POSITION 1: OUTER TIMBER MEMBERS NAILS

1. Input parameters

1.1. Fasteners

nail, 3.4 x 90.0 mm, two-sided, d_k = 7.7 mm, not predrilled
design resistance reduced acc. to DIN EN 1995-1-1, 8.3.1.1(8)
$F_{v,Rk}$ increased acc. to DIN EN 1995-1-1, 8.2.2(2)
$F_{v,Rd}$ calculated with the exact verification acc. to DIN EN 1995-1-1, 8.2.2
96 x nail

1.2. design loads (splice in bending)

service class 2

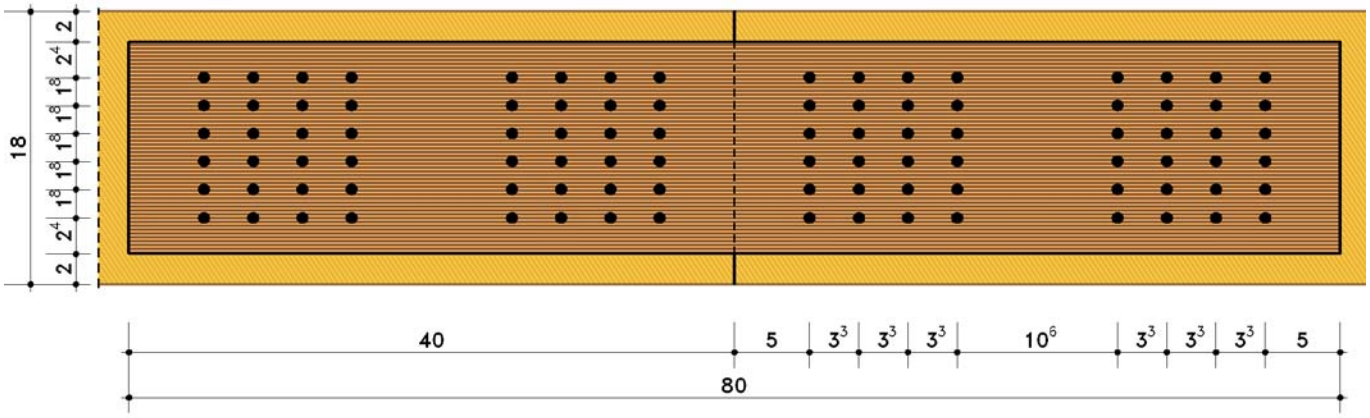
Nr	M_d kNm	N_d kN	V_d kN	k_{mod} -	A	comment
1	2.00	10.00	1.00	0.80		

2. System visualisation

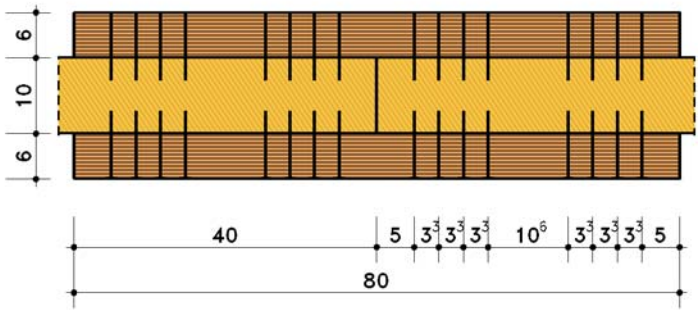
2.1. Static values and constructive boundary conditions

splice with double-sided outer timber members
timber members from solid coniferous timber C24 with ρ_k = 350 kg/m³
outer timber member: t = 6.0 cm, A_n = 84.00 cm², W_n = 196.00 cm³, I_n = 1372.00 cm⁴
inner timber member: t = 10.0 cm, A_n = 180.00 cm², W_n = 540.00 cm³, I_n = 4860.00 cm⁴
min α = 24.5 ° => minimum spacings
a_1 = 3.2 cm, a_2 = 1.7 cm, $a_{3,t}$ = 4.9 cm, $a_{3,c}$ = 3.4 cm, $a_{4,t}$ = 2.0 cm, $a_{4,c}$ = 1.7 cm
$a_{1,exist}$ = 3.25 cm, $a_{2,exist}$ = 1.85 cm
polar moment of inertia I_p = 6079.74 cm²
centroid of fasteners S at x_s = 20.00 cm, y_s = 0.00 cm

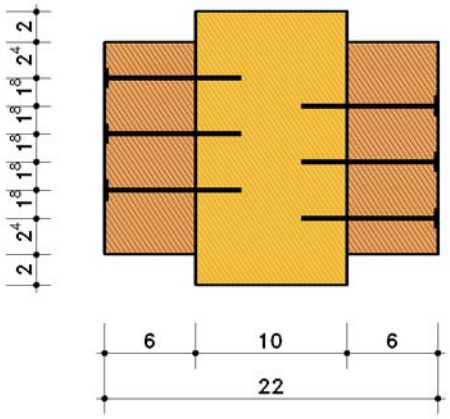
elevation scale 1: 5, unit of length [cm]



longitudinal section scale 1:10, unit of length [cm]



cross section scale 1: 5, unit of length [cm]



3. verifications acc. to DIN EN 1995, Germany

γ_M = 1.30, γ_s = 1.00
min. thickness outer timber members $t_{1,req}$ = 3.14 cm, min. thickness inner timber member $t_{2,req}$ = 2.61 cm
min. thickness of timber members due to possibility of splitting $t_{min,1}$ = 4.76 cm

3.1. Load combination 1

3.1.1. Strengths and design resistances

$f_{t,d}$ = 8.92 N/mm², $f_{m,d}$ = 14.77 N/mm², $f_{c,d}$ = 12.92 N/mm², $f_{v,d}$ = 2.46 N/mm²

3.1.2. Fasteners

N_d = 10.00 kN, V_d = 1.00 kN, $M_{v,d}$ = |2.00| + |0.20 x 1.00| = 2.20 KNm, k_{mod} = 0.80
$F_{Hi,d}$ = 10.00 / (2 x 48) = 0.10 kN
$F_{Vi,d}$ = 1.00 / (2 x 48) = 0.01 kN
α_{min} = 24.46, a_1 = 33 mm, n = 8 => n_{ef} = 5.60
fastener ending in inner timber member, fastener two-sided, penetration depth t = 30 mm
forces per shear plane, mode = decisive failure mode acc. to DIN EN 1995-1-1, 8.2.2

Nr	F_{Mi} kN	F_{MHi} kN	F_{MVi} kN	F_{totHi} kN	F_{totVi} kN	F_{toti} kN	α_{toti} °	$f_{h,\alpha,k}$ N/mm²	mode	$F_{v,Rk}$ kN	$F_{v,Rd}$ kN	u -
1	0.28	0.08	0.27	0.19	0.28	0.34	56.41	19.88	Eq.(e)	0.8670	0.3732	0.91

maximum utilization of fasteners u_{max} = 0.91 ≤ 1 => **verification successful**

3.1.3. timber members

inner timber member : max $V_{90,d}$ = 1.70 N, $\sigma_{90,d}$ = 0.16 N/mm², $f_{t90,d}$ = 1.54 N/mm² ⇒ u = 0.10
outer timber members: max $V_{90,d}$ = 1.70 N, $\sigma_{90,d}$ = 0.27 N/mm², $f_{t90,d}$ = 1.54 N/mm² ⇒ u = 0.17
inner timber member : $\sigma_{t,d}$ = 0.56 N/mm², $\sigma_{m,d}$ = 4.07 N/mm², τ_d = 1.56 N/mm² (mit V_d = 9.33 kN) ⇒ u = 0.63
outer timber members: $\sigma_{t,d}$ = 0.60 N/mm², $\sigma_{m,d}$ = 5.61 N/mm², τ_d = 1.67 N/mm² (mit V_d = 9.33 kN) ⇒ u = 0.68
max. util. of inner timber member resp. of outer t. members u_{max} = 0.68 ≤ 1 ⇒ **verification successful**

4. Summary

maximum utilization of all verifications u_{max} = 0.91 ≤ 1 => **all verifications successful**