

# **Concrete Sections**

From sec.1 to sec.4

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# Section 1

# Flat slab

11

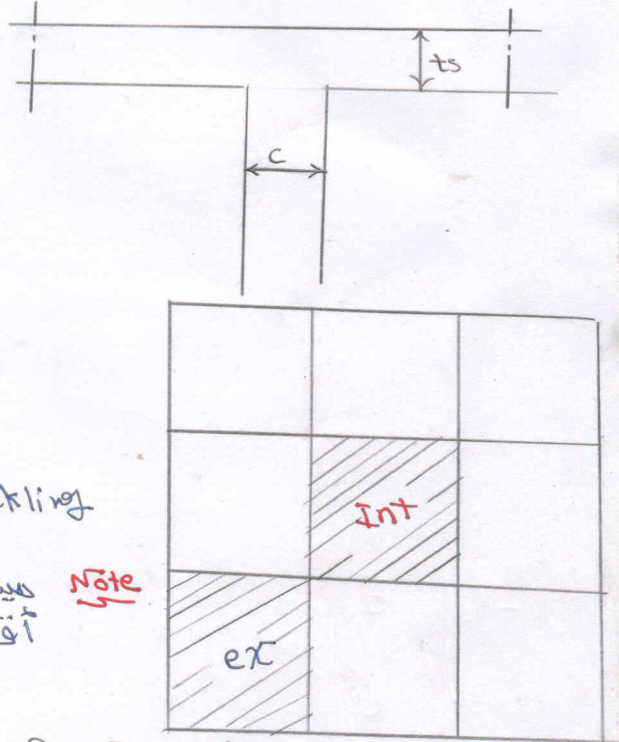
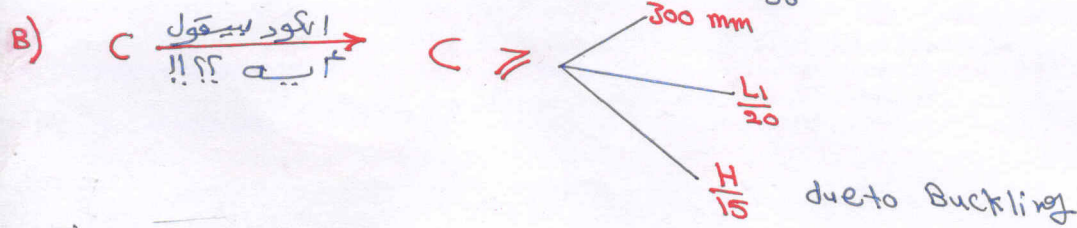
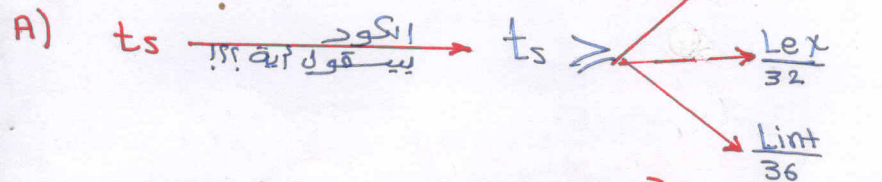
مقدمة:

- \* عيوب Solid slab :- (1) غير اقتصادية (2) أما من الحوائط مرتبطة بالكمات [ من الصعب تعديل شكل عمارة ] (3) تقطع مسالك كهرباء
- \* من ايجاب Flat slab :- (1) مناسبة عمارة [ من السهل واليسر تعديل النظام المتحاري ] (2) تقطع مسالك كهرباء
- \* عيوب Flat slab :- (1) مقاومة الزلزال خيرا أقل من Solid

## \* Type of Flat slab

### 1) Flat slab without Col. Head and drop.

#### 1) Grc. Dimensions



Note: يجب فحص أقص من الكود إذا كان  $c$  لا تساعى 300 لا زلزال أقل حاجة للكود  $c = 300$

#### 2) Loads

\*  $g_s = t_s \sigma_{conc} + f.c$   
 \*  $P.s = L.L$

$w_u = \begin{cases} 1.5 [g_s + P_s] & \text{if } P_s/g_s < 0.75 \\ 1.4 g_s + 1.6 P_s & \text{if } \frac{P_s}{g_s} \geq 0.75 \end{cases}$

#### 3) Total static Moment

\*  $M_o = \frac{w_u L_T}{8} \left[ L - \frac{2}{3} (c) \right]$

بعد الكود  $L_T$   $\rightarrow$  البعد العمودى على إتجاه الشريحة  
 $L$   $\rightarrow$  البعد الموازى لإتجاه الشريحة

#### 4) B.M. D for GI and Field strip

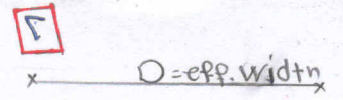
5)  $d$

$d = t_s - \text{cover}$  always  $\text{cover} =$

اللهم لا تكلمنى إلا بنفسى كرفقة عين

2) Flat slab with G.I. Head only

Case 1) *في حالة وجود*



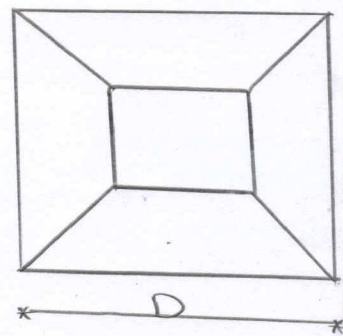
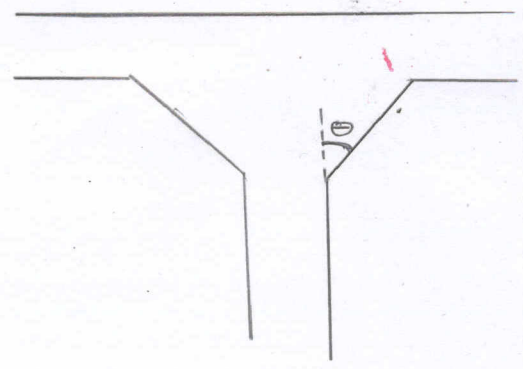
1) Conc. Dimension

A)  $t_s \rightarrow$  From Case 1

B)  $C \rightarrow$  From Case 1

C)  $D \leq 0.25 L_2$  where  $L = \frac{L_1 + L_2}{2}$

D)  $\theta \geq 45$



\* Loads  $\rightarrow$  Case (1)

2) Total static Moment

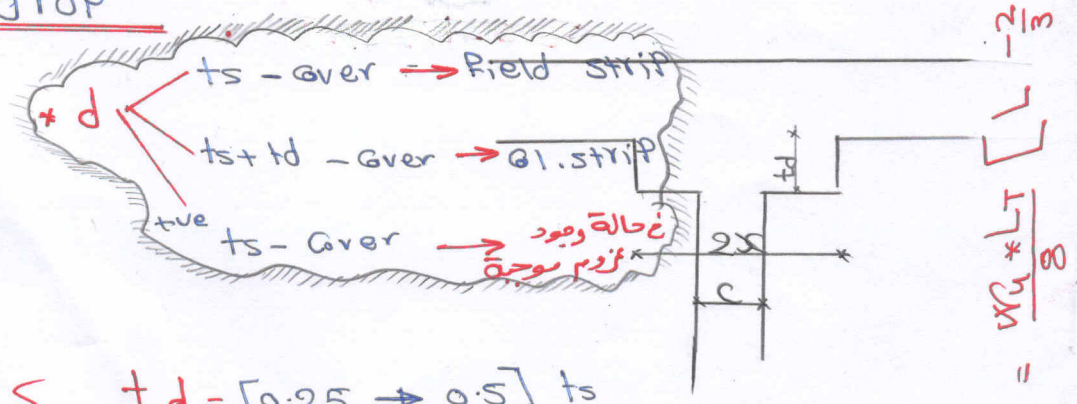
$M_0 = \frac{w_u \times L^2}{8}$  L = eff. (D)

*العمق الفعالي*

d  $\rightarrow$  effective depth  
 $d = t_s - \text{cover}$

3) Flat slab with drop

\*  $t_s \geq \begin{cases} 150 \text{ mm} \\ \frac{L_e \times}{36} \\ \frac{L_{in}}{40} \end{cases}$



\*  $C \rightarrow$  Case (1)

$t_d = [0.25 \rightarrow 0.5] t_s$

$\frac{L_1}{3} \leq 2x \leq \frac{L_2}{2}$

always  $\frac{L_2}{2}$

في الشغل

$M_0 = \frac{w_u \times L^2}{8} \left[ L - \frac{2}{3} (C) \right]^2$

\* Loads  $\therefore P_s = L \cdot L$

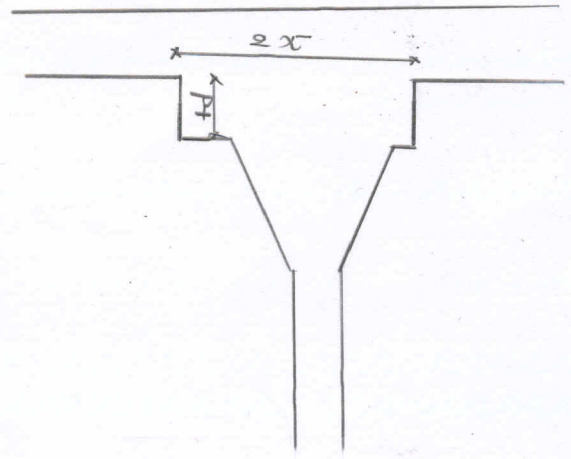
$I_s = t_s \times \sigma_{conc} + f.c$

$\frac{(2x)^2 \times t_d \times \sigma_{conc}}{L_1 \times L_2}$

قسمت لها عن  $L_1 \times L_2$   
 كتلة من اسطح الوزن على المساحة  
 $\sigma_{conc}$

# 4) Flat slab with Col. Head and drop

3



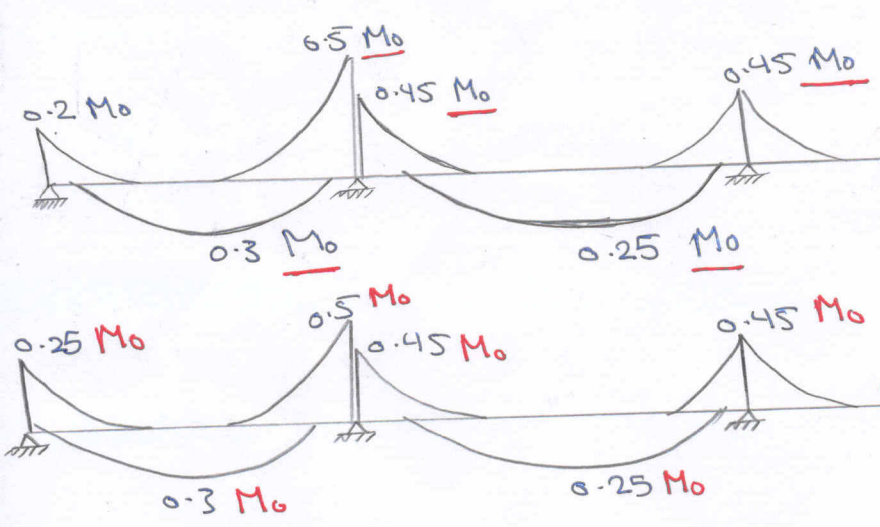
- \*  $D \leq 0.25 L_2$
- \*  $\theta \neq 45^\circ$
- \*  $t_s \rightarrow$  Case (3)
- \*  $C \rightarrow$  Case (1)
- \*  $t_d \rightarrow$  Case (3)
- \*  $2x \rightarrow$  Case (3)
- \* Loads  $\rightarrow$  Case (3)
- \*  $d \rightarrow$  Case (3)

$$* M_o = \frac{W_u \cdot L^2}{8} \left[ L - \frac{2}{3} (D) \right]$$

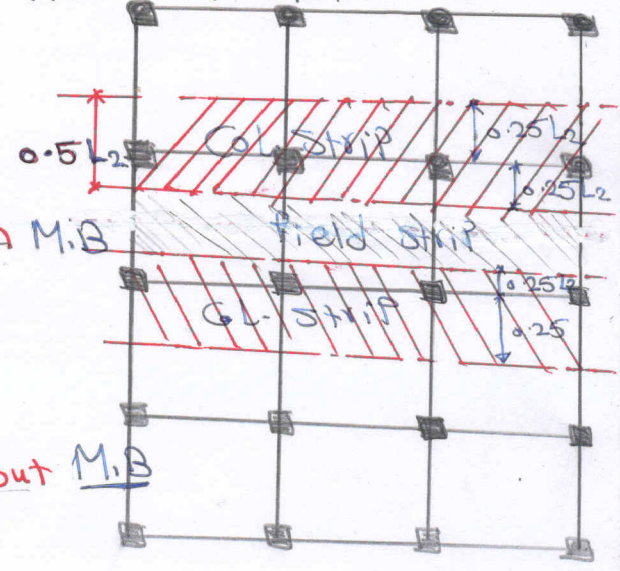
زونی تساه  
لا بوالسباع

## Column strip and field strip

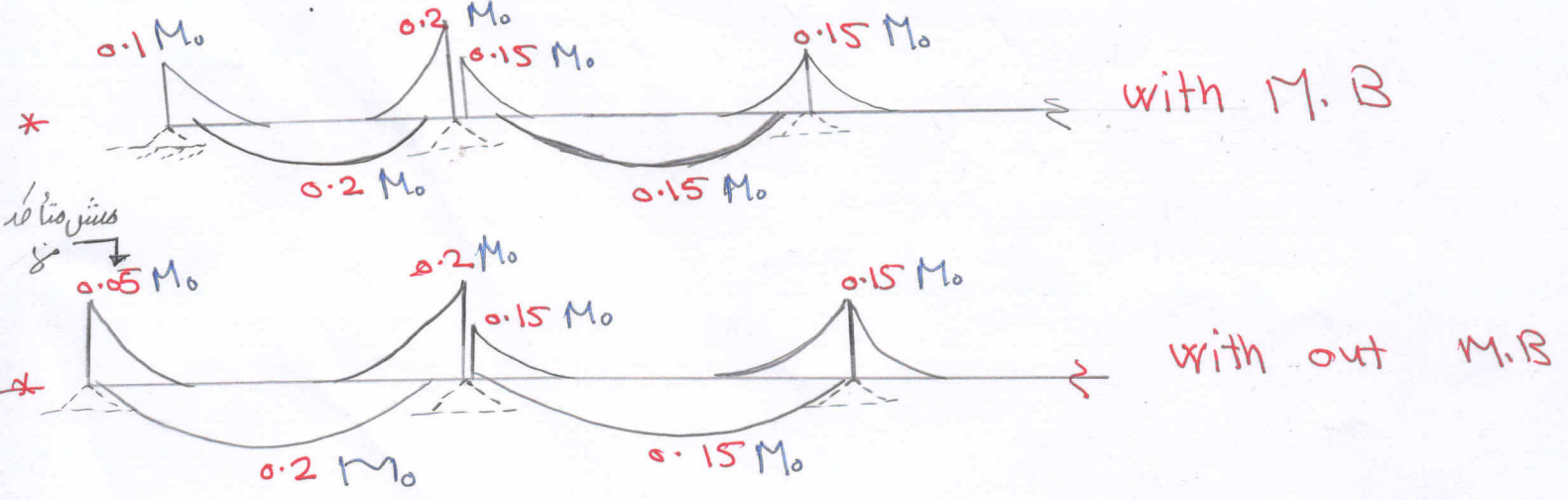
### \* B.M.D For Col. strip



- \* Col. strip width =  $0.5 L_2$
- \* Field strip width =  $\frac{1}{2} L_2$



### \* B.M.D For field strip



Ex :-

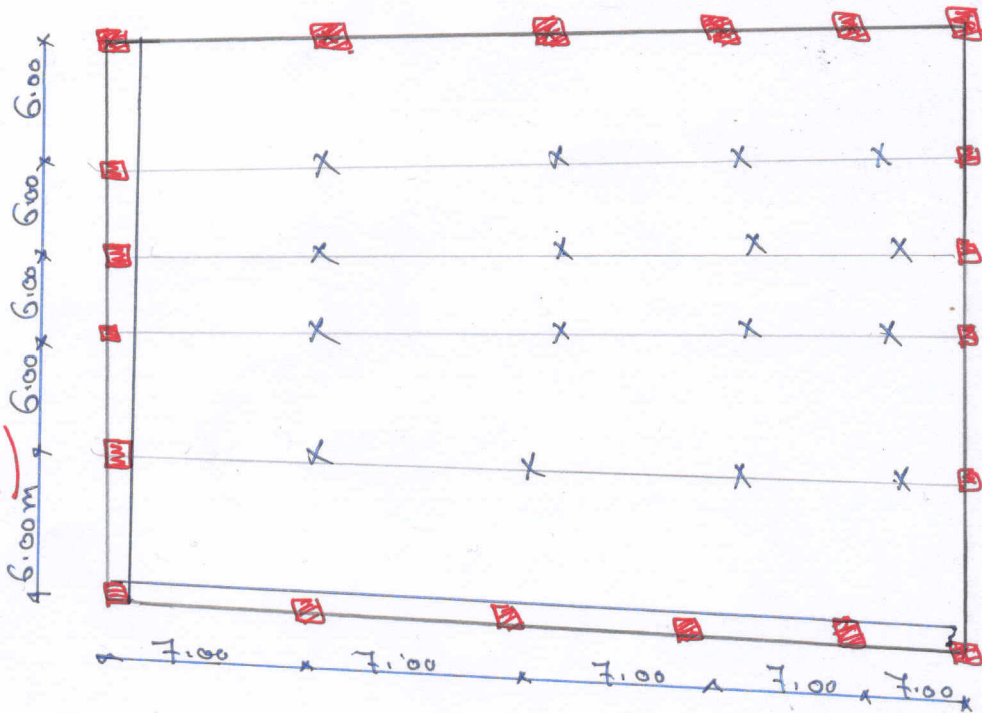
Data :-

$f_{cu} = 30 \text{ MPa}$

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

$L.L = 4 \text{ kN/m}^2$

Height of Floor = 6.00m



(1) Conc. Dimension (Uso'ri' given)

$t_s \Rightarrow$

- 150 mm
- $\frac{65000}{32} = 2037.5 \text{ mm}$
- $\frac{6500}{36} = 181 \text{ mm}$

Take  $t_s = 220 \text{ mm}$

$C \Rightarrow$

- 300 mm
- $\frac{L}{20} = \frac{7000}{20} = 350$
- $\frac{L}{15} = \frac{6000}{15} = 400$

Take Column = 400 x 400

$D \leq 0.25 L = 0.25 \times 65000 = 1625 \text{ mm}^2$

Take Colu head = 1500 x 1500

Take  $\theta = 45^\circ$

→ Loads

$g_s = t_s \times \gamma_{conc} + f.c = 0.22 \times 25 + 2 = 7.5 \text{ kN/m}^2$

$R_s = L.L = 4 \text{ kN/m}^2$

$w_u = 1.5 [g_s + R_s] = 17.25$

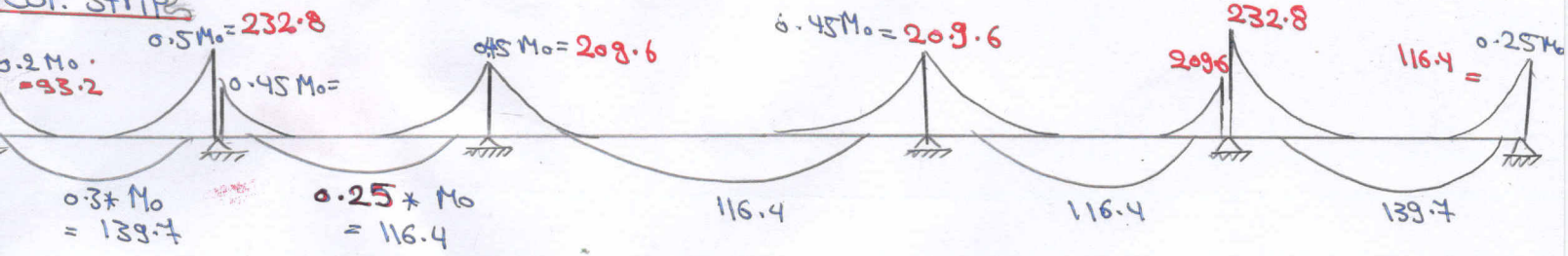
Total static moment Inlong Direction

$M_0 = \frac{w_u \times L^2}{8} \left[ L - \frac{2}{3} \times \left( \frac{L}{3} \right) \right]^2 = 465.75 \text{ kN.m}$

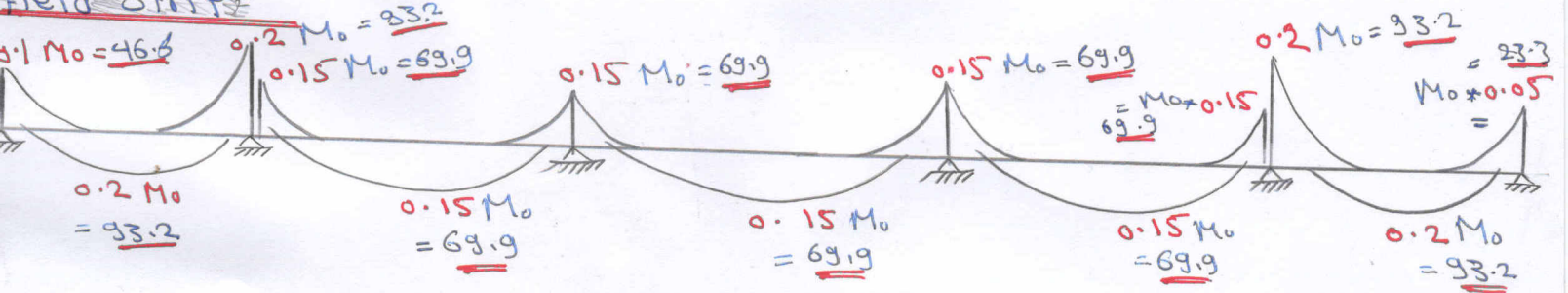
سليق سويق

# 4) Critical strips

## Col. strip



## field strip



## \* Design of flexure

$B = \frac{M_u}{\sigma_{bc}}$

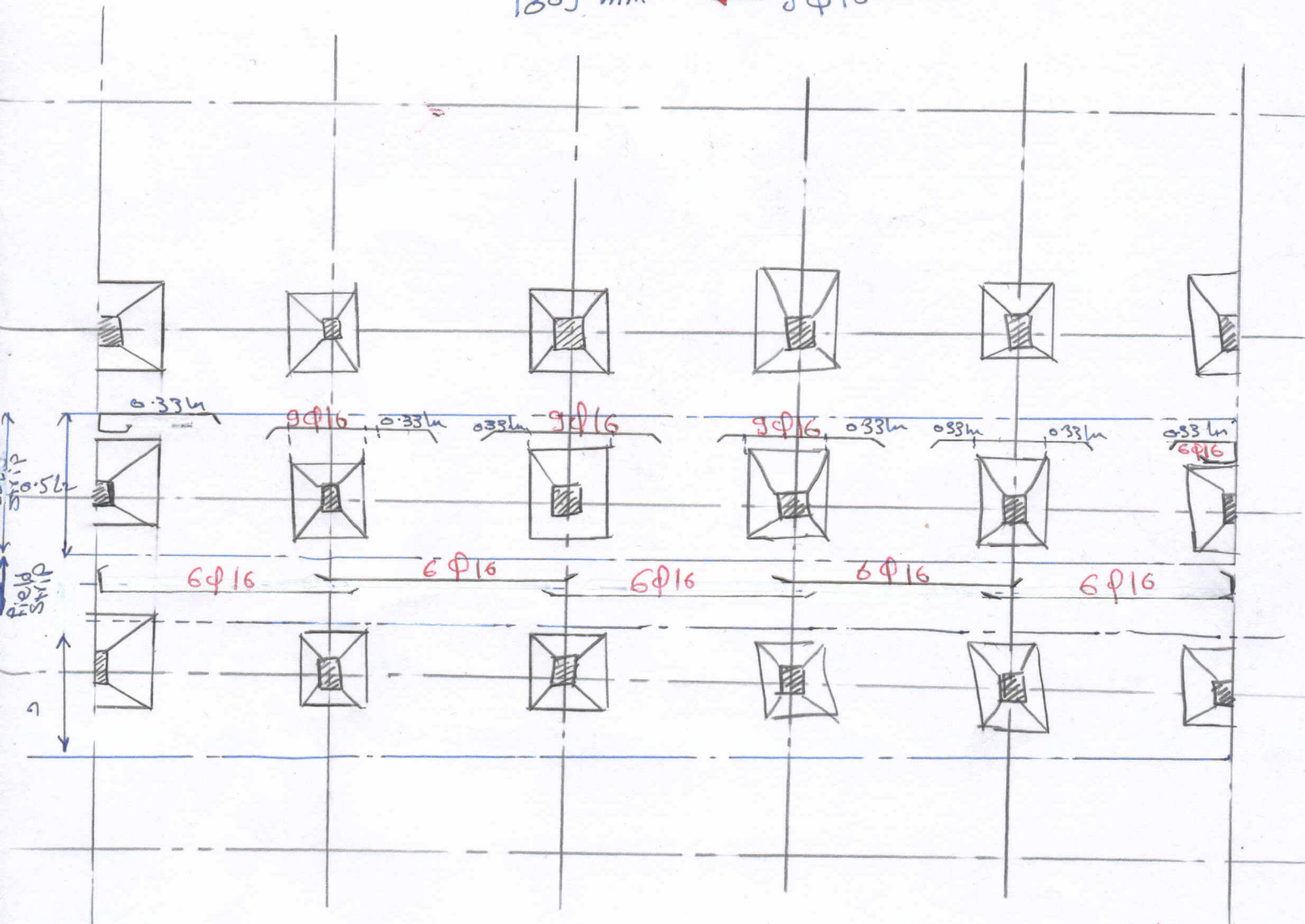
strip no	$M_u$	$d$	$B$	$C_1$	$J$	$A_{s, mm^2}$	$A_{s, m^2}$	Chosen
Column Strip	93.2	$ts - over = 220 - 30 = 190$ mm	$0.5 L_2 = 3000$ mm	5.38	0.826	1649	549.7	6 $\phi$ 12
	193.7			3.738	0.800	3539	1428	9 $\phi$ 16
	232.9			3.41	0.775	4394	871	6 $\phi$ 16
	116.4			4.82	0.826	2060	687	6 $\phi$ 16
	209.6			3.59	0.786	3899	1300	9 $\phi$ 16
Field strip	46.6	190 mm	$0.5 L_1 = 3000$ mm	7.62	0.826	824.8	275	6 $\phi$ 10
	93.2			5.38	0.826	1650	550	6 $\phi$ 12
	69.9			6.22	0.826	1237	413	6 $\phi$ 10
	116.4			10.77	0.826	4124	138	6 $\phi$ 10
	232.8			10.77	0.826	4124	138	6 $\phi$ 10

sec (4)  
 11, 12, 13

# Design of Pleasure

٥.٢.١٣ :- أقل عدد من الأضلاع في تسليح ال Flat ٥ مسنج وأقل قطر  $\phi 10 \rightarrow$  بر  $\phi 12$  أقل عدد

- $417 \text{ mm}^2 \rightarrow 6 \phi 10$
  - $678 \text{ mm}^2 \rightarrow 6 \phi 12$
  - $1206 \text{ mm}^2 \rightarrow 6 \phi 16$
  - $1809 \text{ mm}^2 \rightarrow 9 \phi 16$  ← دة أكبر مابغة
- ينختار من دول



\* ملاحظات :- يفضل ان يكون عدد الأضلاع في عرض ثابت

تسليح ال field نفس تسليح ال Cl. strip مع اختلاف في أنه فير  
 تسليح طيب (طوي) في ال field = 0.22m بدلاً من 0.33m



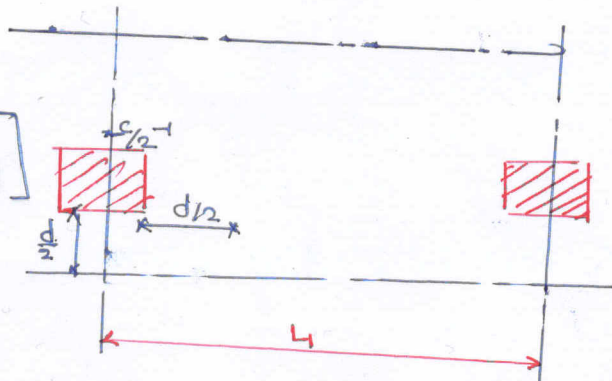
# Check shear

## (1) one way shear

safe غالباً

$$Q_{ucr} = R_u - W_u \cdot L_2 \left[ \frac{c}{2} + \frac{d}{2} \right]$$

$$= 0.5 W_u L_2 \left[ L_1 - \left( \frac{c}{2} + \frac{d}{2} \right) \right]$$



$$q_{ucr} = \frac{Q_{ucr} \times 10^3}{L_2 \times d}$$

$$q_{rcu} = \begin{cases} 0.24 \sqrt{\frac{f_c}{\gamma_c}} \\ 0.16 \sqrt{\frac{f_u}{\gamma_c}} \end{cases}$$

$t_s > 2.50 \text{ mm}$

$$R_u = 0.5 W_u \times L_1 \times L_2$$

$$0.5 \times W_u \times L_1 \times L_2$$

→ If  $q_{ucr} \leq q_{rcu}$  → safe

• If  $q_{ucr} > q_{rcu}$  تصل كاتبة من إثنين → ① Increase  $f_{cu}$  ② Increase  $t_s$

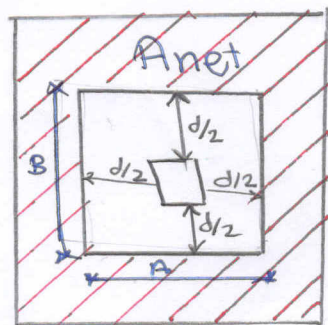
← رف لفالب المفقور ← one way ← وما بستعمل بال لا لبقور بطلب

## Check Punching

→ Case (1) of total load

\* Internal Col

(1) Drawing



$$A = C + d$$

$$B = C + d$$

$$A_{net} = L_1 \times L_2 - A \times B$$

$$Q_{up} = A_{net} \times W_u$$

$$d = t_s - G_{ver}$$

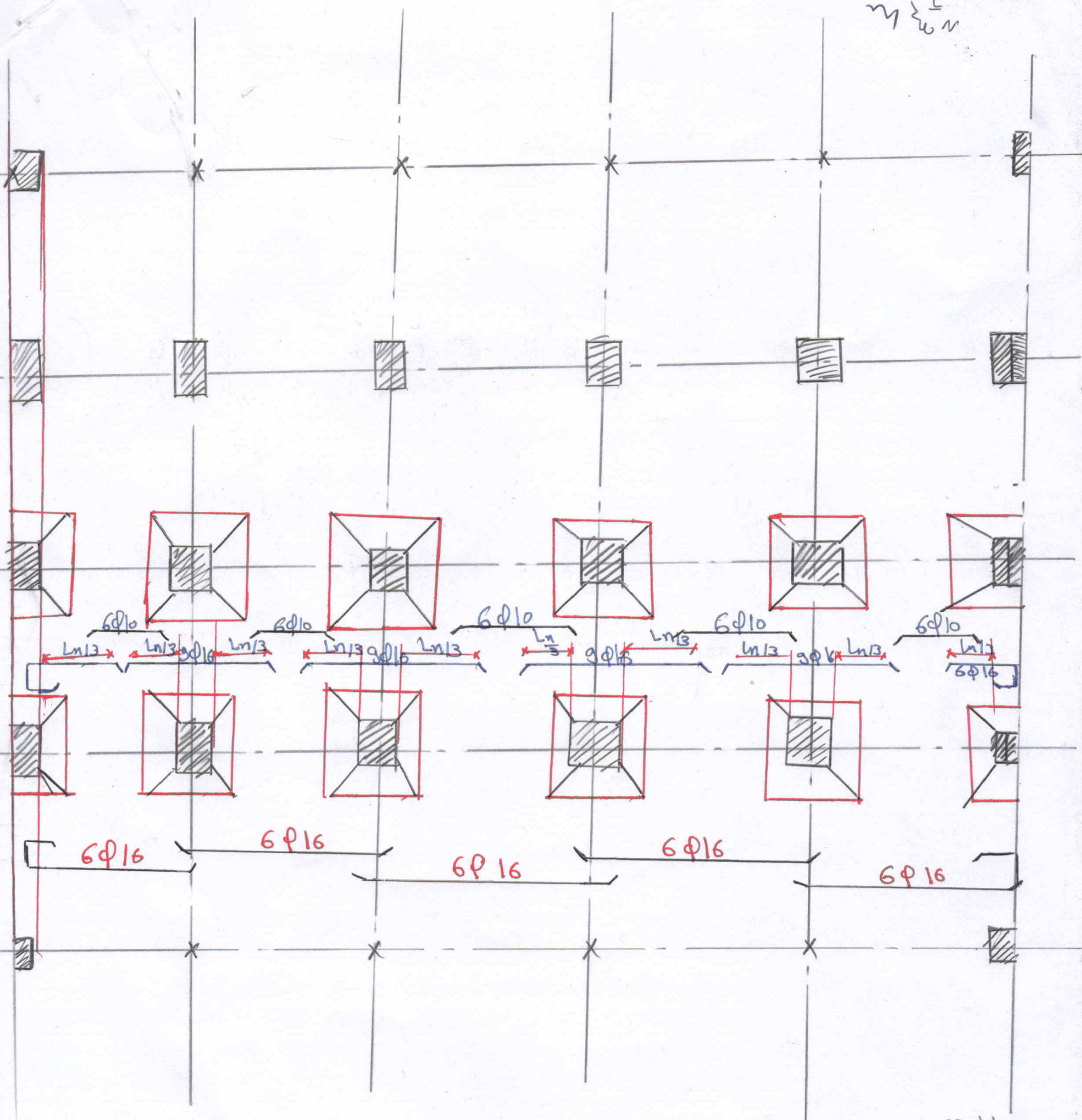
$$b_o = 2(A + B)$$

$$q_{up} = \frac{Q_{up} \times 10^3}{b_o \times d}$$

→ Col. only	Col. head only
C → <span style="font-size: small;">نفس</span>	C → D
d = $t_s - G_{ver}$	d = $t_s - G_{ver}$
→ drop only	Col. head + drop
C → <span style="font-size: small;">سوي</span>	
d = $t_s + d - G_{ver}$	d = $t_s + d - G_{ver}$

# Section 2

ملاحظات



ملاحظات  
 \* أقل عدد من الأضلاع = أضلاع = أقل قطر  $\phi_{min}$   $\leftarrow$   $\phi_{12}$  6 Bars

<p>بعضها من طول</p>	$6 \phi 10 \rightarrow 417 \text{ mm}^2$	$6 \phi 16 \rightarrow 1206 \text{ mm}^2$
	$6 \phi 12 \rightarrow 678 \text{ mm}^2$	$3 \phi 16 \rightarrow 10809 \text{ mm}^2$

\* تسليح ال field strip نفس تسليح ال (strip) مع الاختلاف في  
 (1) التسليح الحديد الطولي  $0.22 L_n$  بدلاً من  $0.33 L_n$

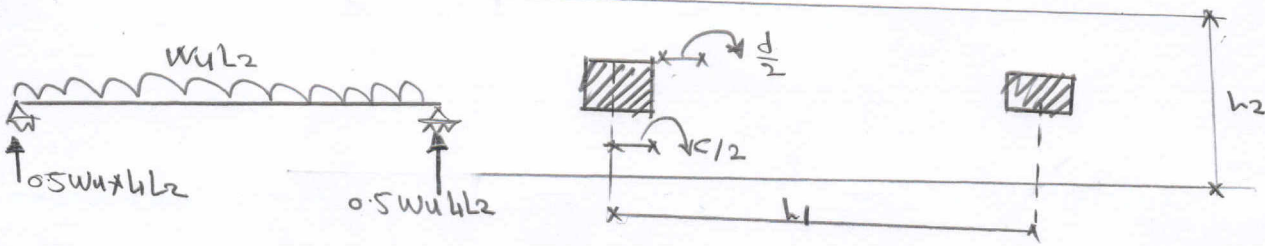
# Check shear

(ii) one way shear

safe

$\frac{L_1}{L_2}$

\*



\*  $Q_{ucr} = W_u \times \text{Area of one way shear}$

$$= W_u \times \left[ L_2 \times \left( \frac{L_1}{2} - \frac{(D+d)}{2} \right) \right] \quad **$$

$$* q_{ucr} = \frac{Q_{ucr} \times 10^3}{L_2 \times d} \quad **$$

$$* q_{cu} = \begin{cases} (0.24) \sqrt{\frac{f_{cu}}{\sigma_c}} & \text{IF } t_s > 250 \text{ mm} \\ (0.16) \sqrt{\frac{f_{cu}}{\sigma_c}} & \text{IF } t_s \leq 250 \text{ mm} \end{cases}$$

\* IF  $q_{ucr} \leq q_{cu}$

safe

IF unsafe   
 Increase  $f_{cu}$    
 Increase  $t_s$

\* safe  $\frac{L_1}{L_2}$  from one way shear

<p><u>on Gl. only</u></p> <p><math>C = C</math>      <math>L_{over}</math></p> <p><math>d = t_s - C_{over}</math></p>	<p><u>Gl. Head only</u></p> <p><math>C \Rightarrow D</math></p> <p><math>d = t_s - C_{over}</math></p>
<p><u>drop only</u></p> <p><math>C \rightarrow C</math></p> <p><math>d = t_s + t_d - C_{over}</math></p>	<p><u>Gl. Head + drop</u></p> <p><math>C \rightarrow D</math></p> <p><math>d \rightarrow t_s + t_d - C_{over}</math></p>

(2) Check two way shear (Punching)

(1) Interior Col.

1) Drawing

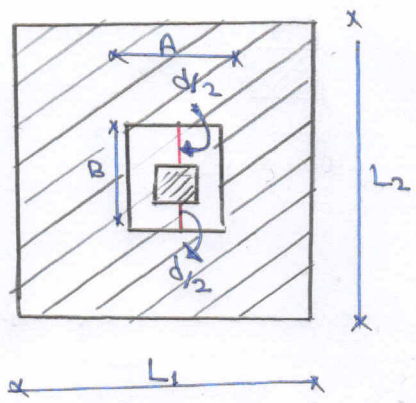
\*  $A = C + d$   
 \*  $B = C + d$   
 \*  $A_{net} = L_1 L_2 - A * B$

\*  $Q_{uP} = W_u * A_{net}$

\*  $d = t_s - \text{cover}$

\*  $b_o = 2A + 2B$

\*  $q_{uP} = \frac{Q_{uP} * b^3}{b_o * d}$



\*  $q_{uP} \leq$

- $0.316 \sqrt{\frac{F_{cu}}{\sigma_c}}$
- $0.8 \left( \frac{\alpha d}{b_o} + 0.2 \right) \sqrt{\frac{F_{cu}}{\sigma_c}}$
- $0.316 \left( \frac{A}{B} + 0.5 \right) \sqrt{\frac{F_{cu}}{\sigma_c}}$
- $1.6 \text{ MPa}$

$\alpha = 4$

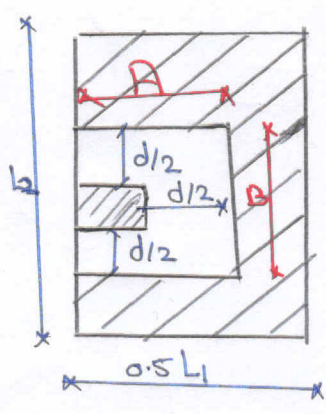
$\alpha =$  Punching shear stress



- 4  $\rightarrow$  Interior Col.
- 3  $\rightarrow$  edge Col.
- 2  $\rightarrow$  Corner Col.

(2) Edge Column

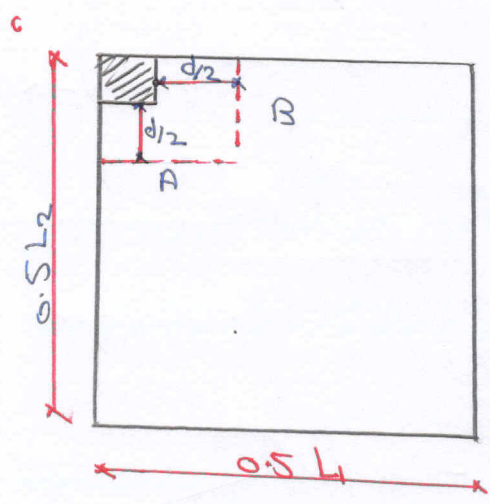
\*  $A = C + d/2$   
 \*  $B = C + d$   
 \*  $b_o = 2A + B$   
 \*  $A_{net} = 0.5 L_1 L_2 - A * B$   
 \*  $d = t_s - \text{cover}$   
 \*  $Q_{uP} = W_u * A_{net}$   
 \*  $q_{uP} = \frac{Q_{uP} * b^3}{b_o * d}$



\*  $\alpha = 3$

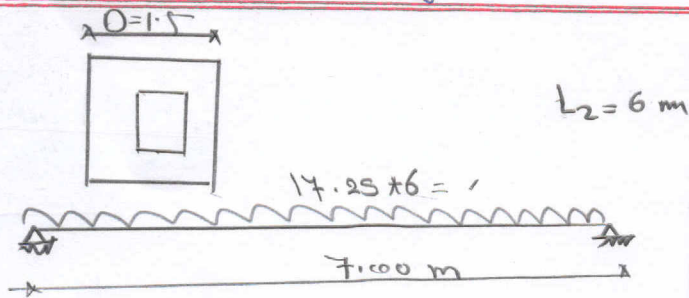
$L_1$

(3) Corner Column



\*  $A = C + \frac{d}{2}$   
 \*  $B = C + \frac{d}{2}$   
 \*  $A_{net} = \frac{1}{2} L_1 * \frac{1}{2} L_2 - A * B$   
 \*  $b_o = A + B$   
 \*  $\alpha = 2$

\* Check one way shear



$$Q_{ucr} = W_u \left[ L_2 \times \left( \frac{L_1}{2} - \frac{D+d}{2} \right) \right]$$

$$\therefore Q_{ucr} = 274.8 \text{ kN.m}$$

$$q_{ucr} = \frac{Q_{ucr}}{L_2 \times d} = \frac{274.8 \times 10^3}{6000 \times 190} = 0.24$$

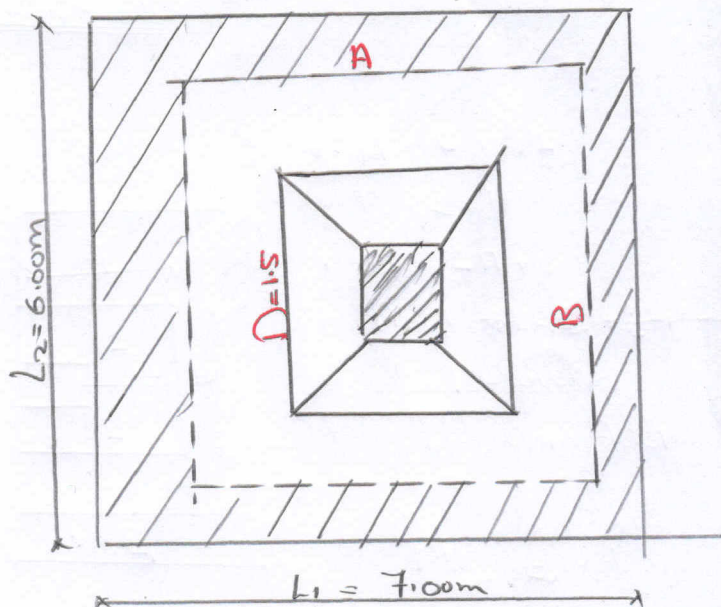
$$q_{cu} = 0.16 \sqrt{\frac{f_{cu}}{\sigma_c}} = 0.72$$

$q_{ucr} \ll q_{cu}$  safe

الكل طبيعي بزيادة القوة وحمولة

AL-Subaey  
2012-2013

\* Check Punching Shear



$$A = D + d = 1.69$$

$$B = D + d = 1.69$$

$$A_{net} = \frac{1}{2} L_1 L_2 - A \times B = 7 \times 6 - 1.69 \times 1.69 = 39.14 \text{ m}^2$$

$$b_o = 2A + 2B = 6.7 \times 10^3 \text{ mm}^2$$

$$Q_{up} = A_{net} \times W_u = 675.17 \text{ kN}$$

$$q_{up} = \frac{Q_{up} \times 10^3}{b_o \times d} = 0.526$$

$$q_{cu} \gg \begin{cases} 0.316 \sqrt{\frac{f_{cu}}{\sigma_c}} = 1.41 \\ 0.8 \left( \frac{A}{b_o} + 0.2 \right) \sqrt{\frac{f_{cu}}{\sigma_c}} = 1.12 \\ 0.316 \left[ \frac{A}{B} + 0.5 \right] \sqrt{\frac{f_{cu}}{\sigma_c}} \\ 1.6 \text{ M.Pa} \end{cases}$$

$q_{cu} > q_{up}$  safe

# Section 3

# \* Moment transfer from flat slab to column

## (1) Interior Column

9

$$M_F = 0.5 M_{-ve} \text{ Column strip}$$

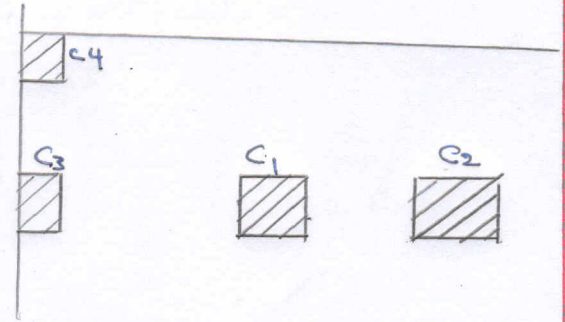
$$\therefore M_F = 0.5 * 0.5 M_0$$

$$C_2 \rightarrow M_F = 0.25 M_0$$

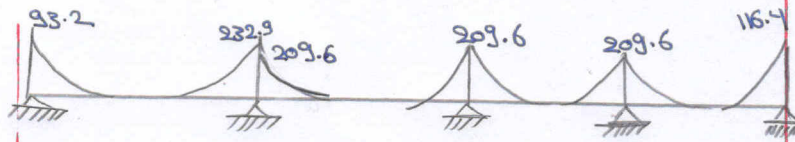


$$M_F = 0.5 * 0.45 M_0$$

$$\rightarrow M_F = 0.225 M_0$$



## Example



## (2) Edge Column C3

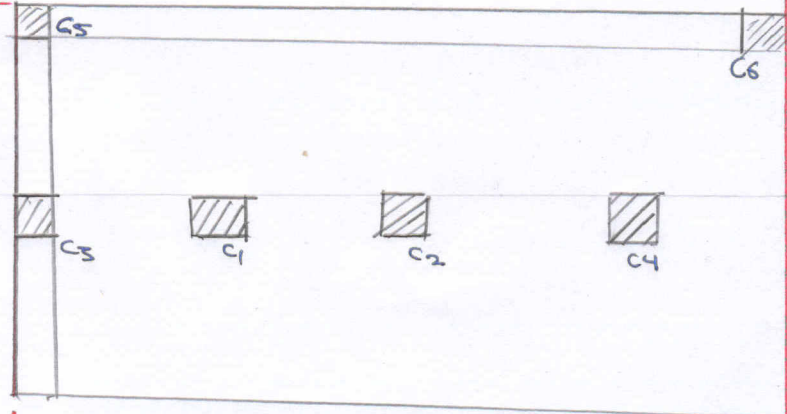
$$M_F = 0.9 M_{\text{Gl. strip}}$$

$$\text{In case of } M_F = 0.9 * 0.2 M_0$$

$$\text{With M.B.} \rightarrow 0.18 M_0$$

$$\text{In case of } M_F = 0.9 * 0.25 M_0$$

$$\text{Without M.B.} \rightarrow 0.225 M_0$$



C1:-

$$M_F = 0.5 M_{C1}$$

$$= 0.5 * 232.9 = 116.45 \text{ kN}\cdot\text{m}$$

C2:-

$$M_F = 0.5 * 209.6 = 104.8 \text{ kN}\cdot\text{m}$$

C3:-

$$C_3 = 0.9 * 93.2 = 83.88 \text{ kN}\cdot\text{m}$$

$$C_4 = 0.5 * 209.6 = 104.8$$

$$C_5 = 0.5 M_{\text{edge}} = 0.5 * 83.88 = 42 \text{ kN}\cdot\text{m}$$

$$C_6 = 0.5 M_{\text{edge}} = 0.5 * 116.4 = 58.2 \text{ kN}\cdot\text{m}$$

## (3) Corner Column C4

$$M_F = 0.5 M_{\text{F edge}}$$

$$\text{In case of M.B.} \rightarrow 0.5 * 0.9 * 0.2 M_0$$

$$\text{In case of Without M.B.} \rightarrow 0.5 * 0.9 * 0.25 M_0$$



# Check Punching

Case II

2

$D.L + \frac{1}{2} L.L$

\* Interior Column

\*  $W_u = 1.4 D.L + 0.5 * 1.6 L.L$

\*  $A = c + d$

\*  $B = c + d$

\*  $A_{net} = L_1 L_2 - AB$

\*  $b_o = 2A + 2B$

\*  $Q_{up} = W_u \cdot A_{net}$

\*  $q_{up} = \frac{Q_{up}}{b_o * d}$

$\rightarrow q_{total} = q_{up} + q_{torsion}$

$q_{torsion} = \frac{M_q * 10^6}{J_{ct}} C_{A.B}$

$M_q = \alpha_q * M_P$

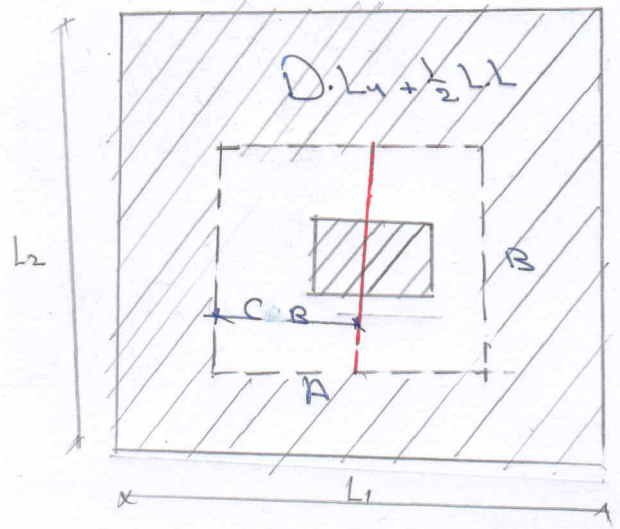
$\alpha_q = 1 - \alpha_P$  ??

$\alpha_P = \frac{1}{1 + \frac{2}{3} \sqrt{\frac{C+A}{C_2+B}}}$

$\Rightarrow M_P = 0.5 M.GI$

$C_{A.B} = \frac{C+d}{2} = \frac{I}{2} d$

استنتاجات مهمة



← A \* البعد المقياس  
 ← B \* البعد المقياس  
 ← C1 \* البعد المقياس  
 ← C2 \* البعد المقياس

$\frac{d(c_2 + d(c_1 + d)^2)}{2}$

$+$   
 $\frac{(G+d)d^3}{6}$

$+$   
 $\frac{d(c_1 + d)^3}{6}$

$J_{ct} =$

\* Edge Glunn

- \*  $W_u = 1.4 D.L + 0.5 * 1.6 L.L$
- \*  $A = C + \frac{d}{2}$
- \*  $B = c + d$
- \*  $b_o = 2A + B$
- \*  $A_{net} = 0.5 L_1 * L_2 - A * B$

\*  $Q_{up} = W_u * A_{net}$

\*  $q_{up} = \frac{Q_{up} * 10^3}{b_o * d}$

→  $M_R = 0.9 * 0.25 * M_o$

$\sigma_R = \frac{1}{1 + \frac{2}{3} \sqrt{\frac{A}{B}}}$

$\sigma_q = 1 - \sigma_R$

\*  $M_q = \sigma_q * M_R$

\*  $r_t = \frac{M_q * 10^6}{J_{cy}}$

$C_{AB} = \frac{(C_1 + \frac{d}{2})^2}{(C_2 + d) + 2(C_1 + \frac{d}{2})}$  خ الكود

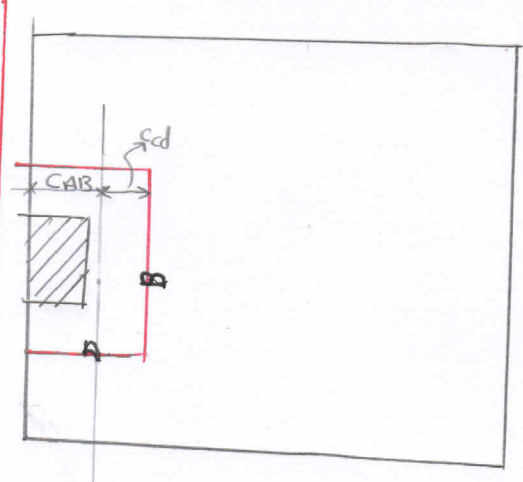
$J_{cy} = d (C_2 + d) * (C_{AB})^2 + \frac{2}{3} * d$

\*  $(c * d^3) + \frac{2}{3} * d (C_{AB})^3$

+  $\frac{(C_1 + \frac{d}{2})}{6} d^3$  ← خ الكود

$C_d = A - C_{AB}$

$c_d = (C_1 + \frac{d}{2}) - C_{AB}$



Example :-

$C_4 \rightarrow$

$$W_u' = 1.4 \times 7.5 + 0.5 \times 1.6 \times 4 = 13.7 \text{ kN}$$

$$A = D + \frac{d}{2} = 1.5 + \frac{0.19}{2} = 1.59$$

$$B = D + d = 1.5 + 0.19 = 1.69$$

$$b_o = 4.87 \text{ m} \approx 4870 \text{ mm}$$

$$A_{net} = 0.5 L_1 L_2 - A + B$$

$$= 3.5 \times 6 \times 0.5 - 1.59 \times 1.69 = 18.3 \text{ m}^2$$

$$Q_{uP} = W_u' \times A_{net} = 13.6 \times 18.3 = 248.88 \text{ kN}$$

$$q_{uP} = \frac{248.88 \times 10^3}{4870 \times 190} = 0.27 \text{ M.Pa}$$

$$M_F = 0.9 \times 116.4 = 104.76 \text{ kN.m}$$

$$\sigma_F = \frac{1}{1 + \frac{2}{3} \sqrt{\frac{A}{B}}} = 0.61$$

$$\sigma_q = 1 - \sigma_F = 0.39$$

$$M_q = \sigma_q \times M_F = 40.86 \text{ kN.m}$$

$$C_{AB} = \frac{\left(D + \frac{d}{2}\right)^2}{(D+d) + 2[D + 0.5d]} = 520 \text{ mm}$$

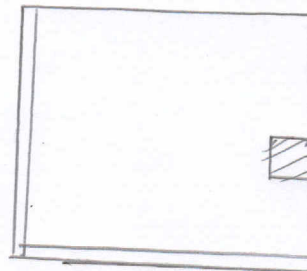
$$C_{cd} = D + \frac{d}{2} - C_{AB} = 1070 \text{ mm}$$

$$J_{cy} = 2.66 \times 10^{11} \text{ mm}^4$$

$$q_{rt} = \frac{40.86}{2.66 \times 10^4} \times 10^6 \times 1070 = 0.08$$

$$q_{rt} = q_{uP} + q_{hor} = 0.27 + 0.08 = 0.35 \text{ M.Pa}$$

$$q_{uP} = 1.13 \text{ M.Pa} > q_{total} \text{ safe} \rightarrow \checkmark$$



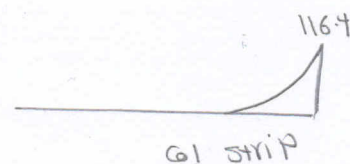
D.L =

L.L =

D = 1.5 m

L = 7

L2 = 6



(given)  $W_u \leftarrow$  خطوة الابعاد (4)

- ① Total D.L = 10 kN/m<sup>2</sup>
- Total L.L = 5 kN/m<sup>2</sup>

$\leftarrow$  خطوة الابعاد (5)

$W_u = 1.5 (10 + 5) = \leftarrow$

$W_u' = 1.4 \times 10 + 1.6 \times 5 \times 0.5$

- ② Total Factorized D.L = 15 kN/m<sup>2</sup> = D.L<sub>u</sub>

Total Factorized L.L = 10 kN/m<sup>2</sup> = L.L<sub>u</sub>

$W_u = D.L_u + L.L_u$

$W_u' = D.L_u + \frac{L.L_u}{2} = \leftarrow$

- ③ Total ultimate Factorized Load = 20 kN/m<sup>2</sup>

$W_u = 20 \text{ kN/m}^2 \Rightarrow W_u' = ??$

$D.L_u = 1.4 (ts \text{ } \alpha_c + P.c) = \leftarrow$

$L.L_u = W_u - D.L_u$

$W_u' = D.L_u - 0.5 L.L_u$

- ④ Eq. Load For wall Load

$D.L = ts \times \alpha_{enc} + P.c$

$L.L = \leftarrow$

$W_u = \begin{cases} 1.5 (D.L + L.L) \\ 1.4 D.L + 1.6 L.L \end{cases}$

$\frac{D.L}{D.L + L.L} < 0.75$

$\frac{L.L}{D.L + L.L} > 0.75$

# \* opening

6

## \* Large opening

$$\bar{x} = x + \frac{D}{2} = 1.15 \text{ m}$$

$$\bar{L} = \frac{1}{2} L_1 + \bar{x} = 3.5 + 1.15 = 4.65 \text{ m}$$

$$A = x + D + \frac{d}{2} = 0.4 + 1.5 + \frac{0.19}{2} = 1.99$$

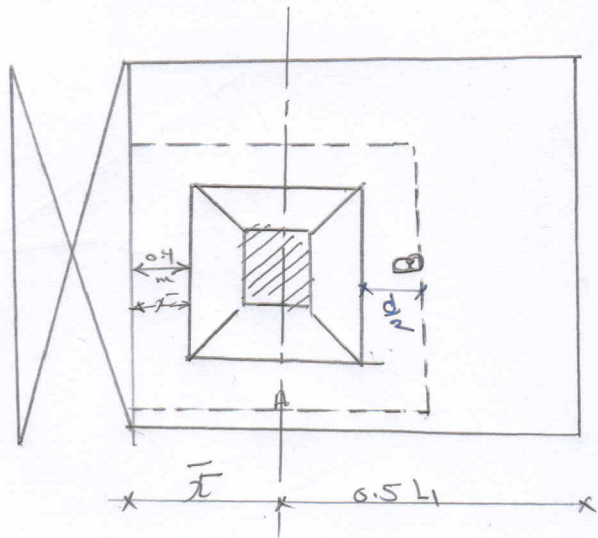
$$B = D + d = 1.69$$

$$b_o = 2A + B = 2 \times 1.99 + 1.69 = 5.68 \text{ m}^2$$

$$A_{net} = L_1 L_2 - A \times B = 24.54$$

$$Q_{up} = A_{net} \times W_u = -$$

$$q_{up} = \frac{Q_{up} \times 10^3}{b_o \times d}$$



## Small opening

$$* A = D + \frac{d}{2}$$

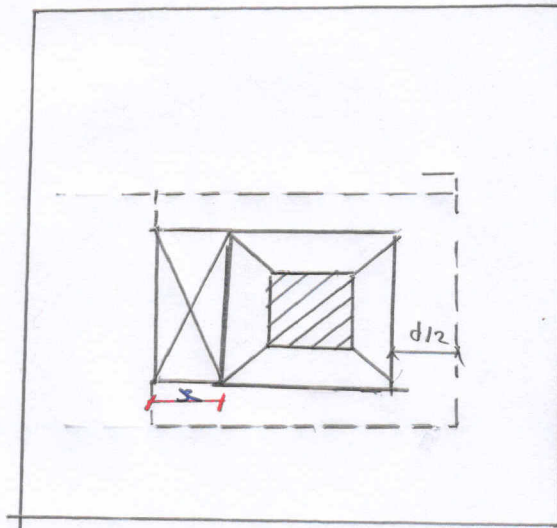
$$B = D + d$$

$$b_o = 2A + B + d$$

$$A_{net} = L_1 L_2 - A \times B - \text{area of wall} (x \cdot D)$$

$$Q_{up} = W_u \times A_{net}$$

$$q_{up} = \frac{Q_{up} \times 10^3}{b_o \times d}$$

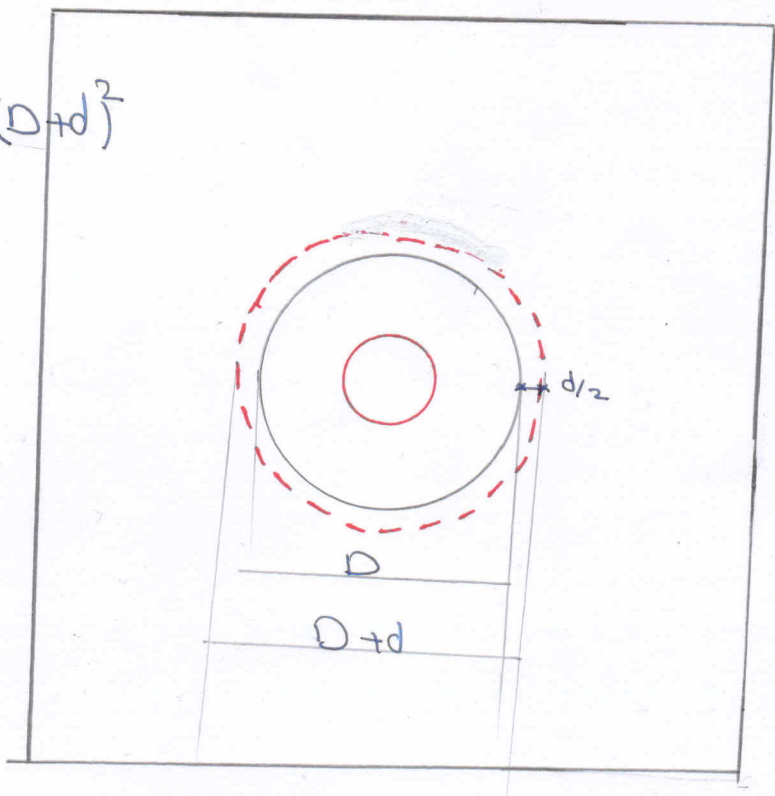


\*  $b_0 = \pi (D+d)$

\*  $A_{net} = L_1 L_2 - \frac{\pi}{4} (D+d)^2$

\*  $Q_{uP} = v_{uP} * A_{net}$

$q_{uP} = \frac{Q_{uP} * 10^3}{b_0 * d}$



$t = \dots$

$d = t - \text{cover}$

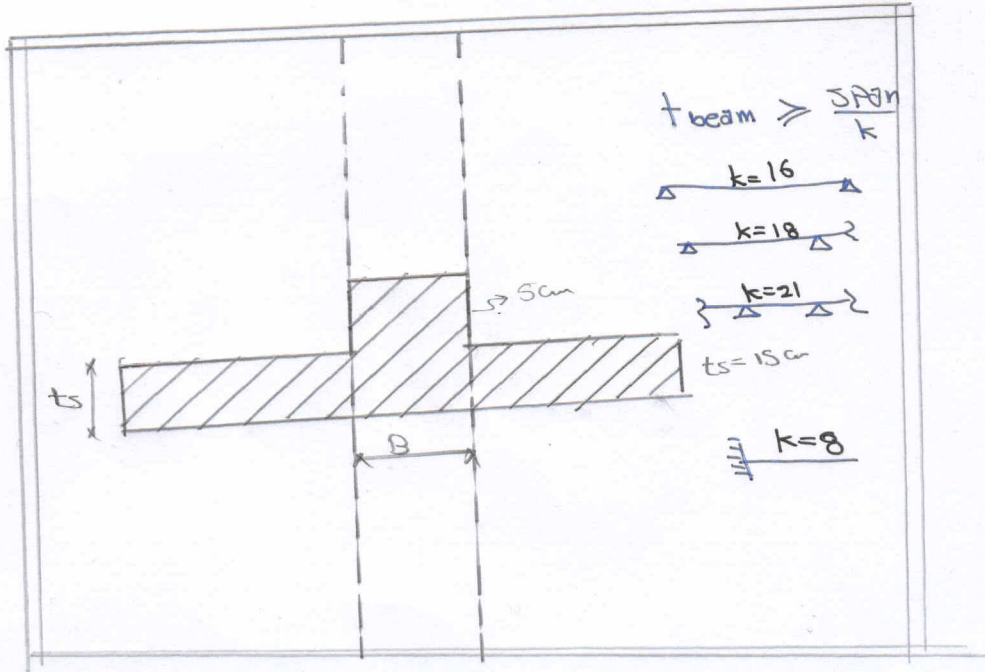
$M_u = \dots$

$d = c_i \sqrt{\frac{M_u \times 10^6}{F_u \times B}}$

$B = \dots$

$Q_{ult} = \dots$

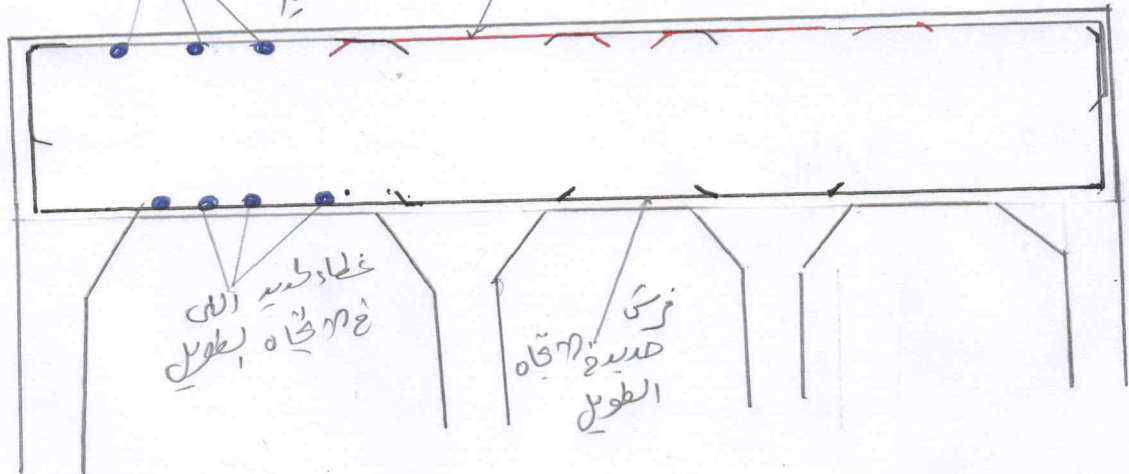
\* الحديد العلوي = الحديد السفلي  
 لأن من فوائد الحديد العلوي تقليل ال defl



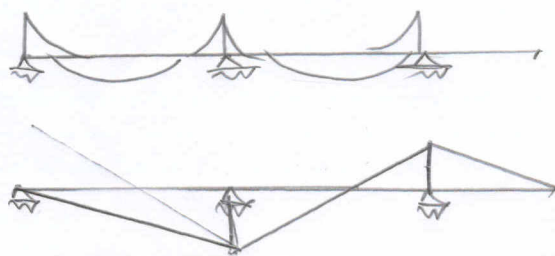
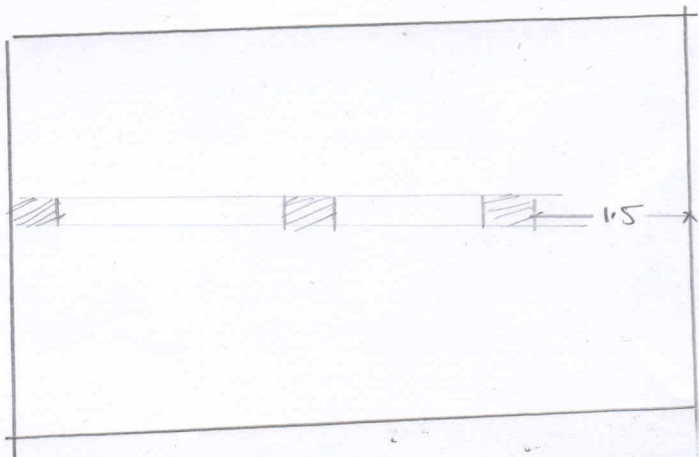
قطاع في ال slab Flat

حديد في الاتجاه القصير

غطاء حديد في اتجاه القصير



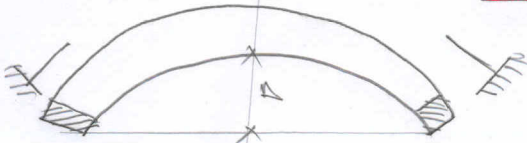
\* لو فرض



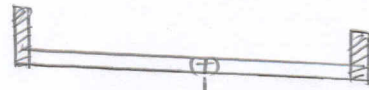
# Section 4



# Torsion



محور الدوران لا يتطابق مع محور القصور  
 يعني يكون على Torsion



Load For S.F.D & B.M.D  $\frac{P}{2}$   
 Load For Torsion  $P \times \Delta$

## Design steps

1- Conc Dimension

30% زيادة

2- Load

- (1) Load for S.F.D
- (2) Load for T.M.D

o.o = غائب

3- Straining action

- (1) V.F.D
- (2) S.F.D
- (3) B.M.D
- (4) T.M.D

4- Design of Flexure

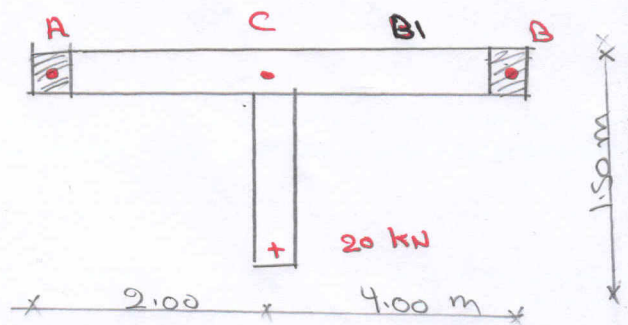
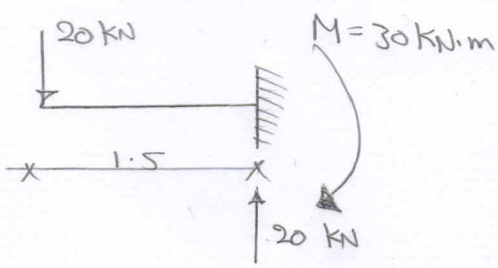
5- Design of shear } Torsion  
} Shear Force

6- R.F.T Details

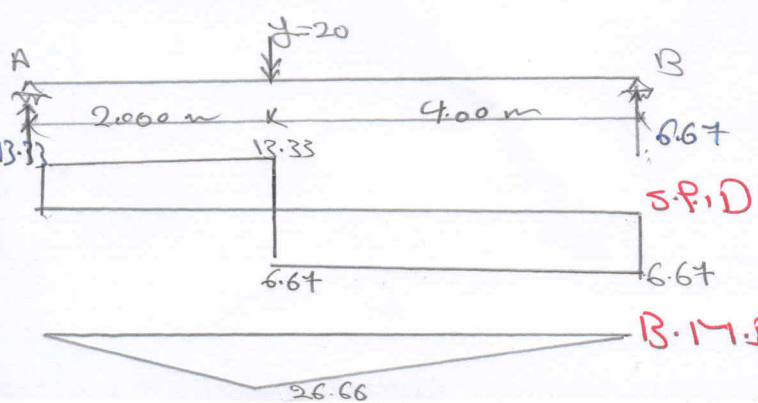
Neglect o.w

Cant. Dc

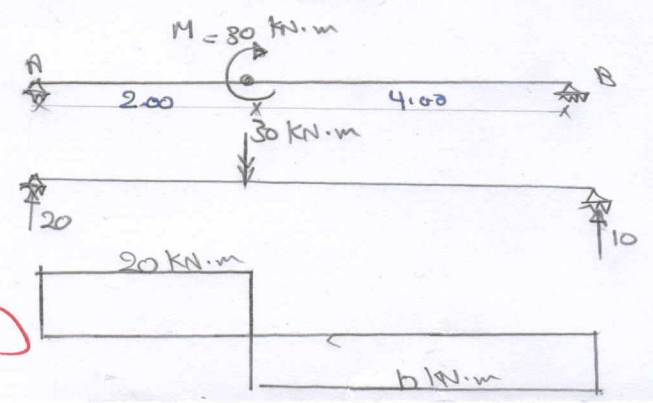
\* Beam (B1)



## Load For S.F.D & B.M.D



## Load For T.M.D

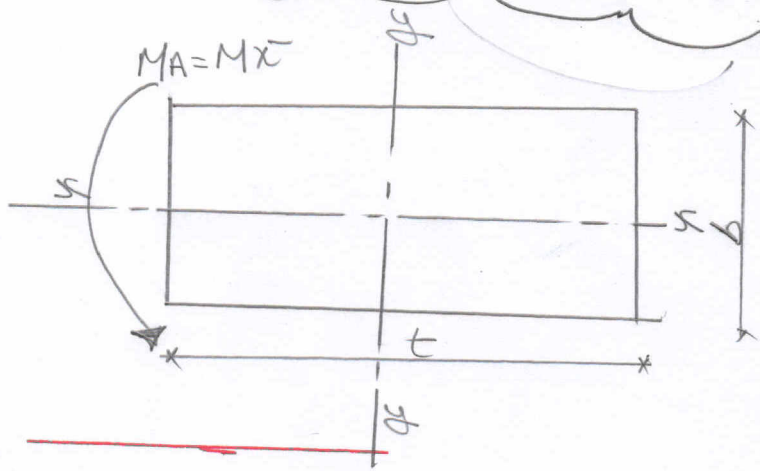


Calculate Load Acting on Columns

2) Studying the action of column + N.B. (مراجعة، عمل، عمل)

$N_u = 1.1 \times \overset{13.33}{\cancel{1.2}} \times \text{No. of Floors}$   
 $M_{1x} = M_A \times \text{No. of Floors}$

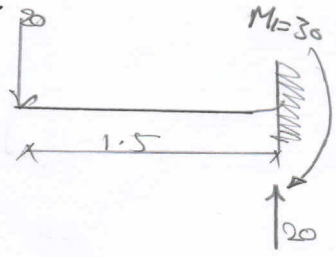
use I-D  $A_s = A_s'$



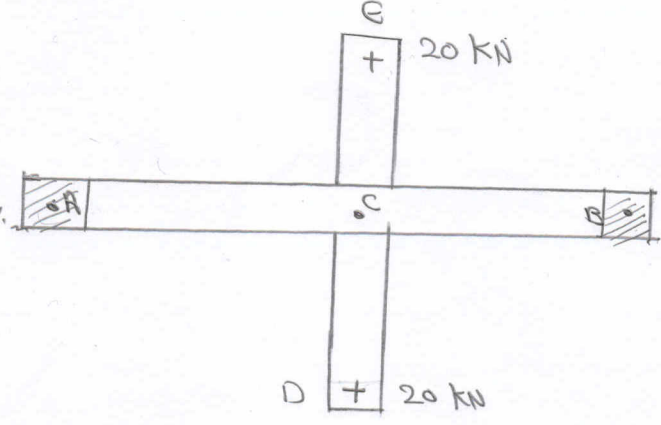
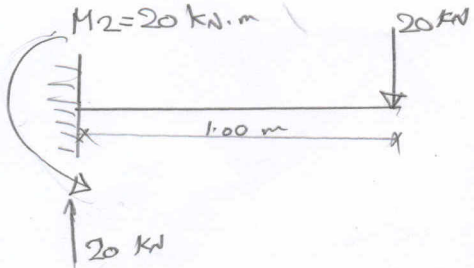
Example (2)

We lect our:

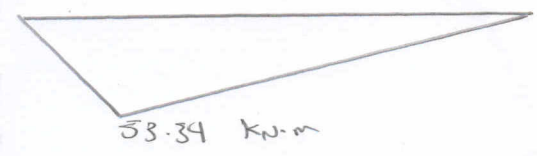
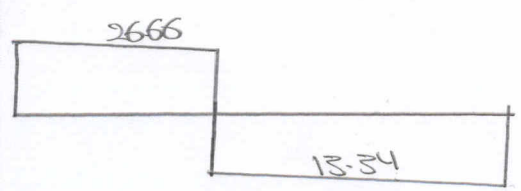
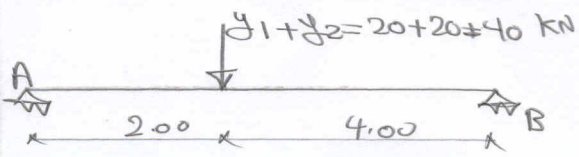
\* Cant. Dc



\* Cant C.E

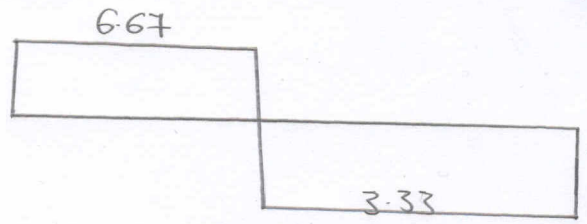
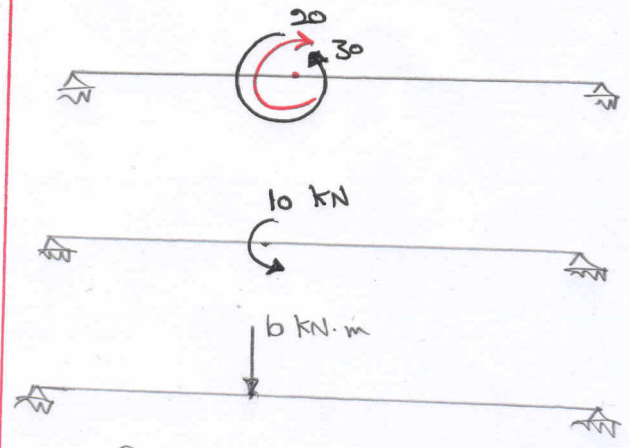


Load for D.P.D & B.M.D



Beam AB

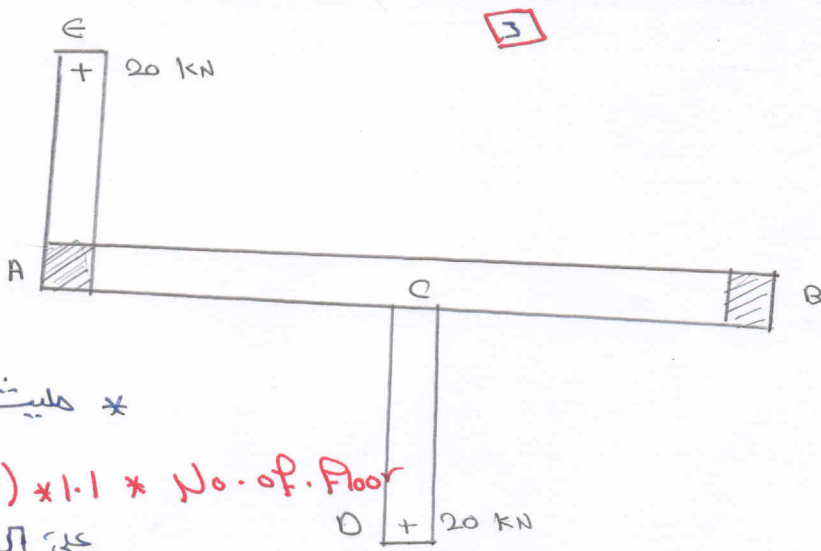
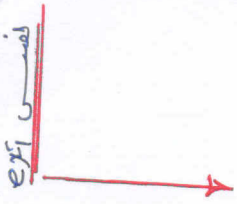
Load For Torsion



T.M.D

Example

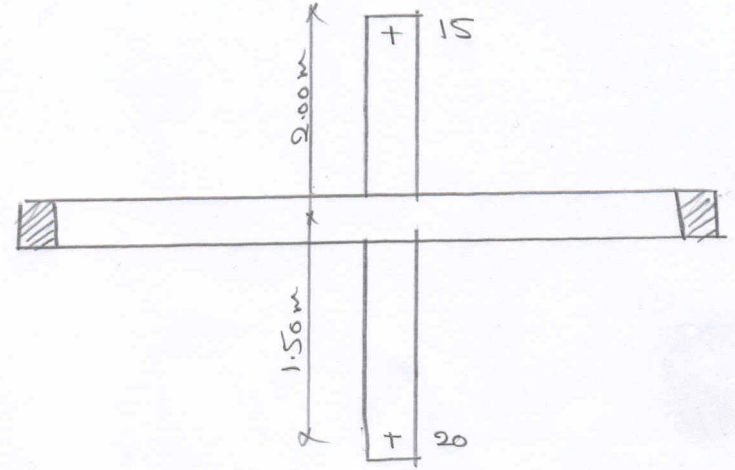
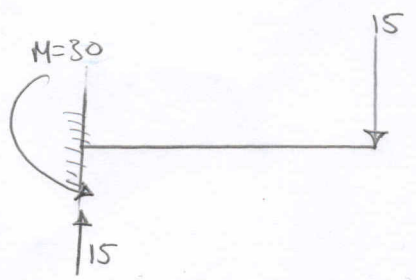
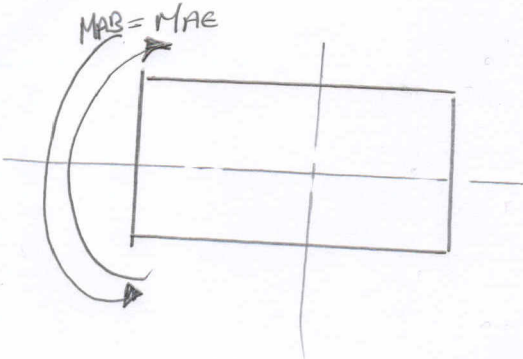
3



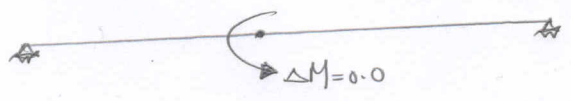
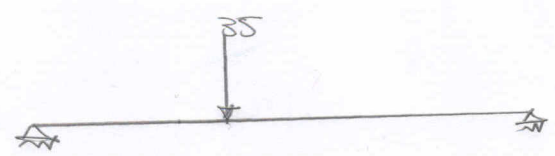
\* هليش دعوة بال Ae Cant

$$N_u = (\cancel{Y_{AB}} + \cancel{Y_{AE}}) \times 1.1 \times \text{No. of Floor}$$

$\Delta M = \text{zero}$  على الصور



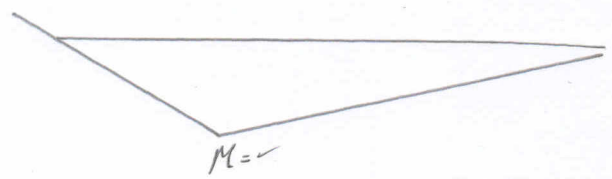
J.F.D



T.M.D

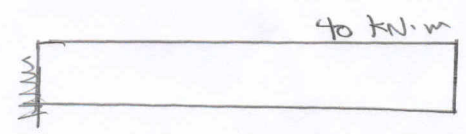
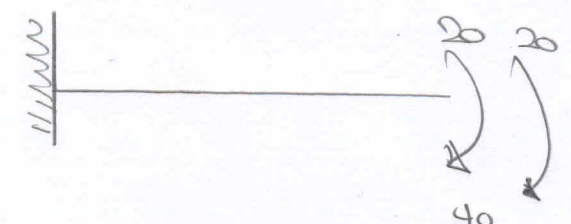
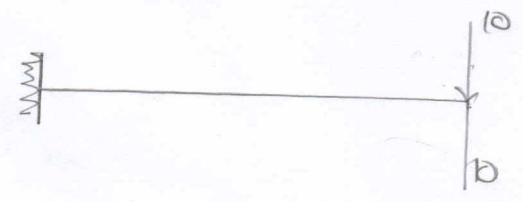
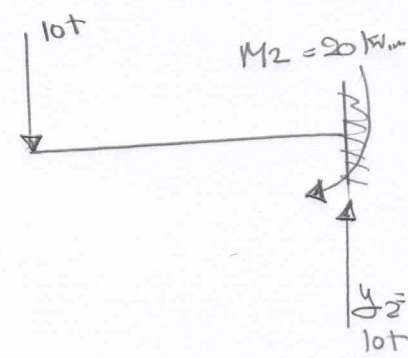
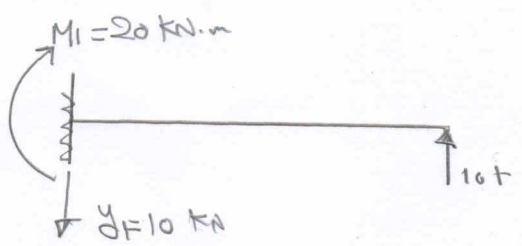
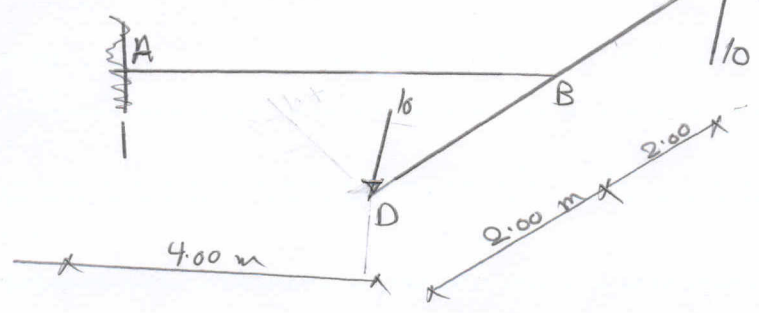


B.M.D



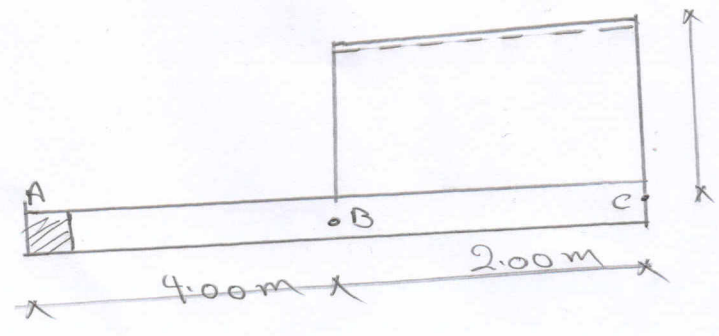
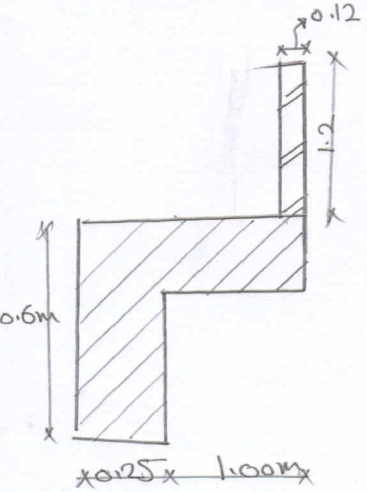
4

Pure torsion



T.M.D

\* Example



Data:-

- $f.c = 1.50 \text{ kN/m}^2$
- $L.L = 8 \text{ kN/m}^2$

1- Conc. Dimen Given

5

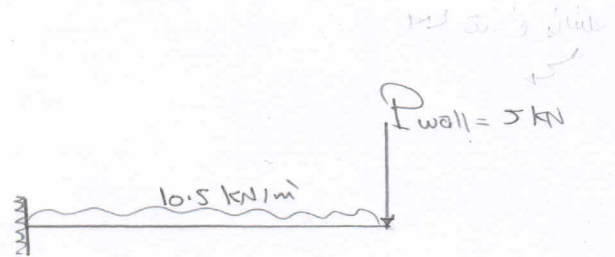
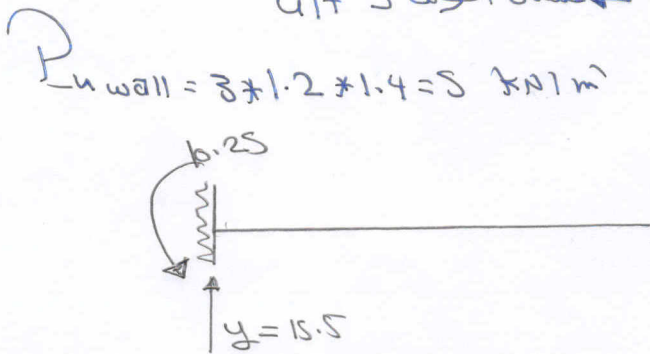
2- Loads

\* O.W. of Beam =  $b \times t \times \rho_{conc} \times 1.4$   
 $= 1.4 \times 0.25 \times 0.6 \times 25 = 5.25 \text{ kNm}^2$

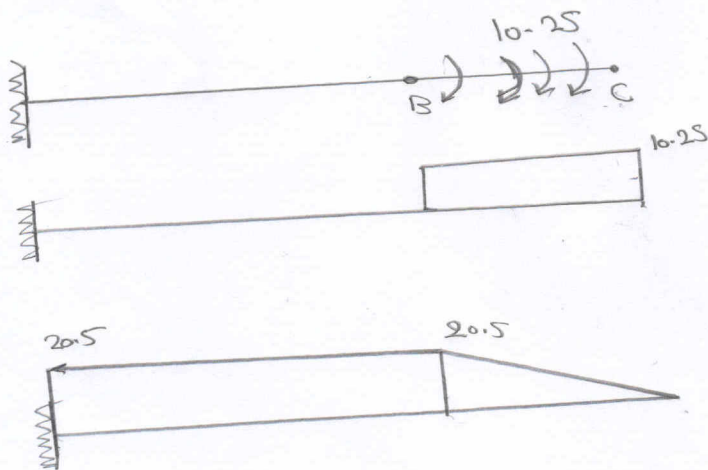
\* Slab Load

$W_{us} = 1.5 (t_s \times \rho_{conc} + F.C + L.L)$   
 $= 1.5 (0.1 \times 25 + 1.5 + 3)$   
 $= 10.5 \text{ kNm}^2$

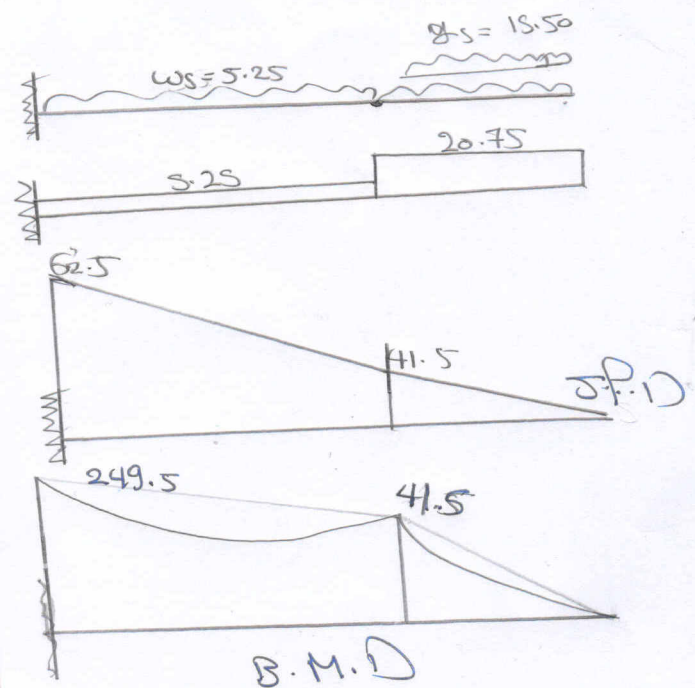
Hand rail =  $Int \times h_w = 3 \times 1.2 \times 1.4$



\* Load For Torsion



Load For S.F.D & B.M.D



At Glum  $C_R$  Calc. Straining action  
 $N_u = 62.5 \times 1.1 \times \text{No. of Floor}$   
 $M_x = 20.5$  due to Torsion  
 $M_y = 249.50$  due to Flexure