CODE

17.6.5.5.2 For all other cases, $\psi_{cp,Na}$ shall be taken as 1.0.

17.7—Shear strength

17.7.1 *Steel strength of anchors in shear*, V_{sa}

17.7.1.1 Nominal steel strength of anchors in shear as governed by the steel, V_{sa}, shall be evaluated based on the properties of the anchor material and the physical dimensions of the anchors. If concrete breakout is a potential failure mode, the required steel shear strength shall be consistent with the assumed breakout surface.

17.7.1.2 Nominal strength of an anchor in shear, V_{sa}, shall not exceed (a) through (c):

(a) For cast-in headed stud anchor

$$V_{sa} = A_{se,V} f_{uta} \qquad (17.7.1.2a)$$

where $A_{se,V}$ is the effective cross-sectional area of an anchor in shear, mm^2, and f_{uta} used for calculations shall not exceed either $\mathbf{1.9}f_{ya}$ or 860 MPa.

(b) For cast-in headed bolt and hooked bolt anchors and for post-installed anchors where sleeves do not extend through the shear plane

$$V_{sa} = 0.6A_{se,V} f_{uta} \qquad (17.7.1.2b)$$

where $A_{se,V}$ is the effective cross-sectional area of an anchor in shear, mm^2, and the value of f_{uta} shall not exceed either $\mathbf{1.9}f_{ya}$ or 860 MPa.

(c) For post-installed anchors where sleeves extend through the shear plane, V_{sa} shall be based on the 5 percent fractile of results of tests performed and evaluated in accordance with ACI 355.2. Alternatively, Eq. (17.7.1.2b) shall be permitted to be used.

17.7.1.2.1 If anchors are used with built-up grout pads, nominal strength V_{sa} calculated in accordance with 17.7.1.2 shall be multiplied by 0.80.

17.7.2 *Concrete breakout strength of anchors in shear*, V_{cb}

17.7.2.1 Nominal concrete breakout strength in shear, V_{cb} of a single anchor or V_{cbg} of an anchor group satisfying 17.5.1.3.1, shall be calculated in accordance with (a) through (d):

(a) For shear perpendicular to the edge on a single anchor

$$V_{cb} = \frac{A_{Vc}}{A_{Vco}} \psi_{ed,V} \psi_{c,V} \psi_{h,V} V_b \qquad (17.7.2.1a)$$

(b) For shear perpendicular to the edge on an anchor group

$$V_{cbg} = \frac{A_{Vc}}{A_{Vco}} \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} V_b \qquad (17.7.2.1b)$$

COMMENTARY

R17.7—Shear strength

R17.7.1 *Steel strength of anchors in shear,* V_{sa}

R17.7.1.1 The shear applied to each anchor in an anchor group may vary depending on assumptions for the concrete breakout surface and load redistribution (refer to R17.7.2.1).

R17.7.1.2 The nominal shear strength of anchors is best represented as a function of f_{uta} rather than f_{ya} because the large majority of anchor materials do not exhibit a well-defined yield point. Welded studs develop a higher steel shear strength than headed anchors due to the fixity provided by the weld between the studs and the base plate. The use of Eq. (17.7.1.2a) and (17.7.1.2b) with the load factors of 5.3 and the ϕ-factors of 17.5.3 result in design strengths consistent with AISC 360.

The limitation of $\mathbf{1.9}f_{ya}$ on f_{uta} is to ensure that, under service load conditions, the anchor stress does not exceed f_{ya}. The limit on f_{uta} of $\mathbf{1.9}f_{ya}$ was determined by converting the LRFD provisions to corresponding service-level conditions, as discussed in R17.6.1.2.

For post-installed anchors having a reduced cross-sectional area anywhere along the anchor length, the effective cross-sectional area of the anchor should be provided by the manufacturer. For threaded rods and headed bolts, ASME B1.1 defines $A_{se,V}$ as

$$A_{se,V} = \frac{\pi}{4}\left(d_a - \frac{0.9743}{n_t}\right)^2$$

where n_t is the number of threads per mm.

R17.7.2 *Concrete breakout strength of anchors in shear,* V_{cb}

R17.7.2.1 The shear strength equations were developed from the CCD Method (refer to R17.5.1.3). They assume a breakout angle of approximately 35 degrees (refer to Fig. R17.5.1.3b) and consider fracture mechanics theory. The effects of multiple anchors, spacing of anchors, edge distance, and thickness of the concrete member on nominal concrete breakout strength in shear are included by applying the reduction factor of A_{Vc}/A_{Vco} in Eq. (17.7.2.1a) and (17.7.2.1b), and $\psi_{ec,V}$ in Eq. (17.7.2.1b). For anchors far from the edge, 17.7.2 usually will not govern. For these cases, 17.7.1 and 17.7.3 often govern.