CODE

COMMENTARY

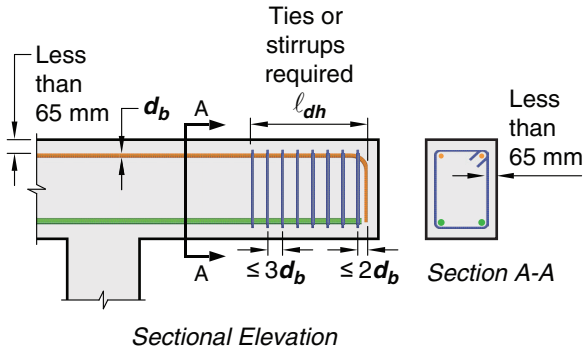

Fig. R25.4.3.4—*Concrete cover according to 25.4.3.4.*

25.4.4 *Development of headed deformed bars in tension*

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25.4.4.1 Use of a head to develop a deformed bar in tension shall be permitted if conditions (a) through (f) are satisfied:

(a) Bar shall conform to 20.2.1.6
(b) Bar size shall not exceed No. 36
(c) Net bearing area of head A_{brg} shall be at least $4A_b$
(d) Concrete shall be normalweight
(e) Clear cover for bar shall be at least $2d_b$
(f) Center-to-center spacing between bars shall be at least $3d_b$

R25.4.4.1 As used in this section, development describes cases in which the force in the bar is transferred to the concrete through a combination of a bearing force at the head and bond forces along the bar. In contrast, Chapter 17 anchorage provisions describe cases in which the force in the bar is transferred through bearing to the concrete at the head alone. Headed bars are limited to those types that meet the criteria in 20.2.1.6 for Class HA heads.

The provisions for headed deformed bars were formulated with due consideration of the provisions for anchorage in Chapter 17 (Shao et al. 2016). Chapter 17 contains provisions for headed anchors related to the individual failure modes of concrete breakout, side-face blowout, and pullout. These failure modes were considered in the formulation of 25.4.4.2. The restrictions to maximum bar size of No. 36 and normalweight concrete are based on a lack of data for larger bars or lightweight concrete (Thompson et al. 2005, 2006a,b; Shao et al. 2016). The upper limit of 420 MPa on f_y that appeared prior to the 2019 Code has been removed.

For bars in tension, heads allow the bars to be developed in a shorter length than required for standard hooks, but otherwise perform in a similar manner (Thompson et al. 2005, 2006a,b; Shao et al. 2016). The head is considered to be part of the bar for the purposes of satisfying the specified cover requirements in 20.5.1.3 and aggregate size requirements of 26.4.2.1(a)(5).

Headed bars with $A_{brg} < 4A_b$ have been used in practice, but their performance is not accurately represented by the provisions in 25.4.4.2, and they should be used only with designs that are supported by test results under 25.4.5. These provisions do not address the design of studs or headed stud assemblies used for shear reinforcement.

25.4.4.2 Development length ℓ_{dt} for headed deformed bars in tension shall be the longest of (a) through (c):

(a) $\left(\dfrac{f_y \psi_e \psi_p \psi_o \psi_c}{31\sqrt{f'_c}}\right) d_b^{1.5}$ with ψ_e, ψ_p, ψ_o, and ψ_c, given in 25.4.4.3
(b) $8d_b$
(c) 150 mm

R25.4.4.2 The provisions for developing headed deformed bars give the length of bar, ℓ_{dt}, measured from the critical section to the bearing face of the head, as shown in Fig. R25.4.4.2a. The provisions are primarily based on tests of simulated beam-column joints (Shao et al. 2016).

If longitudinal headed deformed bars from a beam, slab, or corbel terminate in a supporting member, such as the column shown in Fig. R25.4.4.2b, the bars should extend through the joint to the far face of the confined core of the