POSITION 7: HECO

1. Input parameters

1.1. Fasteners

HECO Topix plus Senkkopf Fräst. Teilgewinde, 6.0 x 100.0 mm, two-sided, d_k = 11.7 mm, l_{ef} = 60.0 mm
made of carbon steel, predrilled
application of timber species: spruce, fir or pine
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
32 x Senkkopf Fräst. Teilgewinde

1.2. characteristic internal forces and moments

LF	type	M_k	N_k	V_k	remark
-		kN	kN	kN	
2	permanent loads	0.500	0.000	0.000	
3	live loads	1.100	12.000	0.000	

LF 3, live loads duration of load medium-term

1.3. design loads (splice in bending)

service class 2

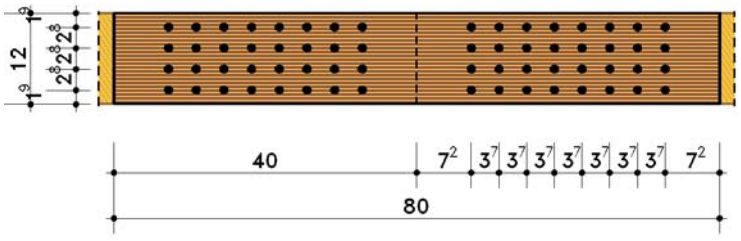
Nr	M_d	N_d	V_d	k_{mod}	A	comment
	kNm	kN	kN	-		
1	0.68	0.00	0.00	0.60		1.35*LF2 / permanent
2	0.50	0.00	0.00	0.60		1.00*LF2 / permanent
3	2.33	18.00	0.00	0.80		1.35*LF2 + 1.00*1.50*LF3 / medium-term
4	2.15	18.00	0.00	0.80		1.00*LF2 + 1.00*1.50*LF3 / medium-term

2. System visualisation

2.1. Static values and constructive boundary conditions

splice with double-sided outer timber members
inner timber member from solid coniferous timber C24 with ρ_k = 350 kg/m³
outer timber members made of Pollm. spruce LVL S 21-81 mm with ρ_k = 480 kg/m³
outer timber member: t = 4.0 cm, A_n = 38.40 cm², W_n = 80.71 cm³, I_n = 484.25 cm⁴
inner timber member: t = 16.0 cm, A_n = 153.60 cm², W_n = 322.84 cm³, I_n = 1937.02 cm⁴
min α = 9.6 ° => minimum spacings
a_1 = 1.0 cm, a_2 = 0.3 cm, $a_{3,t}$ = 7.2 cm, $a_{3,c}$ = 4.2 cm, $a_{4,t}$ = 1.8 cm, $a_{4,c}$ = 1.8 cm
$a_{1,exist}$ = 3.66 cm, $a_{2,exist}$ = 2.76 cm
polar moment of inertia I_p = 2551.47 cm²
centroid of fasteners S at x_s = 20.00 cm, y_s = 0.00 cm

elevation scale 1:10, 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 $t_{1,req}$ = 2.83 cm, min. thickness inner timber member $t_{2,req}$ = 2.56 cm

3.1. Load combination 1

3.1.1. Strengths and design resistances

outer timber members: $f_{t,d}$ = 14.31 N/mm², $f_{m,d}$ = 20.31 N/mm², $f_{c,d}$ = 18.46 N/mm², $f_{v,d}$ = 2.12 N/mm²
inner timber member : $f_{t,d}$ = 6.69 N/mm², $f_{m,d}$ = 11.08 N/mm², $f_{c,d}$ = 9.69 N/mm², $f_{v,d}$ = 1.85 N/mm²

3.1.2. Fasteners

N_d = 0.00 kN, V_d = 0.00 kN, $M_{v,d}$ = |0.68| + |0.20 x 0.00| = 0.68 KNm, k_{mod} = 0.60
α_{min} = 23.84, a_1 = 37 mm, n = 8 => n_{ef} = 3.78
fastener ending in inner timber member, fastener two-sided, penetration depth t = 60 mm

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	0.18	-0.05	-0.17	-0.05	-0.17	0.18	72.08	2.6928	0.5875	0.30
2	0.17	-0.02	-0.17	-0.02	-0.17	0.17	83.85	2.6848	0.5858	0.29
3	0.17	0.02	-0.17	0.02	-0.17	0.17	83.85	2.6848	0.5858	0.29
4	0.18	0.05	-0.17	0.05	-0.17	0.18	72.08	2.6928	0.5875	0.30
5	0.13	-0.05	-0.12	-0.05	-0.12	0.13	65.65	2.7001	0.5891	0.23
6	0.12	-0.02	-0.12	-0.02	-0.12	0.12	81.42	2.6859	0.5860	0.21
7	0.12	0.02	-0.12	0.02	-0.12	0.12	81.42	2.6859	0.5860	0.21
8	0.13	0.05	-0.12	0.05	-0.12	0.13	65.65	2.7001	0.5891	0.23
9	0.09	-0.05	-0.07	-0.05	-0.07	0.09	52.97	2.7191	0.5932	0.15
10	0.07	-0.02	-0.07	-0.02	-0.07	0.07	75.88	2.6894	0.5868	0.13
11	0.07	0.02	-0.07	0.02	-0.07	0.07	75.88	2.6894	0.5868	0.13
12	0.09	0.05	-0.07	0.05	-0.07	0.09	52.97	2.7191	0.5932	0.15
13	0.06	-0.05	-0.02	-0.05	-0.02	0.06	23.84	2.7681	0.6039	0.10
14	0.03	-0.02	-0.02	-0.02	-0.02	0.03	52.97	2.7191	0.5932	0.05
15	0.03	0.02	-0.02	0.02	-0.02	0.03	52.97	2.7191	0.5932	0.05
16	0.06	0.05	-0.02	0.05	-0.02	0.06	23.84	2.7681	0.6039	0.10
17	0.06	-0.05	0.02	-0.05	0.02	0.06	23.84	2.7681	0.6039	0.10
18	0.03	-0.02	0.02	-0.02	0.02	0.03	52.97	2.7191	0.5932	0.05
19	0.03	0.02	0.02	0.02	0.02	0.03	52.97	2.7191	0.5932	0.05
20	0.06	0.05	0.02	0.05	0.02	0.06	23.84	2.7681	0.6039	0.10
21	0.09	-0.05	0.07	-0.05	0.07	0.09	52.97	2.7191	0.5932	0.15
22	0.07	-0.02	0.07	-0.02	0.07	0.07	75.88	2.6894	0.5868	0.13
23	0.07	0.02	0.07	0.02	0.07	0.07	75.88	2.6894	0.5868	0.13
24	0.09	0.05	0.07	0.05	0.07	0.09	52.97	2.7191	0.5932	0.15
25	0.13	-0.05	0.12	-0.05	0.12	0.13	65.65	2.7001	0.5891	0.23
26	0.12	-0.02	0.12	-0.02	0.12	0.12	81.42	2.6859	0.5860	0.21
27	0.12	0.02	0.12	0.02	0.12	0.12	81.42	2.6859	0.5860	0.21
28	0.13	0.05	0.12	0.05	0.12	0.13	65.65	2.7001	0.5891	0.23
29	0.18	-0.05	0.17	-0.05	0.17	0.18	72.08	2.6928	0.5875	0.30
30	0.17	-0.02	0.17	-0.02	0.17	0.17	83.85	2.6848	0.5858	0.29
31	0.17	0.02	0.17	0.02	0.17	0.17	83.85	2.6848	0.5858	0.29
32	0.18	0.05	0.17	0.05	0.17	0.18	72.08	2.6928	0.5875	0.30

maximum utilization of fasteners u_{max} = 0.30 ≤ 1 => **verification successful**

3.1.3. timber members

inner timber member : max $V_{90,d}$ = 0.68 N, $\sigma_{90,d}$ = 0.03 N/mm², $f_{t90,d}$ = 1.15 N/mm² ⇒ u = 0.02
outer timber members: max $V_{90,d}$ = 0.68 N, $\sigma_{90,d}$ = 0.10 N/mm², $f_{t90,d}$ = 3.37 N/mm² ⇒ u = 0.03
inner timber member : $\sigma_{t,d}$ = 0.00 N/mm², $\sigma_{m,d}$ = 2.09 N/mm², τ_d = 0.60 N/mm² (mit V_d = 3.10 kN) ⇒ u = 0.33
outer timber members: $\sigma_{t,d}$ = 0.00 N/mm², $\sigma_{m,d}$ = 4.18 N/mm², τ_d = 0.60 N/mm² (mit V_d = 3.10 kN) ⇒ u = 0.28
max. util. of inner timber member resp. of outer t. members u_{max} = 0.33 ≤ 1 ⇒ **verification successful**

3.2. Load combination 2

3.2.1. Fasteners

N_d = 0.00 kN, V_d = 0.00 kN, $M_{v,d}$ = |0.50| + |0.20 x 0.00| = 0.50 KNm, k_{mod} = 0.60
α_{min} = 23.84, a_1 = 37 mm, n = 8 => n_{ef} = 3.78
fastener ending in inner timber member, fastener two-sided, penetration depth t = 60 mm

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	0.13	-0.04	-0.13	-0.04	-0.13	0.13	72.08	2.6928	0.5875	0.22
2	0.13	-0.01	-0.13	-0.01	-0.13	0.13	83.85	2.6848	0.5858	0.22
3	0.13	0.01	-0.13	0.01	-0.13	0.13	83.85	2.6848	0.5858	0.22
4	0.13	0.04	-0.13	0.04	-0.13	0.13	72.08	2.6928	0.5875	0.22
5	0.10	-0.04	-0.09	-0.04	-0.09	0.10	65.65	2.7001	0.5891	0.17
6	0.09	-0.01	-0.09	-0.01	-0.09	0.09	81.42	2.6859	0.5860	0.15
7	0.09	0.01	-0.09	0.01	-0.09	0.09	81.42	2.6859	0.5860	0.15
8	0.10	0.04	-0.09	0.04	-0.09	0.10	65.65	2.7001	0.5891	0.17
9	0.07	-0.04	-0.05	-0.04	-0.05	0.07	52.97	2.7191	0.5932	0.11
10	0.06	-0.01	-0.05	-0.01	-0.05	0.06	75.88	2.6894	0.5868	0.09
11	0.06	0.01	-0.05	0.01	-0.05	0.06	75.88	2.6894	0.5868	0.09
12	0.07	0.04	-0.05	0.04	-0.05	0.07	52.97	2.7191	0.5932	0.11
13	0.04	-0.04	-0.02	-0.04	-0.02	0.04	23.84	2.7681	0.6039	0.07
14	0.02	-0.01	-0.02	-0.01	-0.02	0.02	52.97	2.7191	0.5932	0.04
15	0.02	0.01	-0.02	0.01	-0.02	0.02	52.97	2.7191	0.5932	0.04
16	0.04	0.04	-0.02	0.04	-0.02	0.04	23.84	2.7681	0.6039	0.07

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 -
17	0.04	-0.04	0.02	-0.04	0.02	0.04	23.84	2.7681	0.6039	0.07
18	0.02	-0.01	0.02	-0.01	0.02	0.02	52.97	2.7191	0.5932	0.04
19	0.02	0.01	0.02	0.01	0.02	0.02	52.97	2.7191	0.5932	0.04
20	0.04	0.04	0.02	0.04	0.02	0.04	23.84	2.7681	0.6039	0.07
21	0.07	-0.04	0.05	-0.04	0.05	0.07	52.97	2.7191	0.5932	0.11
22	0.06	-0.01	0.05	-0.01	0.05	0.06	75.88	2.6894	0.5868	0.09
23	0.06	0.01	0.05	0.01	0.05	0.06	75.88	2.6894	0.5868	0.09
24	0.07	0.04	0.05	0.04	0.05	0.07	52.97	2.7191	0.5932	0.11
25	0.10	-0.04	0.09	-0.04	0.09	0.10	65.65	2.7001	0.5891	0.17
26	0.09	-0.01	0.09	-0.01	0.09	0.09	81.42	2.6859	0.5860	0.15
27	0.09	0.01	0.09	0.01	0.09	0.09	81.42	2.6859	0.5860	0.15
28	0.10	0.04	0.09	0.04	0.09	0.10	65.65	2.7001	0.5891	0.17
29	0.13	-0.04	0.13	-0.04	0.13	0.13	72.08	2.6928	0.5875	0.22
30	0.13	-0.01	0.13	-0.01	0.13	0.13	83.85	2.6848	0.5858	0.22
31	0.13	0.01	0.13	0.01	0.13	0.13	83.85	2.6848	0.5858	0.22
32	0.13	0.04	0.13	0.04	0.13	0.13	72.08	2.6928	0.5875	0.22

maximum utilization of fasteners $u_{max} = 0.22 \leq 1$ => **verification successful**

3.2.2. timber members

inner timber member : max $V_{90,d} = 0.50$ N, $\sigma_{90,d} = 0.02$ N/mm², $f_{t90,d} = 1.15$ N/mm² $\Rightarrow u = 0.02$
outer timber members: max $V_{90,d} = 0.50$ N, $\sigma_{90,d} = 0.07$ N/mm², $f_{t90,d} = 3.37$ N/mm² $\Rightarrow u = 0.02$
inner timber member : $\sigma_{t,d} = 0.00$ N/mm², $\sigma_{m,d} = 1.55$ N/mm², $\tau_d = 0.45$ N/mm² (mit $V_d = 2.29$ kN) $\Rightarrow u = 0.24$
outer timber members: $\sigma_{t,d} = 0.00$ N/mm², $\sigma_{m,d} = 3.10$ N/mm², $\tau_d = 0.45$ N/mm² (mit $V_d = 2.29$ kN) $\Rightarrow u = 0.21$
max. util. of inner timber member resp. of outer t. members $u_{max} = 0.24 \leq 1 \Rightarrow$ **verification successful**

3.3. Load combination 3

3.3.1. Strengths and design resistances

outer timber members: $f_{t,d} = 19.08$ N/mm², $f_{m,d} = 27.08$ N/mm², $f_{c,d} = 24.62$ N/mm², $f_{v,d} = 2.83$ N/mm²
inner timber member : $f_{t,d} = 8.92$ N/mm², $f_{m,d} = 14.77$ N/mm², $f_{c,d} = 12.92$ N/mm², $f_{v,d} = 2.46$ N/mm²

3.3.2. Fasteners

$N_d = 18.00$ kN, $V_d = 0.00$ kN, $M_{v,d} = |2.33| + |0.20 \times 0.00| = 2.33$ KNm, $k_{mod} = 0.80$
$F_{Hi,d} = 18.00 / (2 \times 32) = 0.28$ kN
$\alpha_{min} = 10.06$, $a_1 = 37$ mm, $n = 8$ => $n_{ef} = 3.78$
fastener ending in inner timber member, fastener two-sided, penetration depth t = 60 mm

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	0.61	-0.19	-0.58	0.09	-0.58	0.59	80.97	2.6861	0.7814	0.76
2	0.59	-0.06	-0.58	0.22	-0.58	0.62	69.47	2.6955	0.7841	0.79
3	0.59	0.06	-0.58	0.34	-0.58	0.68	59.46	2.7087	0.7880	0.86
4	0.61	0.19	-0.58	0.47	-0.58	0.75	51.15	2.7222	0.7919	0.95
5	0.46	-0.19	-0.42	0.09	-0.42	0.43	77.46	2.6882	0.7820	0.55
6	0.42	-0.06	-0.42	0.22	-0.42	0.47	62.33	2.7045	0.7868	0.60
7	0.42	0.06	-0.42	0.34	-0.42	0.54	50.44	2.7234	0.7922	0.68
8	0.46	0.19	-0.42	0.47	-0.42	0.63	41.56	2.7391	0.7968	0.79
9	0.31	-0.19	-0.25	0.09	-0.25	0.27	69.65	2.6953	0.7841	0.34
10	0.26	-0.06	-0.25	0.22	-0.25	0.33	48.85	2.7261	0.7930	0.42
11	0.26	0.06	-0.25	0.34	-0.25	0.43	35.99	2.7489	0.7997	0.53
12	0.31	0.19	-0.25	0.47	-0.25	0.53	28.01	2.7620	0.8035	0.66
13	0.21	-0.19	-0.08	0.09	-0.08	0.12	41.95	2.7384	0.7966	0.16
14	0.10	-0.06	-0.08	0.22	-0.08	0.23	20.88	2.7720	0.8064	0.29
15	0.10	0.06	-0.08	0.34	-0.08	0.35	13.61	2.7798	0.8086	0.44
16	0.21	0.19	-0.08	0.47	-0.08	0.48	10.06	2.7825	0.8094	0.59
17	0.21	-0.19	0.08	0.09	0.08	0.12	41.95	2.7384	0.7966	0.16
18	0.10	-0.06	0.08	0.22	0.08	0.23	20.88	2.7720	0.8064	0.29
19	0.10	0.06	0.08	0.34	0.08	0.35	13.61	2.7798	0.8086	0.44
20	0.21	0.19	0.08	0.47	0.08	0.48	10.06	2.7825	0.8094	0.59
21	0.31	-0.19	0.25	0.09	0.25	0.27	69.65	2.6953	0.7841	0.34
22	0.26	-0.06	0.25	0.22	0.25	0.33	48.85	2.7261	0.7930	0.42
23	0.26	0.06	0.25	0.34	0.25	0.43	35.99	2.7489	0.7997	0.53
24	0.31	0.19	0.25	0.47	0.25	0.53	28.01	2.7620	0.8035	0.66
25	0.46	-0.19	0.42	0.09	0.42	0.43	77.46	2.6882	0.7820	0.55
26	0.42	-0.06	0.42	0.22	0.42	0.47	62.33	2.7045	0.7868	0.60
27	0.42	0.06	0.42	0.34	0.42	0.54	50.44	2.7234	0.7922	0.68
28	0.46	0.19	0.42	0.47	0.42	0.63	41.56	2.7391	0.7968	0.79
29	0.61	-0.19	0.58	0.09	0.58	0.59	80.97	2.6861	0.7814	0.76
30	0.59	-0.06	0.58	0.22	0.58	0.62	69.47	2.6955	0.7841	0.79
31	0.59	0.06	0.58	0.34	0.58	0.68	59.46	2.7087	0.7880	0.86
32	0.61	0.19	0.58	0.47	0.58	0.75	51.15	2.7222	0.7919	0.95

maximum utilization of fasteners u_{max} = 0.95 ≤ 1 => **verification successful**

3.3.3. timber members

inner timber member : max $V_{90,d}$ = 2.33 N, $\sigma_{90,d}$ = 0.09 N/mm², $f_{t90,d}$ = 1.54 N/mm² ⇒ u = 0.06
outer timber members: max $V_{90,d}$ = 2.33 N, $\sigma_{90,d}$ = 0.35 N/mm², $f_{t90,d}$ = 4.49 N/mm² ⇒ u = 0.08
inner timber member : $\sigma_{t,d}$ = 1.17 N/mm², $\sigma_{m,d}$ = 7.20 N/mm², τ_d = 2.08 N/mm² (mit V_d = 10.66 kN) ⇒ u = 0.85
outer timber members: $\sigma_{t,d}$ = 2.34 N/mm², $\sigma_{m,d}$ = 14.40 N/mm², τ_d = 2.08 N/mm² (mit V_d = 10.66 kN) ⇒ u = 0.74
max. util. of inner timber member resp. of outer t. members u_{max} = 0.85 ≤ 1 ⇒ **verification successful**

3.4. Load combination 4

3.4.1. Fasteners

N_d = 18.00 kN, V_d = 0.00 kN, $M_{v,d}$ = |2.15| + |0.20 x 0.00| = 2.15 KNm, k_{mod} = 0.80
$F_{Hi,d}$ = 18.00 / (2 x 32) = 0.28 kN
α_{min} = 9.60, a_1 = 37 mm, n = 8 => n_{ef} = 3.78
fastener ending in inner timber member, fastener two-sided, penetration depth t = 60 mm

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	0.57	-0.17	-0.54	0.11	-0.54	0.55	78.79	2.6873	0.7818	0.70
2	0.54	-0.06	-0.54	0.22	-0.54	0.58	67.52	2.6978	0.7848	0.74
3	0.54	0.06	-0.54	0.34	-0.54	0.64	57.82	2.7112	0.7887	0.81
4	0.57	0.17	-0.54	0.46	-0.54	0.71	49.81	2.7245	0.7926	0.89
5	0.42	-0.17	-0.39	0.11	-0.39	0.40	74.49	2.6906	0.7827	0.51
6	0.39	-0.06	-0.39	0.22	-0.39	0.45	59.92	2.7080	0.7878	0.57
7	0.39	0.06	-0.39	0.34	-0.39	0.51	48.62	2.7265	0.7932	0.65
8	0.42	0.17	-0.39	0.46	-0.39	0.60	40.21	2.7415	0.7975	0.75
9	0.29	-0.17	-0.23	0.11	-0.23	0.25	65.18	2.7007	0.7856	0.32
10	0.24	-0.06	-0.23	0.22	-0.23	0.32	46.01	2.7311	0.7945	0.40
11	0.24	0.06	-0.23	0.34	-0.23	0.41	34.26	2.7518	0.8005	0.51
12	0.29	0.17	-0.23	0.46	-0.23	0.51	26.90	2.7637	0.8040	0.64
13	0.19	-0.17	-0.08	0.11	-0.08	0.13	35.79	2.7492	0.7998	0.16
14	0.10	-0.06	-0.08	0.22	-0.08	0.24	19.05	2.7742	0.8070	0.29
15	0.10	0.06	-0.08	0.34	-0.08	0.35	12.79	2.7805	0.8088	0.43
16	0.19	0.17	-0.08	0.46	-0.08	0.46	9.60	2.7828	0.8095	0.57
17	0.19	-0.17	0.08	0.11	0.08	0.13	35.79	2.7492	0.7998	0.16
18	0.10	-0.06	0.08	0.22	0.08	0.24	19.05	2.7742	0.8070	0.29
19	0.10	0.06	0.08	0.34	0.08	0.35	12.79	2.7805	0.8088	0.43
20	0.19	0.17	0.08	0.46	0.08	0.46	9.60	2.7828	0.8095	0.57
21	0.29	-0.17	0.23	0.11	0.23	0.25	65.18	2.7007	0.7856	0.32
22	0.24	-0.06	0.23	0.22	0.23	0.32	46.01	2.7311	0.7945	0.40
23	0.24	0.06	0.23	0.34	0.23	0.41	34.26	2.7518	0.8005	0.51
24	0.29	0.17	0.23	0.46	0.23	0.51	26.90	2.7637	0.8040	0.64
25	0.42	-0.17	0.39	0.11	0.39	0.40	74.49	2.6906	0.7827	0.51
26	0.39	-0.06	0.39	0.22	0.39	0.45	59.92	2.7080	0.7878	0.57
27	0.39	0.06	0.39	0.34	0.39	0.51	48.62	2.7265	0.7932	0.65
28	0.42	0.17	0.39	0.46	0.39	0.60	40.21	2.7415	0.7975	0.75
29	0.57	-0.17	0.54	0.11	0.54	0.55	78.79	2.6873	0.7818	0.70
30	0.54	-0.06	0.54	0.22	0.54	0.58	67.52	2.6978	0.7848	0.74
31	0.54	0.06	0.54	0.34	0.54	0.64	57.82	2.7112	0.7887	0.81
32	0.57	0.17	0.54	0.46	0.54	0.71	49.81	2.7245	0.7926	0.89

maximum utilization of fasteners u_{max} = 0.89 ≤ 1 => **verification successful**

3.4.2. timber members

inner timber member : max $V_{90,d}$ = 2.16 N, $\sigma_{90,d}$ = 0.08 N/mm², $f_{t90,d}$ = 1.54 N/mm² ⇒ u = 0.05
outer timber members: max $V_{90,d}$ = 2.16 N, $\sigma_{90,d}$ = 0.32 N/mm², $f_{t90,d}$ = 4.49 N/mm² ⇒ u = 0.07
inner timber member : $\sigma_{t,d}$ = 1.17 N/mm², $\sigma_{m,d}$ = 6.66 N/mm², τ_d = 1.93 N/mm² (mit V_d = 9.86 kN) ⇒ u = 0.78
outer timber members: $\sigma_{t,d}$ = 2.34 N/mm², $\sigma_{m,d}$ = 13.32 N/mm², τ_d = 1.93 N/mm² (mit V_d = 9.86 kN) ⇒ u = 0.68
max. util. of inner timber member resp. of outer t. members u_{max} = 0.78 ≤ 1 ⇒ **verification successful**

4. Summary

maximum utilization of all verifications u_{max} = 0.95 ≤ 1 => **all verifications successful**