CODE

23.6.4 Spirals enclosing compression reinforcement in struts shall satisfy 25.7.3.

23.7—Strength of ties

23.7.1 Tie reinforcement shall be nonprestressed or prestressed.

23.7.2 The nominal tensile strength of a tie, F_{nt}, shall be calculated by:

$$F_{nt} = A_{ts} f_y + A_{tp} \Delta f_p \quad (23.7.2)$$

where A_{tp} is zero for nonprestressed members.

23.7.2.1 In Eq. (23.7.2), it shall be permitted to take Δf_p equal to 420 MPa for bonded prestressed reinforcement and 70 MPa for unbonded prestressed reinforcement. Higher values of Δf_p shall be permitted if justified by analysis, but Δf_p shall not be taken greater than $(f_{py} - f_{se})$.

23.8—Tie reinforcement detailing

23.8.1 The centroidal axis of the tie reinforcement shall coincide with the axis of the tie assumed in the strut-and-tie model.

23.8.2 Tie reinforcement shall be anchored by mechanical devices, post-tensioning anchorage devices, standard hooks, or straight bar development in accordance with 23.8.3, except for ties extending from curved-bar nodes designed in accordance with 23.10.

COMMENTARY

R23.7—Strength of ties

R23.7.2 The tie strength in 23.7.2 is based on including any effects of prestressing as external loads in accordance with 23.2.8. The total strength of a prestressed tie is $A_{tp}(f_{se} + \Delta f_p)$.

R23.8—Tie reinforcement detailing

R23.8.1 The effective tie width assumed in design, w_t, can vary between the following limits, depending on the distribution of the tie reinforcement:

(a) If the bars in the tie are in one layer, the effective tie width can be taken as the diameter of the bars in the tie plus twice the cover to the surface of the bars, as shown in Fig. R23.2.6b(i).
(b) A practical upper limit of the tie width can be taken as the width corresponding to the width in a hydrostatic nodal zone, calculated as $w_{t,max} = F_{nt}/(f_{ce} b_s)$, where f_{ce} is calculated for the nodal zone in accordance with 23.9.2.

If the tie width exceeds the value from (a), the tie reinforcement should be distributed approximately uniformly over the width and thickness of the tie, as shown in Fig. R23.2.6b(ii).

R23.8.2 Anchorage of ties often requires special attention in nodal zones of corbels or in nodal zones adjacent to exterior supports of deep beams. The reinforcement in a tie should be anchored before it exits the extended nodal zone at the point defined by the intersection of the centroid of the bars in the tie and the extensions of the outlines of either the strut or the bearing area. This length is ℓ_{anc}. In Fig. R23.2.6b, this occurs where the outline of the extended nodal zone is crossed by the centroid of the reinforcement in the tie. Some of the anchorage may be achieved by extending the reinforcement through the nodal zone, as shown in Fig. R23.2.6a(iii) and R23.2.6b, and developing it beyond the nodal zone. If the tie is anchored using 90-degree hooks, the hooks should be confined within reinforcement to avoid cracking along the outside of the hooks in the support region.