CODE

11.5.4.2 V_n at any horizontal section shall not exceed $0.66\sqrt{f'_c}\,A_{cv}$.

11.5.4.3 V_n shall be calculated by:

$$V_n = (\alpha_c \lambda \sqrt{f'_c} + \rho_t f_{yt}) A_{cv} \qquad (11.5.4.3)$$

where:
$\alpha_c = 0.25$ for $h_w/\ell_w \le 1.5$
$\alpha_c = 0.17$ for $h_w/\ell_w \ge 2.0$
α_c varies linearly between 0.25 and 0.17 for $1.5 < h_w/\ell_w < 2.0$

11.5.4.4 For walls subject to a net axial tension, α_c in Eq. (11.5.4.3) shall be taken as:

$$\alpha_c = 0.17\left(1 + \frac{N_u}{3.45A_g}\right) \ge 0.0 \qquad (11.5.4.4)$$

where N_u is negative for tension.

11.5.5 *Out-of-plane shear*

11.5.5.1 V_n shall be calculated in accordance with 22.5.

11.6—Reinforcement limits

11.6.1 If in-plane $V_u \le 0.04\phi\alpha_c\lambda\sqrt{f'_c}\,A_{cv}$, minimum ρ_ℓ and minimum ρ_t shall be in accordance with Table 11.6.1. These limits need not be satisfied if adequate strength and stability can be demonstrated by structural analysis.

COMMENTARY

R11.5.4.2 This limit is imposed to guard against diagonal compression failure in structural walls. The coefficient used in this equation has been reduced from a value of 0.83 in ACI 318M-14 to a value of 0.66 in ACI 318-19 because the effective shear area has been increased to $h\ell_w$, from hd used in prior editions of the Code.

R11.5.4.3 To improve consistency in the Code, the nominal in-plane shear strength equation in 11.5.4.3 now has the same form as the shear strength equation used in 18.10.4.1 for structural walls resisting seismic loads. Research results reported by Orakcal et al. (2009) indicate that nominal strengths calculated using Eq. (11.5.4.3) are similar to values obtained using equations from prior editions of the Code, and thus, provide a comparable level of safety.

R11.5.4.4 For structural walls where a net axial tension force is calculated for the entire wall section, the shear strength contribution attributed to the concrete is reduced and may be negligible. For these members, wall transverse reinforcement must be designed to resist most, if not all, of the factored shear force.

R11.6—Reinforcement limits

R11.6.1 Both horizontal and vertical shear reinforcement are required for all walls. The distributed reinforcement is identified as being oriented parallel to either the longitudinal or transverse axis of the wall. Therefore, for vertical wall segments, the notation used to describe the horizontal distributed reinforcement ratio is ρ_t, and the notation used to describe the vertical distributed reinforcement ratio is ρ_ℓ.

Transverse reinforcement is not required in precast, prestressed walls equal to or less than 3.6 m in width because this width is less than that in which shrinkage and temperature stresses can build up to a magnitude requiring transverse reinforcement. In addition, much of the shrinkage occurs before the members are connected into the structure. Once in the final structure, the members are usually not as rigidly connected transversely as monolithic concrete; thus, the transverse restraint stresses due to both shrinkage and temperature change are significantly reduced.

The minimum area of wall reinforcement for precast walls has been used for many years and is recommended by the Precast/Prestressed Concrete Institute (PCI MNL-120) and the Canadian Precast Concrete Design Standard (2016). Reduced minimum reinforcement and greater spacings in 11.7.2.2 are allowed recognizing that precast wall panels have very little restraint at their edges during early stages