B. Sc. Engg. (CEE)/6th Semester — 20 February 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Mid-Semester Examination — **Summer Semester: 2021–2022**
Course Number: CEE 4611 — **Full Marks: 75**
Course Title: Design of Reinforced Concrete Structures II — **Time: 1.5 Hours**

There are **4 (four)** questions. Answer **3 (three)** of them. Question ***2*** and ***4*** are ***compulsory***. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets.

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1. Determine the slab thickness of the exterior panel of the two-way slab with beam structure shown in Fig. 1. The slab is to support a live load of 120 psf and a dead load of 100 psf, including its own weight. The columns are 15 in. × 15 in. and 12 ft long. Also, determine the negative and positive moment distribution along the long direction for the design of the exterior panel of the two-way slab. Given that $f'_c = 3$ ksi and $f_y = 60$ ksi. CO2, PO3: [25]

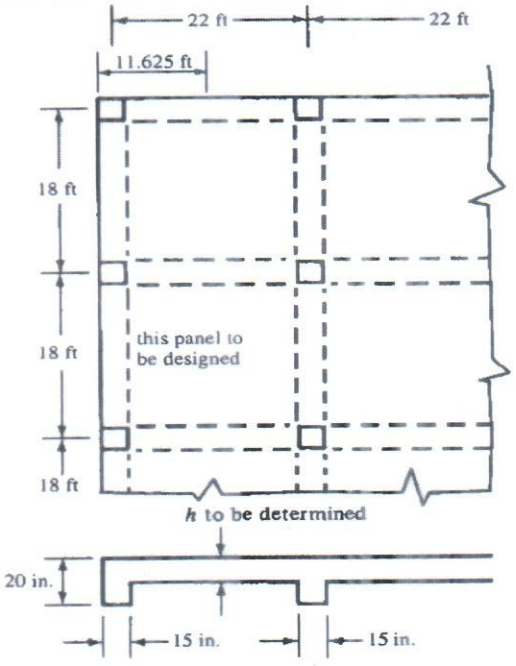
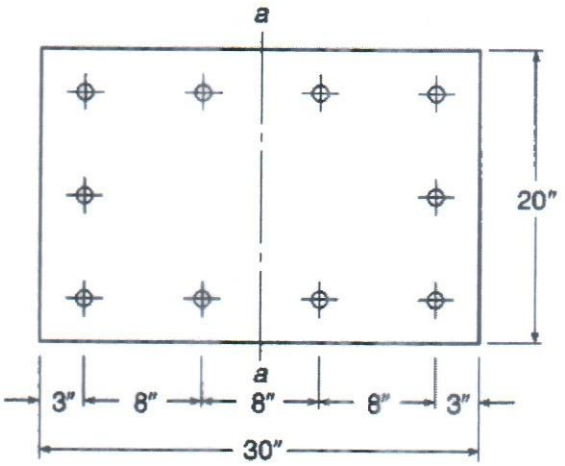


Fig.1 for Question 1

2. (a) What is ACI spiral? Derive the equation for calculating the volumetric ratio of ACI spiral. CO1, PO1: [7.5]

(b) Using appropriate ACI column interaction diagrams, design a short square column of 16 inch by 16 inch for the following conditions: $P_u = 600$ k, $M_u = 80$ ft-k, $f'_c = 4$ ksi and $f_y = 60$ ksi. Place the bars uniformly around all four faces of the column. CO2, PO3: [17.5]

3. Construct the interaction diagram relating P_n to M_n for the building column shown in Fig. 2. Bending will be about axis a-a. Calculate specific coordinates for concentric loading (e = 0), for P_b, and at least three other points, well chosen, on the curve. Material strengths are f'_c= 8000 psi and f_y= 60,000 psi. CO2, PO3: [25]



A_{st} = 10 No. 14 (No. 43)

Fig. 2 for Question 3

4. (a) Derive the equation for calculating the load and moment for a short column subjected to eccentric loading. CO1, PO1: [7.5]

   (b) Determine the design capacity, P_n, of the short-tied column shown in Fig. 2, which is subjected to biaxial bending. Given that, $f'_c = 4$ ksi and $f_y = 60$ ksi., $e_x = 16$ in., and $e_y = 8$ in. CO2, PO3: [17.5]

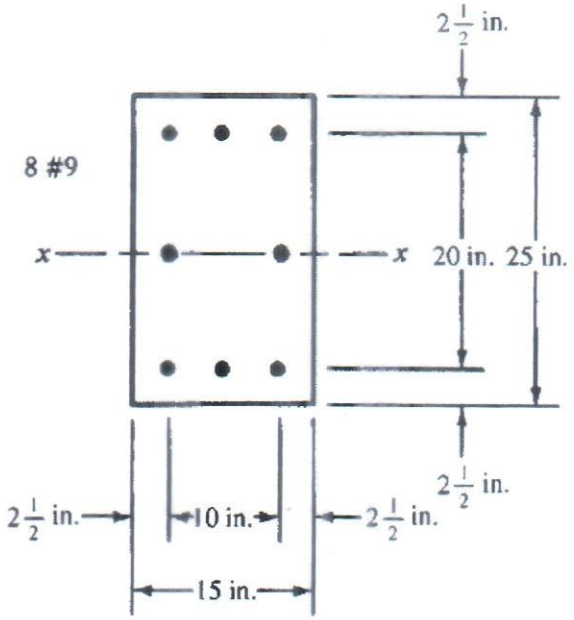
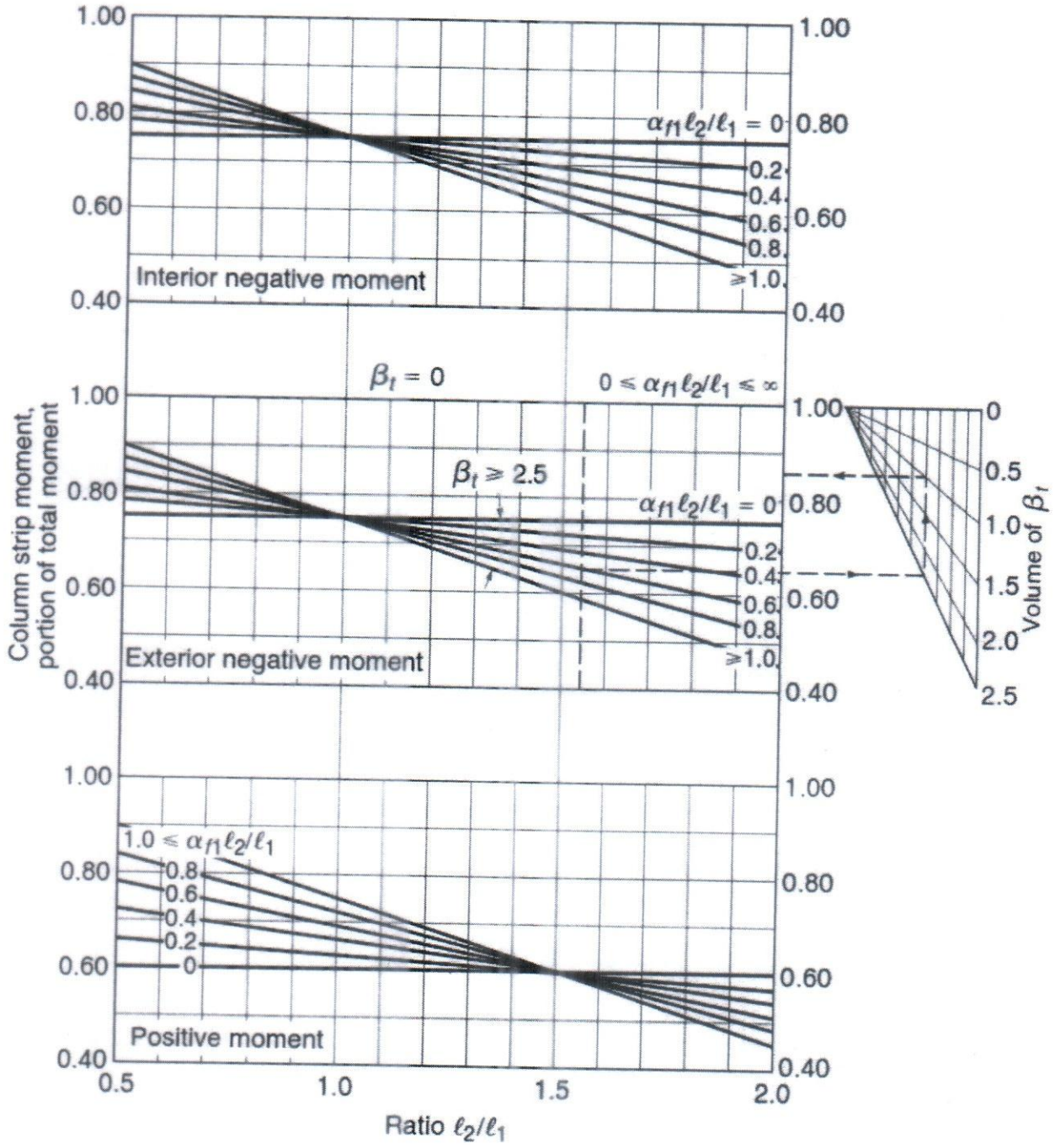
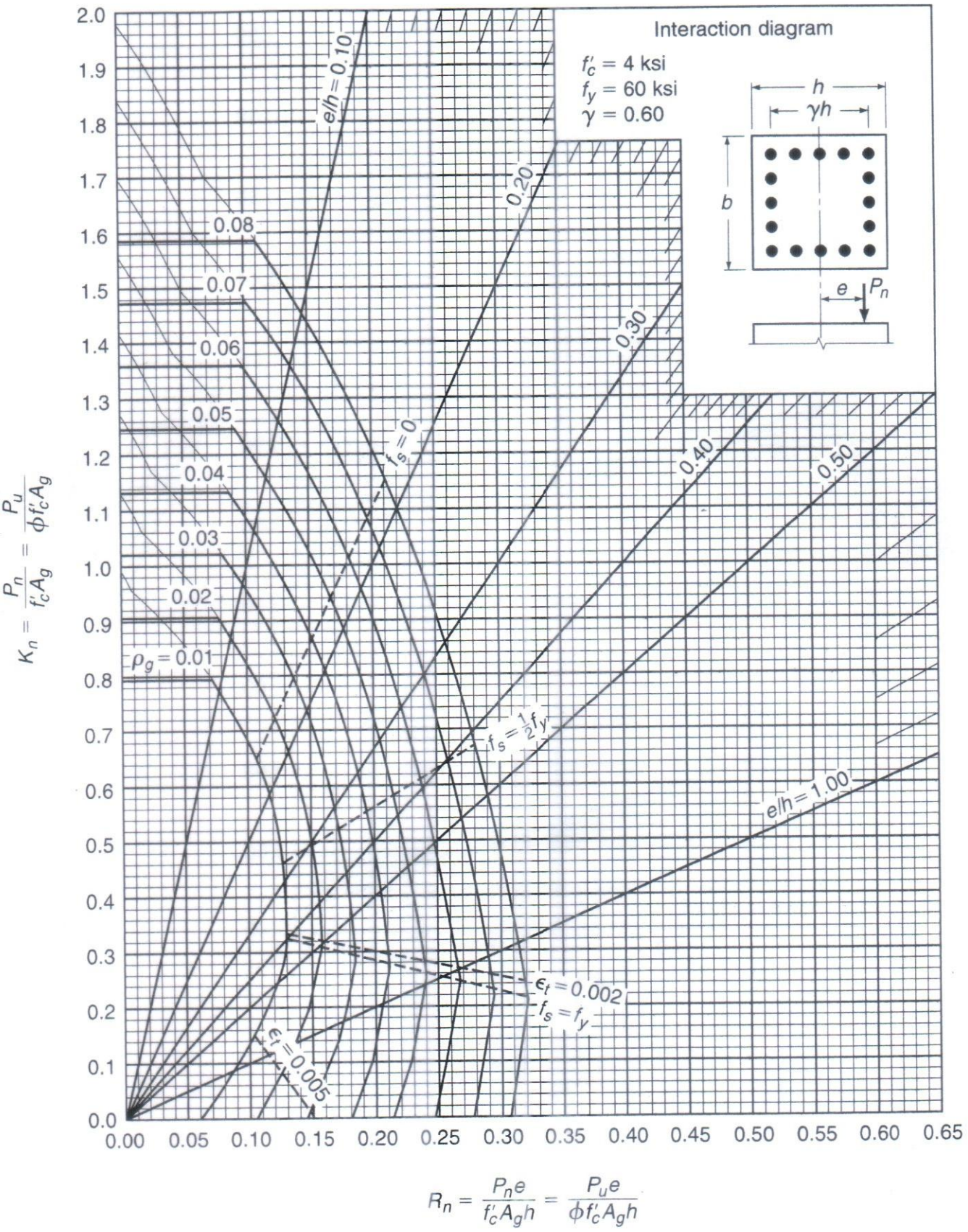
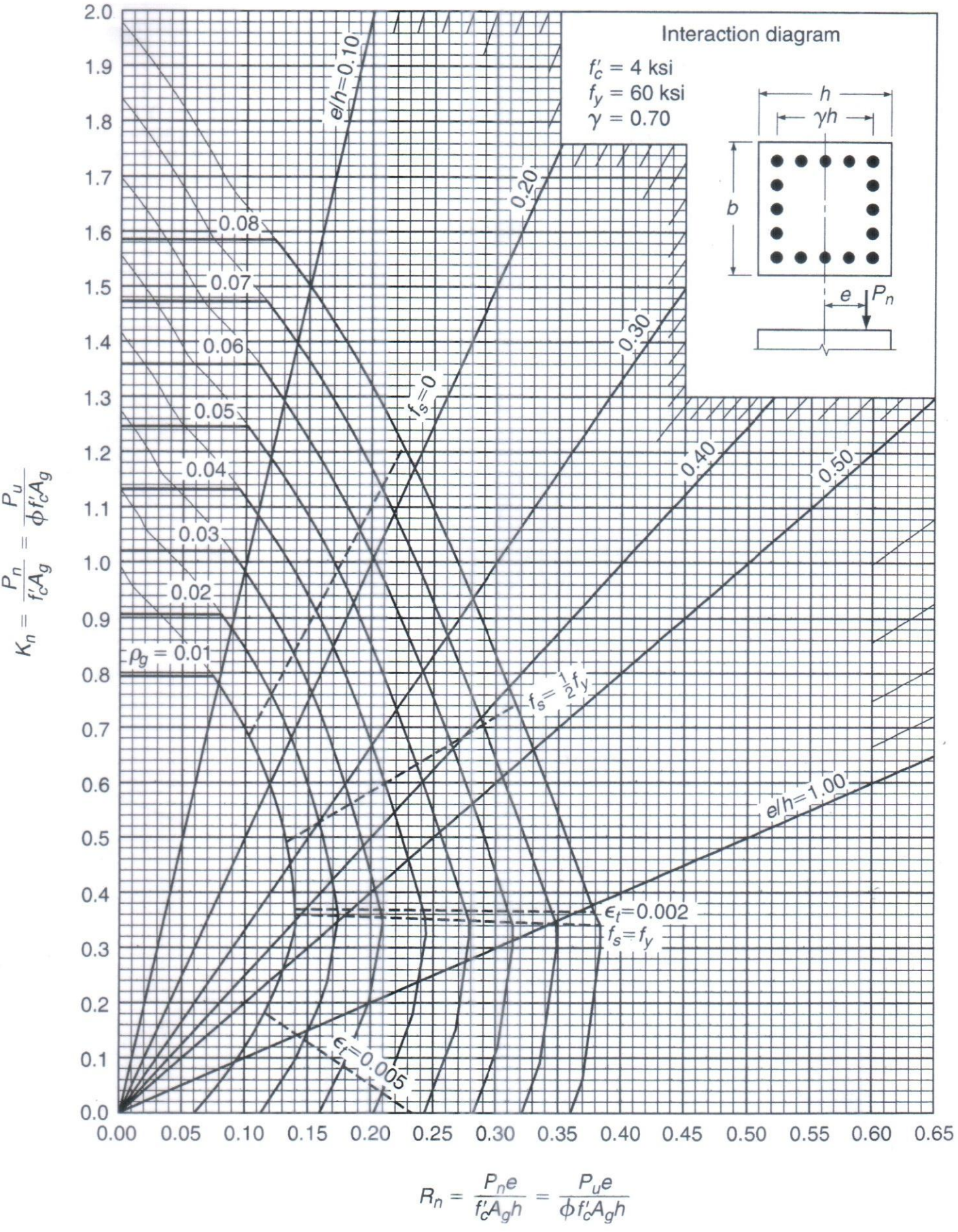


Fig. 3 for Question 4(b)

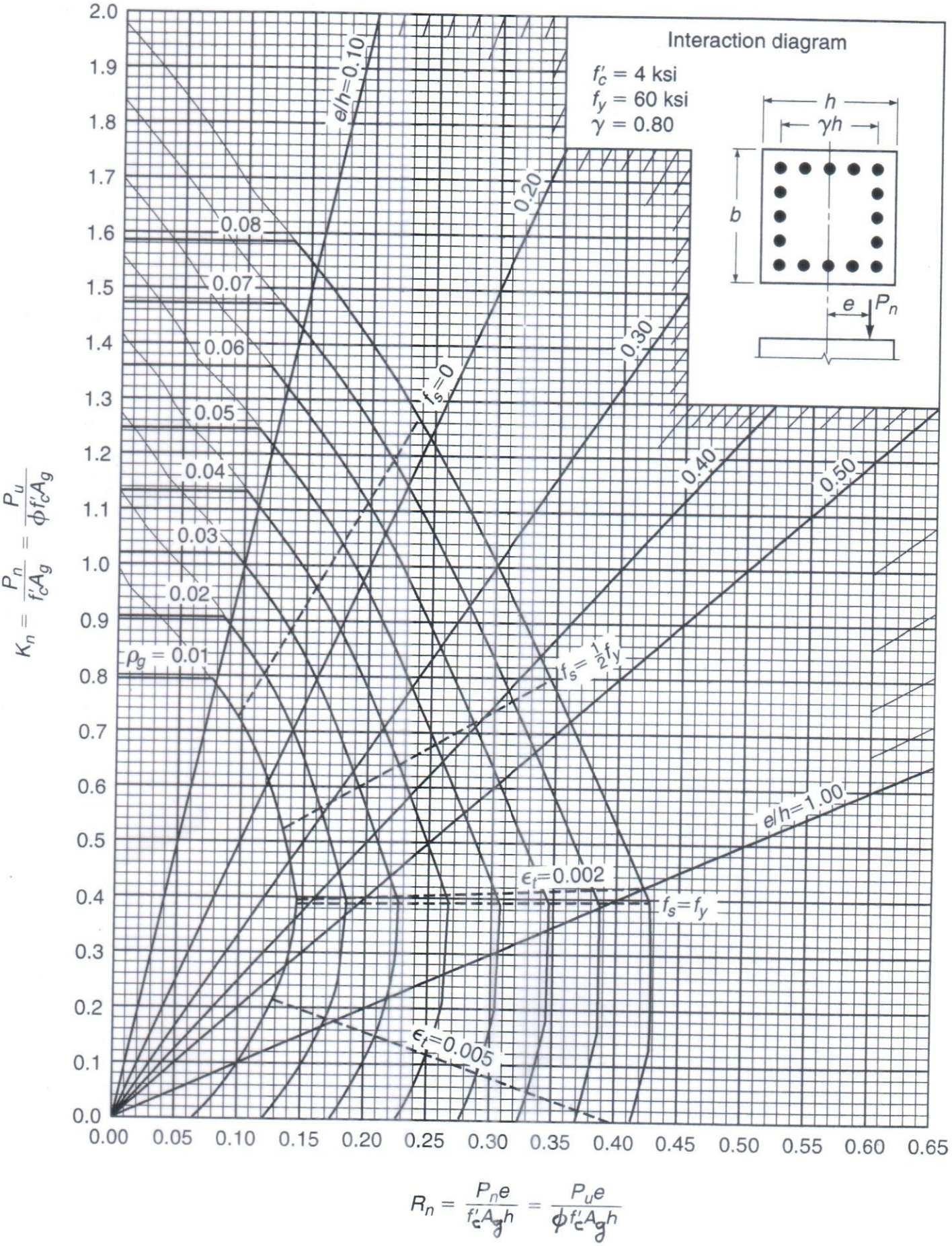

Interior negative moment
$\alpha_{f1}\ell_2/\ell_1 = 0$
0.2
0.4
0.6
0.8
≥1.0
$\beta_t = 0$
$0 \leq \alpha_{f1}\ell_2/\ell_1 \leq \infty$
$\beta_t \geq 2.5$
Exterior negative moment
Positive moment
$1.0 \leq \alpha_{f1}\ell_2/\ell_1$
Column strip moment, portion of total moment
Ratio ℓ_2/ℓ_1
Volume of β_t
1.00
0.80
0.60
0.40
0.5
1.0
1.5
2.0
0
0.5
1.0
1.5
2.0
2.5


Interaction diagram
f'_c = 4 ksi
f_y = 60 ksi
γ = 0.60
h
γh
b
e
P_n
e/h = 0.10
0.20
0.30
0.40
0.50
e/h = 1.00
0.08
0.07
0.06
0.05
0.04
0.03
0.02
ρ_g = 0.01
f_s = 0
$f_s = \frac{1}{2} f_y$
ϵ_t = 0.002
$f_s = f_y$
ϵ_t = 0.005
$K_n = \frac{P_n}{f'_c A_g} = \frac{P_u}{\phi f'_c A_g}$
$R_n = \frac{P_n e}{f'_c A_g h} = \frac{P_u e}{\phi f'_c A_g h}$
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 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 0.60 0.65



$$K_n = \frac{P_n}{f'_c A_g} = \frac{P_u}{\phi f'_c A_g}$$

$$R_n = \frac{P_n e}{f'_c A_g h} = \frac{P_u e}{\phi f'_c A_g h}$$


Interaction diagram
f'_c = 4 ksi
f_y = 60 ksi
γ = 0.80
h
γh
b
e
P_n
$K_n = \frac{P_n}{f'_c A_g} = \frac{P_u}{\phi f'_c A_g}$
$R_n = \frac{P_n e}{f'_c A_g h} = \frac{P_u e}{\phi f'_c A_g h}$
e/h=0.10
0.20
0.30
0.40
0.50
e/h=1.00
0.08
0.07
0.06
0.05
0.04
0.03
0.02
ρ_g = 0.01
f_s=0
$f_s = \frac{1}{2} f_y$
$f_s = f_y$
ϵ_t=0.002
ϵ_t=0.005
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65