CODE

Table 17.5.3(a)—Anchor strength governed by steel

Type of steel element	Strength reduction factor ϕ	
	Tension (steel)	Shear (steel)
Ductile	0.75	0.65
Brittle	0.65	0.60

Table 17.5.3(b)—Anchor strength governed by concrete breakout, bond, and side-face blowout

Supplementary reinforcement	Type of anchor installation	Anchor Category[1] from ACI 355.2 or ACI 355.4M	Strength reduction factor ϕ	
			Tension (concrete breakout, bond, or side-face blowout)	Shear (concrete breakout)
Supplementary reinforcement present	Cast-in anchors	Not applicable	0.75	0.75
	Post-installed anchors	1	0.75	
		2	0.65	
		3	0.55	
Supplementary reinforcement not present	Cast-in Anchors	Not applicable	0.70	0.70
	Post-installed anchors	1	0.65	
		2	0.55	
		3	0.45	

[1]Anchor Category 1 indicates low sensitivity to installation and high reliability; Anchor Category 2 indicates medium sensitivity and medium reliability; Anchor Category 3 indicates high sensitivity and lower reliability.

Table 17.5.3(c)—Anchor strength governed by concrete pullout, or pryout strength

Type of anchor installation	Anchor Category[1] from ACI 355.2 or ACI 355.4M	Strength reduction factor ϕ	
		Tension (concrete pullout)	Shear (concrete pryout)
Cast-in anchors	Not applicable	0.70	0.70
Post-installed anchors	1	0.65	
	2	0.55	
	3	0.45	

[1]Anchor Category 1 indicates low sensitivity to installation and high reliability; Anchor Category 2 indicates medium sensitivity and medium reliability; and Anchor Category 3 indicates high sensitivity and lower reliability.

17.6—Tensile strength

17.6.1 *Steel strength of anchors in tension,* N_{sa}

17.6.1.1 Nominal steel strength of anchors in tension as governed by the steel, N_{sa}, shall be evaluated based on the

COMMENTARY

The ϕ-factors for anchor strength governed by concrete breakout, bond, and side-face blowout in Table 17.5.3(b) are separated into two groups based on the presence or absence of supplementary reinforcement. The supplementary reinforcement classifications of this table replace the "Condition A" and "Condition B" designations in previous Codes. Applications with supplementary reinforcement provide more deformation capacity, permitting the ϕ-factors to be increased. An explicit design of supplementary reinforcement for anchor-related forces is not required; however, the arrangement of supplementary reinforcement should generally conform to that of the anchor reinforcement shown in Fig. R17.5.2.1(a) and R17.5.2.1(b)(i) and (ii). Unlike anchor reinforcement, full development of supplementary reinforcement beyond the assumed breakout failure plane is not required.

For concrete breakout in shear for all anchor types and for brittle concrete failure modes for cast-in anchors, the basic strength reduction factor for brittle concrete failures (**ϕ = 0.70**) was chosen based on results of probabilistic studies. While this factor is greater than the strength reduction factor of structural plain concrete (**ϕ = 0.60**), the nominal resistance expressions used in this chapter and in the test requirements are based on the 5 percent fractiles; therefore, **ϕ = 0.60** would be overly conservative. Comparison with other design procedures and probabilistic studies (Farrow and Klingner 1995) indicated that the choice of **ϕ = 0.70** is justified. For the same cases with supplementary reinforcement, the value of **ϕ = 0.75** is compatible with the level of safety for shear failures in concrete beams; and has been recommended in the *PCI Design Handbook* (MNL 120) and by ACI 349M.

Tests included in ACI 355.2 and ACI 355.4M to assess sensitivity to installation procedures determine the Anchor Categories as given in Table 17.5.3(b) for proprietary post-installed expansion, screw, undercut, and adhesive anchors. ACI 355.2 tests for installation sensitivity measure effects of variability in anchor torque during installation, tolerance on drilled hole size, and energy level used in setting anchors; for expansion, screw, and undercut anchors intended for use in cracked concrete, increased crack widths are considered. ACI 355.4M tests for installation sensitivity assess the influence of adhesive mixing and the influence of hole cleaning in dry, saturated, and water-filled/underwater bore holes.

R17.6—Tensile strength

R17.6.1 *Steel strength of anchors in tension,* N_{sa}