

EC5 Timber Fastener Capacity Check

EN 1995-1-1:2004

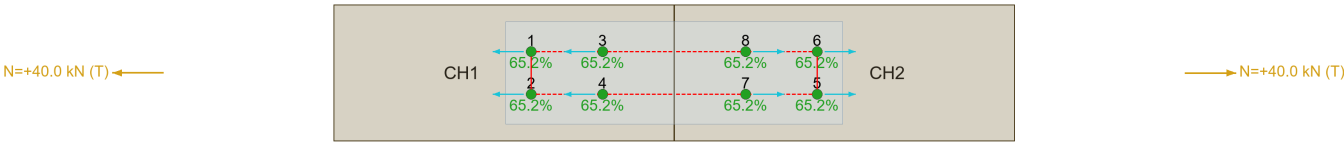
Date: 2026-08-11
Load Case: manual

Input Data Summary

Timber class	GL24h
Service class	1
Load duration	Medium-term
Required fire resistance	R30
Fastener type	Bolt
Fastener diameter	12 mm
Fastener grade	6.8 (480/600)
Plate thickness	10.0 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

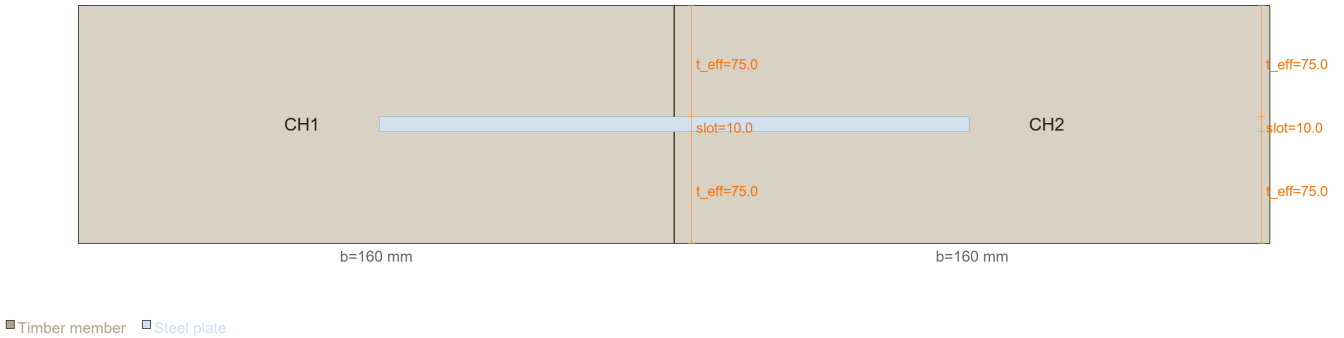
Name	Bearing	b [mm]	h [mm]	Cross-section
CH1	Yes	160	160	160 x 160
CH2	No	160	160	160 x 160

Member Loads (LC: manual)

Member	N [kN]	T/C	Vz [kN]	Vy [kN]	My [kNm]	Mz [kNm]	T [kNm]
CH1 / End	40.00	T	0.00	0.00	0.00	0.00	0.00
CH2 / End	40.00	T	0.00	0.00	0.00	0.00	0.00

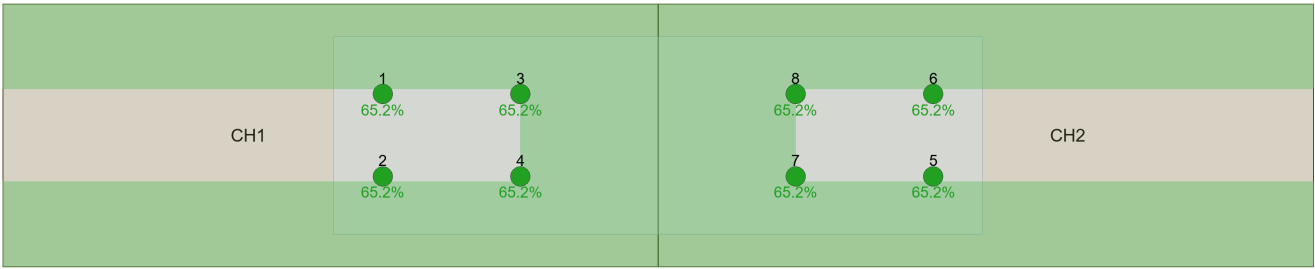
Equilibrium (Forces through node): X +0.00 Y +0.00 Z +0.00 kN Mx +0.00 My +0.00 Mz +0.00 kNm (balanced)
+ Lever arm (fastener group centroid x Vz): My -0.00 kNm
Equilibrium (Forces through fastener centroid): X +0.00 Y +0.00 Z +0.00 kN Mx +0.00 My -0.00 Mz +0.00 kNm (balanced)

TOP VIEW (XY)



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 $a_{1,min} = (4 + \cos \alpha) \cdot d = 60.0 \text{ mm}$ actual = 84.0 mm ✓ PASS
a2 PERPENDICULAR SPACING $a_{2,min} = 48.0 \text{ mm}$ actual = 50.0 mm ✓ PASS
a3,t END DISTANCE (loaded) $a_{3,t,min} = \max(7d, 80) = 84.0 \text{ mm}$ actual = 84.0 mm ✓ PASS
a4,c EDGE DISTANCE (unloaded, Depth+) $a_{4,c,min} = 3d + a_{fi} = 36.0 + 15.8 = 51.8 \text{ mm}$ actual = 55.0 mm ✓ PASS
a4,c EDGE DISTANCE (unloaded, Depth-) $a_{4,c,min} = 3d + a_{fi} = 36.0 + 15.8 = 51.8 \text{ mm}$ actual = 55.0 mm ✓ PASS

Member CH2

a1 PARALLEL SPACING $a_{1,min} = (4 + \cos \alpha) \cdot d = 60.0 \text{ mm}$ actual = 84.0 mm ✓ PASS
a2 PERPENDICULAR SPACING $a_{2,min} = 48.0 \text{ mm}$ actual = 50.0 mm ✓ PASS
a3,t END DISTANCE (loaded) $a_{3,t,min} = \max(7d, 80) = 84.0 \text{ mm}$ actual = 84.0 mm ✓ PASS
a4,c EDGE DISTANCE (unloaded, Depth+) $a_{4,c,min} = 3d + a_{fi} = 36.0 + 15.8 = 51.8 \text{ mm}$ actual = 55.0 mm ✓ PASS
a4,c EDGE DISTANCE (unloaded, Depth-) $a_{4,c,min} = 3d + a_{fi} = 36.0 + 15.8 = 51.8 \text{ mm}$ actual = 55.0 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	0	75/10/75	27.8	10.00	15.34	65.2	5.00	7.67	65.2	-	man...	PASS	g
B2	0	75/10/75	27.8	10.00	15.34	65.2	5.00	7.67	65.2	-	man...	PASS	g
B3	0	75/10/75	27.8	10.00	15.34	65.2	5.00	7.67	65.2	-	man...	PASS	g
B4	0	75/10/75	27.8	10.00	15.34	65.2	5.00	7.67	65.2	-	man...	PASS	g
B5	0	75/10/75	27.8	10.00	15.34	65.2	5.00	7.67	65.2	-	man...	PASS	g
B6	0	75/10/75	27.8	10.00	15.34	65.2	5.00	7.67	65.2	-	man...	PASS	g
B7	0	75/10/75	27.8	10.00	15.34	65.2	5.00	7.67	65.2	-	man...	PASS	g
B8	0	75/10/75	27.8	10.00	15.34	65.2	5.00	7.67	65.2	-	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 B2 (member CH1)

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

EMBEDMENT STRENGTH, PARALLEL TO GRAIN - EC5 (8.32)

$$f_{h,0,k} = 0.082 \cdot (1 - 0.01 \cdot d) \cdot \rho_k = 0.082 \cdot (1 - 0.01 \cdot 12.0) \cdot 385 = \mathbf{27.78 \text{ MPa}}$$

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)

$$f_{h,\alpha,k} = \frac{f_{h,0,k}}{k_{90} \cdot \sin^2 \alpha + \cos^2 \alpha} = 27.78 / (1.530 \cdot 0.0000 + 1.0000) = \mathbf{27.78 \text{ MPa}}$$

CHARACTERISTIC YIELD MOMENT - EC5 (8.30)

$$M_{y,Rk} = 0.3 \cdot f_{u,k} \cdot d^{2.6} = 0.3 \cdot 600 \cdot 12.0^{2.6} = \mathbf{115118 \text{ N}\cdot\text{mm}}$$

JOHANSEN MODE (f) - EC5 (8.11)

$$F_{v,Rk} = f_{h,1,k} \cdot t_1 \cdot d = 27.78 \cdot 75.0 \cdot 12.0 = \mathbf{25.00 \text{ kN}}$$



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

$$F_{v,Rk} = f_{h,1,k} \cdot t_1 \cdot d \cdot [\sqrt{(2 + 4M_{y,Rk} / (f_{h,1,k} \cdot d \cdot t_1^2))} - 1] = 25003 \cdot 0.4985 = \mathbf{12.46 \text{ kN}}$$



JOHANSEN MODE (h) - EC5 (8.11)

$$F_{v,Rk} = 2.30 \cdot \sqrt{M_{y,Rk} \cdot f_{h,1,k} \cdot d} = 2.30 \cdot \sqrt{115118 \cdot 27.78 \cdot 12.0} = \mathbf{14.25 \text{ kN}}$$



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

$$F_{v,Rk} = n_{sp} \cdot F_{v,Rk,plane} = 2 \cdot 12.46 = \mathbf{24.93 \text{ kN}}$$

DESIGN CAPACITY - EC5 §2.4.1 (2.17)

$$F_{v,Rd} = \frac{k_{mod} \cdot F_{v,Rk}}{\gamma_M} = (0.80 \cdot 24.93) / 1.30 = \mathbf{15.34 \text{ kN}}$$

UTILISATION - EC5 (2.17)

$$\eta = \frac{V_{Ed}}{F_{v,Rd}} = (2 \cdot 5.00) / 15.34 = \mathbf{0.65 \leq 1.0 \checkmark \text{ PASS}}$$

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 ($\alpha = 0.0^\circ$) - EC5 (8.34/8.35)

Row 1 (n=2): $\min(2, 2^{0.9 \cdot 4} \sqrt{84/(13 \cdot 12)})$, interp $\alpha \rightarrow n_{ef} = \mathbf{1.60}$

Row 2 (n=2): $\min(2, 2^{0.9 \cdot 4} \sqrt{84/(13 \cdot 12)})$, interp $\alpha \rightarrow n_{ef} = \mathbf{1.60}$

$\Sigma n_{ef} = 1.60 + 1.60 = \mathbf{3.20 \text{ effective fasteners}}$

N_{EF} REDUCTION DISABLED

Perpendicular screw reinforcement provided.

EC5 row-reduction result is not used for group capacity.

Reason: Perpendicular screw reinforcement

Pre-override $\Sigma n_{ef} = 3.20$; used $\Sigma n_{ef} = 4.00$

GROUP CHARACTERISTIC CAPACITY - EC5 (8.1.1)

$F_{v,Rk,group} = \Sigma n_{ef} \cdot F_{v,Rk,fast} = 4.00 \cdot 24.93 = \mathbf{99.7 \text{ kN}}$

GROUP DESIGN CAPACITY - EC5 (8.1.1)

$F_{v,Rd,group} = \Sigma n_{ef} \cdot F_{v,Rd} = 4.00 \cdot 15.34 = \mathbf{61.4 \text{ kN}}$

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

$\eta = F_{Ed} / (\Sigma n_{ef} \cdot F_{v,Rd}) = 40.00 / (4.00 \cdot 15.34) = \mathbf{0.65 \leq 1.0 \checkmark \text{ PASS}}$

Member CH2

N_{EF} FAMILY ROUTING

Family routing: bolt -> 8.5.1.1(4)

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

Row 1 (n=2): $\min(2, 2^{0.9 \cdot 4} \sqrt{84/(13 \cdot 12)})$, interp $\alpha \rightarrow n_{ef} = \mathbf{1.60}$

Row 2 (n=2): $\min(2, 2^{0.9 \cdot 4} \sqrt{84/(13 \cdot 12)})$, interp $\alpha \rightarrow n_{ef} = \mathbf{1.60}$

$\Sigma n_{ef} = 1.60 + 1.60 = \mathbf{3.20 \text{ effective fasteners}}$

GROUP CHARACTERISTIC CAPACITY - EC5 (8.1.1)

$F_{v,Rk,group} = \Sigma n_{ef} \cdot F_{v,Rk,fast} = 3.20 \cdot 24.93 = \mathbf{79.8 \text{ kN}}$

GROUP DESIGN CAPACITY - EC5 (8.1.1)

$F_{v,Rd,group} = \Sigma n_{ef} \cdot F_{v,Rd} = 3.20 \cdot 15.34 = \mathbf{49.1 \text{ kN}}$

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

$\eta = F_{Ed} / (\Sigma n_{ef} \cdot F_{v,Rd}) = 40.00 / (3.20 \cdot 15.34) = \mathbf{0.81 \leq 1.0 \checkmark \text{ PASS}}$

Block Shear (CH1) - EC5 Annex A

Settings: plug shear = ON block-shear sum = ON

NET FRACTURE LENGTHS + MATERIAL - EC5 Annex A $L_{net,v} = \sum l_{v,i} = \mathbf{300.0\text{ mm}}$ $L_{net,t} = \text{gross} - \sum \text{holes} = \mathbf{38.0\text{ mm}}$ $f_{t,0,k} = 19.2\text{ MPa} \quad f_{v,k} = 3.5\text{ MPa} \quad k_{cr} = 0.67 \quad k_{mod} = 0.80 \quad \gamma_M = 1.25$
SEGMENT 0 (outer, t_seg = 75.0 mm) ← GOVERNS - EC5 Annex A $A_{net,v} = \frac{1}{2} \cdot L_{net,v} \cdot (L_{net,t} + 2 \cdot t_{ef}) \cdot k_{cr} = \frac{1}{2} \cdot 300.0 \cdot (38.0 + 2 \cdot 32.7) \cdot 0.67 = \mathbf{10388\text{ mm}^2}$ $A_{net,t} = L_{net,t} \cdot t_{seg} = 38.0 \cdot 75.0 = \mathbf{2850\text{ mm}^2}$ $F_{bs,Rk} = \max(1.5 \cdot A_{net,t} \cdot f_{t,0,k}, 0.7 \cdot A_{net,v} \cdot f_{v,k}) = \max(82.1, 25.5) = \mathbf{82.08\text{ kN (tension)}}$ $F_{bs,Rd} = k_{mod} \cdot F_{bs,Rk} / \gamma_M = 0.80 \cdot 82.08 / 1.25 = \mathbf{52.53\text{ kN}}$ $\eta_{seg} = \text{demand} / F_{bs,Rd} = 20.00 / 52.53 = \mathbf{0.38 \leq 1.0 \checkmark PASS}$
SEGMENT 1 (outer, t_seg = 75.0 mm) - EC5 Annex A $A_{net,v} = \frac{1}{2} \cdot L_{net,v} \cdot (L_{net,t} + 2 \cdot t_{ef}) \cdot k_{cr} = \frac{1}{2} \cdot 300.0 \cdot (38.0 + 2 \cdot 32.7) \cdot 0.67 = \mathbf{10388\text{ mm}^2}$ $A_{net,t} = L_{net,t} \cdot t_{seg} = 38.0 \cdot 75.0 = \mathbf{2850\text{ mm}^2}$ $F_{bs,Rk} = \max(1.5 \cdot A_{net,t} \cdot f_{t,0,k}, 0.7 \cdot A_{net,v} \cdot f_{v,k}) = \max(82.1, 25.5) = \mathbf{82.08\text{ kN (tension)}}$ $F_{bs,Rd} = k_{mod} \cdot F_{bs,Rk} / \gamma_M = 0.80 \cdot 82.08 / 1.25 = \mathbf{52.53\text{ kN}}$ $\eta_{seg} = \text{demand} / F_{bs,Rd} = 20.00 / 52.53 = \mathbf{0.38 \leq 1.0 \checkmark PASS}$
BLOCK SHEAR SUM (plastic redistribution, GOVERNS) - EC5 Annex A $\Sigma F_{bs,Rk} = 82.08 + 82.08 = \mathbf{164.16\text{ kN}}$ $\Sigma F_{bs,Rd} = k_{mod} \cdot \Sigma F_{bs,Rk} / \gamma_M = 0.80 \cdot 164.16 / 1.25 = \mathbf{105.06\text{ kN}}$ $\eta = N_{Ed} / \Sigma F_{bs,Rd} = 40.00 / 105.06 = \mathbf{0.38 \leq 1.0 \checkmark PASS}$

Block Shear (CH2) - EC5 Annex A

Settings: plug shear = ON block-shear sum = ON

NET FRACTURE LENGTHS + MATERIAL - EC5 Annex A $L_{net,v} = \sum l_{v,i} = \mathbf{300.0\ mm}$ $L_{net,t} = \text{gross} - \sum \text{holes} = \mathbf{38.0\ mm}$ $f_{t,0,k} = 19.2\ \text{MPa} \quad f_{v,k} = 3.5\ \text{MPa} \quad k_{cr} = 0.67 \quad k_{mod} = 0.80 \quad \gamma_M = 1.25$
SEGMENT 0 (outer, t_seg = 75.0 mm) ← GOVERNS - EC5 Annex A $A_{net,v} = \frac{1}{2} \cdot L_{net,v} \cdot (L_{net,t} + 2 \cdot t_{ef}) \cdot k_{cr} = \frac{1}{2} \cdot 300.0 \cdot (38.0 + 2 \cdot 32.7) \cdot 0.67 = \mathbf{10388\ mm^2}$ $A_{net,t} = L_{net,t} \cdot t_{seg} = 38.0 \cdot 75.0 = \mathbf{2850\ mm^2}$ $F_{bs,Rk} = \max(1.5 \cdot A_{net,t} \cdot f_{t,0,k}, 0.7 \cdot A_{net,v} \cdot f_{v,k}) = \max(82.1, 25.5) = \mathbf{82.08\ kN\ (tension)}$ $F_{bs,Rd} = k_{mod} \cdot F_{bs,Rk} / \gamma_M = 0.80 \cdot 82.08 / 1.25 = \mathbf{52.53\ kN}$ $\eta_{seg} = \text{demand} / F_{bs,Rd} = 20.00 / 52.53 = \mathbf{0.38 \leq 1.0 \checkmark PASS}$
SEGMENT 1 (outer, t_seg = 75.0 mm) - EC5 Annex A $A_{net,v} = \frac{1}{2} \cdot L_{net,v} \cdot (L_{net,t} + 2 \cdot t_{ef}) \cdot k_{cr} = \frac{1}{2} \cdot 300.0 \cdot (38.0 + 2 \cdot 32.7) \cdot 0.67 = \mathbf{10388\ mm^2}$ $A_{net,t} = L_{net,t} \cdot t_{seg} = 38.0 \cdot 75.0 = \mathbf{2850\ mm^2}$ $F_{bs,Rk} = \max(1.5 \cdot A_{net,t} \cdot f_{t,0,k}, 0.7 \cdot A_{net,v} \cdot f_{v,k}) = \max(82.1, 25.5) = \mathbf{82.08\ kN\ (tension)}$ $F_{bs,Rd} = k_{mod} \cdot F_{bs,Rk} / \gamma_M = 0.80 \cdot 82.08 / 1.25 = \mathbf{52.53\ kN}$ $\eta_{seg} = \text{demand} / F_{bs,Rd} = 20.00 / 52.53 = \mathbf{0.38 \leq 1.0 \checkmark PASS}$
BLOCK SHEAR SUM (plastic redistribution, GOVERNS) - EC5 Annex A $\Sigma F_{bs,Rk} = 82.08 + 82.08 = \mathbf{164.16\ kN}$ $\Sigma F_{bs,Rd} = k_{mod} \cdot \Sigma F_{bs,Rk} / \gamma_M = 0.80 \cdot 164.16 / 1.25 = \mathbf{105.06\ kN}$ $\eta = N_{Ed} / \Sigma F_{bs,Rd} = 40.00 / 105.06 = \mathbf{0.38 \leq 1.0 \checkmark PASS}$

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

Member CH1

NET WIDTH + HOLE DIAMETER - EC5 5.2 $b_{\text{net}} = W - n_{\text{pl}} \cdot (t_{\text{steel}} + 2 \cdot \text{slot}) = 160.0 - 1 \cdot (10.0 + 2 \cdot 0.0) = \mathbf{150.0 \text{ mm}}$ (steel-plate slot removed) $d_0 = d + \text{oversize} = 12 + 0 = \mathbf{12 \text{ mm}}$ (drilled timber hole)
NET CROSS-SECTION AREA - EC5 5.2 $A_{\text{net}} = A_{\text{gross}} - n \cdot d_0 \cdot b = 24000 - 2 \cdot 12 \cdot 150 = \mathbf{20400 \text{ mm}^2}$
DESIGN TENSILE STRENGTH (parallel) - EC5 6.1.2 $f_{t,0,d} = k_{\text{mod}} \cdot k_h \cdot f_{t,0,k} / \gamma_M = 0.80 \cdot 1.1000 \cdot 19.2 / 1.30 = \mathbf{12.997 \text{ MPa}}$
NET-SECTION TENSILE UTILISATION - EC5 6.1.2 $\eta = \sigma_{t,0,d} / f_{t,0,d} = 1.961 / 12.997 = \mathbf{0.15} \leq \mathbf{1.0} \checkmark \mathbf{PASS}$

Member CH2

NET WIDTH + HOLE DIAMETER - EC5 5.2 $b_{\text{net}} = W - n_{\text{pl}} \cdot (t_{\text{steel}} + 2 \cdot \text{slot}) = 160.0 - 1 \cdot (10.0 + 2 \cdot 0.0) = \mathbf{150.0 \text{ mm}}$ (steel-plate slot removed) $d_0 = d + \text{oversize} = 12 + 0 = \mathbf{12 \text{ mm}}$ (drilled timber hole)
NET CROSS-SECTION AREA - EC5 5.2 $A_{\text{net}} = A_{\text{gross}} - n \cdot d_0 \cdot b = 24000 - 2 \cdot 12 \cdot 150 = \mathbf{20400 \text{ mm}^2}$
DESIGN TENSILE STRENGTH (parallel) - EC5 6.1.2 $f_{t,0,d} = k_{\text{mod}} \cdot k_h \cdot f_{t,0,k} / \gamma_M = 0.80 \cdot 1.1000 \cdot 19.2 / 1.30 = \mathbf{12.997 \text{ MPa}}$
NET-SECTION TENSILE UTILISATION - EC5 6.1.2 $\eta = \sigma_{t,0,d} / f_{t,0,d} = 1.961 / 12.997 = \mathbf{0.15} \leq \mathbf{1.0} \checkmark \mathbf{PASS}$

Fire Design - EN 1995-1-2

Note: EN 1995-1-2 fire design is a new feature. The fire capacities, reductions and verdicts on this page are preliminary and should be independently verified by the responsible engineer before use.

Required fire resistance: R30

Steel-plate regime: Internal

PROTECTION STATUS - EN 1995-1-2 (6.2.1.3) $d_g = (b - t_{steel})/2 = (160.0 - 10.0)/2 = \mathbf{0.0\text{ mm}}$ → UNPROTECTED (plate-gap route); board-protected (see below)
SIDE-MEMBER THICKNESS - EN 1995-1-2 (6.4) $t_{l,min} = \max(50, 50+1.25(d-12)) = \mathbf{50.0\text{ mm}}$ actual = 75.0 mm ✓ PASS
FIRE LOAD REDUCTION - EN 1995-1-2 (2.4.2) $\eta_{fi} = \mathbf{0.60} \rightarrow E_{d,fi} = \eta_{fi} \cdot E_d = 0.60 \cdot 40.0 = \mathbf{24.0\text{ kN}}$
COLD CONNECTION CAPACITY (group) - EC5 (8.1.1 / 2.4.1) $F_{v,Rk} = \sum \eta_{ef} \cdot F_{v,Rk,fast} = 3.20 \cdot 24.93 = \mathbf{79.8\text{ kN}}$ $F_{v,Rd} = k_{mod} \cdot F_{v,Rk} / \gamma_M = 0.80 \cdot 79.8 / 1.30 = \mathbf{49.1\text{ kN}}$ $\eta_0 = E_d / F_{v,Rd} = 40.0 / 49.1 = \mathbf{0.81}$
PARAMETER k - EN 1995-1-2 (Table 6.3) $k = \mathbf{0.085}$ (Table 6.3, Bolt steel-to-wood, $d \geq 12\text{ mm}$; max unprotected 30 min)
FIRE CAPACITY REDUCTION η - EN 1995-1-2 (6.5/6.6) $\eta = e^{-k \cdot t_{d,fi}} = e^{-0.085 \cdot 30} = \mathbf{0.0781}$
FIRE RESISTANCE $F_{v,Rd,fi}$ (group) - EN 1995-1-2 (6.5/6.6) $F_{v,Rd,fi} = \eta \cdot F_{v,Rk} \cdot k_{fi} / \gamma_{M,fi} = 0.078 \cdot 79.8 \cdot 1.15 / 1.0 = \mathbf{7.2\text{ kN}}$ bare check $E_{d,fi} / F_{v,Rd,fi} = 24.0 / 7.2 = \mathbf{335\%}$
CHARRING DEPTH - EN 1995-1-2 (4.2.2) $d_{ef} = \beta_n \cdot t + k_0 \cdot d_0 = 0.7 \cdot 30 + 1.00 \cdot 7 = \mathbf{28.0\text{ mm}}$ per exposed face
FIRE SPACING INCREASE - EN 1995-1-2 (6.1) $a_{fi} = \beta_n \cdot k_{flux} \cdot (t_{req} - t_{d,fi}) = \mathbf{15.7\text{ mm}}$
PROTECTIVE BOARD (gypsum-F) - EN 1995-1-2 (6.2.1.2 / 3.12) gypsum-F board $h_p = 12.5\text{ mm} \rightarrow t_{ch} = 2.8 \cdot h_p - 23 = \mathbf{12.0\text{ min}}$ $t_{d,fi,prot} = t_{ch} + 1.2 \cdot t_{d,fi} = 12.0 + 1.2 \cdot 15.8 = \mathbf{30.9\text{ min}} \geq R30 \rightarrow \text{util } 92\% \text{ (min } h_p \geq 12.2\text{ mm)}$
ACHIEVABLE FIRE RESISTANCE - EN 1995-1-2 (6.7) $t_{d,fi} = -(1/k) \cdot \ln(\eta_{fi} \cdot \eta_0 \cdot k_{mod} \cdot \gamma_{M,fi} / (\gamma_M \cdot k_{fi})) = \mathbf{15.8\text{ min}} \rightarrow \text{with board } \mathbf{30.9\text{ min}}$ (required 30 min)
FIRE VERDICT - EN 1995-1-2 §6.2 Fire verdict: ✓ PASS_PROT ($\eta_{fi} = 0.60$, util 92.4%, achieves 30.9 min)

Exposed faces for charring (per member)

Member	Width	Depth +	Depth -	End
CH1	exposed	exposed	exposed	protected
CH2	exposed	exposed	exposed	protected

Charred reduced cross-section (STEP 7, §4.2.2)

Cold resistance of the residual section (d_{ef} removed per exposed face); the fire value $R_{fi} = R_{cold} \cdot k_{fi} \cdot \gamma_M / k_{mod}$ and demand $E_{d,fi} = \eta_{fi} \cdot E_d$ ($\gamma_{M,fi} = 1.0$) are in the fire verdict above.

Block shear on charred section (Annex A) - CH1

NET FRACTURE LENGTHS + MATERIAL - EC5 Annex A

$$\begin{aligned}L_{\text{net},v} &= \sum l_{v,i} = \mathbf{300.0 \text{ mm}} \\L_{\text{net},t} &= \text{gross} - \sum \text{holes} = \mathbf{38.0 \text{ mm}} \\f_{t,0,k} &= 19.2 \text{ MPa} \quad f_{v,k} = 3.5 \text{ MPa} \quad k_{cr} = 0.67 \quad k_{mod} = 0.80 \quad \gamma_M = 1.25\end{aligned}$$

SEGMENT 0 (outer, $t_{\text{seg}} = 47.0 \text{ mm}$) ← GOVERNS - EC5 Annex A

$$\begin{aligned}A_{\text{net},v} &= \frac{1}{2} \cdot L_{\text{net},v} \cdot (L_{\text{net},t} + 2 \cdot t_{\text{ef}}) \cdot k_{cr} = \frac{1}{2} \cdot 300.0 \cdot (38.0 + 2 \cdot 22.0) \cdot 0.67 = \mathbf{8244 \text{ mm}^2} \\A_{\text{net},t} &= L_{\text{net},t} \cdot t_{\text{seg}} = 38.0 \cdot 47.0 = \mathbf{1786 \text{ mm}^2} \\F_{bs,Rk} &= \max(1.5 \cdot A_{\text{net},t} \cdot f_{t,0,k}, 0.7 \cdot A_{\text{net},v} \cdot f_{v,k}) = \max(51.4, 20.2) = \mathbf{51.44 \text{ kN (tension)}} \\F_{bs,Rd} &= k_{mod} \cdot F_{bs,Rk} / \gamma_M = 0.80 \cdot 51.44 / 1.25 = \mathbf{32.92 \text{ kN}} \\\eta_{\text{seg}} &= \text{demand} / F_{bs,Rd} = 20.00 / 32.92 = \mathbf{0.61 \leq 1.0 \checkmark PASS}\end{aligned}$$

SEGMENT 1 (outer, $t_{\text{seg}} = 47.0 \text{ mm}$) - EC5 Annex A

$$\begin{aligned}A_{\text{net},v} &= \frac{1}{2} \cdot L_{\text{net},v} \cdot (L_{\text{net},t} + 2 \cdot t_{\text{ef}}) \cdot k_{cr} = \frac{1}{2} \cdot 300.0 \cdot (38.0 + 2 \cdot 22.0) \cdot 0.67 = \mathbf{8244 \text{ mm}^2} \\A_{\text{net},t} &= L_{\text{net},t} \cdot t_{\text{seg}} = 38.0 \cdot 47.0 = \mathbf{1786 \text{ mm}^2} \\F_{bs,Rk} &= \max(1.5 \cdot A_{\text{net},t} \cdot f_{t,0,k}, 0.7 \cdot A_{\text{net},v} \cdot f_{v,k}) = \max(51.4, 20.2) = \mathbf{51.44 \text{ kN (tension)}} \\F_{bs,Rd} &= k_{mod} \cdot F_{bs,Rk} / \gamma_M = 0.80 \cdot 51.44 / 1.25 = \mathbf{32.92 \text{ kN}} \\\eta_{\text{seg}} &= \text{demand} / F_{bs,Rd} = 20.00 / 32.92 = \mathbf{0.61 \leq 1.0 \checkmark PASS}\end{aligned}$$

BLOCK SHEAR SUM (plastic redistribution, GOVERNS) - EC5 Annex A

$$\begin{aligned}\Sigma F_{bs,Rk} &= 51.44 + 51.44 = \mathbf{102.87 \text{ kN}} \\\Sigma F_{bs,Rd} &= k_{mod} \cdot \Sigma F_{bs,Rk} / \gamma_M = 0.80 \cdot 102.87 / 1.25 = \mathbf{65.84 \text{ kN}} \\\eta &= N_{Ed} / \Sigma F_{bs,Rd} = 40.00 / 65.84 = \mathbf{0.61 \leq 1.0 \checkmark PASS}\end{aligned}$$

Block shear on charred section (Annex A) - CH2

NET FRACTURE LENGTHS + MATERIAL - EC5 Annex A

$L_{net,v} = \sum l_{v,i} = 300.0 \text{ mm}$
 $L_{net,t} = \text{gross} - \sum \text{holes} = 38.0 \text{ mm}$
 $f_{t,0,k} = 19.2 \text{ MPa} \quad f_{v,k} = 3.5 \text{ MPa} \quad k_{cr} = 0.67 \quad k_{mod} = 0.80 \quad \gamma_M = 1.25$

SEGMENT 0 (outer, t_seg = 47.0 mm) ← GOVERNS - EC5 Annex A

$A_{net,v} = \frac{1}{2} \cdot L_{net,v} \cdot (L_{net,t} + 2 \cdot t_{ef}) \cdot k_{cr} = \frac{1}{2} \cdot 300.0 \cdot (38.0 + 2 \cdot 22.0) \cdot 0.67 = 8244 \text{ mm}^2$
 $A_{net,t} = L_{net,t} \cdot t_{seg} = 38.0 \cdot 47.0 = 1786 \text{ mm}^2$
 $F_{bs,Rk} = \max(1.5 \cdot A_{net,t} \cdot f_{t,0,k}, 0.7 \cdot A_{net,v} \cdot f_{v,k}) = \max(51.4, 20.2) = 51.44 \text{ kN (tension)}$
 $F_{bs,Rd} = k_{mod} \cdot F_{bs,Rk} / \gamma_M = 0.80 \cdot 51.44 / 1.25 = 32.92 \text{ kN}$
 $\eta_{seg} = \text{demand} / F_{bs,Rd} = 20.00 / 32.92 = 0.61 \leq 1.0 \quad \checkmark \text{ PASS}$

SEGMENT 1 (outer, t_seg = 47.0 mm) - EC5 Annex A

$A_{net,v} = \frac{1}{2} \cdot L_{net,v} \cdot (L_{net,t} + 2 \cdot t_{ef}) \cdot k_{cr} = \frac{1}{2} \cdot 300.0 \cdot (38.0 + 2 \cdot 22.0) \cdot 0.67 = 8244 \text{ mm}^2$
 $A_{net,t} = L_{net,t} \cdot t_{seg} = 38.0 \cdot 47.0 = 1786 \text{ mm}^2$
 $F_{bs,Rk} = \max(1.5 \cdot A_{net,t} \cdot f_{t,0,k}, 0.7 \cdot A_{net,v} \cdot f_{v,k}) = \max(51.4, 20.2) = 51.44 \text{ kN (tension)}$
 $F_{bs,Rd} = k_{mod} \cdot F_{bs,Rk} / \gamma_M = 0.80 \cdot 51.44 / 1.25 = 32.92 \text{ kN}$
 $\eta_{seg} = \text{demand} / F_{bs,Rd} = 20.00 / 32.92 = 0.61 \leq 1.0 \quad \checkmark \text{ PASS}$

BLOCK SHEAR SUM (plastic redistribution, GOVERNS) - EC5 Annex A

$\Sigma F_{bs,Rk} = 51.44 + 51.44 = 102.87 \text{ kN}$
 $\Sigma F_{bs,Rd} = k_{mod} \cdot \Sigma F_{bs,Rk} / \gamma_M = 0.80 \cdot 102.87 / 1.25 = 65.84 \text{ kN}$
 $\eta = N_{Ed} / \Sigma F_{bs,Rd} = 40.00 / 65.84 = 0.61 \leq 1.0 \quad \checkmark \text{ PASS}$

Splitting on charred section (§8.1.4)

CH1: N/A - auto: |Vz|=0.00 kN < threshold 0.10 kN
CH2: N/A - auto: |Vz|=0.00 kN < threshold 0.10 kN

Checks Not Performed

Perpendicular Splitting - S8.1.4

CH1: not assessed (auto: $|V_z|=0.00$ kN < threshold 0.10 kN)

CH2: not assessed (auto: $|V_z|=0.00$ kN < threshold 0.10 kN)

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	10.00	122.40	8.2	5.00	20.23	24.7	shear	PASS
B2	end/edg	10.00	122.40	8.2	5.00	20.23	24.7	shear	PASS
B3	end/edg	10.00	122.40	8.2	5.00	20.23	24.7	shear	PASS
B4	end/edg	10.00	122.40	8.2	5.00	20.23	24.7	shear	PASS
B5	end/edg	10.00	122.40	8.2	5.00	20.23	24.7	shear	PASS
B6	end/edg	10.00	122.40	8.2	5.00	20.23	24.7	shear	PASS
B7	end/edg	10.00	122.40	8.2	5.00	20.23	24.7	shear	PASS
B8	end/edg	10.00	122.40	8.2	5.00	20.23	24.7	shear	PASS

Plate S355, t = 10.0 mm, gamma_M2 = 1.25, threads in shear. 8 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	tension	40.0	940	345.2	11.6	PASS
CH2	tension	40.0	940	345.2	11.6	PASS

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

Verdict

Member	Check	eta [%]	Status
CH1	Critical fastener (B2)	65.2	PASS
CH2	Critical fastener (B5)	65.2	PASS
CH1	Group capacity (n_ef)	65.2	PASS
CH2	Group capacity (n_ef)	81.5	PASS
CH1	Block / plug shear	38.1	PASS
CH2	Block / plug shear	38.1	PASS
CH1	Net cross-section	15.1	PASS
CH2	Net cross-section	15.1	PASS
CH1	Charred block shear (fire)	60.8	PASS
CH2	Charred block shear (fire)	60.8	PASS

Fire verdict: ✓ PASS_PROT

FINAL VERDICT: PASS

Governing utilisation: eta = 81.5% (CH2 Group capacity (n_ef))