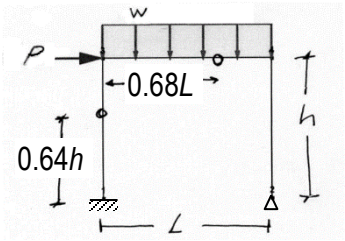
ARCH 631. Exam 2 Practice

Disclaimer: Answers have NOT been painstakingly researched.

Problems:

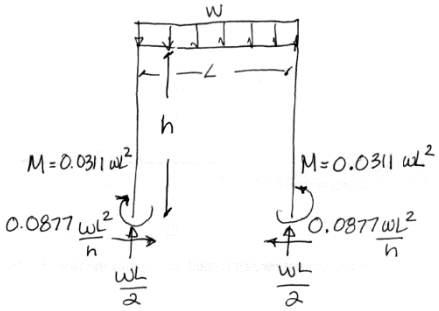
4.1 Using an approximate method of analysis which results in the following reactions, analyze the single-bay frame which carries a horizontal load of 4000 lb acting at the upper-left joint and a distributed load across the beam of 200 lb/ft . Assume that h = 15 ft and L = 18 ft. Draw shear and moment diagrams Indicate numerical values. The reactions are:

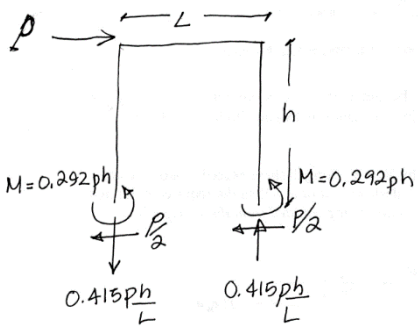


R_{Lx} = -2842 lb, R_{Ly} = -17 lb, M_{RL}= 27,297 lb-ft,
R_{Rx} = -1158 lb, R_{Ry} = -3617 lb

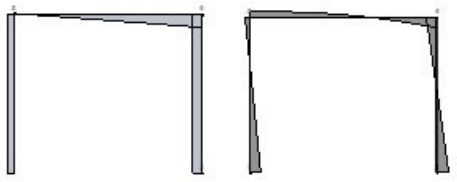
Answer:
M_{max} = -27,297 lb-ft and V_{max} = 3617 lb.

4.3 For the frame of problem 4.1, replace the pin support with a fixed support and use an approximate method of analysis to draw the shear and moment diagrams (from the formulas provided). Indicate numerical values.
Describe how the change in support condition affects the shear values and moment distribution.





Answer: (R_{Lx} = -1921 lb, R_{Ly} = 417 lb, M_{RL}= 15,505 lb-ft,
R_{Rx} = -2379 lb, R_{Ry} = 3183 lb, M_{RR}= 19,535 lb-ft)
M_{max} = 19,535 lb-ft and V_{max} = -3183 lb.



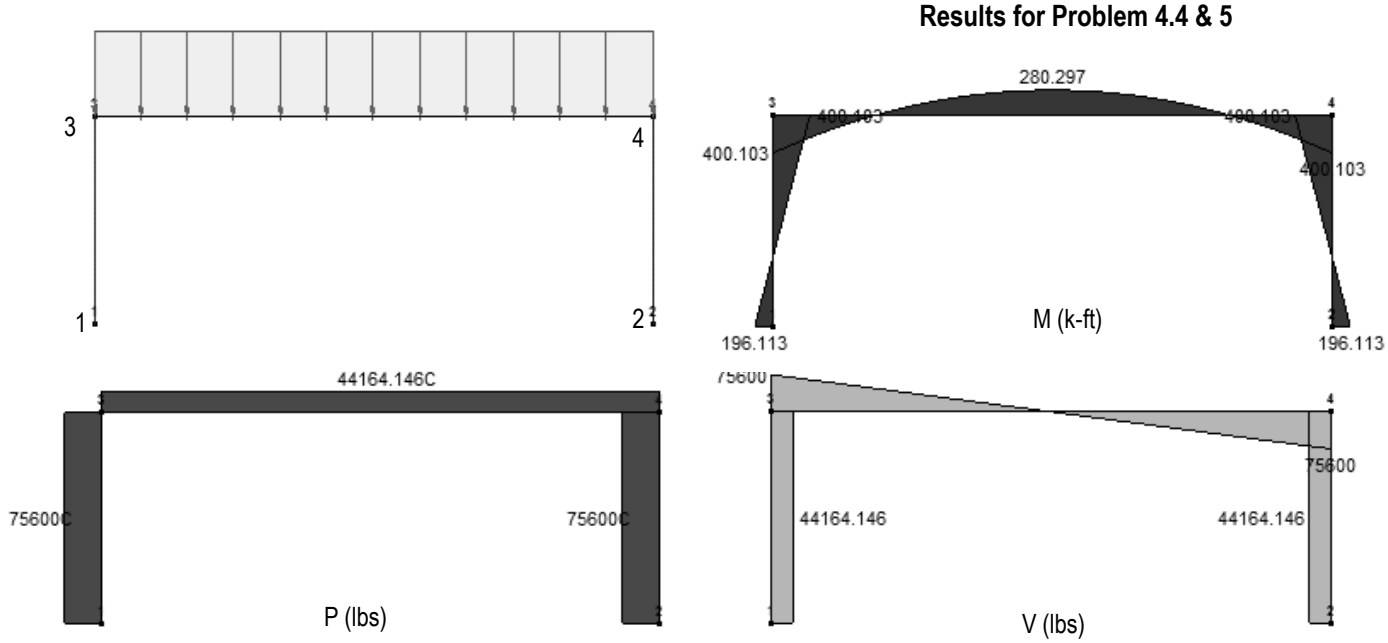
4.4 & 5 A fully fixed single-bay frame has a span of 36 ft and a height of 13.5 ft and carries a uniform loading of 4.2 k/ft on the beam. The moment of inertia of the beams is roughly $^2/_3$ of the moment of inertia of the column. The results provided are below and the diagrams are on the following page:

Member Actions

Member	Load Case	Px' lbf	Vy' lbf	Vz' lbf	Tx' kip-ft	My' kip-ft	Mz' kip-ft
1	Load Case 1	75600.000	-44164.147	0.000	0.000	0.000	-196.113
(Column)		-75600.000	44164.147	0.000	0.000	0.000	-400.103
2	Load Case 1	75600.000	44164.147	0.000	0.000	0.000	196.113
(Column)		-75600.000	-44164.147	0.000	0.000	0.000	400.103
3	Load Case 1	44164.147	75600.000	0.000	0.000	0.000	400.103
(X Primar		-44164.147	75600.000	0.000	0.000	0.000	-400.103

Section Properties (**American section library**):

sections	A (in^2)	I_x (in^4)	S_x top & bottom (in^3)
Columns: W 18 x 86	25.3	1530	166
Beam: W 12 x 120	35.2	1070	163



Calculate the maximum stress at the ends of both columns from combined bending (M/S) and compression stresses (P/A).

Answer: both columns: $f_{max\text{-}top}$ = 31.9 ksi, $f_{max\text{-}bottom}$ = 17.1 ksi

5.1 Using the *design aids in Note Set 8.1*, determine the design moments for a two-span beam that is continuous over three supports. (The ends are not integral with the column supports and the column to beam stiffness is less than 8 in all spans.) Determine the critical design positive and negative moments for each span. Assume that the structure carries a uniformly distributed load of 475 lb/ft and that each span is 24 ft.

Answer: $M_{+\ end\ spans}$ = 24,873 lb-ft, $M\text{-}_{at\ interior\ support}$ = 30,400 lb-ft, $M\text{-}_{at\ exterior\ supports}$ = 0 lb-ft

5.2 For the two span beam of Problem 5.1 determine the critical design shear force.

Answer: $V_{max\ at\ interior}$ = 6,555 lb

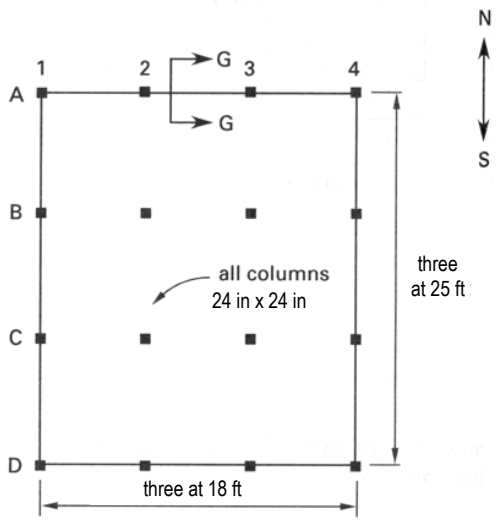
5.3 What are the maximum positive moments present in a square plate that is simply supported on all four sides that carries a uniformly distributed load of 100 lb/ft^2? Assume the plate is 8 inches thick and measures 24 ft by 24 ft. Assume also that the unit weight of light-weight reinforced concrete is 115 lb/ft^3. (See Note Set 8.4 for bending moments in rectangular plates)

Answer: 4,875 lb-ft/ft

5.4 A 45 × 45-ft homogeneous plate carries a live-plus-dead load of 125 lb/ft^2. Consequently, the plate has a bending moment of $m = 0.11wa^2 = 0.11(125)(45 \times 45) = 28{,}000$ lb-ft/ft at midspan. A bar system with a depth of 2.5 ft has members spaced 5 ft on center, has a similar self weight, and carries the same uniformly distributed loading. What is the *approximate* force present in a typical upper or lower chord bar member at midspan?

Answer: T = C = 56,000 lb

5.5 A 18 x 25-ft two way interior bay flat plate supports a live loading of 50 lb/ft^2 and has a dead load of 110 lb/ft^2. All columns are 24 in. square (*reducing the longer side clear span, but not the strip widths).* Determine **all** the design moments for the N-S direction. Use an ultimate strength design approach (combined loads) *based on ASCE-7 (Note Set 3.2) using design aids of Note Set 8.1. An interior bay will have no "end spans".*



Answer: w_u = 212 lb/ft^2, M_o = 252.3 k-ft, column strip:
$m+$ = 5.9 k-ft/ft & $m-$ = 13.7 k-ft/ft , middle strip:
$m+$ = 3.9k-ft/ft & $m-$= 4.5k-ft/ft

5.6 For the two-way system of Problem 5, estimate the plate thickness based on the longest clear span *using the values of Note Set 8.1.*

Answer: t = 9.2 in.

5.7 What is the maximum negative bending moment developed in a 15 x 20-ft corner slab fixed on two adjacent sides and free on two sides that carries a load of 40 lb/ft^2? (See Note Set 8.4 for bending moments in rectangular plates)

Answer. m = 5,600 lb-ft/ft

6.1 Determine the ultimate moment capacity, $\phi_f M_n$, of a beam with dimensions b = 16 in., $d_{effective}$ = 21.25 in., and h = 24 in., and that has five No. 9 bars (5.0 in.^{2}) of tension-reinforcing steel. F_y = 40 ksi, and f'_c = 6 ksi.

Answer: $\phi_f M_n$ = 300.4 k-ft

6.2 For the beam of Problem 6.1 which is simply supported and 45 ft long, and where the loads are dead load = 250 lb/ft (not including self weight) and live load = 160 lb/ft, determine if the beam is adequate in bending. γ = 150 lb/ft^3 (normal weight).

Answer: yes (M_u = 262.2 k-ft)

6.3 For the beam of Problem 6.1, check whether the amount of tension steel is within the limits for ductile beam behavior. (*Refer to the table for maximum ρ in Note Set 10.1)*

Answer: yes ($A_{s\text{-}min}$ = 1.98 in.^{2} & $A_{s\text{-max}}$ = 12.2 in.^{2})

6.4 For the beam of Problem 6.1 and 6.2, calculate the shear capacity, $\phi_v V_c$, and determine if the beam will require stirrups. Also, determine the spacing, s, if #3 U stirrups are required of grade 40 steel (f_y = 40 ksi). Assume λ = 1.0 for normal weight concrete.

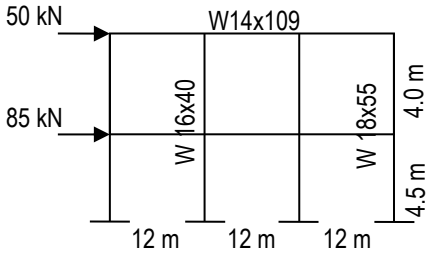
Answer: yes, space at 9.46 in. or less (V_u = 21.5 k at d, $\phi_v V_c$ = 39.5 k, $\frac{\phi_v V_c}{2}$ = 19.75 k,
$s_{req'd}$ = smaller of 11 in. and 9.46 in., s_{max} = 10.625 in.)

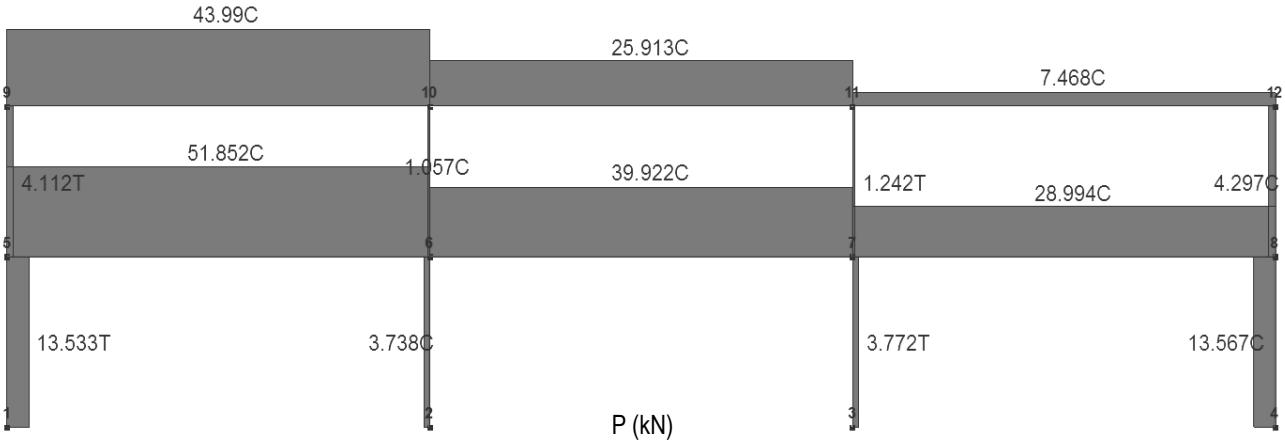
6.5 A reinforced concrete column in a rigid frame has a design compression load of P_u = 435 kips, and a design moment of M_u = 220 k-ft. With the interaction diagram provided on the last page, determine the amount of reinforcement (number and size of bars) required for a 18 in. square column

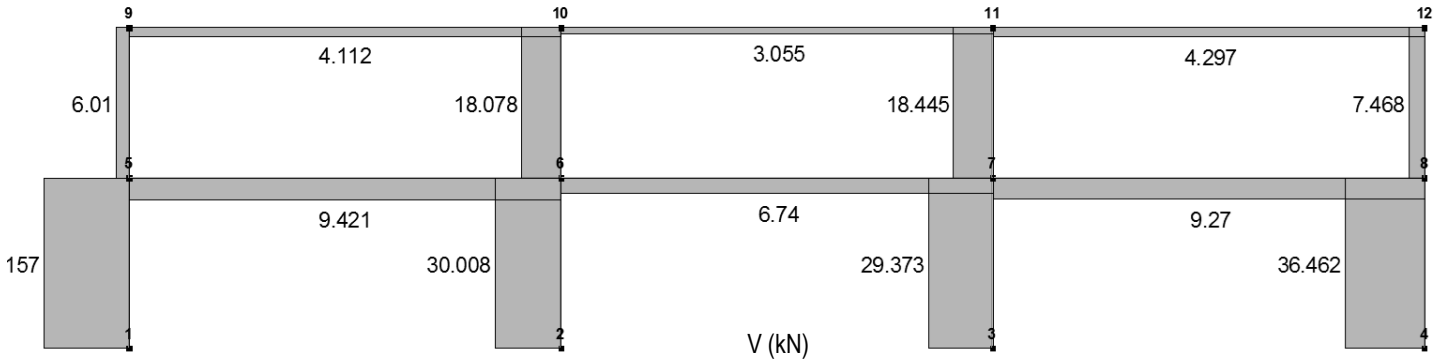
Answer: 4-#11

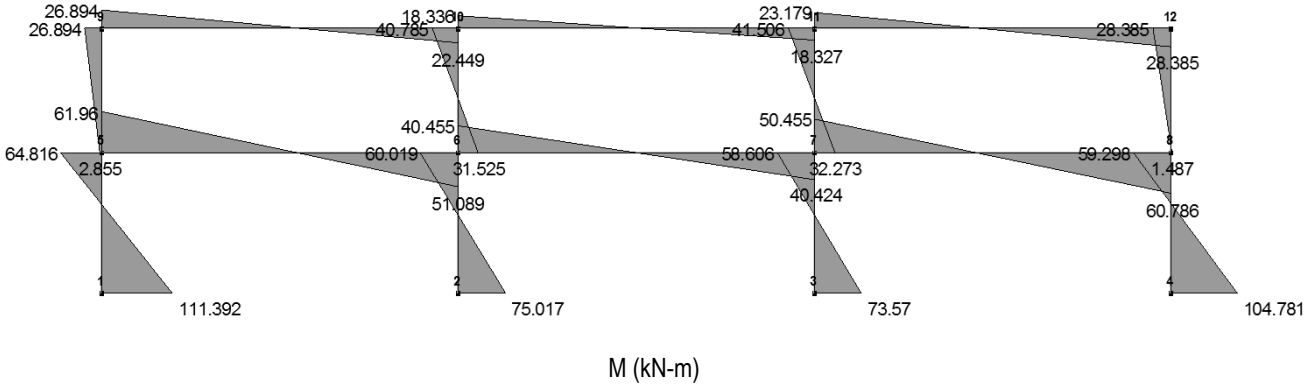
6.6 A two story, three bay portal frame has lateral loads from wind at each story as shown. The exterior columns are W18 x 55's, the interior columns are W 16 x 40's, while all beams are W 14 x 109's. A computer-based structural analysis program was used to determine the shear, bending moment and axial load in each member (V, M & P) as shown. Identify the column and beam with the critical design values.

Answer: The critical column is the left exterior lower. The critical beam is the first story left-most beam.









6.7 Is the ultimate tensile capacity of 5-#7 grade 50 reinforcing bars greater than that of 2-#10 grade 60 bar?

Answer: no (5-#7 $T = 150$ kips, 2-#10 $T = 152.4$ kips)

7.1 A cylindrical balloon has a radius of 2.5 in. and a thickness of 0.03 in. The balloon is blown up with an internal pressure of 75 lb/in.^{2} What are the membrane stresses developed in the surface of the skin of the balloon?

Answer: $T = 187.5$ lb/ft, $f = 6{,}250$ lb/in^2

7.2 A rigid reinforced-concrete shell having a spherical radius of 320 ft is cut off at an angle of $\phi = 25°$. The shell thickness is 5 in. Assume that the unit weight of the shell material is 150 lb/ft^3 and that the shell carries a live load of 40 lb/ft^2. When a tension ring is used in conjunction, what is the magnitude of the force developed in the ring?

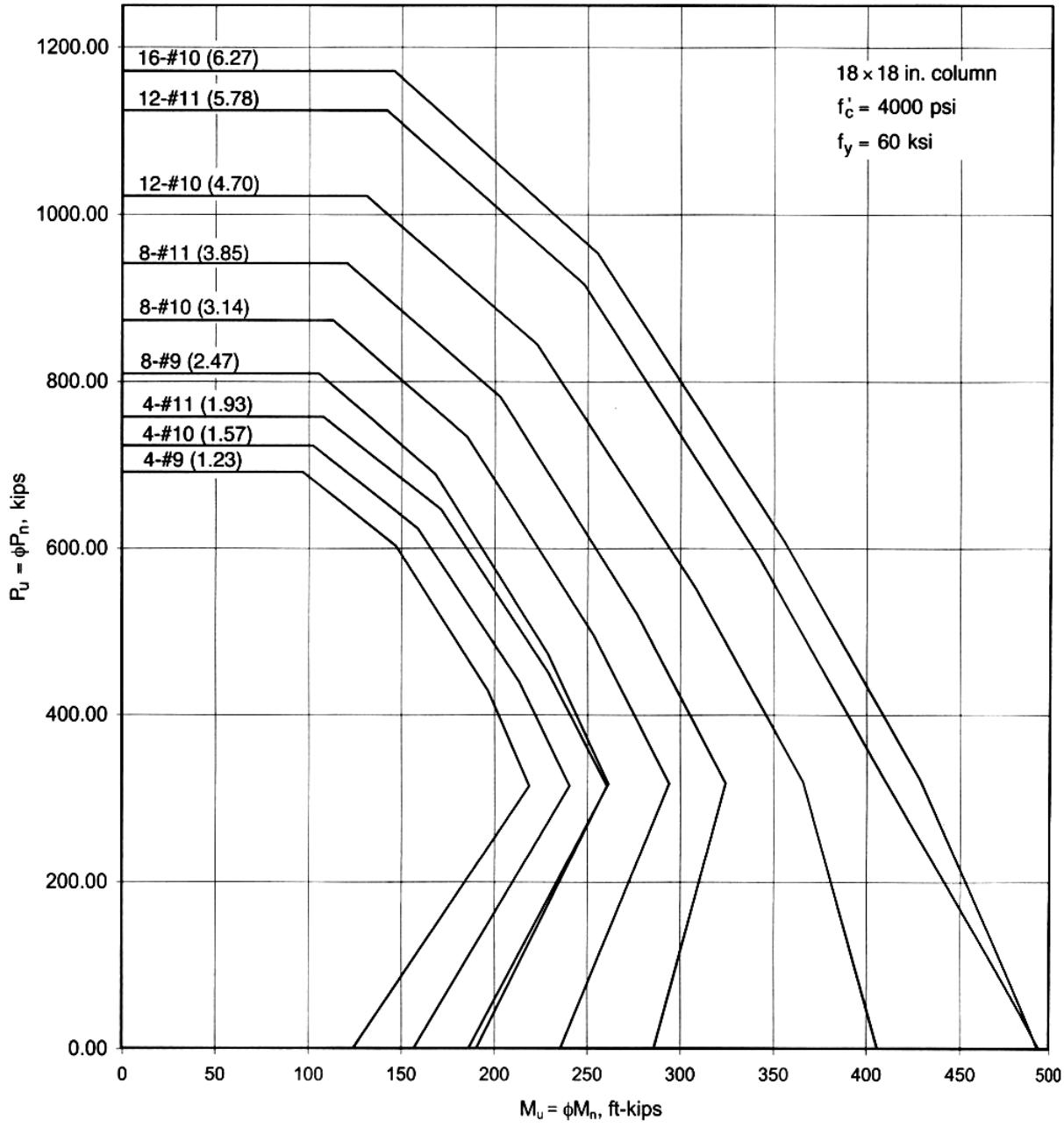
Answer: $T = 2{,}108{,}894$ lb

7.3 For the reinforced concrete shell of problem 7.2, determine the meridional and hoop forces at the base of the shell.

Answer: $N_\phi = 17{,}206$ lb/ft, $N_\theta = 12{,}521$ lb/ft

7.5 Determined the maximum moments (positive and negative) for a beam of 58 ft with a distributed load of 85 lb/ft for *a*) the optimal support location with one overhang and *b*) the optimal support location with two overhangs (*see section 6.4.1*).

Answer: *a)* $M_1 = M_2 = 12{,}295$ lb-ft, *b)* $M_1 = M_2 = 6{,}005$ lb-ft


16-#10 (6.27)
12-#11 (5.78)
12-#10 (4.70)
8-#11 (3.85)
8-#10 (3.14)
8-#9 (2.47)
4-#11 (1.93)
4-#10 (1.57)
4-#9 (1.23)
18 × 18 in. column
f'c = 4000 psi
fy = 60 ksi
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Ru = φPn, kips
0
50
100
150
200
250
300
350
400
450
500
Mu = φMn, ft-kips