

EC5 Timber Fastener Capacity Check

EN 1995-1-1:2004

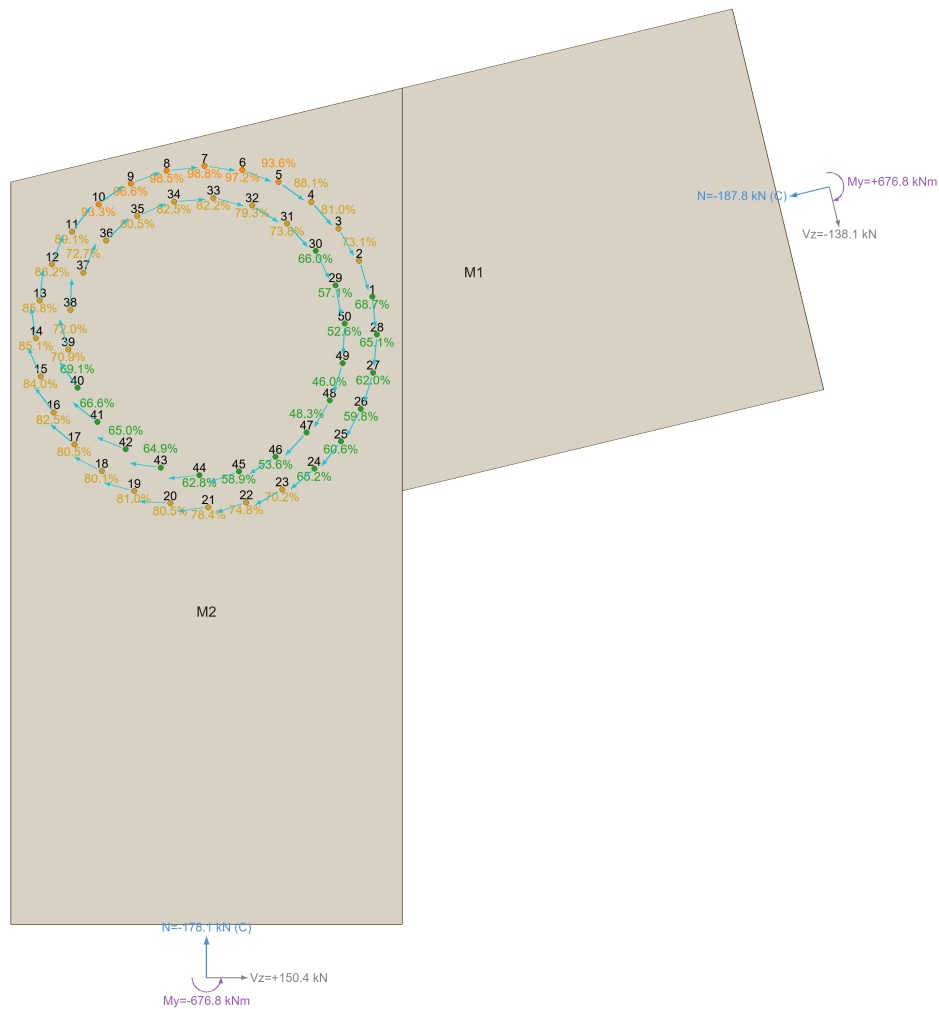
Date: 2026-08-11
Load Case: manual

Input Data Summary

Timber class	GL24h
Service class	1
Load duration	Short-term
Fastener type	Dowel
Fastener diameter	24 mm
Fastener grade	Custom (f _y , f _u) (240/400)
Dowel strength	f _{u,k} = 400 MPa
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
M1	Yes	200	1480	200 x 1480
M2	No	120	1480	120 x 1480

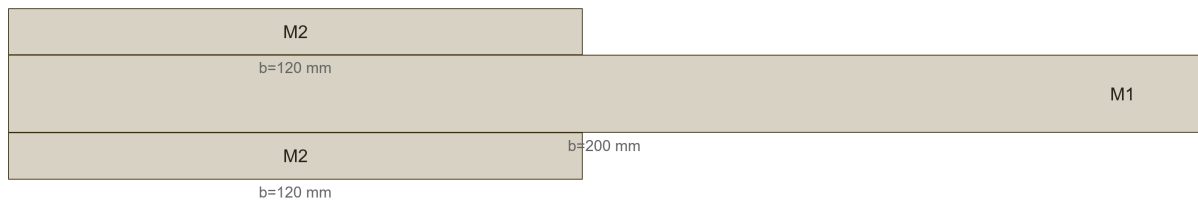
Member Loads (LC: manual)

Member	N [kN]	T/C	Vz [kN]	Vy [kN]	My [kNm]	Mz [kNm]	T [kNm]
M1 / End	-187.80	C	-138.10	0.00	676.80	0.00	0.00
M2 / End	-178.10	C	150.40	0.00	-676.80	0.00	0.00

Equilibrium (Forces through node): X +0.03 Y +0.00 Z -0.03 kN Mx +0.00 My +0.00 Mz +0.00 kNm (balanced)

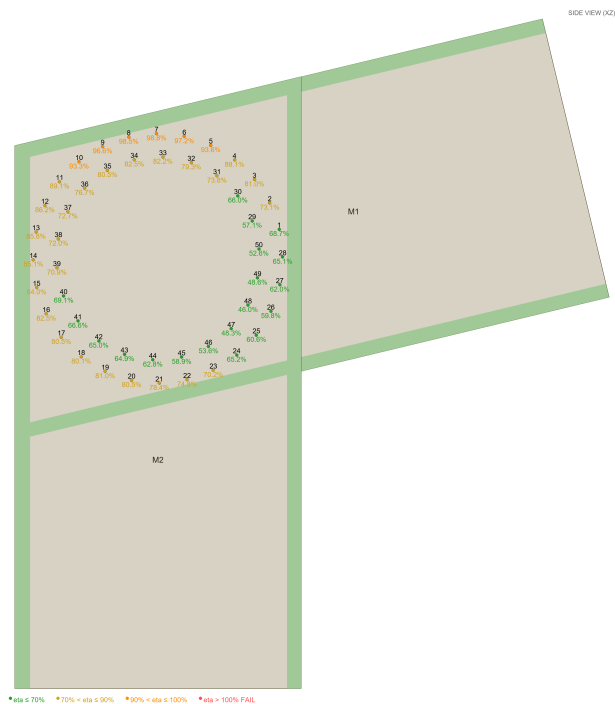
+ Lever arm (fastener group centroid x Vz): My +0.00 kNm

Equilibrium (Forces through fastener centroid): X +0.03 Y +0.00 Z -0.03 kN Mx +0.00 My +0.00 Mz +0.00 kNm (balanced)



■ Timber member

Spacing Validation - S8.5.1.1(3)



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

Member M1

a1 PARALLEL SPACING $a_{1,min} = (3 + 2 \cos \alpha) \cdot d = 110.7 \text{ mm}$ actual = 143.3 mm ✓ PASS
a2 PERPENDICULAR SPACING $a_{2,min} = 95.0 \text{ mm}$ actual = 120.6 mm ✓ PASS
a3,c END DISTANCE (unloaded) $a_{3,c,min} = 72.0 \text{ mm}$ actual = 98.8 mm ✓ PASS
a4,t EDGE DISTANCE (loaded) $a_{4,t,min} = \max((2+2 \sin \alpha)d, 3d) = 76.4 \text{ mm}$ actual = 96.0 mm ✓ PASS
a4,c EDGE DISTANCE (unloaded) $a_{4,c,min} = 3d = 72.0 \text{ mm}$ actual = 96.0 mm ✓ PASS

Member M2

a1 PARALLEL SPACING $a_{1,min} = (3 + 2 \cos \alpha) \cdot d = 108.7 \text{ mm}$ actual = 143.1 mm ✓ PASS
a2 PERPENDICULAR SPACING $a_{2,min} = 105.1 \text{ mm}$ actual = 120.0 mm ✓ PASS
a3,c END DISTANCE (unloaded) $a_{3,c,min} = 72.0 \text{ mm}$ actual = 98.7 mm ✓ PASS
a4,t EDGE DISTANCE (loaded) $a_{4,t,min} = \max((2+2 \sin \alpha)d, 3d) = 79.0 \text{ mm}$ actual = 96.0 mm ✓ PASS
a4,c EDGE DISTANCE (unloaded) $a_{4,c,min} = 3d = 72.0 \text{ mm}$ actual = 96.0 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
D1	69	120/200/120	14.2	22.25	32.40	68.7	11.12	16.20	68.7	-	man...	PASS	k k
D2	73	120/200/120	15.0	23.23	31.78	73.1	11.62	15.89	73.1	-	man...	PASS	jj
D3	61	120/200/120	16.5	24.27	29.96	81.0	12.13	14.98	81.0	-	man...	PASS	jj
D4	49	120/200/120	18.4	25.31	28.74	88.1	12.65	14.37	88.1	-	man...	PASS	jj
D5	36	120/200/120	20.6	26.29	28.10	93.6	13.15	14.05	93.6	-	man...	PASS	jj
D6	23	120/200/120	22.6	27.19	27.98	97.2	13.59	13.99	97.2	-	man...	PASS	jj
D7	9	120/200/120	23.8	27.96	28.30	98.8	13.98	14.15	98.8	-	man...	PASS	jj
D8	6	120/200/120	23.8	28.58	29.00	98.5	14.29	14.50	98.5	-	man...	PASS	jj
D9	6	120/200/120	22.7	29.03	30.05	96.6	14.51	15.03	96.6	-	man...	PASS	jj
D10	10	120/200/120	20.9	29.29	31.40	93.3	14.64	15.70	93.3	-	man...	PASS	jj
D11	26	120/200/120	18.9	29.35	32.95	89.1	14.67	16.47	89.1	-	man...	PASS	jj
D12	41	120/200/120	17.1	29.22	33.91	86.2	14.61	16.96	86.2	-	man...	PASS	k k
D13	57	120/200/120	15.7	28.89	33.69	85.8	14.45	16.84	85.8	-	man...	PASS	k k
D14	72	120/200/120	14.7	28.38	33.36	85.1	14.19	16.68	85.1	-	man...	PASS	k k
D15	67	120/200/120	14.1	27.71	32.97	84.0	13.85	16.48	84.0	-	man...	PASS	k k
D16	53	120/200/120	14.1	26.89	32.58	82.5	13.44	16.29	82.5	-	man...	PASS	k k
D17	40	120/200/120	14.5	25.96	32.25	80.5	12.98	16.12	80.5	-	man...	PASS	k k
D18	27	120/200/120	15.4	24.95	31.13	80.1	12.47	15.56	80.1	-	man...	PASS	jj
D19	15	120/200/120	17.0	23.90	29.51	81.0	11.95	14.76	81.0	-	man...	PASS	jj
D20	4	120/200/120	19.3	22.88	28.42	80.5	11.44	14.21	80.5	-	man...	PASS	jj
D21	8	120/200/120	21.8	21.93	27.97	78.4	10.96	13.99	78.4	-	man...	PASS	jj
D22	8	120/200/120	23.7	21.11	28.22	74.8	10.56	14.11	74.8	-	man...	PASS	jj
D23	3	120/200/120	23.7	20.50	29.18	70.2	10.25	14.59	70.2	-	man...	PASS	jj
D24	14	120/200/120	21.6	20.13	30.86	65.2	10.06	15.43	65.2	-	man...	PASS	jj
D25	25	120/200/120	18.7	20.03	33.08	60.6	10.02	16.54	60.6	-	man...	PASS	jj
D26	36	120/200/120	16.3	20.23	33.81	59.8	10.11	16.90	59.8	-	man...	PASS	k k
D27	46	120/200/120	14.7	20.69	33.38	62.0	10.34	16.69	62.0	-	man...	PASS	k k
D28	57	120/200/120	14.1	21.38	32.86	65.1	10.69	16.43	65.1	-	man...	PASS	k k
D29	74	120/200/120	14.8	18.36	32.13	57.1	9.18	16.07	57.1	-	man...	PASS	k k
D30	64	120/200/120	16.6	19.67	29.80	66.0	9.84	14.90	66.0	-	man...	PASS	jj
D31	49	120/200/120	19.2	20.98	28.44	73.8	10.49	14.22	73.8	-	man...	PASS	jj
D32	33	120/200/120	21.9	22.19	27.97	79.3	11.09	13.98	79.3	-	man...	PASS	jj
D33	15	120/200/120	23.7	23.21	28.23	82.2	11.61	14.11	82.2	-	man...	PASS	jj
D34	4	120/200/120	23.8	24.01	29.09	82.5	12.00	14.55	82.5	-	man...	PASS	jj
D35	3	120/200/120	22.1	24.52	30.46	80.5	12.26	15.23	80.5	-	man...	PASS	jj
D36	18	120/200/120	19.7	24.74	32.24	76.7	12.37	16.12	76.7	-	man...	PASS	jj
D37	39	120/200/120	17.4	24.66	33.94	72.7	12.33	16.97	72.7	-	man...	PASS	k k
D38	60	120/200/120	15.6	24.27	33.69	72.0	12.13	16.84	72.0	-	man...	PASS	k k
D39	74	120/200/120	14.5	23.59	33.27	70.9	11.80	16.63	70.9	-	man...	PASS	k k
D40	55	120/200/120	14.0	22.66	32.78	69.1	11.33	16.39	69.1	-	man...	PASS	k k
D41	39	120/200/120	14.3	21.53	32.33	66.6	10.77	16.16	66.6	-	man...	PASS	k k
D42	23	120/200/120	15.4	20.26	31.15	65.0	10.13	15.58	65.0	-	man...	PASS	jj
D43	8	120/200/120	17.5	18.93	29.17	64.9	9.46	14.59	64.9	-	man...	PASS	jj
D44	6	120/200/120	20.7	17.66	28.09	62.8	8.83	14.05	62.8	-	man...	PASS	jj
D45	7	120/200/120	23.5	16.56	28.14	58.9	8.28	14.07	58.9	-	man...	PASS	jj
D46	7	120/200/120	23.4	15.79	29.44	53.6	7.89	14.72	53.6	-	man...	PASS	jj
D47	20	120/200/120	20.1	15.44	31.99	48.3	7.72	16.00	48.3	-	man...	PASS	jj
D48	33	120/200/120	16.5	15.58	33.85	46.0	7.79	16.92	46.0	-	man...	PASS	k k
D49	47	120/200/120	14.5	16.18	33.27	48.6	8.09	16.64	48.6	-	man...	PASS	k k
D50	60	120/200/120	14.0	17.15	32.60	52.6	8.57	16.30	52.6	-	man...	PASS	k k

Gray values are supplementary and never set the row verdict.

Timber-to-timber fasteners: $\eta_a = V_{Ed,gov} / F_{v,Rd,gov}$ on the governing shear plane.

Rope on j/k modes: Johansen + $\min(F_{ax}, R_k/4, 0.25 \cdot \text{Johansen})$ per plane.

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

Critical fastener D7 (member M1)

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

TIMBER-TO-TIMBER INPUT DATA - EC5 8.2.2

Fastener: Dowel, d = 24.0 mm, f_{u,k} = 400 MPa
Layer stack t = 120/200/120 mm, shear planes = 2
Load-to-grain alpha = 8.6 deg, k_{mod}/gamma_M = 0.90/1.25

TIMBER-TO-TIMBER LAYER STACK (2 shear planes) - EC5 (8.1.3)

Stack: **outer1 | inner | outer1**

EMBEDMENT STRENGTH, SIDE MEMBER - EC5 (8.31)

f_{h,1,k} = **14.14 MPa**

EMBEDMENT STRENGTH, CENTRAL MEMBER - EC5 (8.31)

f_{h,2,k} = **23.83 MPa**

EMBEDMENT STRENGTH RATIO (β) - EC5 (8.8)

$\beta = \frac{f_{h,2,k}}{f_{h,1,k}} = 23.83 / 14.14 = \mathbf{1.685}$

CHARACTERISTIC YIELD MOMENT - EC5 (8.30)

M_{y,Rk} = 0.3 · f_{u,k} · d^{2.6} = **465297 N·mm**

JOHANSEN MODE (g) - EC5 (8.7)

F_{v,Rk} = f_{h,1,k} · t₁ · d = 14.14 · 120.0 · 24.0 = **40.73 kN**



JOHANSEN MODE (h) - EC5 (8.7)

F_{v,Rk} = 0.5 · f_{h,2,k} · t₂ · d = 0.5 · 23.83 · 200.0 · 24.0 = **57.20 kN**



JOHANSEN MODE (j) - EC5 (8.7) ← GOVERNS

$F_{v,Rk} = 1.05 \cdot \frac{f_{h,1,k} \cdot t_1 \cdot d}{2 + \beta} \cdot [\sqrt{2\beta(1+\beta) + 4\beta(2+\beta)M_{y,Rk}/(f_{h,1,k} \cdot d \cdot t_1^2)} - \beta] = \mathbf{19.65\ kN}$



JOHANSEN MODE (k) - EC5 (8.7)

$F_{v,Rk} = 1.15 \cdot \sqrt{2\beta/(1+\beta)} \cdot \sqrt{2 \cdot M_{y,Rk} \cdot f_{h,1,k} \cdot d} = \mathbf{22.90\ kN}$



ROPE-CAPPED MODE VALUES - EC5 §8.2.2(2)

Mode j: Johansen-only 19.65 kN + rope 0.00 kN = 19.65 kN
Mode k: Johansen-only 22.90 kN + rope 0.00 kN = 22.90 kN

PER-PLANE CAPACITY (2 shear planes, §8.1.3(1)) - EC5 (8.1.3)

Plane 1 (outer, t=200.0 mm): F_{v,Rk} = 19.65 kN [mode j]
Plane 2 (outer, t=200.0 mm): F_{v,Rk} = 19.65 kN [mode j]

DESIGN CAPACITY - EC5 §2.4.1 (2.17)

$F_{v,Rd} = \frac{k_{mod} \cdot F_{v,Rk}}{\gamma_M} = (0.90 \cdot 19.65) / 1.25 = \mathbf{14.15\ kN}$

UTILISATION, PLANE 1 (MAX ETA) - EC5 (2.17)

$\eta = \frac{V_{Ed}}{F_{v,Rd}} = 13.981 / 14.149 = \mathbf{0.99 \leq 1.0 \checkmark PASS}$

Effective Fastener Count (n_{ef}) - S8.5.1.1(4)

Member M1

N_{EF} FAMILY ROUTING

Family routing: dowel -> 8.5.1 (EN 8.6(1))

EFFECTIVE FASTENER COUNT - EC5 (8.34/8.35)

$n_{ef} = n$ (rotational regime, no row-split reduction) = **50.00**

GROUP CHARACTERISTIC CAPACITY - EC5 (8.1.1)

$F_{v,Rk,group} = \sum n_{ef} \cdot F_{v,Rk,fast} = 50.00 \cdot 38.85 = \mathbf{1942.3 \text{ kN}}$

Member M2

N_{EF} FAMILY ROUTING

Family routing: dowel -> 8.5.1 (EN 8.6(1))

EFFECTIVE FASTENER COUNT - EC5 (8.34/8.35)

$n_{ef} = n$ (rotational regime, no row-split reduction) = **50.00**

GROUP CHARACTERISTIC CAPACITY - EC5 (8.1.1)

$F_{v,Rk,group} = \sum n_{ef} \cdot F_{v,Rk,fast} = 50.00 \cdot 19.42 = \mathbf{971.2 \text{ kN}}$

Member-grain row direction (S8.1.2(5))

M1: N/A (circular fastener groups have no member-grain rows)

M2: N/A (circular fastener groups have no member-grain rows)

Perpendicular Splitting - S8.1.4

Member M1

CHARACTERISTIC SPLITTING CAPACITY - EC5 (8.4)

$$F_{90,Rk} = 14 \cdot b \cdot w \cdot \sqrt{h_e / (1 - h_e/h)} = 14 \cdot 200 \cdot 1.0 \cdot \sqrt{1384 / (1 - 1384/1480)} = \mathbf{409.00 \text{ kN}}$$

DESIGN SPLITTING CAPACITY - EC5 (2.4.3)

$$F_{90,Rd} = k_{mod} \cdot F_{90,Rk} / \gamma_M = 0.90 \cdot 409.00 / 1.25 = \mathbf{294.48 \text{ kN}}$$

SPLITTING UTILISATION - EC5 (8.1.4)

$$\eta = F_{v,Ed} / F_{90,Rd} = 138.10 / 294.48 = \mathbf{0.47 \leq 1.0 \quad \checkmark \text{ PASS}}$$

Member M2

CHARACTERISTIC SPLITTING CAPACITY - EC5 (8.4)

$$F_{90,Rk} = 14 \cdot b \cdot w \cdot \sqrt{h_e / (1 - h_e/h)} = 14 \cdot 120 \cdot 1.0 \cdot \sqrt{1384 / (1 - 1384/1480)} = \mathbf{245.34 \text{ kN}}$$

DESIGN SPLITTING CAPACITY - EC5 (2.4.3)

$$F_{90,Rd} = k_{mod} \cdot F_{90,Rk} / \gamma_M = 0.90 \cdot 245.34 / 1.25 = \mathbf{176.65 \text{ kN}}$$

SPLITTING UTILISATION - EC5 (8.1.4)

$$\eta = F_{v,Ed} / F_{90,Rd} = 75.20 / 176.65 = \mathbf{0.43 \leq 1.0 \quad \checkmark \text{ PASS}}$$

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

Member M1

NET WIDTH + HOLE DIAMETER - EC5 5.2

$$d_0 = d + \text{oversize} = 24 + 0 = \mathbf{24 \text{ mm}} \quad (\text{drilled timber hole})$$

NET CROSS-SECTION AREA - EC5 5.2

$$A_{\text{net}} = A_{\text{gross}} - n \cdot d_0 \cdot b = 296000 - 4 \cdot 24 \cdot 200 = \mathbf{276800 \text{ mm}^2}$$

DESIGN COMPRESSIVE STRENGTH (parallel) - EC5 6.1.4

$$f_{c,0,d} = k_{\text{mod}} \cdot f_{c,0,k} / \gamma_M = 0.90 \cdot 24.0 / 1.25 = \mathbf{17.280 \text{ MPa}}$$

NET-SECTION COMPRESSIVE UTILISATION - EC5 6.1.4

$$\eta = \sigma_{c,0,d} / f_{c,0,d} = 0.678 / 17.280 = \mathbf{0.04 \leq 1.0 \quad \checkmark \text{ PASS}}$$

BENDING STRESS AT NET SECTION - EC5 6.1.6

$$\sigma_m = M_y \cdot z_s / I_{\text{net}} = 6.768\text{e}+08 \cdot 740 / 4.741\text{e}+10 = \mathbf{10.563 \text{ MPa}} \quad (f_{m,d} = 17.280 \text{ MPa})$$

COMPRESSION + BENDING INTERACTION - EC5 6.2.4

$$\eta = (\sigma_{c,0,d} / f_{c,0,d})^2 + \sigma_m / f_{m,d} = 0.002 + 0.611 = \mathbf{0.61 \leq 1.0 \quad \checkmark \text{ PASS}}$$

NET-SECTION SHEAR UTILISATION - EC5 6.1.7

$$\tau_v = V_z \cdot S_{\text{net}} / (I_{\text{net}} \cdot b \cdot k_{cr}) = 138100 \cdot 4.92\text{e}+07 / (4.74\text{e}+10 \cdot 200 \cdot 0.67) = \mathbf{1.069 \text{ MPa}}$$
$$\eta = \tau_v / f_{v,d} = 1.069 / 2.520 = \mathbf{0.42 \leq 1.0 \quad \checkmark \text{ PASS}}$$

MOMENT-INDUCED SHEAR UTILISATION - EC5 6.1.7

$$V_{dw} = 358.9 \text{ kN} \quad (= V_M)$$
$$\tau_{dw} = V_{dw} \cdot S_{\text{net}} / (I_{\text{net}} \cdot b \cdot k_{cr}) = 358854 \cdot 4.92\text{e}+07 / (4.74\text{e}+10 \cdot 200 \cdot 0.67) = \mathbf{2.776 \text{ MPa}}$$
$$\eta = \tau_{dw} / f_{v,d} = 2.776 / 2.520 = \mathbf{1.10 > 1.0 \quad \times \text{ FAIL}}$$

GOVERNING NET-SECTION UTILISATION

$$\eta_{\text{gov}} = \max(\text{axial, N+M, current shear}) = \mathbf{1.10 > 1.0 \quad \times \text{ FAIL}}$$

Member M2

NET WIDTH + HOLE DIAMETER - EC5 5.2

$$d_0 = d + \text{oversize} = 24 + 0 = \mathbf{24 \text{ mm}} \quad (\text{drilled timber hole})$$

NET CROSS-SECTION AREA - EC5 5.2

$$A_{\text{net}} = A_{\text{gross}} - n \cdot d_0 \cdot b = 177600 - 3 \cdot 24 \cdot 120 = \mathbf{168960 \text{ mm}^2}$$

DESIGN COMPRESSIVE STRENGTH (parallel) - EC5 6.1.4

$$f_{c,0,d} = k_{\text{mod}} \cdot f_{c,0,k} / \gamma_M = 0.90 \cdot 24.0 / 1.25 = \mathbf{17.280 \text{ MPa}}$$

NET-SECTION COMPRESSIVE UTILISATION - EC5 6.1.4

$$\eta = \sigma_{c,0,d} / f_{c,0,d} = 0.527 / 17.280 = \mathbf{0.03 \leq 1.0 \quad \checkmark \text{ PASS}}$$

BENDING STRESS AT NET SECTION - EC5 6.1.6

$$\sigma_m = M_y \cdot z_s / I_{\text{net}} = -3.384\text{e}+08 \cdot 740 / 2.924\text{e}+10 = \mathbf{8.563 \text{ MPa}} \quad (f_{m,d} = 17.280 \text{ MPa})$$

COMPRESSION + BENDING INTERACTION - EC5 6.2.4

$$\eta = (\sigma_{c,0,d} / f_{c,0,d})^2 + \sigma_m / f_{m,d} = 0.001 + 0.496 = \mathbf{0.50 \leq 1.0 \quad \checkmark \text{ PASS}}$$

NET-SECTION SHEAR UTILISATION - EC5 6.1.7

$$\tau_v = V_z \cdot S_{\text{net}} / (I_{\text{net}} \cdot b \cdot k_{cr}) = 75200 \cdot 3.10\text{e}+07 / (2.92\text{e}+10 \cdot 120 \cdot 0.67) = \mathbf{0.992 \text{ MPa}}$$
$$\eta = \tau_v / f_{v,d} = 0.992 / 2.520 = \mathbf{0.39 \leq 1.0 \quad \checkmark \text{ PASS}}$$

MOMENT-INDUCED SHEAR UTILISATION - EC5 6.1.7

$$V_{dw} = 180.1 \text{ kN} \quad (= V_M)$$
$$\tau_{dw} = V_{dw} \cdot S_{\text{net}} / (I_{\text{net}} \cdot b \cdot k_{cr}) = 180050 \cdot 3.10\text{e}+07 / (2.92\text{e}+10 \cdot 120 \cdot 0.67) = \mathbf{2.374 \text{ MPa}}$$
$$\eta = \tau_{dw} / f_{v,d} = 2.374 / 2.520 = \mathbf{0.94 \leq 1.0 \quad \checkmark \text{ PASS}}$$

GOVERNING NET-SECTION UTILISATION

$$\eta_{\text{gov}} = \max(\text{axial, N+M, current shear}) = \mathbf{0.94 \leq 1.0 \quad \checkmark \text{ PASS}}$$

Checks Not Performed

Timber-to-timber Group Capacity - Per-Plane

M1: rotationally dominated (circular fastener pattern) - no group capacity check (the moment share is checked per fastener) [WARNING: significant translational demand ($\tau=0.203 \geq \tau_{\min}=0.20$) - verify the per-plane group capacity is not governing]

Block Shear - EC5 Annex A

Members not requiring a block-shear check:

M1: N/A - rotationally dominated (circular bolt group)

M2: N/A - rotationally dominated (circular bolt group)

Verdict

Member	Check	eta [%]	Status
M1	Critical fastener (D7)	98.8	PASS
	Perpendicular splitting	46.9	PASS
M2	Perpendicular splitting	42.6	PASS
M1	Net cross-section	110.2	FAIL
M2	Net cross-section	94.2	PASS

FINAL VERDICT: FAIL

Governing utilisation: eta = 110.2% (M1 Net cross-section)