CODE

17.1.5 This chapter does not apply to specialty inserts, through-bolts, multiple anchors connected to a single steel plate at the embedded end of the anchors, grouted anchors, or power driven anchors such as powder or pneumatic actuated fasteners.

17.1.6 Reinforcement used as part of an embedment shall have development length established in accordance with other parts of this Code. If reinforcement is used as anchorage, concrete breakout failure shall be considered. Alternatively, anchor reinforcement in accordance with 17.5.2.1 shall be provided.

COMMENTARY

R17.1.5 The wide variety of shapes and configurations of specialty inserts precludes prescription of generalized tests and design equations.

R17.1.6 Concrete breakout strength in tension and shear should be considered for reinforcing bars in a group used as anchorage. Concrete breakout behavior can occur even if reinforcement is fully developed in accordance with Chapter 25. Breakout behavior of straight reinforcement as a group is analogous to tension and shear breakout behavior of adhesive anchors whereby h_{ef} is taken as equal to or less than the embedded bar length. Similarly, breakout behavior of hooked and headed reinforcement groups is similar to tension and shear breakout behavior of headed anchors. Consideration should be given to extending bars beyond the development length.

As an alternative to explicit determination of the concrete breakout strength of a group, anchor reinforcement provided in accordance with 17.5.2.1 may be used, or the reinforcement should be extended.

17.2—General

17.2.1 Anchors and anchor groups shall be designed for critical effects of factored loads calculated by elastic analysis. If nominal strength is controlled by ductile steel elements, plastic analysis is permitted provided that deformation compatibility is taken into account.

17.2.1.1 Anchor group effects shall be considered if two or more anchors loaded by a common structural element are spaced closer than the spacing required for unreduced breakout strength. If adjacent anchors are not loaded by a common structural element, group effects shall consider simultaneous maximum loading of adjacent anchors.

17.2.2 Adhesive anchors shall be installed in concrete having a minimum age of 21 days at time of anchor installation.

17.2.3 Adhesive anchors installed horizontally or upwardly inclined shall be qualified in accordance with ACI 355.4M requirements for sensitivity to installation direction.

17.2.4 *Lightweight concrete modification factor, λ_a*

17.2.4.1 Modification factor λ_a for lightweight concrete shall be in accordance with Table 17.2.4.1. It shall be

R17.2—General

R17.2.1 If the strength of an anchor group is governed by concrete breakout, the behavior is brittle, and there is limited redistribution of forces between the highly stressed and less stressed anchors. In this case, the theory of elasticity is required to be used, assuming the attachment that distributes loads to the anchors is sufficiently stiff. The forces in the anchors are considered to be proportional to the external load and its distance from the neutral axis of the anchor group.

If anchor strength is governed by ductile yielding of the anchor steel, significant redistribution of anchor forces can occur. In this case, an analysis based on the theory of elasticity will be conservative. Cook and Klingner (1992a,b) and Lotze et al. (2001) discuss nonlinear analysis, using theory of plasticity, for the determination of the strengths of ductile anchor groups.

R17.2.2 The design performance of adhesive anchors cannot be ensured by establishing a minimum concrete compressive strength at the time of installation in early-age concrete. Therefore, a concrete age of at least 21 days at the time of adhesive anchor installation was adopted.

R17.2.3 ACI 355.4M includes optional tests to confirm the suitability of adhesive anchors for horizontal or upwardly inclined installations.

R17.2.4 *Lightweight concrete modification factor, λ_a*

R17.2.4.1 The number of tests available to establish the strength of anchors in lightweight concrete is limited. Tests of headed studs cast in lightweight concrete indicate that the