Example 13.1 > One-way slab Design.

A reinforced concrete slab is built integrally with its supports and consists of two equal spans, each with a clear span of 4.5 m.
The service live load is 5 kN/m² and 27 MPa concrete is specified for use with a yield stress equal to 400 MPa.
Design the slab.

Solution >

- Determination of slab thickness

This structural system corresponds to the case of both ends being continuous

$$\frac{l}{28} = 160\,mm$$

The trial thickness of 180 mm will be used, for which the weight is

$$(180 \times 10^{-3}) \times \underbrace{(24\ kN/m^3)}_{\text{unit weight of conc}} = 4.32\ kN/m^2$$

- Factored load

DL : 1.2 × 4.32 = 5.184

LL : 1.6 × 5.00 = 8.0

Total = 13.184 kN/m²

- Factored moment at critical sections (Handout 13-1)

~~At interior support $-M = \frac{1}{9} \times 13.184 \times 4.5^2 = 29.7\ kN \cdot m$~~

At midspan $+M = \frac{1}{14} \times 13.184 \times 4.5^2 = 19.1\ kN \cdot m$

At exterior support $-M = \frac{1}{24} \times 13.184 \times 4.5^2 = 11.1\ kN \cdot m$

- The maximum reinforcement ratio (Handout 13-2)

$$\rho_{max} = (0.85)^2 \frac{27}{400} \frac{0.003}{0.003 + 0.004} = 0.021$$

- If the maximum ρ were actually used, the minimum required effective depth, controlled by negative moment at the interior support would be obtained

$$d^2 = \frac{M_u}{\phi \rho f_y b \left(1 - 0.59 \rho \frac{f_y}{f_{ck}}\right)}$$

<Recall>

$$\phi M_n = \phi A_s f_y \left(d - \frac{a}{2}\right)$$
$$= \phi \rho f_y b d^2 \left(1 - 0.59 \frac{\rho f_y}{f_{ck}}\right)$$
$$= \phi R b d^2$$

$$= \frac{(29.7)(10^3)(10^3)}{(0.85)(0.021)(400)(1{,}000)\left(1 - 0.59 \times 0.021 \times \frac{400}{27}\right)}$$

$$= 5{,}095 \text{ mm}^2$$

"d"

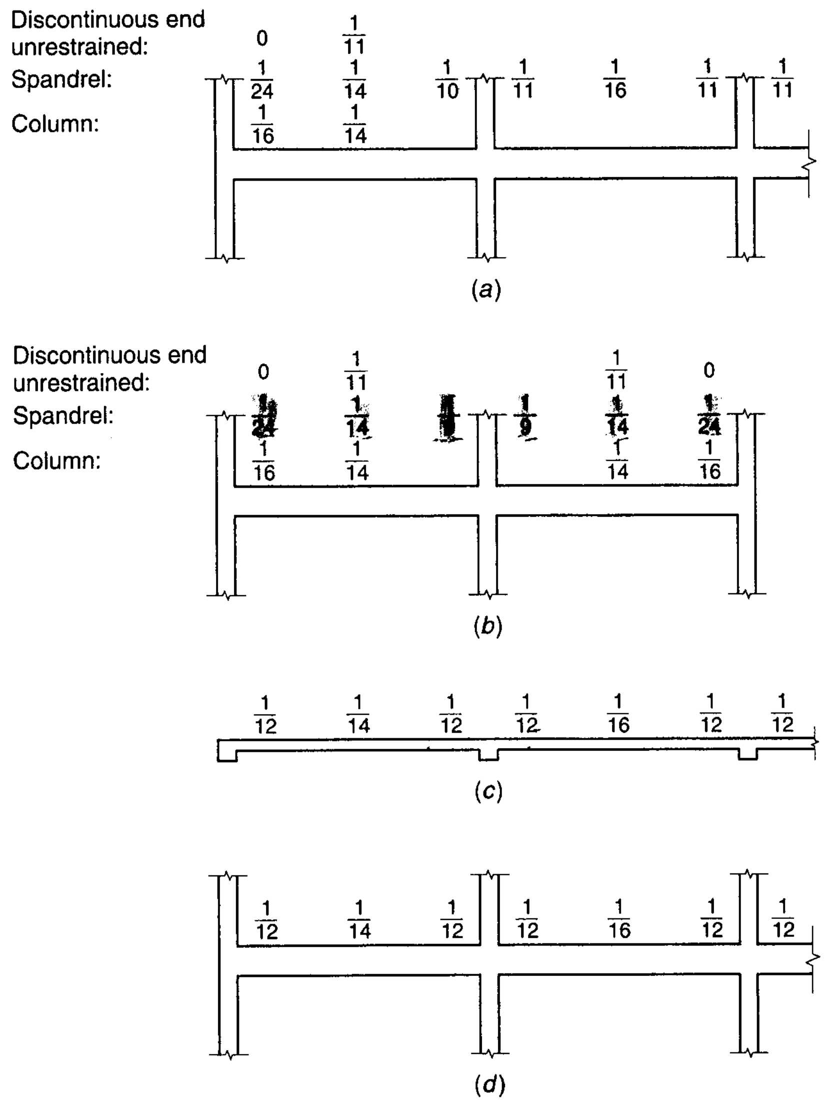
$\rightarrow$ 71.4 mm $<$ 180 − 25 = 155 mm

Code restriction for min. thickness.

Homework #4 Complete the design

Positive moment	
End spans	
Discontinuous end unrestrained	$w_u\ell_n^2/11$
Discontinuous end integral with support	$w_u\ell_n^2/14$
Interior spans	$w_u\ell_n^2/16$
Negative moments at exterior face of first interior support	
Two spans	$w_u\ell_n^2/9$
More than two spans	$w_u\ell_n^2/10$
Negative moment at other faces of interior supports	$w_u\ell_n^2/11$
Negative moment at face of all supports for	
Slabs with spans not exceeding 3 m; and beams where ratio of sum of column stiffnesses to beam stiffness exceeds eight at each end of the span	$w_u\ell_n^2/12$
Negative moment at interior face of exterior support for members built integrally with supports	
Where support is spandrel beam	$w_u\ell_n^2/24$
Where support is a column	$w_u\ell_n^2/16$
Shear in end members at face of first interior support	$1.15\, w_u\ell_n/2$
Shear at face of all other supports	$w_u\ell_n/2$

FIGURE 12.10
Summary of ACI moment coefficients: (*a*) beams with more than two spans; (*b*) beams with two spans only; (*c*) slabs with spans not exceeding 10 ft; (*d*) beams in which the sum of column stiffnesses exceeds 8 times the sum of beam stiffnesses at each end of the span.



Revision of KCI Code for Flexure (2006)

Safe limits for maximum reinforcement ratios take two forms according to revised KCI Code provisions.

1) the Code addresses the Minimum tensile reinforcement STRAIN allowed at nominal strength in the design of beams.

2) Code defines strength reduction factors that may depend on the tensile strain at normal strength

⇐ Both limitations are based on the net tensile strain ε_t and the depth d_t.

· The net tensile strain

$$\varepsilon_t = \varepsilon_u \frac{d_t - c}{c}$$

· The reinforcement ratio to produce a selected value of a net tensile strain is

$$\rho = 0.85 \beta_1 \frac{f_{ck}}{f_y} \frac{\varepsilon_u}{\varepsilon_u + \varepsilon_t}$$

· To ensure underreinforced behavior, KCI 6.2.2 establishes a minimum net tensile strain ε_t of 0.004 for members subjected to axial loads less than $0.1 f_{ck} A_g$

Handout 13-2

Using $\varepsilon_t = 0.004$ provides the maximum reinforcement ratio allowed by the KCI Code for beams.

$$\rho_{max} = 0.85 \beta_1 \frac{f_{ck}}{f_y} \frac{\varepsilon_u}{\varepsilon_u + 0.004}$$

Q1> What is the difference from KCI Code 2003?

Q2> Which is more conservative?

FIGURE 3.9
Variation of strength reduction factor with net tensile strain.

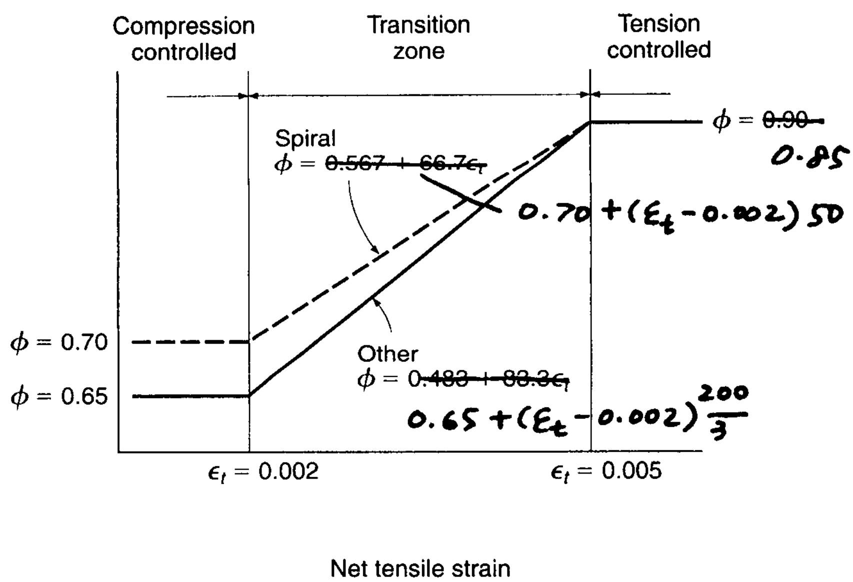


FIGURE 3.10
Net tensile strain and c/d_t ratios.