Design of Eccentrically Loaded Columns Using INteraction Diagrams

11/8/10

Column Design Using INteraction Diagrams Examples

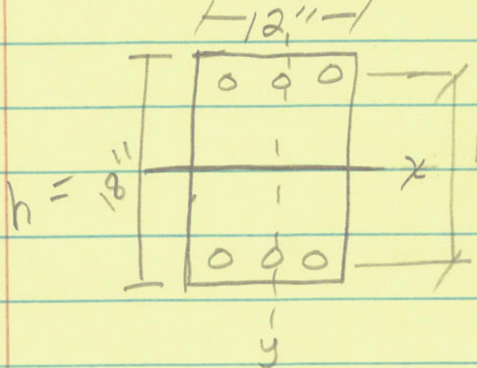
If we prepared them for all combinations there would be too many.

X-axis: $\frac{P_n e}{f'_c A_g h} = R_n$

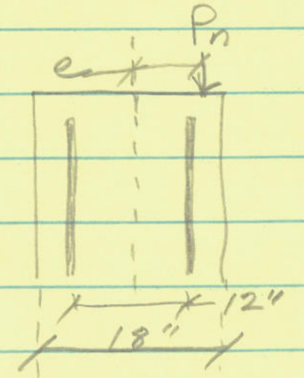
y-axis: $\frac{P_n}{f'_c A_g} = K_N$

Warning: Be sure the picture agrees with the column being consider'd

Example: Use the interaction curves in Appendix A to select reinforceing $f'_c = 4\,ksi$ $f_y = 60\,ksi$



$e_x = 8"$
$P_n = 400^k$



① Structural Analysis (done already)

$P_n = 400^k$

$M_{n_x} = P_n \cdot e_x = (400^k)(8") = 3200$ in-k_x

② Select column cross section

- already done

$\frac{b}{h}$ about bending axis

③ Analyze Column

$\gamma = \text{ratio} = \frac{12''}{18''} = 0.667$

Left side of chart

$K_n = \frac{P_n}{f'_c A_g} = \frac{400^k}{4\,ksi\,(12'' \times 18'')} = 0.463$

Bottom of chart

$R_n = \frac{P_n\, e}{f'_c A_g h} = \frac{(400^k)(8'')}{(4ksi)(12'')(18'')(18'')} = 0.206$

	from chart 0.60	interpolate	from chart 0.70
γ	0.600	0.667	0.70
ρ_g	0.03	0.026	.024

$A_g = \rho_g\, b h \qquad = 0.026(12)(18)$

$A_g = 5.62\ in^2$ use 6 #9 ($A_g = 6.0\ in^2$)

Check fit of bars [7.6.3]

Clear Distance (min. $1.5\, d_b$ or $1\frac{1}{2}''$ [7.6.3]
4/3 max agg. size (3.3.2)

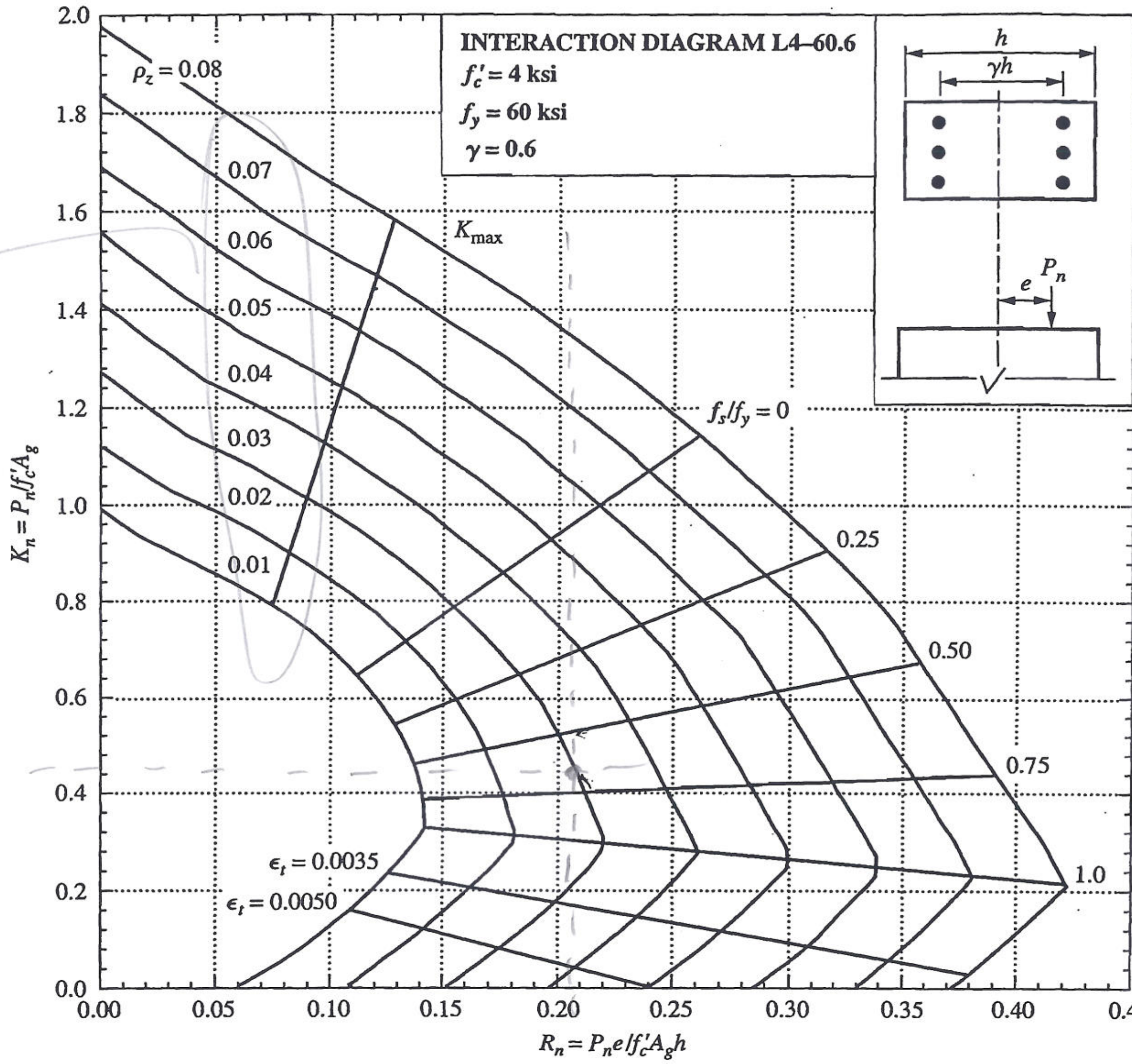
$1.5(1.25) = 1.6875$

$1.5 \longrightarrow 1.5''$

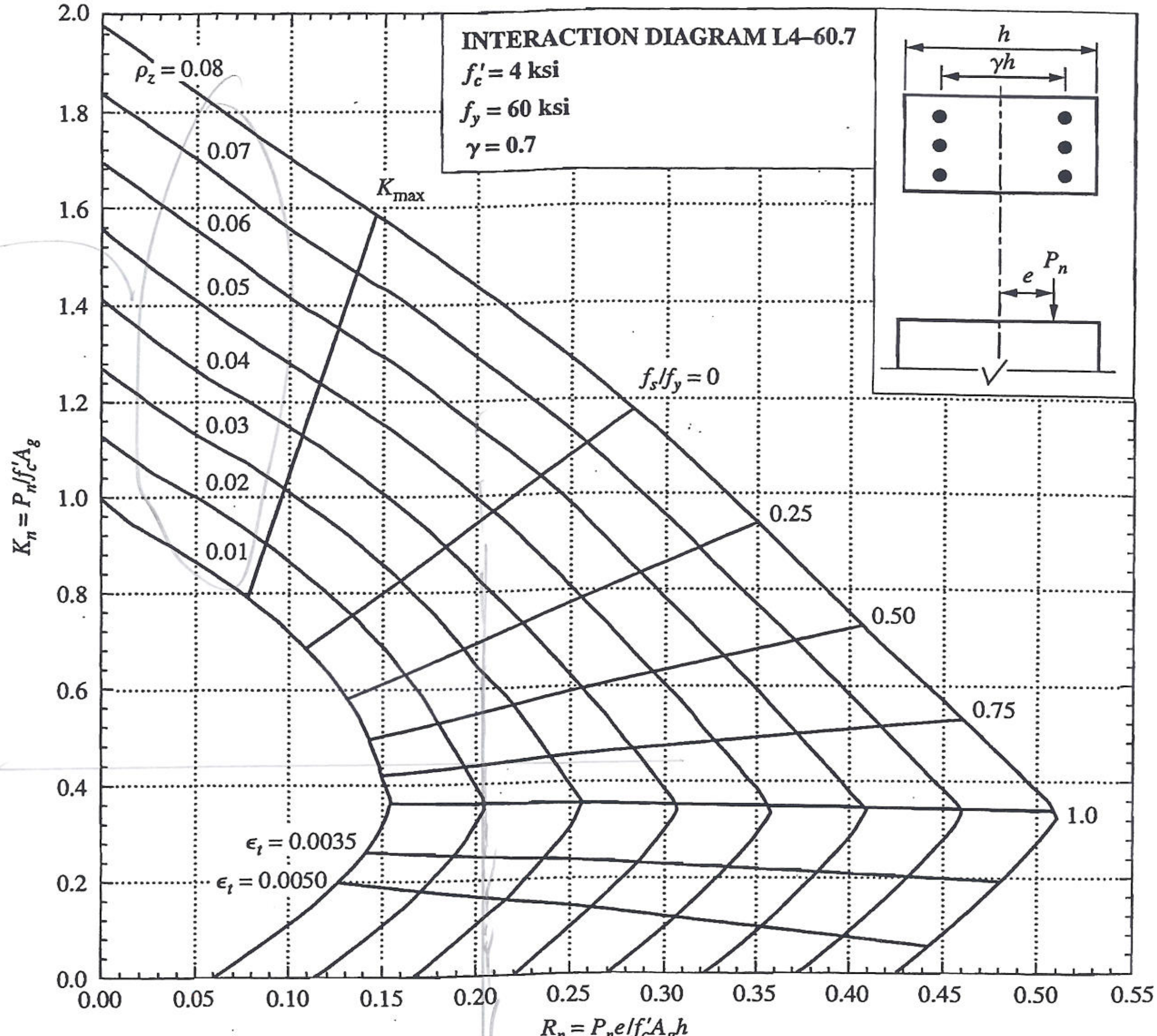
$4/3(1'') = 1.25$

$b_{req} = \underbrace{3(1.125)}_{\text{bars}} + \underbrace{2(3/8)}_{\text{ties}} + \underbrace{2(1.5)}_{\text{spacing between bars}} + \underbrace{2(1)}_{\text{cover}}$

$= 9.125 < 12''$ ok



Graph 2 Column interaction diagrams for rectangular tied columns with bars on end faces only. (Graphs 2 through 13 are published with the permission of the American Concrete Institute.)



Graph 3 Column interaction diagrams for rectangular tied columns with bars on end faces only.

Ties

#3 bars for #9 longitutinal bars

Tie $S_{max} = \min \begin{cases} 16 d_{bar} = 16(1.125) = 18'' \\ 48\, d_{tie} = 48(3/8'') = 18'' \\ b = 12'' \end{cases}$

$S_{max} = 12''$

Check Shear

$$V_c = 2\underbrace{\left[1 + \frac{N_u}{2000 A_g}\right]}_{*} \sqrt{f'_c}\; b_w\, d \quad [eq\ 11\text{-}4]$$

* Accounts for increased capacity due to aggregate interlock

#5 Detail