

CODE

25.6.1.4 Individual bars within a bundle terminated within the span of flexural members shall terminate at different points with at least $40d_b$ stagger.

25.6.1.5 Development length for individual bars within a bundle, in tension or compression, shall be that of the individual bar, increased 20 percent for a three-bar bundle, and 33 percent for a four-bar bundle.

25.6.1.6 A unit of bundled bars shall be treated as a single bar with an area equivalent to that of the bundle and a centroid coinciding with that of the bundle. The diameter of the equivalent bar shall be used for d_b in (a) through (e):

- (a) Spacing limitations based on d_b
- (b) Cover requirements based on d_b
- (c) Spacing and cover values in 25.4.2.3
- (d) Confinement term in 25.4.2.4
- (e) ψ_e factor in 25.4.2.5

25.6.1.7 Lap splices of bars in a bundle shall be based on the lap splice length required for individual bars within the bundle, increased in accordance with 25.6.1.5. Individual bar splices within a bundle shall not overlap. Entire bundles shall not be lap spliced.

25.6.2 Post-tensioning ducts

25.6.2.1 Bundling of post-tensioning ducts shall be permitted if shown that concrete can be satisfactorily placed and if provision is made to prevent the prestressed reinforcement from breaking through the duct.

25.7—Transverse reinforcement

25.7.1 Stirrups

25.7.1.1 Stirrups shall extend as close to the compression and tension surfaces of the member as cover requirements and proximity of other reinforcement permits and shall be anchored at both ends. Where used as shear reinforcement, stirrups shall extend a distance d from extreme compression fiber.

COMMENTARY

R25.6.1.4 Bond research (ACI Committee 408 1966) has shown that cutoff points within bundles should be staggered.

R25.6.1.5 An increased development length for individual bars is required when three or four bars are bundled together. The extra extension is needed because the grouping makes it more difficult to mobilize bond resistance from the core between the bars.

The development of bundled bars by a standard hook of the bundle is not covered by the provisions of 25.4.3.

R25.6.1.6 Although splice and development lengths of bundled bars are a multiple of the diameter of the individual bars being spliced increased by 20 or 33 percent, as appropriate, it is necessary to use an equivalent diameter of the entire bundle derived from the equivalent total area of bars for determining the spacing and cover values in 25.4.2.3, the confinement term, $[(c_b + K_{tr})/d_b]$, in 25.4.2.4, and the ψ_e factor in 25.4.2.5. For bundled bars, bar diameter d_b outside the brackets in the expressions of 25.4.2.3 and of Eq. (25.4.2.4a) is that of a single bar.

R25.6.1.7 The increased length of lap required for bars in bundles is based on the reduction in the exposed perimeter of the bars. Only individual bars are lap spliced along the bundle.

R25.6.2 Post-tensioning ducts

R25.6.2.1 Where ducts for prestressing reinforcement in a beam are arranged closely together vertically, provisions should be made to prevent the prestressed reinforcement from breaking through the duct when tensioned. Horizontal arrangement of ducts should allow proper placement of concrete. A clear spacing of one and one-third times the nominal maximum size of the coarse aggregate, but not less than 25 mm, has proven satisfactory.

Where concentration of tendons or ducts tends to create a weakened plane in the concrete cover, reinforcement should be provided to control cracking.

R25.7—Transverse reinforcement

R25.7.1 Stirrups

R25.7.1.1 Stirrup legs should be extended as close as practicable to the compression face of the member because, near ultimate load, the flexural tension cracks penetrate deeply toward the compression zone.

It is essential that shear and torsional reinforcement be adequately anchored at both ends to be fully effective on either side of any potential inclined crack. This generally requires a hook or bend at the end of the reinforcement as provided by this section.