

Description	
Wall:	SW1
Span:	Floor 15
Segment:	S1
Concrete:	24.53 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 318S-14, 11.5.4)

The worst case forces to be withstood from the analysis are produced at Elevation 49.00 (Base), in the combination of loadcase 0.84·SW+0.84·DL+0.3·SX+SY (6).

$$\phi V_n \geq V_u$$

$$1690.4 \text{ kN} \geq 23.6 \text{ kN} \quad \checkmark$$

Where:

V_u: Factored shear force at section.

$$V_u : \underline{23.6} \text{ kN}$$

V_n: Nominal shear strength.

$$V_n : \underline{2817.4} \text{ kN}$$

$$V_n = V_c + V_s$$

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

V_c: Nominal shear strength provided by concrete.

$$V_c : \underline{1625.2} \text{ kN}$$

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

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

$$V_{c1} : \underline{1625.2} \text{ kN}$$

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

$$V_{c2} : \underline{--} \text{ kN}$$

Equation shall not apply if $(M_u/V_u - l_w/2)$ is negative.

V_s: Nominal shear strength provided by shear reinforcement.

$$V_s : \underline{1192.3} \text{ kN}$$

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

N_u: Factored axial force.

$$N_u : \underline{103.1} \text{ kN}$$

M_u: Factored moment.

$$M_u : \underline{-14.5} \text{ kN}\cdot\text{m}$$

A_v/s: Area of shear reinforcement.

$$A_v/s : \underline{7.10} \text{ cm}^2/\text{m}$$

f'_c: Specified compressive strength of concrete.

$$f'_c : \underline{24.53} \text{ MPa}$$

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

f_y: Specified yield strength of transverse reinforcement.

$$f_y : \underline{420.00} \text{ MPa}$$

l_w: Length of wall.

$$l_w : \underline{500.0} \text{ cm}$$

h: Thickness of wall.

$$h : \underline{30.0} \text{ cm}$$

d: Distance from extreme compression fiber to centroid of longitudinal tension reinforcement.

$$d : \underline{400.0} \text{ cm}$$

$$d = 0.8 \cdot l_w$$

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

$$\lambda : \underline{1.00}$$

φ: Strength reduction factor.

$$\phi : \underline{0.60}$$

Transverse shear (ACI 318S-14, 11.5.4)

The check does not proceed, as there is no shear force.

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

The worst case forces to be withstood from the analysis are produced at Elevation 49.00 (Base), in the combination of loadcase 1.4·SW+1.4·DL.

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

$$\rho_t \geq \rho_{t,min}$$

$$0.0024 \geq 0.0020 \quad \checkmark$$

Where:

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

$$\rho_t : \underline{0.0024}$$

$\rho_{t,min}$: Minimum ratio.

$$\rho_{t,min} : \underline{0.0020}$$

Bar size	f_y	$\rho_{t,min}$
≤ No.16	≥ 420 MPa	0.0020
	< 420 MPa	0.0025
> No.16	--	0.0025

V_u : Factored shear force at section.

$$V_u : \underline{0.0} \text{ kN}$$

V_c : Nominal shear strength provided by concrete.

$$V_c : \underline{1639.0} \text{ kN}$$

d_b : Maximum diameter of the reinforcement.

$$d_b : \underline{9.5} \text{ mm}$$

f_y : Specified yield strength of transverse reinforcement.

$$f_y : \underline{420.00} \text{ MPa}$$

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

The worst case forces to be withstood from the analysis are produced at Elevation 49.00 (Base), in the combination of loadcase 1.4·SW+1.4·DL.

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

$$\rho_l \geq \rho_{l,min}$$

$$0.0024 \geq 0.0012 \quad \checkmark$$

Where:

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

$$\rho_l : \underline{0.0024}$$

$\rho_{l,min}$: Minimum ratio.

$$\rho_{l,min} : \underline{0.0012}$$

Bar size	f_y	$\rho_{l,min}$
≤ No.16	≥ 420 MPa	0.0012
	< 420 MPa	0.0015
> No.16	--	0.0015

V_u : Factored shear force at section.

$$V_u : \underline{0.0} \text{ kN}$$

V_c : Nominal shear strength provided by concrete.

$$V_c : \underline{1639.0} \text{ kN}$$

d_b : Maximum diameter of the reinforcement.

$$d_b : \underline{9.5} \text{ mm}$$

f_y : Specified yield strength of transverse reinforcement.

$$f_y : \underline{420.00} \text{ MPa}$$

Minimum spacing of transverse reinforcement (ACI 318S-14, 25.2.2)

Reinforcement in the upper layers shall be placed directly above reinforcement in the bottom layer with a clear spacing between layers of at least 25mm

$$s \geq 25\text{mm}$$

$$19 \text{ cm} \geq 3 \text{ cm} \quad \checkmark$$

Minimum spacing of longitudinal reinforcement (ACI 318S-14, 25.2.3)

Clear spacing between bars shall be at least the greatest of:

$$s \geq s_{min}$$

$$19 \text{ cm} \geq 4 \text{ cm} \quad \checkmark$$

Where:

s_{min} : Maximum value of s_1, s_2, s_3

$$s_1 = 40\text{mm}$$

$$s_1 : \underline{4} \text{ cm}$$

$$s_2 = 1.5d_b$$

$$s_2 : \underline{1} \text{ cm}$$

$$s_3 = \frac{4}{3} \cdot d_{agg}$$

$$s_3 : \underline{3} \text{ cm}$$

Where:

d_b : Nominal bar diameter.

$$d_b : \underline{9.5} \text{ mm}$$

d_{agg} : Nominal maximum size of coarse aggregate.

$$d_{agg} : \underline{20.0} \text{ mm}$$

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

The worst case forces to be withstood from the analysis are produced at Elevation 49.00 (Base), in the combination of loadcase 1.4·SW+1.4·DL.

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

$$s \leq \min(3h, 450 \text{ mm})$$

$$20 \text{ cm} \leq 45 \text{ cm} \quad \checkmark$$

Where:

s : Spacing of transverse bars.

$$s : \underline{20} \text{ cm}$$

h : Thickness of wall.

$$h : \underline{30.0} \text{ cm}$$

V_u : Factored shear force at section.

$$V_u : \underline{0.0} \text{ kN}$$

V_c : Nominal shear strength provided by concrete.

$$V_c : \underline{1639.0} \text{ kN}$$

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

The worst case forces to be withstood from the analysis are produced at Elevation 49.00 (Base), in the combination of loadcase 1.4·SW+1.4·DL.

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

$$s \leq \min(3h, 450 \text{ mm})$$

$$20 \text{ cm} \leq 45 \text{ cm} \quad \checkmark$$

Where:

s : Spacing of longitudinal bars.

$$s : \underline{20} \text{ cm}$$

h : Thickness of wall.

$$h : \underline{30.0} \text{ cm}$$

V_u : Factored shear force at section.

$$V_u : \underline{0.0} \text{ kN}$$

V_c : Nominal shear strength provided by concrete.

$$V_c : \underline{1639.0} \text{ kN}$$

Number of layers (ACI 318S-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.

$$h : \underline{30.0} \text{ cm}$$

n : Number of layers.

$$n : \underline{2}$$

ACI 318M-14, Work section 18

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

The worst case forces to be withstood from the analysis are produced at Elevation 49.00 (Base), in the combination of loadcase 1.4·SW+1.4·DL.

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

$$\rho_l \geq 0.0012$$

$$0.0024 \geq 0.0012 \quad \checkmark$$

$$\rho_t \geq 0.0020$$

$$0.0024 \geq 0.0020 \quad \checkmark$$

Where:

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

$$\rho_l : \underline{0.0024}$$

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

V_u : Factored shear force at section.

A_{cv} : Area of concrete section.

f'_c : Specified compressive strength of concrete.

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

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

ρ_t	:	<u>0.0024</u>	
V_u	:	<u>0.0</u>	kN
A_{cv}	:	<u>1500000.00</u>	mm ²
f'_c	:	<u>24.53</u>	MPa
λ	:	<u>1.00</u>	

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

Required:

$$s_l \leq 450 \text{ mm}$$

$$s_t \leq 450 \text{ mm}$$

s_l : Spacing of longitudinal bars.

s_t : Spacing of transverse bars.

$20 \text{ cm} \leq 45 \text{ cm}$	✓
$20 \text{ cm} \leq 45 \text{ cm}$	✓
s_l	: <u>20</u> cm
s_t	: <u>20</u> cm

Number of layers (ACI 318S-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 $h_w/l_w \geq 2.0$

n : Number of layers.

V_u : Factored shear force at section.

A_{cv} : Area of concrete section.

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

f'_c : Specified compressive strength of concrete.

h_w : Height of wall.

l_w : Length of wall.

n	:	<u>2</u>	
V_u	:	<u>0.0</u>	kN
A_{cv}	:	<u>1500000.00</u>	mm ²
λ	:	<u>1.00</u>	
f'_c	:	<u>24.53</u>	MPa
h_w	:	<u>300.0</u>	cm
l_w	:	<u>500.0</u>	cm

Shear strength (ACI 318S-14, 18.10.4.1)

The worst case forces to be withstood from the analysis are produced at Elevation 49.00 (Base), in the combination of loadcase 1.26·SW+1.26·DL-0.3·SX-SY (6).

$$\phi V_n \geq V_u$$

Where:

V_u : Factored shear force at section.

V_n : Nominal shear strength.

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

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

A_{cv} : Area of concrete section.

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.

h_w : Height of wall.

l_w : Length of wall.

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

f'_c : Specified compressive strength of concrete.

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

$2008.5 \text{ kN} \geq 23.6 \text{ kN}$	✓		
V_u	:	<u>23.6</u>	kN
V_n	:	<u>3347.4</u>	kN
A_{cv}	:	<u>1500000.00</u>	mm ²
α_c	:	<u>0.25</u>	
h_w	:	<u>300.0</u>	cm
l_w	:	<u>500.0</u>	cm
λ	:	<u>1.00</u>	
f'_c	:	<u>24.53</u>	MPa
ρ_t	:	<u>0.0024</u>	

f_y : Specified yield strength of transverse reinforcement.
 ϕ : Strength reduction factor.

f_y : 420.00 MPa
 ϕ : 0.60

Longitudinal reinforcement ratio (ACI 318S-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 .

$\rho_l \geq \rho_t$

0.0024 \geq 0.0024 ✓

Where:

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

ρ_l : 0.0024

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

ρ_t : 0.0024

h_w/l_w : 0.60

Edge elements (ACI 318S-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 318S-14, 18.10.6.3)

P_u (kN)	M_u (kN·m)	Edge elements	Location	σ (MPa)	$0.2f'_c$ (MPa)	Special element required
172.4	0.0	1.4·SW+1.4·DL	Elevation 49.00 (Base)	0.11	4.91	No

Where:

P_u : Factored axial force.

M_u : Factored moment.

σ : Maximum extreme fiber compressive stress.

f'_c : Specified compressive strength of concrete.

Edge elements (ACI 318S-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 318S-14, 18.10.6.3)

P_u (kN)	M_u (kN·m)	Edge elements	Location	σ (MPa)	$0.2f'_c$ (MPa)	Special element required
155.5	14.5	1.26·SW+1.26·DL-0.3·SX-SY (6)	Elevation 49.00 (Base)	0.12	4.91	No

Where:

P_u : Factored axial force.

M_u : Factored moment.

σ : Maximum extreme fiber compressive stress.

f'_c : Specified compressive strength of concrete.

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

No check required

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

No check required

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

No check required

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

No check required

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

No check required

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

No check required

Spacing of transverse reinforcement (ACI 318S-14, 18.10.6.5) (Initial)

No check required

Spacing of transverse reinforcement (ACI 318S-14, 18.10.6.5) (Final)

No check required

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

No check required

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

No check required