POSITION 4: SHZ/RING CONNECTOR

1. Input parameters

1.1. Fasteners

ring connector type A1 dc 65
bolt M 12, S235 (1052) as fitted bolt
connection rafter/outer timber member: 1 x ring connector A1
connection outer timber member/collar beam: 2 x ring connector A1

1.2. Internal forces combination collar beam

Nr	N_d kN	V_d kN	k_{mod} -	A
1	5.00	0.00	0.90	
2	0.00	5.00	0.90	

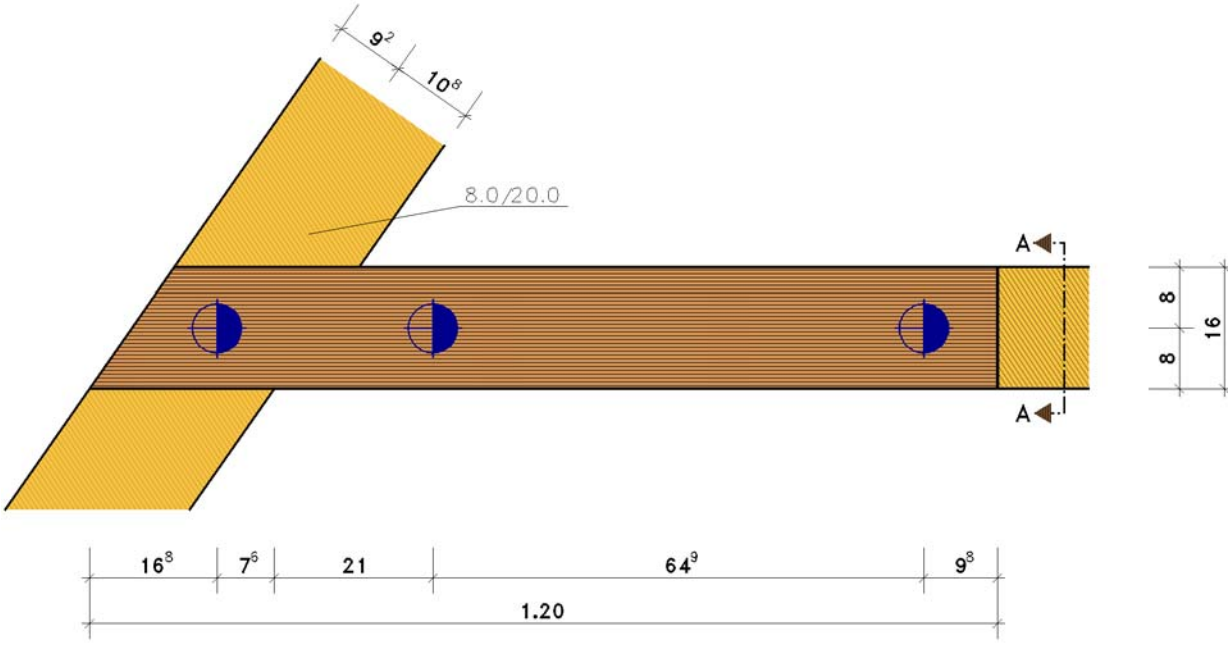
* in column A in case of accidental combination

2. System visualisation

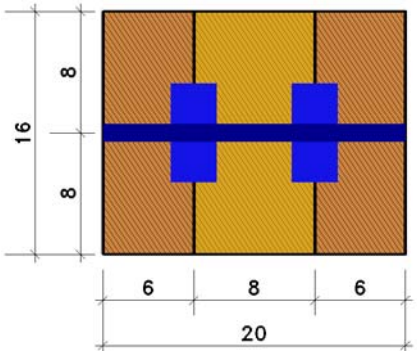
2.1. Static values and constructive boundary conditions

service class 2, connection angle α = 55.0°
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 = 6.0 cm, h = 16.0 cm, A_n = 80.35 cm², W_n = 249.11 cm³, I_n = 1992.90 cm⁴
collar beam: t = 8.0 cm, h = 16.0 cm, A_n = 101.90 cm², W_n = 329.85 cm³, I_n = 2638.77 cm⁴
rafter: t = 8.0 cm, h = 20.0 cm, A_n = 101.90 cm², W_n = 329.85 cm³, I_n = 2638.77 cm⁴
connection outer timber member/rafter
max α = 90.0 ° => minimum spacings at outer timber member
a_1 = 7.8 cm, a_2 = 7.8 cm, $a_{1,t}$ = 9.8 cm, $a_{1,c}$ = 8.4 cm, $a_{2,t}$ = 5.2 cm, $a_{2,c}$ = 3.9 cm
max α = 55.0 ° => minimum spacings at rafter
a_1 = 10.8 cm, a_2 = 7.8 cm, $a_{1,t}$ = 9.8 cm, $a_{1,c}$ = 7.8 cm, $a_{2,t}$ = 5.0 cm, $a_{2,c}$ = 3.9 cm
centroid of fasteners from hinge point S at x_s = -0.98 cm, y_s = 0.00 cm
connetion collar beam/outer timber member
max α = 90.0 ° => minimum spacings
a_1 = 7.8 cm, a_2 = 7.8 cm, $a_{1,t}$ = 9.8 cm, $a_{1,c}$ = 8.4 cm, $a_{2,t}$ = 5.2 cm, $a_{2,c}$ = 3.9 cm
$a_{1,exist}$ = 64.88 cm
centroid of fasteners from hinge point S at x_s = 60.00 cm, y_s = 0.00 cm
polar moment of inertia I_{p2} = 2104.78 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 $t_{1,req}$ = 2.40 cm, min. thickness inner timber member $t_{2,req}$ = 2.50 cm

3.1. Decisive load combination collar beam

3.1.1. Fasteners rafter/outer timber member

N_d = 0.00 kN, V_d = 5.00 kN, $M_{v,d}$ = |-0.01 x 5.00| = 0.05 kNm, k_{mod} = 0.90
$F_{Vi,d}$ = 5.00 / (2 x 1) = 2.50 kN
α_{min} = 35.00, n = 1 => n_{ef} = 1.00

Nr	F_{Mi} kN	F_{MHi} kN	F_{MVi} kN	F_{totHi} kN	F_{totVi} kN	F_{toti} kN	$\alpha_{toti,k}$ °	$\alpha_{toti,s}$ °	$F_{v,Rk}$ kN	$F_{v,Rd}$ kN	U -
1	0.00	0.00	0.00	0.00	2.50	2.50	90.00	35.00	13.4371	9.3026	0.27

maximum utilization of fasteners U_{max} = 0.27 ≤ 1 => **verification successful**

3.1.2. Fasteners collar beam/outer timber member

N_d = 0.00 kN, V_d = 5.00 kN, $M_{v,d}$ = |0.60 x 5.00| = 3.00 kNm, k_{mod} = 0.90
$F_{vi,d}$ = 5.00 / (2 x 2) = -1.25 kN
α_{min} = 90.00, n = 2 => n_{ef} = 2.00
ngsmittel U_{max} = 0.27 ≤ 1 => **verification successful**

Nr	F_{Mi} kN	F_{MHi} kN	F_{MVi} kN	F_{totHi} kN	F_{totVi} kN	F_{toti} kN	α_{toti} °	$F_{v,Rk}$ kN	$F_{v,Rd}$ kN	U -
1	2.31	0.00	-2.31	0.00	-3.56	3.56	90.00	13.4371	9.3026	0.38

maximum utilization of fasteners U_{max} = 0.38 ≤ 1 => **verification successful**

4. Verification timber members

4.1. Decisive load combination collar beam

strengths and design resistances for k_{mod} = 0.90

k_α = 0.77, k_ρ = 1.00, k_t = 1.00
$f_{t,d}$ = 6.46 N/mm², $f_{m,d}$ = 16.62 N/mm², $f_{c,d}$ = 14.54 N/mm², $f_{v,d}$ = 1.38 N/mm²
collar beam : $\sigma_{t,d}$ = 0.49 N/mm², $\sigma_{m,d}$ = 0.00 N/mm², τ_d = 0.00 N/mm² (mit V_d = 0.00 N) => u = 0.05
outer timber members: $\sigma_{t,d}$ = 0.31 N/mm², $\sigma_{m,d}$ = 0.00 N/mm², τ_d = 0.00 N/mm² (mit V_d = 0.00 N) => u = 0.05
max. util. of inner timber member resp. of outer t. members U_{max} = 0.05 ≤ 1 => **verification successful**

5. Verification rafter

b/h = 8.0/20.0 cm, $k_{c,bottom}$ = 0.600, $k_{c,top}$ = 0.720, A_n = 101.90 cm², W_n = 329.85 cm³, I_n = 2638.77 cm⁴
engraving considered c = 4.0 cm

5.1. Internal forces combination rafter upper cutting

Nr	M_d kNm	N_d kN	V_d kN	ΔM_d kNm	k_{mod} -	A
1	-3.00	-5.00	6.00	-0.10	0.60	

* in column A in case of accidental combination
moment due to eccentricity of engraving $\Delta M_d = N_d$ c/2

5.2. Strengths and design resistances

$f_{t,d}$ = 6.46 N/mm², $f_{m,d}$ = 11.08 N/mm², $f_{c,d}$ = 9.69 N/mm², $f_{v,d}$ = 0.92 N/mm²

5.2.1. Decisive load combination upper cutting

$\sigma_{c,d}$ = -0.49 N/mm², $\sigma_{m,d}$ = 9.40 N/mm², τ_d = 1.10 N/mm² => U = 0.92 ≤ 1 => **verification successful**

6. Summary

maximum utilization of all verifications U_{max} = 0.92 ≤ 1 => **all verifications successful**