Anchoring

17

CODE

$\psi_{c,N}$ = **1.25** for cast-in anchors

$\psi_{c,N}$ = **1.4** for post-installed anchors, if the value of k_c used in Eq. (17.6.2.2.1) is 7. If the value of k_c used in Eq. (17.6.2.2.1) is taken from the ACI 355.2 or ACI 355.4M product evaluation report for post-installed anchors:

(i) $\psi_{c,N}$ shall be based on the ACI 355.2 or ACI 355.4M product evaluation report for anchors qualified for use in both cracked and uncracked concrete

(ii) $\psi_{c,N}$ shall be taken as 1.0 for anchors qualified for use in uncracked concrete.

(b) For anchors located in a region of a concrete member where analysis indicates cracking at service load levels, $\psi_{c,N}$ shall be taken as 1.0 for both cast-in anchors and post-installed anchors, and 17.6.2.6 shall be satisfied.

17.6.2.5.2 Post-installed anchors shall be qualified for use in cracked concrete in accordance with ACI 355.2 or ACI 355.4M. Cracking in the concrete shall be controlled by flexural reinforcement distributed in accordance with 24.3.2, or equivalent crack control shall be provided by confining reinforcement.

17.6.2.6 *Breakout splitting factor, $\psi_{cp,N}$*

17.6.2.6.1 Modification factor for post-installed anchors designed for uncracked concrete in accordance with 17.6.2.5 without supplementary reinforcement to control splitting, $\psi_{cp,N}$, shall be determined by (a) or (b) using the critical distance c_{ac} as defined in 17.9.5.

(a) If $c_{a,min} \geq c_{ac}$, then $\psi_{cp,N} = 1.0$ (17.6.2.6.1a)

(b) If $c_{a,min} < c_{ac}$, then $\psi_{cp,N} = \dfrac{c_{a,min}}{c_{ac}} \geq \dfrac{1.5h_{ef}}{c_{ac}}$ (17.6.2.6.1b)

17.6.2.6.2 For all other cases, including cast-in anchors, $\psi_{cp,N}$ shall be taken as 1.0.

17.6.3 *Pullout strength of a single cast-in anchor or a single post-installed expansion, screw, or undercut anchor in tension, N_{pn}*

17.6.3.1 Nominal pullout strength of a single cast-in anchor or a single-post-installed expansion, screw, or undercut anchor in tension, N_{pn}, shall be calculated by:

$$N_{pn} = \psi_{c,P}N_p \qquad (17.6.3.1)$$

COMMENTARY

concrete zones perform well in a crack that is 0.3 mm wide. If wider cracks are expected, reinforcement to control the crack width to approximately 0.3 mm should be provided. Refer to ACI 224R for more information.

The concrete breakout strengths given by Eq. (17.6.2.2.1) and (17.6.2.2.3) assume cracked concrete ($\psi_{c,N}$ = **1.0**) with $\psi_{c,N}k_c$ = **10** for cast-in anchors and 7 for post-installed anchors. If the uncracked concrete $\psi_{c,N}$ factors are applied (1.25 for cast-in and 1.4 for post-installed), $\psi_{c,N}k_c$ factors become 12.5 for cast-in anchors and 10 for post-installed anchors. This agrees with field observations and tests demonstrating cast-in anchor strength exceeds that of post-installed for both cracked and uncracked concrete.

R17.6.2.6 *Breakout splitting factor, $\psi_{cp,N}$*

R17.6.2.6.1 The design provisions in 17.6 are based on the assumption that the basic concrete breakout strength can be achieved if the minimum edge distance $c_{a,min}$ equals **1.5h_{ef}**. Test results (Asmus 1999), however, indicate that many torque-controlled and displacement-controlled expansion anchors and some undercut anchors require edge distances exceeding **1.5h_{ef}** to achieve the basic concrete breakout strength if tested in uncracked concrete without supplementary reinforcement to control splitting. When a tensile load is applied, the resulting tensile stresses at the embedded end of the anchor are added to the tensile stresses induced due to anchor installation, and splitting failure may occur before reaching the concrete breakout strength given in 17.6.2.1. To account for this potential splitting mode of failure, the basic concrete breakout strength is reduced by a factor $\psi_{cp,N}$ if $c_{a,min}$ is less than the critical edge distance c_{ac}.

R17.6.2.6.2 If supplementary reinforcement to control splitting is present or if the anchors are located in a region where analysis indicates cracking of the concrete at service loads, the reduction factor $\psi_{cp,N}$ is taken as 1.0.

R17.6.3 *Pullout strength of a single cast-in anchor or a single post-installed expansion, screw, or undercut anchor in tension, N_{pn}*

R17.6.3.1 The design requirements for pullout are applicable to cast-in anchors and post-installed expansion, screw, and undercut anchors. They are not applicable to adhesive anchors, which are instead evaluated for bond failure in accordance with 17.6.5.