Description	
Wall:	SW1
Span:	Section 1 - (7.00-10.50)
Segment:	S1
Concrete:	35.00 MPa
Steel for horizontal reinforcement:	420.00 MPa
Steel for vertical reinforcement:	420.00 MPa

ACI 318M-14, Work section 11

In-plane shear strength (ACI 318M-14, 11.5.4)

The worst case forces to be withstood from the analysis are produced at Elevation 7.00 (Base), in the combination of loadcase 0.9·PP+0.9·CM+0.3·SX+SY.

$\phi V_n \geq V_u$ — 2382.0 kN ³ 1621.2 kN ✓

Where:

V_u: Factored shear force at section. — V_u : *1621.2* kN

V_n: Nominal shear strength. — V_n : *3970.0* kN

$$V_n = V_c + V_s$$

$$V_n \leq 0.83\sqrt{f'_c}hd$$

V_c: Nominal shear strength provided by concrete. — V_c : *2524.8* kN

$V_c = MIN(V_{c1}, V_{c2})$

$$V_{c1} = 0.27\lambda\sqrt{f'_c}hd + \frac{N_u d}{4l_w}$$

V_{c1} : *2524.8* kN

$$V_{c2} = \left[0.05\lambda\sqrt{f'_c} + \frac{l_w\left(0.1\lambda\sqrt{f'_c} + 0.2\frac{N_u}{l_w h}\right)}{\frac{M_u}{V_u} - \frac{l_w}{2}}\right]hd$$

V_{c2} : *12356.8* kN

V_s: Nominal shear strength provided by shear reinforcement. — V_s : *1445.2* kN

$$V_S = \frac{A_v f_{yt} d}{s}$$

N_u: Factored axial force. — N_u : *3040.0* kN

M_u: Factored moment. — M_u : *-4861.1* kN·m

A_v/s: Area of shear reinforcement. — A_v/s : *8.60* cm²/m

f'_c: Specified compressive strength of concrete. — f'_c : *35.00* MPa

$$\sqrt{f'_c} \leq 8.3\text{MPa}$$

f_y: Specified yield strength of transverse reinforcement. — f_y : *420.00* MPa

l_w: Length of wall. — l_w : *500.0* cm

h: Thickness of wall. — h : *30.0* cm

d: Distance from extreme compression fiber to centroid of longitudinal tension reinforcement. — d : *400.0* cm

$$d = 0.8 \cdot l_w$$

l: Modification factor to reflect the reduced mechanical properties of lightweight concrete relative to normalweight concrete of the same compressive strength. — l : *1.00*

f: Strength reduction factor. — f : *0.60*

Minimum transverse reinforcement (ACI 318M-14, 11.6)

The worst case forces to be withstood from the analysis are produced at Elevation 7.00 (Base), in the combination of loadcase 1.2·PP+1.2·CM-0.3·SX-SY.

If in-plane $V_u > 0.5 \cdot \phi V_c$, shall be satisfied:

$\rho_t \geq 0.0025$ 0.0029 ³ 0.0025 ✓

Where:

r_t: Ratio of area of distributed transverse reinforcement to gross concrete area perpendicular to that reinforcement. r_t : *0.0029*

V_u: Factored shear force at section. V_u : *1614.3* kN

V_c: Nominal shear strength provided by concrete. V_c : *2929.8* kN

Minimum longitudinal reinforcement (ACI 318M-14, 11.6)

The worst case forces to be withstood from the analysis are produced at Elevation 7.00 (Base), in the combination of loadcase 1.2·PP+1.2·CM-0.3·SX-SY.

If in-plane $V_u > 0.5 \cdot \phi V_c$, shall be satisfied:

$\rho_l \geq 0.0025 + 0.5(2.5 - h_w / l_w)(\rho_t - 0.0025)$ 0.0029 ³ 0.0028 ✓

$\rho_l \geq 0.0025$ 0.0029 ³ 0.0025 ✓

Where:

r_l: Ratio of area of distributed longitudinal reinforcement to gross concrete area perpendicular to that reinforcement. r_l : *0.0029*

r_t: Ratio of area of distributed transverse reinforcement to gross concrete area perpendicular to that reinforcement. r_t : *0.0029*

V_u: Factored shear force at section. V_u : *1614.3* kN

V_c: Nominal shear strength provided by concrete. V_c : *2929.8* kN

h_w: Height of wall. h_w : *350.0*

l_w: Length of wall. l_w : *500.0*

Maximum spacing of transverse reinforcement (ACI 318M-14, 11.7.3)

The worst case forces to be withstood from the analysis are produced at Elevation 7.00 (Base), in the combination of loadcase 1.4·PP+1.4·CM.

If in-plane $V_u \leq 0.5 \cdot \phi V_c$, shall be satisfied:

$s \leq \min(3h,\ 450\ mm)$ 30.0 cm £ 45.0 cm ✓

Where:

s: Spacing of transverse bars. s : *30.0* cm

h: Thickness of wall. h : *30.0* cm

V_u: Factored shear force at section. V_u : *0.0* kN

V_c: Nominal shear strength provided by concrete. V_c : *644.4* kN

Maximum spacing of longitudinal reinforcement (ACI 318M-14, 11.7.2)

The worst case forces to be withstood from the analysis are produced at Elevation 7.00 (Base), in the combination of loadcase 1.4·PP+1.4·CM.

If in-plane $V_u \leq 0.5 \cdot \phi V_c$, shall be satisfied:

$s \leq \min(3h,\ 450\ mm)$ 30.0 cm £ 45.0 cm ✓

Where:

s: Spacing of longitudinal bars. s : *30.0* cm

h: Thickness of wall. h : *30.0* cm

V_u: Factored shear force at section. V_u : *0.0* kN

V_c: Nominal shear strength provided by concrete. V_c : *644.4* kN

Number of layers (ACI 318M-14, 11.7.2.3)

For walls with 'h' greater than 250 mm distributed reinforcement for each direction shall be placed in two layers parallel with wall faces. ✓

h: Thickness of wall. h : 30.0 cm

n: Number of layers. n : 2

ACI 318M-14, Work section 18

Distributed web reinforcement ratios (ACI 318M-14, 18.10.2.1)

The worst case forces to be withstood from the analysis are produced at Elevation 7.00 (Base), in the combination of loadcase 1.2·PP+1.2·CM+0.3·SX+SY.

If in-plane $V_u \le 0.083A_{cv}\lambda\sqrt{f'_c}$, shall be satisfied:

$\rho_l \ge 0.0025 + 0.5(2.5 - h_w/l_w)(\rho_t - 0.0025)$ 0.0029 ³ 0.0028 ✓

$\rho_t \ge 0.0025$ 0.0029 ³ 0.0025 ✓

Where:

r_l: Ratio of area of distributed longitudinal reinforcement to gross concrete area perpendicular to that reinforcement. r_l : 0.0029

r_t: Ratio of area of distributed transverse reinforcement to gross concrete area perpendicular to that reinforcement. r_t : 0.0029

V_u: Factored shear force at section. V_u : -1614.3 kN

A_{cv}: Area of concrete section. A_{cv} : 1500000.00 mm²

f'_c: Specified compressive strength of concrete. f'_c : 35.00 MPa

$\sqrt{f'_c} \le 8.3\text{MPa}$

l: Modification factor to reflect the reduced mechanical properties of lightweight concrete relative to normalweight concrete of the same compressive strength. l : 1.00

Maximum reinforcement spacing (ACI 318M-14, 18.10.2.1)

Required:

$s_l \le 450$ mm 30.0 cm £ 45.0 cm ✓

$s_t \le 450$ mm 30.0 cm £ 45.0 cm ✓

s_l: Spacing of longitudinal bars. s_l : 30.0 cm

s_t: Spacing of transverse bars. s_t : 30.0 cm

Number of layers (ACI 318M-14, 18.10.2.2)

At least two curtains of reinforcement shall be used in a wall if $V_u > 0.17A_{cv}\lambda\sqrt{f'_c}$ or $h_w/l_w \ge 2.0$ ✓

n: Number of layers. n : 2

V_u: Factored shear force at section. V_u : 0.0 kN

A_{cv}: Area of concrete section. A_{cv} : 1500000.00 mm²

l: Modification factor to reflect the reduced mechanical properties of lightweight concrete relative to normalweight concrete of the same compressive strength. l : 1.00

f'_c: Specified compressive strength of concrete. f'_c : 35.00 MPa

h_w: Height of wall. h_w : 350.0 cm

l_w: Length of wall. l_w : 500.0 cm

Shear strength (ACI 318M-14, 18.10.4.1)

The worst case forces to be withstood from the analysis are produced at Elevation 7.00 (Base), in the combination of loadcase 1.2·PP+1.2·CM+0.5·Qa-0.3·SX-SY.

$\phi V_n \geq V_u$ 2415.0 kN ³ 1626.3 kN ✓

Where:

V_u: Factored shear force at section. V_u : 1626.3 kN

V_n: Nominal shear strength. V_n : 4025.0 kN

$$V_n = A_{cv}\left(\alpha_c \lambda \sqrt{f'_c} + \rho_t f_y\right)$$

$$V_n \leq 0.83 A_{cv} \sqrt{f'_c} \quad (18.10.4.4)$$

A_{cv}: Area of concrete section. A_{cv} : 1500000.00 mm²

The coefficient α_c is 0.25 for $h_w/l_w \leq 1.50$, is 0.17 for $h_w/l_w \geq 2.00$, and varies linearly between 0.25 and 0.17 for h_w/l_w between 1.50 and 2.00. a_c : 0.25

h_w: Height of wall. h_w : 350.0 cm

l_w: Length of wall. l_w : 500.0 cm

l: Modification factor to reflect the reduced mechanical properties of lightweight concrete relative to normalweight concrete of the same compressive strength. l : 1.00

f'_c: Specified compressive strength of concrete. f'_c : 35.00 MPa

r_t: Ratio of area of distributed transverse reinforcement to gross concrete area perpendicular to that reinforcement. r_t : 0.0029

f_y: Specified yield strength of transverse reinforcement. f_y : 420.00 MPa

f: Strength reduction factor. f : 0.60

Longitudinal reinforcement ratio (ACI 318M-14, 18.10.4.3)

If h_w/l_w does not exceed 2.00, reinforcement ratio ρ_l shall be at least the reinforcement ratio ρ_t.

$\rho_l \geq \rho_t$ 0.0029 ³ 0.0029 ✓

Where:

r_l: Ratio of area of distributed longitudinal reinforcement to gross concrete area perpendicular to that reinforcement. r_l : 0.0029

r_t: Ratio of area of distributed transverse reinforcement to gross concrete area perpendicular to that reinforcement. r_t : 0.0029

h_w/l_w : 0.70

Edge elements (ACI 318M-14, 18.10.6.1, 18.10.6.5) (Initial)

Special boundary elements

Structural wall shall have special boundary elements at boundaries and edges around openings where the maximum extreme fiber compressive stress, σ, exceeds 0.2f'c:

(ACI 318M-14, 18.10.6.3)

P_u (kN)	M_u (kN·m)	Edge elements	Location	σ (MPa)	0.2f'c (MPa)	Necesita elemento especial
4858.1	-4808.2	1.2·PP+1.2·CM+0.5·Qa-0.3·SX+SY	Elevation 7.00 (Base)	7.09	7.00	Yes

Where:

P_u: Factored axial force.

M_u: Factored moment.

s: Maximum extreme fiber compressive stress.

f'c: Specified compressive strength of concrete.

Edge elements (ACI 318M-14, 18.10.6.1, 18.10.6.5) (Final)

Special boundary elements

Structural wall shall have special boundary elements at boundaries and edges around openings where the maximum extreme fiber compressive stress, σ, exceeds 0.2f'$_c$:

(ACI 318M-14, 18.10.6.3)

P_u (kN)	M_u (kN·m)	Edge elements	Location	σ (MPa)	0.2f'$_c$ (MPa)	Necesita elemento especial
5547.8	4877.2	1.2·PP+1.2·CM+0.5·Qa-0.3·SX-SY	Elevation 7.00 (Base)	7.60	7.00	Yes

Where:

P_u: Factored axial force.

M_u: Factored moment.

s: Maximum extreme fiber compressive stress.

f'$_c$: Specified compressive strength of concrete.

Length of boundary element (ACI 318M-14, 18.10.6.4(a)) (Initial)

The worst case forces to be withstood from the analysis are produced at Elevation 7.00 (Base), in the combination of loadcase 1.2·PP+1.2·CM+0.5·Qa-0.3·SX+SY.

The boundary element shall extend horizontally from the extreme compression fiber a distance at least the greater of (c-0.1·l_w) and c/2.

$$\ell_{be} \geq MAX(c - 0.1l_w, c/2)$$ 60.0 ≥ 43.1 ✓

Where:

l_{be}: Length of boundary element — l_{be} : 60.0 cm

c: Largest neutral axis depth calculated for the factored axial force and nominal moment strength. — c : 86.2 cm

l_w: Length of wall. — l_w : 500.0 cm

P_u: Factored axial force. — P_u : 4858.1 kN

M_n: Nominal moment strength. — M_n : -18771.2 kN·m

Length of boundary element (ACI 318M-14, 18.10.6.4(a)) (Final)

The worst case forces to be withstood from the analysis are produced at Elevation 7.00 (Base), in the combination of loadcase 1.2·PP+1.2·CM+0.5·Qa-0.3·SX-SY.

The boundary element shall extend horizontally from the extreme compression fiber a distance at least the greater of (c-0.1·l_w) and c/2.

$$\ell_{be} \geq MAX(c - 0.1l_w, c/2)$$ 60.0 ≥ 45.7 ✓

Where:

l_{be}: Length of boundary element — l_{be} : 60.0 cm

c: Largest neutral axis depth calculated for the factored axial force and nominal moment strength. — c : 91.3 cm

l_w: Length of wall. — l_w : 500.0 cm

P_u: Factored axial force. — P_u : 5547.8 kN

M_n: Nominal moment strength. — M_n : 20082.7 kN·m

Maximum spacing of longitudinal bars laterally supported (ACI 318M-14, 18.10.6.4(e), 18.7.5.2) (Initial)

$$h_x \leq MIN\left(\frac{2}{3}b, 350mm\right)$$ 15.0 ≤ 20.0 ✓

Where:

b: Width of boundary element — b : 30.0 cm

h_x: Spacing of the longitudinal bars that are supported laterally by the corner of a supplementary hook or closed confinement stirrup branch. — h_x : 15.0 cm

Maximum spacing of longitudinal bars laterally supported (ACI 318M-14, 18.10.6.4(e), 18.7.5.2) (Final)

$$h_x \le MIN\left(\frac{2}{3}b, 350mm\right)$$ 15.0 ≤ 20.0 ✓

Where:

b: Width of boundary element — b : 30.0 cm

h_x: Spacing of the longitudinal bars that are supported laterally by the corner of a supplementary hook or closed confinement stirrup branch. — h_x : 15.0 cm

Width of boundary element (ACI 318M-14, 18.10.6.4(b)) (Initial)

Width of the flexural compression zone, 'b', including flange, if present, shall be:

$$b \ge h_u / 16$$ 30.0 ≥ 21.9 cm ✓

When $h_w/l_w \ge 2.0$ and $c/l_w \ge 3/8$

$$b \ge 300mm$$ -- ✓

Where:

h_u: Laterally unsupported height at extreme compression fiber of wall. — h_u : 350.0 cm

l_w: Length of wall. — l_w : 500.0 cm

h_w: Height of wall. — h_w : 350.0 cm

c: Distance from extreme compression fiber to neutral axis. — c : 86.2 cm

Width of boundary element (ACI 318M-14, 18.10.6.4(b)) (Final)

Width of the flexural compression zone, 'b', including flange, if present, shall be:

$$b \ge h_u / 16$$ 30.0 ≥ 21.9 cm ✓

When $h_w/l_w \ge 2.0$ and $c/l_w \ge 3/8$

$$b \ge 300mm$$ -- ✓

Where:

h_u: Laterally unsupported height at extreme compression fiber of wall. — h_u : 350.0 cm

l_w: Length of wall. — l_w : 500.0 cm

h_w: Height of wall. — h_w : 350.0 cm

c: Distance from extreme compression fiber to neutral axis. — c : 91.3 cm

Spacing of transverse reinforcement of boundary element (ACI 318M-14, 18.10.6.4(e), 18.7.5.3) (Initial)

Spacing of transverse reinforcement shall not exceed:

$$s \le \frac{\min(b, \ell_{be})}{3}$$ 9.0 ≤ 10.0 cm ✓

$$s \le 6 \cdot d_{b,min}$$ 9.0 ≤ 9.5 cm ✓

$$s \le s_0$$ 9.0 ≤ 15.0 cm ✓

Where:

b: Width of boundary element — b : 30.0 cm

l_{be}: Length of boundary element — l_{be} : 60.0 cm

$d_{b,min}$: Diameter of the smallest longitudinal bar. — $d_{b,min}$: 1.6 cm

s: Center-to-center spacing of transverse reinforcement. — s : 9.0 cm

h_x: Maximum center-to-center spacing of longitudinal bars laterally supported by corners of crossties or hoop legs around the perimeter of the column. — h_x : 15.0 cm

s_0: Maximum separation — s_0 : 15.0 cm

$$s_0 \le 100 + \left(\frac{350 - h_x}{3}\right), s_0 \le 150 \text{ mm}$$

Spacing of transverse reinforcement of boundary element (ACI 318M-14, 18.10.6.4(e), 18.7.5.3) (Final)

Spacing of transverse reinforcement shall not exceed:

$$s \le \frac{\min(b, \ell_{be})}{3} \qquad 9.0 \le 10.0 \text{ cm}$$

$$s \le 6 \cdot d_{b,min} \qquad 9.0 \le 9.5 \text{ cm}$$

$$s \le s_0 \qquad 9.0 \le 15.0 \text{ cm}$$

Where:

b: Width of boundary element — b : 30.0 cm

l_{be}: Length of boundary element — l_{be} : 60.0 cm

$d_{b,min}$: Diameter of the smallest longitudinal bar. — $d_{b,min}$: 1.6 cm

s: Center-to-center spacing of transverse reinforcement. — s : 9.0 cm

h_x: Maximum center-to-center spacing of longitudinal bars laterally supported by corners of crossties or hoop legs around the perimeter of the column. — h_x : 15.0 cm

s_0: Maximum separation — s_0 : 15.0 cm

$$s_0 \le 100 + \left(\frac{350 - h_x}{3}\right), s_0 \le 150 \text{ mm}$$

Amount of transverse reinforcement of boundary element (ACI 318M-14, 18.10.6.4(f)) (Initial)

The amount of transverse reinforcement shall be in accordance with:

$$A_{sh} \ge 0.3\left(\frac{A_g}{A_{ch}} - 1\right)\frac{f'_c}{f_{yt}} \cdot s \cdot b_c \qquad 283.87 \ge 170.53 \text{ mm}^2$$

$$A_{sh} \ge 0.09\frac{f'_c}{f_{yt}} \cdot s \cdot b_c \qquad 283.87 \ge 162.00 \text{ mm}^2$$

Where:

A_{sh}: Total cross-sectional area of transverse reinforcement, including crossties, within spacing s and perpendicular to dimension, b_c.

A_g: Gross area of concrete section. — A_g : 180000.00 mm²

A_{ch}: Cross-sectional area measured to the outside edges of transverse reinforcement. — A_{ch} : 136800.00 mm²

b_c: Cross-sectional dimension of member core measured to the outside edges of the transverse reinforcement composing area A_{sh}. — b_c : 24.0 cm

s: Center-to-center spacing of transverse reinforcement. — s : 9.0 cm

f'_c: Specified compressive strength of concrete. — f'_c : 35.00 MPa

f_{yt}: Specified yield strength of transverse reinforcement. — f_{yt} : 420.00 MPa

Amount of transverse reinforcement of boundary element (ACI 318M-14, 18.10.6.4(f)) (Final)

The amount of transverse reinforcement shall be in accordance with:

$$A_{sh} \ge 0.3\left(\frac{A_g}{A_{ch}} - 1\right)\frac{f'_c}{f_{yt}} \cdot s \cdot b_c \qquad 283.87 \ge 170.53 \text{ mm}^2$$

$$A_{sh} \ge 0.09\frac{f'_c}{f_{yt}} \cdot s \cdot b_c \qquad 283.87 \ge 162.00 \text{ mm}^2$$

Where:

A_{sh}: Total cross-sectional area of transverse reinforcement, including crossties, within spacing s and perpendicular to dimension, b_c.

A_g: Gross area of concrete section. — A_g : 180000.00 mm²

A_{ch}: Cross-sectional area measured to the outside edges of transverse reinforcement. — A_{ch} : 136800.00 mm²

b_c: Cross-sectional dimension of member core measured to the outside edges of the transverse reinforcement composing area A_{sh}. — b_c : 24.0 cm

s: Center-to-center spacing of transverse reinforcement. — s : 9.0 cm

f'_c: Specified compressive strength of concrete. — f'_c : 35.00 MPa

f_{yt}: Specified yield strength of transverse reinforcement. f_{yt} : *420.00* MPa