

POSITION 2: OUTER TIMBER MEMBERS - CONNECTORS

1. Input parameters

1.1. Fasteners

shear plate connector C1 $d_c = 50$ mm, FK 4.6

bolt M 16, FK 4.6

washer $d = 56$ mm

$F_{v,Rk}$ increased acc. to DIN EN 1995, 8.2.2(2) with washer $d = 56$ mm

$F_{v,Rd}$ calculated with the exact verification acc. to DIN EN 1995-1-1, 8.2.2

2 x shear plate connector C1

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	8.00	1.00	0.80		

2. System visualisation

2.1. Static values and constructive boundary conditions

splice with double-sided outer timber members and double shear fasteners

timber members from solid coniferous timber C24 with $\rho_k = 350$ kg/m³

outer timber member: $t = 8.0$ cm, $A_n = 128.70$ cm², $W_n = 428.32$ cm³, $I_n = 3854.84$ cm⁴

inner timber member: $t = 10.0$ cm, $A_n = 159.60$ cm², $W_n = 535.09$ cm³, $I_n = 4815.78$ cm⁴

min $\alpha = 71.6^\circ \Rightarrow$ minimum spacings

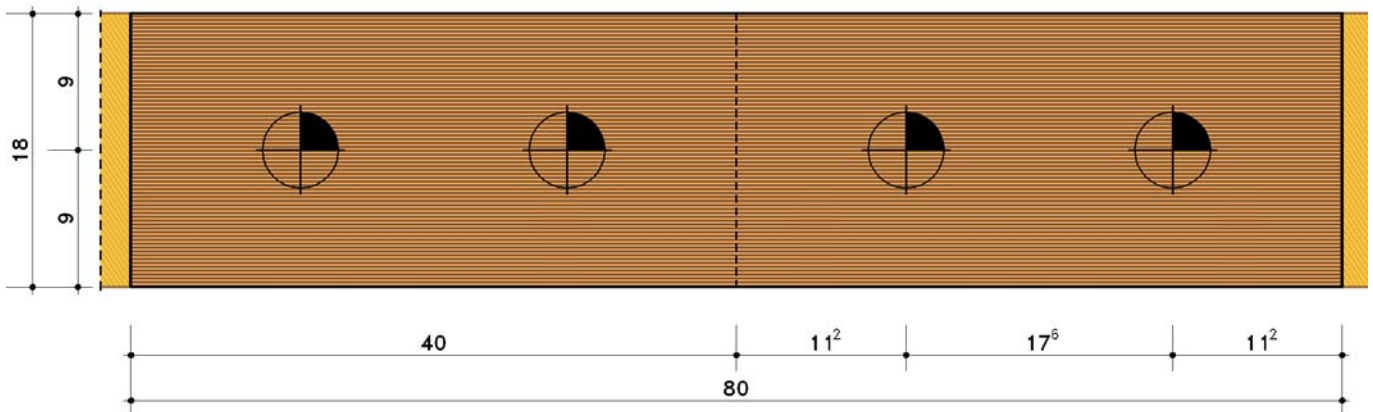
$a_1 = 6.9$ cm, $a_2 = 6.4$ cm, $a_{3,t} = 11.2$ cm, $a_{3,c} = 7.3$ cm, $a_{4,t} = 6.2$ cm, $a_{4,c} = 4.8$ cm

$a_{1,exist} = 17.60$ cm

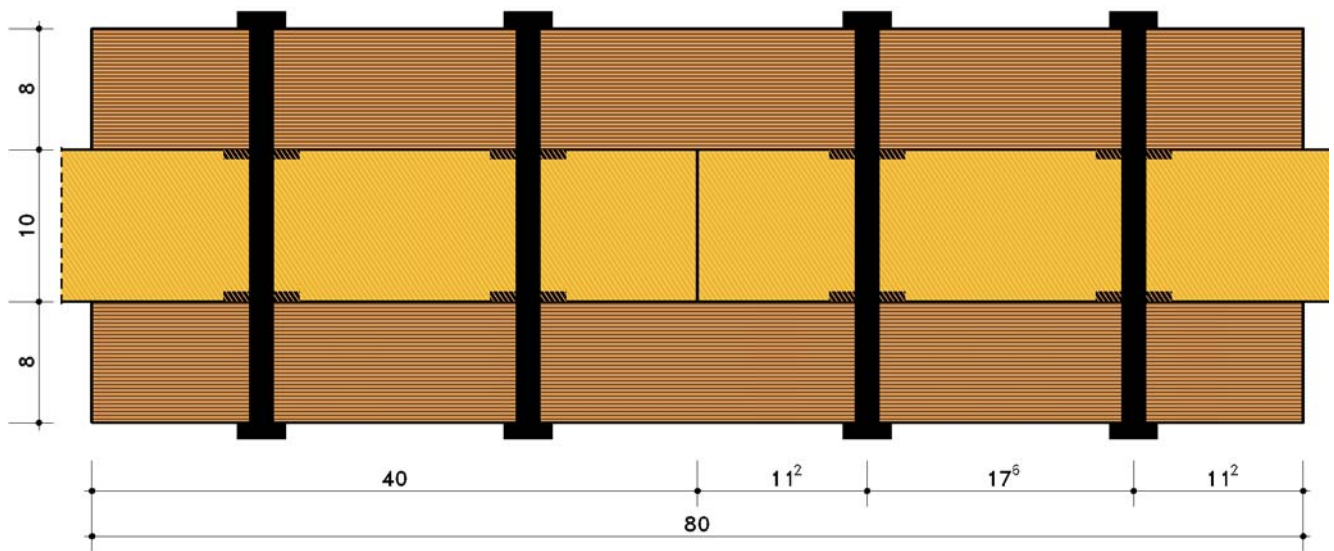
polar moment of inertia $I_p = 154.88$ cm²

centroid of fasteners S at $x_s = 20.00$ cm, $y_s = 0.00$ cm

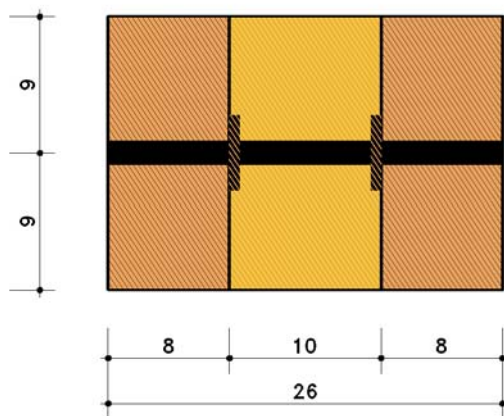
elevation scale 1: 5, unit of length [cm]



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



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



3. verifications acc. to DIN EN 1995, Germany

$\gamma_M = 1.30$, $\gamma_s = 1.00$

min. thickness outer timber members $t_{1,req} = 2.40$ cm, min. thickness inner timber member $t_{2,req} = 3.00$ cm

3.1. Load combination 1

3.1.1. Strengths and design resistances

$k_p = 1.00$, $k_t = 1.00 \Rightarrow R_{ks} = 6363.96$ N

$k_{90} = 2.10$, $f_{h,0,k} = 14.35$ N/mm², $\beta = 1.00$

$f_{t,d} = 8.92$ 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

$N_d = 8.00$ kN, $V_d = 1.00$ kN, $M_{v,d} = |2.00| + |0.20 \times 1.00| = 2.20$ kNm, $k_{mod} = 0.80$

$F_{H1,d} = 8.00 / (2 \times 2) = 2.00$ kN

$F_{V1,d} = 1.00 / (2 \times 2) = 0.25$ kN

$\alpha_{min} = 71.57$, $n = 2 \Rightarrow n_{ef} = 2.00$

forces per shear plane, mode = decisive failure mode acc. to DIN EN 1995-1-1, 8.2.2

Nr	F_{M1} kN	F_{MH1} kN	F_{MV1} kN	F_{toth1} kN	F_{totV1} kN	F_{tot1} kN	α_{tot1} °	$f_{h,\alpha,k}$ N/mm ²	mode	$F_{v,Rk}$ kN	$F_{v,Rd}$ kN	u
1	6.25	0.00	-6.25	2.00	-6.00	6.32	71.57	15.42	Eq.(h)	16.5464	10.1824	0.62
2	6.25	0.00	6.25	2.00	6.50	6.80	72.90	15.34	Eq.(h)	16.4652	10.1324	0.67

maximum utilization of fasteners $u_{max} = 0.67 \leq 1 \Rightarrow$ verification successful

verification acc. to DIN EN 1995-1-1 NA:2010-12 NCI NA.8.1.6

$A_{bol1} = 201.06$ mm², $\sigma_{R,d} = 363.64$ N/mm², $N_{R,d} = 16.56$ kN ($\varnothing_{washer} = 56$ mm), $F_{t,d} = 0.91$ kN

$u_F = 0.05 \leq 1 \Rightarrow$ verification successful

3.1.3. timber members

inner timber member : $\sigma_{t,d} = 0.50 \text{ N/mm}^2$, $\sigma_{m,d} = 4.11 \text{ N/mm}^2$, $\tau_d = 2.44 \text{ N/mm}^2$ (mit $V_d = 13.00 \text{ kN}$) $\Rightarrow u = 0.99$

outer timber members: $\sigma_{t,d} = 0.31 \text{ N/mm}^2$, $\sigma_{m,d} = 2.57 \text{ N/mm}^2$, $\tau_d = 1.52 \text{ N/mm}^2$ (mit $V_d = 13.00 \text{ kN}$) $\Rightarrow u = 0.62$

max. util. of inner timber member resp. of outer t. members $u_{\max} = 0.99 \leq 1 \Rightarrow$ **verification successful**

4. Summary

maximum utilization of all verifications $u_{\max} = 0.99 \leq 1 \Rightarrow$ **all verifications successful**