CODE

9.8.3.1 If fillers not complying with 9.8.2.1 or removable forms are used, slab thickness shall be at least the greater of one-twelfth the clear distance between ribs and 50 mm.

9.9—Deep beams

9.9.1 *General*

9.9.1.1 Deep beams are members that are loaded on one face and supported on the opposite face such that strut-like compression elements can develop between the loads and supports and that satisfy (a) or (b):

(a) Clear span does not exceed four times the overall member depth h
(b) Concentrated loads exist within a distance $2h$ from the face of the support

9.9.1.2 Deep beams shall be designed taking into account nonlinear distribution of longitudinal strain over the depth of the beam.

9.9.1.3 The strut-and-tie method in accordance with Chapter 23 is deemed to satisfy 9.9.1.2.

9.9.2 *Dimensional limits*

9.9.2.1 Except as permitted by 23.4.4, deep beam dimensions shall be selected such that:

$$V_u \le 0.83\phi\sqrt{f'_c}b_w d \qquad (9.9.2.1)$$

9.9.3 *Reinforcement limits*

9.9.3.1 Distributed reinforcement along the side faces of deep beams shall be at least that required in (a) and (b):

(a) The area of distributed reinforcement perpendicular to the longitudinal axis of the beam, A_v, shall be at least $0.0025b_w s$, where s is the spacing of the distributed transverse reinforcement.
(b) The area of distributed reinforcement parallel to the longitudinal axis of the beam, A_{vh}, shall be at least $0.0025b_w s_2$, where s_2 is the spacing of the distributed longitudinal reinforcement.

9.9.3.2 The minimum area of flexural tension reinforcement, $A_{s,min}$, shall be determined in accordance with 9.6.1.

9.9.4 *Reinforcement detailing*

9.9.4.1 Concrete cover shall be in accordance with 20.5.1.

COMMENTARY

R9.9—Deep beams

R9.9.1 *General*

R9.9.1.1 The behavior of deep beams is discussed in Schlaich et al. (1987), Rogowsky and MacGregor (1986), Marti (1985), and Crist (1966). For a deep beam supporting gravity loads, this provision applies if the loads are applied on the top of the beam and the beam is supported on its bottom face. If the loads are applied through the sides or bottom of such a member, the strut-and-tie method, as defined in Chapter 23 should be used to design reinforcement to internally transfer the loads to the top of the beam and distribute them to adjacent supports.

R9.9.1.2 The Code does not contain detailed requirements for designing deep beams for moment, except that a nonlinear strain distribution should be considered. Guidance for the design of deep beams for flexure is given in Chow et al. (1953), Portland Cement Association (1946), and Park and Paulay (1975).

R9.9.2 *Dimensional limits*

R9.9.2.1 This limit imposes a dimensional restriction to control cracking under service loads and to guard against diagonal compression failures in deep beams.

R9.9.3 *Reinforcement limits*

R9.9.3.1 The minimum reinforcement requirements of this section are to be used irrespective of the method used for design and are intended to control the width and propagation of inclined cracks. Tests (Rogowsky and MacGregor 1986; Marti 1985; Crist 1966) have shown that vertical shear reinforcement, perpendicular to the longitudinal axis of the member, is more effective for member shear strength than horizontal shear reinforcement, parallel to the longitudinal axis of the member, in a deep beam; however, the specified minimum reinforcement is the same in both directions to control the growth and width of diagonal cracks.

R9.9.4 *Reinforcement detailing*