

EC5 Timber Fastener Capacity Check

EN 1995-1-1:2004

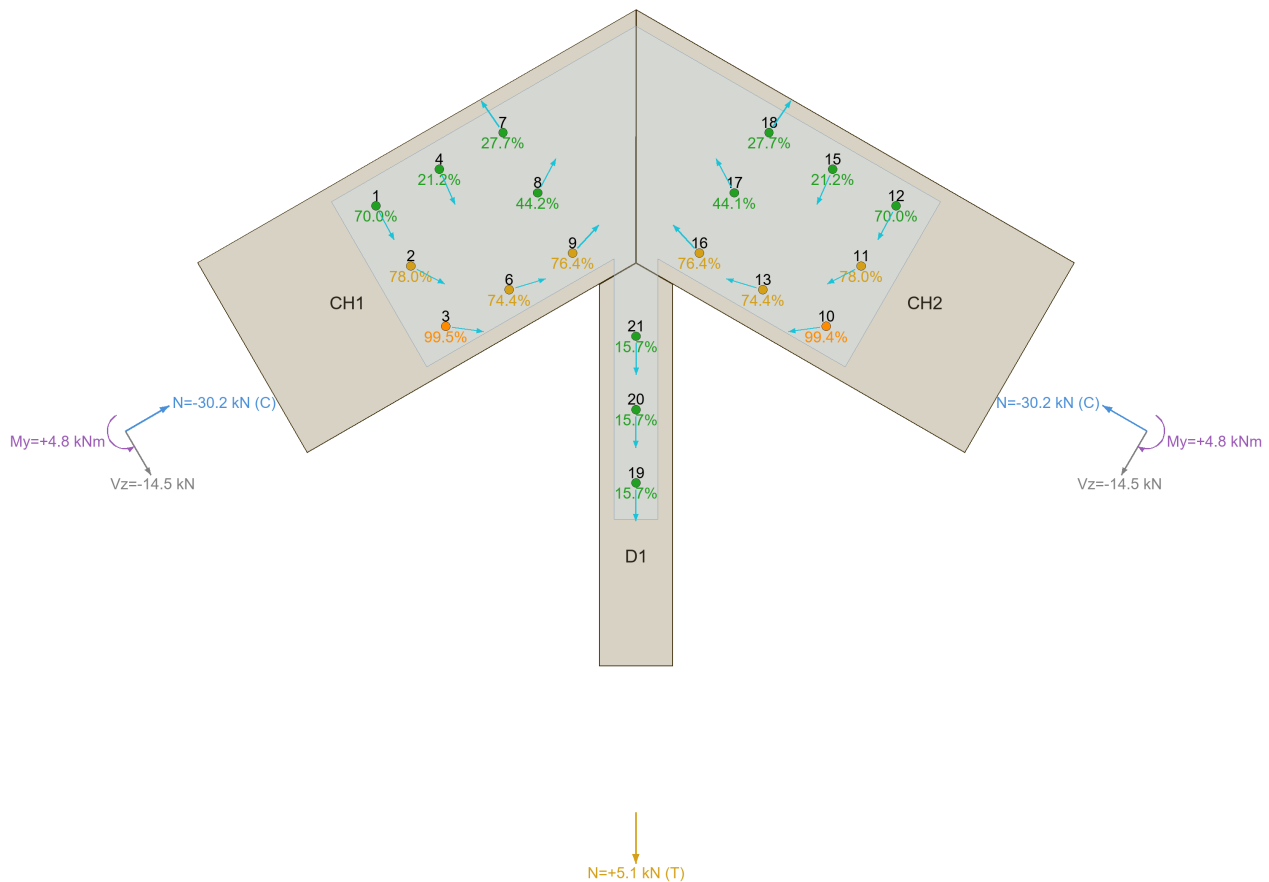
Date: 2026-08-11
Load Case: manual

Input Data Summary

Timber class	C24
Service class	1
Load duration	Medium-term
Fastener type	Bolt
Fastener diameter	12 mm
Fastener grade	4.6 (240/400)
Plate thickness	8.0 mm
Plate grade	S355
Plate type	Inserted
Number of plates	1
Slot tolerance	0.0 mm (per side)
Recess	0.0 mm/end
a3 end-distance offset	0.0 mm

Connection Views

SIDE VIEW (XZ)



• eta ≤ 70% • 70% < eta ≤ 90% • 90% < eta ≤ 100% • eta > 100% FAIL

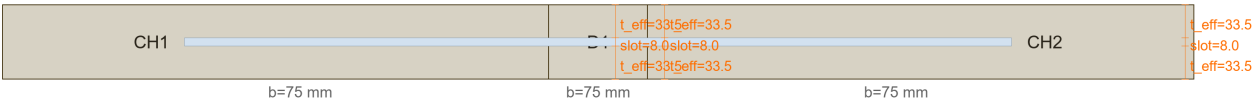
Members

Name	Bearing	b [mm]	h [mm]	Cross-section
CH1	Yes	75	300	75 x 300
CH2	No	75	300	75 x 300
D1	No	75	100	75 x 100

Member Loads (LC: manual)

Member	N [kN]	T/C	Vz [kN]	Vy [kN]	My [kNm]	Mz [kNm]	T [kNm]
CH1 / End	-30.20	C	-14.50	0.00	4.77	0.00	0.00
CH2 / End	-30.20	C	-14.50	0.00	4.77	0.00	0.00
D1 / End	5.09	T	0.00	0.00	0.00	0.00	0.00

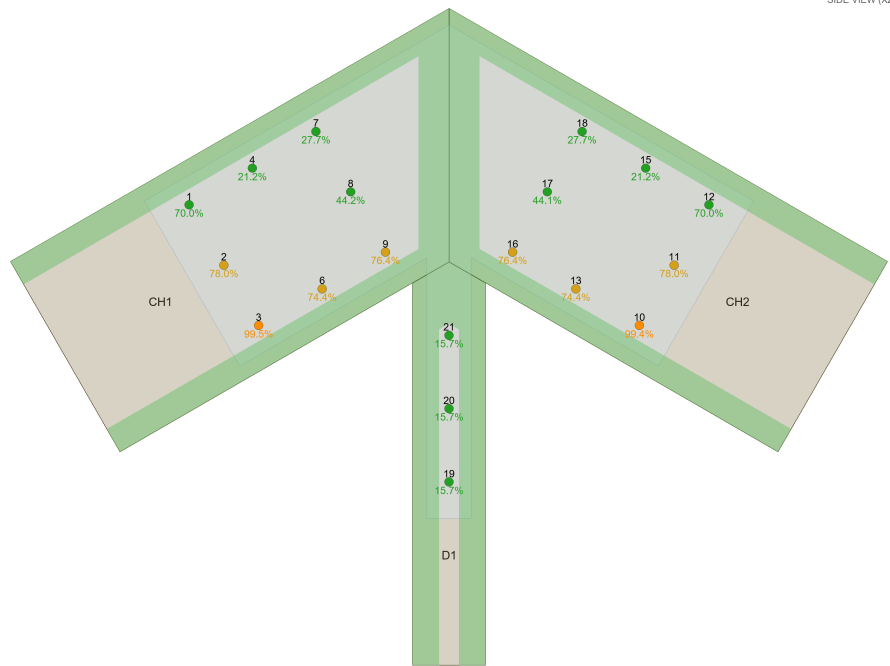
Equilibrium (Forces through node): X -0.00 Y +0.00 Z -0.00 kN Mx +0.00 My +0.00 Mz +0.00 kNm (balanced)
+ Lever arm (fastener group centroid x Vz): My +0.00 kNm
Equilibrium (Forces through fastener centroid): X -0.00 Y +0.00 Z -0.00 kN Mx +0.00 My +0.00 Mz +0.00 kNm (balanced)



■ Timber member ■ Steel plate

Spacing Validation - S8.5.1.1(3)

SIDE VIEW (XZ)



• eta ≤ 70% • 70% < eta ≤ 90% • 90% < eta ≤ 100% • eta > 100% FAIL

a3 end-distance + a4 edge-distance zones, shown exactly as the on-screen side view (green = pass, red = fail).

Member CH1

a1 PARALLEL SPACING

$a_{1,min} = (4 + |\cos \alpha|) \cdot d = 58.8 \text{ mm}$ actual = 100.0 mm ✓ PASS

a2 PERPENDICULAR SPACING

$a_{2,min} = 48.0 \text{ mm}$ actual = 95.0 mm ✓ PASS

a3,c END DISTANCE (unloaded)

$a_{3,c,min} = 48.0 \text{ mm}$ actual = 100.0 mm ✓ PASS

a4,t EDGE DISTANCE (loaded)

$a_{4,t,min} = \max((2+2|\sin \alpha|)d, 3d) = 36.0 \text{ mm}$ actual = 55.0 mm ✓ PASS

a4,c EDGE DISTANCE (unloaded)

$a_{4,c,min} = 3d = 36.0 \text{ mm}$ actual = 55.0 mm ✓ PASS

Member CH2

a1 PARALLEL SPACING

$a_{1,min} = (4 + |\cos \alpha|) \cdot d = 58.8 \text{ mm}$ actual = 100.0 mm ✓ PASS

a2 PERPENDICULAR SPACING

$a_{2,min} = 48.0 \text{ mm}$ actual = 95.0 mm ✓ PASS

a3,c END DISTANCE (unloaded)

$a_{3,c,min} = 48.0 \text{ mm}$ actual = 100.0 mm ✓ PASS

a4,t EDGE DISTANCE (loaded)

$a_{4,t,min} = \max((2+2|\sin \alpha|)d, 3d) = 36.0 \text{ mm}$ actual = 55.0 mm ✓ PASS

a4,c EDGE DISTANCE (unloaded)

$a_{4,c,min} = 3d = 36.0 \text{ mm}$ actual = 55.0 mm ✓ PASS

Member D1

a1 PARALLEL SPACING

$a_{1,min} = (4 + |\cos \alpha|) \cdot d = \mathbf{60.0\ mm}$ actual = **100.0 mm** ✓ **PASS**

a3,t END DISTANCE (loaded)

$a_{3,t,min} = \max(7d, 80) = \mathbf{84.0\ mm}$ actual = **100.0 mm** ✓ **PASS**

a4,c EDGE DISTANCE (unloaded, Depth+)

$a_{4,c,min} = 3d = \mathbf{36.0\ mm}$ actual = **50.0 mm** ✓ **PASS**

a4,c EDGE DISTANCE (unloaded, Depth-)

$a_{4,c,min} = 3d = \mathbf{36.0\ mm}$ actual = **50.0 mm** ✓ **PASS**

Fastener Capacity - EN 1995-1-1:2004

Fastener	a[°]	t [mm]	f _{ha}	V _{Ed,Σ}	F _{vRd,Σ}	ηΣ%	V _{Ed,pl}	F _{vRd,pl}	ηpl%	Compat	LC	Status	Md
B1	88	34/8/34	16.5	5.99	8.56	70.0	3.00	4.28	70.0	-	man...	PASS	g
B2	58	34/8/34	18.3	7.08	9.07	78.0	3.54	4.54	78.0	-	man...	PASS	g
B3	38	34/8/34	21.1	9.79	9.85	99.5	4.90	4.92	99.5	-	man...	PASS	g
B4	84	34/8/34	16.6	1.82	8.58	21.2	0.91	4.29	21.2	-	man...	PASS	g
B6	13	34/8/34	24.6	7.96	10.69	74.4	3.98	5.34	74.4	-	man...	PASS	g
B7	85	34/8/34	16.5	2.38	8.57	27.7	1.19	4.29	27.7	-	man...	PASS	g
B8	32	34/8/34	22.0	4.46	10.09	44.2	2.23	5.05	44.2	-	man...	PASS	g
B9	17	34/8/34	24.2	8.10	10.60	76.4	4.05	5.30	76.4	-	man...	PASS	g
B10	38	34/8/34	21.1	9.79	9.85	99.4	4.90	4.92	99.4	-	man...	PASS	g
B11	58	34/8/34	18.3	7.08	9.07	78.0	3.54	4.54	78.0	-	man...	PASS	g
B12	88	34/8/34	16.5	5.99	8.56	70.0	3.00	4.28	70.0	-	man...	PASS	g
B13	13	34/8/34	24.6	7.95	10.69	74.4	3.98	5.34	74.4	-	man...	PASS	g
B15	84	34/8/34	16.6	1.82	8.58	21.2	0.91	4.29	21.2	-	man...	PASS	g
B16	17	34/8/34	24.2	8.10	10.60	76.4	4.05	5.30	76.4	-	man...	PASS	g
B17	32	34/8/34	22.0	4.46	10.09	44.1	2.23	5.05	44.1	-	man...	PASS	g
B18	85	34/8/34	16.5	2.37	8.57	27.7	1.19	4.29	27.7	-	man...	PASS	g
B19	0	34/8/34	25.3	1.70	10.84	15.7	0.85	5.42	15.7	-	man...	PASS	g
B20	0	34/8/34	25.3	1.70	10.84	15.7	0.85	5.42	15.7	-	man...	PASS	g
B21	0	34/8/34	25.3	1.70	10.84	15.7	0.85	5.42	15.7	-	man...	PASS	g

Gray values are supplementary and never set the row verdict.

Compatible-mode fasteners: $\eta = V_{Ed,\Sigma} / F_{v,Rd,\Sigma}$

Mode-incompatible fasteners: $\eta = V_{Ed,gov} / F_{v,Rd,gov}$ per S8.1.3(2)

Per-plane capacities cannot be summed across embedment + yielding mode families.

Fastener Johansen Derivation - EN 1995-1-1:2004

Critical fastener B3 (member CH1)

EN 1995-1-1:2004 · Bolt · governs LC manual

EMBEDMENT STRENGTH, PARALLEL TO GRAIN - EC5 (8.32)

$$f_{h,0,k} = 0.082 \cdot (1 - 0.01 \cdot d) \cdot \rho_k = 0.082 \cdot (1 - 0.01 \cdot 12.0) \cdot 350 = \mathbf{25.26 \text{ MPa}}$$

SOFTWOOD CORRECTION FACTOR - EC5 (8.33)

$$k_{90} = 1.35 + 0.015 \cdot d = 1.35 + 0.015 \cdot 12.0 = \mathbf{1.530}$$

EMBEDMENT STRENGTH AT ANGLE α - EC5 (8.31)

$$f_{h,\alpha,k} = \frac{f_{h,0,k}}{k_{90} \cdot \sin^2 \alpha + \cos^2 \alpha} = 25.26 / (1.530 \cdot 0.3743 + 0.6257) = \mathbf{21.07 \text{ MPa}}$$

CHARACTERISTIC YIELD MOMENT - EC5 (8.30)

$$M_{y,Rk} = 0.3 \cdot f_{u,k} \cdot d^{2.6} = 0.3 \cdot 400 \cdot 12.0^{2.6} = \mathbf{76745 \text{ N}\cdot\text{mm}}$$

ROPE EFFECT - EC5 §8.2.2(2)

$$F_{ax,Rk} = \min(F_{tens,Rk}, F_{wash,Rk}) = \min(30.35, 6.64) = \mathbf{6.64 \text{ kN}} \quad (\text{washer-bearing, } d_w = 36 \text{ mm})$$
$$F_{ax,Rk}/4 = 6.64 / 4 = \mathbf{1.66 \text{ kN}} \quad (\text{rope term; capped at } 0.25 \cdot F_{v,Rk,Jhs} \text{ per mode})$$

JOHANSEN MODE (f) - EC5 (8.11)

$$F_{v,Rk} = f_{h,1,k} \cdot t_1 \cdot d = 21.07 \cdot 33.5 \cdot 12.0 = \mathbf{8.47 \text{ kN}}$$



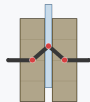
JOHANSEN MODE (g) - EC5 (8.11) ← GOVERNS

$$F_{v,Rk,Jhs} = f_{h,1,k} \cdot t_1 \cdot d \cdot [\sqrt{(2 + 4M_{y,Rk}/(f_{h,1,k} \cdot d \cdot t_1^2))} - 1] = 8472 \cdot 0.7555 = \mathbf{6.40 \text{ kN}}$$
$$+ \text{ rope} = \min(F_{ax,Rk}/4, 0.25 \cdot F_{v,Rk,Jhs}) = 1.60 \text{ kN} \rightarrow F_{v,Rk} = 6.40 + 1.60 = \mathbf{8.00 \text{ kN}}$$



JOHANSEN MODE (h) - EC5 (8.11)

$$F_{v,Rk,Jhs} = 2.30 \cdot \sqrt{M_{y,Rk} \cdot f_{h,1,k} \cdot d} = 2.30 \cdot \sqrt{76745 \cdot 21.07 \cdot 12.0} = \mathbf{10.13 \text{ kN}}$$
$$+ \text{ rope} = \min(F_{ax,Rk}/4, 0.25 \cdot F_{v,Rk,Jhs}) = 1.66 \text{ kN} \rightarrow F_{v,Rk} = 10.13 + 1.66 = \mathbf{11.79 \text{ kN}}$$



TOTAL CHARACTERISTIC CAPACITY (2 shear planes) - EC5 §8.2.3

$$F_{v,Rk} = n_{sp} \cdot F_{v,Rk,plane} = 2 \cdot 8.00 = \mathbf{16.00 \text{ kN}}$$

DESIGN CAPACITY - EC5 §2.4.1 (2.17)

$$F_{v,Rd} = \frac{k_{mod} \cdot F_{v,Rk}}{\gamma_M} = (0.80 \cdot 16.00) / 1.30 = \mathbf{9.85 \text{ kN}}$$

UTILISATION - EC5 (2.17)

$$\eta = \frac{V_{Ed}}{F_{v,Rd}} = (2 \cdot 4.90) / 9.85 = \mathbf{0.99 \leq 1.0 \checkmark \text{ PASS}}$$

Effective Fastener Count (n_ef) - S8.5.1.1(4)

Member CH1

N_EF FAMILY ROUTING

Family routing: bolt -> 8.5.1.1(4)

EFFECTIVE FASTENER COUNT - per row ($\alpha = 25.6^\circ$) - EC5 (8.34/8.35)

Row 1 (n=3): $\min(3, 3^{0.9 \cdot 4 \sqrt{(100/(13 \cdot 12))}})$, interp $\alpha \rightarrow n_{ef} = 2.57$

Row 2 (n=2): $\min(2, 2^{0.9 \cdot 4 \sqrt{(200/(13 \cdot 12))}})$, interp $\alpha \rightarrow n_{ef} = 1.99$

Row 3 (n=3): $\min(3, 3^{0.9 \cdot 4 \sqrt{(100/(13 \cdot 12))}})$, interp $\alpha \rightarrow n_{ef} = 2.57$

$\Sigma n_{ef} = 2.57 + 1.99 + 2.57 = 7.13$ effective fasteners

GROUP CHARACTERISTIC CAPACITY - EC5 (8.1.1)

$F_{v,Rk,group} = \Sigma n_{ef} \cdot F_{v,Rk,fast} = 7.13 \cdot 13.92 = 99.2 \text{ kN}$

GROUP DESIGN CAPACITY - EC5 (8.1.1)

$F_{v,Rd,group} = \Sigma n_{ef} \cdot F_{v,Rd} = 7.13 \cdot 8.56 = 61.1 \text{ kN}$

GROUP UTILISATION (EC5) - EC5 (8.1.1) / (2.17)

$\eta = F_{Ed} / (\Sigma n_{ef} \cdot F_{v,Rd}) = 30.20 / (7.13 \cdot 8.56) = 0.49 \leq 1.0 \checkmark \text{ PASS}$

Member CH2

N_EF FAMILY ROUTING

Family routing: bolt -> 8.5.1.1(4)

EFFECTIVE FASTENER COUNT - per row ($\alpha = 25.6^\circ$) - EC5 (8.34/8.35)

Row 1 (n=3): $\min(3, 3^{0.9 \cdot 4 \sqrt{(100/(13 \cdot 12))}})$, interp $\alpha \rightarrow n_{ef} = 2.57$

Row 2 (n=2): $\min(2, 2^{0.9 \cdot 4 \sqrt{(200/(13 \cdot 12))}})$, interp $\alpha \rightarrow n_{ef} = 1.99$

Row 3 (n=3): $\min(3, 3^{0.9 \cdot 4 \sqrt{(100/(13 \cdot 12))}})$, interp $\alpha \rightarrow n_{ef} = 2.57$

$\Sigma n_{ef} = 2.57 + 1.99 + 2.57 = 7.13$ effective fasteners

GROUP CHARACTERISTIC CAPACITY - EC5 (8.1.1)

$F_{v,Rk,group} = \Sigma n_{ef} \cdot F_{v,Rk,fast} = 7.13 \cdot 13.92 = 99.2 \text{ kN}$

GROUP DESIGN CAPACITY - EC5 (8.1.1)

$F_{v,Rd,group} = \Sigma n_{ef} \cdot F_{v,Rd} = 7.13 \cdot 8.56 = 61.1 \text{ kN}$

GROUP UTILISATION (EC5) - EC5 (8.1.1) / (2.17)

$\eta = F_{Ed} / (\Sigma n_{ef} \cdot F_{v,Rd}) = 30.20 / (7.13 \cdot 8.56) = 0.49 \leq 1.0 \checkmark \text{ PASS}$

Member D1

N_EF FAMILY ROUTING

Family routing: bolt -> 8.5.1.1(4)

EFFECTIVE FASTENER COUNT - per row ($\alpha = 0.0^\circ$) - EC5 (8.34/8.35)

Row 1 (n=3): $\min(3, 3^{0.9 \cdot 4 \sqrt{(100/(13 \cdot 12))}})$, interp $\alpha \rightarrow n_{ef} = 2.41$

$\Sigma n_{ef} = 2.41 = 2.41$ effective fasteners

GROUP CHARACTERISTIC CAPACITY - EC5 (8.1.1)

$F_{v,Rk,group} = \Sigma n_{ef} \cdot F_{v,Rk,fast} = 2.41 \cdot 17.61 = 42.4 \text{ kN}$

GROUP DESIGN CAPACITY - EC5 (8.1.1)

$F_{v,Rd,group} = \Sigma n_{ef} \cdot F_{v,Rd} = 2.41 \cdot 10.84 = 26.1 \text{ kN}$

GROUP UTILISATION (EC5) - EC5 (8.1.1) / (2.17)

$\eta = F_{Ed} / (\Sigma n_{ef} \cdot F_{v,Rd}) = 5.09 / (2.41 \cdot 10.84) = 0.19 \leq 1.0 \checkmark \text{ PASS}$

Perpendicular Splitting - S8.1.4

Member CH1

CHARACTERISTIC SPLITTING CAPACITY - EC5 (8.4)

$$F_{90,Rk} = 14 \cdot b \cdot w \cdot \sqrt{h_e / (1 - h_e/h)} = 14 \cdot 75 \cdot 1.0 \cdot \sqrt{245 / (1 - 245/300)} = \mathbf{38.38 \text{ kN}}$$

DESIGN SPLITTING CAPACITY - EC5 (2.4.3)

$$F_{90,Rd} = k_{mod} \cdot F_{90,Rk} / \gamma_M = 0.80 \cdot 38.38 / 1.30 = \mathbf{23.62 \text{ kN}}$$

SPLITTING UTILISATION - EC5 (8.1.4)

$$\eta = F_{v,Ed} / F_{90,Rd} = 14.50 / 23.62 = \mathbf{0.61 \leq 1.0 \checkmark \text{ PASS}}$$

Member CH2

CHARACTERISTIC SPLITTING CAPACITY - EC5 (8.4)

$$F_{90,Rk} = 14 \cdot b \cdot w \cdot \sqrt{h_e / (1 - h_e/h)} = 14 \cdot 75 \cdot 1.0 \cdot \sqrt{245 / (1 - 245/300)} = \mathbf{38.38 \text{ kN}}$$

DESIGN SPLITTING CAPACITY - EC5 (2.4.3)

$$F_{90,Rd} = k_{mod} \cdot F_{90,Rk} / \gamma_M = 0.80 \cdot 38.38 / 1.30 = \mathbf{23.62 \text{ kN}}$$

SPLITTING UTILISATION - EC5 (8.1.4)

$$\eta = F_{v,Ed} / F_{90,Rd} = 14.50 / 23.62 = \mathbf{0.61 \leq 1.0 \checkmark \text{ PASS}}$$

D1: not assessed (auto: |Vz|=0.00 kN < threshold 0.10 kN)

Member Net Cross-Section - S5.2 / S6.1

Member CH1

NET WIDTH + HOLE DIAMETER - EC5 5.2

$$b_{\text{net}} = W - n_{\text{pl}} \cdot (t_{\text{steel}} + 2 \cdot \text{slot}) = 75.0 - 1 \cdot (8.0 + 2 \cdot 0.0) = \mathbf{67.0 \text{ mm}} \quad (\text{steel-plate slot removed})$$
$$d_0 = d + \text{oversize} = 12 + 0 = \mathbf{12 \text{ mm}} \quad (\text{drilled timber hole})$$

NET CROSS-SECTION AREA - EC5 5.2

$$A_{\text{net}} = A_{\text{gross}} - n \cdot d_0 \cdot b = 20100 - 3 \cdot 12 \cdot 67 = \mathbf{17688 \text{ mm}^2}$$

DESIGN COMPRESSIVE STRENGTH (parallel) - EC5 6.1.4

$$f_{c,0,d} = k_{\text{mod}} \cdot f_{c,0,k} / \gamma_M = 0.80 \cdot 21.0 / 1.30 = \mathbf{12.923 \text{ MPa}}$$

NET-SECTION COMPRESSIVE UTILISATION - EC5 6.1.4

$$\eta = \sigma_{c,0,d} / f_{c,0,d} = 1.707 / 12.923 = \mathbf{0.13 \leq 1.0 \quad \checkmark \text{ PASS}}$$

BENDING STRESS AT NET SECTION - EC5 6.1.6

$$\sigma_m = M_y \cdot z_s / I_{\text{net}} = 4.770\text{e}+06 \cdot 150 / 1.362\text{e}+08 = \mathbf{5.253 \text{ MPa}} \quad (f_{m,d} = 14.769 \text{ MPa})$$

COMPRESSION + BENDING INTERACTION - EC5 6.2.4

$$\eta = (\sigma_{c,0,d} / f_{c,0,d})^2 + \sigma_m / f_{m,d} = 0.017 + 0.356 = \mathbf{0.37 \leq 1.0 \quad \checkmark \text{ PASS}}$$

NET-SECTION SHEAR UTILISATION - EC5 6.1.7

$$\tau_v = V_z \cdot S_{\text{net}} / (I_{\text{net}} \cdot b \cdot k_{cr}) = 14500 \cdot 6.77\text{e}+05 / (1.36\text{e}+08 \cdot 67 \cdot 0.67) = \mathbf{1.606 \text{ MPa}}$$
$$\eta = \tau_v / f_{v,d} = 1.606 / 2.462 = \mathbf{0.65 \leq 1.0 \quad \checkmark \text{ PASS}}$$

MOMENT-INDUCED SHEAR UTILISATION - EC5 6.1.7

$$V_{dw} = 12.5 \text{ kN} \quad (= V_M)$$
$$\tau_{dw} = V_{dw} \cdot S_{\text{net}} / (I_{\text{net}} \cdot b \cdot k_{cr}) = 12536 \cdot 6.77\text{e}+05 / (1.36\text{e}+08 \cdot 67 \cdot 0.67) = \mathbf{1.389 \text{ MPa}}$$
$$\eta = \tau_{dw} / f_{v,d} = 1.389 / 2.462 = \mathbf{0.56 \leq 1.0 \quad \checkmark \text{ PASS}}$$

GOVERNING NET-SECTION UTILISATION

$$\eta_{\text{gov}} = \max(\text{axial}, N+M, \text{current shear}) = \mathbf{0.65 \leq 1.0 \quad \checkmark \text{ PASS}}$$

Member CH2

NET WIDTH + HOLE DIAMETER - EC5 5.2

$$b_{\text{net}} = W - n_{\text{pl}} \cdot (t_{\text{steel}} + 2 \cdot \text{slot}) = 75.0 - 1 \cdot (8.0 + 2 \cdot 0.0) = \mathbf{67.0 \text{ mm}} \quad (\text{steel-plate slot removed})$$
$$d_0 = d + \text{oversize} = 12 + 0 = \mathbf{12 \text{ mm}} \quad (\text{drilled timber hole})$$

NET CROSS-SECTION AREA - EC5 5.2

$$A_{\text{net}} = A_{\text{gross}} - n \cdot d_0 \cdot b = 20100 - 3 \cdot 12 \cdot 67 = \mathbf{17688 \text{ mm}^2}$$

DESIGN COMPRESSIVE STRENGTH (parallel) - EC5 6.1.4

$$f_{c,0,d} = k_{\text{mod}} \cdot f_{c,0,k} / \gamma_M = 0.80 \cdot 21.0 / 1.30 = \mathbf{12.923 \text{ MPa}}$$

NET-SECTION COMPRESSIVE UTILISATION - EC5 6.1.4

$$\eta = \sigma_{c,0,d} / f_{c,0,d} = 1.707 / 12.923 = \mathbf{0.13 \leq 1.0 \quad \checkmark \text{ PASS}}$$

BENDING STRESS AT NET SECTION - EC5 6.1.6

$$\sigma_m = M_y \cdot z_s / I_{\text{net}} = 4.770\text{e}+06 \cdot 150 / 1.362\text{e}+08 = \mathbf{5.253 \text{ MPa}} \quad (f_{m,d} = 14.769 \text{ MPa})$$

COMPRESSION + BENDING INTERACTION - EC5 6.2.4

$$\eta = (\sigma_{c,0,d} / f_{c,0,d})^2 + \sigma_m / f_{m,d} = 0.017 + 0.356 = \mathbf{0.37 \leq 1.0 \quad \checkmark \text{ PASS}}$$

NET-SECTION SHEAR UTILISATION - EC5 6.1.7

$$\tau_v = V_z \cdot S_{\text{net}} / (I_{\text{net}} \cdot b \cdot k_{cr}) = 14500 \cdot 6.77\text{e}+05 / (1.36\text{e}+08 \cdot 67 \cdot 0.67) = \mathbf{1.606 \text{ MPa}}$$
$$\eta = \tau_v / f_{v,d} = 1.606 / 2.462 = \mathbf{0.65 \leq 1.0 \quad \checkmark \text{ PASS}}$$

MOMENT-INDUCED SHEAR UTILISATION - EC5 6.1.7

$$V_{dw} = 12.5 \text{ kN} \quad (= V_M)$$

$$\tau_{dw} = V_{dw} \cdot S_{net} / (I_{net} \cdot b \cdot k_{cr}) = 12536 \cdot 6.77e+05 / (1.36e+08 \cdot 67 \cdot 0.67) = \mathbf{1.389 \text{ MPa}}$$

$$\eta = \tau_{dw} / f_{v,d} = 1.389 / 2.462 = \mathbf{0.56 \leq 1.0 \quad \checkmark \text{ PASS}}$$

GOVERNING NET-SECTION UTILISATION

$$\eta_{gov} = \max(\text{axial, N+M, current shear}) = \mathbf{0.65 \leq 1.0 \quad \checkmark \text{ PASS}}$$

Member D1**NET WIDTH + HOLE DIAMETER - EC5 5.2**

$$b_{net} = W - n_{pl} \cdot (t_{steel} + 2 \cdot \text{slot}) = 75.0 - 1 \cdot (8.0 + 2 \cdot 0.0) = \mathbf{67.0 \text{ mm}} \quad (\text{steel-plate slot removed})$$

$$d_0 = d + \text{oversize} = 12 + 0 = \mathbf{12 \text{ mm}} \quad (\text{drilled timber hole})$$

NET CROSS-SECTION AREA - EC5 5.2

$$A_{net} = A_{gross} - n \cdot d_0 \cdot b = 6700 - 1 \cdot 12 \cdot 67 = \mathbf{5896 \text{ mm}^2}$$

DESIGN TENSILE STRENGTH (parallel) - EC5 6.1.2

$$f_{t,0,d} = k_{mod} \cdot k_h \cdot f_{t,0,k} / \gamma_M = 0.80 \cdot 1.0845 \cdot 14.0 / 1.30 = \mathbf{9.343 \text{ MPa}}$$

NET-SECTION TENSILE UTILISATION - EC5 6.1.2

$$\eta = \sigma_{t,0,d} / f_{t,0,d} = 0.863 / 9.343 = \mathbf{0.09 \leq 1.0 \quad \checkmark \text{ PASS}}$$

Checks Not Performed

Block Shear - EC5 Annex A

Members not requiring a block-shear check:

CH1: N/A - compression

CH2: N/A - compression

D1: N/A - only one row of fasteners parallel to member axis

Fastener Capacity

EN 1993-1-8:2005 + AC:2009 (Steel plate gate)

Independent of EC5/FprEN Johansen

F4 conservative path (steel/bolt check)

MIN end/edge distances, resultant fastener magnitude

Fastener	Class	V_Ed,pl[kN]	F_b,Rd[kN]	etaB%	V_Ed,pn[kN]	F_v,Rd[kN]	etaV%	Gov	Status
B1	end/edg	5.99	76.80	7.8	3.00	16.19	18.5	shear	PASS
B2	end/inn	7.08	76.80	9.2	3.54	16.19	21.9	shear	PASS
B3	end/edg	9.79	76.80	12.8	4.90	16.19	30.3	shear	PASS
B4	inn/edg	1.82	76.80	2.4	0.91	16.19	5.6	shear	PASS
B6	end/edg	7.96	76.80	10.4	3.98	16.19	24.6	shear	PASS
B7	end/inn	2.38	76.80	3.1	1.19	16.19	7.3	shear	PASS
B8	end/edg	4.46	76.80	5.8	2.23	16.19	13.8	shear	PASS
B9	end/edg	8.10	76.80	10.5	4.05	16.19	25.0	shear	PASS
B10	end/inn	9.79	76.80	12.7	4.90	16.19	30.2	shear	PASS
B11	end/edg	7.08	76.80	9.2	3.54	16.19	21.9	shear	PASS
B12	inn/edg	5.99	76.80	7.8	3.00	16.19	18.5	shear	PASS
B13	inn/edg	7.95	76.80	10.4	3.98	16.19	24.6	shear	PASS
B15	end/inn	1.82	76.80	2.4	0.91	16.19	5.6	shear	PASS
B16	end/edg	8.10	76.80	10.5	4.05	16.19	25.0	shear	PASS
B17	end/edg	4.46	76.80	5.8	2.23	16.19	13.8	shear	PASS
B18	inn/edg	2.37	76.80	3.1	1.19	16.19	7.3	shear	PASS
B19	end/edg	1.70	76.80	2.2	0.85	16.19	5.2	shear	PASS
B20	inn/edg	1.70	76.80	2.2	0.85	16.19	5.2	shear	PASS
B21	end/edg	1.70	76.80	2.2	0.85	16.19	5.2	shear	PASS

Plate S355, t = 8.0 mm, gamma_M2 = 1.25, threads in shear. 19 fasteners checked, 0 EC3-FAIL.

Only the Status cell is coloured by verdict (green PASS / red FAIL); all other values are neutral.

Per-plate demand sums two adjoining face forces (multi-plate Q5).

EC3 is an INDEPENDENT verification - both timber Johansen and this steel gate must pass independently.

Steel Plate Net Cross-Section (EN 1993-1-1 6.2.3 / 6.2.4)

Net rupture / gross yield of the plate(s) carrying each member axial force

Member	Type	N_Ed[kN]	A_net[mm2]	N_Rd[kN]	eta%	Status
CH1	compression	-30.2	2088	852.0	3.5	PASS
CH2	compression	-30.2	2088	852.0	3.5	PASS
D1	tension	5.1	696	255.6	2.0	PASS

Tension: min(gross yield $A \cdot f_y / \gamma_{M0}$, net rupture $0.9 \cdot A_{net} \cdot f_u / \gamma_{M2}$); compression uses the gross area.

- 6.2.4: compression -> gross area (fastener holes filled by bolts)

- plate depth capped at the member depth (shared-gusset guard)

Verdict

Member	Check	eta [%]	Status
CH1	Critical fastener (B3)	99.5	PASS
CH2	Critical fastener (B10)	99.4	PASS
D1	Critical fastener (B19)	15.7	PASS
CH1	Group capacity (n_ef)	49.4	PASS
CH2	Group capacity (n_ef)	49.4	PASS
D1	Group capacity (n_ef)	19.5	PASS
CH1	Perpendicular splitting	61.4	PASS
CH2	Perpendicular splitting	61.4	PASS
CH1	Net cross-section	65.3	PASS
CH2	Net cross-section	65.3	PASS
D1	Net cross-section	9.2	PASS

FINAL VERDICT: PASS

Governing utilisation: eta = 99.5% (CH1 Critical fastener (B3))