CODE

COMMENTARY

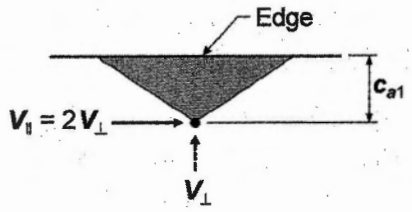

Fig. R17.5.2.1c—Shear force parallel to an edge.

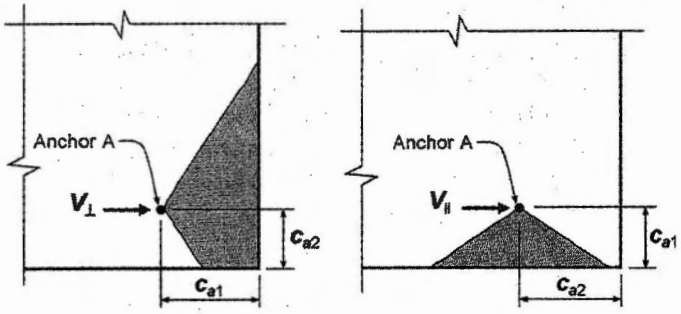

Fig. R17.5.2.1d—Shear force near a corner.

17.5.2.2 The basic concrete breakout strength in shear of a single anchor in cracked concrete, V_b, shall be the smaller of (a) and (b):

$$\text{(a) } V_b = \left(7\left(\frac{\ell_e}{d_a}\right)^{0.2}\sqrt{d_a}\right)\lambda_a\sqrt{f'_c}\,(c_{a1})^{1.5} \qquad (17.5.2.2a)$$

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, and $\ell_e \le 8d_a$ in all cases.

$$\text{(b) } V_b = 9\lambda_a\sqrt{f'_c}\,(c_{a1})^{1.5} \qquad (17.5.2.2b)$$

17.5.2.3 For cast-in headed studs, headed bolts, or hooked bolts that are continuously welded to steel attachments having a minimum thickness equal to the greater of 3/8 in. and half of the anchor diameter, the basic concrete breakout strength in shear of a single anchor in cracked concrete, V_b, shall be the smaller of Eq. (17.5.2.2b) and Eq. (17.5.2.3)

$$V_b = \left(8\left(\frac{\ell_e}{d_a}\right)^{0.2}\sqrt{d_a}\right)\lambda_a\sqrt{f'_c}\,(c_{a1})^{1.5} \qquad (17.5.2.3)$$

where ℓ_e is defined in 17.5.2.2 provided that:

(a) For groups of anchors, the strength is determined based on the strength of the row of anchors farthest from the edge

R17.5.2.2 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 size effect. The strength is also influenced by the anchor stiffness and the anchor diameter (Fuchs et al. 1995; Eligehausen and Balogh 1995; Eligehausen et al. 1987/1988, 2006b). 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. (17.5.2.2b).

The constant, 7, in the shear strength equation was determined from test data reported in Fuchs et al. (1995) at the 5 percent fractile adjusted for cracking.

R17.5.2.3 For the case of 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 welding connection clamping the bolt more effectively than an attachment with an anchor gap. Because of this, the basic shear value for such anchors is increased but the upper limit of Eq. (17.5.2.2b) is imposed because tests on large-diameter anchors welded to steel attachments are not available to justify any higher value than Eq. (17.5.2.2b). The design of supplementary reinforcement is discussed in CEB (1997), Eligehausen et al. (1997/1998), and Eligehausen and Fuchs (1988).