Thickness Determination for Two Way Slabs With Beams on All Sides- or Without Any Beams

Question: What are the ACI guidelines for the minimum thickness, h for slabs with beams spanning between the supports on all sides?

Slabs with Interior Beams

To determine the minimum thickness of slabs with beams spanning between their supports on all sides, Section 9.5.3.3 of the code must be followed. Involved in the expressions presented there are span lengths, panel shapes, flexural stiffness of beams if they are used, steel yield stresses, and so on. In these equations, the following terms are used:

ℓ_n = the clear span in the long direction, measured face to face, of (a) columns for slabs without beams and (b) beams for slab with beams

β = the ratio of the long to the short clear span

α_{fm} = the average value of the ratios of beam-to-slab stiffness on all sides of a panel

The minimum thickness of slabs or other two-way construction may be obtained by substituting into the equations to follow, which are given in Section 9.5.3.3 of the code. In the equations, the quantity β is used to take into account the effect of the shape of the panel on its deflection, while the effect of beams (if any) is represented by α_{fm}. If there are no beams present (as is the case for flat slabs), α_{fm} will equal 0.

1. For $\alpha_{fm} \leq 0.2$, the minimum thicknesses are obtained as they were for slabs without interior beams spanning between their supports.
2. For $0.2 \leq \alpha_{fm} \leq 2.0$, the thickness may not be less than 5 in. or

$$h = \frac{\ell_n \left(0.8 + \frac{f_y}{200{,}000}\right)}{36 + 5\beta(\alpha_{fm} - 0.2)} \qquad \text{(ACI Equation 9-12)}$$

3. For $\alpha_{fm} > 2.0$, the thickness may not be less than 3.5 in. or

$$h = \frac{\ell_n \left(0.8 + \frac{f_y}{200{,}000}\right)}{36 + 9\beta} \qquad \text{(ACI Equation 9-13)}$$

where ℓ_n and f_y are in inches and psi, respectively.

Minimum thickness of slabs without interior beams

Note: According to **ACI code 9.5.3.3,** for α_m equal to or less than 0.2, the minimum thickness of **ACI Table 9.5(c):** shall apply.

ACI Table 9.5(c): Minimum thickness of slabs without interior beams

	Without Drop Panels			With Drop Panels		
Yield Stress f_y, psi	**Exterior Panels**		**Interior Panels**	**Exterior Panels**		**Interior Panels**
	Without Edge Beams	**With Edge Beams[a]**		**Without Edge Beams**	**With Edge Beams[a]**	
40,000	$l_n/33$	$l_n/36$	$l_n/36$	$l_n/36$	$l_n/40$	$l_n/40$
60,000	$l_n/30$	$l_n/33$	$l_n/33$	$l_n/33$	$l_n/36$	$l_n/36$
75,000	$l_n/28$	$l_n/31$	$l_n/31$	$l_n/31$	$l_n/34$	$l_n/34$

[a] Slabs with beams along exterior edges. The value of α for the edge beam shall not be less than 0.8.

where l_n = clear span in long direction, inches

α_m = average value of α for all beams on edges of a panel.

β= ratio of clear span in long direction to clear span in short direction.

f_y = Yield strength of steel in psi

Note: At discontinuous edges, an edge beam must be provided with a stiffness ratio α not less than 0.8; otherwise the minimum thickness provided by Eq. (01) or (02) must be increased by at least 10 percent in the panel with the discontinuous edge.

Additional Notes:

In all cases, slab thickness less than stated minimum may be used if it can be shown by computation that deflections will not exceed the limit values of ACI Table **9.5 (b)**.

ACI Table 9.5 (b): Maximum allowable computed deflections

Type of member	Deflection to be considered	Deflection Limitation
Flat roofs not supporting or attached to nonstructural elements likely to be damaged by large deflections	Immediate deflection due to the live load (LL)	$\frac{l}{180}$
Floors not supporting or attached to nonstructural elements likely to be damaged by large deflections	Immediate deflection due to the live load (LL)	$\frac{l}{360}$
Roof or floor construction supporting or attached to nonstructural elements likely to be damaged by large deflections	That part of the total deflection occurring after attachment of the nonstructural elements (sum of the long-time deflection due to all sustained loads and the immediate deflection due to any additional live load)	$\frac{l}{480}$
Roof or floor construction supporting or attached to nonstructural elements not likely to be damaged by large deflections		$\frac{l}{240}$

Minimum Thickness for Two-Way Slab Systems using a graph

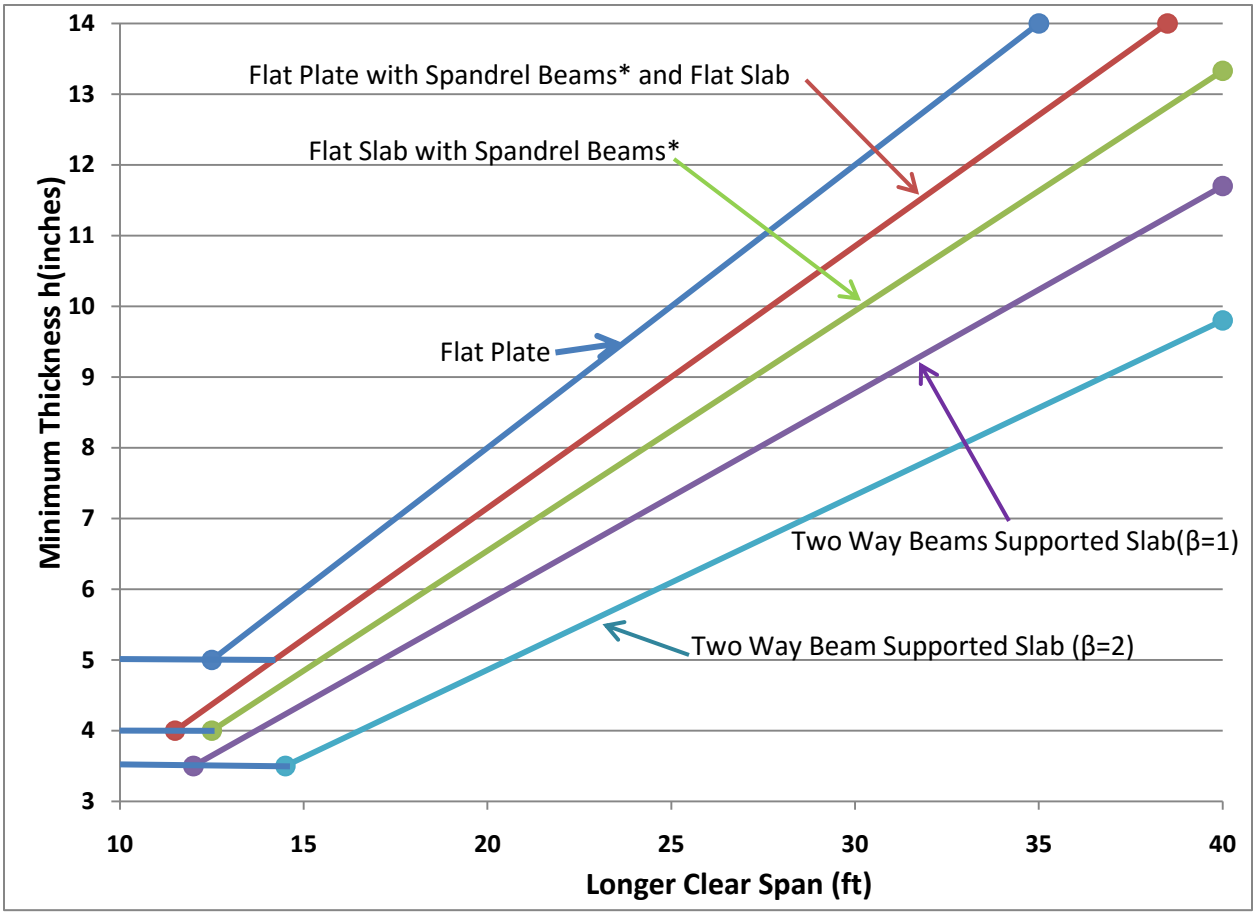

Figure 2.4: Minimum Slab Thickness for Two-Way Slab Systems.[1]

1. *Minimum Slab Thickness for Two-Way Slab Systems*, Figure 4- 4 , Simplified Design of Reinforced Concrete Buildings, Mahmoud E. Kamara and Lawrence C. Novak, Fourth Edition.