

CODE

22.7.6.1.2 In Eq. (22.7.6.1a) and (22.7.6.1b), it shall be permitted to take θ equal to (a) or (b):

- (a) 45 degrees for nonprestressed members or members with $A_{ps}f_{se} < 0.4(A_{ps}f_{pu} + A_s f_y)$
- (b) 37.5 degrees for prestressed members with $A_{ps}f_{se} \geq 0.4(A_{ps}f_{pu} + A_s f_y)$

22.7.7 Cross-sectional limits

22.7.7.1 Cross-sectional dimensions shall be selected such that (a) or (b) is satisfied:

(a) For solid sections

$$\sqrt{\left(\frac{V_u}{b_w d}\right)^2 + \left(\frac{T_u p_h}{1.7 A_{oh}^2}\right)^2} \leq \phi \left(\frac{V_c}{b_w d} + 0.66 \sqrt{f'_c} \right) \quad (22.7.7.1a)$$

(b) For hollow sections

$$\left(\frac{V_u}{b_w d} \right) + \left(\frac{T_u p_h}{1.7 A_{oh}^2} \right) \leq \phi \left(\frac{V_c}{b_w d} + 0.66 \sqrt{f'_c} \right) \quad (22.7.7.1b)$$

COMMENTARY

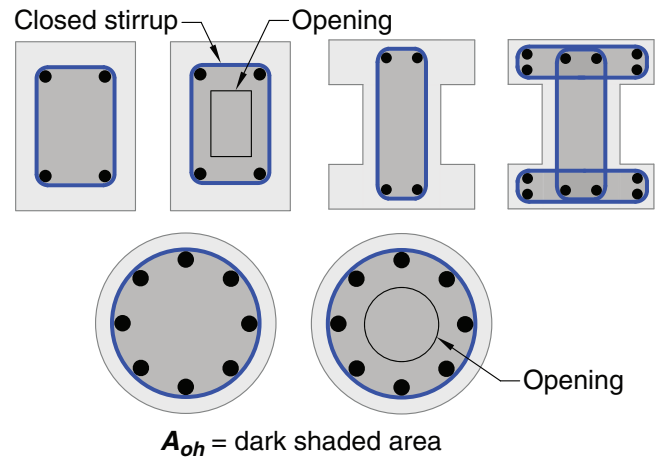


Fig. R22.7.6.1.1—Definition of A_{oh} .

R22.7.6.1.2 The angle θ can be obtained by analysis (Hsu 1990) or may be taken equal to the values given in 22.7.6.1.2(a) or (b). The same value of θ is required to be used in both Eq. (22.7.6.1a) and (22.7.6.1b). With smaller values of θ , the amount of stirrups required by Eq. (22.7.6.1a) decreases. At the same time, the amount of longitudinal reinforcement required by Eq. (22.7.6.1b) increases.

R22.7.7 Cross-sectional limits

R22.7.7.1 The size of a cross section is limited for two reasons: first, to reduce excessive cracking, and second, to minimize the potential for crushing of the surface concrete due to inclined compressive stresses due to shear and torsion. In Eq. (22.7.7.1a) and (22.7.7.1b), the two terms on the left-hand side are the shear stresses due to shear and torsion. The sum of these stresses may not exceed the stress causing shear cracking plus $0.66 \sqrt{f'_c}$, similar to the limiting strength given in 22.5.1.2 for shear without torsion. The limit is expressed in terms of V_c to allow its use for nonprestressed or prestressed concrete. It was originally derived on the basis of crack control. It is not necessary to check against crushing of the web because crushing occurs at higher shear stresses.

In a hollow section, the shear stresses due to shear and torsion both occur in the walls of the box as shown in Fig. R22.7.7.1(a) and hence are directly additive at Point A as given in Eq. (22.7.7.1b). In a solid section, the shear stresses due to torsion act in the tubular outside section while the shear stresses due to V_u are spread across the width of the section, as shown in Fig. R22.7.7.1(b). For this reason, stresses are combined in Eq. (22.7.7.1a) using the square root of the sum of the squares rather than by direct addition.