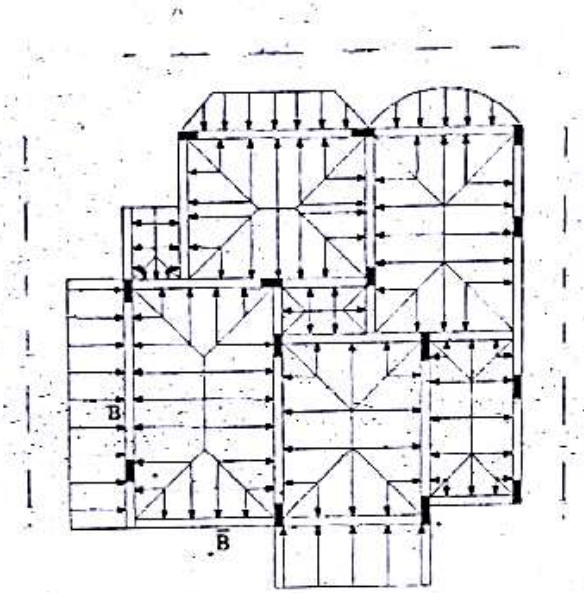


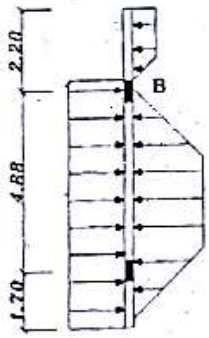
Question IV solution:-

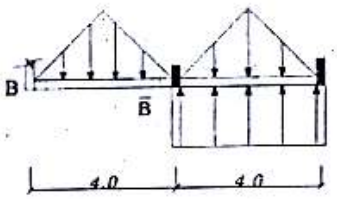
Data

consider slab thickness = 140 mm, width of all beams 250 mm,
F.C load = 2.50 kN/m , Live load = 2.50 kN/m and walls exist over all beams with intensity 3 kN/m and blacony's with height of 1.2m, floor height 3.10m total beams thickness 650 mm. Column dimension 250 * 400 mm

1. the load distribution of slabs on plan.







* نلاحظ فى المسأله دى :-

← إنه الكمره (B') كمره ثانويه على الكمره (B)

يبقى طرح رد فعل (B') الأول علشان نحسب رد فعلها على الكمره الرئيسيه (B)

① for Beam (B') :-

→ Loads :-

① o.w = $b(t-t_s)\gamma_{R.C}$

$= 0.25(0.65-0.14) * 25 = 3.2$ KN/m`

② $w_{wall} = \gamma_w h_w$, $h_w = (h_f - t)$

$= 3(3.1-0.65) = 7.35$ KN/m`

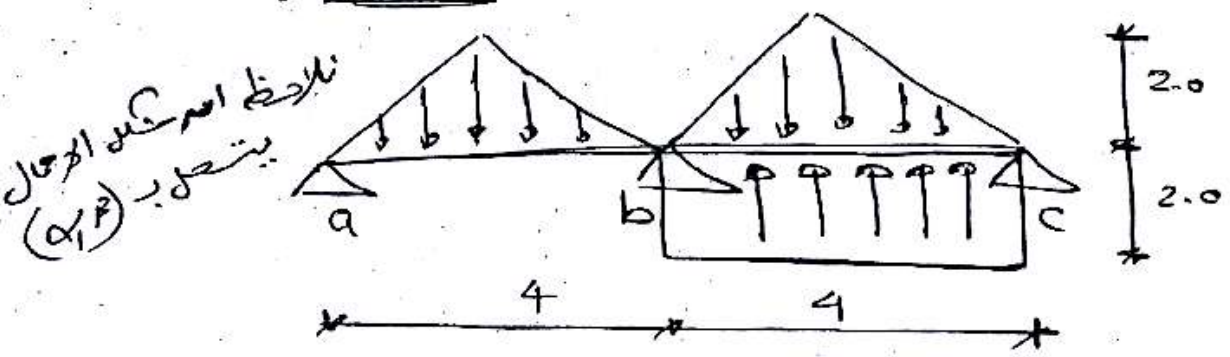
③ load from Slab:

① Value:

$g_s = t_s * \gamma_{R.C} + f.C = 0.14 * 25 + 2.0 = 5.5$ KN/m²

$P_s = 3$ KN/m²

② Shape:



→ for Part (ab) :-

$$g_{mod} = g_s \times \frac{\Sigma Area}{span} = 5.5 * \left(\frac{\frac{1}{2} \times 2 \times 4}{4}\right) = \boxed{5.5}$$

$$P_{mod} = P_s \times \frac{\Sigma Area}{span} = 5 * \left(\frac{\frac{1}{2} \times 2 \times 4}{4}\right) = \boxed{5}$$

$$g_{tot} = g_{mod} + o.w + wall = \boxed{16.05 \text{ KN/m}}$$

$$P_{tot} = \boxed{5 \text{ KN/m}}$$

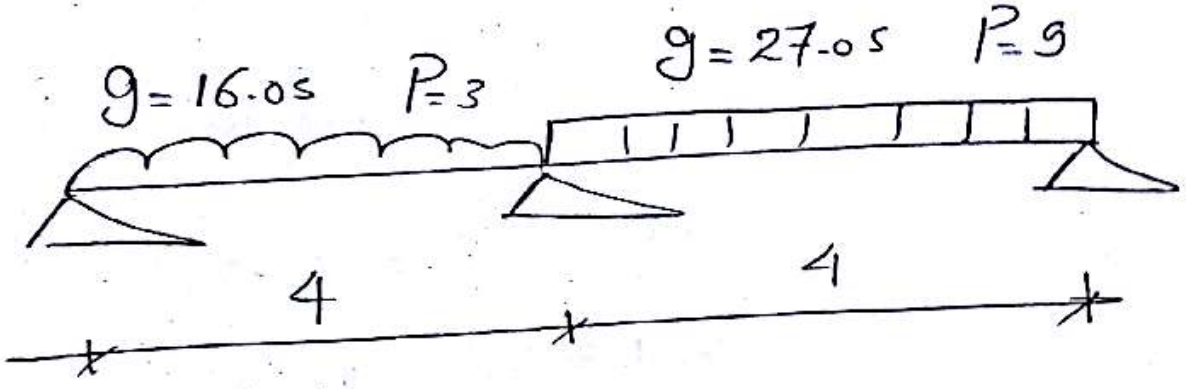
→ for Part (bc) :-

$$g_{mod} = g_s \times \frac{\Sigma Area}{span} = 5.5 * \left[\frac{\frac{1}{2} \times 2 \times 4 + 2 \times 4}{4}\right] = \boxed{16.5}$$

$$P_{mod} = P_s \times \frac{\Sigma Area}{span} = 5 * \left[\frac{\frac{1}{2} \times 2 \times 4 + 2 \times 4}{4}\right] = \boxed{9}$$

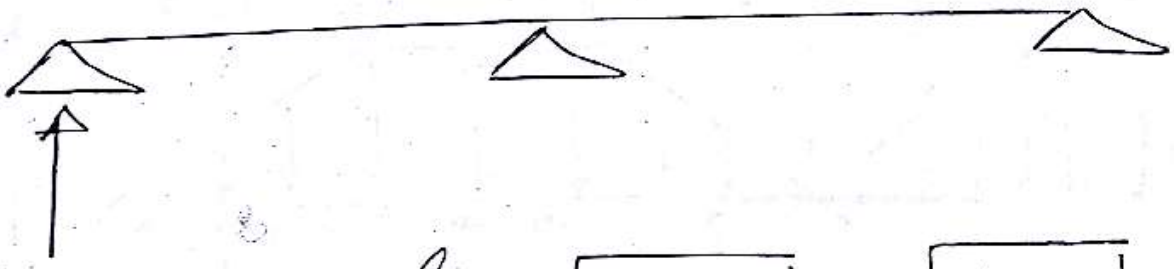
$$\therefore \quad g_{tot} = \boxed{27.05 \text{ KN/m}}$$

$$P_{tot} = \boxed{9 \text{ KN/m}}$$



المتوسط $g_{av} = 21.55$

المتوسط $P_{av} = 6$



$$R_g = \frac{0.6}{0.6} g_{av} l_{av} = \boxed{38.8} \simeq \boxed{40\ kN}$$

$$R_p = \frac{0.6}{0.6} P_{av} l_{av} = \boxed{10.8} \simeq \boxed{11\ kN}$$

② for Beam (B) :-

① Loads :-

① o.w = 3.2 Kn/m`

② W_{wall} = 7.35 Kn/m`

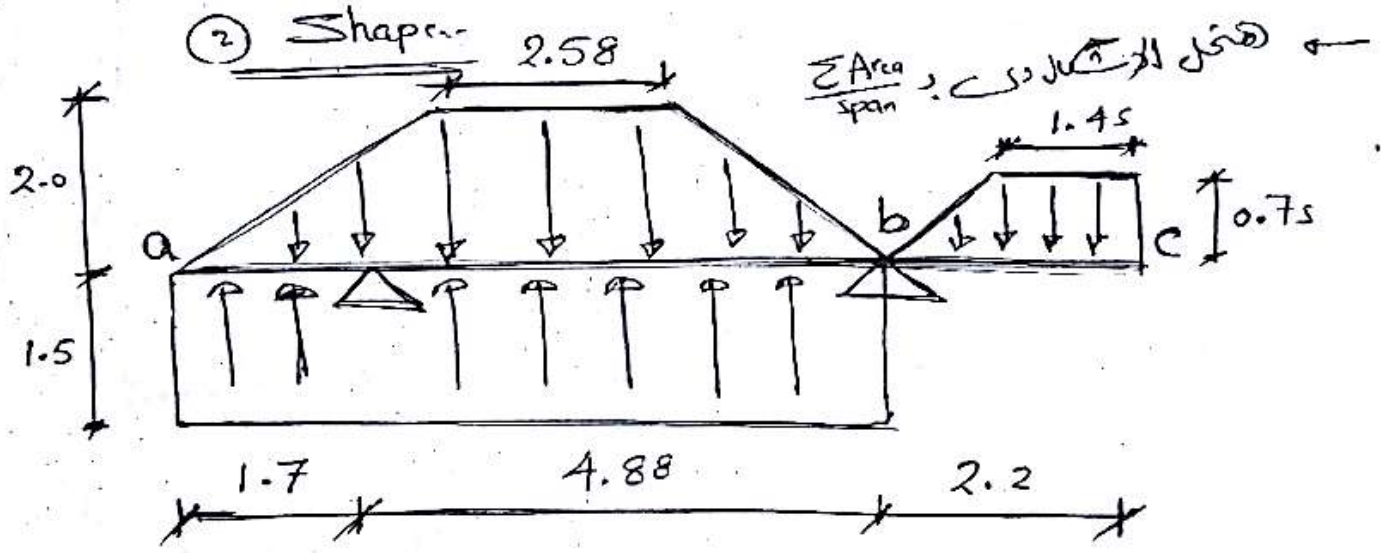
③ Load from Slab :-

① Valve :-

g_s = 5.5 Kn/m`

P_s = 3 Kn/m`

② Shape :-



$\frac{\Sigma Area}{span}$: شكل المثلث

for part (ab)

$$g = g_s * \frac{\Sigma Area}{span} = 5.5 * \left[\frac{\frac{(2.58+6.58)}{2} \times 2 + (6.58 \times 1.5)}{6.58} \right]$$

$$g = 5.5 * 2.89 = 16 \text{ Kn/m`}$$

$$P = P_s * \frac{\Sigma Area}{span} = 3 * 2.89 = 8.7 \text{ Kn/m`}$$

$$g_{total} = o.w + \omega_{wall} + g = 26.45 \text{ Kn/m`}$$

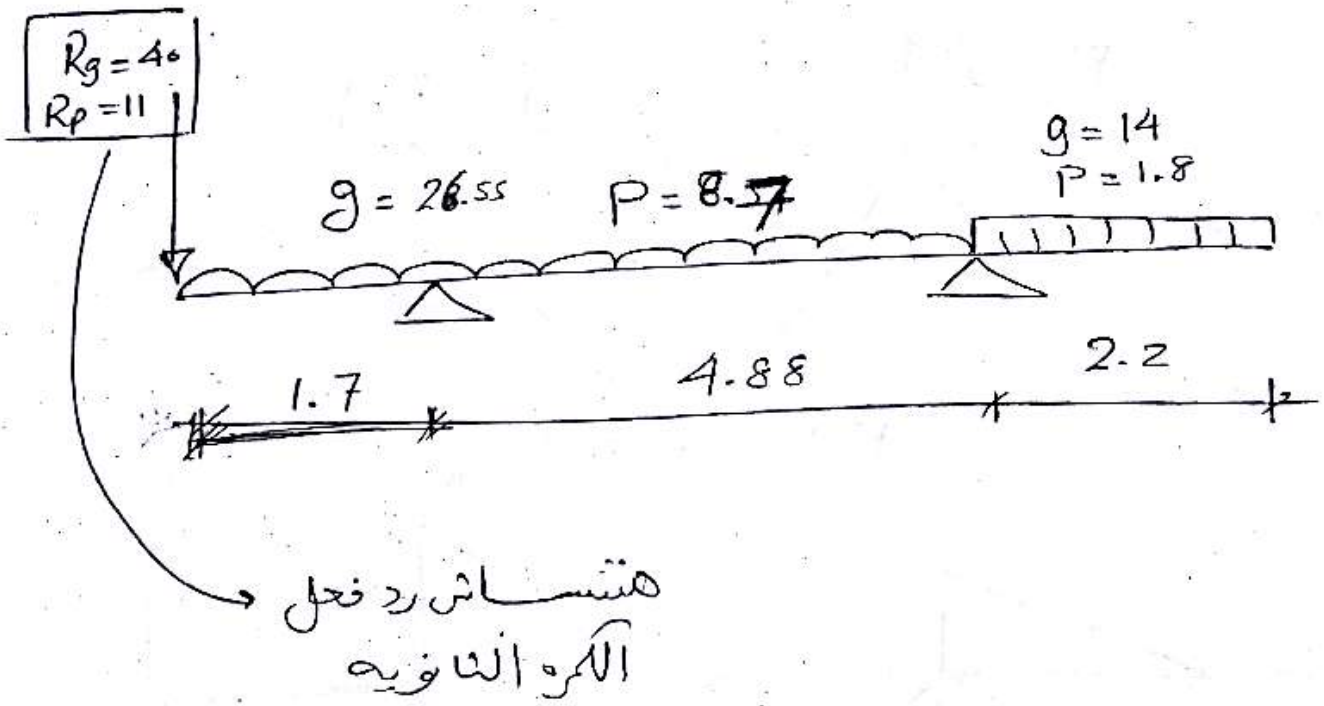
for Part(bc) :-

$$g_{mod} = g_s \times \frac{\Sigma Area}{span} = 5.5 * \left[\frac{\left(\frac{1.45+2.2}{2}\right) 0.75}{2.2}\right] = \boxed{3.4}$$

$$P_{mod} = P_s \times \frac{\Sigma Area}{span} = 3 * \quad // \quad = \boxed{1.8}$$

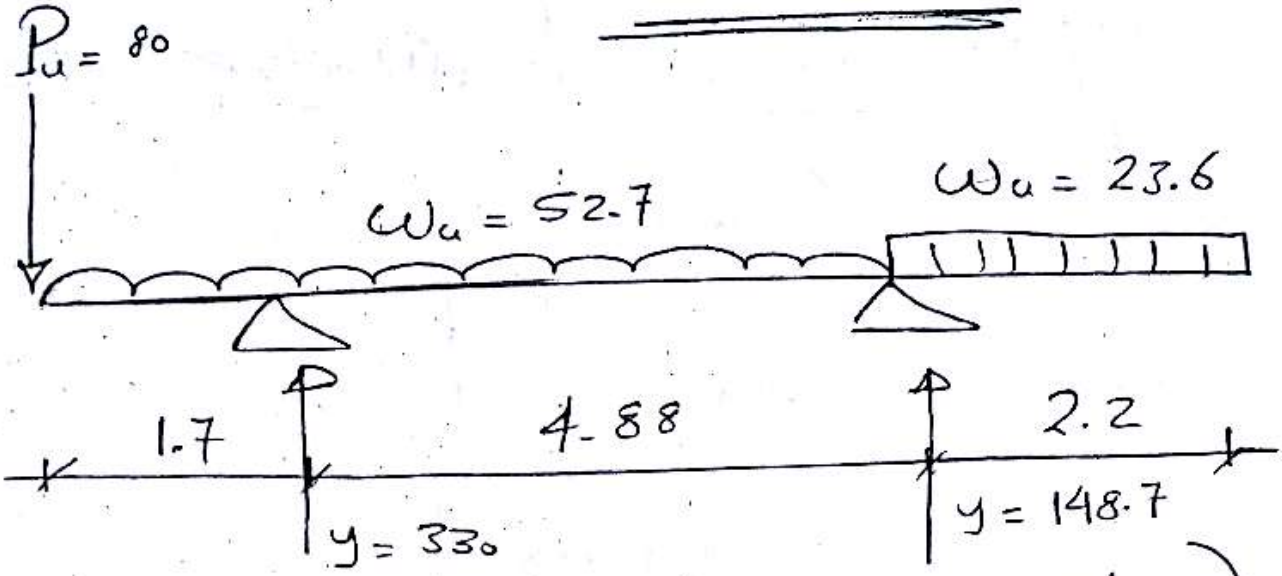
$$g_{total} = o.w + w_{wall} + g_{mod} = \boxed{13.95 \text{ K/m}} \simeq 14$$

$$P_{t.tal} = \boxed{1.8}$$

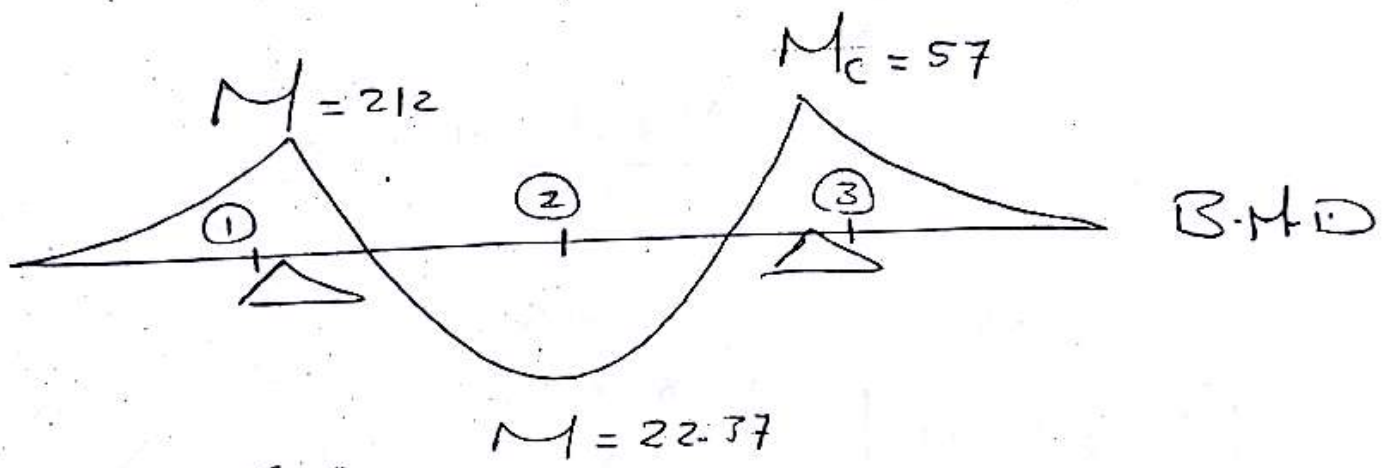


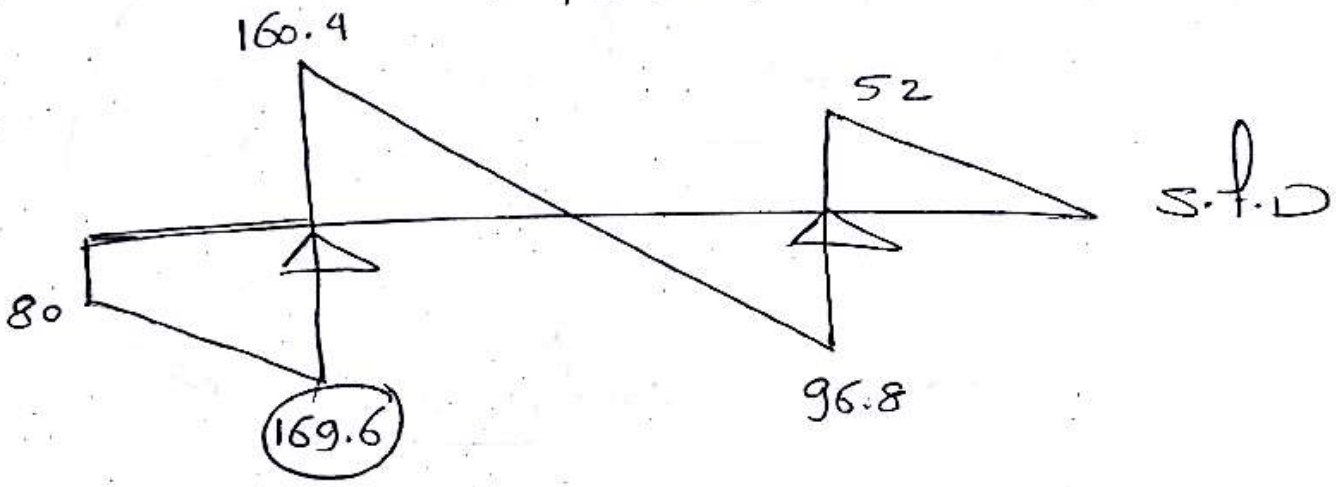
هتشاش رد فعل
الكمره التانيه

① نحمل كل البحور بال Max



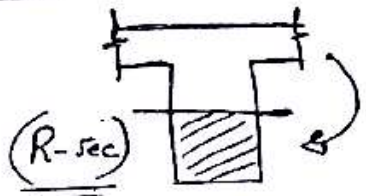
② Straining actions (Moment , Shear)





(3) 1 Design for flexure:-

① for Section ① :- $\boxed{M_u = 212 \ \text{Kn.m}}$



$$d = C_1 \sqrt{\frac{M_u * 10^6}{F_u * b}}$$

$$d = t - 50 = 650 - 50 = 600 \ mm$$

$$600 = C_1 \sqrt{\frac{220 * 10^6}{25 * 250}}$$

$C_1 = 3.46 \xrightarrow{\text{Table}} j = 0.8$ مثلاً

$$A_s = \frac{M_u * 10^6}{f_y \ j \ d} =$$

$$A_s = \frac{220 * 10^6}{360 * 0.8 * 600} = 1273 \ mm^2$$

$\boxed{\text{use } 6 \not\phi 18}$

$$A_s' = 0.2 A_s = 304.8 \ mm^2$$

$\boxed{\text{use } 3 \not\phi 12}$

Check $A_{s\min}$ هتشوفه

بعد التقريب

① $M_{R_1} = \dfrac{6 * \frac{\pi (18)^2}{4}}{1273} * 212 = \boxed{254 \ \text{Kn.m}}$.

قبل التقريب

② l_{a_1} $\frac{M_{bx}}{\sigma_F}$

$0.7d = 0.7 * 600 = 420 \text{ mm}$

$10\not{\phi} = 10 \times 18 = 180 \text{ mm}$

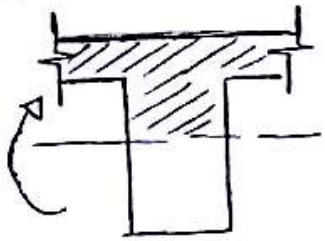
$\therefore l_a = \boxed{420 \text{ mm}}$

③ $l_{d_1} = \dfrac{\alpha \beta \gamma \not{\phi} \, f_y/\sigma_s}{4 f_{bu}}$, $f_{bu} = 0.3 \sqrt{\dfrac{f_{cu}}{\sigma_c}}$.

$l_d = 1287 \text{ mm}$

for Section ②:- $\boxed{M_u = 22.37}$

$$d = C_1 \sqrt{\frac{M_u * 10^6}{f_{cu} * B}}$$



(T - sec)

B Min $\rightarrow 16 t_s + b = 2490$

$\rightarrow \frac{L'}{5} + b = \boxed{935}$

$\rightarrow$ ℄ - ℄

$$L' = 0.7\, L = 0.7 * 4.88 = 3.4$$

$$600 = C_1 \sqrt{\frac{22.37 * 10^6}{25 * 933}}$$

$$C_1 = 19.37 \xrightarrow{\text{Table}} j = 0.826$$

طا C_1 تطلع اكبر مسم قيمة في الجدول
ناخد الـ (j) اللي قيمة في الجدول

$$A_s = \frac{M_u' * 10^6}{F_y\, j\, d}$$

$$A_s = \frac{22.37 * 10^6}{360 * 0.826 * 600} = 125 \ mm^2$$

Use $\boxed{2 \not\phi 12}$ أقل حاجه

Check $A_{s\,min}$ هتشاش

$$A_s' = 0.2\, A_s$$

Use $\boxed{2 \not\phi 10}$ أقل حاجه

① $M_{R_2} = \dfrac{2 * \frac{\pi (12)^2}{4}}{125} * 22.57 = \boxed{40.44 \text{ KN.m}}$

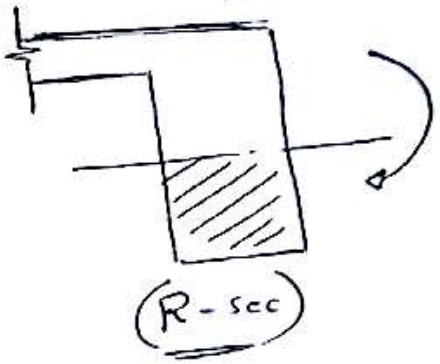
② l_{a_2} Max of → $0.7d = 420\,mm$; → $10\not{\phi} = 10 * 12 = 120\,mm$

③ $l_{d_2} = 660\,mm$

for Section ③ :- $M_u = 57$

طريقة القطاع ده هيتصمم (R-Sec)

Section ① نأخذ القطاع ①



حكم نعمله تسيبو وتتناسب مع

Section ①

220 ⟶ 6Ø18 = 1524

57 ⟶ A_s

$$A_s = \frac{57 * 1524}{220} = 349.85 \ mm^2$$

use 4Ø12

$$A_s' = 0.2 A_s = 78$$

use 2Ø10

Check $A_{s\min}$ متنساش

① $M_{R_3} = \dfrac{4 * \dfrac{\pi (12)^2}{4}}{349.85} * 57 = \boxed{74 \ \text{Kw.m}}$

② l_{a_3} Max of
- → $0.7 d = \boxed{480 \ \text{mm}}$
- → $10 \phi = 10 * 12 = 120 \text{mm}$

③ $l_{d_3} = \boxed{858 \ \text{mm}}$

④ Check of Shear

$Q_{umax} = 169.6 \simeq 170$ KN من برنامج الـ S.F.D

① $Q_{ucr} = Q_{umax} - w_u \left(\frac{c}{2} + \frac{d}{2}\right)$

assume $C = 0.5m$

$Q_{ucr} = 170 - 52.7\left(\frac{0.5}{2} + \frac{0.6}{2}\right)$

$Q_{ucr} = 141$ KN

② $q_{sh} = \frac{Q_{ucr} * 10^3}{b \times d}$

$= \frac{141 * 10^3}{250 * 600} = 0.94$ N/mm²

③ $q_{cu} = 0.24\sqrt{\frac{f_{cu}}{\gamma_c}} = 0.98$ N/mm²

④ $\because q_{sh} < q_{cu} \longrightarrow \therefore$ Safe

use Min stirrups

5Φ 8/m'