general wooden joint nach EC 3 - NA-Deutschland

1. input data

1.1. general statements

service class 1, origin of the coordinate system at the intersection of the beams

1.2. node plate

external steel plate S235 (St37), thickness t=5.0 mm, shape: rectangle
dimensions: b = 700.0 mm, h=650.0 mm, steel plate external, on both sides
The steel plate must be structurally secured against buckling
fastener with a diameter < 8.0mm are discretised as a point and not as a hole
The missing areas are taken into account by reducing the cross-section thickness.
coordinates of the steel plate

Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm
1	-350.0	-165.0	4	350.0	-165.0
2	-350.0	485.0	5	-350.0	-165.0
3	350.0	485.0			

1.3. connected beams

Nr.	bar	material	b mm	t mm	α °
1	strap both sides w. kink	solconiftimbr C24	340	180	-10
2	strut	solconiftimbr C14	120	180	90
3	diagonal left	solconiftimbr C16	90	180	40
4	diagonal right	solconiftimbr C16	90	180	40

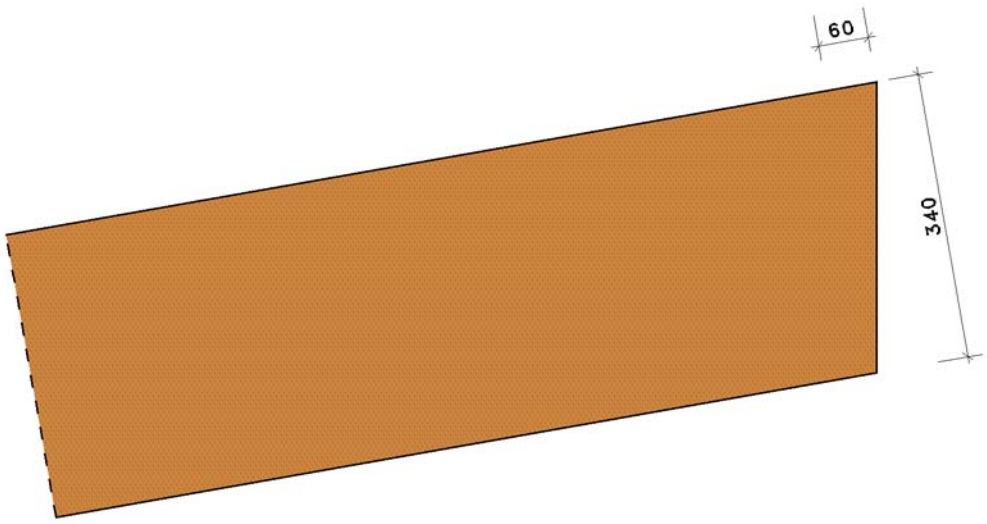
1.4. fastener

1.4.1. strap left

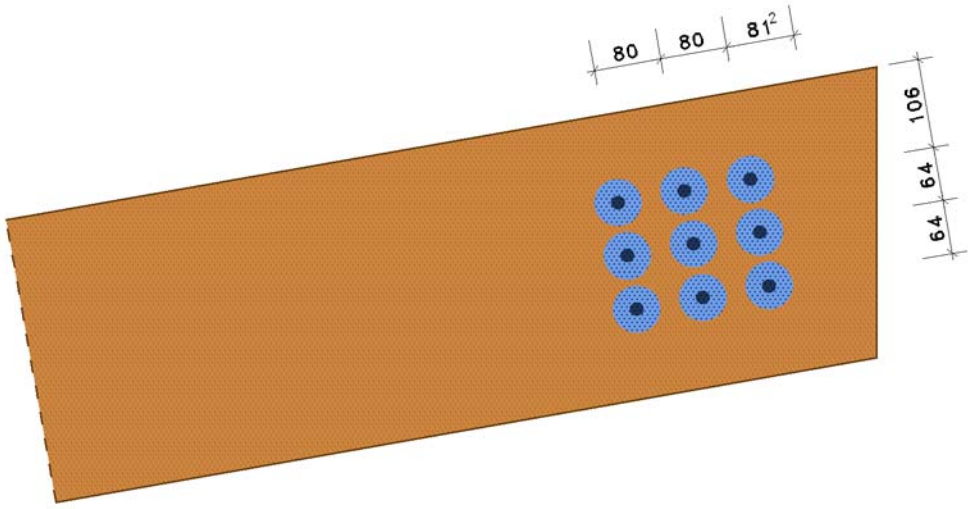
bolt 16 mm, FK 5.8
washer d = 56 mm
load-bearing capacity is reduced acc. to DIN EN 1995-1-1, 8.3.1.1(8)
$F_{v,Rk}$ increased acc. to DIN EN 1995, 8.2.2(2) with washer d = 56 mm
$F_{v,Rd}$ is calculated with the exact verification acc. to DIN EN 1995-1-1, 8.2.3
9 fastener, a_1 = 80 mm, a_2 = 64 mm
centroid of the fasteners from nodal point S at x_s = -217 mm, y_s = -38 mm
polar moment of inertia I_p = 62976 mm^4
coordinates of the fasteners (origin in the nodal point, x to the right, y to the top)

Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm
1	-149.0	38.7	4	-227.8	24.8	7	-306.6	10.9
2	-137.9	-24.3	5	-216.7	-38.2	8	-295.4	-52.1
3	-126.8	-87.3	6	-205.5	-101.2	9	-284.3	-115.1

view strap left scale 1:90



fastener strap left scale 1:90

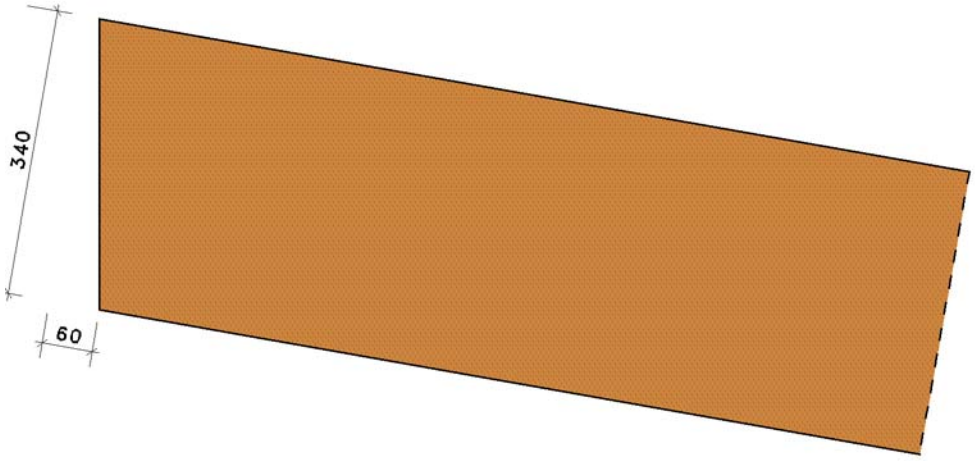


1.4.2. strap right

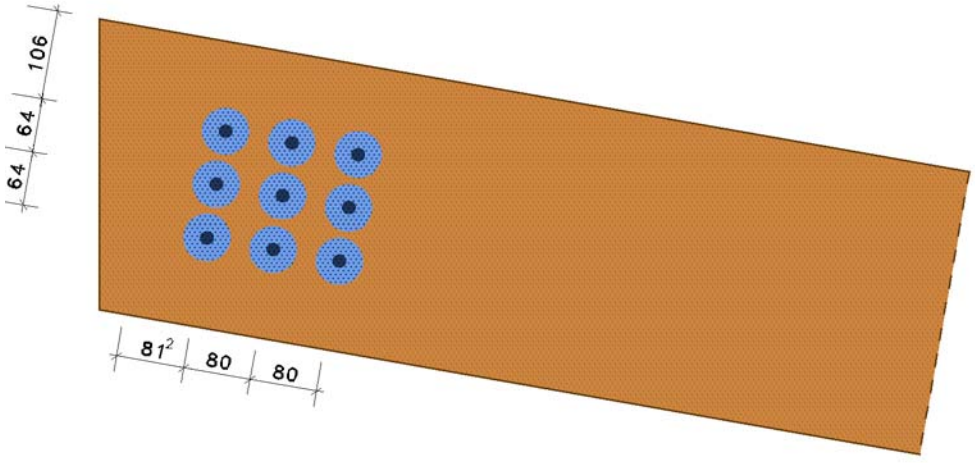
bolt 16 mm, FK 5.8
washer d = 56 mm
load-bearing capacity is reduced acc. to DIN EN 1995-1-1, 8.3.1.1(8)
$F_{v,Rk}$ increased acc. to DIN EN 1995, 8.2.2(2) with washer d = 56 mm
$F_{v,Rd}$ is calculated with the exact verification acc. to DIN EN 1995-1-1, 8.2.3
9 fastener, a_1 = 80 mm, a_2 = 64 mm
centroid of the fasteners from nodal point S at x_s = 217 mm, y_s = -38 mm
polar moment of inertia I_p = 62976 mm^4
coordinates of the fasteners (origin in the nodal point, x to the right, y to the top)

Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm
1	149.0	38.7	4	227.8	24.8	7	306.6	10.9
2	137.9	-24.3	5	216.7	-38.2	8	295.4	-52.1
3	126.8	-87.3	6	205.5	-101.2	9	284.3	-115.1

view strap right scale 1:90



fastener strap right scale 1:90

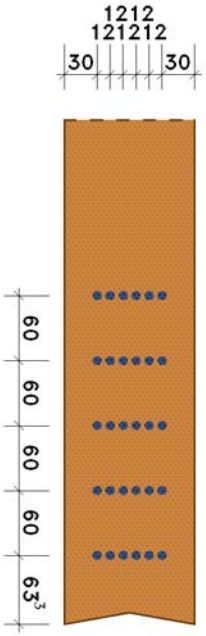


1.4.3. strut

nail, 4.2 x 120.0 mm, double-sided, d_k = 8.0 mm, predrilled
load-bearing capacity is reduced acc. to DIN EN 1995-1-1, 8.3.1.1(8)
$F_{v,Rk}$ increased acc. to DIN EN 1995-1-1, 8.2.3(4)
$F_{v,Rd}$ is calculated with the exact verification acc. to DIN EN 1995-1-1, 8.2.3
30 fastener, a_1 = 60 mm, a_2 = 12 mm on both sides
centroid of the fasteners from nodal point S at x_s = 0 mm, y_s = 345 mm
polar moment of inertia I_p = 228600 mm⁴
fastener caused holes are taken into account by increasing the rated stresses in the hole area
area hole range = 19722.24 mm², area holes = 415.63 mm² ⇒ increase factor = 1.0215
coordinates of the fasteners (origin in the nodal point, x to the right, y to the top)

Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm
1	30.0	225.3	9	6.0	285.3	17	-18.0	345.3	25	30.0	465.3
2	18.0	225.3	10	-6.0	285.3	18	-30.0	345.3	26	18.0	465.3
3	6.0	225.3	11	-18.0	285.3	19	30.0	405.3	27	6.0	465.3
4	-6.0	225.3	12	-30.0	285.3	20	18.0	405.3	28	-6.0	465.3
5	-18.0	225.3	13	30.0	345.3	21	6.0	405.3	29	-18.0	465.3
6	-30.0	225.3	14	18.0	345.3	22	-6.0	405.3	30	-30.0	465.3
7	30.0	285.3	15	6.0	345.3	23	-18.0	405.3			
8	18.0	285.3	16	-6.0	345.3	24	-30.0	405.3			

fastener strut scale 1:70

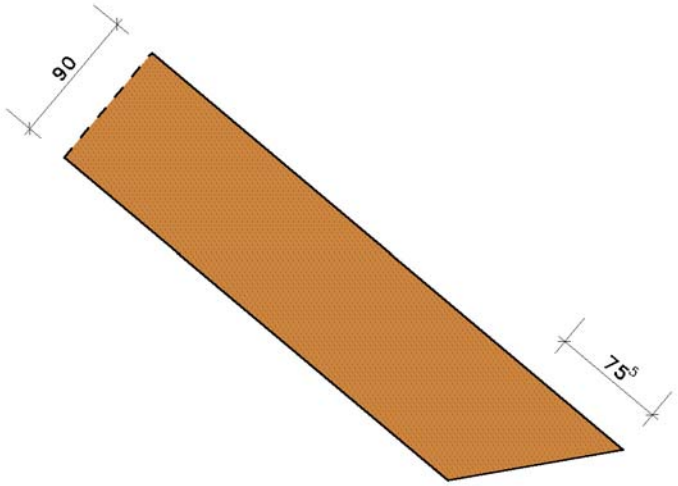


1.4.4. diagonal left

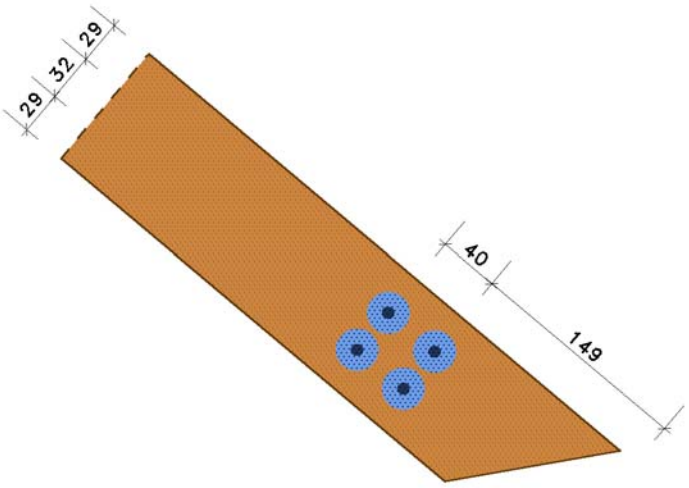
bolt 8 mm, FK 5.8
washer d = 28 mm
load-bearing capacity is reduced acc. to DIN EN 1995-1-1, 8.3.1.1(8)
$F_{v,Rk}$ increased acc. to DIN EN 1995, 8.2.2(2) with washer d = 28 mm
$F_{v,Rd}$ is calculated with the exact verification acc. to DIN EN 1995-1-1, 8.2.3
4 fastener, a_1 = 40 mm, a_2 = 32 mm
centroid of the fasteners from nodal point S at x_s = -260 mm, y_s = 219 mm
polar moment of inertia I_p = 2624 mm^4
coordinates of the fasteners (origin in the nodal point, x to the right, y to the top)

Nr	x_k mm	y_k mm
1	-234.8	217.9
2	-255.4	193.4
3	-265.5	243.7
4	-286.1	219.1

view diagonal left scale 1:50



fastener diagonal left scale 1:50

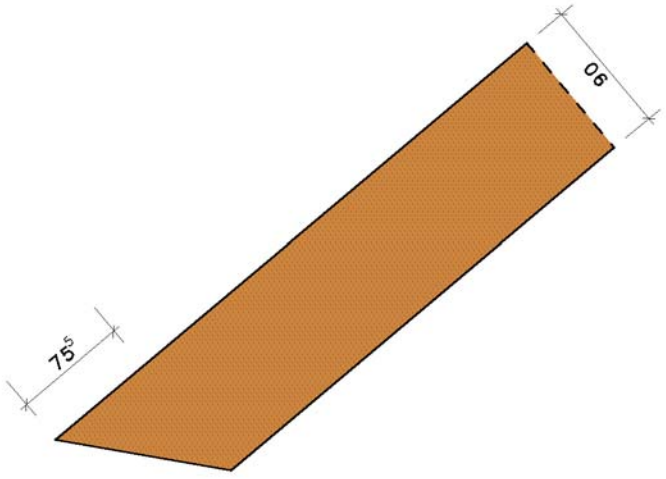


1.4.5. diagonal right

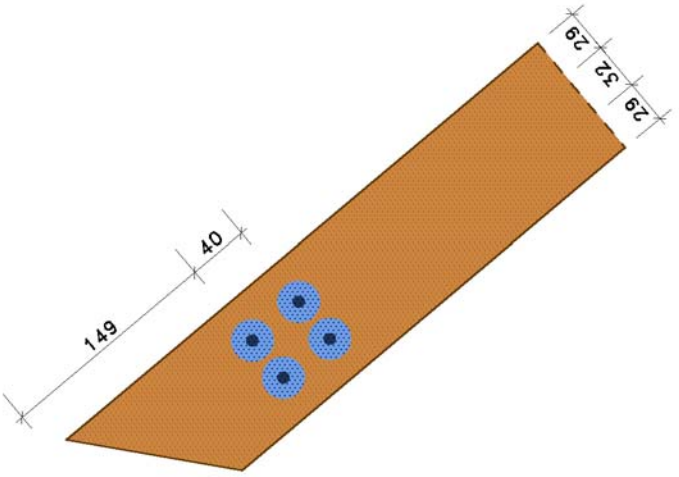
bolt 8 mm, FK 5.8
washer d = 28 mm
load-bearing capacity is reduced acc. to DIN EN 1995-1-1, 8.3.1.1(8)
$F_{v,Rk}$ increased acc. to DIN EN 1995, 8.2.2(2) with washer d = 28 mm
$F_{v,Rd}$ is calculated with the exact verification acc. to DIN EN 1995-1-1, 8.2.3
4 fastener, a_1 = 40 mm, a_2 = 32 mm
centroid of the fasteners from nodal point S at x_s = 260 mm, y_s = 219 mm
polar moment of inertia I_p = 2624 mm^4
coordinates of the fasteners (origin in the nodal point, x to the right, y to the top)

Nr	x_k mm	y_k mm
1	255.4	193.4
2	234.8	217.9
3	286.1	219.1
4	265.5	243.7

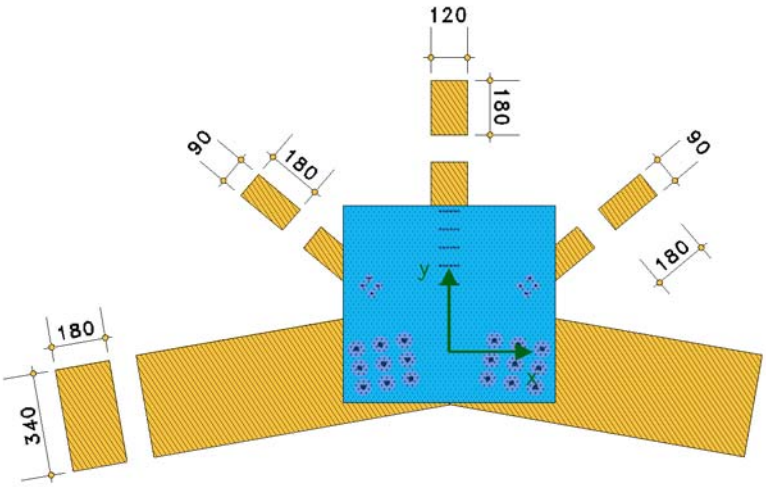
view diagonal right scale 1:50



fastener diagonal right scale 1:50

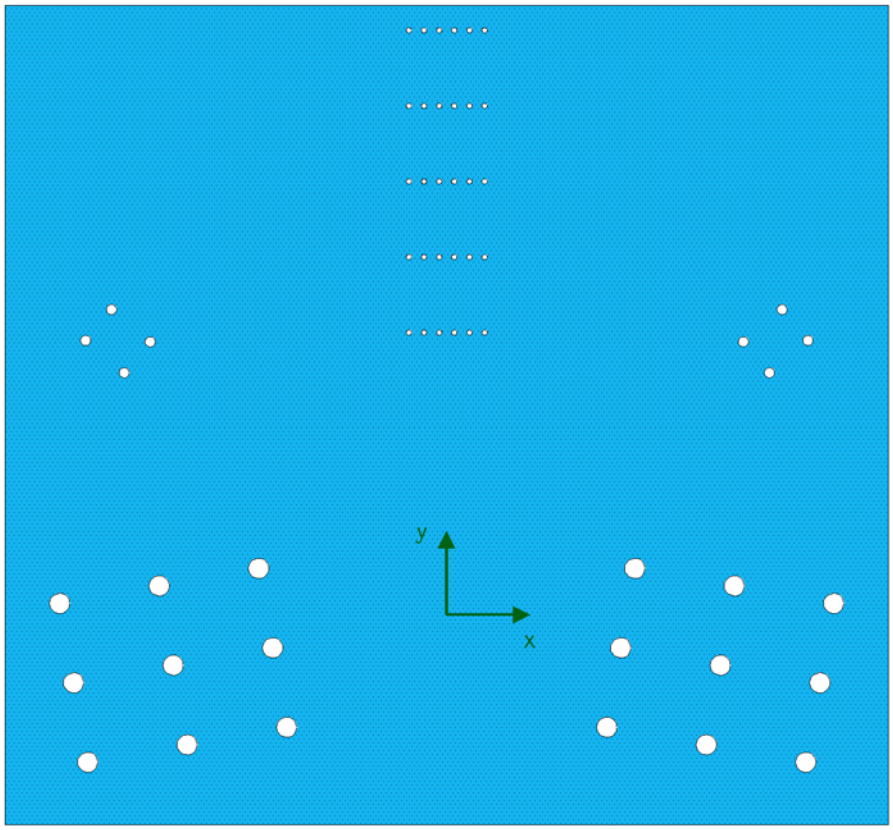


1.5. nodal point
view scale 1:250

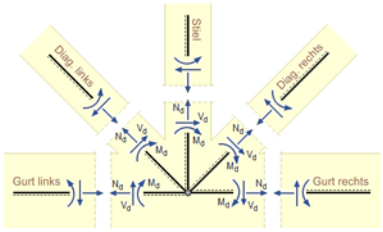


1.6. node plate

view scale 1:60



1.7. load combinations (design internal forces)



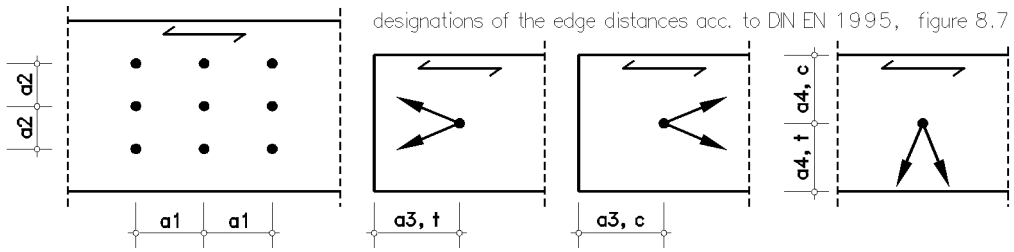
1.7.1. sum M straps, KLED: short-term

Nr	beam	N_d kN	M_d kNm	V_d kN	k_{mod} -	γ -
1	strap left	50.00	0.00	-34.70	0.900	1.30
2	strap right	50.00	0.00	34.70	0.900	1.30
3	strut	60.00	0.00	0.00	0.900	1.30
4	diag. left	20.00	0.00	0.00	0.900	1.30
5	diag. right	20.00	0.00	0.00	0.900	1.30
6	ΣH, ΣM, ΣV	-0.00	0.00	0.00	---	---

2. results of all load case combinations

2.1. fastener strap left

member	a_1 mm	a_2 mm	a_{3t} mm	a_{4t} mm	a_{3c} mm	a_{4c} mm
stplts	40.8	40.8	20.4	20.4	20.4	20.4
centr.t.m.	80.0	64.0	112.0	64.0	64.0	48.0



2.1.1. sum M straps

N_d = 50.000 kN, V_d = -34.700 kN, $M_{v,d}$ = 0.000 + -0.220 x -34.700 + -0.000 x 50.000 = 7.634 KNm

Nr	F_{Mi} kN	F_{Mxi} kN	F_{Myi} kN	F_{MNi} kN	F_{MVi} kN	F_{totHi} kN	F_{totVi} kN	F_{toti} kN	α_{toti} °	$f_{h,\alpha,k}$ N/mm²	$F_{v,Rd}$ kN	$U_{n,ef}$ -	$U_{F,v}$ -
1	12.42	9.32	8.20	7.76	9.70	13.31	5.84	14.54	23.7	21.70	23.6132	0.72	0.62
2	9.70	1.68	9.55	0.00	9.70	5.56	5.84	8.06	46.4	18.08	21.5519	0.30	0.37
3	12.42	-5.96	10.90	-7.76	9.70	-2.20	5.84	6.24	110.7	15.57	20.0027	0.12	0.31
4	7.76	7.64	-1.35	7.76	-0.00	13.31	-3.86	13.86	-16.2	22.76	24.1802	0.73	0.57
5	0.00	0.00	-0.00	0.00	-0.00	5.56	-3.86	6.76	-34.8	19.91	22.6155	0.30	0.30
6	7.76	-7.64	1.35	-7.76	-0.00	-2.20	-3.86	4.44	-119.7	16.36	20.5018	0.12	0.22
7	12.42	5.96	-10.90	7.76	-9.70	13.31	-13.55	19.00	-45.5	18.21	21.6325	0.72	0.88
8	9.70	-1.68	-9.55	-0.00	-9.70	5.56	-13.55	14.65	-67.7	15.69	20.0799	0.30	0.73
9	12.42	-9.32	-8.20	-7.76	-9.70	-2.20	-13.55	13.73	-99.2	14.99	19.6233	0.12	0.70

maximum utilization of fasteners U_{max} = 0.88 ≤ 1 => **verification fulfilled**

2.1.2. verification block shear failure acc. to DIN EN 1995-1-1, annex A, strap left

$L_{net,t}$ = 128 mm, t_1 = 180 mm ⇒ $A_{net,t}$ = 23040 mm², $M_{y,k}$ = 202676.4 Nmm, $f_{h,k}$ = 23.82 N/mm²
$L_{net,v}$ = 282 mm, t_{ef} = 180 mm ⇒ $A_{net,v}$ = 50766 mm² (failure mechanism c,f,j/l,k,m)
$L_{net,v}$ = 282 mm ⇒ $A_{net,v}$ = 50766 mm² ⇒ $F_{bs,Rk}$ = 501.12 kN

load	N_d kN	$F_{bs,Rd}$ kN	U_{bs} -
1	50.000	346.929	0.14

maximum utilization block shear failure U_{max} = 0.14 ≤ 1 => **verification fulfilled**

2.2. fastener strap right

member	a_1 mm	a_2 mm	a_{3t} mm	a_{4t} mm	a_{3c} mm	a_{4c} mm
stplts	40.8	40.8	20.4	20.4	20.4	20.4
centr.t.m.	80.0	64.0	112.0	64.0	64.0	48.0

2.2.1. sum M straps

N_d = 50.000 kN, V_d = 34.700 kN, $M_{v,d}$ = 0.000 + -0.220 x 34.700 + 0.000 x 50.000 = -7.634 KNm

Nr	F_{Mi} kN	F_{Mxi} kN	F_{Myi} kN	F_{MNi} kN	F_{MVi} kN	F_{totHi} kN	F_{totVi} kN	F_{toti} kN	α_{toti} °	$f_{h,\alpha,k}$ N/mm²	$F_{v,Rd}$ kN	$U_{n,ef}$ -	$U_{F,v}$ -
1	-12.42	-9.32	8.20	7.76	-9.70	13.31	-5.84	14.54	-23.7	21.70	23.6132	0.72	0.62
2	-9.70	-1.68	9.55	0.00	-9.70	5.56	-5.84	8.06	-46.4	18.08	21.5519	0.30	0.37
3	-12.42	5.96	10.90	-7.76	-9.70	-2.20	-5.84	6.24	-110.7	15.57	20.0027	0.12	0.31
4	-7.76	-7.64	-1.35	7.76	0.00	13.31	3.86	13.86	16.2	22.76	24.1802	0.73	0.57
5	-0.00	-0.00	-0.00	0.00	0.00	5.56	3.86	6.76	34.8	19.91	22.6155	0.30	0.30
6	-7.76	7.64	1.35	-7.76	-0.00	-2.20	3.86	4.44	119.7	16.36	20.5018	0.12	0.22
7	-12.42	-5.96	-10.90	7.76	9.70	13.31	13.55	19.00	45.5	18.21	21.6325	0.72	0.88
8	-9.70	1.68	-9.55	-0.00	9.70	5.56	13.55	14.65	67.7	15.69	20.0799	0.30	0.73
9	-12.42	9.32	-8.20	-7.76	9.70	-2.20	13.55	13.73	99.2	14.99	19.6233	0.12	0.70

maximum utilization of fasteners U_{max} = 0.88 ≤ 1 => **verification fulfilled**

2.2.2. verification block shear failure acc. to DIN EN 1995-1-1, annex A, strap right

$L_{net,t}$ = 128 mm, t_1 = 180 mm ⇒ $A_{net,t}$ = 23040 mm², $M_{y,k}$ = 202676.4 Nmm, $f_{h,k}$ = 23.82 N/mm²
$L_{net,v}$ = 282 mm, t_{ef} = 180 mm ⇒ $A_{net,v}$ = 50766 mm² (failure mechanism c,f,j/l,k,m)
$L_{net,v}$ = 282 mm ⇒ $A_{net,v}$ = 50766 mm² ⇒ $F_{bs,Rk}$ = 501.12 kN

load	N_d kN	$F_{bs,Rd}$ kN	U_{bs} -
1	50.000	346.929	0.14

maximum utilization block shear failure U_{max} = 0.14 ≤ 1 => **verification fulfilled**

2.3. fastener strut

member	a_1 mm	a_2 mm	a_{3t} mm	a_{4t} mm	a_{3c} mm	a_{4c} mm
stplt	12.5	12.5	6.2	6.2	6.2	6.2
outtimbmbr	14.7	8.8	50.4	12.6	29.4	12.6

2.3.1. sum M straps

N_d = 60.000 kN, V_d = 0.000 kN, $M_{v,d}$ = 0.000 + -0.345 x 0.000 + 0.000 x 60.000 = 0.000 KNm

Nr	F_{Mi} kN	F_{Mxi} kN	F_{Myi} kN	F_{MNi} kN	F_{MVi} kN	F_{totHi} kN	F_{totVi} kN	F_{toti} kN	α_{toti} °	$f_{h,\alpha,k}$ N/mm²	$F_{v,Rd}$ kN	$U_{n,ef}$ -	$U_{F,v}$ -
1	0.00	-0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
2	0.00	-0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
3	0.00	-0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
4	0.00	-0.00	-0.00	-0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
5	0.00	-0.00	-0.00	-0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74

Nr	F_{Mi} kN	F_{Mxi} kN	F_{Myi} kN	F_{MNi} kN	F_{MVi} kN	F_{totHi} kN	F_{totVi} kN	F_{toti} kN	α_{toti} °	$f_{h,\alpha,k}$ N/mm²	$F_{v,Rd}$ kN	$U_{n,ef}$ -	$U_{F,v}$ -
6	0.00	-0.00	-0.00	-0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
7	0.00	-0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
8	0.00	-0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
9	0.00	-0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
10	0.00	-0.00	-0.00	-0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
11	0.00	-0.00	-0.00	-0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
12	0.00	-0.00	-0.00	-0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
13	0.00	-0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
14	0.00	-0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
15	0.00	-0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
16	0.00	-0.00	-0.00	-0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
17	0.00	-0.00	-0.00	-0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
18	0.00	-0.00	-0.00	-0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
19	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
20	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
21	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
22	0.00	0.00	-0.00	0.00	-0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
23	0.00	0.00	-0.00	0.00	-0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
24	0.00	0.00	-0.00	0.00	-0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
25	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
26	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
27	0.00	0.00	0.00	0.00	0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
28	0.00	0.00	-0.00	0.00	-0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
29	0.00	0.00	-0.00	0.00	-0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74
30	0.00	0.00	-0.00	0.00	-0.00	2.00	0.00	2.00	0.0	22.78	2.6998	0.74	0.74

maximum utilization of fasteners $U_{max} = 0.74 \leq 1$ => **verification fulfilled**

2.3.2. verification block shear failure acc. to DIN EN 1995-1-1, annex A, strut

$L_{net,t} = 60$ mm, $t_1 = 90$ mm $\Rightarrow A_{net,t} = 5400$ mm², $M_{y,k} = 7511.4$ Nmm, $f_{h,k} = 22.78$ N/mm²
$L_{net,v} = 585$ mm, $t_{ef} = 39$ mm $\Rightarrow A_{net,v} = 24822$ mm² (failure mechanism d)
$L_{net,v} = 585$ mm $\Rightarrow A_{net,v} = 24822$ mm² $\Rightarrow F_{bs,Rk} = 58.32$ kN

load	N_d kN	$F_{bs,Rd}$ kN	U_{bs} -
1	30.000	40.375	0.74

maximum utilization block shear failure $U_{max} = 0.74 \leq 1$ => **verification fulfilled**

2.4. fastener diagonal left

member	a_1 mm	a_2 mm	a_{3t} mm	a_{4t} mm	a_{3c} mm	a_{4c} mm
stplts	21.6	21.6	10.8	10.8	10.8	10.8
centr.t.m.	40.0	32.0	80.0	24.0	32.0	24.0

2.4.1. sum M straps

$N_d = 20.000$ kN, $V_d = 0.000$ kN, $M_{v,d} = 0.000 + -0.340 \times 0.000 + -0.000 \times 20.000 = -0.000$ KNm

Nr	F_{Mi} kN	F_{Mxi} kN	F_{Myi} kN	F_{MNi} kN	F_{MVi} kN	F_{totHi} kN	F_{totVi} kN	F_{toti} kN	α_{toti} °	$f_{h,\alpha,k}$ N/mm²	$F_{v,Rd}$ kN	$U_{n,ef}$ -	$U_{F,v}$ -
1	-0.00	0.00	-0.00	-0.00	-0.00	5.00	-0.00	5.00	-0.0	23.13	7.7261	0.88	0.65
2	-0.00	0.00	-0.00	0.00	-0.00	5.00	-0.00	5.00	-0.0	23.13	7.7261	0.88	0.65
3	-0.00	-0.00	0.00	-0.00	0.00	5.00	0.00	5.00	0.0	23.13	7.7261	0.88	0.65
4	-0.00	-0.00	0.00	0.00	0.00	5.00	0.00	5.00	0.0	23.13	7.7261	0.88	0.65

maximum utilization of fasteners $U_{max} = 0.88 \leq 1$ => **verification fulfilled**

2.4.2. verification block shear failure acc. to DIN EN 1995-1-1, annex A, diagonal left

$L_{net,t} = 32$ mm, $t_1 = 180$ mm $\Rightarrow A_{net,t} = 5760$ mm², $M_{y,k} = 33429.1$ Nmm, $f_{h,k} = 23.13$ N/mm²
$L_{net,v} = 276$ mm, $t_{ef} = 72$ mm $\Rightarrow A_{net,v} = 24302$ mm² (failure mechanism a)
$L_{net,v} = 276$ mm $\Rightarrow A_{net,v} = 24302$ mm² $\Rightarrow F_{bs,Rk} = 73.44$ kN

load	N_d kN	$F_{bs,Rd}$ kN	U_{bs} -
1	20.000	50.843	0.39

maximum utilization block shear failure $U_{max} = 0.39 \leq 1$ => **verification fulfilled**

2.5. fastener diagonal right

member	a_1 mm	a_2 mm	a_{3t} mm	a_{4t} mm	a_{3c} mm	a_{4c} mm
stplts	21.6	21.6	10.8	10.8	10.8	10.8
centr.t.m.	40.0	32.0	80.0	24.0	32.0	24.0

2.5.1. sum M straps

N_d = 20.000 kN, V_d = 0.000 kN, $M_{v,d}$ = 0.000 + -0.340 x 0.000 + -0.000 x 20.000 = -0.000 KNm

Nr	F_{Mi} kN	F_{Mxi} kN	F_{Myi} kN	F_{MNi} kN	F_{MVi} kN	F_{totHi} kN	F_{totVi} kN	F_{toti} kN	α_{toti} °	$f_{h,\alpha,k}$ N/mm²	$F_{v,Rd}$ kN	$U_{n,ef}$ -	$U_{F,v}$ -
1	-0.00	0.00	0.00	-0.00	-0.00	5.00	-0.00	5.00	-0.0	23.13	7.7261	0.88	0.65
2	-0.00	0.00	0.00	0.00	-0.00	5.00	-0.00	5.00	-0.0	23.13	7.7261	0.88	0.65
3	-0.00	-0.00	-0.00	-0.00	0.00	5.00	0.00	5.00	0.0	23.13	7.7261	0.88	0.65
4	-0.00	-0.00	-0.00	0.00	0.00	5.00	0.00	5.00	0.0	23.13	7.7261	0.88	0.65

maximum utilization of fasteners U_{max} = 0.88 ≤ 1 => **verification fulfilled**

2.5.2. verification block shear failure acc. to DIN EN 1995-1-1, annex A, diagonal right

$L_{net,t}$ = 32 mm, t_1 = 180 mm ⇒ $A_{net,t}$ = 5760 mm², $M_{y,k}$ = 33429.1 Nmm, $f_{h,k}$ = 23.13 N/mm²
$L_{net,v}$ = 276 mm, t_{ef} = 72 mm ⇒ $A_{net,v}$ = 24302 mm² (failure mechanism a)
$L_{net,v}$ = 276 mm ⇒ $A_{net,v}$ = 24302 mm² ⇒ $F_{bs,Rk}$ = 73.44 kN

load	N_d kN	$F_{bs,Rd}$ kN	U_{bs} -
1	20.000	50.843	0.39

maximum utilization block shear failure U_{max} = 0.39 ≤ 1 => **verification fulfilled**

2.6. results beams

2.6.1. strap left with A_n = 52020 mm², W_n = 3319244 mm³, I_n = 564271395 mm⁴, k_h = 1.000

load	$f_{m,d}$ N/mm²	$f_{t,d}$ N/mm²	$f_{c,d}$ N/mm²	$f_{v,d}$ N/mm²	N_d kN	M_d kNm	$\sigma_{0,d}$ N/mm²	$\sigma_{mo,d}$ N/mm²	$\sigma_{mu,d}$ N/mm²	V_d kN	τ_d N/mm²	U_σ -	U_τ -
1	16.62	10.04	14.54	2.77	50.000	7.634	0.96	2.30	2.30	46.443	2.68	0.23	0.97

beam maximum utilization U_{max} = 0.97 ≤ 1 => **verification fulfilled**

2.6.2. strap right with A_n = 52020 mm², W_n = 3319244 mm³, I_n = 564271395 mm⁴, k_h = 1.000

load	$f_{m,d}$ N/mm²	$f_{t,d}$ N/mm²	$f_{c,d}$ N/mm²	$f_{v,d}$ N/mm²	N_d kN	M_d kNm	$\sigma_{0,d}$ N/mm²	$\sigma_{mo,d}$ N/mm²	$\sigma_{mu,d}$ N/mm²	V_d kN	τ_d N/mm²	U_σ -	U_τ -
1	16.62	10.04	14.54	2.77	50.000	-7.634	0.96	-2.30	-2.30	46.443	2.68	0.04	0.97

beam maximum utilization U_{max} = 0.97 ≤ 1 => **verification fulfilled**

2.6.3. strut with A_n = 17064 mm², W_n = 400078 mm³, I_n = 24004659 mm⁴, k_h = 1.000

load	$f_{m,d}$ N/mm²	$f_{t,d}$ N/mm²	$f_{c,d}$ N/mm²	$f_{v,d}$ N/mm²	N_d kN	M_d kNm	$\sigma_{0,d}$ N/mm²	$\sigma_{mo,d}$ N/mm²	$\sigma_{mu,d}$ N/mm²	V_d kN	τ_d N/mm²	U_σ -	U_τ -
1	9.69	4.98	11.08	2.08	60.000	0.000	3.52	0.00	0.00	0.000	0.00	0.71	0.00

beam maximum utilization U_{max} = 0.71 ≤ 1 => **verification fulfilled**

2.6.4. diagonal left with A_n = 12960 mm², W_n = 224082 mm³, I_n = 10083690 mm⁴, k_h = 1.000

load	$f_{m,d}$ N/mm²	$f_{t,d}$ N/mm²	$f_{c,d}$ N/mm²	$f_{v,d}$ N/mm²	N_d kN	M_d kNm	$\sigma_{0,d}$ N/mm²	$\sigma_{mo,d}$ N/mm²	$\sigma_{mu,d}$ N/mm²	V_d kN	τ_d N/mm²	U_σ -	U_τ -
1	11.08	5.88	11.77	2.22	20.000	-0.000	1.54	-0.00	-0.00	0.000	0.00	0.26	0.00

beam maximum utilization U_{max} = 0.26 ≤ 1 => **verification fulfilled**

2.6.5. diagonal right with A_n = 12960 mm², W_n = 224082 mm³, I_n = 10083690 mm⁴, k_h = 1.000

load	$f_{m,d}$ N/mm²	$f_{t,d}$ N/mm²	$f_{c,d}$ N/mm²	$f_{v,d}$ N/mm²	N_d kN	M_d kNm	$\sigma_{0,d}$ N/mm²	$\sigma_{mo,d}$ N/mm²	$\sigma_{mu,d}$ N/mm²	V_d kN	τ_d N/mm²	U_σ -	U_τ -
1	11.08	5.88	11.77	2.22	20.000	-0.000	1.54	-0.00	-0.00	0.000	0.00	0.26	0.00

beam maximum utilization U_{max} = 0.26 ≤ 1 => **verification fulfilled**

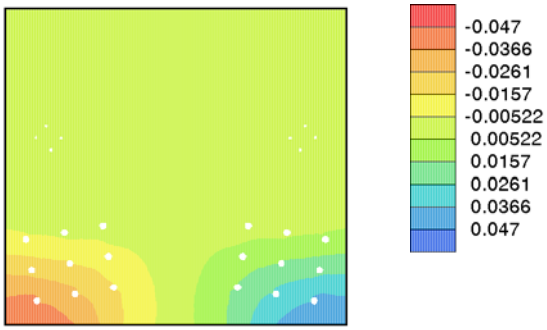
2.7. results node plate

with $\sigma_{v,R,k}$ = 235.00 N/mm², $\tau_{R,k}$ = 135.68 N/mm², $\gamma_{S/V}$ = 1.00, γ_A = 1.00

2.7.1. sum M straps

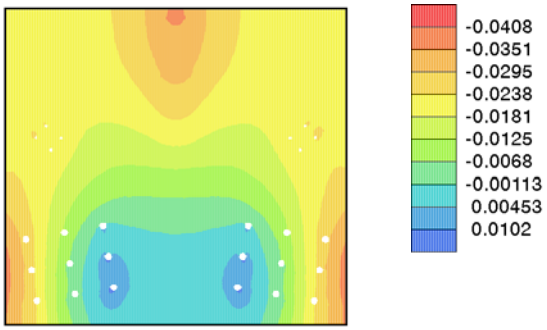
deformations u_x [mm]

min u_x = -0.0466 mm, max u_x = 0.0468 mm



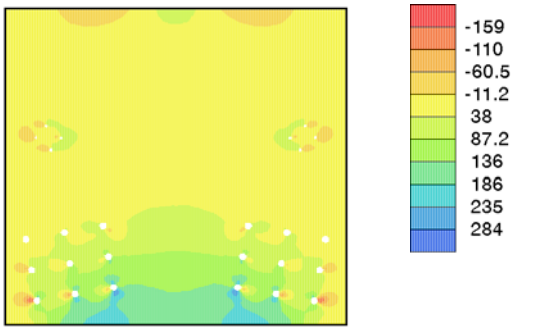
deformations u_y [mm]

min u_y = -0.0382 mm, max u_y = 0.0126 mm



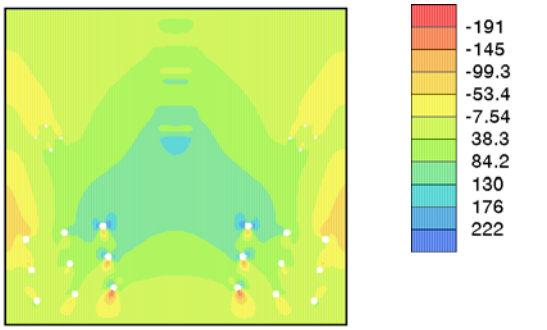
normal forces n_{xx} [kN/m]

min n_{xx} = -158.93 kN/m, max n_{xx} = 283.99 kN/m



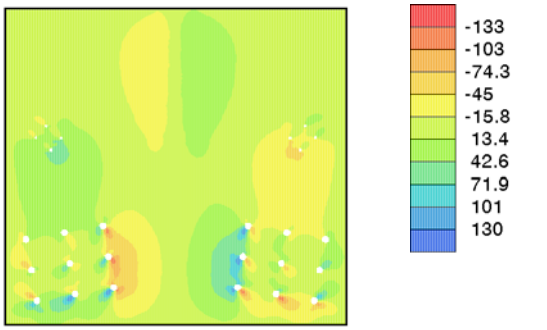
normal forces n_{yy} [kN/m]

min n_{yy} = -191.08 kN/m, max n_{yy} = 221.55 kN/m



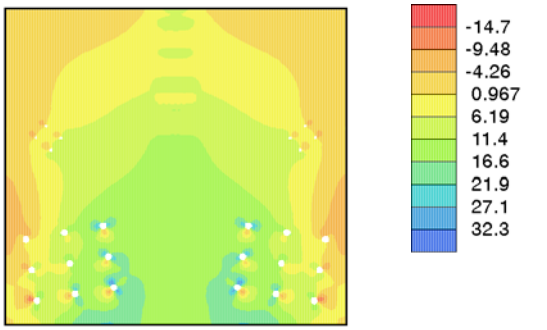
normal forces n_{xy} [kN/m]

min n_{xy} = -132.69 kN/m, max n_{xy} = 130.23 kN/m



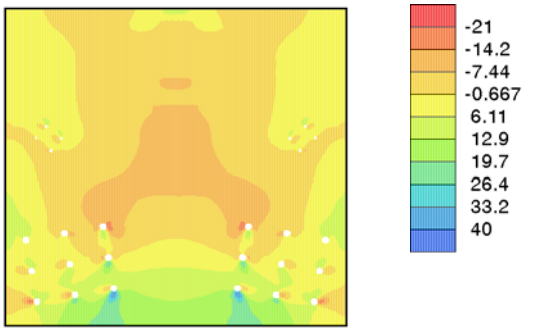
main normal stresses σ_1 [N/mm²]

min σ_1 = -14.66 N/mm², max σ_1 = 32.14 N/mm²



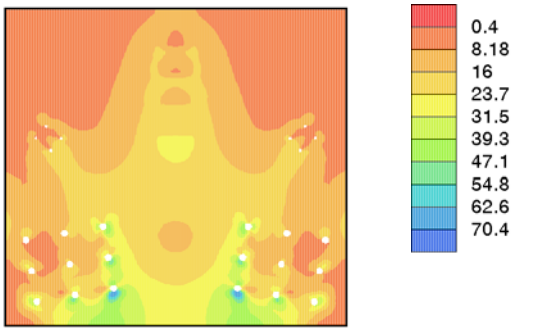
main shear stresses τ_1 [N/mm²]

min τ_1 = -20.97 N/mm², max τ_1 = 39.57 N/mm²



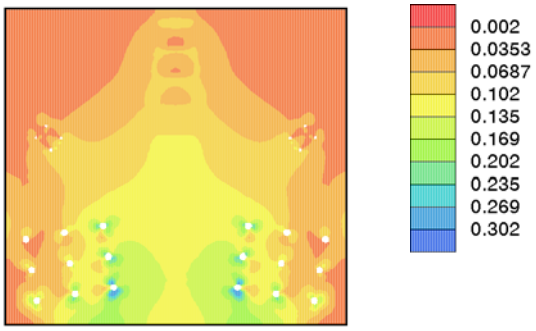
equivalent stresses σ_v [N/mm²]

min σ_v = 0.42 N/mm², max σ_v = 70.13 N/mm²



utilization of the node plate U_p

min U_p = 0.002, max U_p = 0.298



utilization of the node plate

Kno	x mm	y mm	u_x mm	u_y mm	n_{xx} kN/m	n_{yy} kN/m	n_{xy} kN/m	σ_1 N/mm²	τ_1 N/mm²	σ_v N/mm²	U_p
4	350.0	165.0	0.047	-0.036	2.11	1.82	-2.64	0.39	0.03	1.00	0.004
10	-137.9	32.3	-0.012	0.012	130.89	-109.08	-27.36	2.18	24.00	42.69	0.182
41	141.0	-38.7	0.001	0.001	7.49	217.19	48.29	22.47	-20.97	45.87	0.200
315	-122.8	94.3	-0.018	0.008	283.99	-25.82	-91.09	25.82	30.98	67.39	0.287
390	130.9	80.5	0.017	0.008	190.71	130.67	81.49	32.14	6.00	44.02	0.290
873	-134.8	96.1	-0.023	0.011	48.02	-131.07	130.23	-8.30	17.91	55.37	0.236
874	-129.3	98.8	-0.020	0.010	210.21	-185.53	42.23	2.47	39.57	70.13	0.298
955	-295.7	112.3	-0.042	-0.027	-158.93	12.70	-38.98	-14.62	-17.16	35.77	0.152
967	137.8	-41.5	0.002	-0.000	22.63	221.55	19.51	24.42	-19.89	42.77	0.209
983	130.2	98.5	0.021	0.010	189.61	-191.08	-62.23	-0.15	38.07	69.37	0.295
984	135.4	95.3	0.023	0.010	24.40	-110.82	-132.69	-8.64	13.52	52.31	0.223
1058	295.5	112.0	0.042	-0.027	-156.57	10.00	45.81	-14.66	-16.66	36.04	0.153

x,y: node coordinates; u_x,u_y: deformations; n_{xx},n_{yy},n_{xy}: normal forces; σ,τ: stresses
U_p: total utilization of the node plate

maximum utilization of the node plate U_{max} = 0.30 ≤ 1 => **verification fulfilled**

2.8. bearing forces strap left

p_1 = 80 mm, e_1 = 41 mm, e_2 = 106 mm, p_2 = 64.00 mm, α_b = 1.00, k_1 = 2.50 => $F_{b,Rk}$ = 72.00 kN
e_1 = 41 mm, e_2 = 106 mm, p_2 = 64 mm, α_b = 0.77, k_1 = 2.50 => $F_{b,Rk,Rand}$ = 55.26 kN

2.8.1. sum M straps

Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -	Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -	Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -
1	7.27	44.21	0.16	4	6.93	44.21	0.16	7	9.50	44.21	0.21
2	4.03	44.21	0.09	5	3.38	44.21	0.08	8	7.32	44.21	0.17
3	3.12	44.21	0.07	6	2.22	44.21	0.05	9	6.87	44.21	0.16

maximum utilization of the bearing forces U_{max} = 0.21 ≤ 1 => **verification fulfilled**

2.9. bearing forces strap right

p_1 = 80 mm, e_1 = 41 mm, e_2 = 106 mm, p_2 = 64.00 mm, α_b = 1.00, k_1 = 2.50 => $F_{b,Rk}$ = 72.00 kN
e_1 = 41 mm, e_2 = 106 mm, p_2 = 64 mm, α_b = 0.77, k_1 = 2.50 => $F_{b,Rk,Rand}$ = 55.26 kN

2.9.1. sum M straps

Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -	Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -	Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -
1	7.27	44.21	0.16	4	6.93	44.21	0.16	7	9.50	44.21	0.21
2	4.03	44.21	0.09	5	3.38	44.21	0.08	8	7.32	44.21	0.17
3	3.12	44.21	0.07	6	2.22	44.21	0.05	9	6.87	44.21	0.16

maximum utilization of the bearing forces U_{max} = 0.21 ≤ 1 => **verification fulfilled**

2.10. bearing forces strut

p_1 = 60 mm, e_1 = 18 mm, e_2 = 30 mm, p_2 = 12.00 mm, α_b = 1.00, k_1 = 1.53 => $F_{b,Rk}$ = 11.57 kN
e_1 = 18 mm, e_2 = 30 mm, p_2 = 12 mm, α_b = 1.00, k_1 = 1.53 => $F_{b,Rk,Rand}$ = 11.57 kN

2.10.1. sum M straps

Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -	Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -	Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -
1	1.00	9.26	0.11	11	1.00	9.26	0.11	21	1.00	9.26	0.11
2	1.00	9.26	0.11	12	1.00	9.26	0.11	22	1.00	9.26	0.11
3	1.00	9.26	0.11	13	1.00	9.26	0.11	23	1.00	9.26	0.11
4	1.00	9.26	0.11	14	1.00	9.26	0.11	24	1.00	9.26	0.11
5	1.00	9.26	0.11	15	1.00	9.26	0.11	25	1.00	9.26	0.11
6	1.00	9.26	0.11	16	1.00	9.26	0.11	26	1.00	9.26	0.11
7	1.00	9.26	0.11	17	1.00	9.26	0.11	27	1.00	9.26	0.11
8	1.00	9.26	0.11	18	1.00	9.26	0.11	28	1.00	9.26	0.11
9	1.00	9.26	0.11	19	1.00	9.26	0.11	29	1.00	9.26	0.11
10	1.00	9.26	0.11	20	1.00	9.26	0.11	30	1.00	9.26	0.11

maximum utilization of the bearing forces U_{max} = 0.11 ≤ 1 => **verification fulfilled**

2.11. bearing forces diagonal left

p_1 = 40 mm, e_1 = 62 mm, e_2 = 29 mm, p_2 = 32.00 mm, α_b = 1.00, k_1 = 2.50 => $F_{b,Rk}$ = 36.00 kN
e_1 = 62 mm, e_2 = 29 mm, p_2 = 32 mm, α_b = 1.00, k_1 = 2.50 => $F_{b,Rk,Rand}$ = 36.00 kN

2.11.1. sum M straps

Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -
1	2.50	28.80	0.09
2	2.50	28.80	0.09
3	2.50	28.80	0.09
4	2.50	28.80	0.09

maximum utilization of the bearing forces U_{max} = 0.09 ≤ 1 => **verification fulfilled**

2.12. bearing forces diagonal right

p_1 = 40 mm, e_1 = 62 mm, e_2 = 29 mm, p_2 = 32.00 mm, α_b = 1.00, k_1 = 2.50 => $F_{b,Rk}$ = 36.00 kN
e_1 = 62 mm, e_2 = 29 mm, p_2 = 32 mm, α_b = 1.00, k_1 = 2.50 => $F_{b,Rk,Rand}$ = 36.00 kN

2.12.1. sum M straps

Nr	F_{toti} kN	$F_{v,Rd}$ kN	U -
1	2.50	28.80	0.09
2	2.50	28.80	0.09
3	2.50	28.80	0.09
4	2.50	28.80	0.09

maximum utilization of the bearing forces U_{max} = 0.09 ≤ 1 => **verification fulfilled**

3. summary

total utilization of all verifications $u_{max,Ges}$ = 0.967 ≤ 1 ⇒ ok.