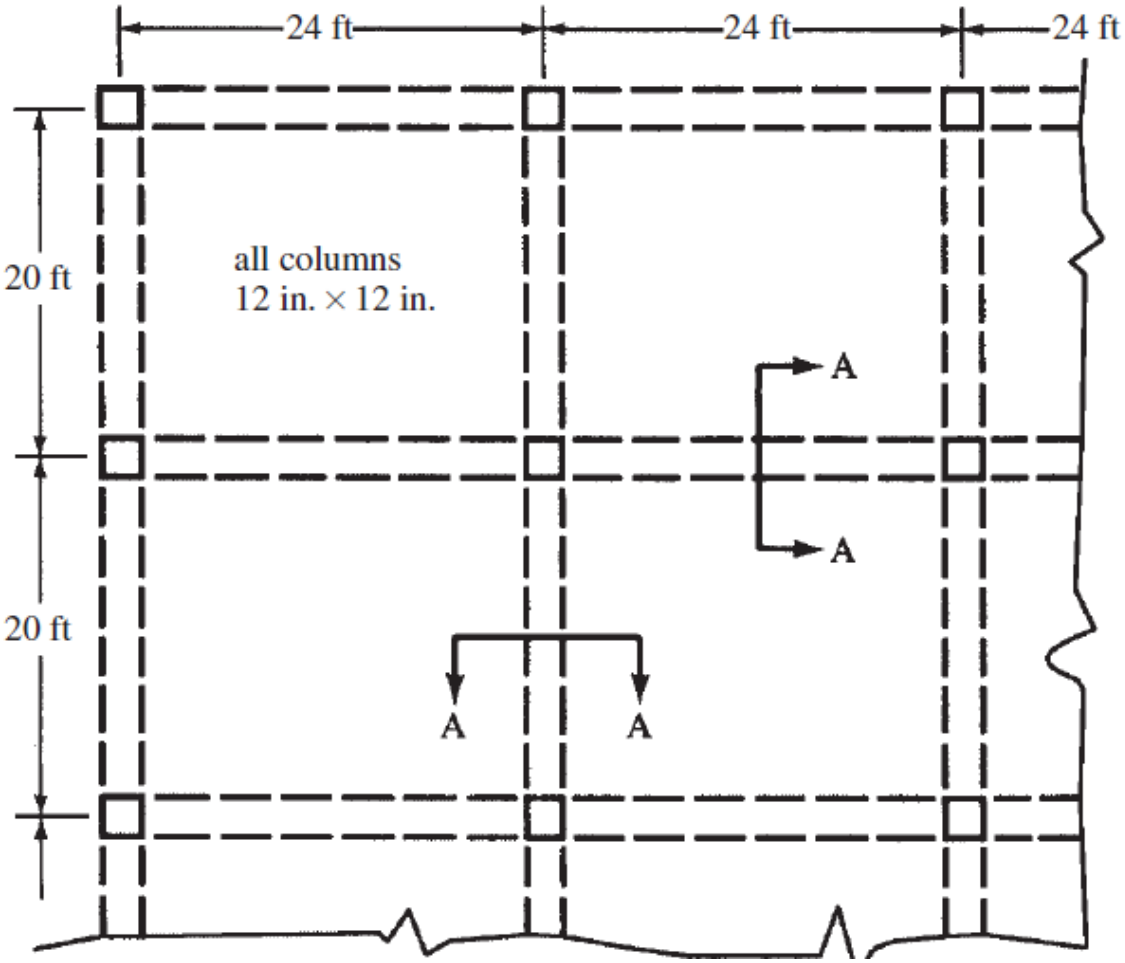
Finding the Adequacy of slab thickness for two way slab with edge beams

Example: The two-way slab shown in Figure below has been assumed to have a thickness of 7 in. Section A–A in the figure shows the beam cross section. Check the ACI equations to determine if the slab thickness is satisfactory for an interior panel. f'c = 3000 psi, fy = 60,000 psi, and normal-weight concrete.



Solution:

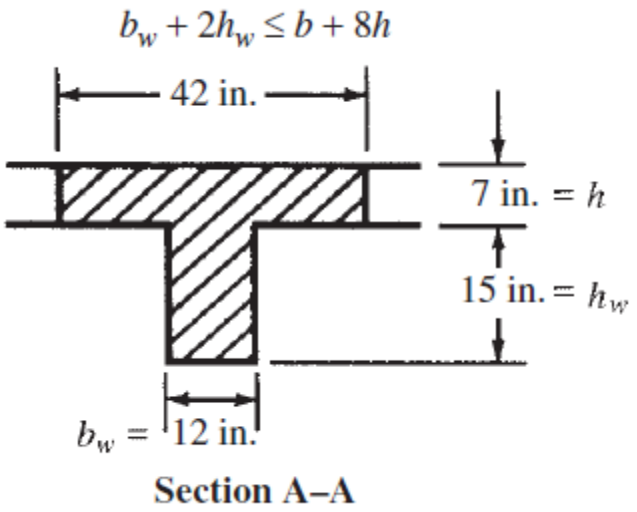
Computing α_1 for Long (Horizontal) Span for Interior Beams

I_s = gross moment of inertia of slab 20 ft wide

$$= \left(\frac{1}{12}\right)(12 \text{ in/ft} \times 20 \text{ in.})(7 \text{ in.})^3 = 6860 \text{ in.}^4$$

I_b = gross I of T-beam cross section shown in Figure about centroidal axis = 18,060 in.^{4}

$$\alpha_1 = \frac{EI_b}{EI_s} = \frac{(E)(18{,}060 \text{ in.}^4)}{(E)(6860 \text{ in.}^4)} = 2.63$$



Section A–A

Computing α_2 for Long Interior Beams

$$I_s \text{ for 24-ft-wide slab} = \left(\frac{1}{12}\right)(12 \text{ in/ft} \times 24 \text{ in.})(7 \text{ in.})^3 = 8232 \text{ in.}^4$$

$$I_b = 18{,}060 \text{ in.}^4$$

$$\alpha_2 = \frac{(E)(18{,}060 \text{ in.}^4)}{(E)(8232 \text{ in.}^4)} = 2.19$$

$$\alpha_{fm} = \frac{\alpha_1 + \alpha_2}{2} = \frac{2.63 + 2.19}{2} = 2.41$$

Determining Slab Thickness per ACI Section 9.5.3.3

$\alpha_{fm} = 2.41 > 2$ ∴ Use ACI Equation 9-13

$$h = \frac{\ell_n\left(0.8 + \frac{f_y}{200{,}000 \text{ psi}}\right)}{36 + 9\beta}$$

$$\ell_{n \text{ long}} = 24 \text{ ft} - 1 \text{ ft} = 23 \text{ ft}$$

$$\ell_{n \text{ short}} = 20 \text{ ft} - 1 \text{ ft} = 19 \text{ ft}$$

$$\beta = \frac{23 \text{ ft}}{19 \text{ ft}} = 1.21$$

$$h = \frac{(23 \text{ ft})\left(0.8 + \frac{60{,}000 \text{ psi}}{200{,}000 \text{ psi}}\right)}{36 + (9)(1.21)} = 0.540 \text{ ft} = 6.47 \text{ in.}$$

Use 7-in. slab

Note that the interior panel will generally not control the required slab thickness. Usually it will be an edge or corner panel. The interior panel was chosen here to illustrate the calculations and to avoid excess complexity. Had a corner panel been selected, each edge of the panel would have had a different α_f.