Design of Special Structural (Shear) Walls

(Compressive Stress Approach)

Effective Flange Width

1. Effective Flange Width

$$\text{Lesser of } \begin{Bmatrix} s_1 / 2 \\ h_{w,above} / 4 \end{Bmatrix}$$ 18.10.5.2

2. Total Effective Flange Width

$$b_w + 2 \times \text{Effective Flange Width} < l_w$$

Load Combinations — Table 5.3.1

Minimum Web Reinforcement Number of Curtains

1. Minimum Web Reinforcement Ratios

$$\begin{Bmatrix} \rho_{l,min} = 0.0025 \\ \rho_{t,min} = 0.0025 \end{Bmatrix} \text{ if } V_u \geq \lambda \sqrt{f_c'} A_{cv}$$ 18.10.2.1

$$\begin{Bmatrix} \rho_{l,min} = 0.0025 \\ \rho_{t,min} \text{ accordance with Table 11.6.1} \end{Bmatrix} \text{ if } V_u < \lambda \sqrt{f_c'} A_{cv}$$

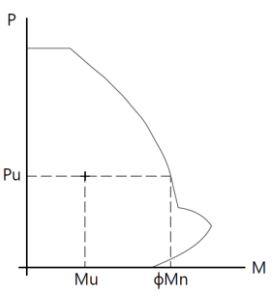
2. Number of Curtains of Web Reinforcement

At least two curtains shall be used if:

$$V_u > 2\lambda \sqrt{f_c'} A_{cv} \text{ or } h_w / l_w \geq 2.0$$ 18.10.2.2

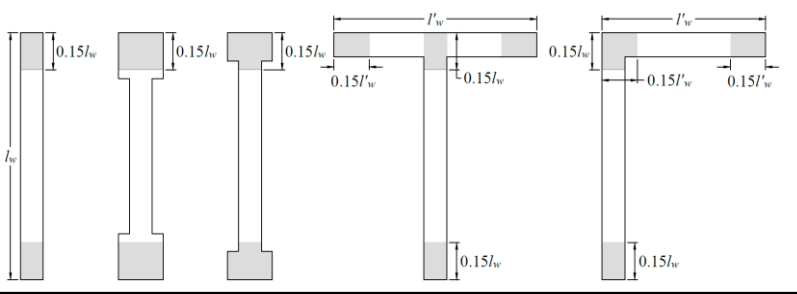
Required Longitudinal Reinforcement

Flexural strength of a wall or wall segment is determined according to procedures commonly used for columns based on a strain compatibility analysis. 18.10.5



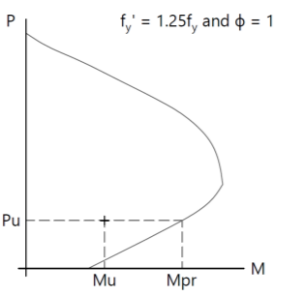
Longitudinal reinforcement ratio within $0.15l_w$ from the end of a vertical wall segment and over a width equal to the wall thickness:

$$\rho_l \text{ within } 0.15l_w > \frac{6\sqrt{f_c'}}{f_y}$$ 18.10.2.4(a)



Design Shear Force & Shear Strength

M_{pr} is the probable flexural strength of members, determined assuming $f_y' = 1.25f_y$ and $\phi = 1.0$. 2.2



Design Shear Force

$$\omega_v = \begin{cases} 0.9 + \frac{n_s}{10} & n_s \leq 6 \\ 1.3 + \frac{n_s}{30} \leq 1.8 & n_s > 6 \\ 1.0 & \text{when } \frac{h_{wcs}}{l_w} < 2.0 \end{cases}$$ 18.10.3.1.3

$$\Omega_v = \begin{cases} \text{Greater of } \begin{Bmatrix} \frac{M_{pr}}{M_u} \\ 1.5 \end{Bmatrix} & \frac{h_{wcs}}{l_w} > 1.5 \\ 1.0 & \frac{h_{wcs}}{l_w} \leq 1.5 \end{cases}$$ Table 18.10.3.1.2

$$V_e = \Omega_v \omega_v V_u \leq 3V_u$$ 18.10.3.1

Shear Strength

$$\phi_v V_n = \phi_v \left(\alpha_c \lambda \sqrt{f_c'} + \rho_t f_{yt} \right) A_{cv}$$ 18.10.4.1

$$\alpha_c = \begin{cases} 3 & \text{for } h_w / l_w \leq 1.5 \\ 2 & \text{for } h_w / l_w \geq 2.0 \\ 2 < \alpha_c < 3 & \text{for } 1.5 < h_w / l_w < 2.0 \end{cases}$$ 18.10.4.1

$$\phi_v V_n \begin{cases} < \phi_v 8\sqrt{f_c'} A_{cv} & \text{For Vertical Wall Segments (VWS)} \quad 18.10.4.4 \\ < \phi_v 10\sqrt{f_c'} A_{cw} & \text{For any one of the individual VWS} \quad 18.10.4.4 \\ < \phi_v 10\sqrt{f_c'} A_{cv} & \text{For Horizontal Wall Segments} \quad 18.10.4.5 \end{cases}$$

Special Boundary Elements

Are special boundary elements required?

$$f_{cu} = \frac{P_u}{A_g} + \frac{M_u \times l_w}{2 \times I_g} > 0.2 f_c'$$ 18.10.6.3

Yes — Special Boundary Elements are Required

1. Vertical extent of the special boundary element transverse reinforcement:

The special boundary element can be discontinued where:

$$f_{cu} < 0.15 f_c'$$ 18.10.6.3

2. Horizontal length:

The special boundary element can be extended horizontally a distance:

$$l_{be} = \text{ greater of } \begin{Bmatrix} c - 0.1 \times l_w \\ c / 2 \end{Bmatrix}$$ 18.10.6.4(a)

For flanged sections, the boundary element shall:

- Include the effective flange width in compression
- Extend at least 12 in. into the web.

18.10.6.4(d)

3. Width of the flexural compression zone:

$$b \geq \frac{h_u}{16}$$ 18.10.6.4(b)

$$b \geq 12 \text{ in. if } \begin{cases} \frac{c}{l_w} < \frac{3}{8} \\ \text{and} \\ \frac{h_w}{l_w} \geq 2.0 \end{cases}$$ 18.10.6.4(c)

4. Required Transverse reinforcement 18.10.6.4(g)

For Rectilinear Hoop

$$\frac{A_{sh}}{sb_c} = \text{Greater of } \begin{cases} 0.3\left(\frac{A_g}{A_{ch}} - 1 \right) \frac{f_c'}{f_{yt}} \\ 0.09 \frac{f_c'}{f_{yt}} \end{cases}$$

For Spiral / Circular Hoop

$$\rho_s = \text{Greater of } \begin{cases} 0.45\left(\frac{A_g}{A_{ch}} - 1 \right) \frac{f_c'}{f_{yt}} \\ 0.12 \frac{f_c'}{f_{yt}} \end{cases}$$

Where maximum vertical spacing is calculated in accordance with 18.10.6.4(e) and (f).

5. Other provisions to consider:

18.10.6.4(h), 18.10.6.4(i), 18.10.6.4(j), 18.10.6.4(k)

No — Special Boundary Elements are NOT Required

1. Transverse reinforcement in accordance with 18.10.6.5
2. The size of the transverse reinforcement must satisfy the requirements of 25.7.2.2

Reference: ACI 318-19