ZAPATA CONECTADA

MÓDULO III

Se diseñará para las columnas E-4 y C-4 por ser excentricas.

E-4 → $l_x = 0.813m$, $l_y = 0.269m$

C-4 → $l_x = -0.253m$, $l_y = 0.322m$.

E-4 → CM = 79.31 Tn, CV = 18.48 Tn > $P_{S1} = 97.79$ Tn

C-4 → CM = 109.55 Tn, CV = 30.41 Tn. > $P_{S2} = 139.96$ Tn

- EMS:

$q_{ult} = 7.5 kg/cm^2$

$\gamma_s = 1.74 Tn/m^3$

F.S = 3

S = 1.20

U = 1.00

Z = 2 ⇒ Z = 0.25

$F'c = 210 kg/cm^2$ (zapata).

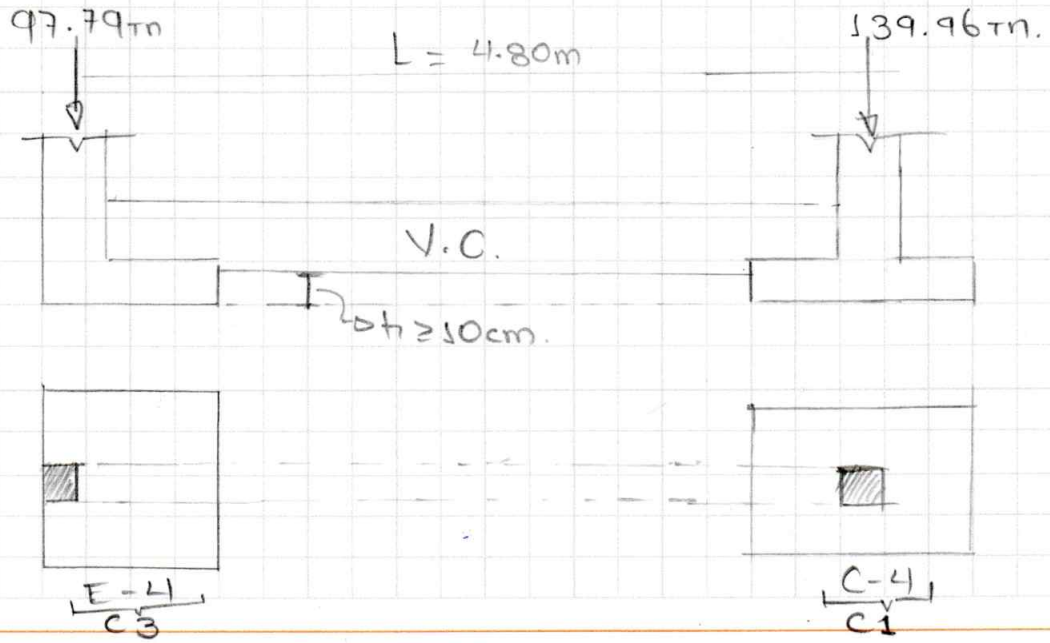
$F'c = 280 kg/cm^2$ (columna).

$Fy = 4200 kg/cm^2$.

$D_F = 1.5m$.

L = 4.80m

$S/C = 200 kg/m^2 = 0.2 Tn/m^2$.



Para: C-3:

$$Ac = \frac{1.25\,Ps_1}{0.25\,F'c} = t_1 x t_2$$

$$t_1 x t_2 = 0.45m \times 0.45m$$

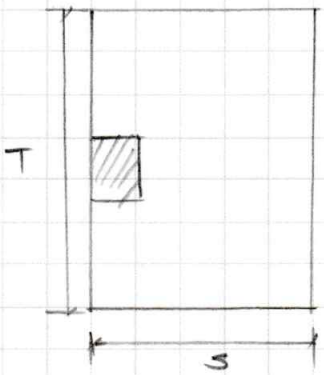
Para: C-1

$$Ac = \frac{1.1\,Ps_2}{0.3\,F'c} = t_1 x t_2.$$

$$t_1 x t_2 = 0.45m \times 0.45m.$$

SE SABE:

$$q_{net} = 22.02\ Tn/m^2$$



$$Az = \frac{1.2\,Ps_1}{q_{net}} = 2S^2$$

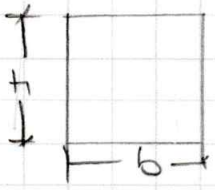
$Az = T \geq 2S, 2.5S.$

$Az = S x T = S x 2S = 2S^2$

$$Az = \frac{1.2 \times 97.79\ Tn}{22.02\ Tn/m^2} = 2S^2$$

$$S = 1.63m = 1.65m.$$

⊛ Viga de Cimentación:

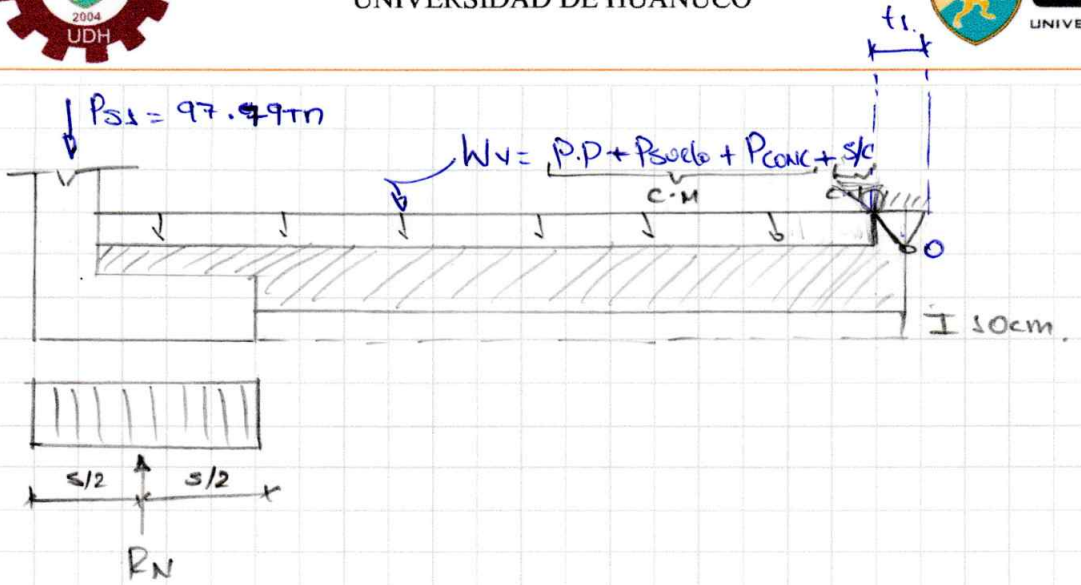


$$h = \frac{L}{7} = \frac{4.80}{7} = 0.69m \cong 0.70m$$

$$b = \frac{Ps_1}{3l \times L} = \frac{97.79}{3l \times 4.80} = 0.66 \cong 0.70m.$$

$$\Rightarrow \frac{h}{2} \leq b \leq h$$

$0.35m \leq 0.70m \leq 0.70m$. .... OKbbb.



$$Wv = (0.70)\times(0.70)\times(2.4) + (0.70)(1.5 - 0.1 - 0.70)(1.74) + (0.2)(0.70)$$

$$Wv = \underbrace{2.0286\ Tn/m}_{W.CM} + \underbrace{0.14\ Tn/m}_{W.CV}$$

$$Wv = 2.1686\ Tn/m \downarrow$$

$$+\circlearrowleft \Sigma M_O = 0 \Rightarrow R_N(4.80 + 0.45 - 1.65/2) - P_{S1}(4.80) - W_V(4.80 - 2\times 0.45)\left(\frac{4.80 - 2\times 0.45}{2} + \frac{0.45}{2}\right) = 0$$

$$R_N(4.425) - P_{S1}(4.80) - W_V(3.9)(1.95 + 0.225) = 0$$

$$R_N(4.425) - 97.79(4.80) - 2.1686(3.9)(2.175) = 0$$

$$R_N = 110.23\ Tn \downarrow$$

$$A_Z = \frac{R_N}{q_{neta}} = \frac{110.23}{22.02} = 5.00\,m^2 = T\times S = T\times 1.65 \Rightarrow T = 3.03$$

$$T = 3.10$$

$$\Rightarrow A_Z = T\times S = 3.10\times 1.65 = 5.115\,m^2 = 5.12\,m^2 \downarrow$$

DISEÑO DE LA VIGA 8

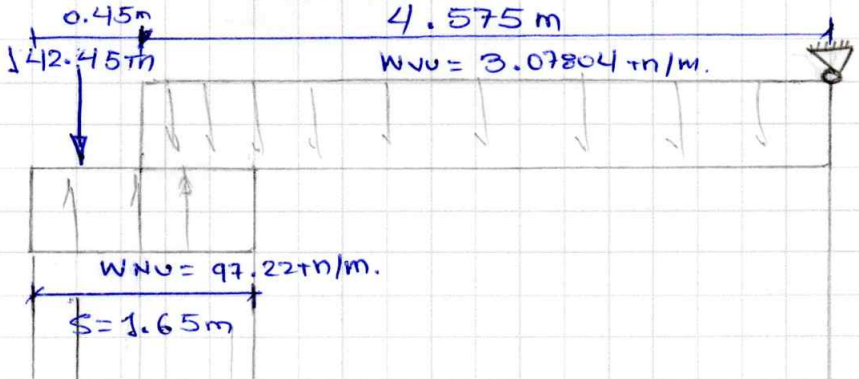
- $W_{VU} = 1.4\,W_{CM} + 1.7\,W_{CV}$
- $P_{S1U} = 1.4\,P_{CM} + 1.7\,P_{CV}$

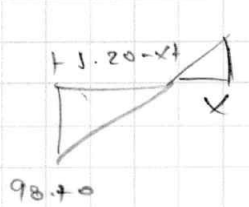
$$R_{NU} = [W_{VU}(3.9)(2.175) + P_{S1}(4.80)] / 4.425$$

$$R_{NU} = [3.0784(3.9)(2.175) + 142.45(4.80)] / 4.425$$

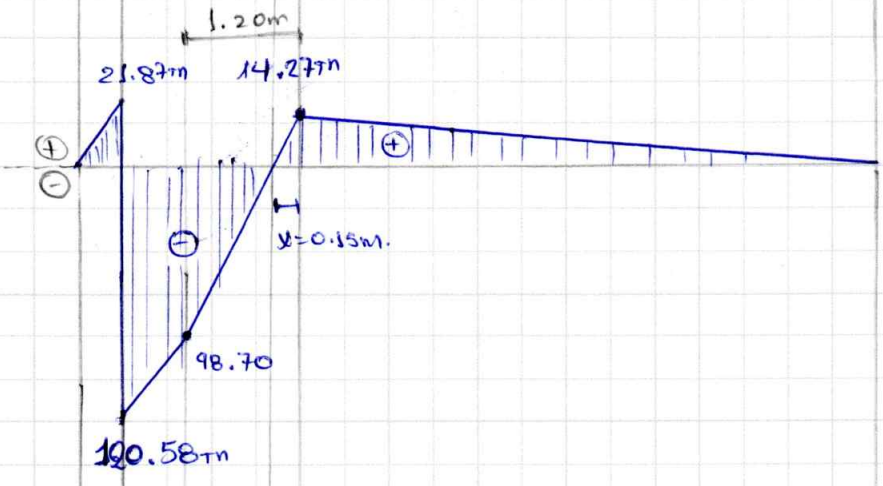
$$R_{NU} = 160.42\ Tn \downarrow$$

$$\Rightarrow W_{NU} = \frac{R_{NU}}{S} = \frac{160.42}{1.65} = 97.22 \text{ Tn/m}$$

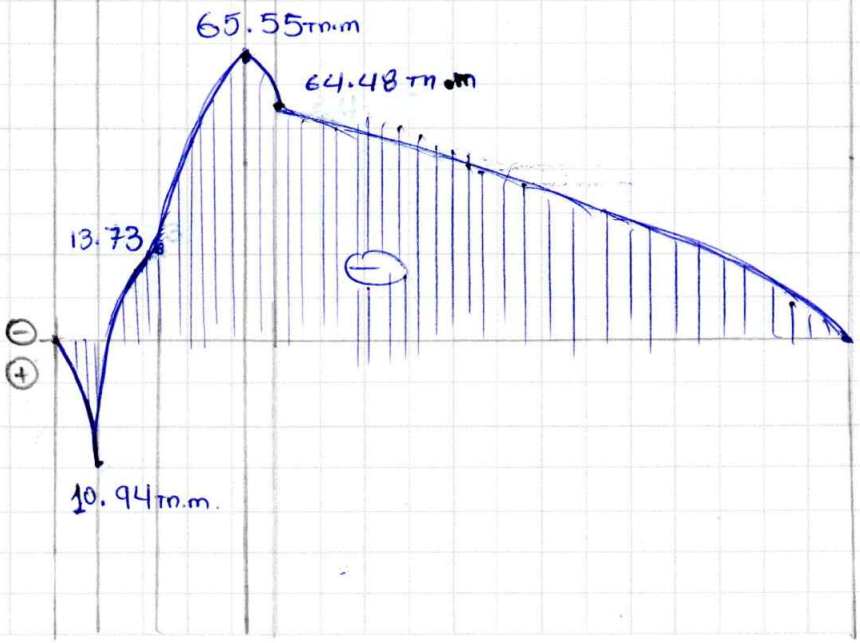




X = 0.15m



V (Tn).



M (Tn.m).

⊛ Calculo del Acero:

1° Verificamos $X_o < S$

$X_o \Rightarrow V(X_o) = 0 \longrightarrow$ Graficamente $X_o = 0.15m$

$\therefore X_o < S$
$0.15m < 1.65m.$ $\Rightarrow M(X_o) = 65.55 \text{ Tn.m.}$

- $\rho = 1.75\rho_{min} \rightarrow \rho_{min} = 0.7\dfrac{\sqrt{F'c}}{Fy}$

- $w = \rho\dfrac{Fy}{F'c} = 1.75 \times 0.7\dfrac{\sqrt{F'c}}{Fy} \times \dfrac{Fy}{F'c} = 1.75 \times 0.7\dfrac{\sqrt{F'c}}{F'c.} = 1.75 \times 0.7\dfrac{\sqrt{280}}{280.}$

$w = 0.07321$ ↓

$$d = \sqrt{\frac{65.55}{0.90 \times 2800 \times 0.70 \times 0.07321(1 - 0.59 \times 0.07321)}}$$

$d = 0.7283\,m \Rightarrow d = 72.83cm$ ↓

$h = d + \phi/2 + r + \phi_s = 72.83 + \dfrac{2.54}{2} + 7 + \dfrac{3}{8}(2.54)$

▶ $h = 82.05\,cm.$ ≡ ▶ $b = 0.70m$

$h = 83cm$

$d = h - \phi/2 - r - \phi_s \Rightarrow 83 - \dfrac{2.54}{2} - 7 - \dfrac{3}{8}(2.54) = d$

$73.78cm = d$

$$a = \frac{2d - \sqrt{4d^2 - \dfrac{8MU}{\phi F'c \times b \times 0.85}}}{2} = \frac{2(.7378) - \sqrt{4(0.7378)^2 - \dfrac{8 \times 65.55}{0.90 \times 2800 \times 0.70 \times 0.85}}}{2}$$

$a = 0.0618_m \Rightarrow a = 6.18cm.$ ↓

- Diseño por Flexión:

$$As = \frac{Mu}{\phi Fy(d - a/2)} = \frac{65.55}{0.90 \times 42000(0.7378 - 0.0618/2)}$$

$$As = 0.002453\ m^2 \Rightarrow \boxed{As = 24.53\ cm^2}$$

- $$\rho d = \frac{As}{bd} = \frac{24.53}{70 \times 73.78} = 0.004750$$

$$\rho min \leq \rho d \leq \rho max$$

- $$Ru = \frac{Mu}{bd^2} = \frac{65.55}{0.70 \times 0.7378} = 172.03\ tn/m^2 = 17.203\ kg/cm^2$$

$$\rho = \frac{Ru}{\phi Fy \times \left(1 - 0.59\rho \frac{Fy}{F'c}\right)} = \frac{17.203}{0.90 \times 4200 \times \left(1 - 0.59 \times \rho \times \frac{4200}{280}\right)}$$

$$\rho = 0.004751. \Rightarrow \rho \equiv \rho d \quad \text{--- OK!!!.}$$

$$\rho min \leq \rho d \leq \rho max$$

$$0.7\frac{\sqrt{f'c}}{Fy} \leq \rho d \leq 0.85\frac{F'c}{Fy}\left(\frac{6000}{6000 + Fy}\right)0.85$$

$$0.7\frac{\sqrt{280}}{4200} \leq \rho d \leq 0.85^2 \times \frac{280}{4200}\left(\frac{6000}{6000 + 4200}\right)$$

$$0.002789 \leq 0.004751 \leq 0.02833 \quad \text{------ OK!!!.}$$

Calculando # y ø Varillas de ø = 1"

$$As = \rho d\, b\, d = 0.004751 \times 70 \times 73.78 = 24.54\ cm^2$$

$$N°v = \frac{As}{A\phi} = \frac{24.54\ cm^2}{\frac{\pi(2.54)^2}{4}} = 4.84 \cong 5\ \text{Varillas.}$$

$$Exc = 5(5.07) - 24.54 = 0.81\ cm^2$$

24.54 ..... 100%
0.81 X

$$Exc\,\% = 3.3\%\ As \leq 11\%\ As. \quad \text{------ OK!!!.}$$

$$Sr = \frac{b - 2r - n°v\,\phi - 2\phi s}{n°v - 1}$$

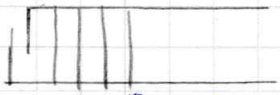
$$Sr = \frac{70 - 2\times 7 - 5 - 2\times \frac{3}{8}(2.54)}{5 - 1}$$

$$Sr = 12.27\ cm \downarrow$$

- TMN 3/4"
- TM 1"

$TM \leq Sr \leq 40cm$

$2.54 \leq 12.27cm \leq 40cm$ ---- OK!!



2 ⇒ ρmin
- $\frac{1}{2}\rho d$
- $\frac{1}{3}\rho d$.

$$A's = \frac{1}{3}\rho' d \ \vee\ \frac{1}{2}\rho' d \ \vee\ \rho min = \frac{0.7\sqrt{F'c}}{Fy}$$

ρmin

$\frac{1}{3}(0.004751) = 0.001584 \ \vee\ \frac{1}{2}(0.004751) = 0.002376 \ \vee\ 0.002789$

$\rho' = 0.002789 \Rightarrow A's = \rho' \times b \times d = 0.002789 \times 70 \times 73.78 = 14.40\ cm^2$

$n°v = \frac{14.40}{5.07} = 2.84 \cong 3$ varillas.

$Exc = 3 \times 5.07 - 14.40 = 0.81\ cm$

14.40 ... 100%
0.81 ... x

$Exc\% = 5.63\%\ As \leq 11\%\ As$. ... OK!!

$$Sr = \frac{b - 2r - n°v\,\phi - 2\phi s}{n°v - 1} = \frac{70 - 2\times 7 - 3(1") - 2\times\frac{3}{8}(2.54)}{3 - 1}$$

$Sr = 25.55cm \downarrow$

④ DISEÑO X CORTANTE:

$$V_n = V_c + V_s$$

$$V_c = 0.53\sqrt{f'c}\ b \times d = 0.53\sqrt{280} \times 70 \times 73.78 = 45.80\,Tm$$

$$V_s = ?$$

$$V_n = \frac{V_u}{\phi} = \frac{98.70}{0.85} = 116.12\,Tm$$

$$V_n = V_c + V_s \Rightarrow V_s = V_n - V_c = 116.12 - 45.80$$

$$V_s = 70.32\,m$$

VERIFICANDO:

① $V_n \leq \frac{V_c}{2} \Rightarrow 116.12\,m \leq \frac{45.80\,m}{2}$ .... NO CUMPLE.

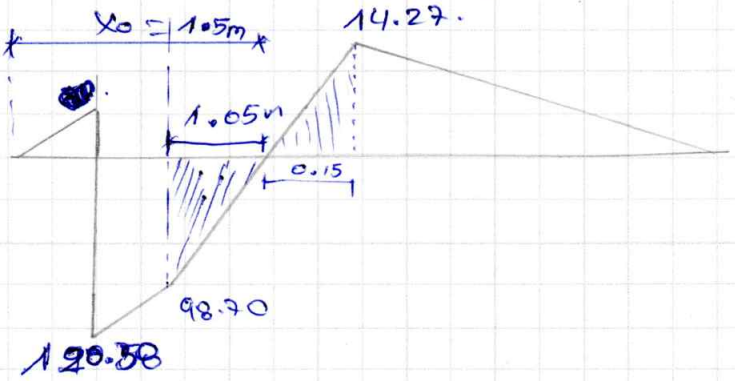
② $\frac{V_c}{2} < V_n \leq V_c \Rightarrow 22.90\,m < 116.12 \leq 45.80$ ---NO CUMPLE.

③ $A_{s(min)} = \frac{s\,b\,(3.5)}{F_y} \Rightarrow s \leq 60\,cm \wedge s \leq d/2$

$$V_n = V_c + V_s \Rightarrow V_n > V_c$$

(a) $V_s \leq 1.06\sqrt{f'c}\ b\,d \Rightarrow s \leq 60\,cm \vee s \leq d/2$

D.F.C



▶ EN ③

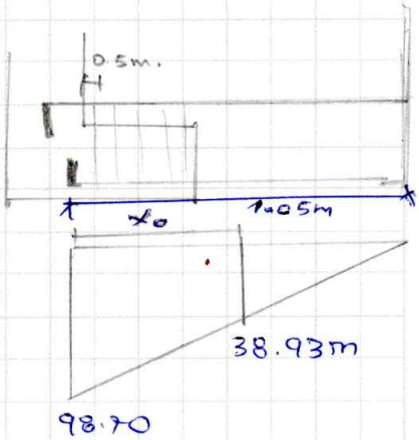
$$Vn = Vc + Vs = 45.80m + 70.32m. = 116.12m.$$

$$116.12_{m.} > 45.80m$$

▶ ② $Vs \leq 1.06\sqrt{f'c}\, bd \Rightarrow 70.32m \leq 91.65m.$

$$S = \frac{Asfyd}{Vs} = \frac{2x0.71cm^2 \times 4200 \times 73.38}{70.32} = 6.26cm.$$

$\boxed{S = 6.30cm} \Rightarrow 6.30cm \leq 60cm \;\; y \;\; S \leq d/2$ OK.



▶ $Vn = Vc = 45.80\ tn$

$Vu = 45.80 \times 0.85 = 38.93\ tn.$

$$\frac{1.05}{98.70} = \frac{1.05 - Xo}{38.93}$$

$Xo = 0.64m$

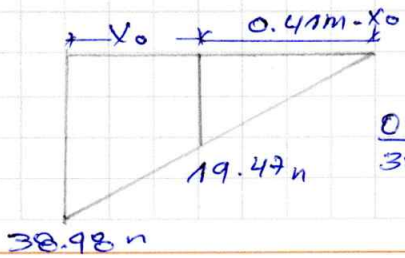
$$n°v = \frac{0.64 - 0.05}{0.063} = 9.37 \cong 10 \text{ varillas.}$$

▶ EN ② °

$$S = \frac{Asmin\, fy}{3.5b} \Rightarrow S = \frac{Asfyd}{Vs.}$$

$$S = \frac{0.71v^2 \times 4200}{3.5 \times 70} \Rightarrow S = 24.34cm \cong 24cm.$$

$$n°v = \frac{Xo}{S} \Rightarrow Xo = ?$$



$$\frac{0.41}{38.98} = \frac{0.41 - Xo}{19.47}$$

$Xo = 0.21m$

▶ $Vn = \frac{Vc}{2} = 22.90m$

▶ $Vu = 19.47\ tn$

⇨ como $X_o = 0.21m$

$$\eta°V = \frac{0.21}{0.24} = 0.875 \simeq 1 \text{ varilla.}$$

➢ EN (1) : $V_n \leq \frac{V_c}{2}$ ⇨ NO REQUIERE ACE. (Se colocará cada 60cm)

$22.90\ tn \leq 22.90\ m$ ... OK!!!.

Para el sigt. tramo :

➢ EN (1) : DE SABE: $V_c = 45.80\ tn.$

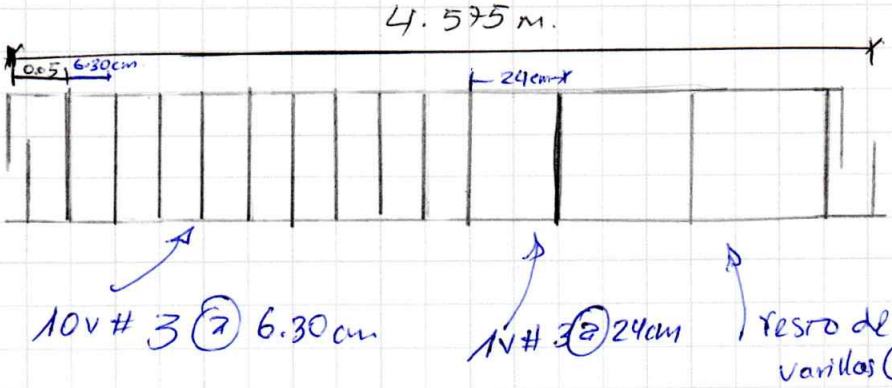
$$V_n = \frac{V_u}{\phi} = \frac{14.27}{0.85} = 16.79\ m.$$

$$V_n \leq \frac{V_c}{2}$$

$$16.79 \frac{}{m} \leq \frac{45.80\ m}{2} \Rightarrow 16.79\ tn \leq 22.9\ tn$$ (NO REQUIERE ACERO)

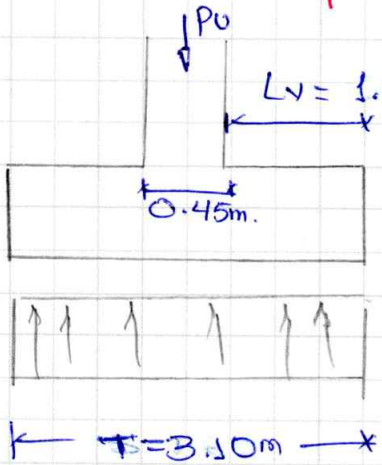
⇨ SE colocará ACERO CADA 60cm

EN RESUMEN :



10 v # 3 @ 6.30cm 1 v # 3 @ 24cm resto de varillas @ 60cm

⑥ DISEÑO ZAPATA EXTERIOR:



▷ $W_{NU} = \frac{P_{NU}}{T} = \frac{160.42}{3.10}$

$W_{NU} = 51.75$ tn/m.

▷ $M_{max} = 51.75 \times \frac{1.325^2}{2} = 45.43$ tn.m. ⇨ Mu.

▷ $\rho = 1.50 \times \rho_{min} = 1.50 \times 0.002787 = 0.0041805$.

▷ $= w = \rho_v \frac{Fy}{F'c} = 0.0041805 \times \frac{4200}{280} = 0.062708$ ↓

$$d = \sqrt{\frac{45.43}{0.90 \times 2100 \times 1.65 \times 0.062708 \times (1 - 0.59w)}}$$

$d = 0.4912$m ⇨ $d = 49.12$cm ↓

▷ $h_z = d + \phi/2 + r = 49.12 + \frac{2.54}{2} + 7 = 57.39$cm ↓

$h_z = 58$cm ⇨ $d = h_z - \phi/2 - r = 58 - 2.54/2 - 7$

$d = 49.73$cm
LOREAL

⑦ DISEÑO POR CORTANTE 8 ($\phi = 0.85$)

$V_U = W_{NU}(L_V - d) = 51.75(1.325 - 49.73 \times 10^{-2})$

▷ $V_U = 42.83$ tn. ↓

▷ $V_n = \frac{V_U}{\phi} = \frac{42.83}{0.85} = 50.39$ tn ↓

▷ $V_C = 0.53\sqrt{250} \times 1.65 \times 0.4973 = 63.02$ tn ↓

DISEÑO POR FLEXIÓN (Ø=0.90)

$$a = \frac{2d - \sqrt{4d^2 - \frac{8Mu}{\phi \times f'c \times b \times 0.85}}}{2}$$

$$a = \frac{2(0.4973) - \sqrt{4(0.4973)^2 - \frac{8 \times 45.43}{0.90 \times 2500 \times 1.65 \times 0.85}}}{2}$$

$a = 0.0357\ m \Rightarrow a = 3.57\ cm$

$$As = \frac{Mu}{\phi \times Fy\,(d - a/2)} = \frac{45.43}{0.90 \times 42000\,(0.4973 - 0.0357/2)}$$

▸ $As = 0.002507\ m^2 \Rightarrow As = 25.07\ cm^2$

▸ $A_{s\,min} = \rho_{dmin} \times b \times d = 0.002787 \times 165\ cm \times 49.73\ cm = 22.87\ cm^2$

$As > Asmin$ ... OK!!!

$\emptyset = 1''$

▸ $n°v = \frac{As}{A\emptyset} = \frac{25.07}{5.07} = 4.94 \cong 5$ varillas.

Exc = 5(5.07) − 25.07 = 0.28

Exc% = 1.12 As% ≤ 11% As. .... OK!!!

25.07 ..... 100%
0.28 x

$$Sr = \frac{B - 2r - n°v(\emptyset)}{n°v - 1} = \frac{165 - 2 \times 7 - 5(2.54)}{5 - 1}$$

$Sr = 36.5\ cm$

TM x 1/3 = 3/4 11

TM = 1"

$TH \leq Sr \leq 40\ cm$

$2.54\ cm \leq 36.5\ cm \leq 40\ cm$ ... OK!!!

5v#8 @ 36.5cm.

TRANSVERSAL:

$\phi = 1''$

$A'_s = \rho_{min} \times T \times d$

$A'_s = 0.002787 \times 3.10 \times 0.4973 = 0.004297\ m^2$

$A'_s = 42.97\ cm^2$ ↓

$N°V = \frac{42.97}{5.07} = 8.47 \cong 9$ varillas. ↓

$Exc = 9(5.07) - (42.97) = 2.66$

$Exc\% = 6.19\% A_s < 15\% A_s$ ..... OK666.

42.97 ... 100%
2.66 ... x

$S_r = \frac{B - 2r - n°V(\phi)}{n°V - 1} = \frac{310 - 2(7) - 9(2.54)}{9-1} = 35.875\ cm.$

$S_r = 36cm$ ↓

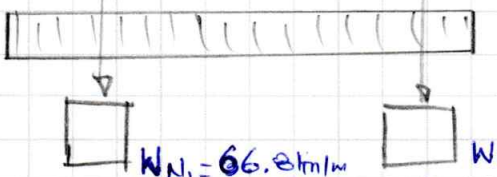
$2.54cm < 36cm < 40cm$ ..... OK666.

9 vari. # 8 @ 36 cm.

DISEÑO DE ZAPATA INTERIOR.

$P_{U1} = 142.45 tn$ $P_{U2} = 205.07 tn.$

$P_{S1} = 97.79 tn$ $P_{S2} = 139.96 tn.$



$W_{N1} = 66.81 tn/m$

$W_{N1U} = 97.22 tn/m.$

$R_{N1} = 110.23 tn$

$R_{NU1} = 160.42 tn.$

$W_{N2} = R_{N2}/S = 84.05\ tn/m$

$W_{N2U} = \frac{R_{NU2}}{S} = 53.98\ tn/m$

$R_{N2} =$

$R_{NU2} =$

$R_{N2} = 97.79 + 2.1686\left(\frac{4.35}{2}\right)^2 + 139.96 - 110.23$

$R_{N2} = 327.80 tn$

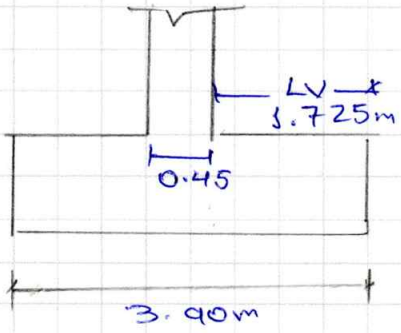
$W_{N1} = \frac{R_{N1}}{S} = \frac{110.23}{1.65} = 66.81 tn/m$

$W_{NU1} = \frac{R_{NU1}}{S} = \frac{160.42}{1.65} = 97.22 tn/m.$

$R_{NU_2} = 3.07804\left(\frac{3.9}{2}\right)^2 + 142.45 - 160.42 + 205.07$

$R_{NU2} = 210.51 tn.$

Dimensionando la Zapata:



$$A_Z = \frac{P_{N2}}{q_{neT}} = \frac{327.80\ Tn.}{22.02} = 14.89$$

$$A_Z = 3.90 \times 3.90 = S \times T$$

$$W_{N2} = \frac{P_{N2}}{S} = \frac{327.80}{3.90} = 84.05\ Tn/m$$

$$W_{N2U} = \frac{P_{N2U}}{S} = \frac{210.51}{3.90} = 53.98\ Tn/m.$$

$$Lv = \frac{3.90 - 0.45}{2} = 1.725m$$

$$d = h_2 - r - \frac{\phi_2}{2} = 58 - 7 - \frac{2.54}{2}$$

$$d = 49.73cm$$

* VERIFICACIÓN X PUNZONAMIENTO.

$$\phi = 0.85.$$

$$n = 0.45 + 0.4973 = 94.73cm$$
$$m = 0.45 + 0.4973 = 94.73cm.$$

$$V_u = P_{u2} - \frac{W_{NU2}}{b} \times m \times n$$

$$V_u = 205.07 - \frac{53.98}{3.90} \times 0.9473^2$$

$$V_u = 192.65\ Tn$$

$$b_o = 2(m+n) = 378.92cm.$$

$$V_c = 1.06\sqrt{f'c} \times b_o \times d$$

$$V_c = 289.46\ Tn$$

$$V_n = \frac{V_u}{\phi} = \frac{192.65}{0.85} = 226.65\ Tn = V_n \leq 289.46 = V_c \quad \text{.... OK!!}$$

▶ VERIFICACIÓN x CORTE: ($\phi = 0.85$)

$$\frac{Vud}{\phi} \leq Vc$$

▶ $Vud = W_{NU2} \times (Lv - d) = 53.98\ (1.725 - 0.4973)$

$Vud = 66.27$ tn ↓

▶ $Vc = 0.53\sqrt{F'c} \times bvd = 0.53\sqrt{210} \times 3.90 \times 0.4973.$

$Vc = 148.96$ tn ↓

$$\frac{66.27}{0.85} \leq 148.96$$

77.96 tn $\leq$ 148.96 tn ↓ OK!!!.

▶ DISEÑO POR FLEXIÓN:

$$Mu = 53.98 \times \frac{1.725^2}{2} = 80.31 \text{ tn-m} \downarrow$$

$$a = 2d - \sqrt{4d^2 - \frac{8Mu}{\phi \times F'c \times b \times 0.85}}$$

$$a = 2(0.4973) - \sqrt{4(0.4973)^2 - \frac{8 \times 80.31}{0.90 \times 2100 \times 3.90 \times 0.85}}$$

$$2$$

$a = 0.0265$ m ⇨ $a = 2.65$ cm.

$$As = \frac{Mu}{\phi \times Fy(d - a/2)} = \frac{80.31}{0.90 \times 4200 \times (0.4973 - 0.0265/2)} \Rightarrow As = 0.00439 \text{ m}^2$$

$As = 43.89$ cm^2

$\phi = 1''$

$$N°V = \frac{As}{Ad} = \frac{43.89}{5.07} = 8.66 \cong 9 \text{ varillas } (1'').$$

$$EXC = 9(5.07) - (43.89) = 1.74$$

$$EXC\% = 3.96\% As \leq 5\% As.$$

43.89 ..... 100%
1.74 ---- X

$$S_r = \frac{390 - 2x7 - 9(2.54)}{9-1} \; 45.875 \cong 46cm.$$

9 v #8 @ 46cm.

RPTA