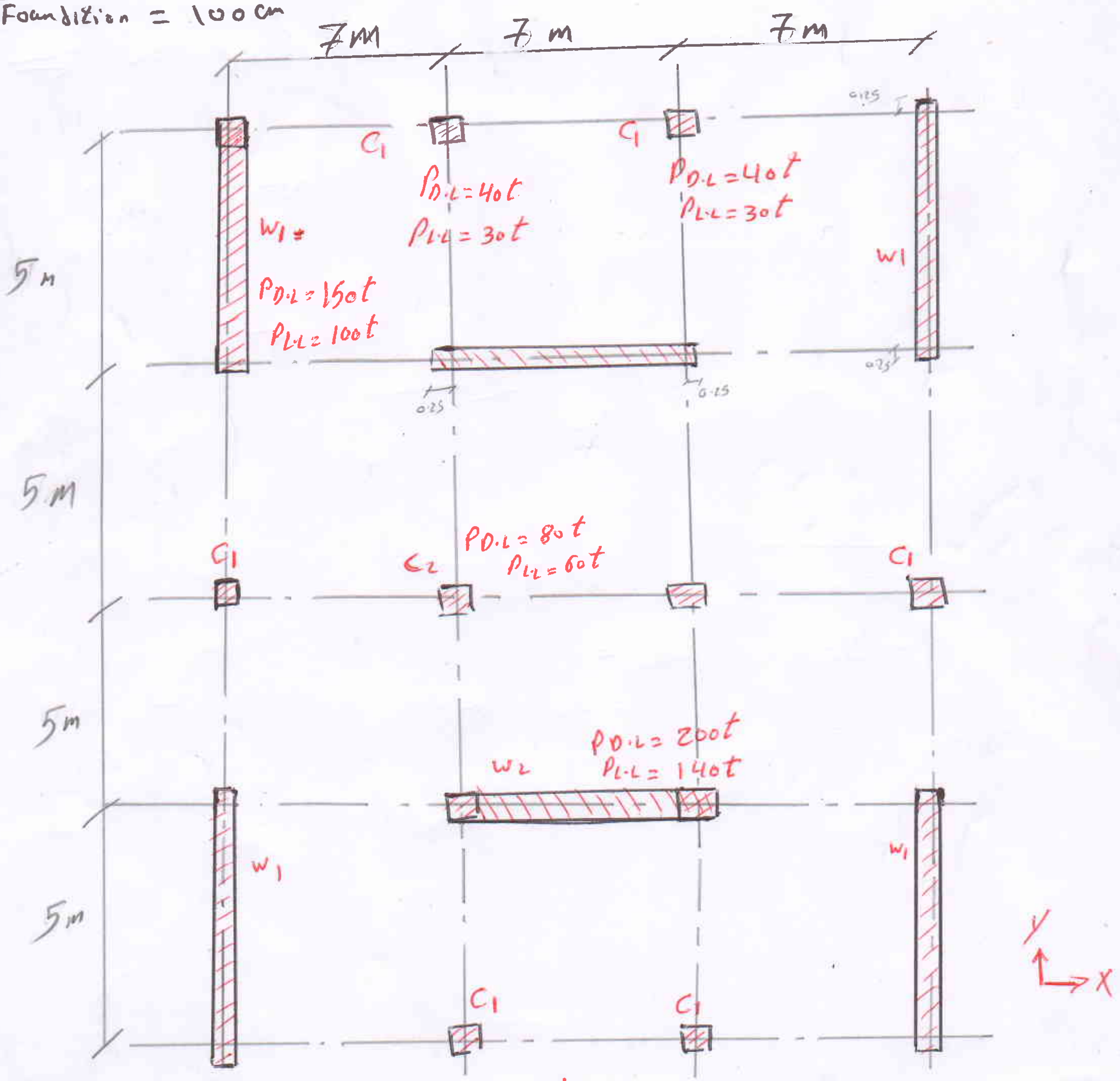
* columns *

* Ground Floor height = 5 m
* Typical Floor height = 3 m
* F_{cu} = 250 Kg / cm^2
* F_y = 3600 Kg / cm^2
* n = 7 Floor
* all thicknesses walls = 30 Cm
* t_{Floor} = 25 Cm
* $t_{Foundation}$ = 100 cm



$$\Rightarrow \alpha = H\sqrt{\frac{N}{\Sigma EI}} \leq 0.6 \qquad n \geq 4$$

$$\alpha = H\sqrt{\frac{N}{\Sigma EI}} \leq (0.2+0.1n) \qquad n < 4$$

$\therefore H = 5 + 6*3 = 23\ m$

$E_c = 14000\sqrt{F_{cu}} = 14000\sqrt{250} = 221359.44\ Kg/cm^2$

$= 2213594.4\ t/m^2$

N = workingLoads

$N = 4W_1 + 2W_2 + 6C_1 + 2C_2$

$N = [4(150+100) + 2(200+140) + 6(40+30) + 2(80+60)]*7$

$N = 16660\ t$

$\Rightarrow$ y direction

$$\alpha_y = H\sqrt{\frac{N}{\Sigma EI_x}}$$

$$I_{x_{w1}} = \frac{0.3*(5.5)^3}{12}*4 = 16.637\ m^4$$

$$\alpha_y = 23\sqrt{\frac{16660}{16.637*2213594.4}} = 0.489 < 0.6$$

The Building is Braced in y direction

⇒ X direction :-

$$\alpha_X = H\sqrt{\frac{N}{\Sigma E I_X}}$$

$$I_{y_{w_2}} = \frac{0.3 * (7.5)^3}{12} * 2 = 21.09\,m^4$$

$$\alpha_X = 23\sqrt{\frac{18880}{21.09 * 2213594.4}} = 0.43 < 0.6$$

The Building is Braced in X direction

* Design C1 :-

$$P_u = [1.4(40) + 1.6(30)] * 7 * 1.1$$

$$P_u = 800.8\,t$$

$$P_u = 0.35\,F_{cu}\,A_c + 0.67\,A_s\,F_y$$

assume $A_s = 1\%\,A_c$

$$800.8 * 10^3 = 0.35 * 250 * A_c + 0.67 * 1/100 * A_c * 3600$$

$$A_c = \frac{800.8 * 10^3}{111.62} = 7174.34$$

$A_c = t^2 \Rightarrow t = 84.7 \simeq 85\,cm$

Column (85 X 85)

To get(K)

* Case A :-

Fixed ⟹ $t_b > t_c$ or $t_b > b_c$

and Foundation when designed To carry moment

* Case B :-

Partially Fixed $t_b < t_c$

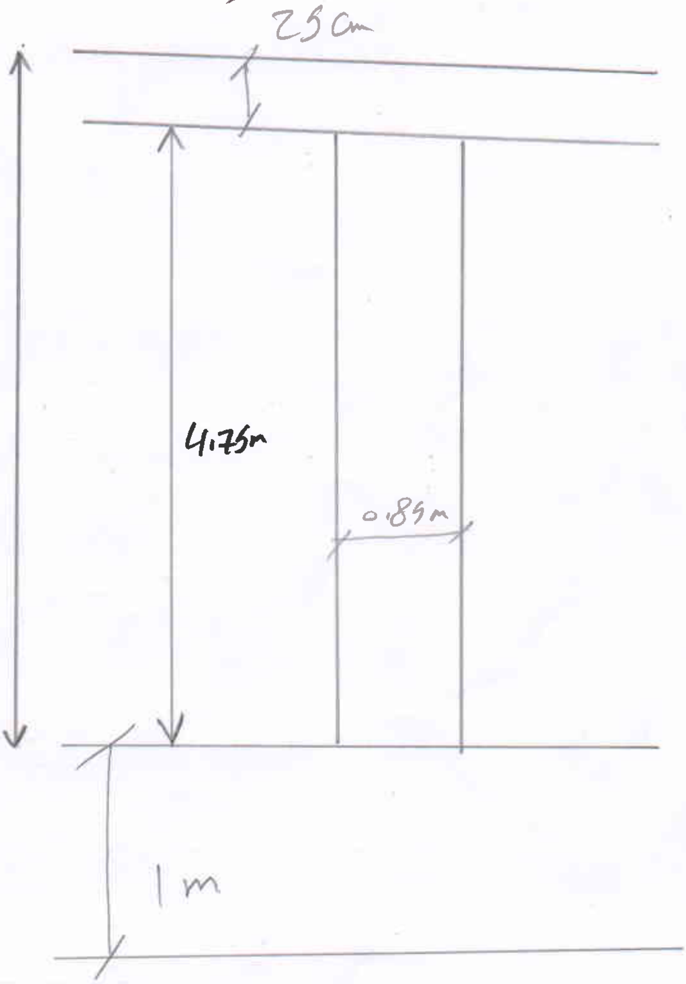
* Case C :-

hinged   (unable To prevent Rotation → Slabs)

* Case D :-

Free end

⟹ at X & Y direction :-   (check slenderness)



$t = 0.85\,m$

$H_o = 4.75\,m$

lower end → A

upper end → B

$K = 0.8$

$H_e = K\,H_o$

$= 0.8 * 4.75 = 3.8\,m$

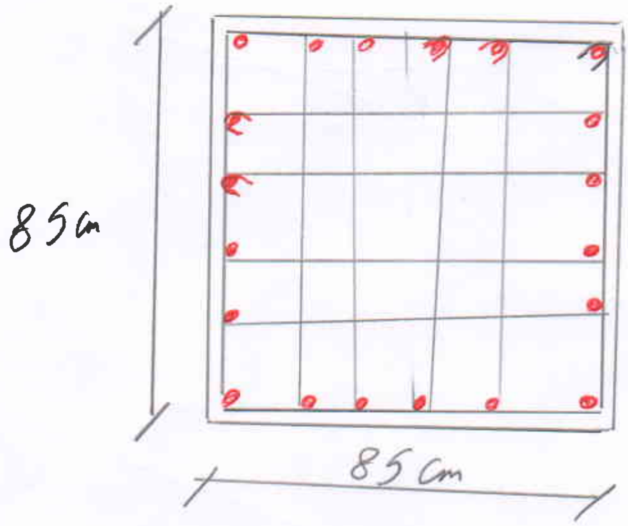
$\lambda = \frac{H_e}{t} = \frac{3.8}{0.85} = 4.47$

The column is short in both direction

$A_s = 1\% A_c = \frac{1}{100} (85 * 85)$

$A_s = 72.25 \ cm^2$

Take 20 Ø 22



* check stirrups:

$$\frac{V_s}{V_c} > 0.25\%$$

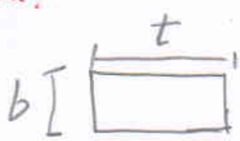
* Example:-

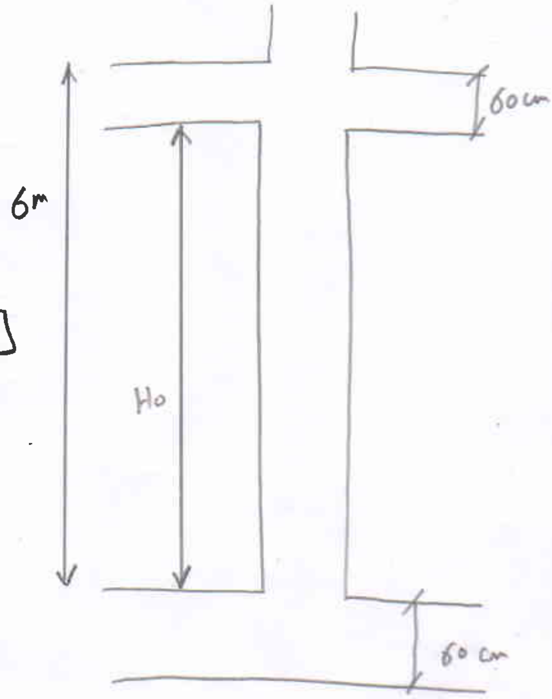
Braced building in Two direction

$b = 25\,cm$, $F_{cu} = 250\ Kg/cm^2$

$F_y = 3600\ Kg/cm^2$, $P_u = 290\,t$

Solution:-





$$P_u = 0.35 F_{cu} A_c + 0.67 F_y A_s$$

$$A_s = 1\% A_c$$

$$290 * 10^3 = A_c \left[0.35 * 250 + \tfrac{1}{100} * 0.67 * 3600\right]$$

$$A_c = 2598.1\ cm^2 = b * t$$

$$t = \frac{A_c}{b} \simeq 105\ cm$$

⇒ In plan Bucling:-

$t = 105\,cm$

$H_o = 6 - 0.6 = 5.4\,m$

$H_e = K * H_o$

$K = 0.85$

$H_e = 0.85 * 5.4 = 4.59\,m$

$\lambda = H_e/t = \frac{4.59}{1.05} = 4.37 < 15$ Short Column

upper $t_b < t_c$ case B

Lower $t_b < t_c$ case B

* out of Plan Buckling :

$b = 25$ cm

$H_o = 5.4$

$K = 0.75$

upper $t_b > t_c$

lower $t_b > t_c$

$H_e = 0.75 * 5.4 = 4.05$ m

$\lambda_b = \frac{H_e}{b} = \frac{4.05}{0.25} = 16.2 > 5$

Long column

⇒ Design column As Long column

M_u Design →
- $M_{add} = \delta . P_u$
- $P . e_{min}$ → 2 cm, 0.05t

→ max

$= 0.05 * 105$
$= 5.25$ cm

$M_u = $
- $M_{add} = \frac{\lambda_b^2 * b}{2000} . P_u = \frac{16.2^2 * 0.25}{2000} * 290$ $= 9.513$ t.m
- $P . e_{min} = 290 * 0.052 = 15.225$

→ 15.22

$M_{Design} = 15.225$ t.m

⇒ use The Interaction Diagram :.

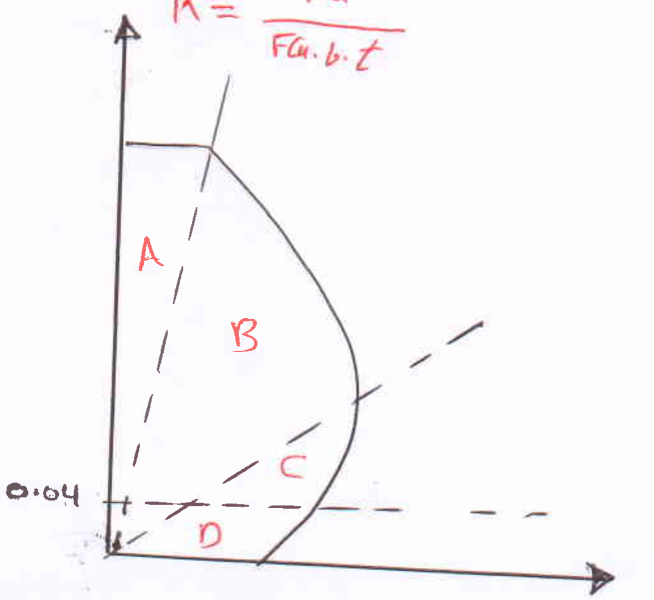
$$K = \frac{Pu}{Fcu \cdot b \cdot t} = \frac{290 * 10^3}{250 * 25 * 105} = 0.441$$

$$K \cdot e/t = \frac{Mu}{Fcu \cdot b \cdot t^2} = \frac{15.225 * 10^5}{250 * 25 * (105)^2}$$

$$= 0.022$$

$$\zeta = \frac{t - 2cover}{t} = \frac{105 - 5}{105} = 0.95$$

$Fy = 3600\ Kg/cm^2$



⇒ use uniformly Distributed STeeL

Zone B

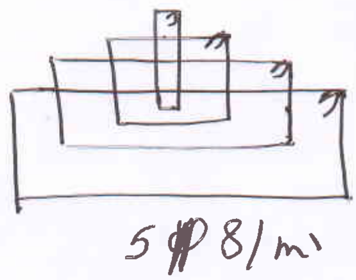
$\rho = 4$

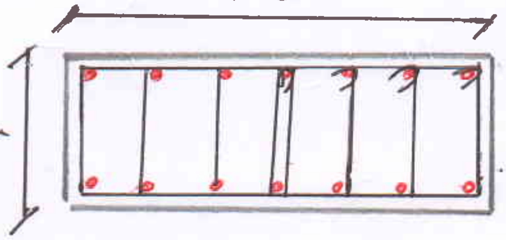
$$\mu = \rho * Fcu * 10^{-5} = 4 * 250 * 10^{-5}$$

$$= 0.01$$

$$As = \mu\, b\, t = 0.01 * 25 * 105 = 26.25\ Cm^2$$

Take = 14 ϕ16





$\Rightarrow$ Check stirrups

$$V_s / V_c \geq 0.25\%$$

$$V_s = n * A_s * [\Sigma L] = 5 * 0.5 [8*20 + 2*100 + 67*2 + 32*2]$$

n → عدد الكانات

A_s → مساحة قطر الكانة

ΣL → مجموع أطوال الكانة الواحدة.

$$= 39600 \ cm^3$$

$$V_c = 25*105*100 = 262500$$

$$\frac{39600}{262500} = 0.15 > \frac{0.25}{100} \quad \underline{ok}$$

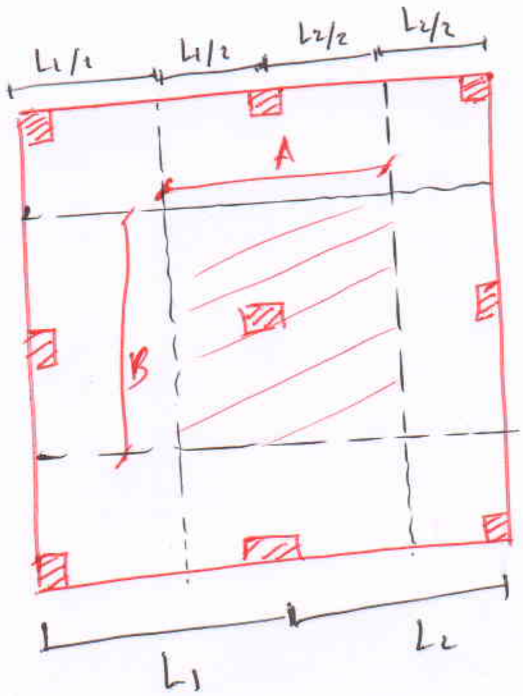
* ملحوظة لحساب حمل العمود (Pu] بطريقة Area method

مجموع أطوال الكمرات في مساحة خدمة العمود

مجموع أطوال الحوائط في مساحة خدمة العمود

$$P_u = 1.2\left[1.4\left\{\gamma_c * t_s + F.L + \frac{\gamma_c * b * t_b \Sigma L + \gamma_w * h_w * t_w * \Sigma L}{A * B}\right\} + 1.6 * L.L\right] * n * A * B$$

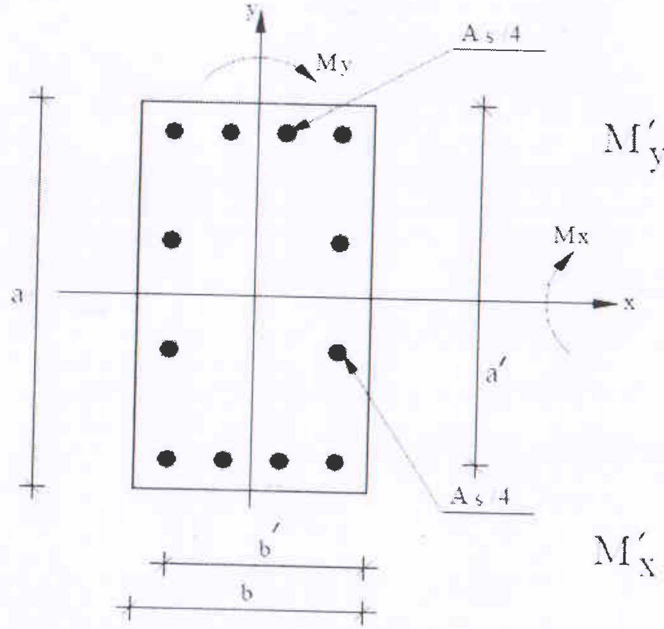
n ← عدد الأدوار



Design of Biaxial Column

أ - في حالة $\left(\frac{M_x}{a'} \le \frac{M_y}{b'}\right)$

يؤخذ العزم التصميمى $M'y$ حول محور y طبقا للمعادلة



$$M'_y = M_y + \beta\left(\frac{b'}{a'}\right)M_x$$

ب - في حالة $\left(\frac{M_x}{a'} > \frac{M_y}{b'}\right)$

يؤخذ العزم التصميمى M'_x حول محور x طبقا للمعادلة

$$M'_x = M_x + \beta\left(\frac{a'}{b'}\right)M_y$$

$R_b = \frac{P_u}{f_{cu} \cdot b \cdot a}$	< 0.2	0.3	0.4	0.5	> 0.6
β	0.80	0.75	0.70	0.65	0.60

* ملاحوظة يتجيب من Biaxial ⇒ my واحد
Inter Action Diagram ⇐ حق ندخل
⇒ Pu & Mu (m'y or m'x) ⇒ ثم يتم التصميم