CODE

17.7.2.1.3 A_{Vco} is the projected area for a single anchor in a deep member with a distance from edges of at least $1.5c_{a1}$ in the direction perpendicular to the shear. It shall be permitted to calculate A_{Vco} by Eq. (17.7.2.1.3), which gives the area of the base of a half-pyramid with a side length parallel to the edge of $3c_{a1}$ and a depth of $1.5c_{a1}$.

$$A_{Vco} = 4.5(c_{a1})^2 \qquad (17.7.2.1.3)$$

17.7.2.1.4 If anchors are located at varying distances from the edge and the anchors are welded to the attachment so as to distribute the force to all anchors, it shall be permitted to evaluate the strength based on the distance to the farthest row of anchors from the edge. In this case, it shall be permitted to base the value of c_{a1} on the distance from the edge to the axis of the farthest anchor row that is selected as critical, and all of the shear shall be assumed to be resisted by this critical anchor row alone.

17.7.2.2 *Basic single anchor breakout strength*, V_b

17.7.2.2.1 Basic concrete breakout strength of a single anchor in shear in cracked concrete, V_b, shall not exceed the lesser of (a) and (b):

$$\text{(a)}\quad V_b = \left(0.6\left(\frac{\ell_e}{d_a}\right)^{0.2}\sqrt{d_a}\right)\lambda_a\sqrt{f_c'}(c_{a1})^{1.5} \qquad (17.7.2.2.1a)$$

where ℓ_e is the load-bearing length of the anchor for shear:
$\ell_e = h_{ef}$ for anchors with a constant stiffness over the full length of embedded section, such as headed studs and post-installed anchors with one tubular shell over full length of the embedment depth;
$\ell_e = 2d_a$ for torque-controlled expansion anchors with a distance sleeve separated from expansion sleeve;
$\ell_e \leq 8d_a$ in all cases.

$$\text{(b)}\quad V_b = 3.7\lambda_a\sqrt{f_c'}\,(c_{a1})^{1.5} \qquad (17.7.2.2.1b)$$

17.7.2.2.2 For cast-in headed studs, headed bolts, or hooked bolts that are continuously welded to steel attachments, basic concrete breakout strength of a single anchor in shear in cracked concrete, V_b, shall be the lesser of Eq. (17.7.2.2.1b) and Eq. (17.7.2.2.2) provided that (a) through (d) are satisfied.

$$V_b = \left(0.66\left(\frac{\ell_e}{d_a}\right)^{0.2}\sqrt{d_a}\right)\lambda_a\sqrt{f_c'}(c_{a1})^{1.5} \qquad (17.7.2.2.2)$$

where ℓ_e is defined in 17.7.2.2.1.

(a) Steel attachment thickness is the greater of $0.5d_a$ and 10 mm.

COMMENTARY

R17.7.2.2 *Basic single anchor breakout strength*, V_b

R17.7.2.2.1 Like the concrete breakout tensile strength, the concrete breakout shear strength does not increase with the failure surface, which is proportional to $(c_{a1})^2$. Instead, the strength increases proportionally to $(c_{a1})^{1.5}$ due to the size effect. The constant, 7, in the shear strength equation (17.7.2.2.1a) was determined from test data reported in Fuchs et al. (1995) at the 5 percent fractile adjusted for cracking.

The strength is also influenced by the anchor stiffness and the anchor diameter (Fuchs et al. 1995; Eligehausen and Balogh 1995; Eligehausen et al. 1987, 2006b; Eligehausen and Fuchs 1988). The influence of anchor stiffness and diameter is not apparent in large-diameter anchors (Lee et al. 2010), resulting in a limitation on the shear breakout strength provided by Eq. (17.7.2.2.1b).

R17.7.2.2.2 For cast-in headed bolts continuously welded to an attachment, test data (Shaikh and Yi 1985) show that somewhat higher shear strength exists, possibly due to the stiff welded connection clamping the bolt more effectively than an attachment with an anchor gap. Because of this, the basic shear breakout strength for such anchors is increased, but the upper limit of Eq. (17.7.2.2.1b) is imposed because tests on large-diameter anchors welded to steel attachments are not available to justify a higher value than Eq. (17.7.2.2.1b). The design of supplementary reinforcement is discussed in *fib* (2011), Eligehausen et al. (1987, 2006b), and Eligehausen and Fuchs (1988).