

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, $h=520.0$ mm, steel plate external, on both sides

The steel plate must be structurally secured against buckling

fastener with a diameter < 10.0 mm 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	-390.0	-90.0	4	310.0	-90.0
2	-390.0	430.0	5	-390.0	-90.0
3	310.0	430.0			

1.3. connected beams

Nr.	bar	material	b mm	t mm	α °
1	strap continuous	solconiftimbr C30	180	80	0
2	diagonal left	solconiftimbr C30	160	80	45
3	diagonal right	solconiftimbr C30	100	80	60

1.4. fastener

1.4.1. strap

shear plate connector B1 $d_c = 80$ mm, S235 (1052)

bolt M 12, S235 (1052)

washer $d = 28$ mm

load-bearing capacity is reduced acc. to DIN EN 1995-1-1, 8.3.1.1(8)

3 fastener, $a_1 = 160$ mm, $a_2 = 102$ mm

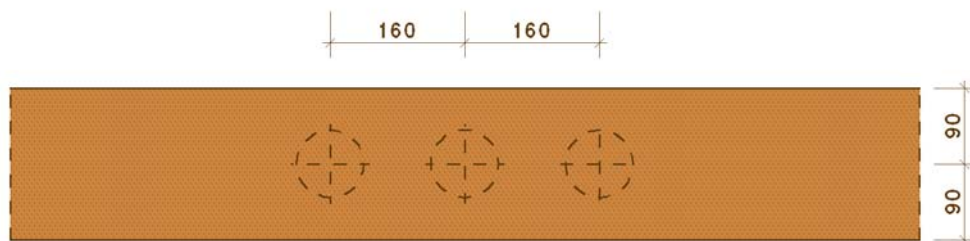
centroid of the fasteners from nodal point S at $x_s = 0$ mm, $y_s = 0$ mm

polar moment of inertia $I_p = 51200$ mm⁴

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	-160.0	0.0
2	0.0	0.0
3	160.0	0.0

fastener strap left scale 1:90



1.4.2. diagonal left

shear plate connector B1 $d_c = 80$ mm, S235 (1052)

bolt M 12, S235 (1052)

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 1995-1-1, 8.2.3(4)

2 fastener, $a_1 = 160$ mm, $a_2 = 102$ mm

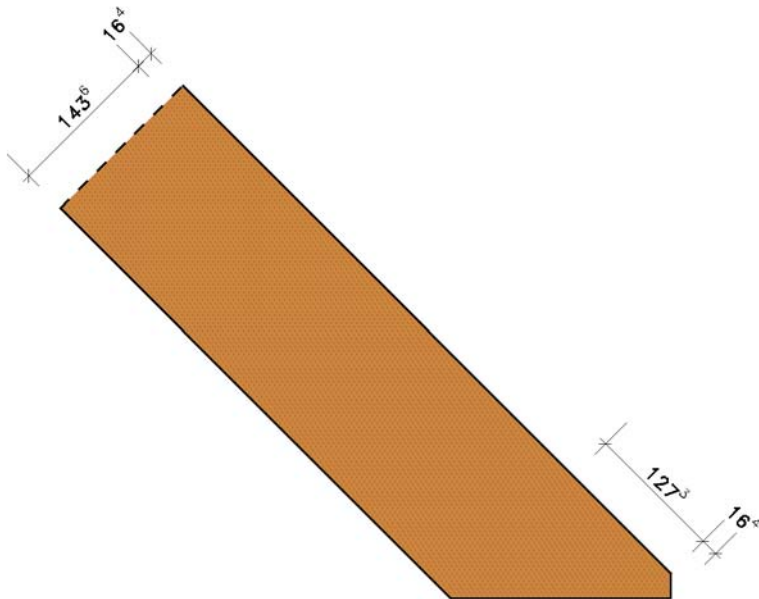
centroid of the fasteners from nodal point S at $x_s = -261$ mm, $y_s = 261$ mm

polar moment of inertia $I_p = 12800$ mm⁴

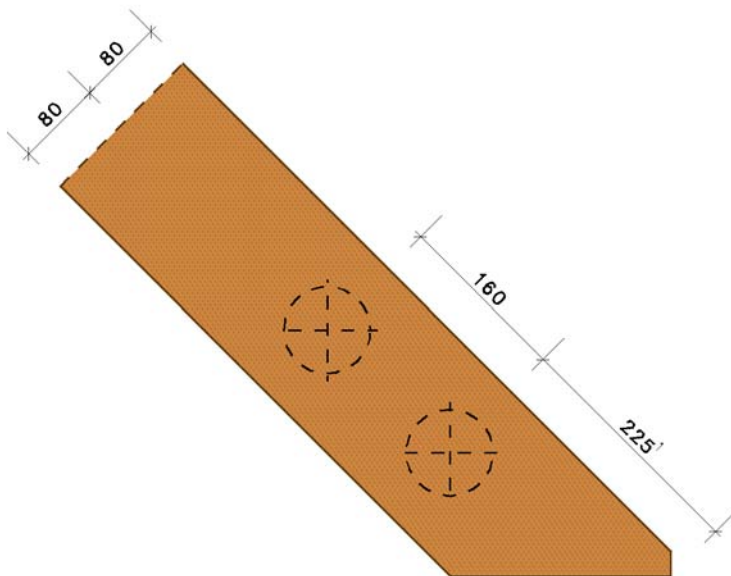
coordinates of the fasteners (origin in the nodal point, x to the right, y to the top)

Nr	x _k mm	y _k mm
1	-204.2	204.2
2	-317.3	317.3

view diagonal left scale 1:70



fastener diagonal left scale 1:70



1.4.3. diagonal right

shear plate connector B1 d_c = 80 mm, S235 (1052)

bolt M 12, S235 (1052)

washer d = 28 mm

load-bearing capacity is reduced acc. to DIN EN 1995-1-1, 8.3.1.1(8)

2 fastener, a₁ = 160 mm, a₂ = 102 mm

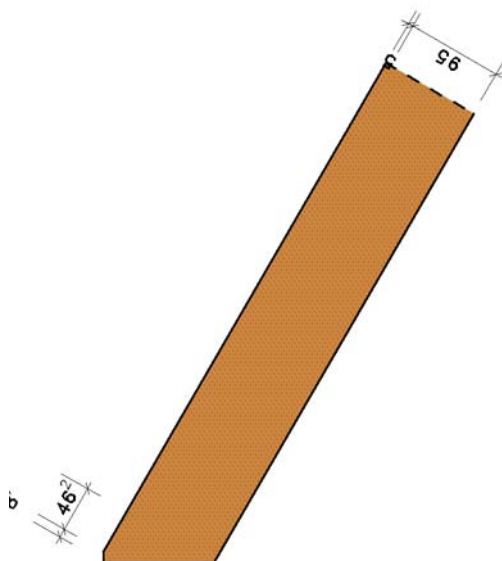
centroid of the fasteners from nodal point S at x_s = 141 mm, y_s = 244 mm

polar moment of inertia I_p = 12800 mm⁴

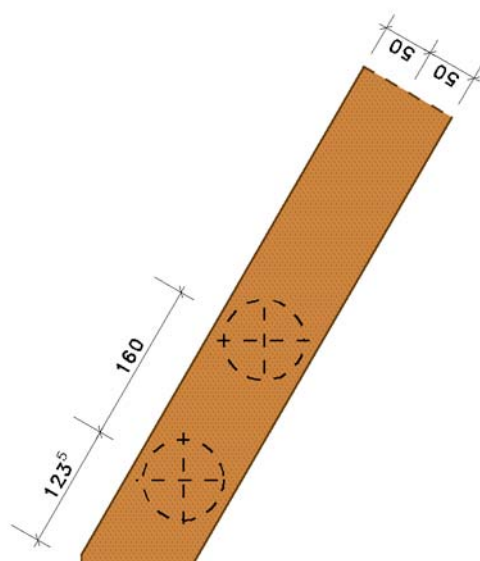
coordinates of the fasteners (origin in the nodal point, x to the right, y to the top)

Nr	x _k mm	y _k mm
1	100.7	174.4
2	180.7	313.0

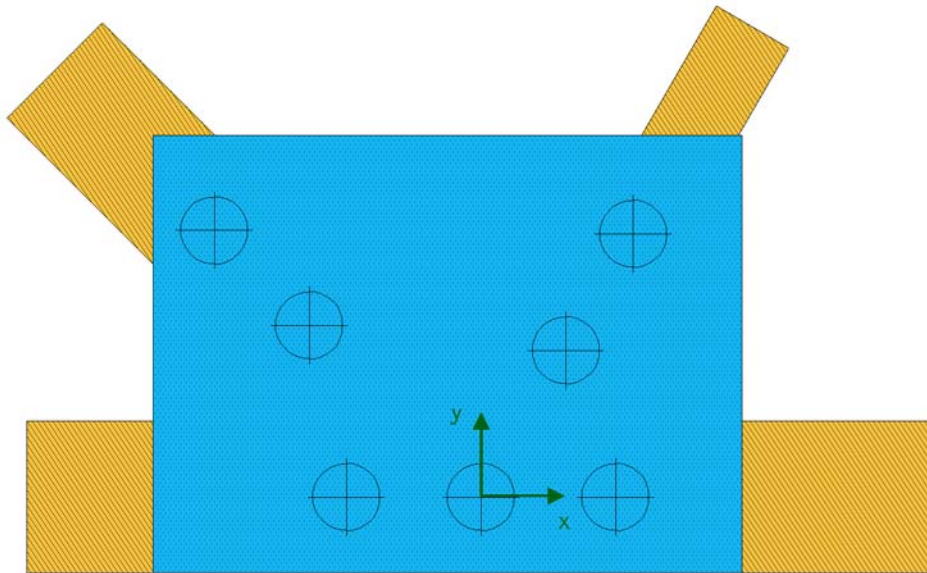
view diagonal right scale 1:75



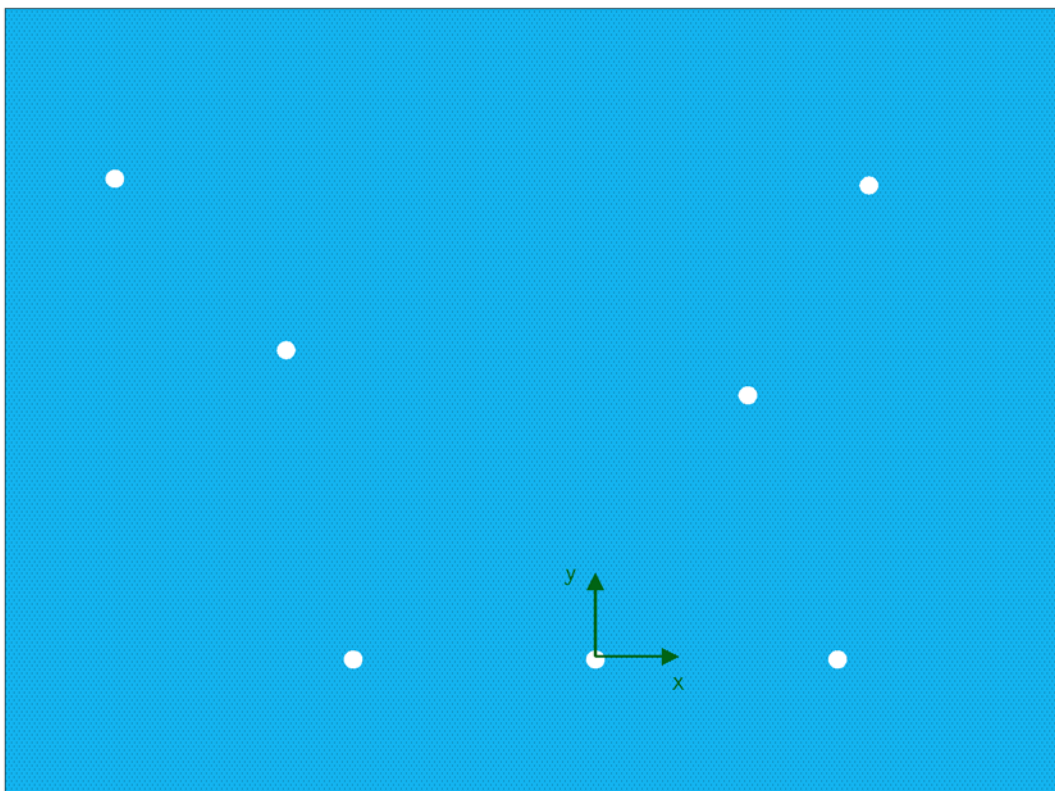
fastener diagonal right scale 1:75



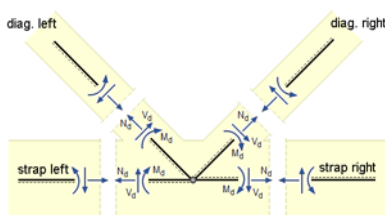
1.5. nodal point
view scale 1:90



1.6. node plate
view scale 1:50



1.7. load combinations (design internal forces)



1.7.1. Lf1, KLED: short-term

Nr	bar	N _d kN	M _d kNm	V _d kN	k _{mod} -	γ -
1	strap left	-49.000	0.000	0.000	0.900	1.30
2	strap right	49.367	0.000	0.000	0.900	1.30
3	diag. left	88.200	0.000	0.000	0.900	1.30
4	diag. right	-72.000	0.000	0.000	0.900	1.30
5	ΣH, ΣM, ΣV	-0.000	0.000	0.013	---	---

2. results of all load case combinations

2.1. fastener strap

2.1.1. Lf1

N_d = -98.367 kN, V_d = -0.013 kN, M_{v,d} = -0.000 + -0.000 x -0.013 + 0.000 x -98.367 = -0.000 KNm

Nr	F _{M1} kN	F _{Mx1} kN	F _{My1} kN	F _{MN1} kN	F _{MV1} kN	F _{totH1} kN	F _{totV1} kN	F _{tot1} kN	α _{tot1} °	F _{v,Rd} kN	U _{n,ef} -	U _{F,v} -
1	-0.000	-0.000	0.000	-0.000	0.000	-32.789	-0.004	32.789	-180.0	41.4134	0.83	0.79
2	-0.000	-0.000	-0.000	0.000	-0.000	-32.789	-0.004	32.789	-180.0	41.4134	0.83	0.79
3	-0.000	-0.000	-0.000	0.000	-0.000	-32.789	-0.004	32.789	-180.0	41.4134	0.83	0.79

maximum utilization of fasteners U_{max} = 0.83 ≤ 1 ⇒ **verification fulfilled**

2.2. fastener diagonal left

2.2.1. Lf1

N_d = 88.200 kN, V_d = 0.000 kN, M_{v,d} = 0.000 + -0.369 x 0.000 + -0.000 x 88.200 = -0.000 KNm

Nr	F _{M1} kN	F _{Mx1} kN	F _{My1} kN	F _{MN1} kN	F _{MV1} kN	F _{totH1} kN	F _{totV1} kN	F _{tot1} kN	α _{tot1} °	F _{v,Rd} kN	U _{n,ef} -	U _{F,v} -
1	-0.000	0.000	-0.000	-0.000	-0.000	44.100	-0.000	44.100	-0.0	41.4134	1.12	1.06
2	-0.000	-0.000	0.000	-0.000	0.000	44.100	0.000	44.100	0.0	41.4134	1.12	1.06

maximum utilization of fasteners U_{max} = 1.12 > 1 ⇒ **verification not fulfilled**

!!

2.3. fastener diagonal right

2.3.1. Lf1

N_d = -72.000 kN, V_d = 0.000 kN, M_{v,d} = 0.000 + -0.281 x 0.000 + -0.000 x -72.000 = 0.000 KNm

Nr	F _{M1} kN	F _{Mx1} kN	F _{My1} kN	F _{MN1} kN	F _{MV1} kN	F _{totH1} kN	F _{totV1} kN	F _{tot1} kN	α _{tot1} °	F _{v,Rd} kN	U _{n,ef} -	U _{F,v} -
1	0.000	-0.000	-0.000	0.000	0.000	-36.000	0.000	36.000	180.0	41.4134	0.87	0.87
2	0.000	0.000	0.000	-0.000	-0.000	-36.000	-0.000	36.000	-180.0	41.4134	0.87	0.87

maximum utilization of fasteners U_{max} = 0.87 ≤ 1 ⇒ **verification fulfilled**

2.4. results beams

2.4.1. strap left with A_n = 11350 mm², W_n = 413471 mm³, I_n = 37212413 mm⁴, k_n = 1.000

load	f _{m,d} N/mm ²	f _{t,d} N/mm ²	f _{c,d} N/mm ²	f _{v,d} N/mm ²	N _d kN	M _d kNm	σ _{0,d} N/mm ²	σ _{mo,d} N/mm ²	σ _{mu,d} N/mm ²	V _d kN	τ _d N/mm ²	U _σ -	U _τ -
1	20.77	13.15	16.62	2.77	-49.000	-0.000	-4.32	-0.00	-0.00	0.000	0.00	0.07	0.00

beam maximum utilization U_{max} = 0.07 ≤ 1 ⇒ **verification fulfilled**

2.4.2. strap right with A_n = 11350 mm², W_n = 413471 mm³, I_n = 37212413 mm⁴, k_n = 1.000

load	f _{m,d} N/mm ²	f _{t,d} N/mm ²	f _{c,d} N/mm ²	f _{v,d} N/mm ²	N _d kN	M _d kNm	σ _{0,d} N/mm ²	σ _{mo,d} N/mm ²	σ _{mu,d} N/mm ²	V _d kN	τ _d N/mm ²	U _σ -	U _τ -
1	20.77	13.15	16.62	2.77	49.367	-0.000	4.35	0.00	0.00	0.000	0.00	0.33	0.00

beam maximum utilization U_{max} = 0.33 ≤ 1 ⇒ **verification fulfilled**

2.4.3. diagonal left with A_n = 9750 mm², W_n = 320488 mm³, I_n = 25639079 mm⁴, k_n = 1.000

load	f _{m,d} N/mm ²	f _{t,d} N/mm ²	f _{c,d} N/mm ²	f _{v,d} N/mm ²	N _d kN	M _d kNm	σ _{0,d} N/mm ²	σ _{mo,d} N/mm ²	σ _{mu,d} N/mm ²	V _d kN	τ _d N/mm ²	U _σ -	U _τ -
1	20.77	13.15	16.62	2.77	88.200	-0.000	9.05	-0.00	-0.00	0.000	0.00	0.69	0.00

beam maximum utilization U_{max} = 0.69 ≤ 1 ⇒ **verification fulfilled**

2.4.4. diagonal right with A_n = 4950 mm², W_n = 99982 mm³, I_n = 4999079 mm⁴, k_n = 1.084

load	f _{m,d} N/mm ²	f _{t,d} N/mm ²	f _{c,d} N/mm ²	f _{v,d} N/mm ²	N _d kN	M _d kNm	σ _{0,d} N/mm ²	σ _{mo,d} N/mm ²	σ _{mu,d} N/mm ²	V _d kN	τ _d N/mm ²	U _σ -	U _τ -
1	20.77	13.15	16.62	2.77	-72.000	0.000	-14.55	0.00	0.00	0.000	0.00	0.77	0.00

beam maximum utilization U_{max} = 0.77 ≤ 1 ⇒ **verification fulfilled**

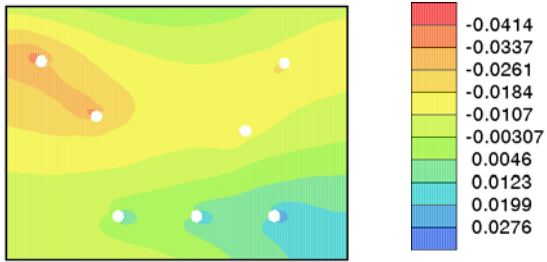
2.5. results node plate

with $\sigma_{v,R,k} = 235.00 \text{ N/mm}^2$, $\tau_{R,k} = 135.68 \text{ N/mm}^2$, $\gamma_{S/V} = 1.00$, $\gamma_A = 1.00$

2.5.1. Lf1

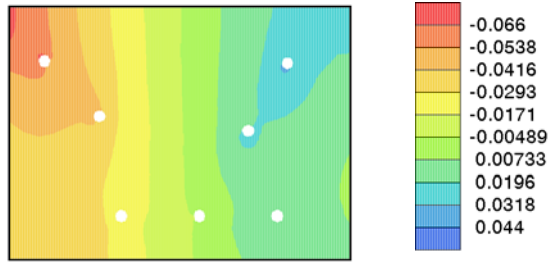
deformations u_x [mm]

min $u_x = -0.0416 \text{ mm}$, max $u_x = 0.0277 \text{ mm}$



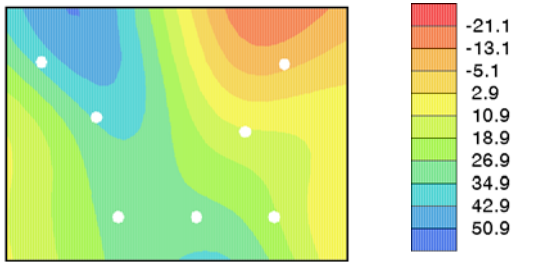
deformations u_y [mm]

min $u_y = -0.0702 \text{ mm}$, max $u_y = 0.0366 \text{ mm}$



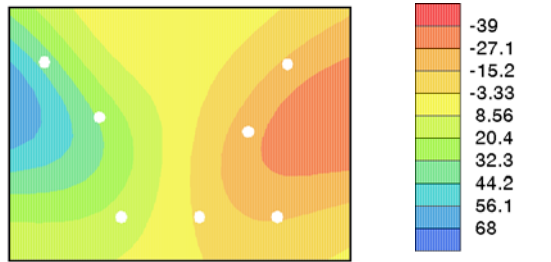
normal forces n_{xx} [kN/m]

min $n_{xx} = -21.06 \text{ kN/m}$, max $n_{xx} = 51.34 \text{ kN/m}$



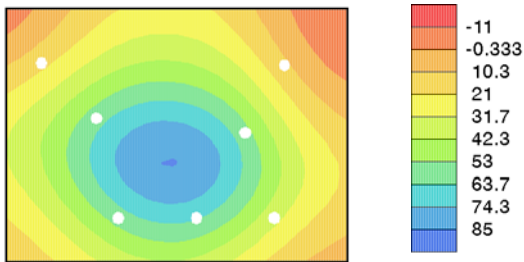
normal forces n_{yy} [kN/m]

min $n_{yy} = -39.00 \text{ kN/m}$, max $n_{yy} = 68.39 \text{ kN/m}$



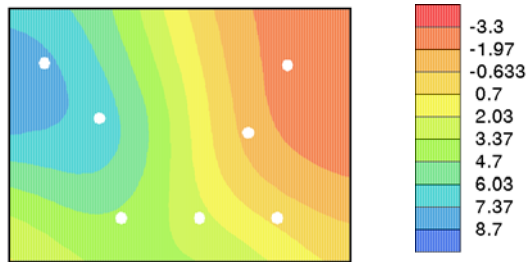
normal forces n_{xy} [kN/m]

min $n_{xy} = -10.97 \text{ kN/m}$, max $n_{xy} = 85.24 \text{ kN/m}$



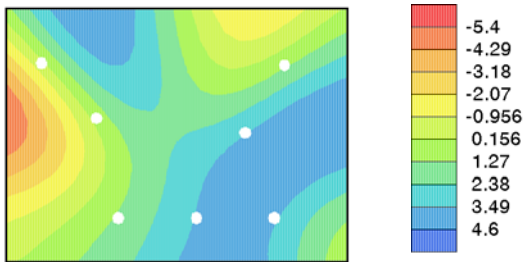
main normal stresses σ_1 [N/mm²]

min $\sigma_1 = -3.31 \text{ N/mm}^2$, max $\sigma_1 = 8.60 \text{ N/mm}^2$



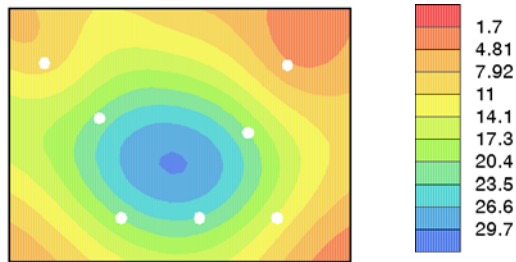
main shear stresses τ_1 [N/mm²]

min $\tau_1 = -5.42 \text{ N/mm}^2$, max $\tau_1 = 4.63 \text{ N/mm}^2$



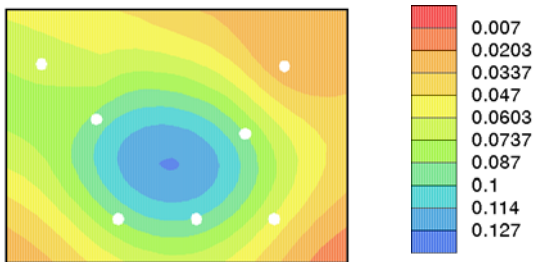
equivalent stresses σ_v [N/mm²]

min $\sigma_v = 1.72 \text{ N/mm}^2$, max $\sigma_v = 29.99 \text{ N/mm}^2$



utilization of the node plate U_p

min $U_p = 0.007$, max $U_p = 0.128$



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/mm ²	τ ₁ N/mm ²	σ _v N/mm ²	U _p
3	310.0	-430.0	-0.010	0.021	-10.75	-13.47	-10.97	-2.42	0.27	4.53	0.024
15	172.8	0.0	0.028	0.012	18.19	-16.02	32.21	0.22	3.42	12.64	0.054
39	-390.0	-187.9	-0.018	-0.041	11.49	65.64	29.72	7.71	-5.42	15.92	0.074
40	-390.0	-221.8	-0.021	-0.044	14.31	68.39	25.97	8.27	-5.41	15.40	0.077
42	-390.0	-275.2	-0.025	-0.051	21.06	64.94	17.09	8.60	-4.39	12.91	0.076
53	-252.8	-430.0	-0.003	-0.042	51.34	7.41	10.47	5.87	4.39	10.27	0.052
54	-217.8	-430.0	-0.001	-0.036	50.07	3.75	14.90	5.38	4.63	10.95	0.049
62	153.6	-430.0	-0.005	0.020	-21.06	-2.27	5.11	-2.33	-1.88	4.38	0.021
72	310.0	-225.0	-0.009	0.013	5.87	-39.00	6.83	-3.31	4.49	8.77	0.037
153	174.4	-301.9	-0.022	0.037	-5.85	-18.70	15.51	-2.45	1.28	6.31	0.027
849	-44.7	-114.1	-0.009	-0.007	27.14	2.16	85.24	2.93	2.50	29.99	0.128

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 $U_{\max} = 0.13 \leq 1 \Rightarrow$ verification fulfilled

2.6. bearing forces strap

p₁ = 160 mm, e₁ = 90 mm, e₂ = 90 mm, p₂ = 204.00 mm, α_b = 1.00, k₁ = 2.50 ⇒ F_{b,Rk} = 114.75 kN
e₁ = 90 mm, e₂ = 90 mm, p₂ = 204 mm, α_b = 1.00, k₁ = 2.50 ⇒ F_{b,Rk,Rand} = 114.75 kN

2.6.1. Lf1

Nr	F _{tot1} kN	F _{v,Rd} kN	U -
1	16.39	91.80	0.18
2	16.39	91.80	0.18
3	16.39	91.80	0.18

maximum utilization of the bearing forces $U_{\max} = 0.18 \leq 1 \Rightarrow$ verification fulfilled

2.7. bearing forces diagonal left

p₁ = 160 mm, e₁ = 73 mm, e₂ = 80 mm, p₂ = 204.00 mm, α_b = 1.00, k₁ = 2.50 ⇒ F_{b,Rk} = 114.75 kN
e₁ = 73 mm, e₂ = 80 mm, p₂ = 204 mm, α_b = 0.95, k₁ = 2.50 ⇒ F_{b,Rk,Rand} = 109.00 kN

2.7.1. Lf1

Nr	F _{tot1} kN	F _{v,Rd} kN	U -
1	22.05	87.20	0.25
2	22.05	87.20	0.25

maximum utilization of the bearing forces $U_{\max} = 0.25 \leq 1 \Rightarrow$ verification fulfilled

2.8. bearing forces diagonal right

p₁ = 160 mm, e₁ = 117 mm, e₂ = 50 mm, p₂ = 204.00 mm, α_b = 1.00, k₁ = 2.50 ⇒ F_{b,Rk} = 114.75 kN
e₁ = 117 mm, e₂ = 50 mm, p₂ = 204 mm, α_b = 1.00, k₁ = 2.50 ⇒ F_{b,Rk,Rand} = 114.75 kN

2.8.1. Lf1

Nr	F _{tot1} kN	F _{v,Rd} kN	U -
1	18.00	91.80	0.20
2	18.00	91.80	0.20

maximum utilization of the bearing forces $U_{\max} = 0.20 \leq 1 \Rightarrow$ verification fulfilled

3. summary

total utilization of all verifications $U_{\max,Ges} = 1.121 > 1 \Rightarrow$ not ok. !!