Hollow Blocks Examples.

خطوات حل مسائل البلاطات

١- نرسم الـ *plan* و نحدد نوع البلاطات و نرسم الاسهم التى تحدد اتجاه الـ *Loads*

خطوات التصميم .

١- نحسب الـ t_s للبلاطات الـ *solid* و الـ t للبلاطات الـ *Hollow*

٢- نحسب الـ w_s للبلاطات الـ *solid* و الـ w_{rib} للبلاطات الـ *Hollow*

٣- نحسب الـ γ للبلاطات الـ *Two way*

ثم نحسب α ، β للبلاطات الـ *solid* عن طريق الـ *Code of Practice*

و الـ α ، β للبلاطات الـ *Hollow* عن طريق الـ *Marcus*

٤- نأخذ شرائح بالعرض ثم شرائح بالطول مع مراعاه عرض الشريحه .

- اذا كانت الشريحه تمر ببلاطه *Hollow* يكون عرض الشريحه $S=e+b$
- اذا كانت الشريحه تمر ببلاطه *solid* فقط و لا تمر ببلاطه *Hollow* يكون عرض الشريحه =١,٠م

ثم نرسم الـ *B.M.D.* لهذه الشرائح

٥- نعمل تصميم للشرائح مع مراعاه عرض الشريحه

و مراعاه اذا كان التسليح $2\phi\checkmark\backslash rib$ أم $\checkmark\phi\checkmark\backslash S$

٦- نحسب عرض الـ *solid part* و رص البلوكات .

خطوات التسليح .

١- نرسم تسليح شرائح بالعرض .

٢- نرسم تسليح شرائح بالطول .

٣- اذا وجدت بلاطات *One Way solid* نرسم حديد *Secondary* ($5\phi10\backslash m$) و يكون حديد سفلى .

٤- اذا وجد *Cantilevers* نرسم حديد ($5\phi10\backslash m$ *Top & Bottom*)

٥- اذا كان الـ*moment* علوى على كل الـ *span* .

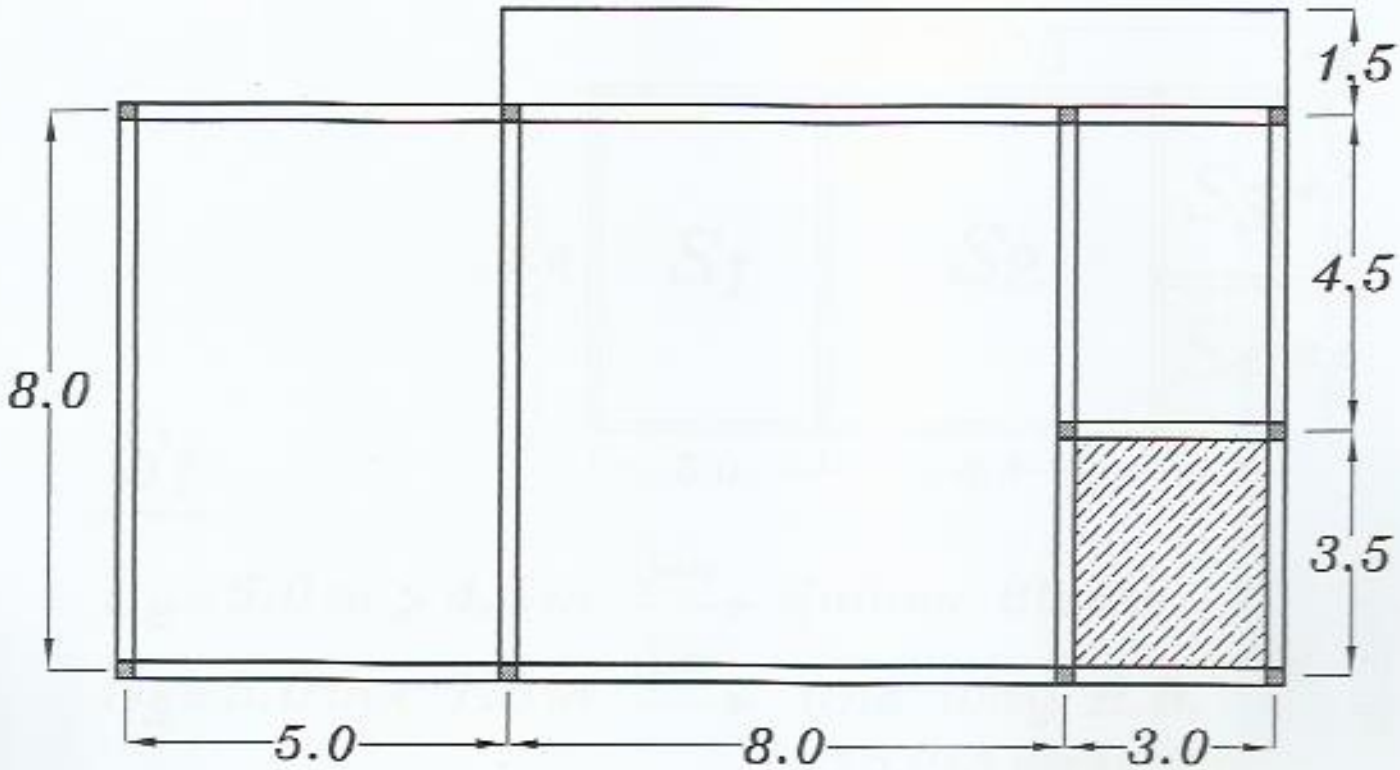
نرسم بقيه الشبكتين السفليه و العلويه فى البلاطه .

٦- نرسم الشبكه ($5\phi10\backslash m$ & $4\phi10\backslash m$) فى البلاطات الـ *One way Hollow Blocks*

و نرسم الشبكه ($4\phi10\backslash m$ & $4\phi10\backslash m$) فى البلاطات الـ *Two way Hollow Blocks*

٧- نرسم بقيه الشبكتين السفليه و العلويه فى البلاطه اذا زادت الـ t_s للبلاطات الـ *solid* عن ١٦٠ مم

Example.



Data.

$F_{cu} = 25\ N\backslash mm^2$ $F_y = 360\ N\backslash mm^2$

$F.C. = 2.0\ kN\backslash m^2$ $L.L. = 1.5\ kN\backslash m^2$

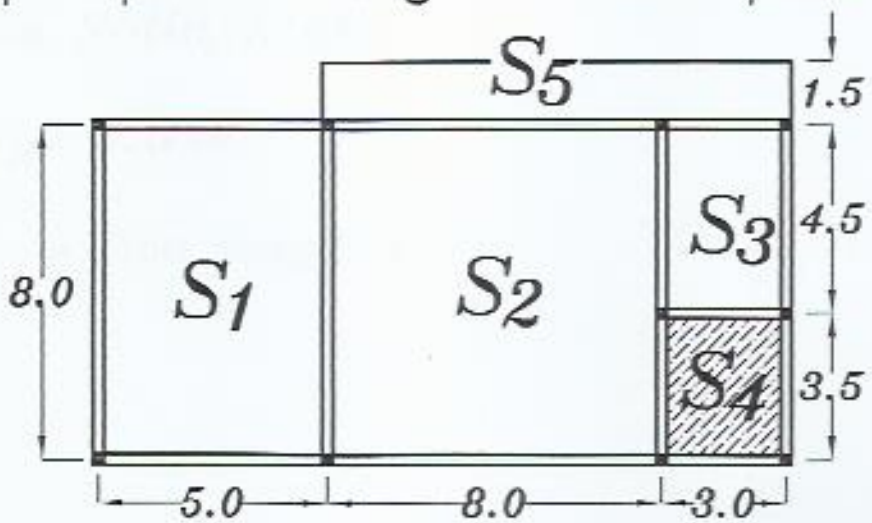
Req.

① Design the Slab as Solid Slab.

② Draw Details of RFT. in plan.

Solution.

١- نرسم الـ plan و نحدد نوع البلاطات و نرسم الاسهم التى تحدد اتجاه الـ Loads



S_1

$L_s = 5.0\,m > 4.5\,m \xrightarrow{\text{يفضل}}$ *Hollow Blocks*

$L_s = 5.0\,m < 7.0\,m \xrightarrow{\text{يفضل}}$ *One way H.B.*
at 5.0 m direction
No Cross rib

S_2

$L_s = 8.0\,m > 4.5\,m \xrightarrow{\text{يفضل}}$ *Hollow Blocks*

$L_s = 8.0\,m > 7.0\,m \;\&\; \frac{L}{L_s} < \frac{4}{3} \longrightarrow$ *Two way H.B.*

S_3

$L_s = 3.0\,m < 4.5\,m \xrightarrow{\text{يفضل}}$ *Solid Slab*

$L = 4.5\,m\ ,\ L_s = 3.0\,m$

$\therefore \frac{L}{L_s} < 2.0 \longrightarrow$ *Two way S.S.*

S_4

بلاطه حمام $\xrightarrow{\text{يفضل}}$ *Solid Slab*

$L = 3.5\,m$, $L_S = 3.0\,m$

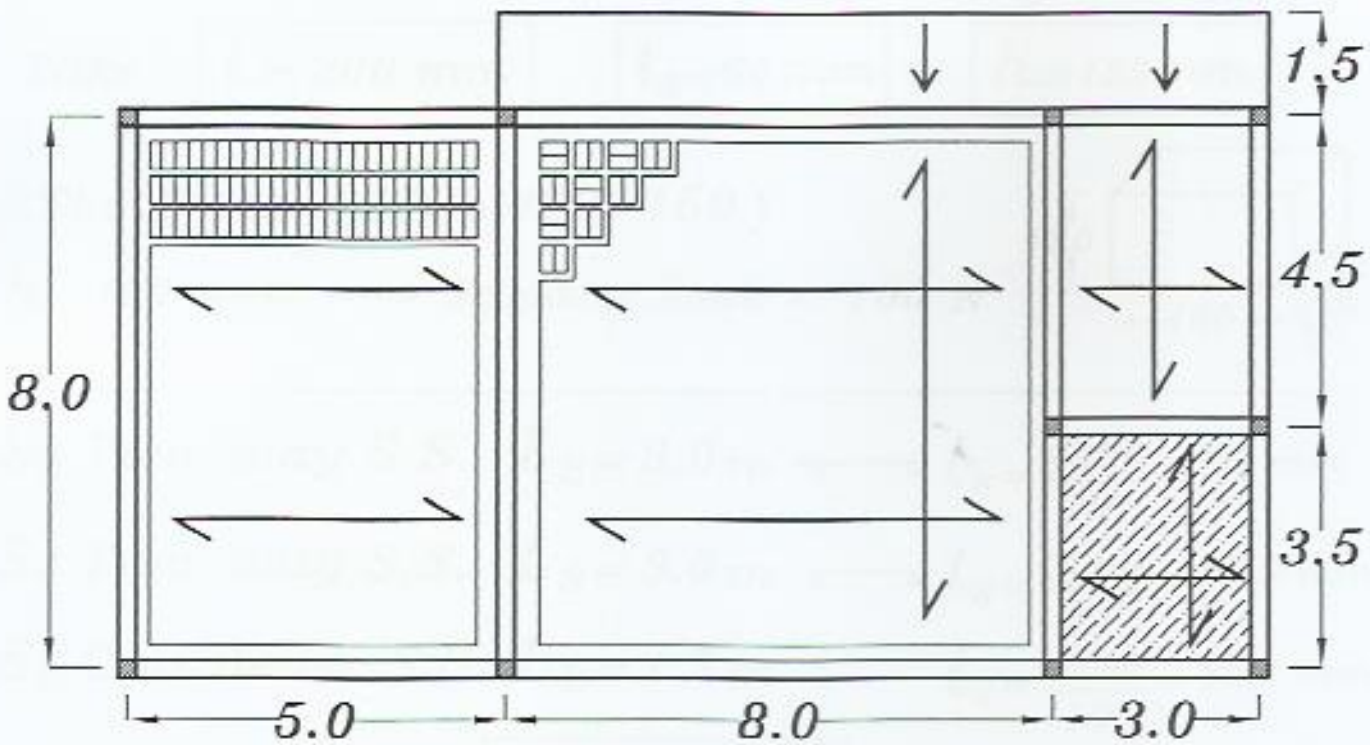
$\therefore \frac{L}{L_s} < 2.0 \longrightarrow$ *Two way S.S.*

S_5

Cantilever $\xrightarrow{\text{يفضل}}$ *Solid Slab* فى الكليه

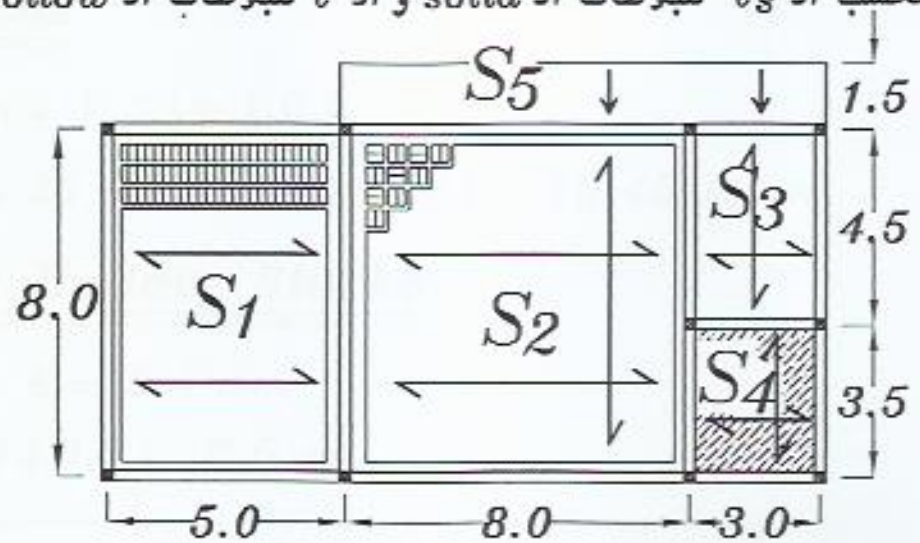
$L_c < 2.0\,m \xrightarrow{\text{يفضل}}$ *Solid Slab* فى الشغل

فى هذا المثال سنأخذ بلاطه الحمام *Simple*



خطوات التصميم .

١- نحسب الـ t_s للبلاطات الـ solid و الـ t للبلاطات الـ Hollow



S_1 One way H.B. $L_s = 5.0\,m$

$t = \frac{5000}{25} = 200\ mm$ $\boxed{t = 200\ mm}$

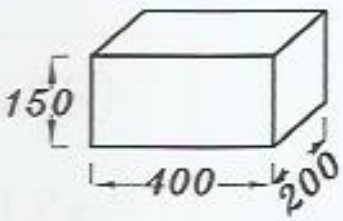
S_2 Two way H.B. $L_s = 8.0\,m$

$t = \frac{8000}{40} = 200\ mm$ $\boxed{t = 200\ mm}$

Take $\boxed{t = 200\ mm}$ $\boxed{t_s = 50\ mm}$ $\boxed{h = 150 mm}$

The Block $(200 * 400 * 150)$

$h = 150\ mm \longrightarrow$ Weight of Block $= 100\ N$



S_3 Two way S.S. $L_s = 3.0\,m$ $t_s = \frac{3000}{40} = 75\ mm$

S_4 Two way S.S. $L_s = 3.0\,m$ $t_s = \frac{3000}{35} = 85.7\,mm$

S_5 Cantilever S.S. $L_c = 1.5\,m$ $t_s = \frac{1500}{10} = 150\ mm$

$\boxed{t_s = 150\,mm}$

٢ـ نحسب الـ w_s للبلاطات الـ solid و الـ w_{rib} للبلاطات الـ Hollow

For Solid Slabs.

$$w_s = 1.4\left(t_s\,\delta_c + F.C.\right) + 1.6\ L.L.$$

$$w_s = 1.4\,(0.15 * 25 + 2.0\,) + 1.6\,(1.5) = 10.45\ kN\backslash m^2$$

For One way Hollow Blocks.

$$b = 0.1\,m \qquad e = 0.4\,m$$

$$S = e + b = 0.4 + 0.1 = 0.5\ m$$

$$w_{rib1} = \left[1.4\,(t_s\,\delta_c + F.C.) + 1.6\,(L.L.)\right](S * 1.0) + 1.4\,(b\,h * 1.0\,m * \delta_c) + 1.4 * (\text{وزن الـ Block})\left(\frac{1.0}{a}\right)$$

$$\therefore w_{rib1} = \left[1.4\,(0.05 * 25 + 2.0\,) + 1.6\,(1.5)\right]\,(0.50 * 1.0) + 1.4\,(0.10 * 0.15 * 1.0 * 25) + 1.4\left(\frac{100}{1000}\right)\left(\frac{1.0}{0.2}\right) = 4.70$$

$$(kN\backslash(m * S))$$

For Two way Hollow Blocks.

$$w_{ribT} = \left[1.4\,(t_s\,\delta_c + F.C.) + 1.6\,(L.L.)\right](S * 2S) + 1.4 * b\,h * (4S - 2b) * \delta_c + 1.4 * (\text{وزن الـ Block})\,(2 * \frac{e}{a})$$

$$\therefore w_{ribT} = \left[1.4\,(0.05 * 25 + 2.0\,) + 1.6\,(1.5)\right]\,(0.5 * 1.0) + 1.4\,(0.1 * 0.15 * (4 * 0.5 - 2 * 0.1) * 25) + 1.4\left(\frac{100}{1000}\right)\left(2 * \frac{0.4}{0.2}\right) = 4.98$$

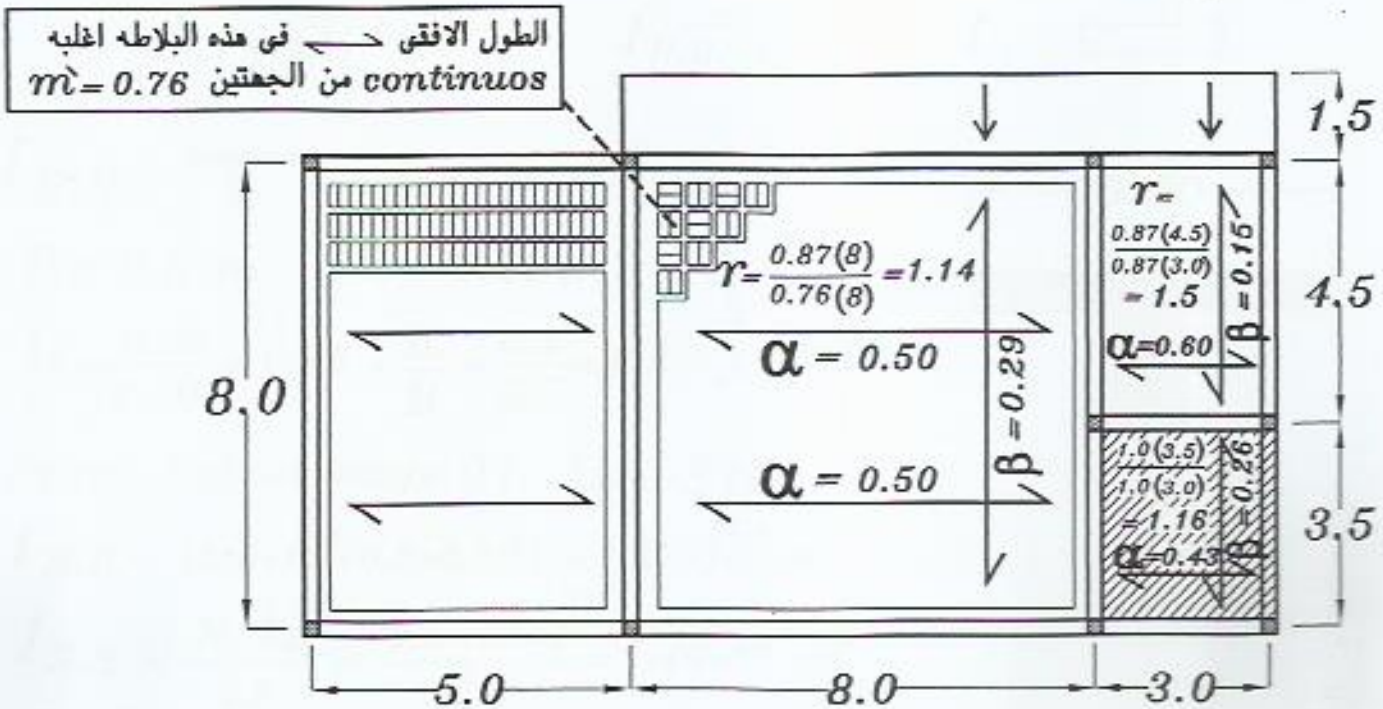
$$(kN\backslash(S * 2S))$$

$$w_{rib} = \frac{w_{ribT}}{2 * S} = \frac{4.98}{2 * 0.5} = 4.98\ \ kN\backslash(S * m)$$

٣- نحسب الـ r للبلاطات الـ *Two way*

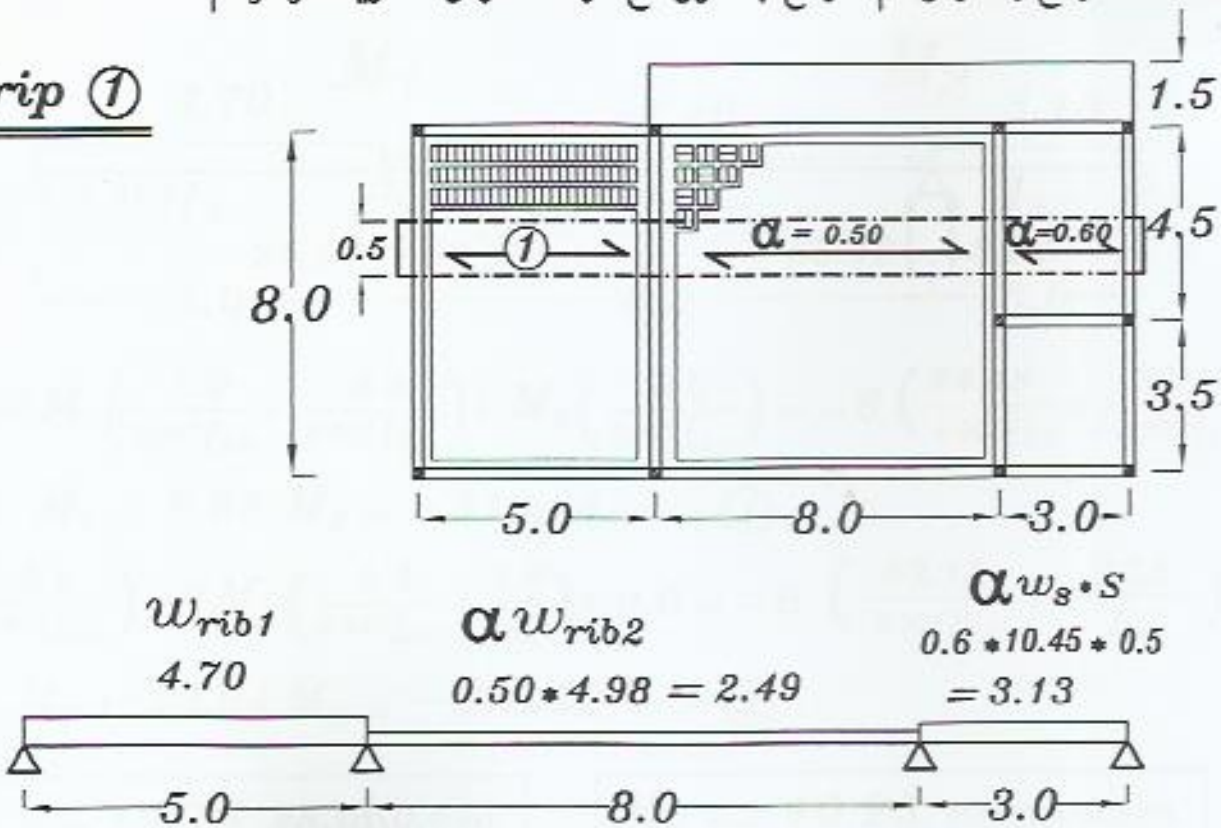
ثم نحسب α ، β للبلاطات الـ *solid* عن طريق الـ *Code of Practice*

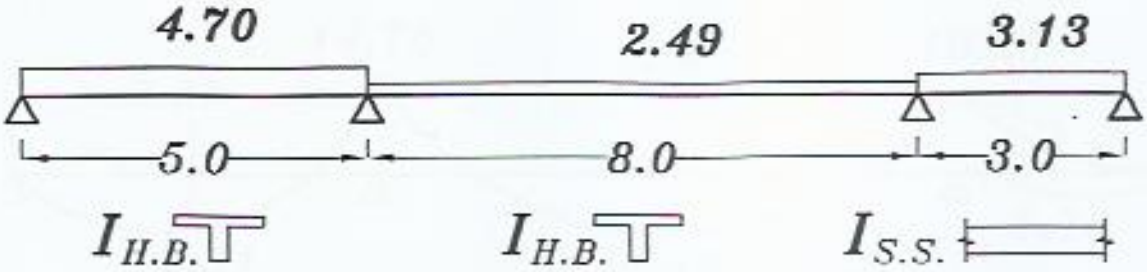
و الـ α ، β للبلاطات الـ *Hollow* عن طريق الـ *Marcus*



٤- نأخذ شرائح بالعرض ثم شرائح بالطول مع مراعاه عرض الشريحه و نرسم الـ *moment*

Strip ①

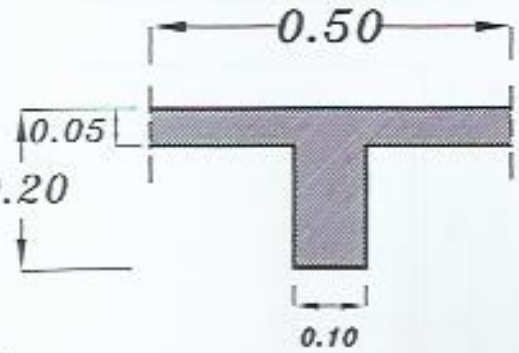




$I_{H.B.}=$ T $\quad I_1=(\mu \cdot 10^{-4})\, B\, t^3$

$B = 0.5\ m\ ,\ t = 0.20\,m$

$\frac{t_s}{t}=\frac{0.05}{0.20}=0.25\ ,\ \frac{b_o}{B}=\frac{0.1}{0.5}=0.2$

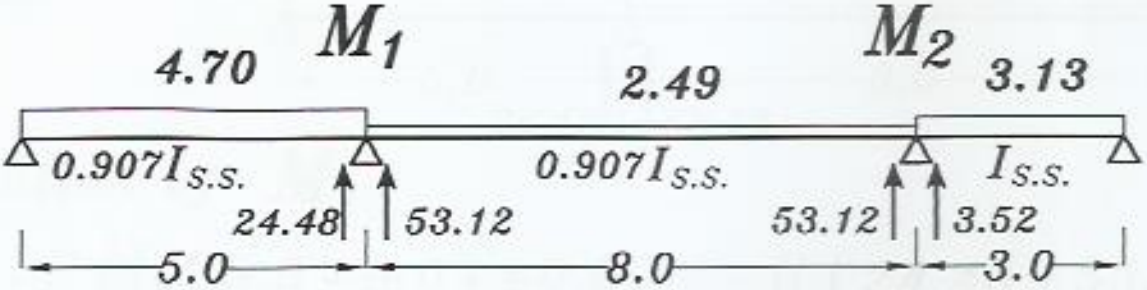


From Tables page 91 $\mu = 318$

$I_{H.B.}=(318 \cdot 10^{-4} \cdot 0.5 \cdot 0.20^3)=1.27 \cdot 10^{-4}\ m^4$

$I_{S.S.}=\frac{S\,(t_s)^3}{12}=\frac{0.5\,(0.15)^3}{12}=1.40 \cdot 10^{-4}\ m^4$

$\therefore\ \frac{I_{H.B.}}{I_{S.S.}}=\frac{1.27 \cdot 10^{-4}}{1.40 \cdot 10^{-4}}=0.907\ \ \therefore\ \boxed{I_{H.B.}=0.907\, I_{S.S.}}$



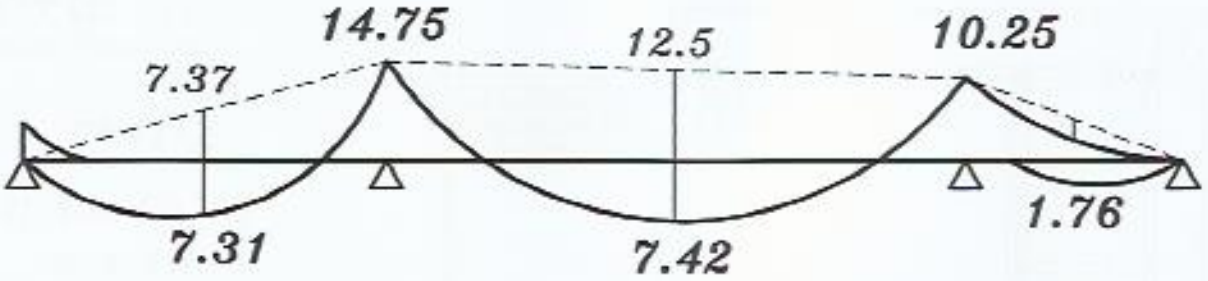
$$0.0+2M_1\left(\frac{5.0}{0.907I_{S.S.}}+\frac{8.0}{0.907I_{S.S.}}\right)+M_2\left(\frac{8.0}{0.907I_{S.S.}}\right)=-6\left(\frac{24.48}{0.907I_{S.S.}}+\frac{53.12}{0.907I_{S.S.}}\right)$$

$28.66\ M_1+8.82\ M_2=-513.34$ -----①

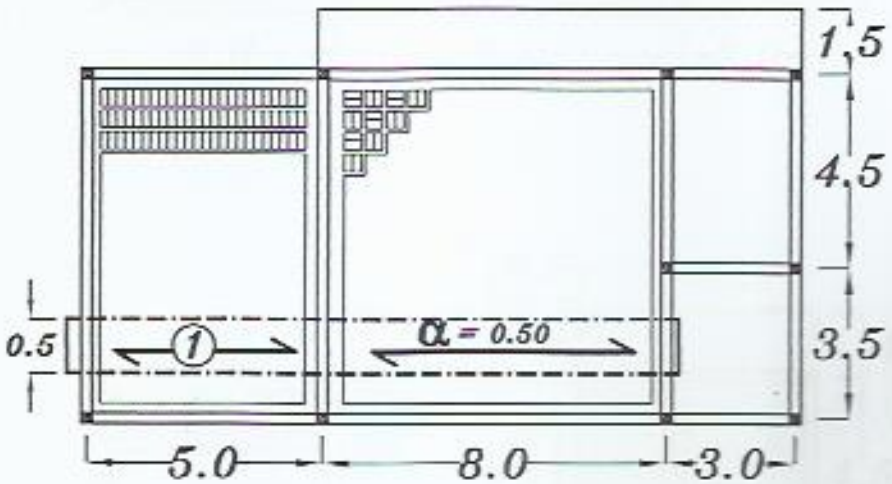
$$M_1\left(\frac{8.0}{0.907I_{S.S.}}\right)+2M_2\left(\frac{8.0}{0.907I_{S.S.}}+\frac{3.0}{I_{S.S.}}\right)+0.0=-6\left(\frac{53.12}{0.907I_{S.S.}}+\frac{3.52}{I_{S.S.}}\right)$$

$8.82\ M_1+23.64\,M_2=-372.52$ -----②

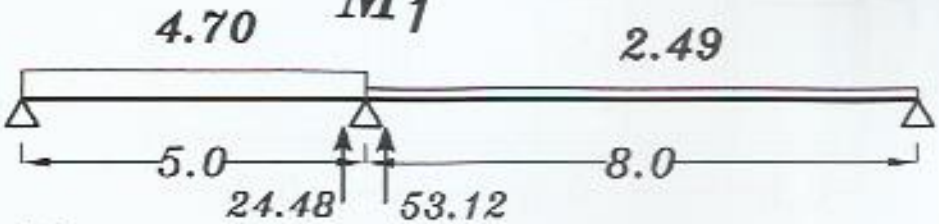
$\boxed{M_1=-14.75\ kN.m\backslash 0.5m}$ $\quad$ $\boxed{M_2=-10.25\ kN.m\backslash 0.5m}$



Strip ②



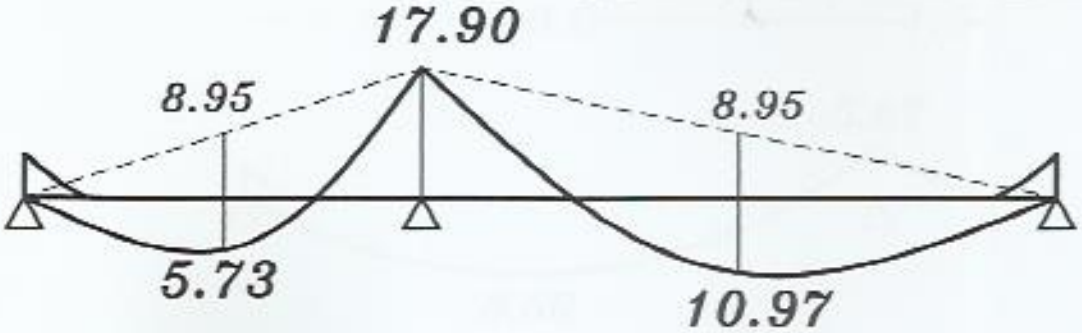
M_1



Equation of M_1

$$0.0 + 2M_1(5.0 + 8.0) + 0.0 = -6(24.48 + 53.12)$$

$$\boxed{M_1 = -17.90\,kN.m}$$

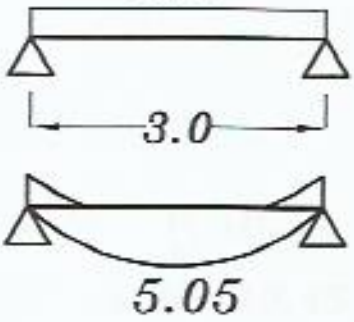


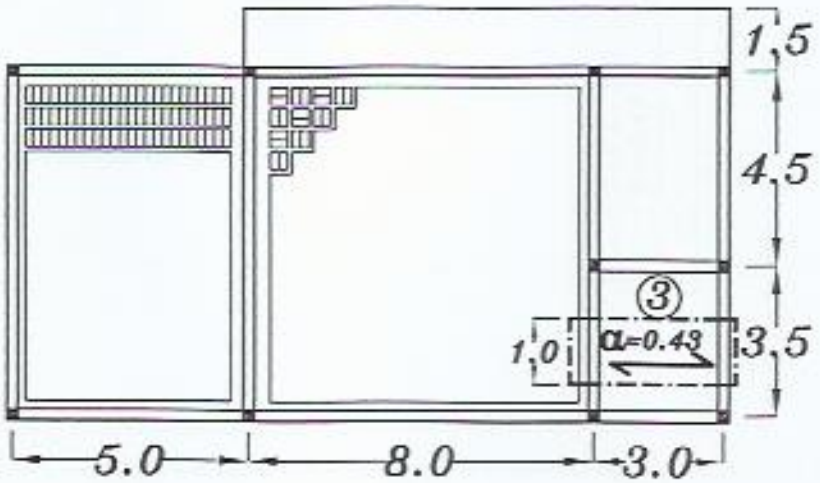
Strip ③

αw_s

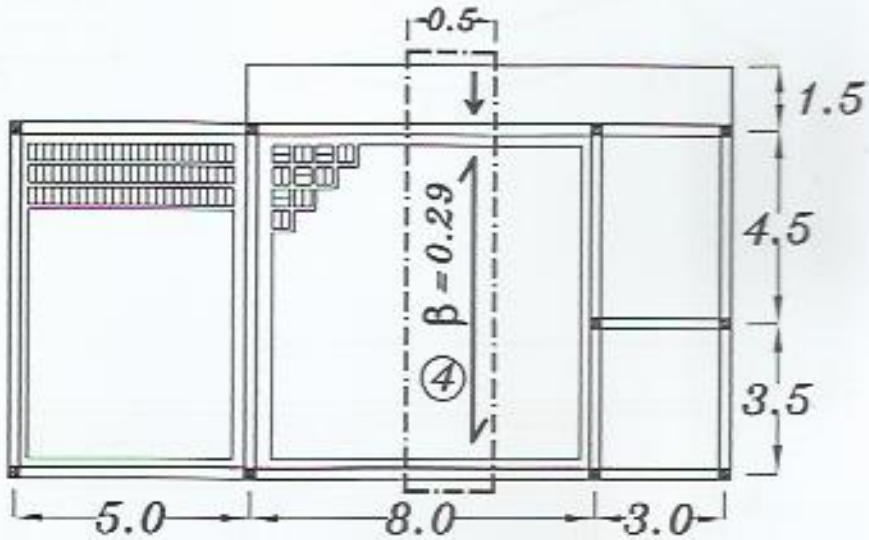
$0.43 * 10.45$

$= 4.49$





Strip ④



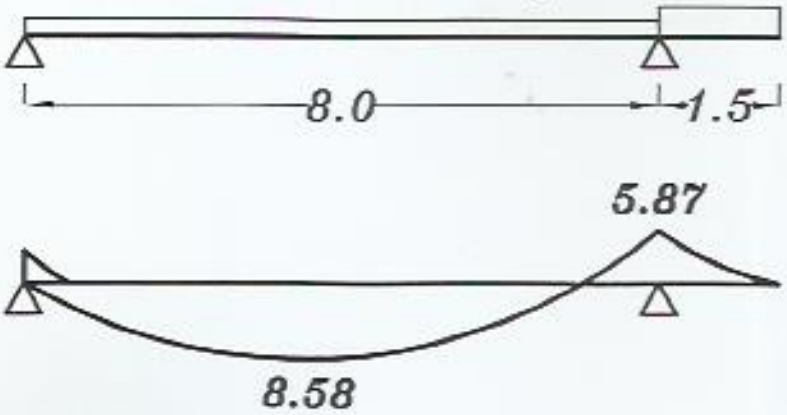
βw_{rib2}

$0.29 * 4.98 = 1.44$ kN\m`

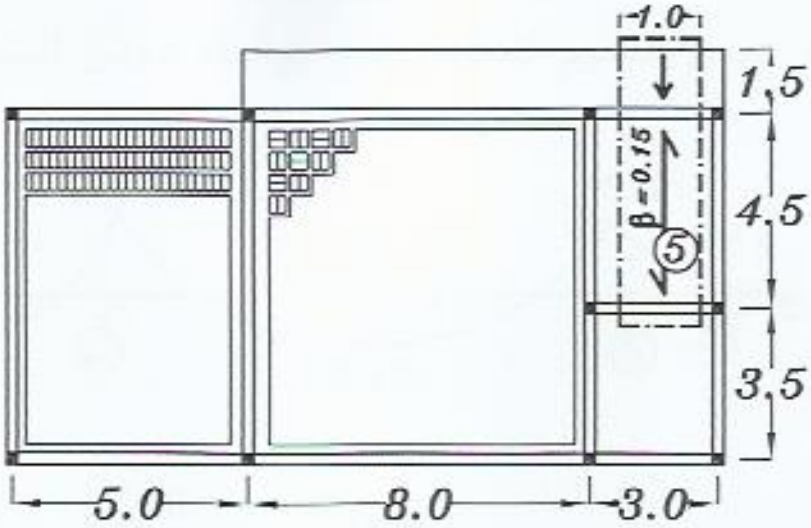
$w_s * S$

$10.45 * 0.5$

$= 5.22$



Strip ⑤



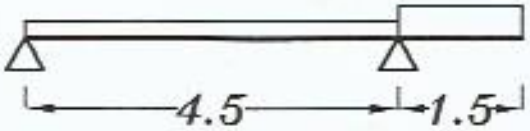
βw_s

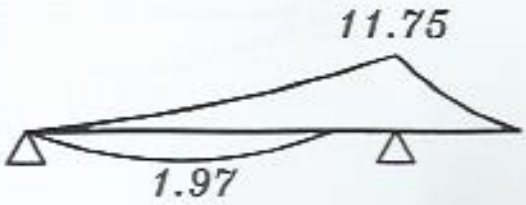
$0.15 * 10.45$

$= 1.56$

w_s

10.45



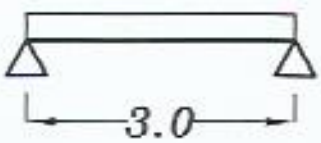


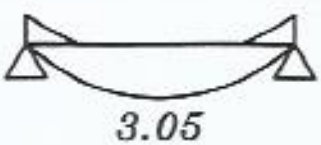
Strip ⑥

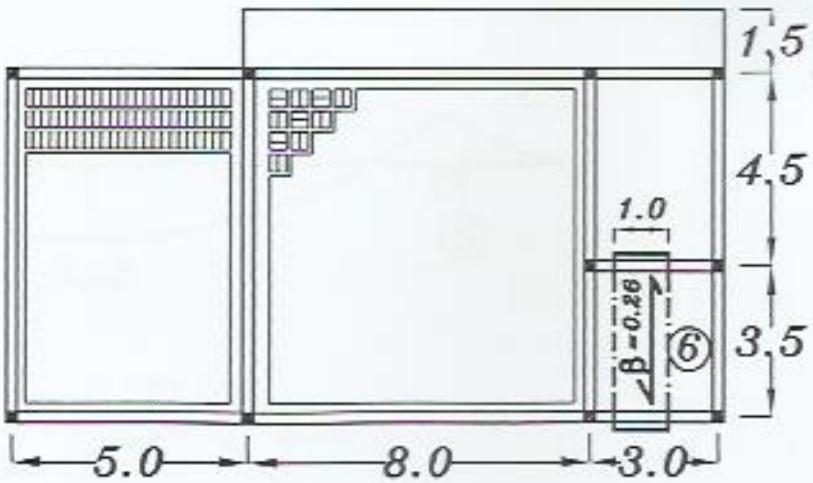
βw_s

$0.26 * 10.45$

$= 2.71$

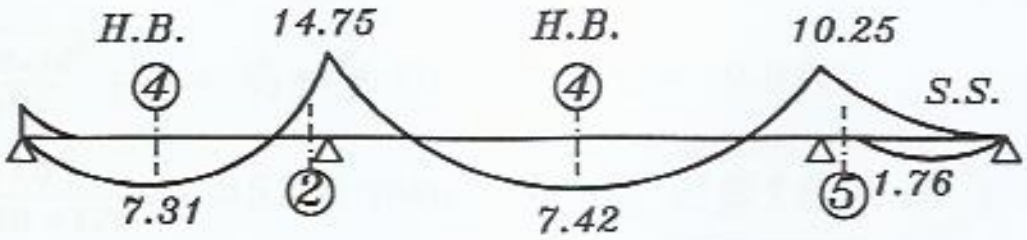




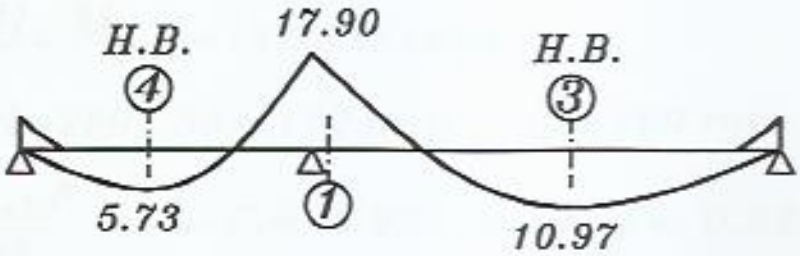


٥- نعمل تصميم للشرائح مع مراعاه عرض الشريحه .

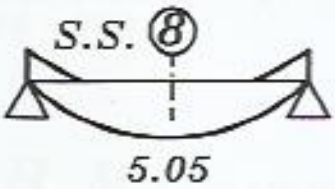
Strip ①



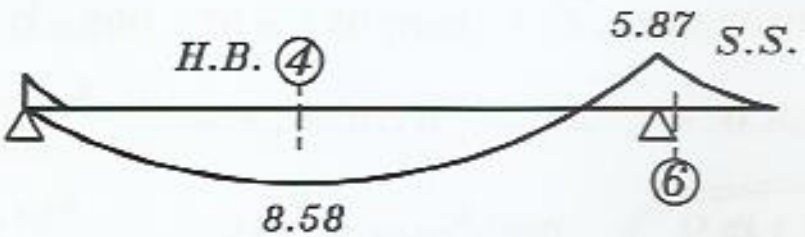
Strip ②



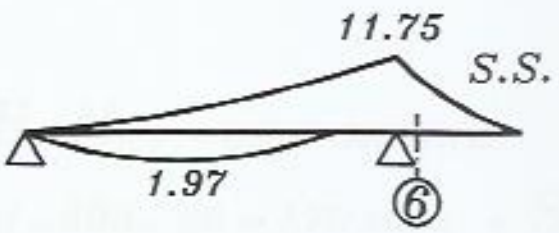
Strip ③



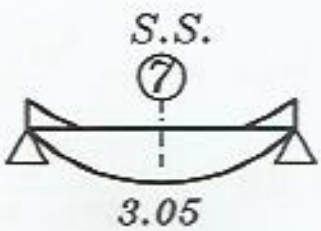
Strip ④



Strip ⑤



Strip ⑥



Sec.① H.B. $M_{U.L.} = 17.90$ kN.m\rib

$t = 200\ mm$, $d = 200 - 30 = 170\ mm$, $S = 500\ mm$ عرض الشريحه

$$170 = C_1\sqrt{\frac{17.90*10^6}{25*500}} \longrightarrow C_1 = 4.49 \longrightarrow J = 0.818$$

$$A_S = \frac{17.90*10^6}{0.818*360*170} = 357.5\ mm^2/rib$$ **2Φ16\rib**

Sec.② H.B. $M_{U.L.} = 14.75$ kN.m\rib

$t = 200\ mm$, $d = 200 - 30 = 170\ mm$, $S = 500\ mm$ عرض الشريحه

$$170 = C_1\sqrt{\frac{14.75*10^6}{25*500}} \longrightarrow C_1 = 4.94 \longrightarrow J = 0.826$$

$$A_S = \frac{14.75*10^6}{0.826*360*170} = 291.8\ mm^2/rib$$ **2Φ16\rib**

Sec.③ H.B. $M_{U.L.} = 10.97$ kN.m\rib

$t = 200\ mm$, $d = 200 - 30 = 170\ mm$, $S = 500\ mm$ عرض الشريحه

$$170 = C_1\sqrt{\frac{10.97*10^6}{25*500}} \longrightarrow C_1 = 5.73 \longrightarrow J = 0.826$$

$$A_S = \frac{10.97*10^6}{0.826*360*170} = 217.0\ mm^2/rib$$ **2Φ12\rib**

Sec.④ H.B. $M_{U.L.} = 8.58$ kN.m\rib

$t = 200\ mm$, $d = 200 - 30 = 170\ mm$, $S = 500\ mm$ عرض الشريحه

$$170 = C_1\sqrt{\frac{8.58*10^6}{25*500}} \longrightarrow C_1 = 6.49 \longrightarrow J = 0.826$$

$$A_S = \frac{8.58*10^6}{0.826*360*170} = 169.7\ mm^2/rib$$ **2Φ12\rib**

Sec.⑤ S.S. $M_{U.L.} = 10.25$ kN.m\rib

$t = 150\,mm$, $d = 150 - 20 = 130\,mm$, $S = 500\,mm$ عرض الشريحه

$$130 = C_1\sqrt{\frac{10.25*10^6}{25*500}} \longrightarrow C_1 = 4.54 \longrightarrow J = 0.819$$

$$A_S = \frac{10.25*10^6}{0.819*360*130} = 267.4\ mm^2/0.5\ m$$

$$A_S = \frac{267.4}{0.50} = 534.8\ mm^2/m$$

8Φ10\m` عدد زوجى

Sec.⑥ S.S. $M_{U.L.} = 11.75$ kN.m\rib

$t = 150\,mm$, $d = 150 - 20 = 130\,mm$, $S = 1000\,mm$ عرض الشريحه

$$130 = C_1\sqrt{\frac{11.75*10^6}{25*1000}} \longrightarrow C_1 = 5.99 \longrightarrow J = 0.826$$

$$A_S = \frac{11.75*10^6}{0.826*360*130} = 303.9\ mm^2/m$$

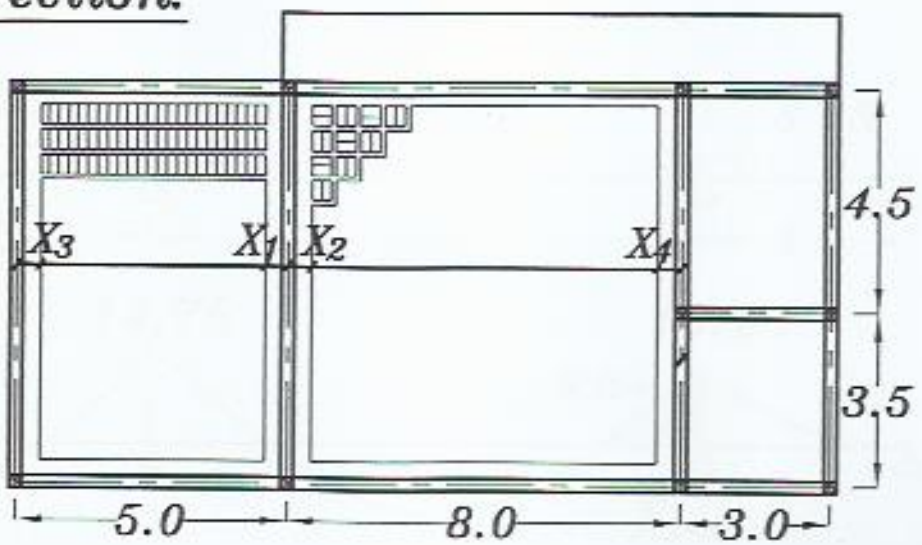
6Φ10\m`

عدد زوجى

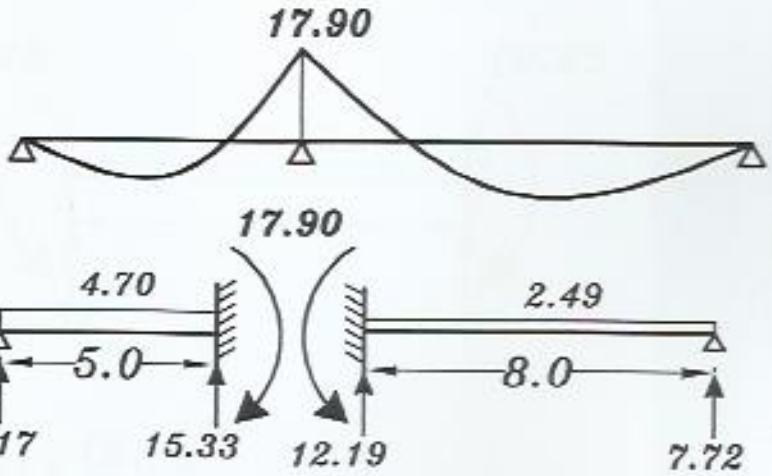
Sec.⑦ S.S. $M_{U.L.} = 3.05$ kN.m\rib **5Φ10\m`**

٦ـ نحسب عرض الـ solid part و رص البلوكات .

Horizontal Direction.

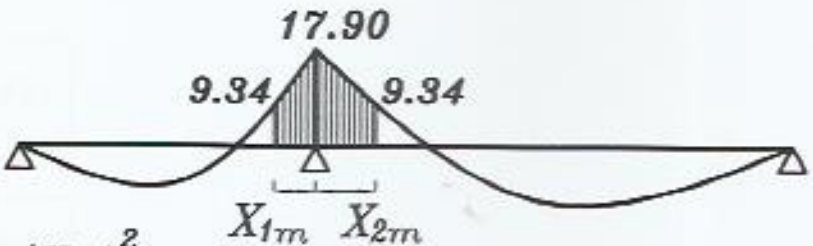


Calculate X_m



$$M_R = R_{max} * \frac{F_{cu}}{\delta_c} * b * d^2 = 0.194 * \frac{25}{1.5} * 100 * 170^2$$

$$= 9344333 \quad N.mm = 9.34 \; kN.m$$



$$M_R = M\_R\,(X_{1m}) + w_e \frac{(X_{1m})^2}{2}$$

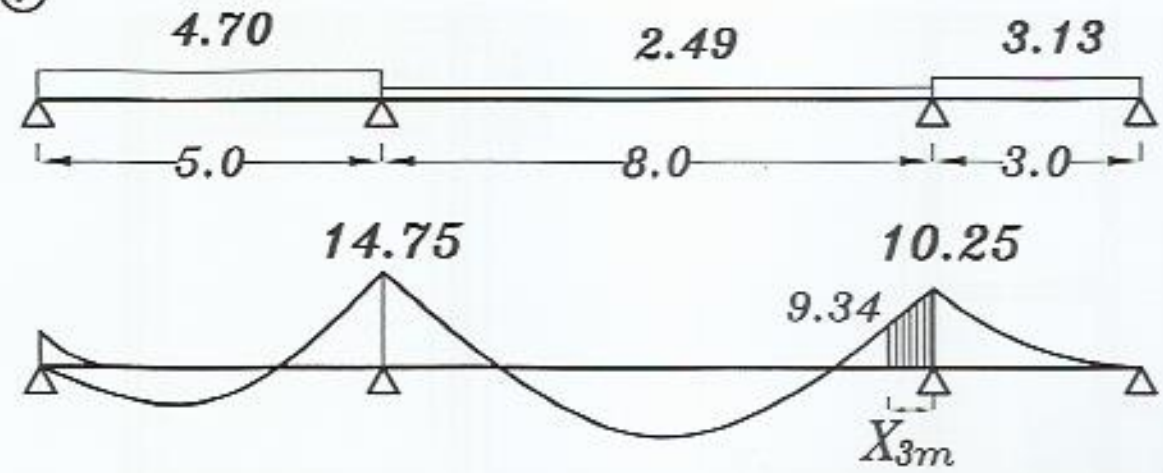
$$9.34 = 17.90 - 15.33\,(X_{1m}) + 4.70 \frac{(X_{1m})^2}{2} \longrightarrow \boxed{X_{1m} = 0.61\ m}$$

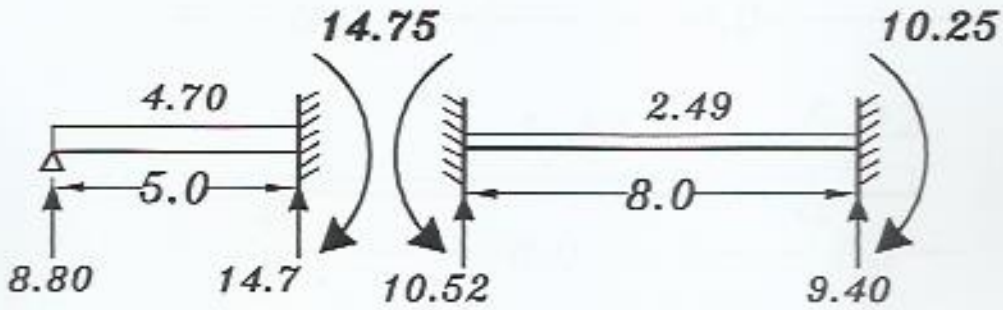
$$M_R = M\_R\,(X_{2m}) + w_e \frac{(X_{2m})^2}{2}$$

$$9.34 = 17.90 - 12.19\,(X_{2m}) + 2.49 \frac{(X_{2m})^2}{2} \longrightarrow \boxed{X_{2m} = 0.85\ m}$$

Calculate X_{3m} & X_{4m}

Strip ①





$$M_R = M\_R(X_{3m}) + w_e \frac{(X_{3m})^2}{2}$$

$$9.34 = 10.25 - 9.40(X_{3m}) + 2.49 \frac{(X_{3m})^2}{2} \longrightarrow \boxed{X_{3m} = 0.09\ m}$$

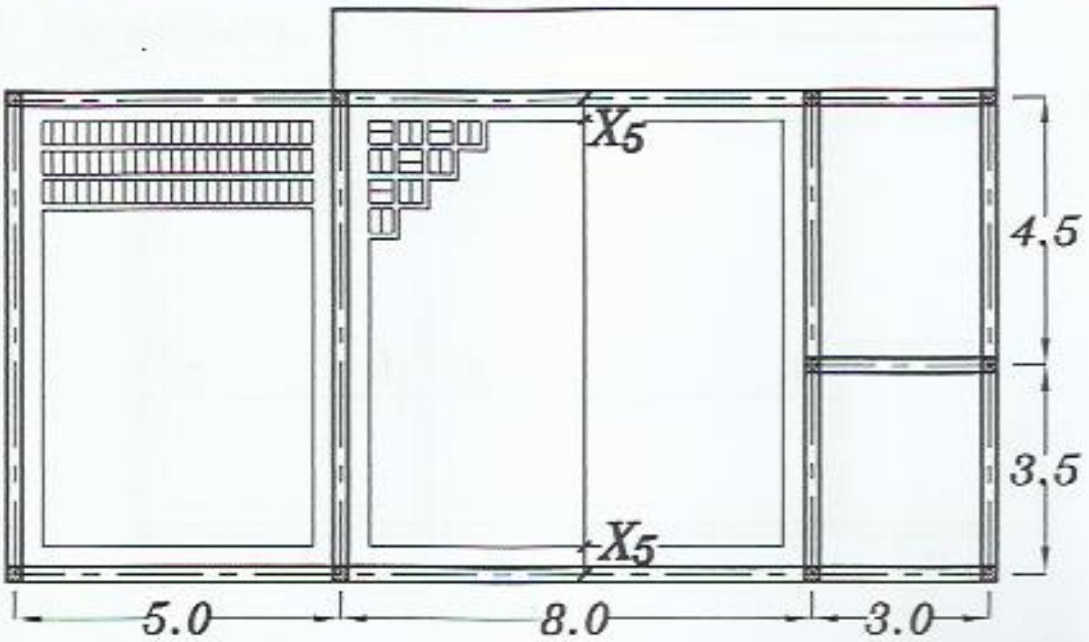
$$\boxed{X_{1min} = 0.61\ m}$$

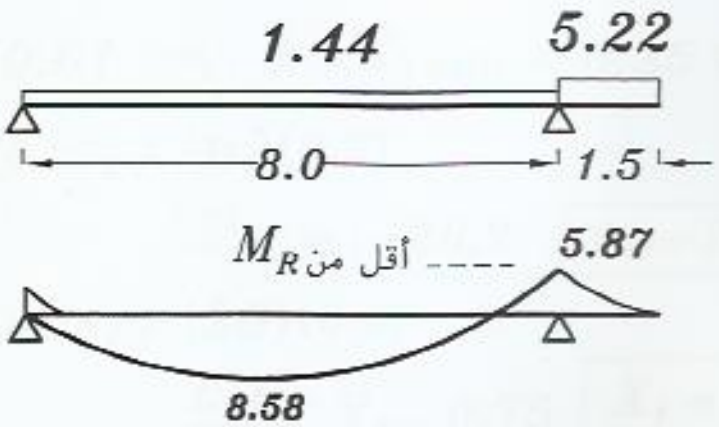
$$\boxed{X_{2min} = 0.85\ m}$$

$$\boxed{X_{3min} = 0.25\ m}$$

$$\boxed{X_{4min} = 0.25\ m}$$

Vertical Direction.

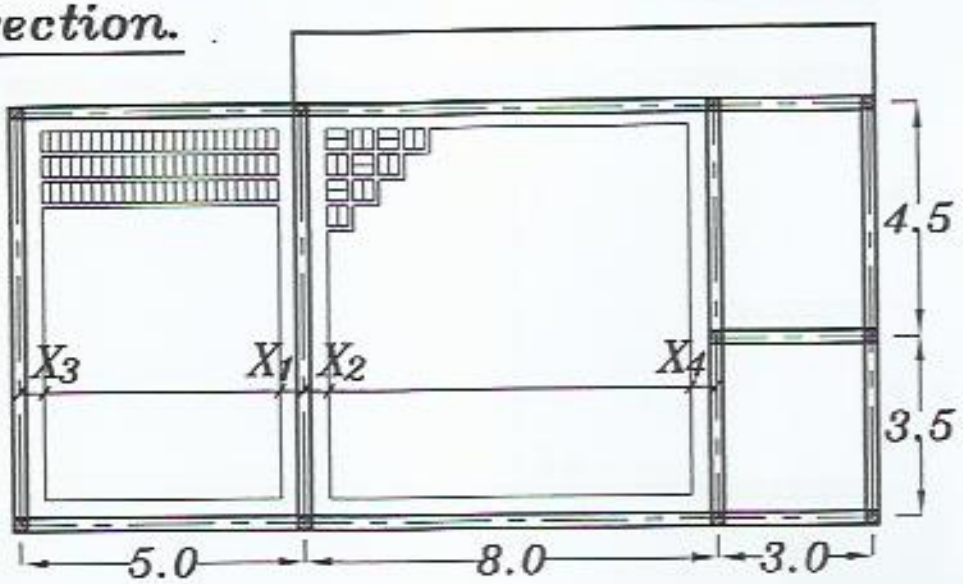




$$X_{5min} = 0.25\ m$$

Arrangement of Blocks.

Horizontal Direction.



5.0 m

$$L = X_1 + X_3 + (n_1)(0.2)$$

Take $X_{1\,min} = 0.61$ m & $X_{3\,min} = 0.25$ m

$$5.0 = (0.61) + (0.25) + (n_1)(0.2)$$

$$\xrightarrow{Get} n_1 = 20.7 \quad \boxed{n_1 = 20 \text{ Block}}$$

$$5.0 = (X_1) + (0.25) + (20)(0.2)$$

$$\xrightarrow{Get} X_1 = 0.75 \quad \boxed{X_1 = 0.75 \text{ m.}}$$

8.0 m

$$L = X_2 + X_4 + (n_2)(0.4) + (n_2 - 1)(0.10)$$

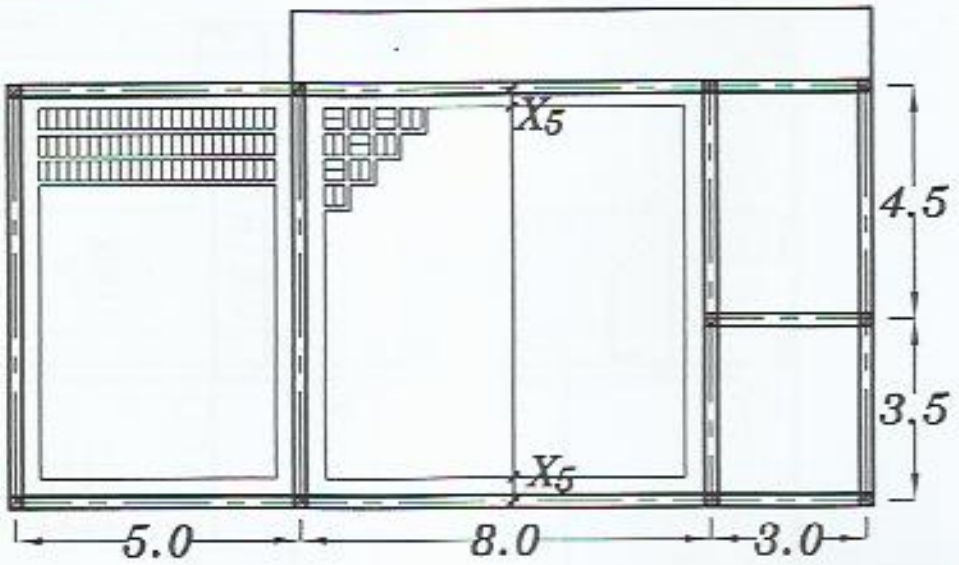
Take $X_{2\,min} = 0.85$ m & $X_{4\,min} = 0.25$ m

$$8.0 = (0.85) + (0.25) + (n_2)(0.4) + (n_2 - 1)(0.10)$$

$$\xrightarrow{Get} n_2 = 14.0 \quad \boxed{n_2 = 14 \text{ Block}}$$

$$\boxed{X_2 = 0.85 \text{ m.}}$$

Vertical Direction.



8.0 m

$$L = 2X_5 + (n_3)(0.4) + (n_3 - 1)(0.10)$$

Take $X_{5min} = 0.25\ m$

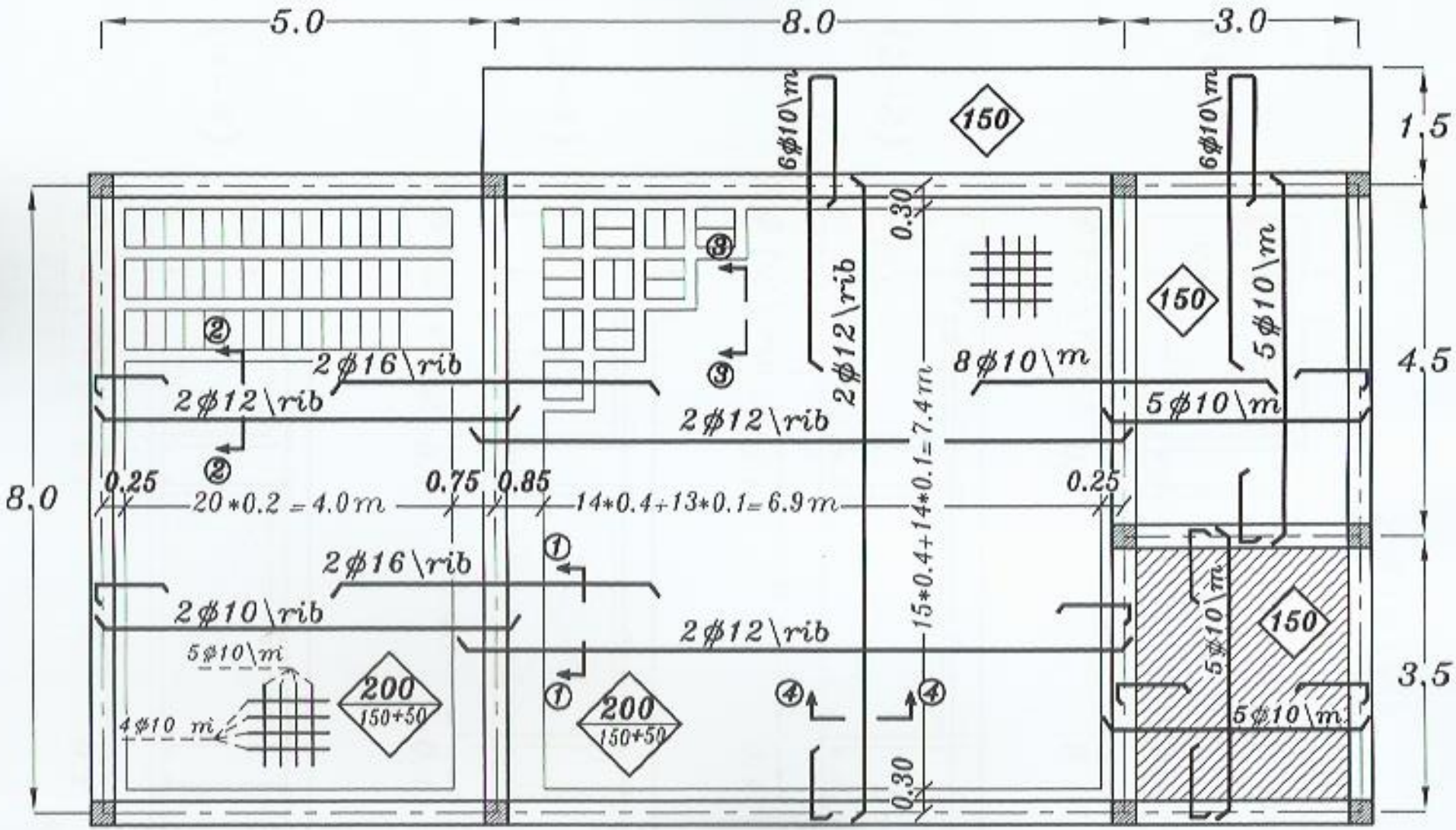
$$8.0 = 2(0.25) + (n_3)(0.4) + (n_3 - 1)(0.10)$$

$$\xrightarrow{Get} n_3 = 15.2 \qquad \boxed{n_3 = 15\ Block}$$

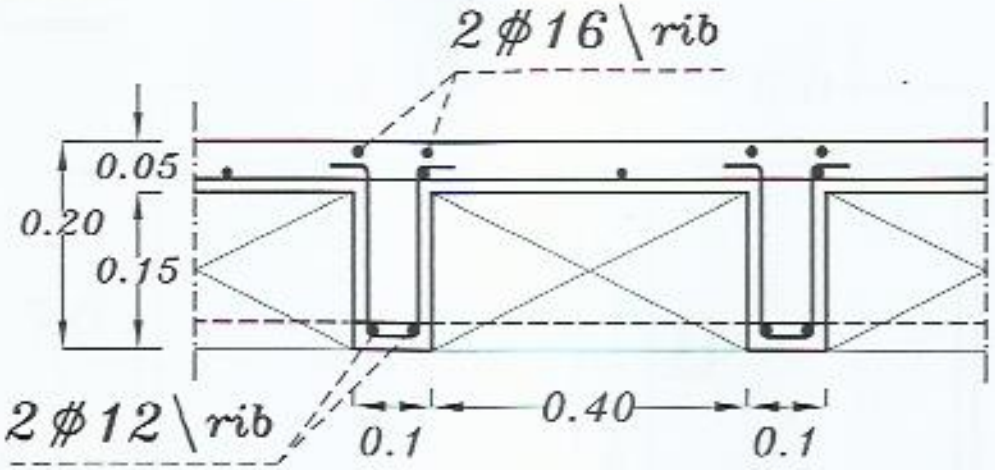
$$8.0 = 2(X_5) + (15)(0.4) + (15 - 1)(0.10)$$

$$\xrightarrow{Get} X_5 = 0.30 \qquad \boxed{X_5 = 0.30\ m.}$$

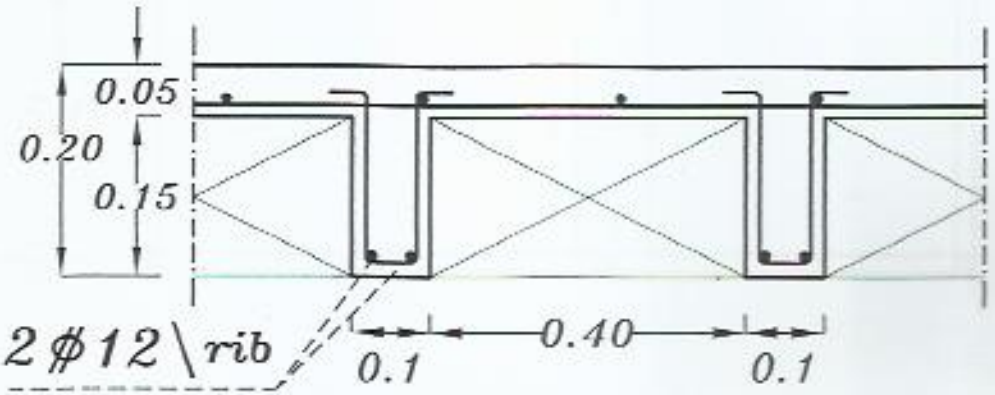
RFT. of the slab in plan.



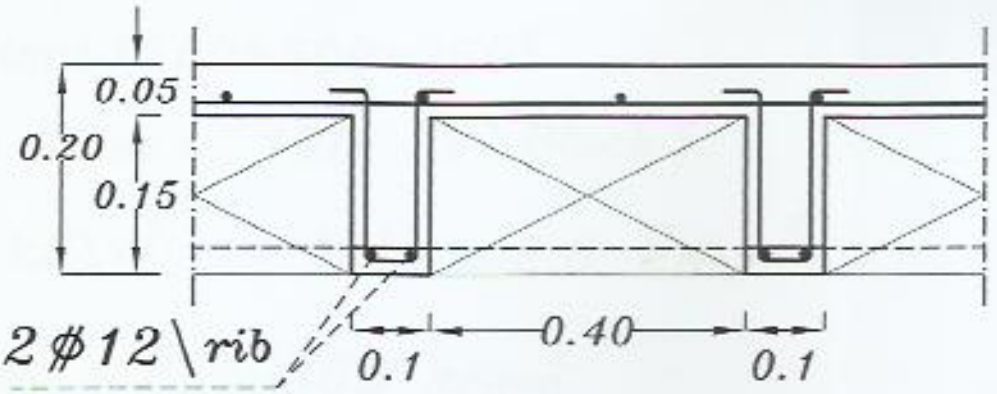
Sec. (1–1)



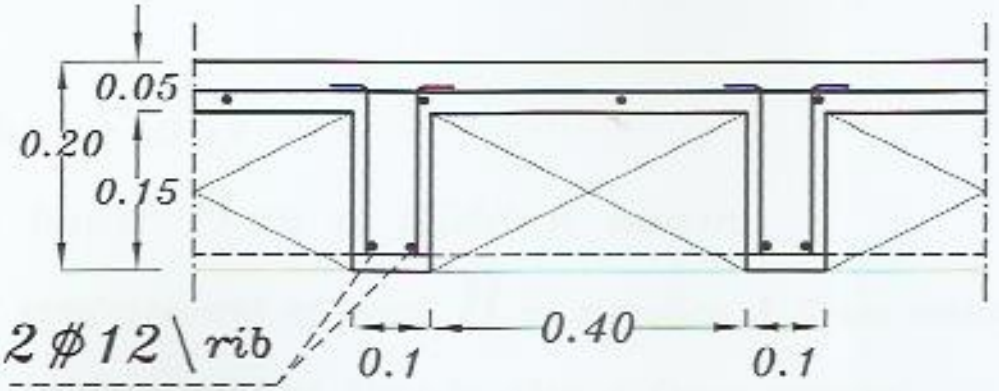
Sec. (2–2)



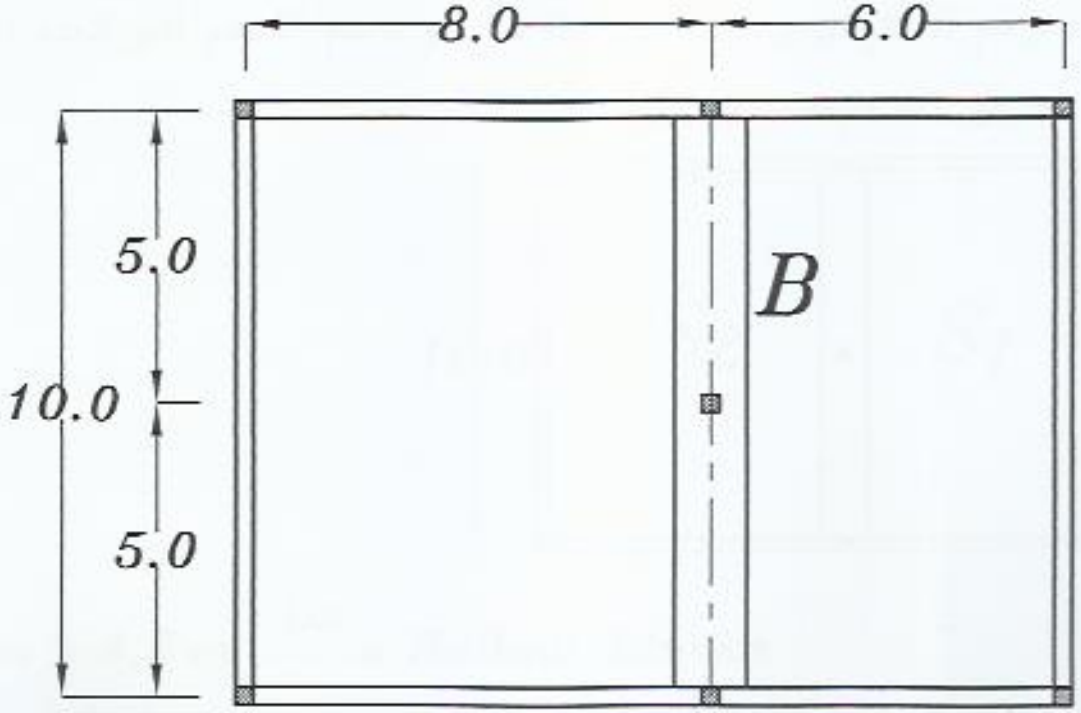
Sec. (3–3)



Sec. (4–4)



Example.



Data:

Block Dimensions (500*500*250)

weight of One Block = 120 (N\Block)

F.C. = 1.5 $kN\backslash m^2$ L.L. = 2.0 $kN\backslash m^2$

F_{cu}= 25 N/mm^2 F_y = 360 N/mm^2

Required.

1- Design the Slabs.

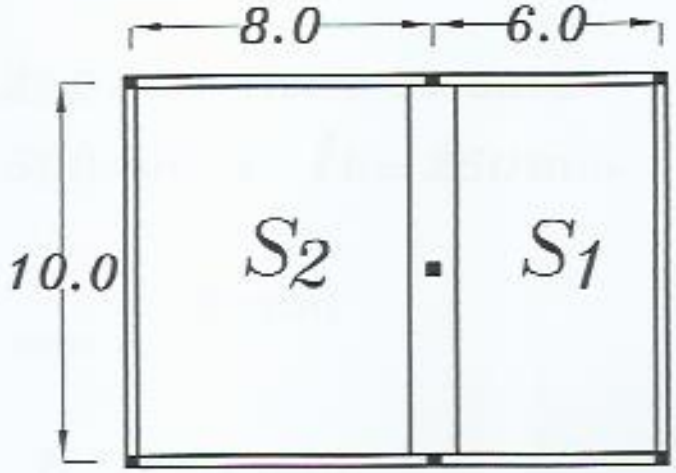
2- Design the beam B as a Hidden beam.

3- Draw details of reinforcement of beam B in elevation & Cross section.

3- Draw details of reinforcement of Slabs in plan & Cross sections.

Solution.

١- نرسم الـ *plan* و نحدد نوع البلاطات و نرسم الاسهم التى تحدد اتجاه الـ *Loads*



S_1

$L_s = 6.0\,m > 4.5\,m \xrightarrow{\text{يفضل}}$ ***Hollow Blocks***

$L_s = 6.0\,m < 7.0\,m \longrightarrow$ *One way H.B. at 6.0m direction*

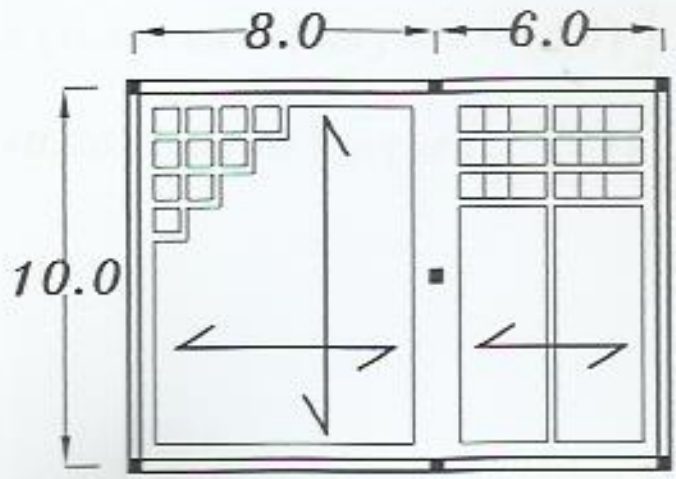
1.0 Cross rib

S_2

$L_s = 8.0\,m > 4.5\,m \xrightarrow{\text{يفضل}}$ ***Hollow Blocks***

$L = 8.0\,m\ ,\ L_s = 8.0\,m$

$\therefore L_s = 8.0\,m > 7.0\,m\ \ \&\ \ \frac{L}{L_s} < \frac{4}{3} \longrightarrow$ *Two way H.B.*



خطوات التصميم :

١ـ نحسب الـ t للبلاطات الـ *Hollow*

Block $(500*500*250)$ *as given in data*

$\because a=500\ mm\ ,\ e=500\,mm\ ,\ h=250\,mm$

$$\therefore t_s \begin{cases} \not< 50mm \\ \not< \frac{e}{10}=\frac{500}{10}=50\ mm \end{cases} 50\ mm$$

$$\because e>400\ mm \xrightarrow{\text{يفضل}} b=150\ mm$$

$S=e+b=0.5+0.15=0.65\,m$ عرض الشريحه

$$t=h+t_s=250+50=300\,mm$$

٢ـ نحسب الـ w_{rib} للبلاطات الـ *Hollow*

One way

$$w_{rib1}=\left[1.4\,(t_s\,\delta_c+F.C.)+1.6\,(L.L.)\right](S*1.0)$$
$$+1.4(b\,h*1.0m*\delta_c)+1.4*(\text{وزن الـ }Block)\left(\frac{1.0}{a}\right)$$

$$\therefore w_{rib1}=\left[1.4\,(0.05*25+1.50)+1.6\,(2.0)\right]\,(0.65*1.0)$$
$$+1.4\,(0.15*0.25*1.0*25)+1.4\left(\frac{120}{1000}\right)\left(\frac{1.0}{0.5}\right)=6.23$$
$$(kN\backslash(m*S))$$

Two way

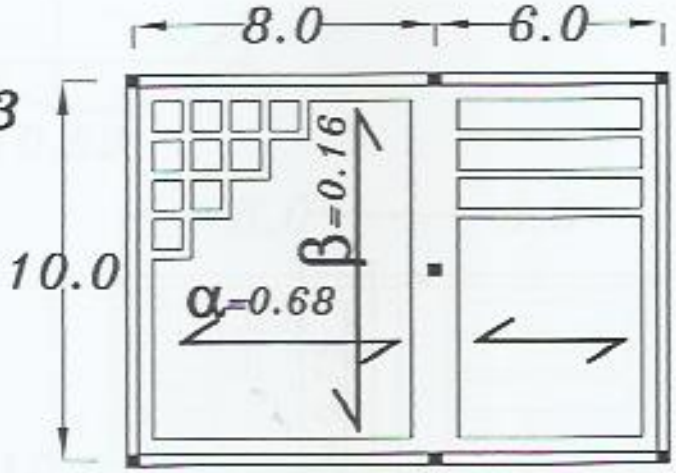
$$W_{rib2T} = \left[1.4\,(t_s \gamma_c + F.C.) + 1.6\,(L.L.)\right](S*2S) + 1.4*b\,h*(4S-2b)*\gamma_c + 1.4*(\text{Block وزن ال})\left(2*\frac{e}{\alpha}\right)$$

$$\therefore W_{rib2T} = \left[1.4\,(0.05*25+1.50) + 1.6\,(2.0)\right](0.65*1.30) + 1.4\,(0.15*0.25*(4*0.65-2*0.15)*25) + 1.4\left(\frac{120}{1000}\right)\left(2*\frac{0.5}{0.5}\right) = 9.312 \quad (kN \setminus (S*2S))$$

$$W_{rib2} = \frac{W_{rib2T}}{2*S} = \frac{9.312}{2*0.65} = 7.16 \quad kN \setminus (S*m)$$

٣- نحسب الـ r و الـ α ، β للبلاطات الـ Two way

$$r = \frac{m\,L}{\grave{m}\,L_s} = \frac{1.0\,(10)}{0.87(8)} = 1.43$$



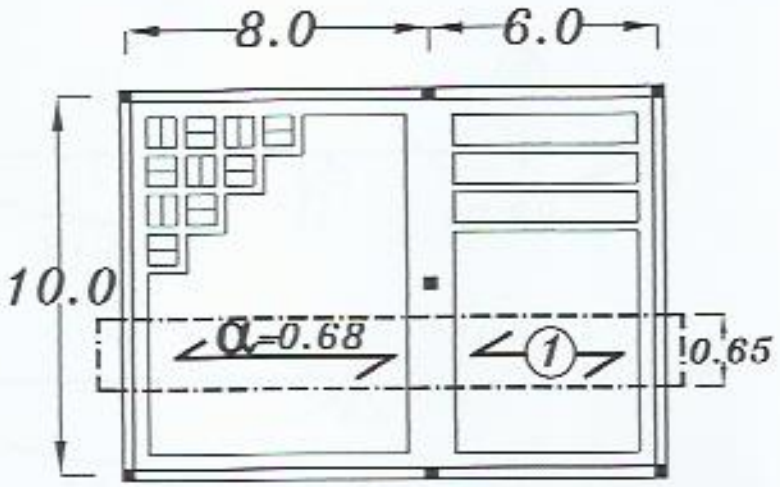
Use Marcus

old Tables Page 90

$$\alpha = 0.68 \qquad \beta = 0.16$$

٤- نأخذ شرائح بالعرض ثم شرائح بالطول مع مراعاه عرض الشريحه .

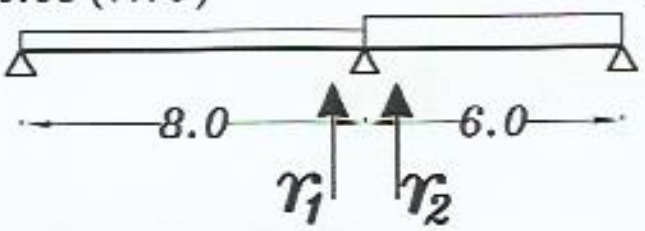
Strip ①



M_1

$\alpha\ w_{rib\,2}$ $\quad w_{rib\,1}$

$0.68\,(7.16) = 4.87 \quad = 6.23$

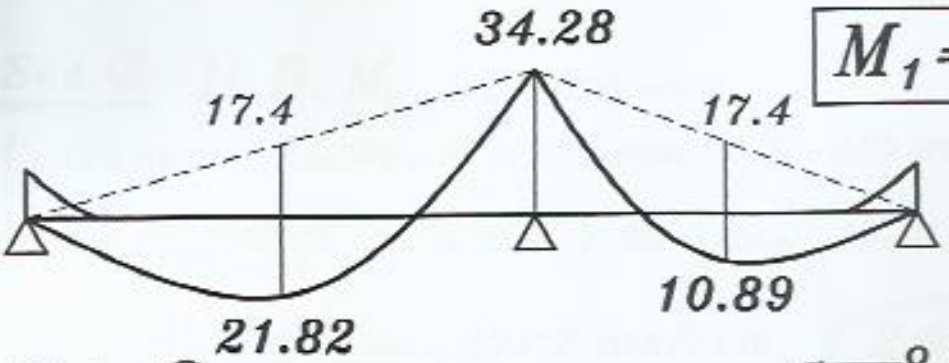


$$r_1 = \frac{wL^3}{24} = \frac{4.87 * 8.0^3}{24} = 103.9 \quad , \quad r_2 = \frac{wL^3}{24} = \frac{6.23 * 6.0^3}{24} = 56.07$$

Equation of M_1

$$0.0 + 2M_1\,(8.0 + 6.0) + 0.0 = -6\,(103.9 + 56.07)$$

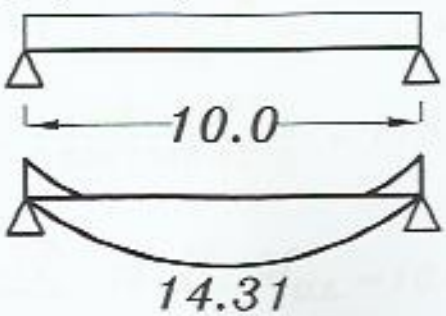
$M_1 = -34.28$ kN.m.

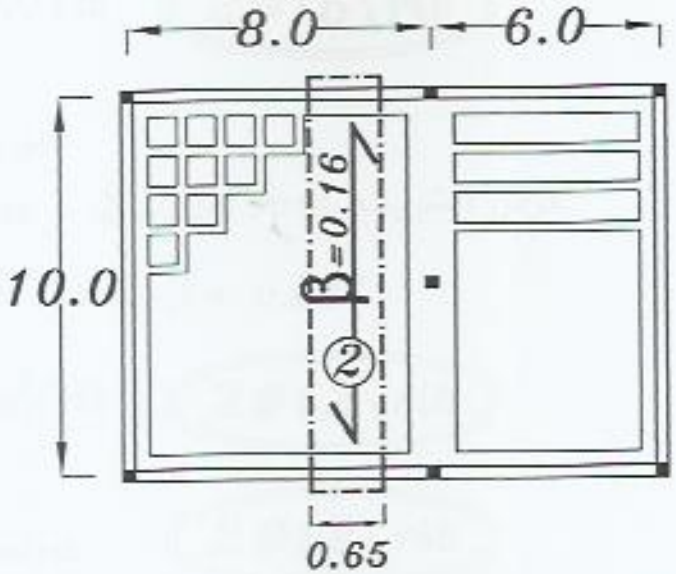


Strip ②

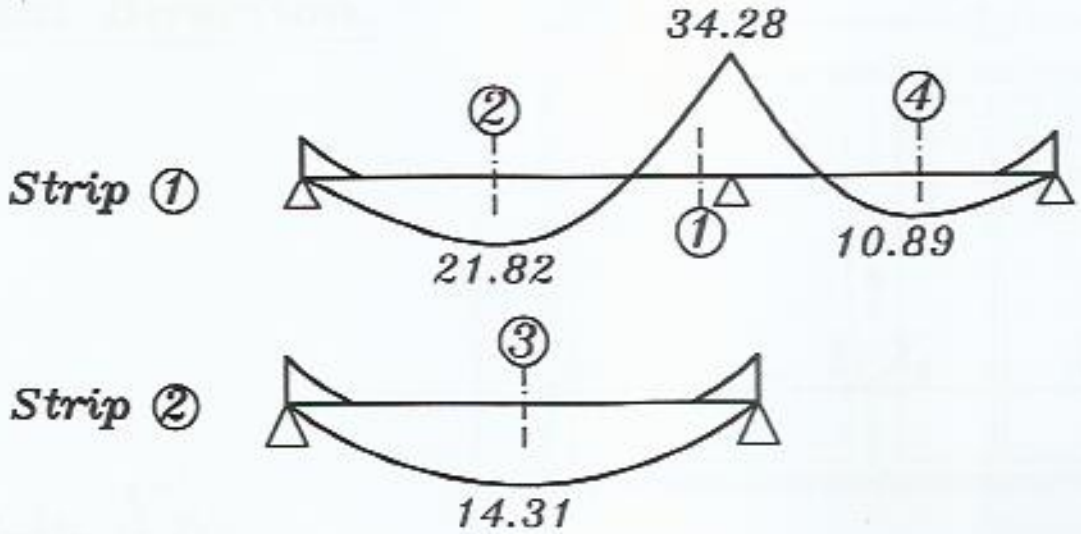
$\beta\ w_{rib}$

$0.16\,(7.16) = 1.145$ kN\m`





٥ – نعمل تصميم للشرائح مع مراعاه عرض الشريحه .



Sec. ① H.B. $M_{U.L.} = 34.28\ kN.m\backslash rib$

$t = 300\ mm$, $d = 300 - 30 = 270\ mm$, $S = 650\ mm$ عرض الشريحه

$$270 = C_1\sqrt{\frac{34.28 * 10^6}{25 * 650}} \longrightarrow C_1 = 5.87 \longrightarrow J = 0.826$$

$$A_s = \frac{34.28 * 10^6}{0.826 * 360 * 270} = 426.9\ mm^2/rib$$ **2Φ18\rib**

Sec. ② H.B. $M_{U.L.} = 21.82\ kN.m\backslash rib$

$t = 300\ mm$, $d = 300 - 30 = 270\ mm$, $S = 650\ mm$ عرض الشريحه

$$270 = C_1\sqrt{\frac{21.82 * 10^6}{25 * 650}} \longrightarrow C_1 = 7.36 \longrightarrow J = 0.826$$

$$A_s = \frac{21.82 * 10^6}{0.826 * 360 * 270} = 271.7\ mm^2/rib$$ **2Φ16\rib**

Sec. ③ H.B. $M_{U.L.} = 14.31\ kN.m\backslash rib$

$t = 300\ mm$, $d = 300 - 30 = 270\ mm$, $S = 650\ mm$ عرض الشريحه

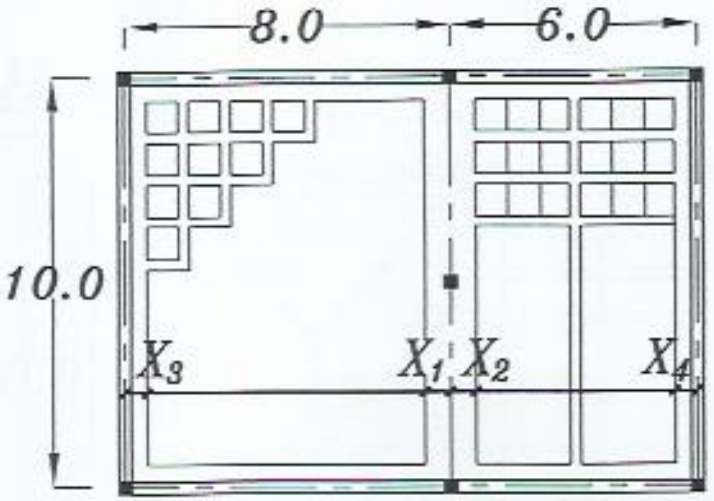
$$270 = C_1\sqrt{\frac{14.31 * 10^6}{25 * 650}} \longrightarrow C_1 = 9.10 \longrightarrow J = 0.826$$

$$A_s = \frac{14.31 * 10^6}{0.826 * 360 * 270} = 178.2\ mm^2/rib$$ **2Φ12\rib**

Sec. ④ H.B. $M_{U.L.} = 10.89\ kN.m\backslash rib$ **2Φ12\rib**

٦- نحسب عرض الـ solid part و رص البلوكات .

Horizontal Direction.

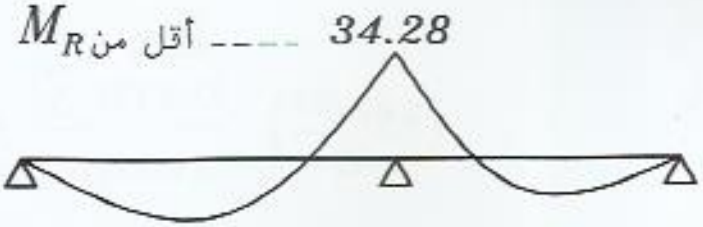


Calculate X_m

$$M_R = R_{max} * \frac{F_{cu}}{\delta_c} * b * d^2 = 0.194 * \frac{25}{1.5} * 150 * 270^2$$

$$= 35356500\ N.mm = 35.35\ kN.m$$

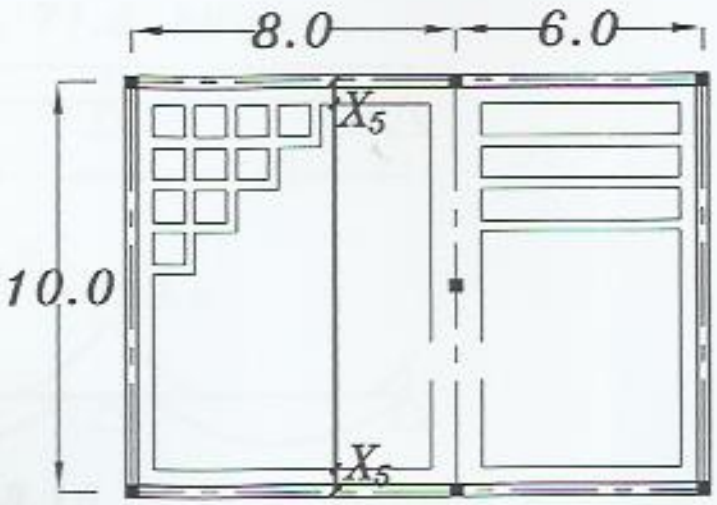
$X_m = Zero$



$X_{min} = 0.25\ m$

$\therefore X_{1\,min} = X_{2\,min} = X_{3\,min} = X_{4\,min} = 0.25\ m$

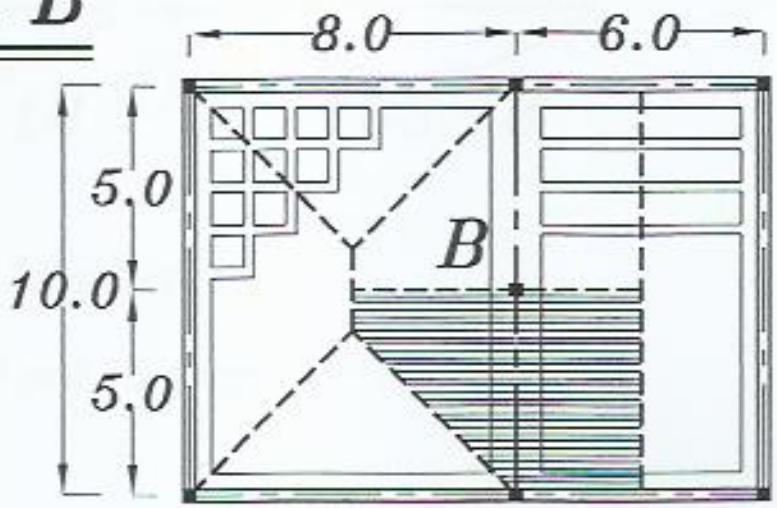
Vertical Direction.



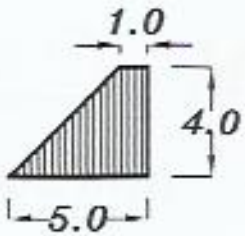
$X_{5min} = 0.25\ m$

Design the Hidden B

Loads on Beam B



For the Trapeziam



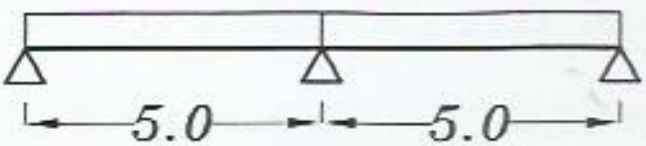
$$\frac{\sum area}{span} = \frac{\left(\frac{1.0+5.0}{2.0}\right) * 4.0}{4.0} = 3.0$$

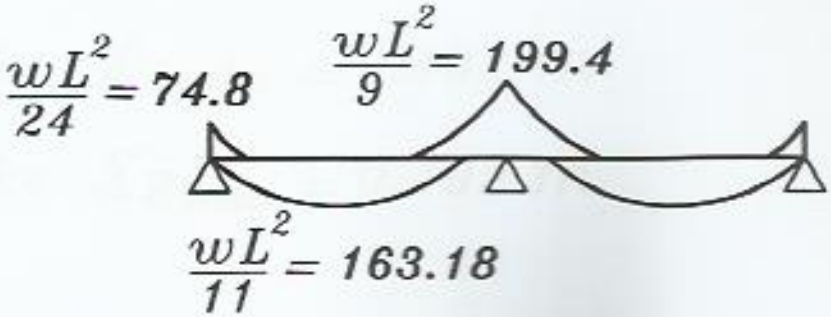
assume O.W.(Beam) $= 10\ kN\backslash m^{`}$ (U.L.)

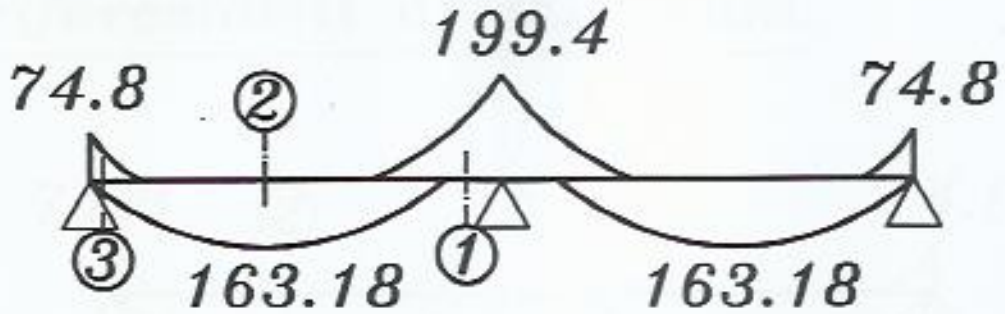
$$W = o.w. + \left(\frac{w_{rib1}}{S}\right)\left(\frac{L_{s1}}{2}\right) + \frac{\sum area}{span}\left(\frac{w_{rib2}}{S}\right)$$

$$W = 10.0 + \left(\frac{6.23}{0.65}\right)\left(\frac{6.0}{2}\right) + 3.0\left(\frac{7.16}{0.65}\right) = 71.8 \quad kN\backslash m^{`}$$

$W = 71.8\ kN\backslash m^{`}$







Sec. ① $M_{U.L.} = 199.4 kN.m\backslash rib$

$t = 300\,mm$, $d = 300 - 30 = 270\,mm$

Take $C_1 = 3.0$

$$270 = 3.0\sqrt{\frac{199.4 * 10^6}{25 * B}} \rightarrow B = 984.7\,mm$$

$X_{1min} = 0.25\ m$ $\quad$ $B = 0.984\ m$

$X_{2min} = 0.25\ m$

$X_{1min} + X_{2min} = 0.25 + 0.25 = 0.50\ m$

$X_{1min} + X_{2min} = 0.50\ m$ $\quad$ $B = 0.984\ m$

$\therefore\ B > X_1 + X_2$

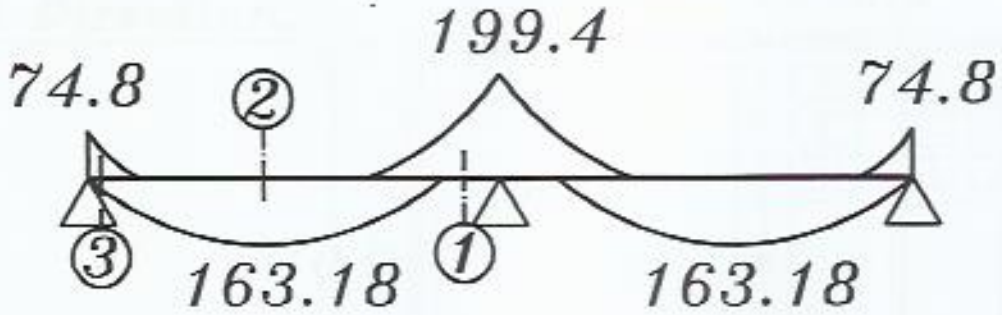
نحسب الفرق بين B و $X_1 + X_2$ و نوزعه على X_1 , X_2

$B - (X_1 + X_2) = 0.984 - 0.50 = 0.484\ m$

$\therefore$ Take $X_{1min} = 0.492\ m$

Take $X_{2min} = 0.492\ m$

Get Reinforcement of the beam.



Sec. ①

$\because\ C_1 = 3.0 \longrightarrow J = 0.743$

$$A_S = \frac{M_{U.L.}}{J\,F_y\,d} = \frac{199.4 * 10^6}{0.743 * 360 * 270} = 2761.0\ mm^2$$

11ϕ18

Sec. ② $M_{U.L.} = 163.18$ kN.m\rib

$t = 300\ mm$, $d = 300 - 30 = 270\ mm$, $B = 984.7\ mm$

$$270 = C_1\sqrt{\frac{163.18 * 10^6}{25 * 984.7}} \longrightarrow C_1 = 3.31 \longrightarrow J = 0.769$$

$$A_S = \frac{163.18 * 10^6}{0.769 * 360 * 270} = 2183.1\ mm^2$$ 9ϕ18

Sec. ③ $M_{U.L.} = 74.8$ kN.m\rib

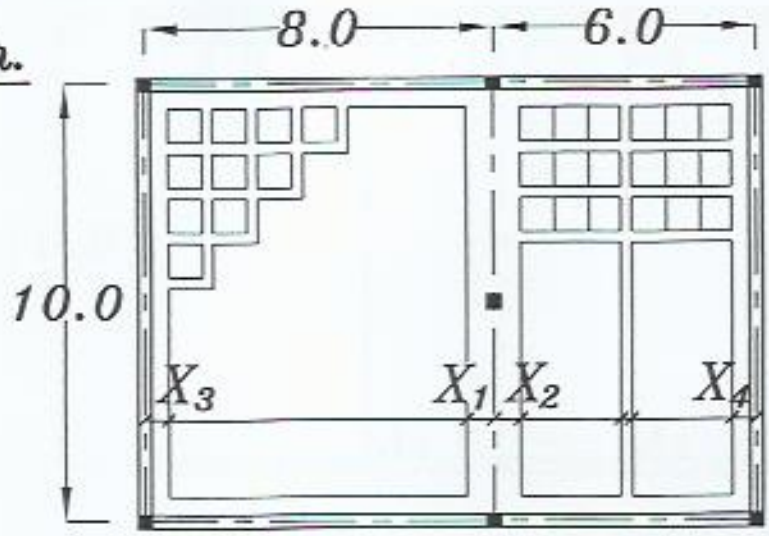
$t = 300\ mm$, $d = 300 - 30 = 270\ mm$, $B = 984.7\ mm$

$$270 = C_1\sqrt{\frac{74.8 * 10^6}{25 * 984.7}} \longrightarrow C_1 = 4.90 \longrightarrow J = 0.826$$

$$A_S = \frac{74.8 * 10^6}{0.826 * 360 * 270} = 931.6\ mm^2$$ 5ϕ16

Arrangement of Blocks.

Horizontal Direction.



8.0 m

$$L = X_1 + X_3 + (n_1)(0.5) + (n_1 - 1)(0.15)$$

Take $X_{1\,min} = 0.492$ m & $X_{3\,min} = 0.25$ m

$$8.0 = (0.492) + (0.25) + (n_1)(0.5) + (n_1 - 1)(0.15)$$

$$\xrightarrow{Get} n_1 = 11.39 \quad \boxed{n_1 = 11 \text{ Block}}$$

$$8.0 = (X_1) + (0.25) + (11)(0.5) + (11 - 1)(0.15)$$

$$\xrightarrow{Get} X_1 = 0.75 \quad \boxed{X_1 = 0.75 \text{ m.}}$$

6.0 m

$$L = X_2 + X_4 + (n_2)(0.5) + (0.15)$$

Take $X_{2\,min} = 0.492$ m & $X_{4\,min} = 0.25$ m

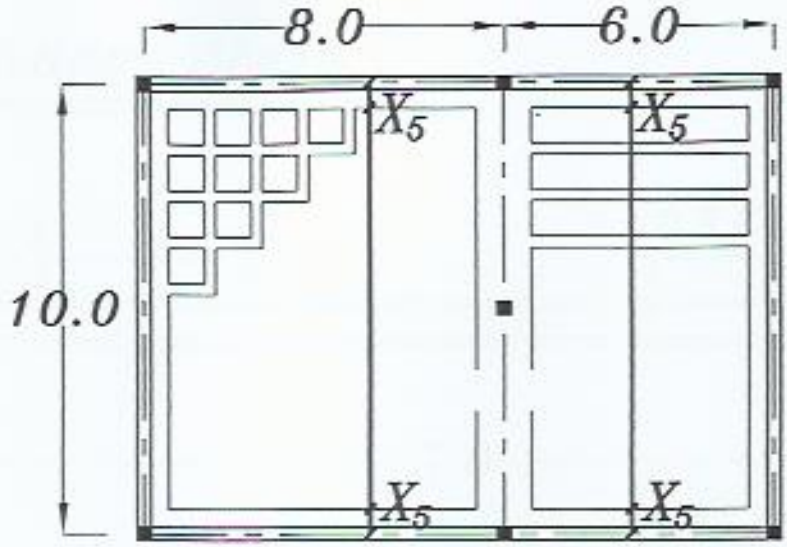
$$6.0 = (0.492) + (0.25) + (n_2)(0.5) + (0.15)$$

$$\xrightarrow{Get} n_2 = 10.2 \quad \boxed{n_2 = 10 \text{ Block}}$$

$$6.0 = X_2 + (0.25) + (10)(0.5) + (0.15)$$

$$\xrightarrow{Get} X_2 = 0.6 \quad \boxed{X_2 = 0.60 \text{ m.}}$$

Vertical Direction.



10.0 m

$$L = 2X_5 + (n_3)(0.5) + (n_3 - 1)(0.15)$$

Take $X_{5\,min} = 0.25\ m$

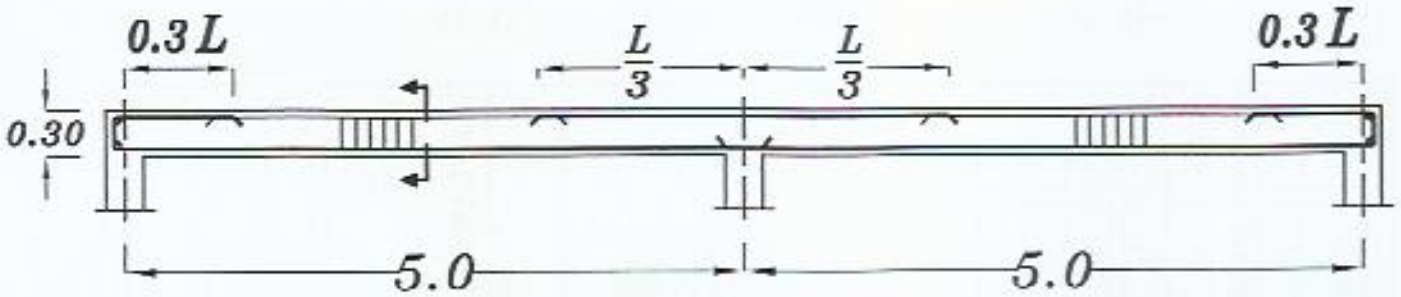
$$10.0 = 2(0.25) + (n_3)(0.5) + (n_3 - 1)(0.15)$$

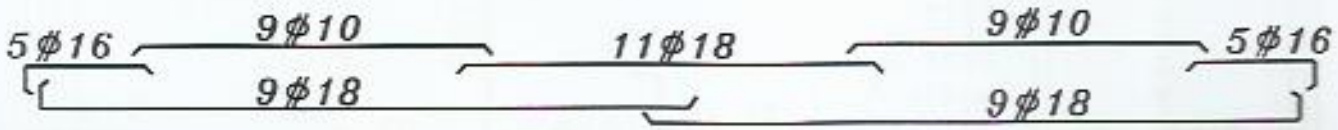
$$\xrightarrow{Get} n_3 = 14.84 \quad \boxed{n_3 = 14\ Block}$$

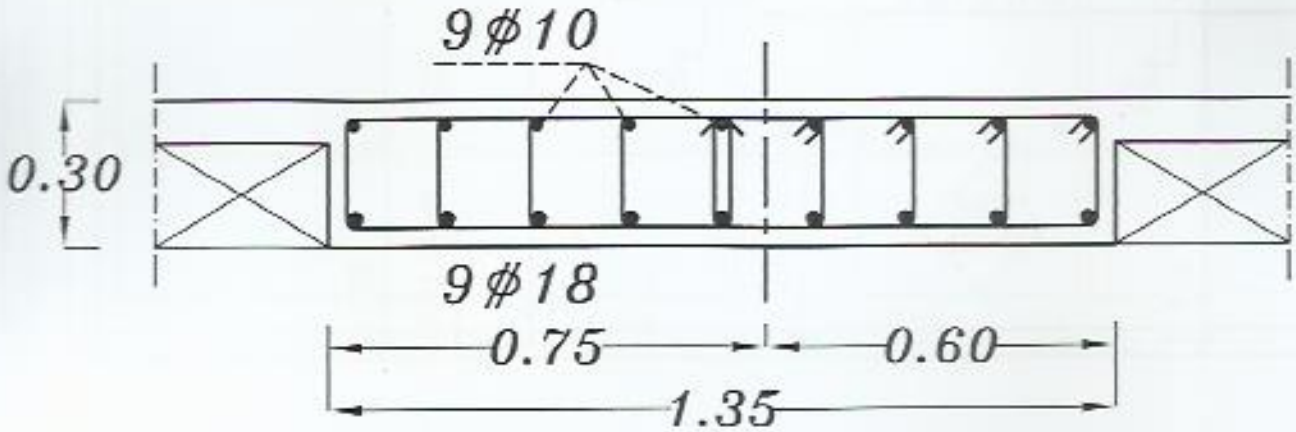
$$10.0 = 2(X_5) + (14)(0.5) + (14 - 1)(0.15)$$

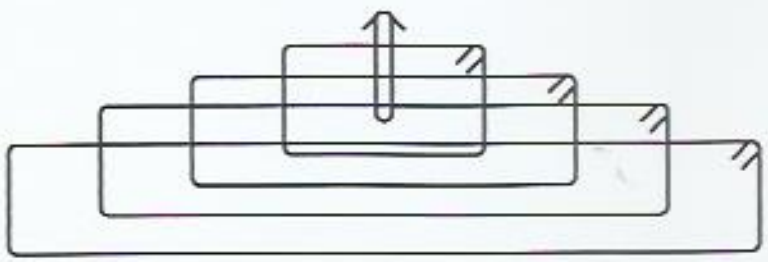
$$\xrightarrow{Get} X_5 = 0.525 \quad \boxed{X_5 = 0.525\ m.}$$

Reinforcement of Hidden Beam B

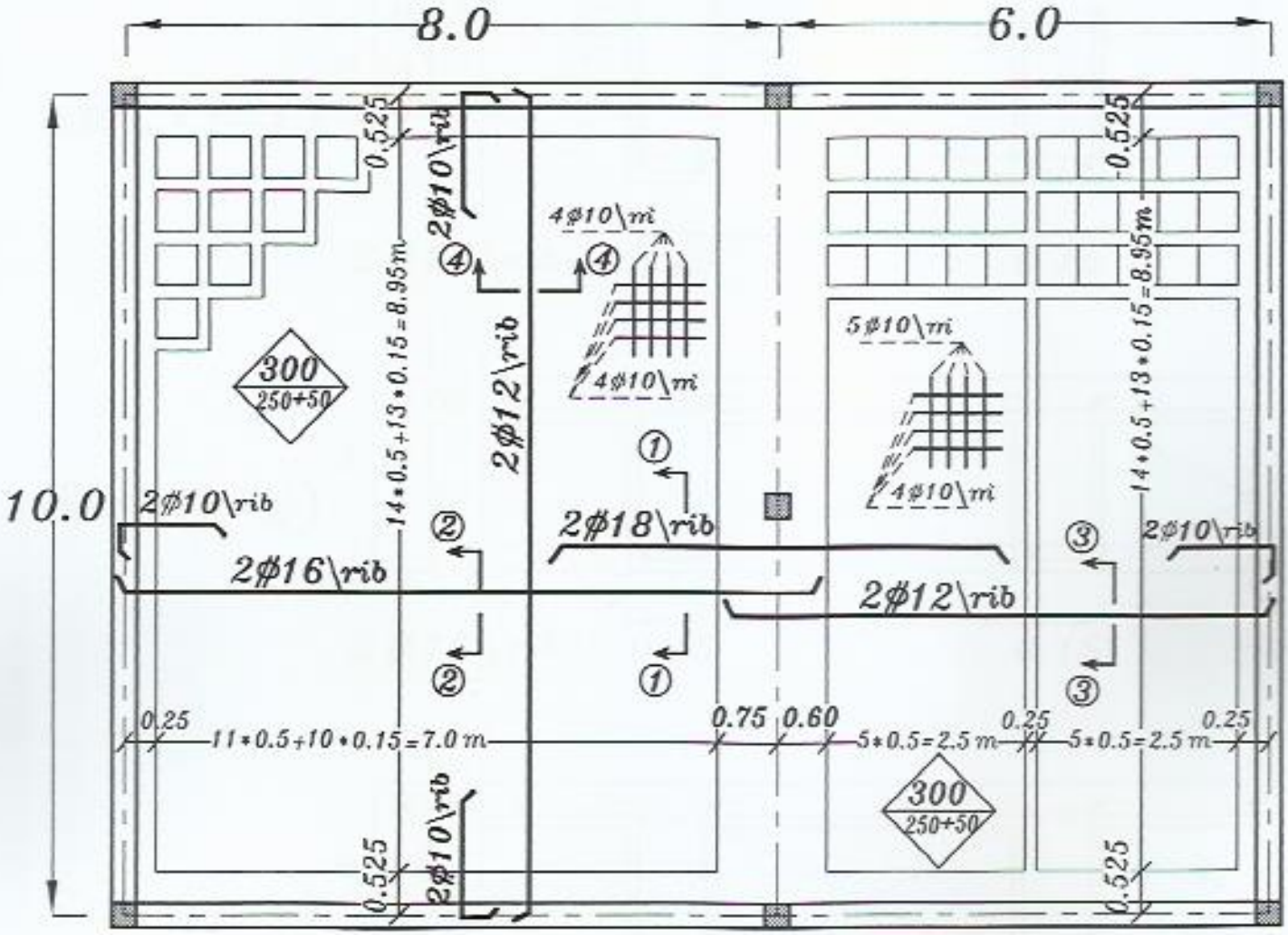




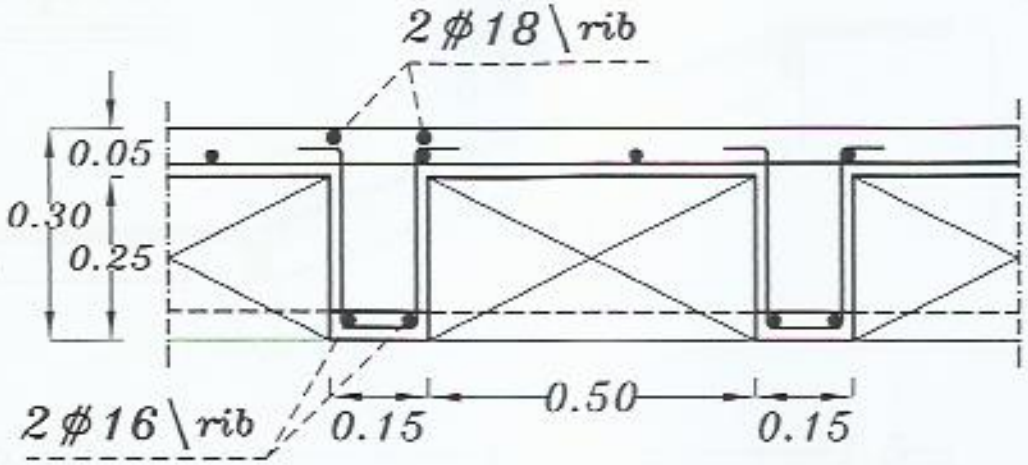




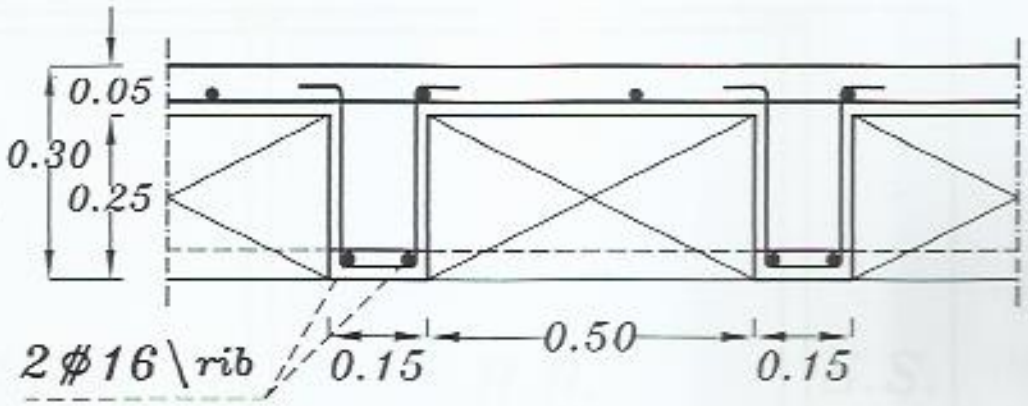
RFT. of the slab in plan.



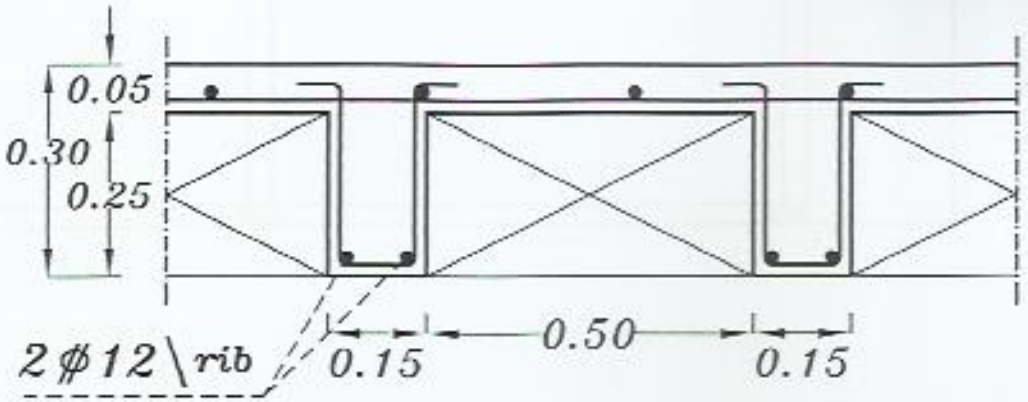
Sec. (1–1)



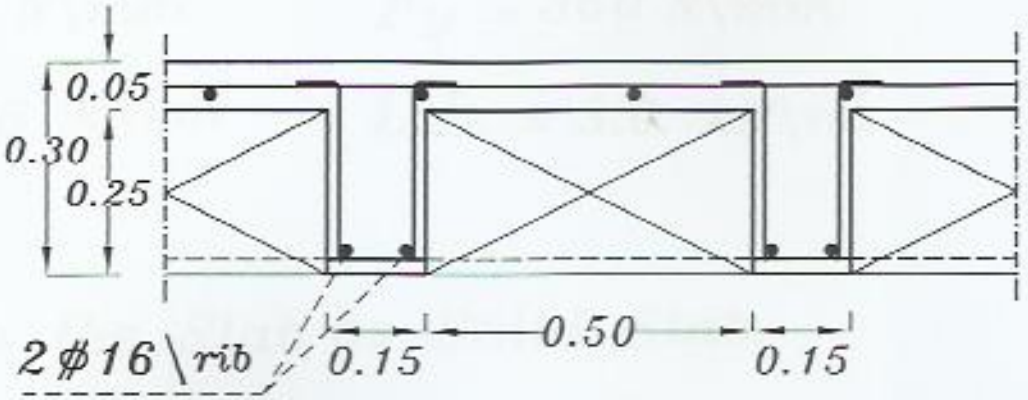
Sec. (2–2)



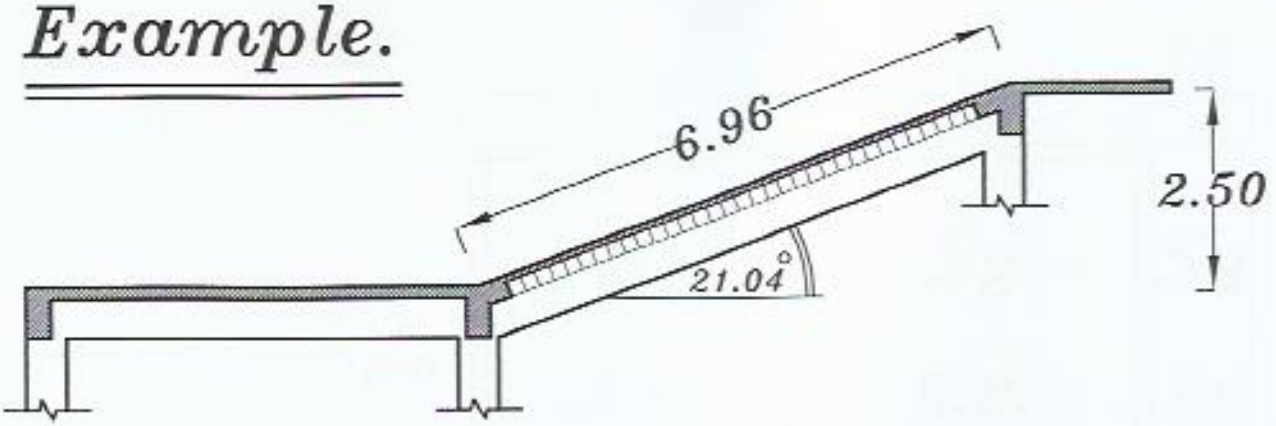
Sec. (3–3)

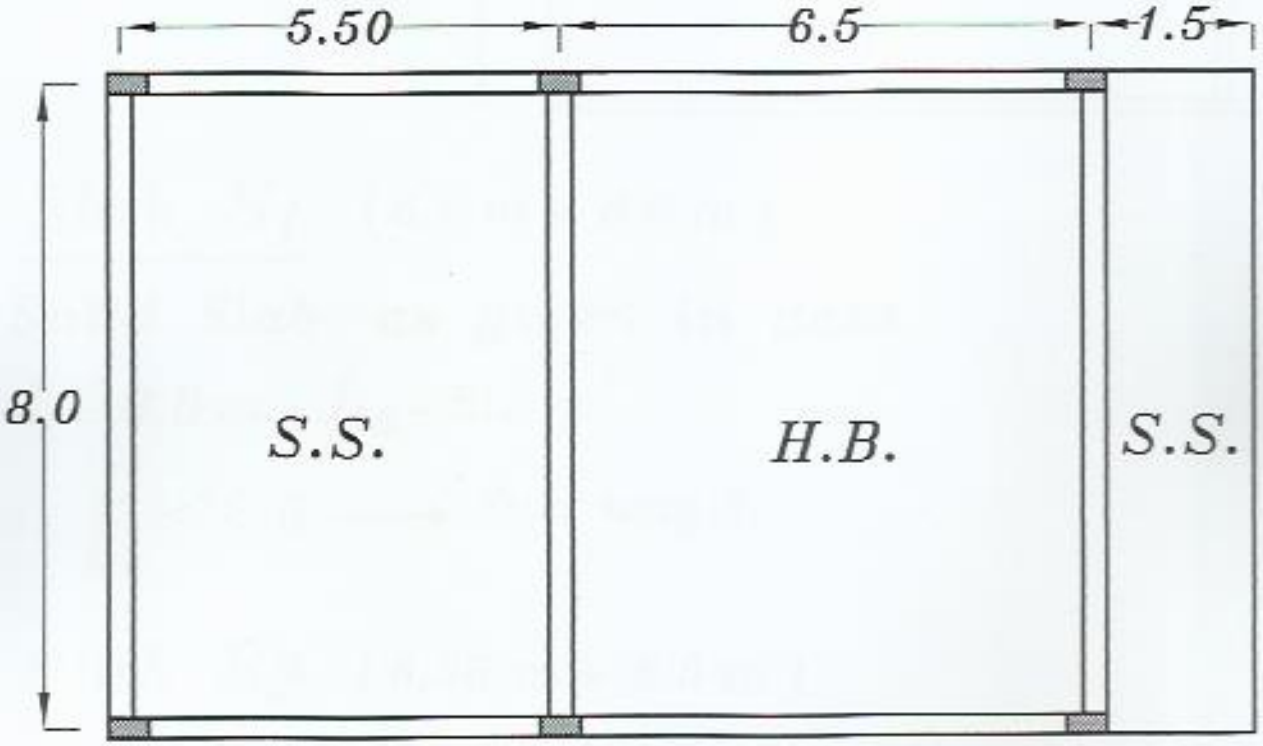


Sec. (4–4)



Example.





Data.

$F_{cu} = 25\ N\backslash mm^2$ $F_y = 360\ N\backslash mm^2$

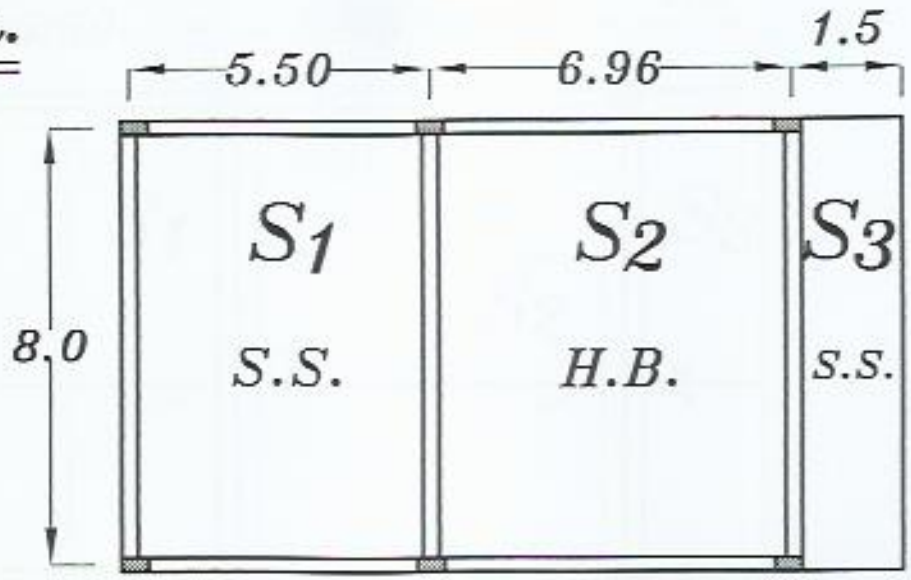
$F.C. = 1.5\ kN\backslash m^2$ $L.L. = 3.0\ kN\backslash m^2$

Req.

① Design the Slab as Solid Slab.

② Draw Details of RFT. in plan.

Solution.



Slab S_1 ($5.5\,m * 8.0\,m$)

Solid Slab as given in data.

$L = 8.0\,m$, $L_S = 5.5\,m$

$\therefore \frac{L}{L_s} < 2.0 \longrightarrow$ *Two way S.S.*

Slab S_2 ($6.96\,m * 8.0\,m$)

Hollow Blocks as given in data.

$\Theta = 21.04^{\circ} > 20 \longrightarrow$ *Use one way H.B. Slab*
at the inclined direction $= 6.96\,m$

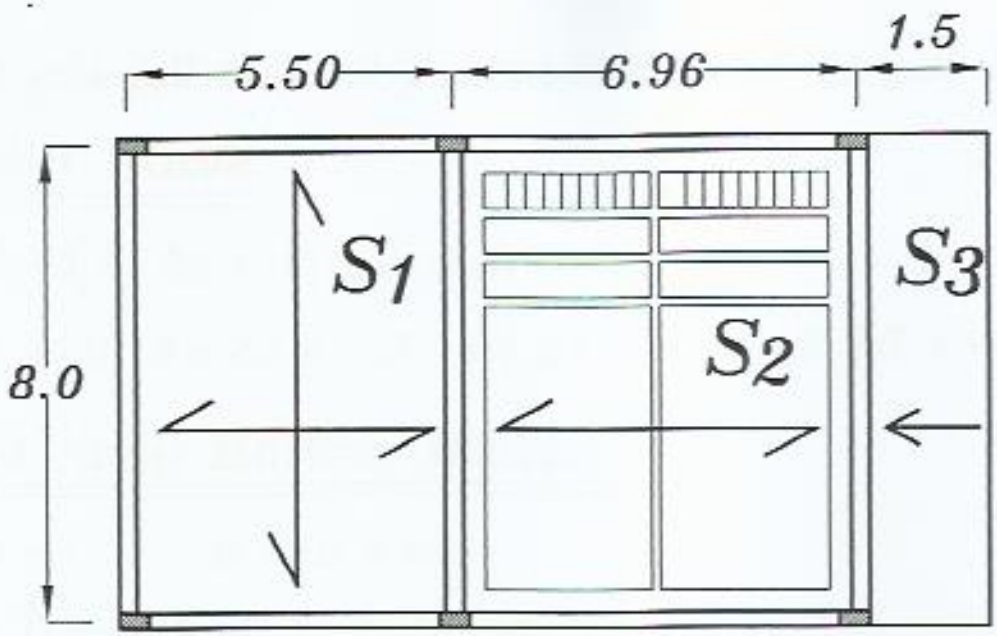
$\because L_s < 7.0\,m \longrightarrow$ *Use One cross rib.*

أبعاد البلوك ليست معطاه
لذا يفضل ان نختار الابعاد الـ standard للبلوك

$a = 200\,mm$
$e = 400\,mm$

Slab S_3

Cantilever $\longrightarrow$ **Solid Slab as given in data.**



خطوات التصميم .

١- نحسب الـ t_s للبلاطات الـ solid و الـ t للبلاطات الـ Hollow

① For Solid Slab.

S_1 Two way S.S. $L_S = 5.5\,m$

$t = \frac{5500}{40} = 137.5mm$

S_3 Cantilever S.S. $L_C = 2.0\,m$

$t = \frac{1500}{10} = 150\ mm$ $\boxed{t_s = 150\,mm}$

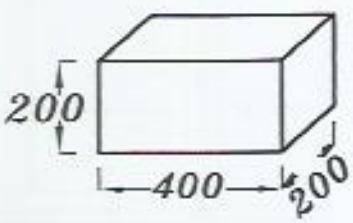
② For Hollow Blocks.

S_2 One way H.B. $L_S = 6.96\ m$

$t = \frac{6960}{28} = 248\ mm$ $\boxed{t = 250\ mm}$

The Block (200 * 400 * 200)

$h = 200\ mm \longrightarrow$ Weight of Block $= 150N$



٢- نحسب الـ w_s للبلاطات الـ solid و الـ w_{rib} للبلاطات الـ Hollow

For Solid Slabs.

$$w_s = 1.4\left(t_s\,\delta_c + F.C.\right) + 1.6\ L.L.$$

$$w_s = 1.4\,(0.15 * 25 + 1.5) + 1.6\,(3.0) = 12.15\ kN\backslash m^2$$

For One way Hollow Blocks.

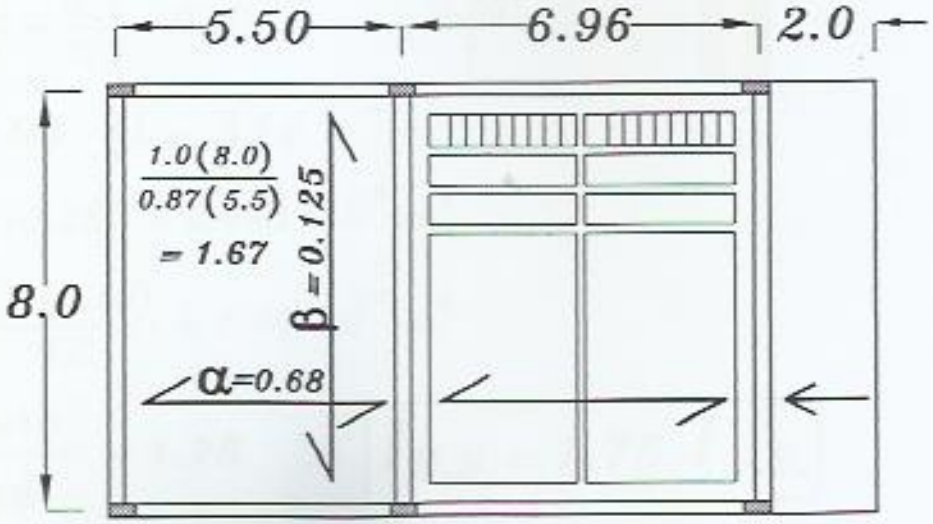
$$b = 0.1\,m \qquad e = 0.4\,m$$

$$S = e + b = 0.4 + 0.1 = 0.5\ m$$

$$w_{rib\,i} = \left[1.4\,(t_s\,\delta_c + F.C.) + 1.6\,(L.L.)(Cos\,\theta)\right](S * 1.0) + 1.4\,(b\,h * 1.0\,m * \delta_c) + 1.4 * (\text{وزن الـ Block})\left(\frac{1.0}{a}\right)$$

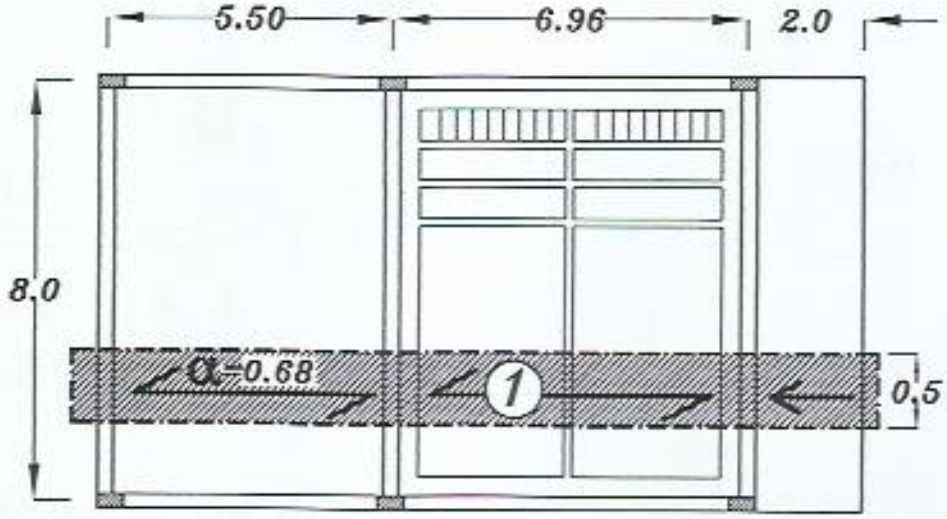
$$\therefore w_{ribi} = \left[1.4\,(0.05 * 25 + 1.50) + 1.6\,(3.0)\,(Cos\,21.04)\right](0.50 * 1.0) + 1.4\,(0.10 * 0.20 * 1.0 * 25) + 1.4\left(\frac{150}{1000}\right)\left(\frac{1.0}{0.2}\right) = 5.91\ kN\backslash(1.0 * S)$$

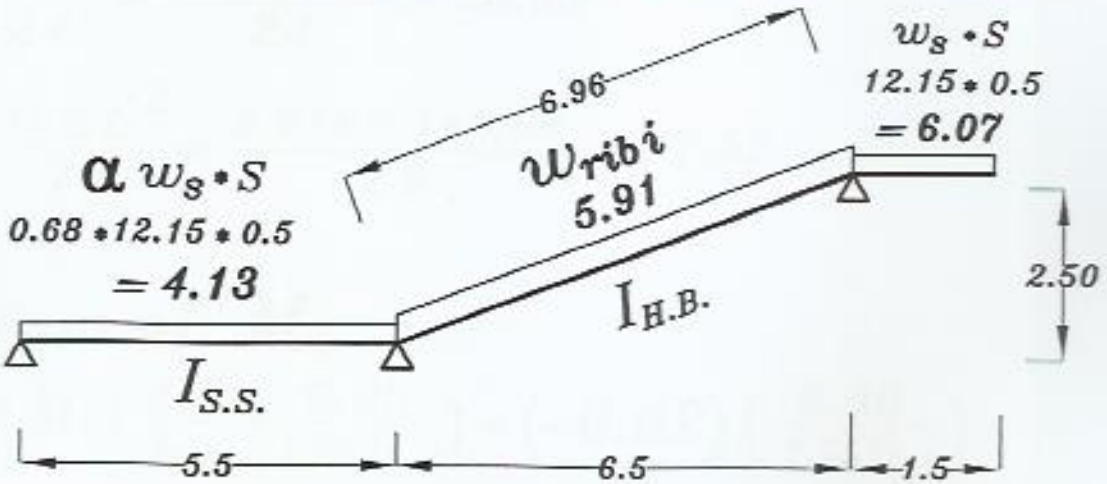
٣- نحسب الـ r للبلاطات الـ Two way



٤ـ نأخذ شرائح بالعرض ثم شرائح بالطول مع مراعاه عرض الشريحه .

Strip ①

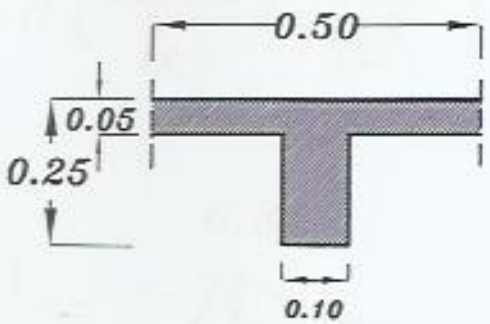




$$I_{H.B.} = \top \qquad I_1 = (\mu * 10^{-4})\, B\, t^3$$

$$B = 0.5\ m\ ,\ t = 0.25\,m$$

$$\frac{t_s}{t} = \frac{0.05}{0.25} = 0.2\ ,\ \frac{b_o}{B} = \frac{0.1}{0.5} = 0.2$$

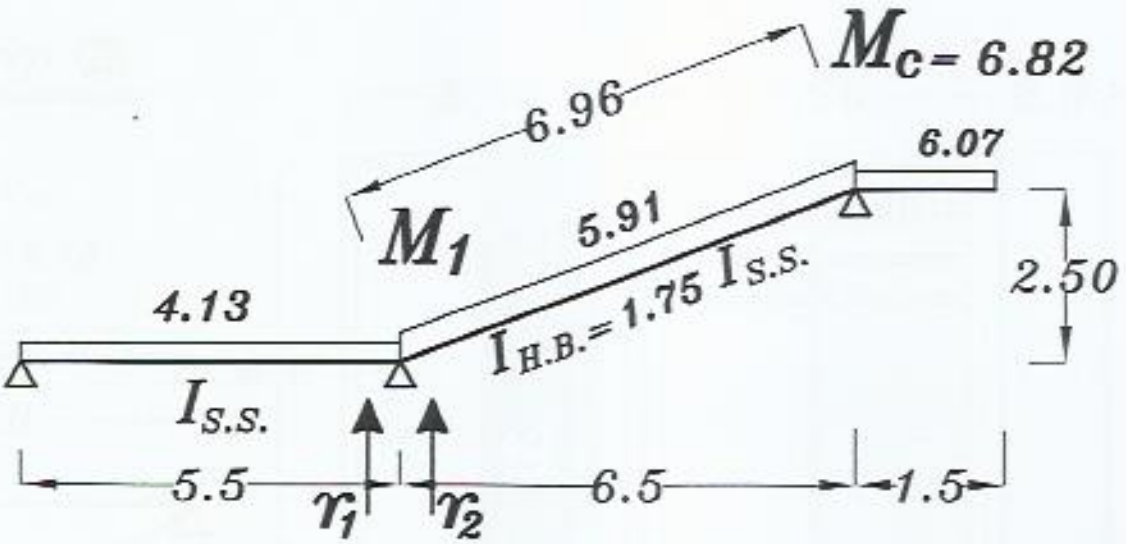


From Tables page 91 $\mu = 314$

$$I_{H.B.} = (314 * 10^{-4} * 0.5 * 0.25^3) = 2.453 * 10^{-4}\ m^4$$

$$I_{S.S.} = \frac{S\,(t_s)^3}{12} = \frac{0.5\,(0.15)^3}{12} = 1.40 * 10^{-4}\ m^4$$

$$\therefore \frac{I_{H.B.}}{I_{S.S.}} = \frac{2.453 * 10^{-4}}{1.40 * 10^{-4}} = 1.75 \quad \therefore \boxed{I_{H.B.} = 1.75\ I_{S.S.}}$$



$$\gamma_1 = \frac{wL^3}{24} = \frac{4.13 * 5.5^3}{24} = 28.63$$

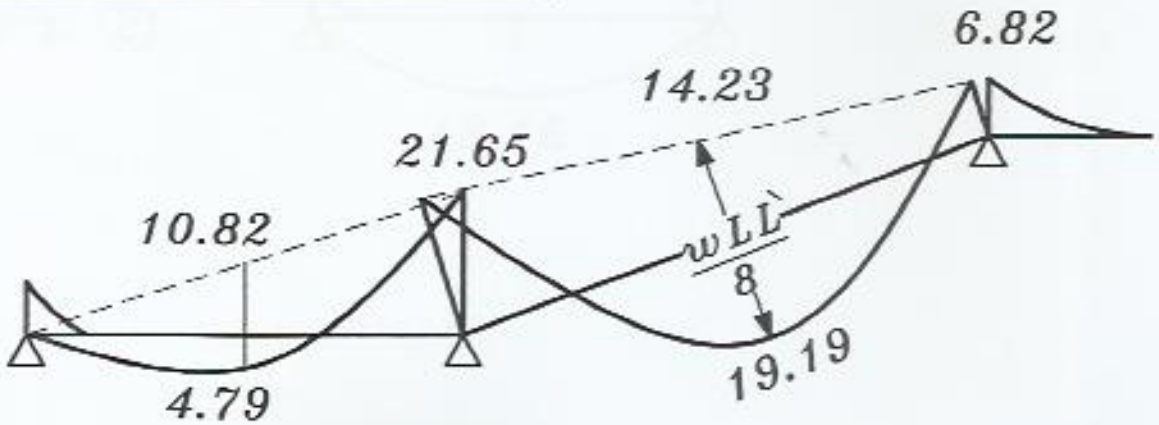
$$\gamma_2 = \frac{wLL`^2}{24} = \frac{5.91 * 6.5 * 6.96^2}{24} = 77.53$$

Equation of M_1

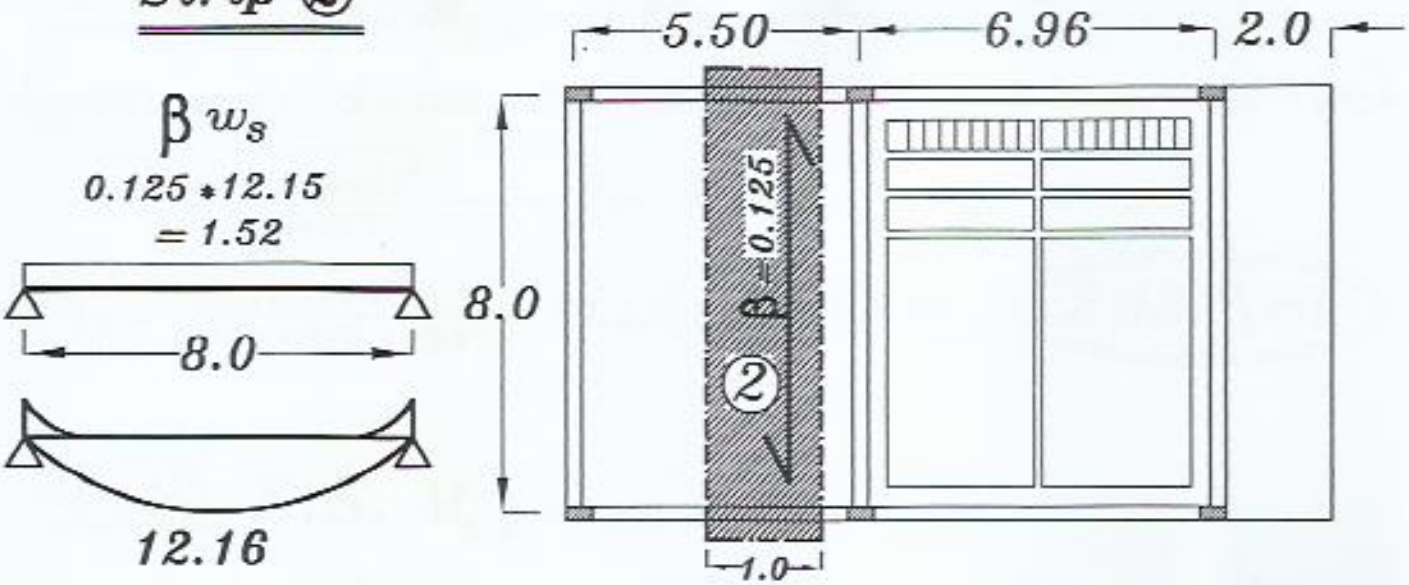
$$0.0 + 2M_1\left(\frac{5.5}{I_{S.S.}} + \frac{6.96}{1.75 I_{S.S.}}\right) + (-6.82)\left(\frac{6.96}{1.75 I_{S.S.}}\right)$$

$$= -6\left(\frac{28.63}{I_{S.S.}} + \frac{77.53}{1.75 I_{S.S.}}\right)$$

$$\boxed{M_1 = -21.65\,kN.m}$$



Strip ②



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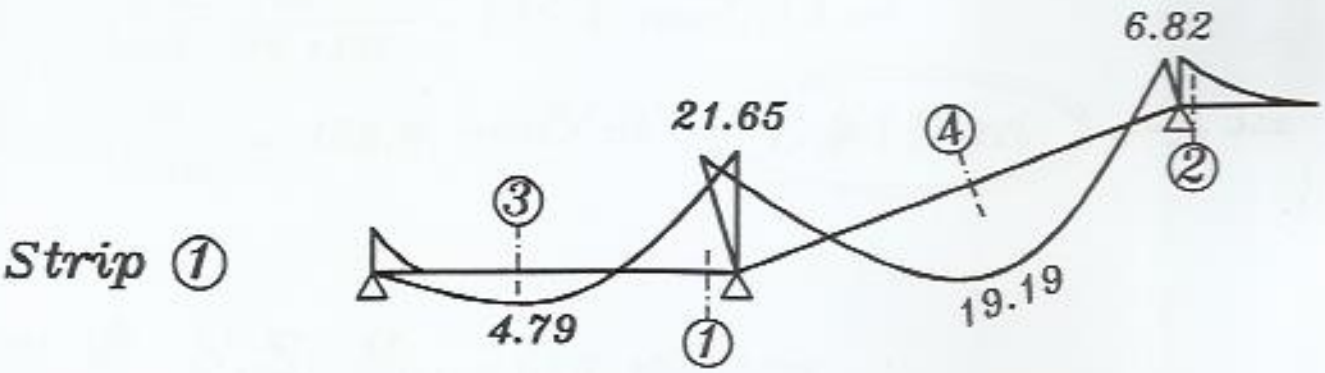
٥ ـ نعمل تصميم للشرائح مع مراعاه عرض الشريحه .



Sec.① S.S. $M_{U.L.} = 21.65\ kN.m\backslash 0.5m$

$t_s = 150\ mm$, $d = 150 - 20 = 130\ mm$, $S = 500\ mm$ عرض الشريحه

$$130 = C_1\sqrt{\frac{21.65 * 10^6}{25 * 500}} \longrightarrow C_1 = 3.12 \longrightarrow J = 0.754$$

$$A_S = \frac{21.65 * 10^6}{0.754 * 360 * 130} = 613.5\ mm^2/0.5\ m$$ **2Φ22\rib**

Sec.② S.S. $M_{U.L.} = 6.82\ kN.m\backslash 0.5m$

$t_s = 150\ mm$, $d = 150 - 20 = 130\ mm$, $S = 500\ mm$ عرض الشريحه

$$130 = C_1\sqrt{\frac{6.82 * 10^6}{25 * 500}} \longrightarrow C_1 = 5.56 \longrightarrow J = 0.826$$

$$A_S = \frac{6.82 * 10^6}{0.826 * 360 * 130} = 176.4\ mm^2/0.5\ m$$

$$A_S = \frac{176.4}{0.50} = 352.8\ mm^2/m`$$ **6Φ10\m`** عدد زوجى

Sec.③ S.S. $M_{U.L.} = 4.79\ kN.m\backslash 0.5m$

$t_s = 150\ mm$, $d = 150 - 20 = 130\ mm$, $S = 500\ mm$ عرض الشريحه

$$130 = C_1\sqrt{\frac{4.79 * 10^6}{25 * 500}} \longrightarrow C_1 = 6.64 \longrightarrow J = 0.826$$

$$A_S = \frac{4.79 * 10^6}{0.826 * 360 * 130} = 123.9\ mm^2/0.5\ m$$

$$A_S = \frac{123.9}{0.50} = 247.8\ mm^2/m`$$ **5Φ10\m`**

Sec.④ H.B. $M_{U.L.} = 19.19\ kN.m\backslash rib$

$t = 250\ mm$, $d = 250 - 30 = 220\ mm$, $S = 500\ mm$ عرض الشريحه

$$220 = C_1\sqrt{\frac{19.19 * 10^6}{25 * 500}} \longrightarrow C_1 = 5.61 \longrightarrow J = 0.826$$

$$A_S = \frac{19.19 * 10^6}{0.826 * 360 * 220} = 293.3\ mm^2/rib$$ **2Φ16\rib**

Sec.⑤ S.S. $M_{U.L.} = 12.16\ kN.m\backslash m$

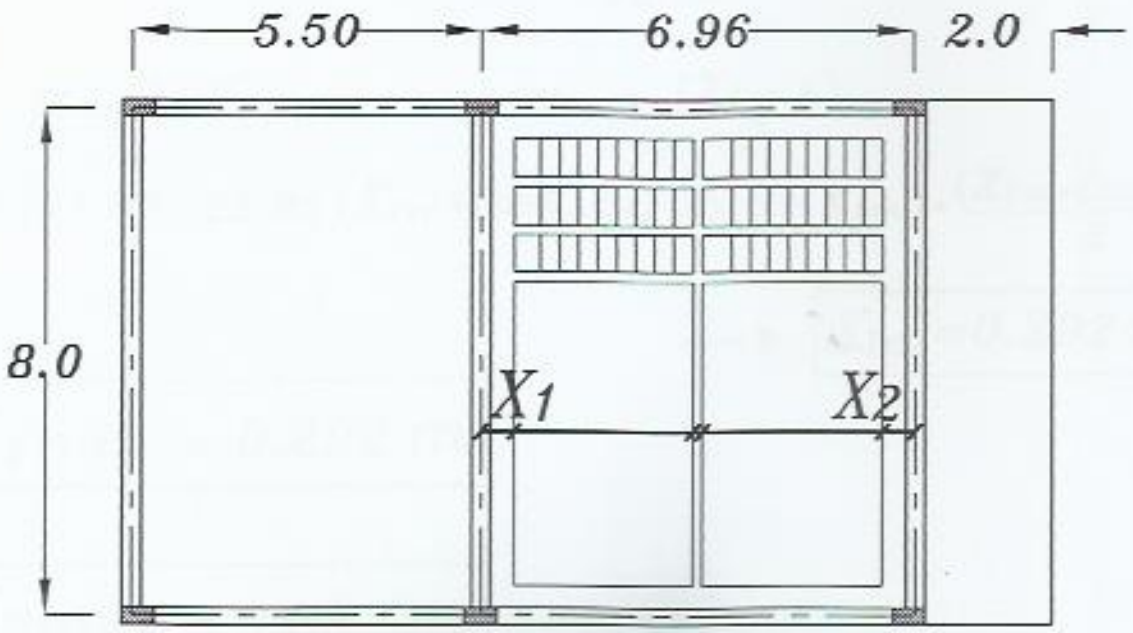
$t_S = 150\ mm$, $d = 150 - 20 = 130\ mm$, $S = 1000\ mm$ عرض الشريحه

$$130 = C_1\sqrt{\frac{12.16 * 10^6}{25 * 1000}} \longrightarrow C_1 = 5.89 \longrightarrow J = 0.826$$

$$A_S = \frac{12.16 * 10^6}{0.826 * 360 * 130} = 314.5\ mm^2/m$$ **5Φ10\m`**

٦- نحسب عرض الـ solid part و رص البلوكات .

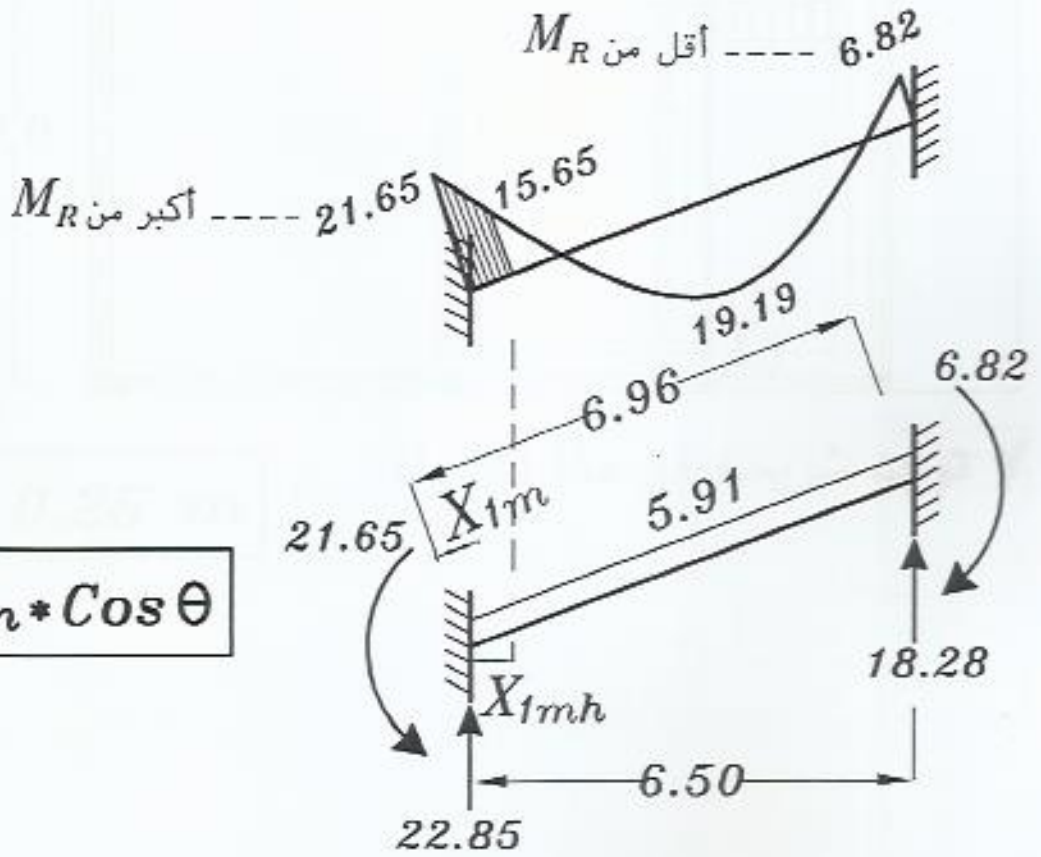
Horizontal Direction.



Calculate X_m

$$M_R = R_{max} * \frac{F_{cu}}{\gamma_c} * b * d^2 = 0.194 * \frac{25}{1.5} * 100 * 220^2$$

$$= 15649333\ N.mm = \mathbf{15.65}\ kN.m$$



$$X_{1m\,h} = X_{1m} * Cos\,\theta$$

$$M_R = M\_R\,(X_{1m\,h}) + We\,(X_{1m}) * \frac{(X_{1m\,h})}{2}$$

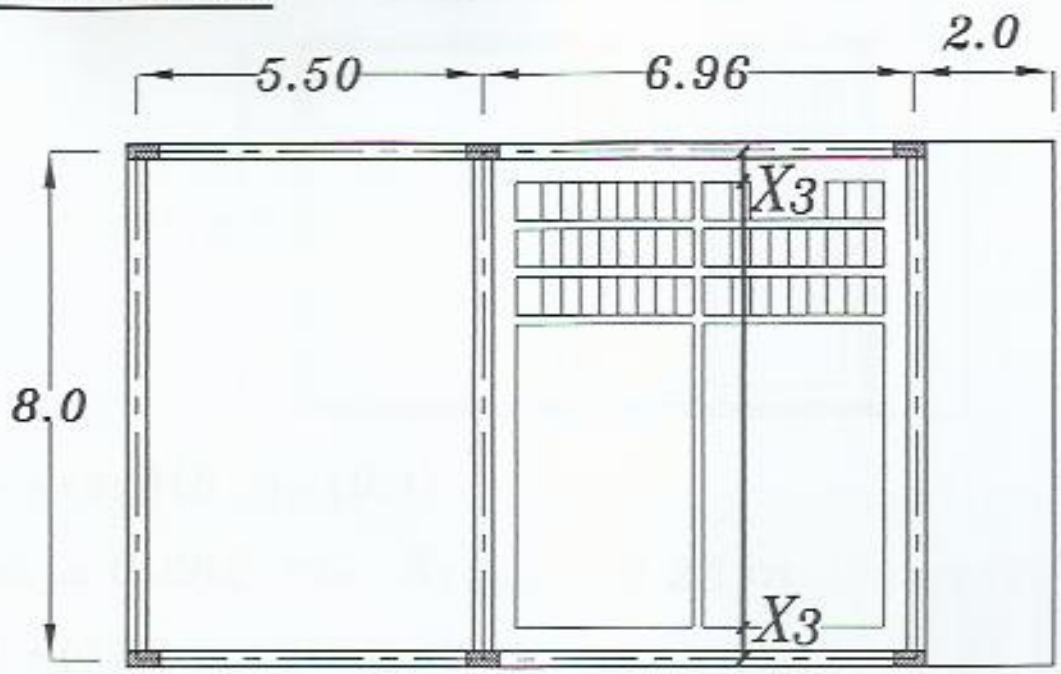
$$15.65 = 21.65 - 22.85\,(X_{1m} * Cos\,21.04) + 5.91(X_{1m}) * \frac{(X_{1m} * Cos\,21.04)}{2}$$

$$\longrightarrow \boxed{X_{1m} = 0.292\ m}$$

$$\boxed{X_{1min} = 0.292\ m}$$

$$\boxed{X_{2min} = 0.25\ \ m}$$

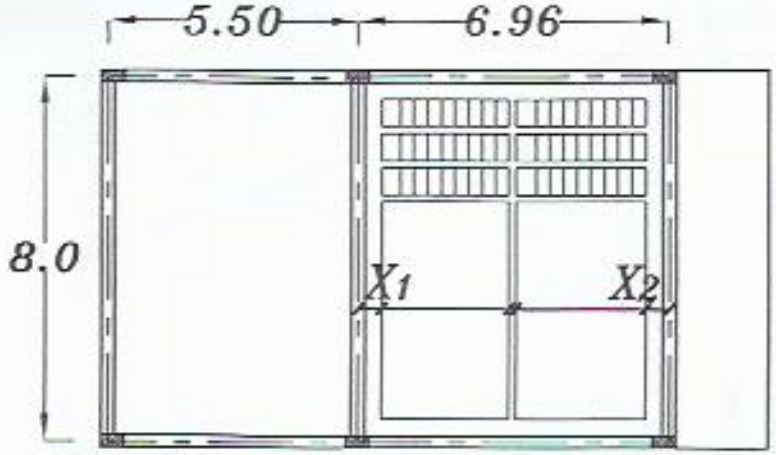
Vertical Direction.



لا توجد شريحه فى هذا الاتجاه

$$X_{3min} = 0.25\ m$$

Horizontal Direction.



$$L = X_1 + X_2 + (n_1)(0.2) + (0.1)$$

Take $X_{1\,min} = 0.292\ m$, $X_{2\,min} = 0.25\ m$

$$6.96 = (0.292) + (0.25) + (n_1)(0.2) + (0.1)$$

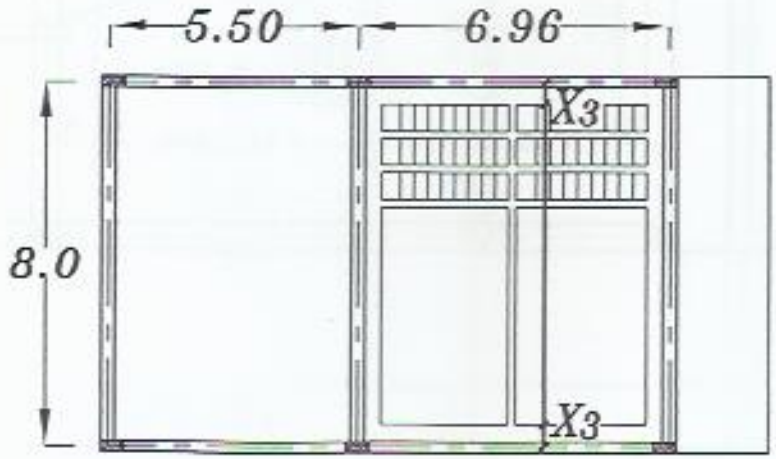
Take $\boxed{X_2 = 0.25\ m}$

$\xrightarrow{Get}$ $n_1 = 31.59$ $\boxed{n_1 = 31\ Block}$

$$6.96 = X_1 + (0.25) + (31)(0.2) + (0.1)$$

$\xrightarrow{Get}$ $X_1 = 0.41$ $\boxed{X_1 = 0.41\ m.}$

Vertical Direction.



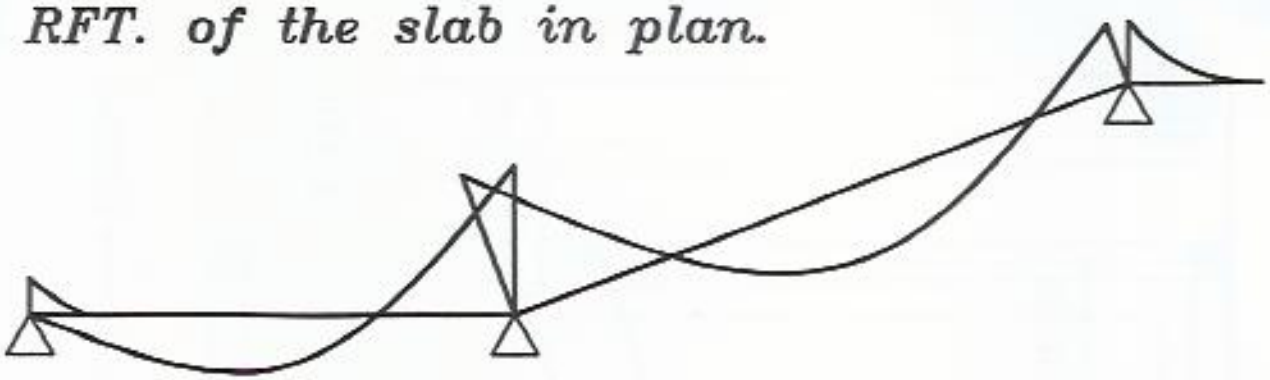
$$L = 2\,(X_3) + (n_2)(0.4) + (n_2 - 1)(0.10)$$

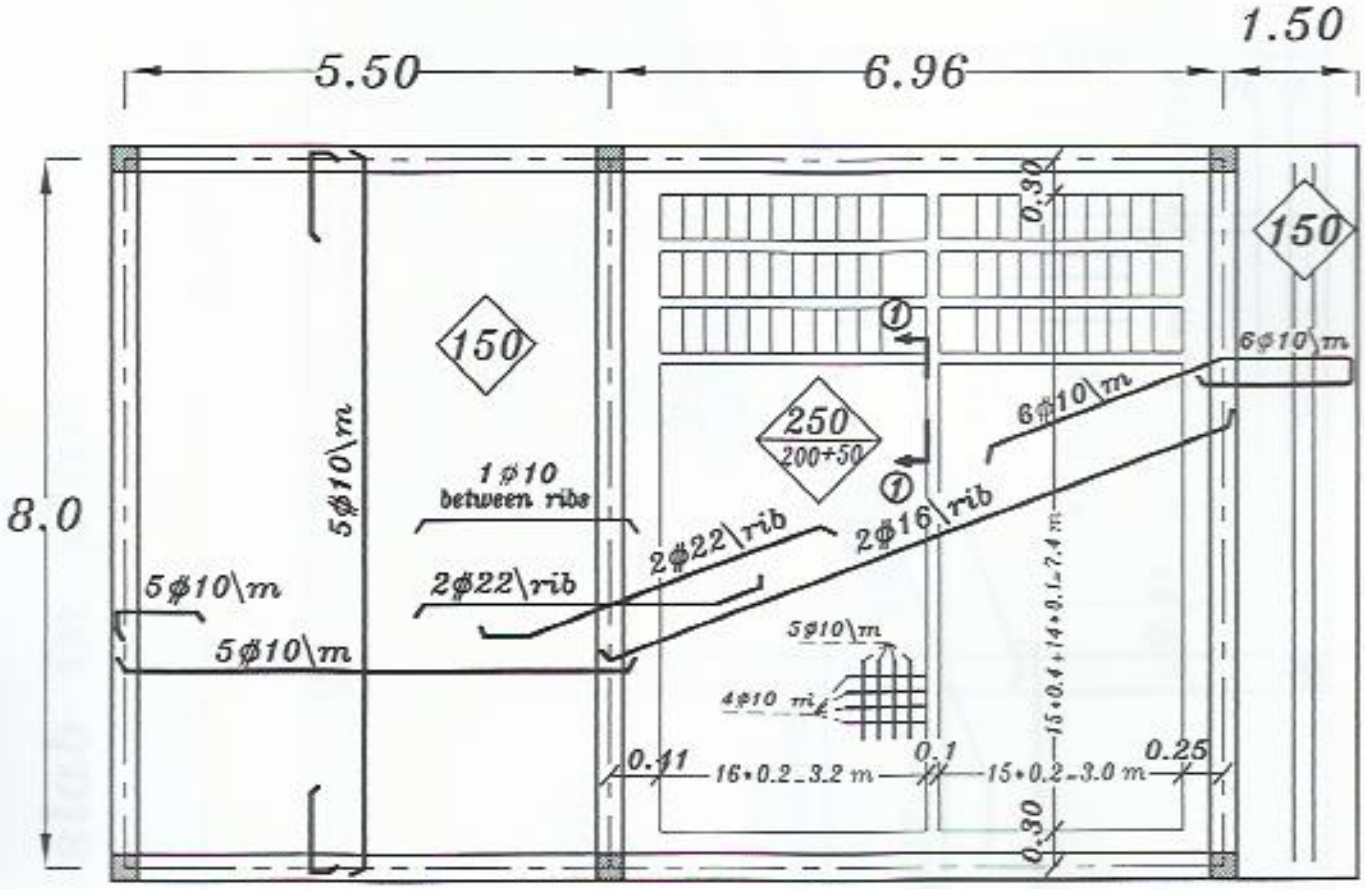
Take $X_3 = 0.25\ m$

$8.0 = 2\,(0.25) + (n_2)\,(0.4) + (n_2 - 1)(0.10)$ $\xrightarrow{Get}$ $n_2 = 15.2$ $\boxed{n_2 = 15\ Block}$

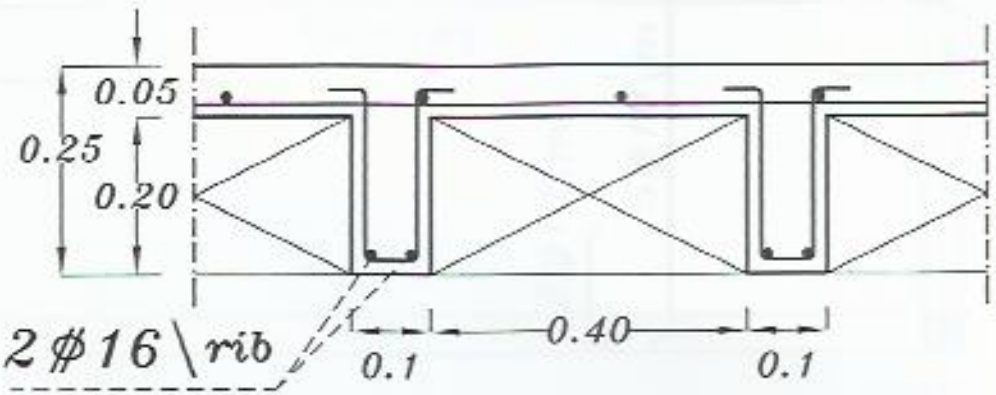
$8.0 = 2\,(X_3) + (15)(0.4) + (15 - 1)(0.1)$ $\xrightarrow{Get}$ $X_3 = 0.30$ $\boxed{X_3 = 0.30\ m}$

RFT. of the slab in plan.





Sec. (1–1)



RFT. of the slab in plan.