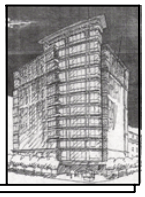
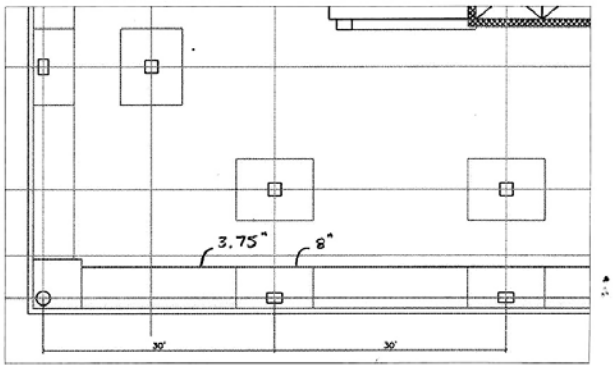
APPENDIX A

Post Tension
Hand Checks



Material

Normal wt 150 pcf
f'_c = 4000 psi
f'_{ci} = 3000 psi
f_y = 60 ksi
f_{pu} = 270 ksi
f_{se} = 174 ksi
f_{eff} = 26.6 k/tendon



Loading

LL_o = 100 psf A_T = 255 ft² ∴ no LL reduction

Super DL = 20 psf

Self wt = $(6/12)(150) + \frac{(4.5' \times 4.5')(\frac{8}{12})(150)}{255\ ft^2} + \frac{(20.5' \times 4')(\frac{3.75}{12})(150)}{255\ ft^2} + \frac{(4 \times 10')(\frac{8}{12})(150)}{255}$

= 113.7 psf

Slab Section Properties

A = 792 in²

$S = \frac{(8.5 \times 12)(6^2)}{6} + \frac{(4 \times 12)(3.75^2)}{6} = 724.5\ in^3$

Parameters

At Jacking

f'_{ci} = 3000 psi

comp = .6 f'_{ci} = 1800 psi

Tension = $3\sqrt{f'_{ci}}$ = 164 psi

At service Loads

f'_c = 4000 psi

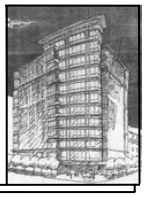
comp = .45 f'_c = 1800 psi

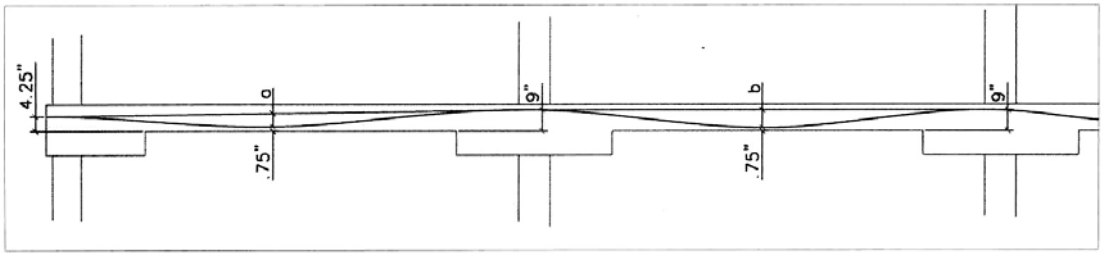
tension = $6\sqrt{f'_c}$ = 380 psi

Ave Precomp

P/A = 125 psi min

1/4





$a = \left(\frac{4.25+9}{2}\right) - .75 = 5.875"$

$b = 9 - .75 = 8.25"$

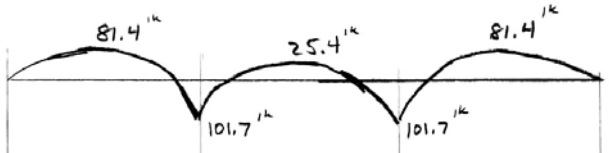
$P = (9\ \text{tendon})(26.6^k) = 239^k$

$P/A = \frac{239(1000)}{792\ in^2} = 302\ psi > 125$ ok

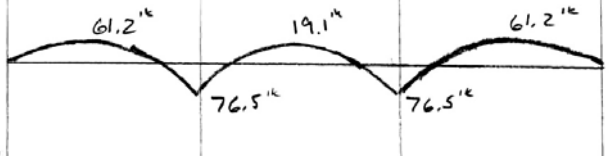
$w_b = \frac{(239^k)(8)(5.87/12")}{30^2} = 1.04\ klf$

$= \frac{239(8)(8.25/12")}{30^2} = 1.46\ klf$

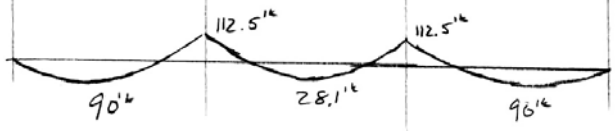
$w_{DL} = 1.13\ klf$



$w_{LL} = .85\ klf$



$w_{bal} = 1.25\ klf$



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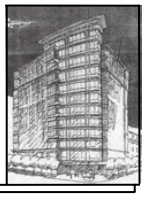


After Jacking

Interior span

midspan stress

$f_{Top} = \frac{(+25.4 + 28.1)(12)(1000)}{724\ in^3} - 302\ psi = -346\ psi < -1800\ psi$ ok

$f_{bot} = \frac{(-25.4 + 28.1)(12)(1000)}{724\ in^3} - 302\ psi = -257\ psi < -1800\ psi$ ok

end stress

$f_{Top} = \frac{(112.5 - 101.7)(12)(1000)}{724} - 302 = -123\ psi < -1800\ psi$ ok

$f_{bot} = \frac{(-112.5 + 101.7)(12)(1000)}{724} - 302 = -481\ psi < 1800\ psi$ ok

Exterior spans

midspan stress

$f_{top} = \frac{(81.4 - 90)(12)(1000)}{724} - 302 = -444\ psi < 1800\ psi$ ok

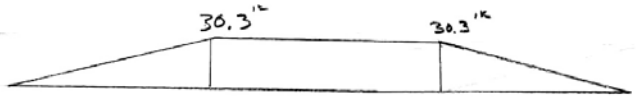
$f_{bot} = \frac{(-81.4 + 90)(12)(1000)}{724} - 302 = -159.4\ psi < 1800\ psi$ ok

Ultimate Strength

$M_1 = P \cdot e$

$= 239 \cdot (9 - 4.875)/12" = 82.1^{'k}$

$M_{sec} = M_{bal} - M_1 = 112.5 - 82.1 = 30.3^{'k}$



at midspan

$M_u = 1.2(81.4) + 1.6(61.2) + 1.0\left(\frac{30.3}{2}\right) = 210.7^{'k}$

at support

$M_u = 1.2(-101.7) + 1.6(-76.5) + 1.0(30.3) = -214.1^{'k}$

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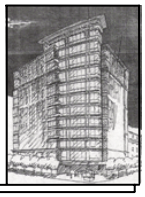


Reinforcement

Bottom & Top bar

			ft-k	ft	ft-k/ft	#4	check?
mid	210.7	CS .60	126.4	4'	31.6	95.6	good
		MS .40	84.3	4.5'	18.7	55.1	good
support	214.1	CS .75	160.6	4'	40.15	95.6	good
		MS .25	53.5	4.5'	11.8	55.1	good

#4 @ 12"

C.S

$A_s = .2\ in^2/ft$

$d = 9"$

$a = \frac{.20(60)}{.85(4)(12)} = .29\ in$

$\phi M_n = \phi(.2)(60)(9.0 - \frac{.29}{2})$

$\phi M = 95.6^{k}$

M.S

$A_s = .2\ in^2/ft$

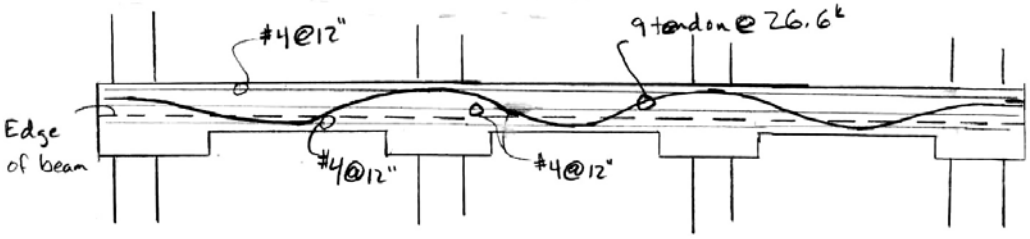
$d = 5.25$

$a = \frac{.20(60)}{.85(4)(12)} = .29\ in$

$\phi M_n = \phi(.2)(60)(5.25 - \frac{.29}{2})$

$\phi M_n = 55.1^{k}$

USE #4@12" o.c
+ 9 tendons PT



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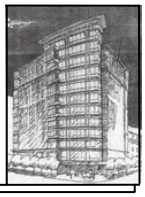
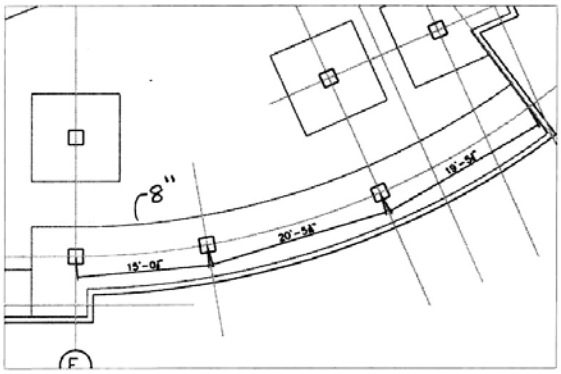


Assuming curve to act as a straight system



Materials

Normal wt 150 pcf
f'_c = 4000psi
f'_{ci} = 3000psi
f_y = 60ksi
f_{pu} = 270 ksi
P_{eff} = 26.6 k/ten

Loading

LL_o = 100psf A_T = 235.7 ft (for largest bay ∴ no LL Reduction)
Sup DL = 20psf Ave width = 11.5'
Self wt = $(6/12)(150) + \frac{(7\times55)(\frac{8}{12})(150)}{632.5\ ft^2}$ = 135.8 psf

Slab Properties

$A = 1500\ in^2$
$S = \frac{(11.5\times12)(6)^2}{6} + \frac{(7\times12)(8)^2}{6} = 1724\ in^3$

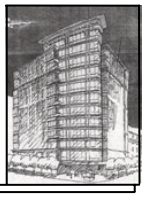
Parameters

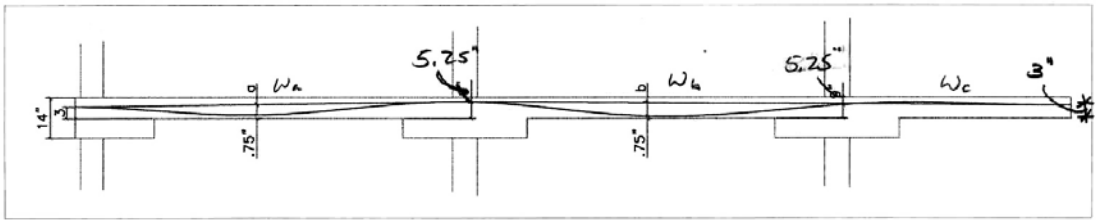
At jacking
f'_{ci} = 3000psi
comp = .6 f'_{ci} = 1800 psi
Tension = $3\sqrt{f'_{ci}}$ = 164psi

At service loads
f'_c = 4000psi
comp = .45f'_c = 1800 psi
tension = $6\sqrt{f'_c}$ = 380 psi

Ave Precomp
P/A = 125 psi min

1/4





$a = \frac{(5.25+3)}{2} - .75 = 3.37"$

$b = 4.5"$

$P = (9\text{ tendons})(26.6) = 239^k$

$P/A = \frac{239(1000)}{1500 in^2} = 159.3 psi > 125$ ok

$w_a = \frac{(239)(8)(3.37"/12)}{15^2} = 2.39$ klf

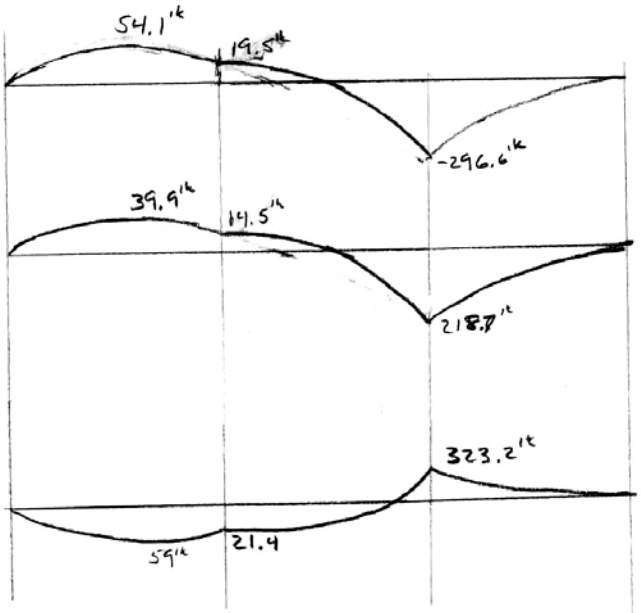
$w_b = 1.7$ klf

$w_c = .94$ klf

$w_{DL} = 1.56$ klf

$w_{LL} = 1.15$

$w_b = 1.7$ klf



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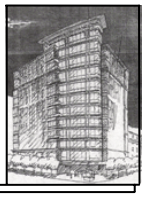


After jacking

"15' foot" span

midspan stress

$f_{top} = \frac{(54.1-59)(12)(1000)}{1724 in^3} - 159.3 psi = -193.1 psi < 1800 psi$ ok

$f_{bot} = \frac{(-54.1+59)(12)(1000)}{1724} - 159.3 = -125.2 psi < 1800 psi$ ok

support

$f_{top} = \frac{(19.5-21.4)(12)(1000)}{1724} - 159.3 = -172.5 psi < 1800 psi$ ok

$f_{bot} = +13.2 - 159.3 = -146.1 psi < 1800 psi$ ok

"20.5'/19.5'" span

support

$f_{top} = \frac{(-296.6+323.2^{1k})(12)(1000)}{1724} - 159.3 = +25.8 psi < 164 psi$ tension ok

$f_{bot} = -25.8 - 159.3 = -185.1 psi < 1800 psi$ ok

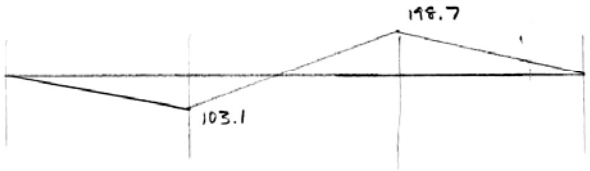
Ultimate Strength

$M_1 = P \cdot e$

$= 239(6.25)/12 = 124.5^{1k}$

$M_{sec} = M_{bal} - M_1 = -103.1^{1k}$

$= +198.7^{1k}$



"15' foot"

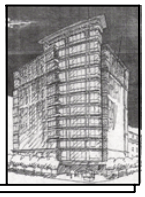
Mid $M_u = 1.2(54.1^{1k}) + 1.6(39.9^{1k}) + 1.0(\frac{103.1}{2}) = 77.2^{1k}$

Sup $M_u = 1.2(19.5) + 1.6(14.5) + 1.0(-103.1) = -56.5^{1k}$

"20.5/19.5"

Sup $M_u = 1.2(-296.6) + 1.6(-218.7) + 1.0(198.7) = -507.14$

3/4



Reinforcement

			ft-k	ft	ft-k/ft	# 4	check	
77.2	cs	.60	46.3	7'	6.6	11.8	ok	
	ms	.40	30.8	4.5'	6.8	4.6	2.2	ft-k/ft ①
-56.6	cs	.75	-42.4	7'	-6.0	-11.8	ok	
	ms	.25	-14.1	4.5'	-3.1	-4.6	ok	
-507.1	cs	.75	-380.3	7'	-54.3	-11.8	42.5	ft-k/ft ②
	ms	.25	-126.8	4.5'	-28.17	-4.6	24.1	ft-k/ft ③

#4@12" o.c.

C.S

$A_s = .20\ in^2/ft$

$d = 13.25$

$a = \frac{.20(60)}{.85(4)(12)} = .29\ in$

$\phi M_n = \phi(.2)(60)(13.25 - \frac{.29}{2})/12"$

$\phi M_n = 11.8^{k}/ft$

M.S.

$A_s = .2\ in^2/ft$

$d = 5.25$

$a = .29\ in$

$\phi M_n = \phi(.2)(60)(5.25 - \frac{.29}{2})/12"$

$\phi M_n = 4.6^{k}/ft$

① try 1#5

$M_n = (2.2^{k}/ft)(4.5') = 9.9^{k}$

$a = \frac{.31(60)}{.85(4)(4.5\times12)} = .10"$

$\phi M_n = \phi(.31)(60)(5.25 - \frac{.10}{2})/12$

$\phi M_n = 7.25 < 9.9^{k}$ USE 2#5

② try 8#8

$M_n = (42.5)(7') = 297.5^{k}$

$a = \frac{6.28(60)}{.85(4)(7\times12)} = 1.32$

$\phi M_n = \phi(6.28)(60)(13.0 - \frac{1.32}{2})/12$

$\phi M_n = 348.7^{k} > 297.5^{k}$ ok

③ try 8#8

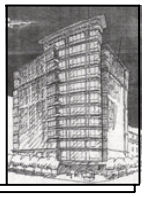
$M_n = (24.1)(4.5) = 108.4^{k}$

$a = \frac{6.28(60)}{.85(4)(4.5\times12)} = 2.05$

$\phi M_n = \phi(6.28)(60)(5 - \frac{2.05}{2})/12$

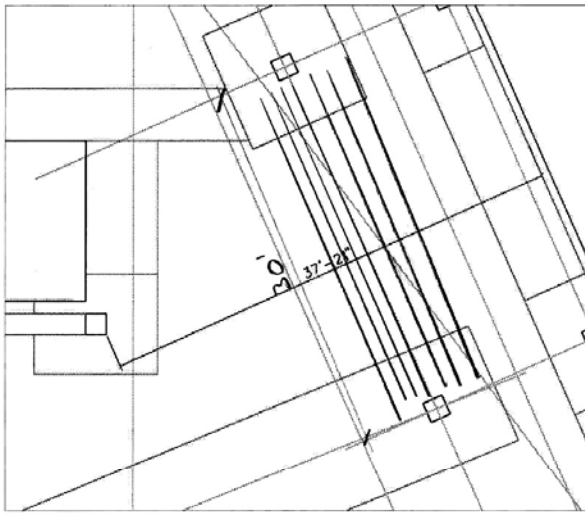
$\phi M_n = 113.0^{k} > 108.4^{k}$ ok

4/4



Materials

Normal wt conc 150pcf
f'_c = 4000psi
f'_{ci} = 3000psi
f_y = 60ksi
f_{pu} = 270 ksi
Peff = 26.6 k/ten



Loading

LL_o = 100psf
A_T = 2341 ft²

$$LL = LL_o\left(.25 + \frac{15}{\sqrt{A_T}}\right)$$

$$= 100\left(.25 + \frac{15}{\sqrt{2341}}\right) = 56.0 \text{ psf}$$

Sup Dead = 20psf

Slab Properties

A = 1260 ft²
S = 1260 ft²

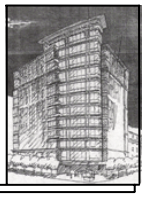
Parameters

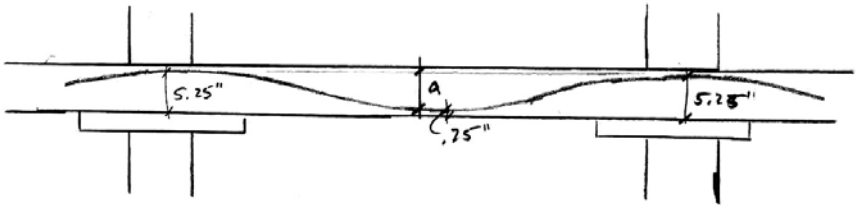
At jacking
f'_{ci} = 3000psi
comp = .6 f'_{ci} = 1800psi
tensin = $3\sqrt{f'_{ci}}$ = 164psi

At service loads
f'_c = 4000psi
comp = .45 f'_c = 1800psi
tensin = $6\sqrt{f'_c}$ = 380psi

Ave Precomp
P/A = 125 psi min

1/4





$a = 5.25" - .75 = 4.5"$

$P = (16 \text{ tendons})(26.6) = 425.6 \text{ k}$

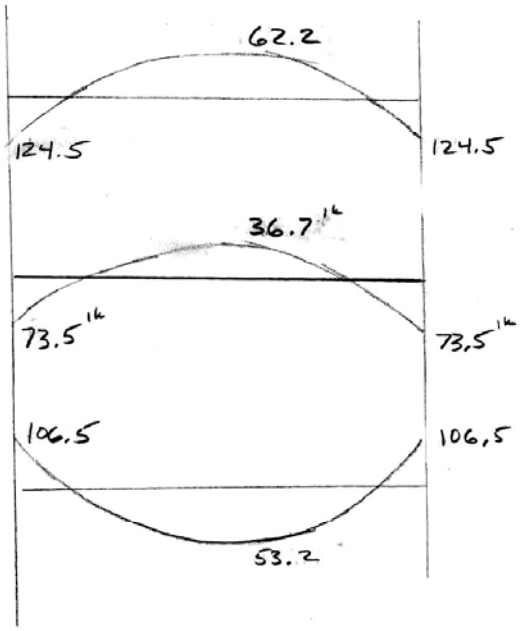
$P/A = \frac{425.6^{k}(1000)}{1260 \text{ in}^2} = 337.8 \text{ psi} > 125 \text{ psi}$ ok

$w_a = \frac{(425.6)(8)(4.5"/12)}{30^2} = 1.42 \text{ klf}$

$w_{DL} = 1.66 \text{ klf}$

$w_{LL} = .98 \text{ klf}$

$w_b = 1.42 \text{ klf}$



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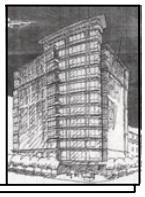


After Jacking

mid span stress

$$f_{top} = \frac{(62.2 - 53.2)(12)(1000)}{1260} - 337.8 \text{ psi} = -252.1 < 164 \text{ psi ok}$$

$$f_{bot} = \frac{(-62.2 + 53.2)(12)(1000)}{1260} - 337.8 = -423.5 > -1800 \text{ psi ok}$$

Support

$$f_{top} = \frac{(-124.5 + 106.5)(12)(1000)}{1260} - 337.8 = -509.2 > -1800 \text{ psi ok}$$

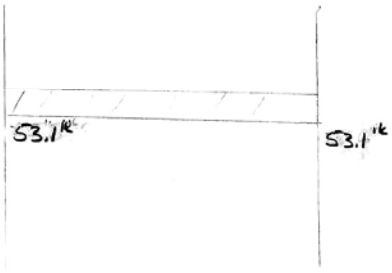
$$f_{bot} = \frac{(124.5 - 106.5)(12)(1000)}{1260} - 337.8 = -166.4 < 164 \text{ psi ok}$$

Ultimate

$M_1 = P \cdot e$

$= 425.6^k (4.5') / 12 = 159.6^{'k}$

$M_{sec} = M_{bal} - M_1 = 106.5 - 159.6 = 53.1^{'k}$



Mid

$M_u = 1.2(62.2) + 1.6(36.7) - 1.0(53.1)$

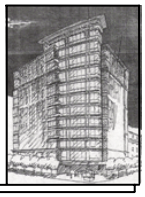
$= 86.26^{'k}$

Support

$M_u = 1.2(-124.5) + 1.6(-73.5) + 1.0(106.5)$

$= 160.5^{'k}$

3/4



Reinforcement

		ft-k	ft	ft²/ft	#4	check	
80.2C	CS .60	48.2	8.7	5.54	11.8	ok	
	ms .40	32.1	8.7	3.69	4.6	ok	
-160.5	CS .75	120.4	8.7	13.84	11.8	2.04	①
	ms .25	40.1	8.7	4.61	4.6	ok	

#4 @ 12" o.c.

C.S.

$A_s = .20 in^2/ft$ $\quad a = \frac{.20(60)}{.85(4)(12)} = .29"$ $\quad \phi M_n = \phi(.2)(60)(13.25 - \frac{.29}{2})/12$

$d = 13.25"$ $\quad = 11.8^{k}/ft$

M.S

$A_s = .20 in^2/ft$ $\quad a = .29"$ $\quad \phi M_n = \phi(.2)(60)(5.25 - \frac{.29}{2})/12$

$d = 5.25"$ $\quad = 4.6^{k}/ft$

① $M_u = 2.04(8.7) = 17.7^{k}$

try 1#6

$a = \frac{.44(60)}{.85(4)(8.7 \times 12)} = .07"$ $\quad \phi M_n = \phi(.44)(60)(5.25 - \frac{.07}{2})/12$

$= 10.3^{k}$ ~~no good~~

USE 2#6