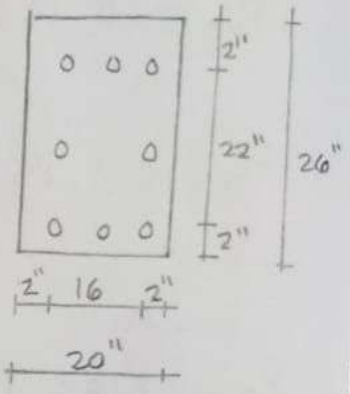
PROBLEMA 1

≡ DATOS GENERALES

$A_g = b \cdot h = 20\,(26) = 520 \text{ pulg}^2$

$A_s = 8\,(1{,}41) = 11{,}28 \text{ pulg}^2$

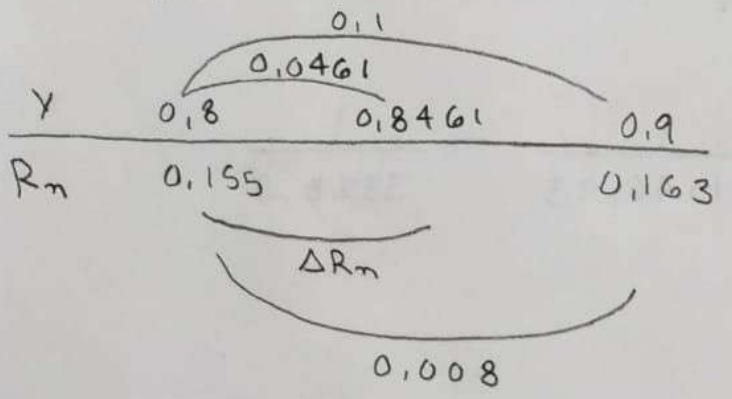
$\rho_g = \dfrac{A_s}{A_g} = \dfrac{11{,}28}{520} = 0{,}0217$



$e_x = 12"$ $e_y = 9"$

≡ PARA FLEXION EN X

$Y = \dfrac{22}{26} = 0{,}8461$ $\dfrac{e}{h} = \dfrac{12}{26} = \dfrac{6}{13} = \dfrac{1}{2{,}17}$



$\dfrac{\Delta R_n}{0{,}0461} = \dfrac{0{,}008}{0{,}1}$

$\Delta R_n = 0{,}003688$

$R_n = 0{,}1587$

$P_{nx} = \dfrac{0{,}1587\,(6)\,(520)\,(26)}{12} = 1072{,}81 \text{ Klb}$

≡ PARA FLEXION EN Y

$$Y = \frac{16}{20} = 0,8 \qquad \frac{e_1}{h} = \frac{9}{20} = \frac{1}{2,22}$$

$$R_n = 0,151$$

$$P_{nY} = \frac{0,151\,(6)(520)(20)}{9} = 1046,93 \text{ Klb}$$

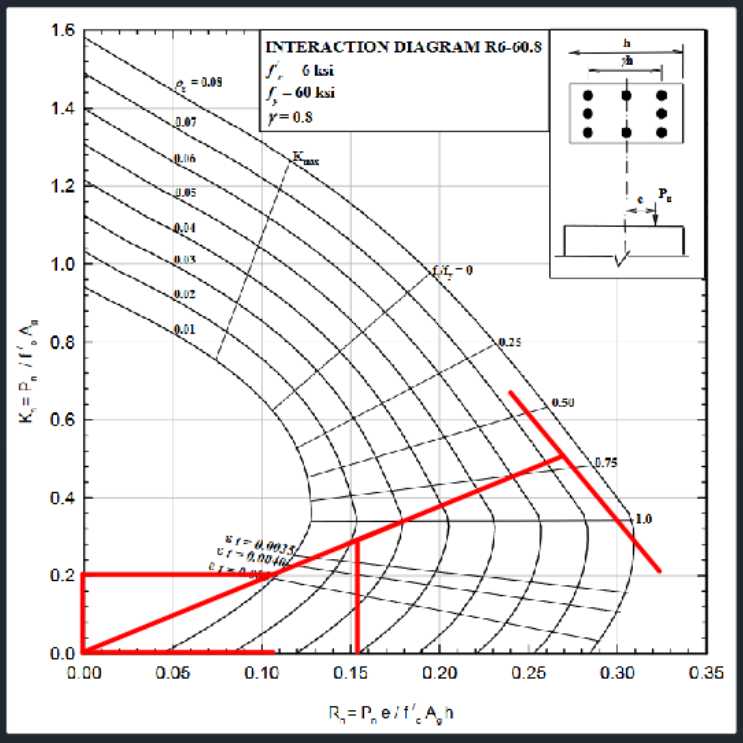
$$P_o = 0,85\,(6)(520) + 11,28\,(66) = 3328,8 \text{ Klb}$$

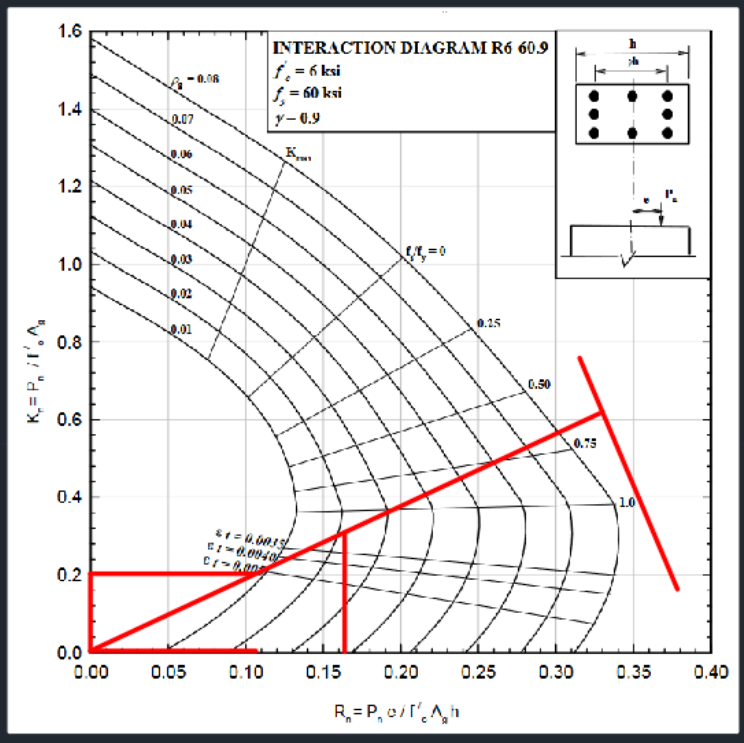
$$\frac{1}{P_{ni}} = \frac{1}{P_{nx}} + \frac{1}{P_{nY}} - \frac{1}{P_o}$$

$$\frac{1}{P_{ni}} = \frac{1}{1072,81} + \frac{1}{1046,93} - \frac{1}{3328,8}$$

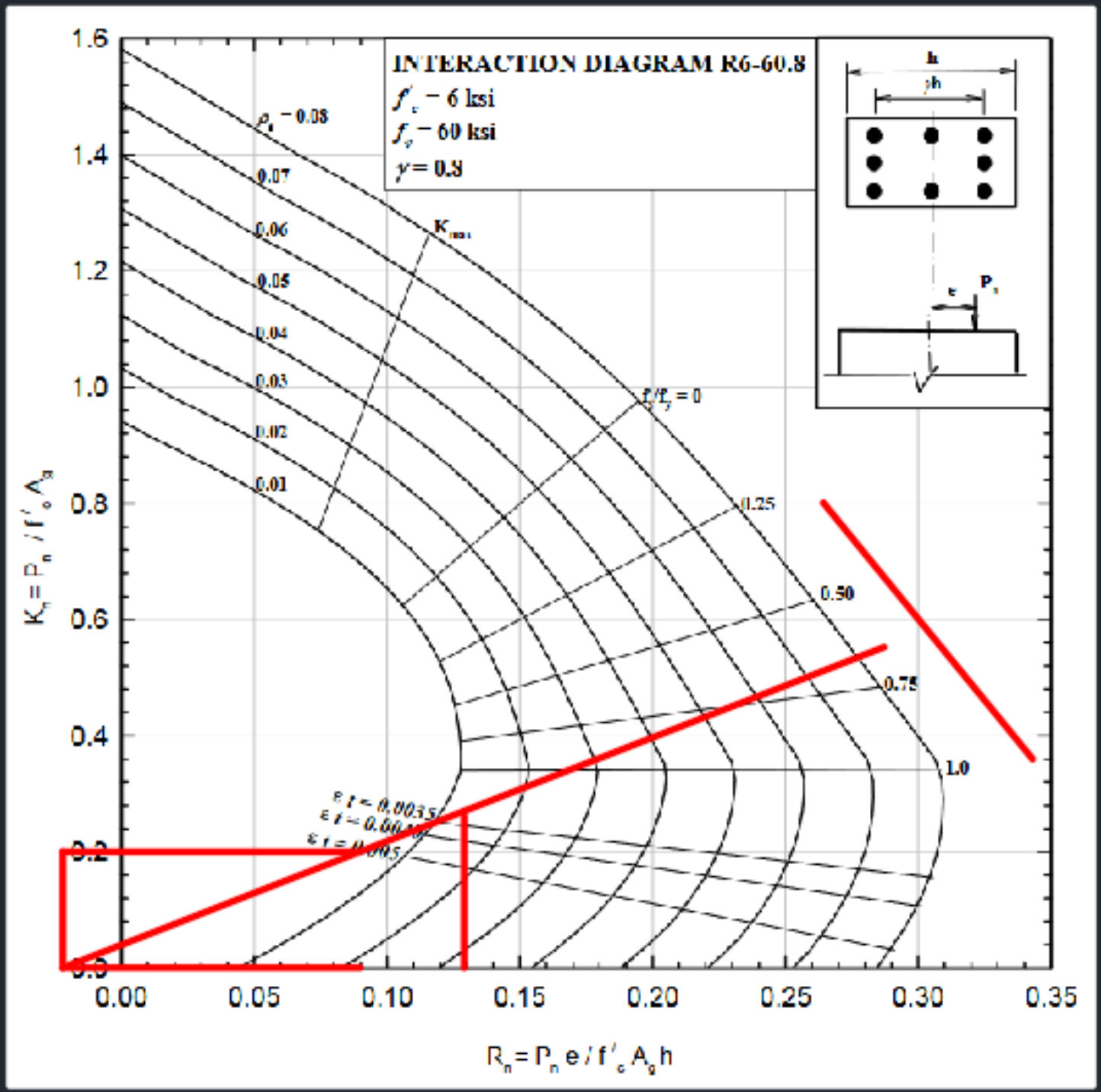
$$P_{ni} = 630,16 \text{ Klb}$$

PARA FLEXIÓN EN X





PARA FLEXIÓN EN Y



PROBLEMA #2

$l_u = 22\,ft$

CARGA MUERTA	CARGA VIVA
$P_D = 225\ K$	$P_L = 125\ K$
$M_D = 63\ K \cdot ft$	$M_L = 45\ K \cdot ft$

$$P_U = 1,2(225) + 1,6(125) = 470\ K$$

$$M_U = 1,2(63) + 1,6(45) = 147,6\ K \cdot ft$$

$$A_g = \frac{P_U}{0,6\,f'_c} = \frac{470}{0,6(4)} = 195,83\ pulg^2$$

$$A_g = b \cdot h = 10(20) = 200\ pulg^2 \qquad b = 10\ pulg \quad h = 20\ pulg$$

SEGUN NOMOGRAMA $K = 0,89$

$$\frac{K l_u}{r} = \frac{0,89(22)(12)}{0,3(20)} = 39,16$$

$$34 - 12(1)$$

$$22$$

$39,16 \leq 22 \rightsquigarrow$ "COLUMNA ESBELTA"

$$E_c = 57\,000\sqrt{4000} = 3605\ Klb/pulg^2$$

$$I_g = \frac{10(20)^3}{12} = 6666,67 \text{ pulg}^4$$

$$\beta_d = \frac{1,2(225)}{470} = 0,5745$$

$$EI = \frac{0,4(3605)(6666,67)}{1 + 0,5745} = 6\,105\,645,06 \text{ Klb.pulg}^2$$

$$P_c = \frac{\pi^2(6\,105\,645,06)}{((0,89)(22)(12))^2} = 1091,55 \text{ Klb}$$

$$C_m = 0,6 + 0,4(1) = 1$$

$$\delta = \frac{1}{1 - \frac{470}{0,75(1091,55)}} = 2,35$$

$$M_{2\,MIN} = 470(0,6 + 0,003(20)) = 310,2 \text{ Klb} \cdot \text{pulg}$$

$$M_{2\,MIN} = 25,85 \text{ Klb} \cdot \text{ft}$$

$$M_c = \delta M_2 = 2,35(147,6) = 346,86 \text{ Klb} \cdot \text{ft}$$

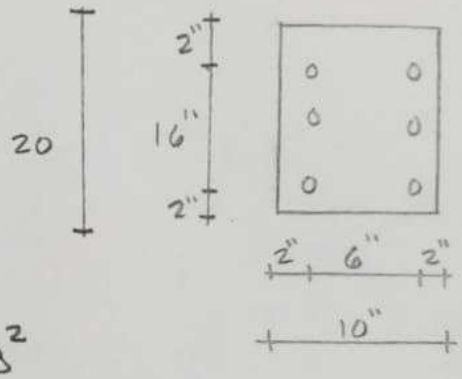
$$e = \frac{M_c}{P_0} = \frac{346,86(12)}{470} = 8,856$$

$$P_n = \frac{470}{0,65} = 723,08 \text{ K}$$

$$K_n = \frac{723,08}{4(200)} = 0,9$$

$$R_n = 0,9 \left(\frac{8,856}{20} \right) = 0,398$$

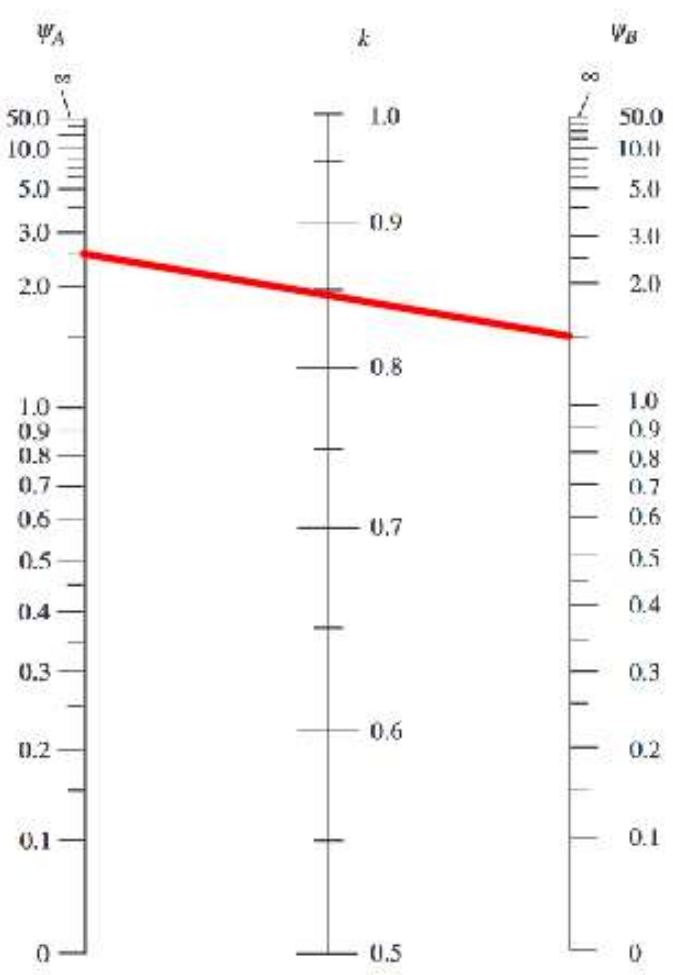
$$y = \frac{h'}{h} = \frac{16}{20} = 0,8$$



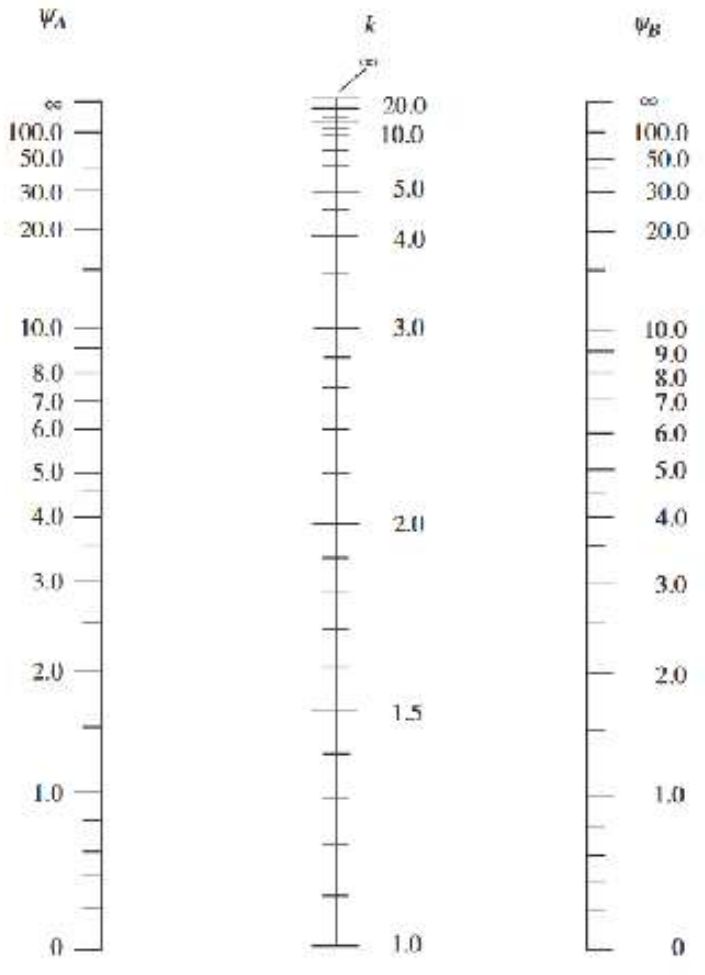
$$\rho_s = 0,0695$$

$$A_s = 0,0695 (200) = 13,9 \text{ pulg}^2$$

" USAR 10 # 11 " A_s REAL = 14,1 pulg^2



a) Marcos riostrados

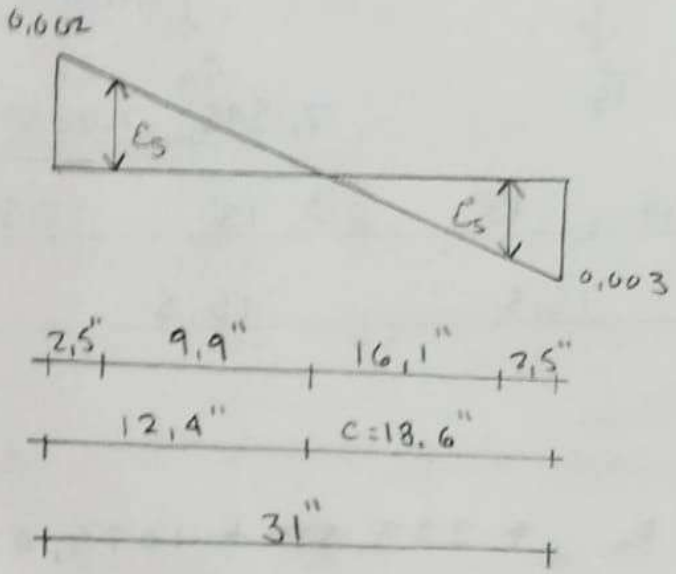


b) Marcos no riostrados

PROBLEMA 3

$b = 31"$ $\quad h = 20"$

$$C_c = \left(\frac{0,003}{0,003 + 0,002}\right)(31) = 18,6 \text{ pulg}$$



$$\varepsilon'_s = \left(\frac{16,1}{18,6}\right)(0,003) = 0,0026$$

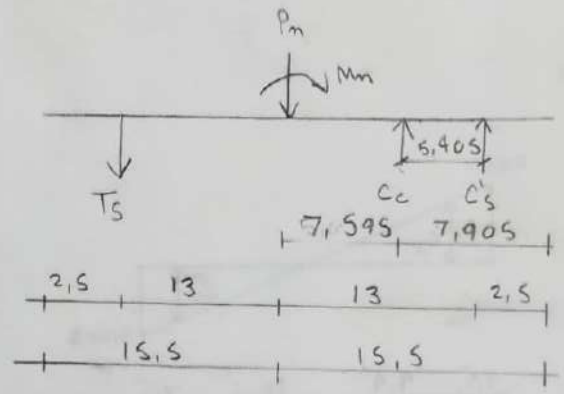
$$\varepsilon_s = \frac{9,9}{12,4}(0,002) = 0,0016$$

$$a = 0,85(18,6) = 15,81 \text{ pulg}$$

$$C_c = 0,85(15,81)(20)(4) = 1075,08 \text{ klb}$$

$C'_S = 60(5)(0,79) - 0,85(5)(0,79)(4) = 223,57$ Klb

$T_S = 0,0016(29000)(5)(0,79) = 183,28$ Klb



+

$\uparrow \Sigma F_v = 0$

$-183,28 - P_n + 223,57 + 1075,08 =$

$P_n = 1115,37$ K

$\circlearrowleft + \Sigma M_{T_S} = 0$

$M_N + 13(1115,37) - 20,595(1075,08) + 26(223,57) = 0$

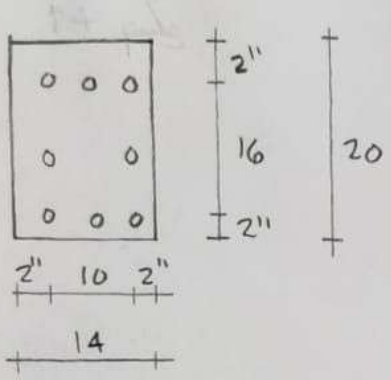
$M_N = 13\,449,48$ Klb · pulg $= 1120,79$ Klb · ft

PROBLEMA #4

$P_u = 600\ K \qquad M_u = 95\ K$

$$A_g = \frac{P_u}{0,6\,(f'_c)} = \frac{600}{0,6\,(4)} = 250\ pulg^2$$

$$A_g = b \cdot h = 14\,(20) = 280\ pulg^2$$



$$P_n = \frac{600}{0,65} = 923,08\ K$$

$$M_n = \frac{95}{0,65} = 146,15\ K \cdot ft$$

$$e = \frac{146,15\,(12)}{923,08} = 1,899 \qquad \gamma = \frac{16}{20} = 0,8$$

$$K_n = \frac{923,08}{4\,(280)} = 0,8242$$

$$R_n = 0,8242\left(\frac{1,899}{20}\right) = 0,0783$$

$$\rho_g = 0,013$$

$$A_s = 0,013\,(280) = 3,64\ pulg^2$$

"USAR 10 # 6" $\qquad A_{s\,REAL} = 4,4\ pulg^2$

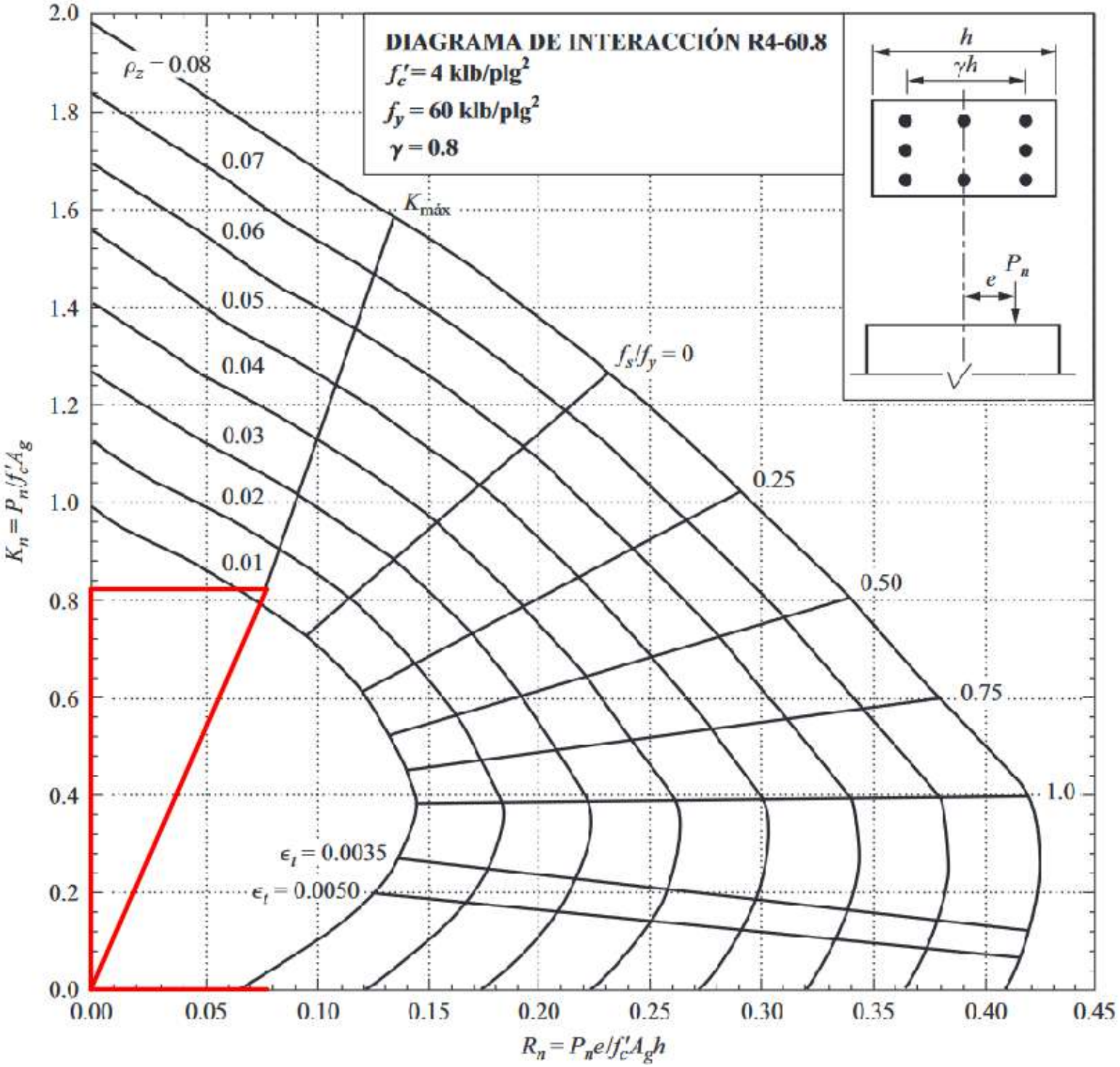
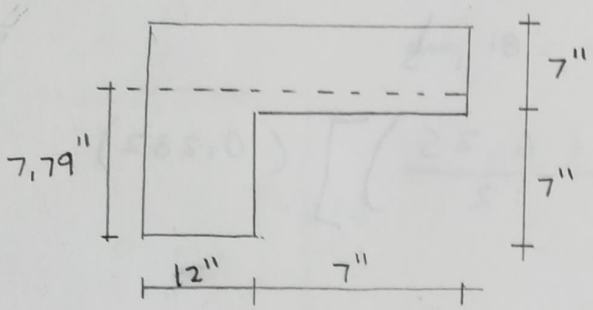
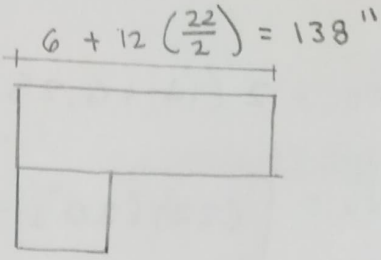


DIAGRAMA DE INTERACCIÓN R4-60.8
$f'_c = 4$ klb/plg^2
$f_y = 60$ klb/plg^2
$\gamma = 0.8$
$\rho_z = 0.08$
0.07
0.06
0.05
0.04
0.03
0.02
0.01
$K_{máx}$
$f_s/f_y = 0$
0.25
0.50
0.75
1.0
$\epsilon_t = 0.0035$
$\epsilon_t = 0.0050$
h
γh
P_n
e
$K_n = P_n/f'_cA_g$
$R_n = P_ne/f'_cA_gh$
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45

PROBLEMA #1

≡ CALCULAR h





$$\bar{X} = \frac{12(14)(6) + 7(7)\left(12 + \frac{7}{2}\right)}{(12)(14) + 7(7)} = 8,14"$$

$$\bar{Y} = \frac{12(14)(7) + (7)(7)\left(7 + \frac{7}{2}\right)}{12(14) + 7(7)} = 7,79"$$

$$Ib = \frac{1}{3}(12)(7,79)^3 + \frac{1}{3}(7)(0,79)^3 + \frac{1}{3}(19)(6,21)^3$$

$$Ib = 3408,8 \text{ pulg}^4$$

$$I_S = \frac{1}{12}(138)(7)^3 = 3944,5 \text{ pulg}^4$$

$$a = \frac{3408,8}{3944,5} = 0,887 > 0,8$$

$$h_{MIN} = \frac{\ell_n}{33} = \frac{20 - \frac{14}{12}}{33} = 0,57 \text{ ft} = 6,84 \text{ pulg} \simeq 7 \text{ pulg}$$

"USAR h = 7 pulg"

≡ REVISIÓN CORTANTE POR PUNZONAMIENTO

$$q_u = 1,2\,CM + 1,6\,CV = 1,2(115) + 1,6(90) = 282\ \frac{lb}{pie^2}$$

$$b_o = 2(14 + 6,25) + 2(14 + 6,25) = 81\ pulg$$

$$V_u = \left[(22)(20) - \left(\frac{14 + 6,25}{12}\right)\left(\frac{14 + 6,25}{12}\right)\right](0,282)$$

$$V_u = 123,12\ Klb$$

$$\emptyset V_c = 0,75\,(1)(4)\sqrt{4000}\,(81)(6,25) = 96,05$$

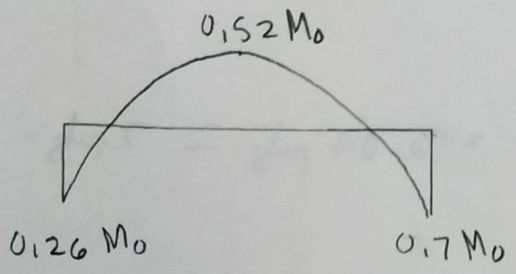
$$96,05 < 123,12$$

"NO CUMPLE PARA PUNZONAMIENTO"

≡ MOMENTOS ESTATICOS EN LA DIRECCIÓN LARGA Y CORTA

$$M_{oL} = \frac{q_u\, l_2\, l_n^2}{8} = 0,282\,(22)\left(20 - \tfrac{14}{12}\right)^2 = 275,06\ K\cdot pie$$

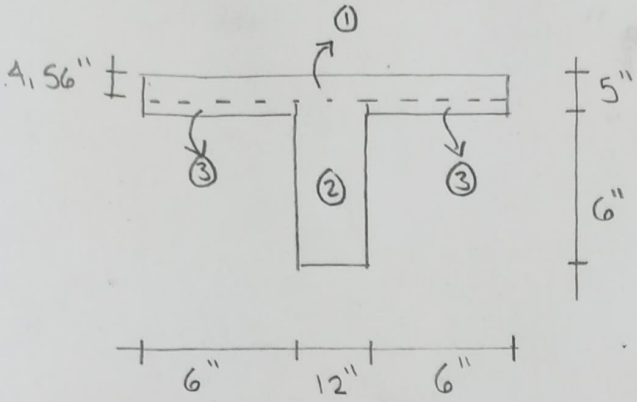
$$M_{oS} = \frac{q_u\, l_1\, l_n^2}{8} = 0,282\,(20)\left(22 - 14/12\right)^2 = 305,98\ K\cdot pie$$



COMO HAY VIGAS INTERIORES EL 75 % VA A LA FRANJA DE COLUMNA Y EL OTRO 25 % A LA FRANJA CENTRAL

	CLARO EN Y				CLARO EN X			
	FRANJA DE COLUMNA		FRANJA CENTRAL		FRANJA DE COLUMNA		FRANJA CENTRAL	
	−	+	−	+	−	+	−	+
M_u	(0,26)(0,75)(275) = −53,63	(0,52)(0,25)(275) = 35,75	(0,26)(275) = −71,5	(0,25)(275) = 68,75	(0,26)(0,75)(305,98) = −59,67	(0,52)(0,25)(305,98) = 39,65	(0,26)(305) = −79,3	0,25 (305) = 76,25
$\frac{M_u}{\phi b d^2}$	2269	150,65	301,3	289,71	251,45	167,08	334,17	321,31
ρ	0,0059	0,00385	0,0079	0,0076	0,0038	0,0043	0,0089	0,0085
A_s	3 pulg²	1,94 pulg²	4 pulg²	3,84 pulg²	1,92 pulg²	2,17 pulg²	4,5 pulg²	4,3 pulg²
VARILLA	15 #4	10 #4	20 #4	20#4	10#4	12#4	24 #4	22#4

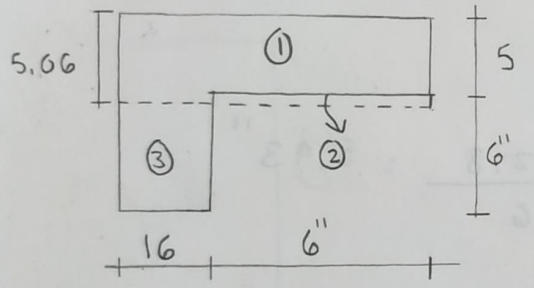
PROBLEMA #2



$$\bar{Y} = \frac{5(24)(2,5) + 6(12)(8)}{5(24) + 6(12)}$$

$$\bar{Y} = 4,56"$$

$$I_b = \frac{1}{3}(24)(4,56)^3 + \frac{1}{3}(12)(6,44)^3 + \frac{1}{3}(6)(0,44)^3(2) = 1827,25 \text{ pulg}^4$$



$$\bar{Y} = \frac{5(22)(2,5) + 6(16)(8)}{5(22) + 6(16)}$$

$$\bar{Y} = 5,06"$$

$$I_b = \frac{1}{3}(22)(5,06)^3 - \frac{1}{3}(6)(0,06)^3(2) + \frac{1}{3}(16)(5,94)^3 = 2067,85 \text{ pulg}^4$$

≡ CALCULAR a

- VIGA DE BORDE

$$\text{ANCHO} = \frac{20(12)}{2} + 8 = 128 \text{ pulg}$$

$$I_s = \frac{1}{12}(128)(5)^3 = 1333,33 \text{ pulg}^4 \qquad a_f = \frac{2067,85}{1333,33} = 1,55$$

- VIGA INTERIOR DE 22'

$$I_s = \frac{1}{12}(20)(12)(6)^3 = 4320 \text{ pulg}^4 \qquad a_f = \frac{1827,25}{4320} = 0,42$$

- VIGA INTERIOR DE 20

$$I_s = \frac{1}{12}(22)(12)(6)^3 = 4752 \text{ pulg}^4 \qquad a_f = \frac{1827,25}{4752} = 0,38$$

$$a_f = \frac{1,55 + 0,42 + 2(0,38)}{4} = 0,68$$

l_n LARGO $= 22(12) - 8 - 8 = 248''$

l_n CORTO $= 20(12) - 8 - 8 = 224''$

$$\beta = \frac{248}{224} = 1,11$$

$$\frac{a_{f1}\, l_2^2}{a_{f2}\, l_1^2} = \frac{0,38\ (20)^2}{0,42\ (22)^2}$$

$0,2 < 0,75 < 5$

"COMPLE LA CONDICIÓN"

$$h = \frac{248\left(0,8 + \frac{60000}{200000}\right)}{36 + 9(1,11)} = \frac{272,8}{46} = 5,93''$$

"USAR $h = 6$ pulg"

$q_u = 1,2\,CM + 1,6\,CV = 1,2(110) + 1,6(105) = 300\ lb/pie^2$

$$M_{ox} = \frac{0,3(20)(22 - 16/12)^2}{8} = 320,33\ K\cdot ft$$

$$M_{oy} = \frac{0,3(22)(20 - 16/12)^2}{8} = 287,47\ K\cdot ft$$

$M^-_{\text{FRANJA DE COLUMNA EN X}} = 0,75(0,26)(320,33) = 62,46\ K\cdot ft$

$M^+_{\text{FRANJA DE LOSA EN Y}} = 0,25(0,52)(287,47) = 37,37\ K\cdot ft$

≡ ACERO PARA FRANJA DE COLUMNA EN Y

$$\frac{M_u}{\phi b d^2} = \frac{62,46\,(12\,000)}{0,9\,(85)(5,25)^2} = 355,47 \frac{lb}{pulg^2}$$

$$\rho = 0,0063$$

$$A_s^- = 0,0063\,(85)(5,25) = 2,81\ pulg^2$$

"USAR 10 #5"

≡ ACERO POSITIVO PARA FRANJA DE LOSA

$$\frac{M_u}{\phi b d^2} = \frac{37,37\,(12\,000)}{0,9\,(85)\,(5,25)^2} = 212,68\ lb/pulg^2$$

$$\rho = 0,0037$$

$$A_s^+ = 0,0037\,(85)\,(5,25) = 1,65\ pulg^2$$

"USAR 9 #4"

PROBLEMA 1

≡ DATOS

$W_L = 1050$ lb/pie

$W_D = 520$ lb/pie

$L = 64$ ft

$f'_c = 4500$ PSI

$f'_{c\ AL\ 70\%} = 3150$ PSI

$f_{cT} = 0,6\,(3150) = -1890$ PSI

$f_{t1} = 3\sqrt{3150} = +168,37$ PSI

$f_{cS} = 0,6\,(4500) = -2700$ PSI

$f_{tS} = 6\sqrt{4500} = +402,49$ PSI

$W_D = 250$ lb/pie

$$M_D = \frac{0,25\,(64)^2}{8} = 128 \text{ Klb} \cdot \text{pie}$$

$$M_d + M_L = \frac{1,57\,(64)^2}{8} = 803,84 \text{ Klb} \cdot \text{pie}$$

$$S_1 \geq \frac{(1-0,75)(128) + (803,84)}{0,75(168,37) + 2700}\,(12000) = 3548,86 \text{ pulg}^3$$

$$S_2 \geq \frac{(1-0,75)(128) + (803,84)}{402,49 + 0,75\,(1890)}\,(12000) = 5511,06 \text{ pulg}^3$$

(1)

≡ UTILIZAR NV 1350

$$f_{cc1} = f_{t1} - \frac{1}{2}(f_{t1} - f_{c1}) = 168,37 - \frac{1}{2}(168,37 + 1890)$$

$$= -860 \text{ lb/pulg}$$

$$P_1 = A_c f_{cc1} = \frac{295,41(-860)}{1000} = -254,06 \text{ Kips}$$

$$e = (f_{t1} - f_{cc1})\left(\frac{S_1}{P_1}\right) + \frac{M_o}{P_1}$$

$$= (168,37 + 860)\left(\frac{3548,86}{254\,060}\right) + \left(\frac{128(12000)}{254\,060}\right)$$

$$= 1028,37(0,013968) + (6,045816) = 20,41 \text{ pulg}$$

$$f_{pi} = 0,82\, f_{py} = 0,82(0,9)(270) = 199 \text{ KSI}$$

$$= 0,74\, f_{pu} = 0,74(270) = 200 \text{ KSI}$$

≡ CÁLCULO DE ACERO

$$A_p = \frac{254}{199} = 1,27 \text{ pulg}^2$$

- PARA ACERO DE $\frac{1}{2}$" Y 270 KSI ÁREA INDIVIDUAL $0,153 \text{ pulg}^2$

- $\frac{1,27}{0,153} = 8,34 \rightsquigarrow$ "USAR 2 PAQUETES DE 5 TORONES"

PROBLEMA 2

≡ DATOS

$L = 40\ ft$

$W_D = 160\ lb/ft$

$W_L = 580\ lb/ft$

$f'_c = 5000\ PSI$

PESO PROPIO $= 250\ lb/ft$

$f_{c1} = -0.6(0.75)(5000) = -2250\ lb/pulg^2$

$f_{t1} = 3\sqrt{0.75(5000)} = +183.71\ lb/pulg^2$

$f_{cs} = -0.6(5000) = -3000\ lb/pulg^2$

$f_{ts} = 6\sqrt{5000} = +424.26\ lb/pulg^2$

$$M_D = \frac{0.125(40)^2}{8} = 50\ K\cdot ft$$

$$M_D + 0.75M_L = \frac{(0.16 + 0.75(0.58))(40)^2}{8} = 119\ K\cdot pie$$

$$S_1 \geq \frac{(0.20)(50) + 119}{0.8(183.71) + 3000}(12000) = 491.90\ pulg^3$$

$$S_2 \geq \frac{(0.20)(50) + 119}{424.26 + 0.8(2250)}(12000) = 695.96\ pulg^3$$

①

PARA $S = 696 \text{ pulg}^3$

$I_c = 19904 \text{ pulg}^4$

$S = 1422 \text{ pulg}^3$

$A = 240 \text{ pulg}^2$

$r = 82.9 \text{ pulg}^2$

$W_0 = 250 \text{ lb/ft}$

$$P_i = A_c f_{cci}$$
$$= 240 (1033,14)$$
$$= 247,95 \text{ K}$$

$$f_{cci} = f_{ti} - \tfrac{1}{2}(f_{ti} - f_{ci}) = 183,71 - \tfrac{1}{2}(183,71 + 2250)$$

$$= -1033,14 \text{ lb/pulg}^2$$

$$e = (f_{ti} - f_{cci})\frac{S_i}{P_i} + \frac{M_0}{P_i}$$

$$= (183,71 + 1033,14)\left(\frac{1422}{247950}\right) + \frac{50(12000)}{247950}$$

$$= 9,39 \text{ pulg}$$

$$f_{pi} = 0,82\,(0,9)(270) = 199 \text{ KSI}$$

$$A_p = \frac{P_i}{f_{pi}} = \frac{247,95}{199} = 1,24 \text{ pulg}^2 \qquad \frac{1,24}{0,153} = 8,14$$

"USAR DOS PAQUETES DE 5 TORONES DE ½ pulg"

PROBLEMA 3

≡ DATOS

$L_x = 15$ ft

$f_{pe} = 160\,000$ PSI

$f'_c = 5000$ PSI

$f_{pu} = 270$ KSI

PESO VIGA $= 910$ lb/pie

$L = 62$ ft

$W_L = 2000$ lb/ft

$W_D = 550$ lb/ft

$I = 433\,350$ pulg^4

$Y_t = 25$ pulg

$$M_d = 31(0,55)(15) - 15(0,55)\left(\frac{15}{2}\right) = 193,875 \text{ K·ft}$$

$$f_d = \frac{Y_t (M_d)}{I} = \frac{25(193\,875)(12)}{433\,350} = 134,22 \text{ lb/pulg}^2$$

$$M_{CR} = \frac{I}{Y_t}\left(6\lambda\sqrt{f'_c} + f_{pe} - f_d\right)$$

$$= \frac{433\,350}{25(12)}\left(6(1)(\sqrt{5000})(1600 - 134,22)\right)$$

$$= 2\,730\,168,66 \text{ lb·ft}$$

W_U SIN CONTAR EL PESO DE LA VIGA $= 1,2(0,55) + 1,6(2) = 3,86$ K·ft

$$M_{MAX} = 31(3,86)(15) - \frac{3,86(15)^2}{2} = 1360,65 \text{ K·ft}$$

$V_L = 31(3,81) - 15(3,81) = 60,96$ Kip

$$V_d = 31(0,55) - (15)(0,55) = 8,8 \text{ Kip}$$

$$d = 63 - 3 - 3 = 57 \text{ pulg}$$

$$V_{ci} = 0,6\,\lambda\sqrt{f'_c}\,b_w\,d_p + V_d + \frac{V_i\,M_{CR}}{M_{MAX}}$$

$$= 0,6(1)\sqrt{5000}\,(18)(57) + 8\,800 + \frac{(60\,960)(2730\,160)}{1\,360\,650}$$

$$= 174\,647 \text{ lb}$$

$$f_{pe} = \frac{270\,000}{8,76} = 308 \text{ lb/pulg}^2$$

$$V_p = \frac{32}{\sqrt{32^2 + 372^2}}\,(270\,000) = 23\,140 \text{ lb}$$

$$V_{cw} = (3,5\,\lambda\sqrt{f'_c} + 0,3\,f_{pc})\,b_w\,d + V_p$$

$$= (3,5(1)\sqrt{5000} + 0,3(308))(18)(57) + 23140$$

$$= 371\,864 \text{ lb}$$

≡ USAR EL MENOR DE V_{ci} o V_{cw} ⟶ $V_c = 174\,647$ lb

$$\phi V_c = \frac{0,75\,(174\,647)}{1000} = 130,98 \text{ Kip}$$

$$V_u = 60,96 \text{ K}$$

$$V_u > \frac{\phi V_c}{2} < \phi V_c$$

$$60,96 < 65,49 < 130,98 \rightsquigarrow \text{"OK"}$$

$$A_v = \frac{A_{ps}}{80} \left(\frac{f_{pu}}{f_{yt}}\right) \left(\frac{s}{d}\right) \sqrt{\frac{d}{b_w}}$$

$$2(0,11) = \frac{(20)(0,153)}{80} \left(\frac{270}{40}\right) \left(\frac{s}{57}\right) \sqrt{\frac{57}{18}}$$

$$0,122 = 0,00806\, s$$

$$s = 27,29 \text{ pulg}$$

$$s_{MAX} = \frac{3}{4}(63) = 47 \text{ pulg}$$

" USAR $s = 27$ pulg "