CODE

24.3—Distribution of flexural reinforcement in one-way slabs and beams

24.3.1 Bonded reinforcement shall be distributed to control flexural cracking in tension zones of nonprestressed and Class C prestressed slabs and beams reinforced for flexure in one direction only.

24.3.2 Spacing of bonded reinforcement closest to the tension face shall not exceed the limits in Table 24.3.2, where c_c is the least distance from surface of deformed or prestressed reinforcement to the tension face. Calculated stress in deformed reinforcement, f_s, and calculated change in stress in bonded prestressed reinforcement, Δf_{ps}, shall be in accordance with 24.3.2.1 and 24.3.2.2, respectively.

Table 24.3.2—Maximum spacing of bonded reinforcement in nonprestressed and Class C prestressed one-way slabs and beams

Reinforcement type	Maximum spacing s	
Deformed bars or wires	Lesser of:	$380\left(\frac{280}{f_s}\right) - 2.5c_c$
		$300\left(\frac{280}{f_s}\right)$
Bonded prestressed reinforcement	Lesser of:	$\left(\frac{2}{3}\right)\left[380\left(\frac{280}{\Delta f_{ps}}\right) - 2.5c_c\right]$
		$\left(\frac{2}{3}\right)\left[300\left(\frac{280}{\Delta f_{ps}}\right)\right]$
Combined deformed bars or wires and bonded prestressed reinforcement	Lesser of:	$\left(\frac{5}{6}\right)\left[380\left(\frac{280}{\Delta f_{ps}}\right) - 2.5c_c\right]$
		$\left(\frac{5}{6}\right)\left[300\left(\frac{280}{\Delta f_{ps}}\right)\right]$

COMMENTARY

R24.3—Distribution of flexural reinforcement in one-way slabs and beams

R24.3.1 Where service loads result in high stresses in the reinforcement, visible cracks should be expected, and steps should be taken in detailing of the reinforcement to control cracking. For reasons of durability and appearance, many fine cracks are preferable to a few wide cracks. Detailing practices limiting bar spacing will usually lead to adequate crack control where Grade 420 reinforcement is used.

Extensive laboratory work (Gergely and Lutz 1968; Kaar 1966; Base et al. 1966) involving deformed bars demonstrated that crack width at service loads is proportional to reinforcement stress. The significant variables reflecting reinforcement detailing were found to be thickness of concrete cover and the spacing of reinforcement.

Crack width is inherently subject to wide scatter even in careful laboratory work and is influenced by shrinkage and other time-dependent effects. Improved crack control is obtained where the reinforcement is well distributed over the zone of maximum concrete tension. Several bars at moderate spacing are much more effective in controlling cracking than one or two larger bars of equivalent area.

R24.3.2 The spacing of reinforcement is limited to control cracking (Beeby 1979; Frosch 1999; ACI Committee 318 1999). For the case of beams with Grade 420 reinforcement and 50 mm clear cover to the primary reinforcement, with f_s **= 280 MPa**, the maximum bar spacing is 250 mm.

Crack widths in structures are highly variable. The Code provisions for spacing are intended to limit surface cracks to a width that is generally acceptable in practice but may vary widely in a given structure.

The role of cracks in the corrosion of reinforcement is controversial. Research (Darwin et al. 1985; Oesterle 1997) shows that corrosion is not clearly correlated with surface crack widths in the range normally found with reinforcement stresses at service load levels. For this reason, the Code does not differentiate between interior and exterior exposures.

Only tension reinforcement nearest the tension face need be considered in selecting the value of c_c used in calculating spacing requirements. To account for prestressed reinforcement, such as strand, having bond characteristics less effective than deformed reinforcement, a two-thirds effectiveness factor is used in Table 24.3.2.

For post-tensioned members designed as cracked members, it will usually be advantageous to provide crack control by the use of deformed reinforcement, for which the provisions in Table 24.3.2 for deformed bars or wires may be used. Bonded reinforcement required by other provisions of the Code may also be used as crack control reinforcement.