POSITION 1: S-HOLZ STABDBL.

1. Input parameters

1.1. Fasteners

dowel 10 mm, S235 (1052)
$F_{v,Rd}$ calculated with the exact verification acc. to DIN EN 1995, 8.2.2
connection rafter/outer timber member: 4 x dowel
connection outer timber member/collar beam: 4 x dowel

1.2. Internal forces combination collar beam

Nr	N_d kN	V_d kN	k_{mod} -	A
1	5.00	2.00	0.60	

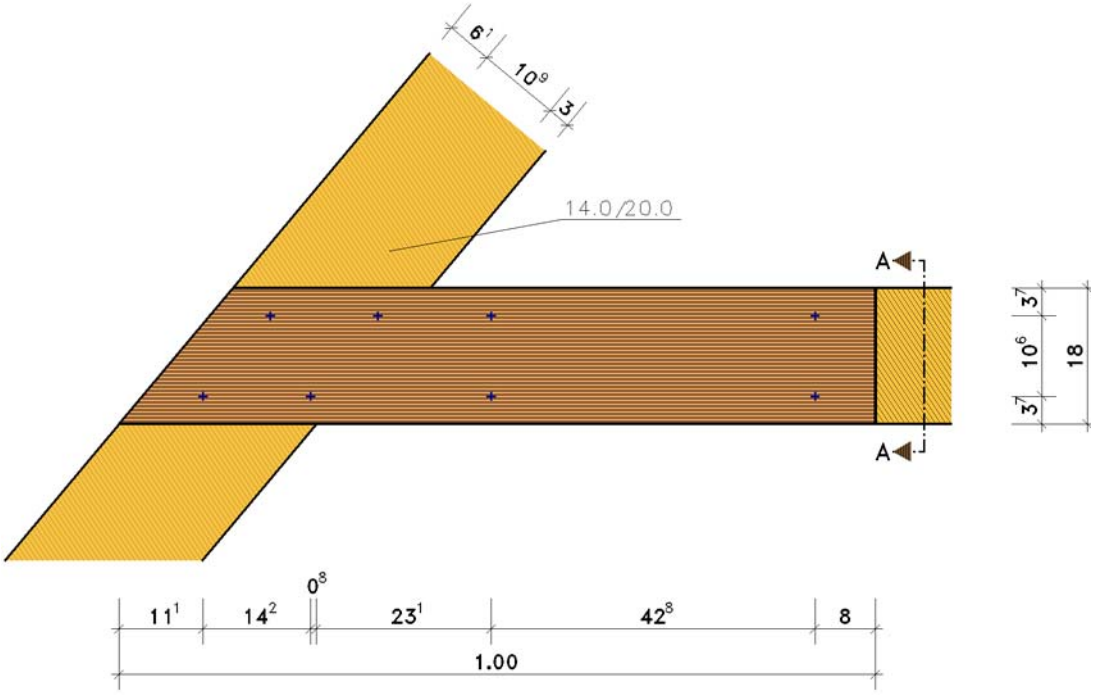
* in column A in case of accidental combination

2. System visualisation

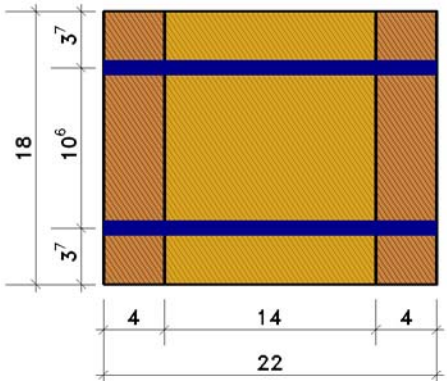
2.1. Static values and constructive boundary conditions

service class 2, connection angle α = 50.0°
connection with two-sided outer timber members and double shear fasteners
timber members of solid coniferous timber, C24 (S10) with ρ_k = 350 kg/m³, service class 2292624
outer timber member: t = 4.0 cm, h = 18.0 cm, A_n = 64.00 cm², W_n = 190.98 cm³, I_n = 1718.83 cm⁴
collar beam: t = 14.0 cm, h = 18.0 cm, A_n = 224.00 cm², W_n = 668.44 cm³, I_n = 6015.92 cm⁴
rafter: t = 14.0 cm, h = 20.0 cm, A_n = 240.80 cm², W_n = 773.73 cm³, I_n = 7427.85 cm⁴
connection outer timber member/rafter
max α = 58.6 ° => minimum spacings at outer timber member
a_1 = 4.0 cm, a_2 = 3.0 cm, $a_{1,t}$ = 8.0 cm, $a_{1,c}$ = 0.0 cm, $a_{2,t}$ = 3.7 cm, $a_{2,c}$ = 3.0 cm
max α = 24.6 ° => minimum spacings at rafter
a_1 = 4.8 cm, a_2 = 3.0 cm, $a_{1,t}$ = 8.0 cm, $a_{1,c}$ = 0.0 cm, $a_{2,t}$ = 3.0 cm, $a_{2,c}$ = 3.0 cm
$a_{1,exist}$ = 14.19 cm, $a_{2,exist}$ = 10.59 cm
centroid of fasteners from hinge point S at x_s = 2.04 cm, y_s = 0.00 cm
polar moment of inertia I_{p1} = 392.69 cm⁴
connetion collar beam/outer timber member
max α = 58.6 ° => minimum spacings
a_1 = 4.0 cm, a_2 = 3.0 cm, $a_{1,t}$ = 8.0 cm, $a_{1,c}$ = 0.0 cm, $a_{2,t}$ = 3.7 cm, $a_{2,c}$ = 3.0 cm
$a_{1,exist}$ = 42.79 cm, $a_{2,exist}$ = 10.59 cm
centroid of fasteners from hinge point S at x_s = 50.00 cm, y_s = 0.00 cm
polar moment of inertia I_{p2} = 1943.07 cm⁴

elevation scale 1:10



section A-A collar beam scale 1: 5



3. Verification of fasteners acc. to DIN EN 1995, NA Germany

$\gamma_{M,outer\ timber\ member}$ = 1.30, $\gamma_{M,central\ timber\ member}$ = 1.30, γ_{steel} = 1.10, $\gamma_{accidental}$ = 1.00
min. thickness outer timber members $t_{1,req}$ = 6.96 cm, min. thickness inner timber member $t_{2,req}$ = 5.77 cm

3.1. Decisive load combination collar beam

3.1.1. Fasteners rafter/outer timber member

N_d = 5.00 kN, V_d = 2.00 kN, $M_{v,d}$ = |0.02 x 2.00| = 0.04 kNm, k_{mod} = 0.60
$F_{Hi,d}$ = 5.00 / (2 x 4) = 0.63 kN
$F_{Vi,d}$ = 2.00 / (2 x 4) = 0.25 kN
α_{min} = 24.59, a_1 = 142 mm, n = 2 => n_{ef} = 1.93
forces per shear plane (mode = decisive failure mode acc. to DIN EN 1995, 8.2.2)

Nr	F_{Mi} kN	F_{MHi} kN	F_{MVi} kN	F_{totHi} kN	F_{totVi} kN	F_{toti} kN	$\alpha_{toti,k}$ °	$\alpha_{toti,s}$ °	$f_{h,\alpha,k}$ N/mm²	mode	$F_{v,Rk}$ kN	$F_{v,Rd}$ kN	U -
1	0.07	0.03	0.06	0.65	0.31	0.72	25.41	24.59	23.65	(j)	4.3615	1.9381	0.37

maximum utilization of fasteners U_{max} = 0.37 ≤ 1 => **verification successful**

3.1.2. Fasteners collar beam/outer timber member

N_d = 5.00 kN, V_d = 2.00 kN, $M_{v,d}$ = |0.50 x 2.00| = 1.00 kNm, k_{mod} = 0.60
$F_{Hi,d}$ = 5.00 / (2 x 4) = 0.63 kN
$F_{Vi,d}$ = 2.00 / (2 x 4) = -0.25 kN
α_{min} = 21.54, a_1 = 428 mm, n = 2 => n_{ef} = 2.00
forces per shear plane (mode = decisive failure mode acc. to DIN EN 1995, 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	0.57	0.14	-0.55	0.76	-0.80	1.10	46.44	20.46	(j)	3.8993	1.7997	0.61

maximum utilization of fasteners U_{max} = 0.61 ≤ 1 => **verification successful**

4. Verification timber members

4.1. Decisive load combination collar beam

strengths and design resistances for k_{mod} = 0.60

k_{90} = 1.50, $f_{h,0,k}$ = 25.83 N/mm²
$f_{t,d}$ = 4.31 N/mm², $f_{m,d}$ = 11.08 N/mm², $f_{c,d}$ = 9.69 N/mm², $f_{v,d}$ = 0.92 N/mm²
collar beam : $\sigma_{t,d}$ = 0.22 N/mm², $\sigma_{m,d}$ = 1.50 N/mm², τ_d = 0.16 N/mm² (mit V_d = 1.20 N) => u = 0.17
outer timber members: $\sigma_{t,d}$ = 0.39 N/mm², $\sigma_{m,d}$ = 2.62 N/mm², τ_d = 0.28 N/mm² (mit V_d = 1.20 N) => u = 0.33
max. util. of inner timber member resp. of outer t. members U_{max} = 0.33 ≤ 1 => **verification successful**

5. Summary

maximum utilization of all verifications U_{max} = 0.61 ≤ 1 => **all verifications successful**