Reading Assignment

Read Example 9.11 page 339,
Sect. 9.9. Practical Design Considerations Chapter 9 of text
Chapter 10 of ACI

Design Example

Given

$f_c = 4,000 \quad ksi$

$f_y = 60,000 \quad psi$

$P_u = 450 \quad kip$

$M_u = 385 \quad ft - kip$

$\rho_g = 0.03$

Find required *b*, and *h* (width and height of the cross section).

Solution:

Select a tied column dimension *h*, *h*=20, use 3" cover, thus:

$$\gamma = \frac{h - 2d'}{h} = \frac{20 - 6}{20} = 0.7$$

Use the design aid given in your book on page 792, Figure B.13
Eccentricity will be equal to:

$$e = \frac{M_u}{P_u} = \frac{385 \times 12}{450} = 10.26$$

$$\frac{e}{h} = \frac{10.26}{20} = 0.51$$

with *e/h* = 0.51, from graph given on the next page read:

$$\frac{P_n}{f'_c A_g} = 0.44$$

$$\frac{P_u / \phi}{f'_c A_g} = 0.44$$

Assume $\phi = 0.65$

$$\frac{450/0.65}{4\times A_g}=0.44$$

$$A_g = 393 \quad in^2$$

$$bh = 393 \quad in^2$$

$$b=\frac{393}{20}=19.67 \quad in$$

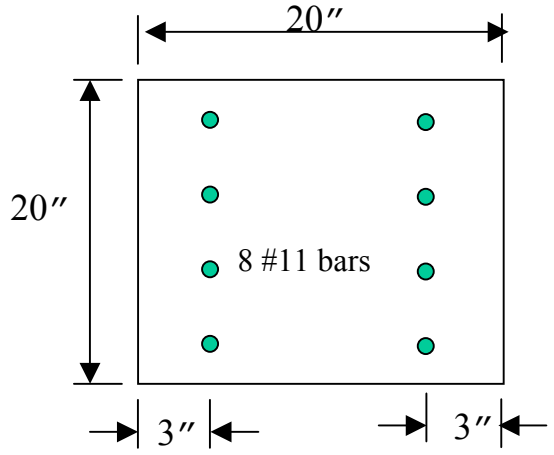
Use a column of 20x20. The area of steel will be:

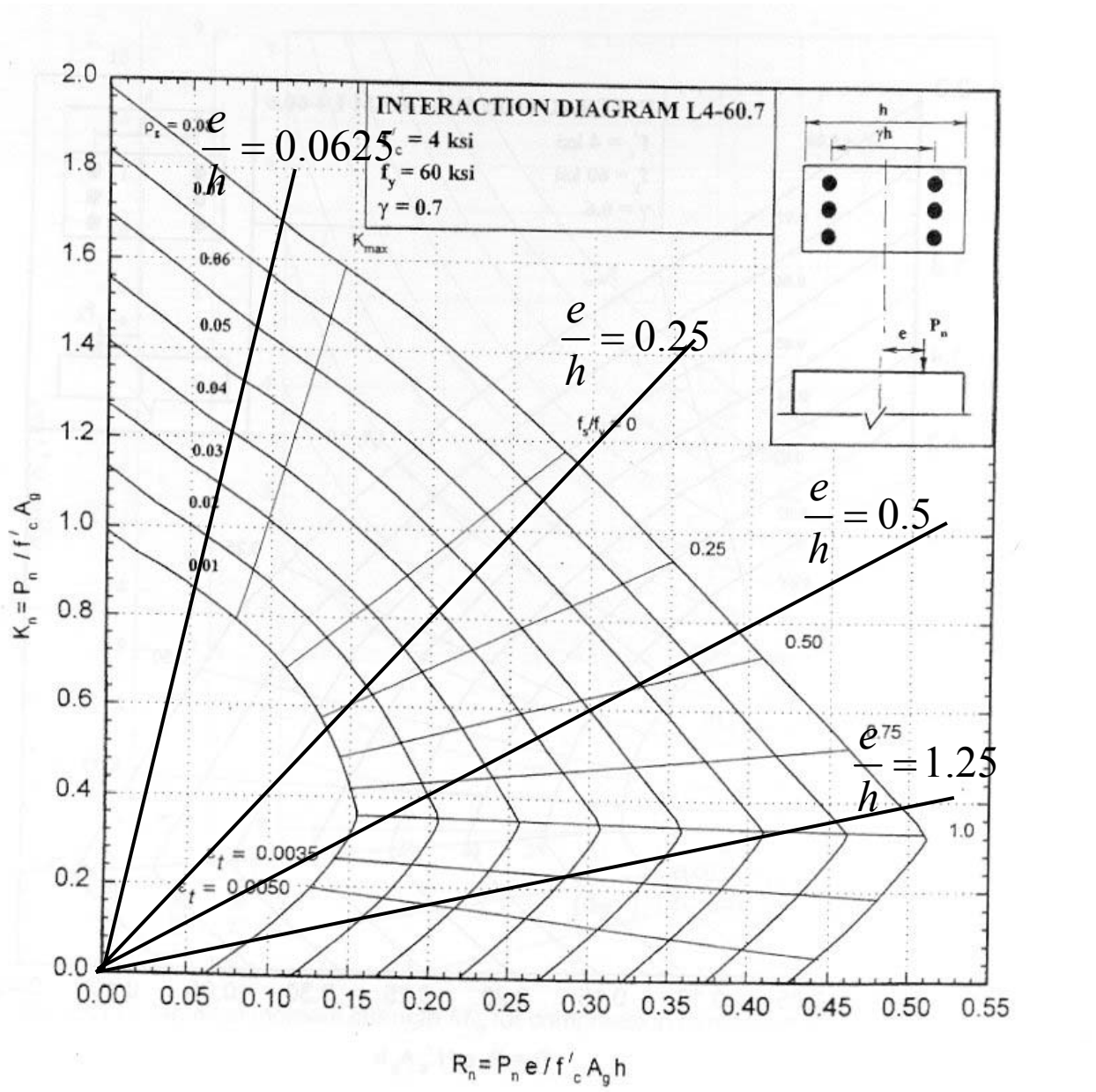
$$A_s = 0.03\times 20\times 20 = 12 \quad in^2$$

Use 8 #11 bars $A_s = 12.5 \quad in^2$

Note.
For design must insure satisfying ACI code provisions:

1. Min cover consideration ACI 7.7.
2. Min bar spacing ACI 7.6.
3 Arrangement of steel to achieve approximate agreement with design aid assumptions.
4. Evaluation of capacity of actual section chosen after all details have been satisfied.




INTERACTION DIAGRAM L4-60.7
f'c = 4 ksi
fy = 60 ksi
γ = 0.7
e/h = 0.0625
e/h = 0.25
e/h = 0.5
e/h = 1.25
0.86
0.05
0.04
0.03
0.02
0.01
0.25
0.50
0.75
1.0
εt = 0.0035
εt = 0.0050
h
γh
e
Pn
Kn = Pn / f'c Ag
Rn = Pn e / f'c Ag h
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55

Design Example Using the Design Aids

Use of graphic design aid for a column with axial load and uniaxial bending.

Consider that we wish to design a rectangular tied column to accept the following service dead and live loads and moments. Architectural considerations limit allowable column width b = 16 in and h = 20 in (tied column). For now neglect length effects and bending about weak axis.

$f_c = 4,000 \quad ksi$
$f_y = 60,000 \quad psi$
$P_D = 184 \quad kip$
$P_L = 213 \quad kip$
$M_D = 107 \quad ft - kip$
$M_L = 124 \quad ft - kip$

Solution
Calculate design loads:

$$P_u = 1.2P_D + 1.6P_L = 1.2(184) + 1.6(213) = 561 \quad kip$$
$$M_u = 1.2M_D + 1.6D_L = 1.2(107) + 1.6(124) = 327 \quad ft - kip$$

Use a cover of 3.0 inches.

The column parameters (assuming bending about the strong axis)

$$\frac{P_u / \phi}{f_c' A_g} = \frac{561/0.65}{4 \times 320} = 0.67$$
$$\frac{eP_u / \phi}{hf_c' A_g} = \frac{M_u / \phi}{hf_c' A_g} = \frac{327 \times 12/0.65}{20 \times 4 \times 320} = 0.24$$

and

$$\gamma = \frac{h - 2d'}{h} = \frac{20 - 6}{20} = 0.7$$

From the design aid (see next page) read:

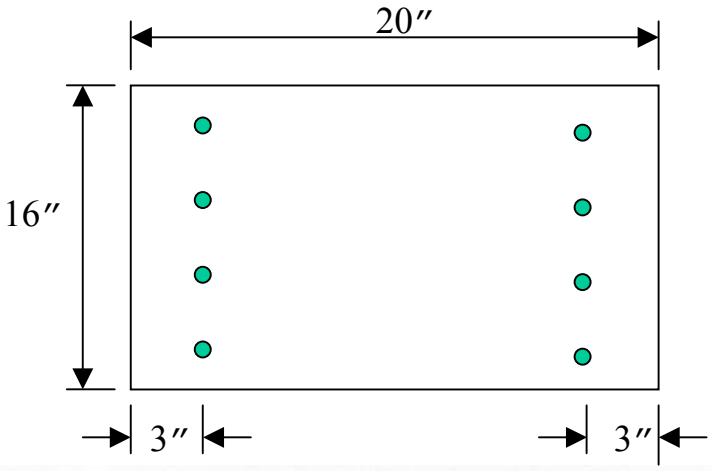
$\rho_g = 0.031$

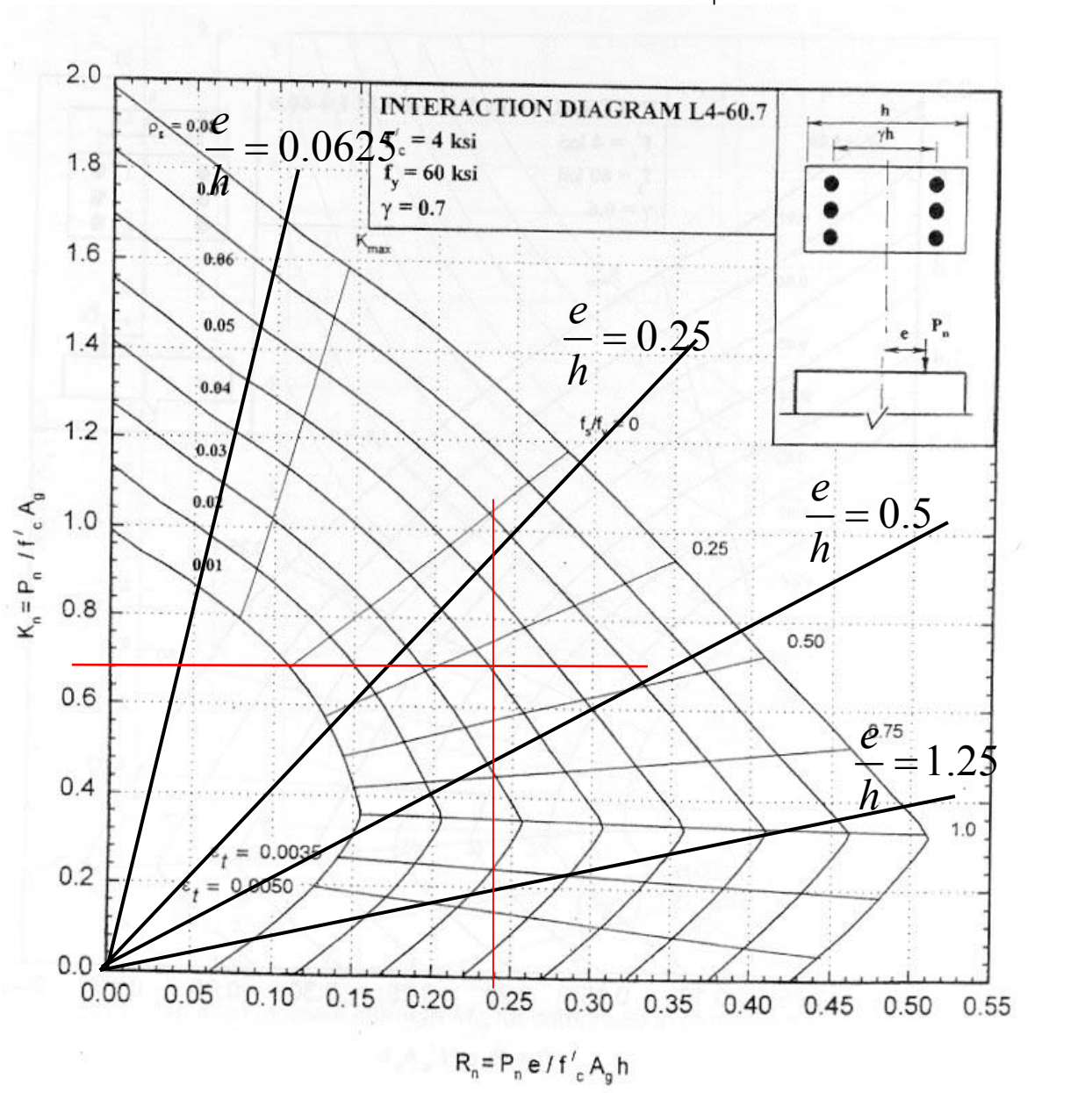
Area of steel will be:

$A_{st} = 0.031 \times 20 \times 16 = 9.92 \quad in^2$

Use 8 #10 bars with $A_{st} = 10.12 \quad in^2$

Check ϕ factor


20″
16″
3″
3″


INTERACTION DIAGRAM L4-60.7
f'c = 4 ksi
fy = 60 ksi
γ = 0.7
e/h = 0.0625
e/h = 0.25
e/h = 0.5
e/h = 1.25
0.06
0.05
0.04
0.03
0.02
0.01
0.25
0.50
0.75
1.0
εt = 0.0035
εt = 0.0050
Kn = Pn / f'c Ag
Rn = Pn e / f'c Ag h