

1.4.2. Gurt rechts

Simpson CSA, 5.0 x 80.0 mm, zweiseitig, $d_k = 8.3$ mm, $l_{ef} = 74.0$ mm, nicht vorgebohrt

Tragfähigkeit wird gemäß DIN EN 1995-1-1, 8.3.1.1(8) abgemindert

$F_{v,Rk}$ wird gemäß DIN EN 1995-1-1, 8.2.3(4) erhöht

$F_{v,Rd}$ wird mit dem genauen Nachweis nach DIN EN 1995-1-1, 8.2.3 berechnet, ETA-04/0013

30 Verbindungsmittel, $a_1 = 50$ mm, $a_2 = 25$ mm beidseitig

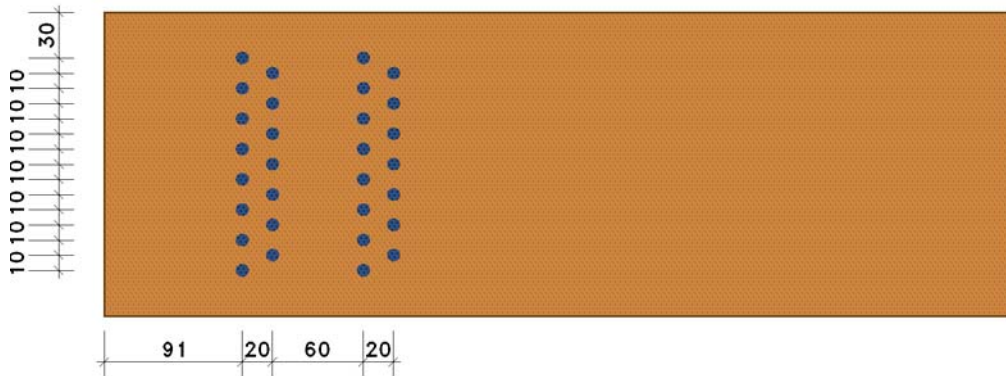
Schwerpunkt der Verbindungsmittel vom Knotenpunkt S bei $x_s = 139$ mm, $y_s = 0$ mm

Polares Trägheitsmoment $I_p = 106987$ mm⁴

Koordinaten der Verbindungsmittel (Ursprung im Knotenpunkt, x nach rechts, y nach oben)

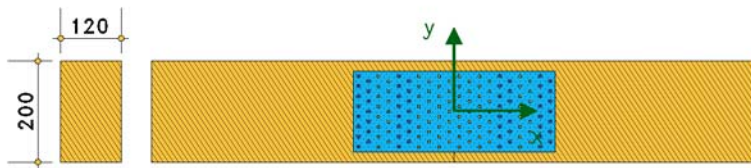
Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm	Nr	x_k mm	y_k mm
1	90.0	-70.0	9	110.0	-60.0	17	170.0	-50.0	25	190.0	-40.0
2	90.0	-50.0	10	110.0	-40.0	18	170.0	-30.0	26	190.0	-20.0
3	90.0	-30.0	11	110.0	-20.0	19	170.0	-10.0	27	190.0	0.0
4	90.0	-10.0	12	110.0	0.0	20	170.0	10.0	28	190.0	20.0
5	90.0	10.0	13	110.0	20.0	21	170.0	30.0	29	190.0	40.0
6	90.0	30.0	14	110.0	40.0	22	170.0	50.0	30	190.0	60.0
7	90.0	50.0	15	110.0	60.0	23	170.0	70.0			
8	90.0	70.0	16	170.0	-70.0	24	190.0	-60.0			

Verbindungsmittel Gurt rechts Maßstab 1:50



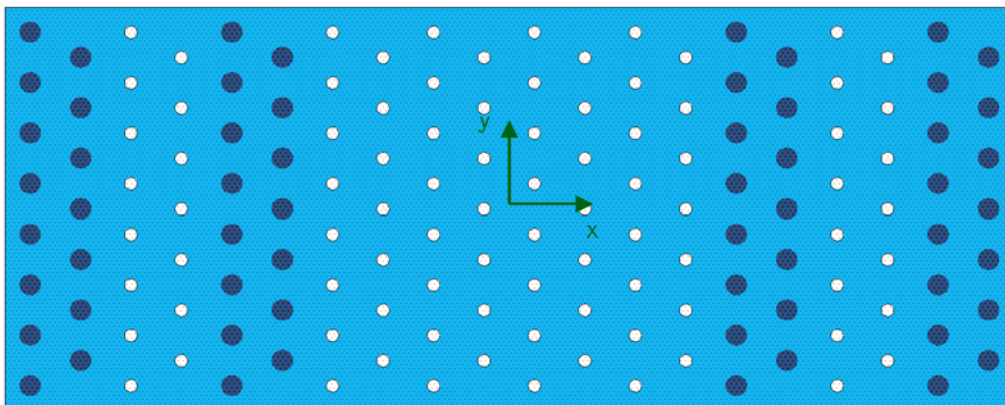
1.5. Knotenpunkt

Ansicht Maßstab 1:150

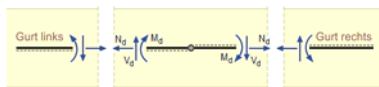


1.6. Knotenblech

Ansicht Maßstab 1:30



1.7. Lastkombinationen (Bemessungsschnittgrößen)



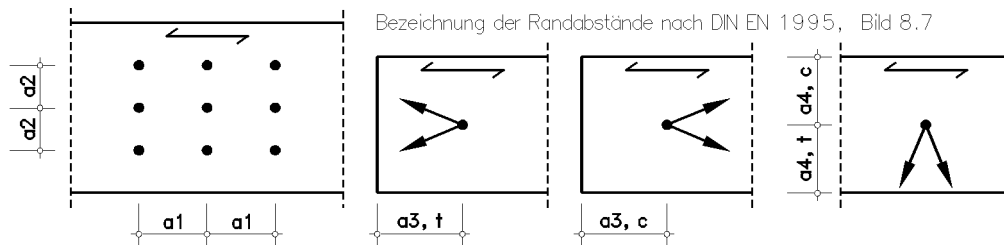
1.7.1. Summe M Gurte, KLED: mittel

Nr	Stab	N _d kN	M _d kNm	V _d kN	k _{mod} -	γ -
1	Gurt links	5.0000	2.0000	5.0000	0.800	1.30
2	Gurt rechts	5.0000	-2.0000	5.0000	0.800	1.30
3	ΣH, ΣM, ΣV	-0.0000	0.0000	0.0000	---	---

2. Ergebnisse alle Lastfallkombinationen

2.1. Verbindungsmittel Gurt links

Bauteil	a1 mm	a2 mm	a3t mm	a4t mm	a3c mm	a4c mm
Blech	14.4	14.4	7.2	7.2	7.2	7.2
Seitenholz	28.0	14.0	60.0	28.0	40.0	20.0



2.1.1. Summe M Gurte

N_d = 5.000 kN, V_d = 5.000 kN, M_{v,d} = 2.000 + -0.141 x 5.000 + 0.000 x 5.000 = 1.297 kNm

Nr	F _{M1} kN	F _{Mx1} kN	F _{My1} kN	F _{MN1} kN	F _{MV1} kN	F _{t0tH1} kN	F _{t0tV1} kN	F _{t0t1} kN	α _{t0t1} °	F _{v,Rd} kN	U _{n,ef} -	U _{F,v} -
1	1.0379	-0.8484	-0.5979	-0.8484	-0.5979	-0.6817	-0.4312	0.8067	-147.7	2.6369	0.26	0.31
2	0.8513	-0.6060	-0.5979	-0.6060	-0.5979	-0.4393	-0.4312	0.6156	-135.5	2.6369	0.17	0.23
3	0.6998	-0.3636	-0.5979	-0.3636	-0.5979	-0.1969	-0.4312	0.4741	-114.5	2.6369	0.07	0.18
4	0.6101	-0.1212	-0.5979	-0.1212	-0.5979	0.0455	-0.4312	0.4336	-84.0	2.6369	0.02	0.16
5	0.6101	0.1212	-0.5979	0.1212	-0.5979	0.2879	-0.4312	0.5185	-56.3	2.6369	0.11	0.20
6	0.6998	0.3636	-0.5979	0.3636	-0.5979	0.5303	-0.4312	0.6835	-39.1	2.6369	0.20	0.26
7	0.8513	0.6060	-0.5979	0.6060	-0.5979	0.7727	-0.4312	0.8849	-29.2	2.6369	0.29	0.34
8	1.0379	0.8484	-0.5979	0.8484	-0.5979	1.0151	-0.4312	1.1029	-23.0	2.6369	0.38	0.42
9	0.8094	-0.7272	-0.3555	-0.7272	-0.3555	-0.5605	-0.1889	0.5915	-161.4	2.6369	0.21	0.22
10	0.6012	-0.4848	-0.3555	-0.4848	-0.3555	-0.3181	-0.1889	0.3700	-149.3	2.6369	0.12	0.14
11	0.4303	-0.2424	-0.3555	-0.2424	-0.3555	-0.0757	-0.1889	0.2035	-111.9	2.6369	0.03	0.08
12	0.3555	0.0000	-0.3555	0.0000	-0.3555	0.1667	-0.1889	0.2519	-48.6	2.6369	0.06	0.10
13	0.4303	0.2424	-0.3555	0.2424	-0.3555	0.4091	-0.1889	0.4506	-24.8	2.6369	0.16	0.17
14	0.6012	0.4848	-0.3555	0.4848	-0.3555	0.6515	-0.1889	0.6783	-16.2	2.6369	0.25	0.26
15	0.8094	0.7272	-0.3555	0.7272	-0.3555	0.8939	-0.1889	0.9136	-11.9	2.6369	0.34	0.35
16	0.9262	-0.8484	0.3717	-0.8484	0.3717	-0.6817	0.5383	0.8687	141.7	2.6369	0.26	0.33
17	0.7109	-0.6060	0.3717	-0.6060	0.3717	-0.4393	0.5383	0.6949	129.2	2.6369	0.17	0.26
18	0.5199	-0.3636	0.3717	-0.3636	0.3717	-0.1969	0.5383	0.5732	110.1	2.6369	0.07	0.22
19	0.3909	-0.1212	0.3717	-0.1212	0.3717	0.0455	0.5383	0.5403	85.2	2.6369	0.02	0.20
20	0.3909	0.1212	0.3717	0.1212	0.3717	0.2879	0.5383	0.6105	61.9	2.6369	0.11	0.23
21	0.5199	0.3636	0.3717	0.3636	0.3717	0.5303	0.5383	0.7556	45.4	2.6369	0.20	0.29
22	0.7109	0.6060	0.3717	0.6060	0.3717	0.7727	0.5383	0.9417	34.9	2.6369	0.29	0.36
23	0.9262	0.8484	0.3717	0.8484	0.3717	1.0151	0.5383	1.1490	27.9	2.6369	0.38	0.44
24	0.9518	-0.7272	0.6141	-0.7272	0.6141	-0.5605	0.7807	0.9611	125.7	2.6369	0.21	0.36
25	0.7824	-0.4848	0.6141	-0.4848	0.6141	-0.3181	0.7807	0.8431	112.2	2.6369	0.12	0.32
26	0.6602	-0.2424	0.6141	-0.2424	0.6141	-0.0757	0.7807	0.7844	95.5	2.6369	0.03	0.30
27	0.6141	0.0000	0.6141	-0.0000	0.6141	0.1667	0.7807	0.7983	77.9	2.6369	0.06	0.30
28	0.6602	0.2424	0.6141	0.2424	0.6141	0.4091	0.7807	0.8814	62.3	2.6369	0.16	0.33
29	0.7824	0.4848	0.6141	0.4848	0.6141	0.6515	0.7807	1.0168	50.2	2.6369	0.25	0.39
30	0.9518	0.7272	0.6141	0.7272	0.6141	0.8939	0.7807	1.1868	41.1	2.6369	0.34	0.45

Maximale Ausnutzung der Verbindungsmittel $U_{\max} = 0.45 \leq 1 \Rightarrow$ **Nachweis erfüllt**

2.1.2. Nachweis Blockscherversagen gemäß DIN EN 1995-1-1, Anhang A, Gurt links

$L_{\text{net},t} = 140 \text{ mm}$, $t_1 = 45 \text{ mm} \Rightarrow A_{\text{net},t} = 6300 \text{ mm}^2$, $M_{y,k} = 5000.0 \text{ Nmm}$, $f_{h,k} = 17.71 \text{ N/mm}^2$

$L_{\text{net},v} = 182 \text{ mm}$, $t_{\text{ef}} = 45 \text{ mm} \Rightarrow A_{\text{net},v} = 8190 \text{ mm}^2$ (Versagensmechanismus c,f,j/l,k,m)

$L_{\text{net},v} = 182 \text{ mm} \Rightarrow A_{\text{net},v} = 8190 \text{ mm}^2 \Rightarrow F_{bs,Rk} = 137.03 \text{ kN}$

Last	N _d kN	F _{bs,Rd} kN	U _{bs} -
1	2.500	84.323	0.03

Maximale Ausnutzung Blockscherversagen $U_{\max} = 0.03 \leq 1 \Rightarrow$ **Nachweis erfüllt**

2.2. Verbindungsmittel Gurt rechts

Bauteil	a ₁ mm	a ₂ mm	a _{3t} mm	a _{4t} mm	a _{3c} mm	a _{4c} mm
Blech	14.4	14.4	7.2	7.2	7.2	7.2
Seitenholz	28.0	14.0	60.0	28.0	40.0	20.0

2.2.1. Summe M Gurte

$N_d = 5.000 \text{ kN}$, $V_d = 5.000 \text{ kN}$, $M_{v,d} = -2.000 + -0.139 \times 5.000 + -0.000 \times 5.000 = -2.697 \text{ KNm}$

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	-2.1585	1.7644	1.2435	-1.7644	-1.2435	-1.5977	-1.0768	1.9267	-146.0	2.6369	0.61	0.73
2	-1.7705	1.2603	1.2435	-1.2603	-1.2435	-1.0936	-1.0768	1.5348	-135.4	2.6369	0.41	0.58
3	-1.4553	0.7562	1.2435	-0.7562	-1.2435	-0.5895	-1.0768	1.2276	-118.7	2.6369	0.22	0.47
4	-1.2688	0.2521	1.2435	-0.2521	-1.2435	-0.0854	-1.0768	1.0802	-94.5	2.6369	0.03	0.41
5	-1.2688	-0.2521	1.2435	0.2521	-1.2435	0.4187	-1.0768	1.1554	-68.8	2.6369	0.16	0.44
6	-1.4553	-0.7562	1.2435	0.7562	-1.2435	0.9228	-1.0768	1.4181	-49.4	2.6369	0.35	0.54
7	-1.7705	-1.2603	1.2435	1.2603	-1.2435	1.4269	-1.0768	1.7877	-37.0	2.6369	0.54	0.68
8	-2.1585	-1.7644	1.2435	1.7644	-1.2435	1.9311	-1.0768	2.2110	-29.1	2.6369	0.73	0.84
9	-1.6834	1.5123	0.7394	-1.5123	-0.7394	-1.3457	-0.5727	1.4625	-156.9	2.6369	0.51	0.55
10	-1.2503	1.0082	0.7394	-1.0082	-0.7394	-0.8416	-0.5727	1.0179	-145.8	2.6369	0.32	0.39
11	-0.8949	0.5041	0.7394	-0.5041	-0.7394	-0.3374	-0.5727	0.6647	-120.5	2.6369	0.13	0.25
12	-0.7394	-0.0000	0.7394	0.0000	-0.7394	0.1667	-0.5727	0.5965	-73.8	2.6369	0.06	0.23
13	-0.8949	-0.5041	0.7394	0.5041	-0.7394	0.6708	-0.5727	0.8820	-40.5	2.6369	0.25	0.33
14	-1.2503	-1.0082	0.7394	1.0082	-0.7394	1.1749	-0.5727	1.3070	-26.0	2.6369	0.45	0.50
15	-1.6834	-1.5123	0.7394	1.5123	-0.7394	1.6790	-0.5727	1.7740	-18.8	2.6369	0.64	0.67
16	-1.9263	1.7644	-0.7730	-1.7644	0.7730	-1.5977	0.9396	1.8536	149.5	2.6369	0.61	0.70
17	-1.4784	1.2603	-0.7730	-1.2603	0.7730	-1.0936	0.9396	1.4418	139.3	2.6369	0.41	0.55
18	-1.0813	0.7562	-0.7730	-0.7562	0.7730	-0.5895	0.9396	1.1092	122.1	2.6369	0.22	0.42
19	-0.8130	0.2521	-0.7730	-0.2521	0.7730	-0.0854	0.9396	0.9435	95.2	2.6369	0.03	0.36
20	-0.8130	-0.2521	-0.7730	0.2521	0.7730	0.4187	0.9396	1.0287	66.0	2.6369	0.16	0.39
21	-1.0813	-0.7562	-0.7730	0.7562	0.7730	0.9228	0.9396	1.3170	45.5	2.6369	0.35	0.50
22	-1.4784	-1.2603	-0.7730	1.2603	0.7730	1.4269	0.9396	1.7085	33.4	2.6369	0.54	0.65
23	-1.9263	-1.7644	-0.7730	1.7644	0.7730	1.9311	0.9396	2.1475	25.9	2.6369	0.73	0.81
24	-1.9794	1.5123	-1.2771	-1.5123	1.2771	-1.3457	1.4438	1.9736	133.0	2.6369	0.51	0.75
25	-1.6271	1.0082	-1.2771	-1.0082	1.2771	-0.8416	1.4438	1.6711	120.2	2.6369	0.32	0.63
26	-1.3730	0.5041	-1.2771	-0.5041	1.2771	-0.3374	1.4438	1.4827	103.2	2.6369	0.13	0.56
27	-1.2771	-0.0000	-1.2771	-0.0000	1.2771	0.1667	1.4438	1.4533	83.4	2.6369	0.06	0.55
28	-1.3730	-0.5041	-1.2771	0.5041	1.2771	0.6708	1.4438	1.5920	65.1	2.6369	0.25	0.60
29	-1.6271	-1.0082	-1.2771	1.0082	1.2771	1.1749	1.4438	1.8614	50.9	2.6369	0.45	0.71
30	-1.9794	-1.5123	-1.2771	1.5123	1.2771	1.6790	1.4438	2.2144	40.7	2.6369	0.64	0.84

Maximale Ausnutzung der Verbindungsmittel $U_{\max} = 0.84 \leq 1 \Rightarrow$ **Nachweis erfüllt**

2.2.2. Nachweis Blockscherversagen gemäß DIN EN 1995-1-1, Anhang A, Gurt rechts

$L_{\text{net},t} = 140 \text{ mm}$, $t_1 = 60 \text{ mm} \Rightarrow A_{\text{net},t} = 8400 \text{ mm}^2$, $M_{y,k} = 5000.0 \text{ Nmm}$, $f_{h,k} = 17.71 \text{ N/mm}^2$

$L_{\text{net},v} = 182 \text{ mm}$, $t_{\text{ef}} = 60 \text{ mm} \Rightarrow A_{\text{net},v} = 10920 \text{ mm}^2$ (Versagensmechanismus c,f,j/l,k,m)

$L_{\text{net},v} = 182 \text{ mm} \Rightarrow A_{\text{net},v} = 10920 \text{ mm}^2 \Rightarrow F_{bs,Rk} = 182.70 \text{ kN}$

Last	N _d kN	F _{bs,Rd} kN	U _{bs} -
1	2.500	112.431	0.02

Maximale Ausnutzung Blockscherversagen $U_{\max} = 0.02 \leq 1 \Rightarrow$ **Nachweis erfüllt**

2.3. Ergebnisse Stäbe

2.3.1. Gurt links mit $A_n = 24000 \text{ mm}^2$, $W_n = 800000 \text{ mm}^3$, $I_n = 80000000 \text{ mm}^4$, $k_h = 1.000$

Last	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	14.77	8.92	12.92	2.46	5.000	1.297	0.21	1.62	1.62	9.772	1.22	0.13	0.50

Maximale Ausnutzung des Stabes $U_{\max} = 0.50 \leq 1 \Rightarrow$ **Nachweis erfüllt**

2.3.2. Gurt rechts mit $A_n = 24000 \text{ mm}^2$, $W_n = 800000 \text{ mm}^3$, $I_n = 80000000 \text{ mm}^4$, $k_h = 1.000$

Last	$f_{m,d}$ 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	$\sigma_{0,d}$ N/mm ²	$\sigma_{m0,d}$ N/mm ²	$\sigma_{mu,d}$ N/mm ²	V_d kN	τ_d N/mm ²	U_σ -	U_τ -
1	14.77	8.92	12.92	2.46	5.000	-2.697	0.21	-3.37	-3.37	17.623	2.20	0.20	0.89

Maximale Ausnutzung des Stabes $U_{\max} = 0.89 \leq 1 \Rightarrow$ **Nachweis erfüllt**

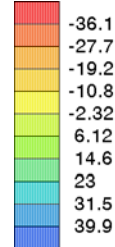
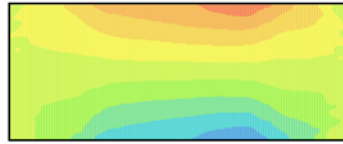
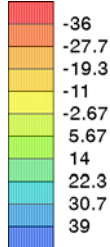
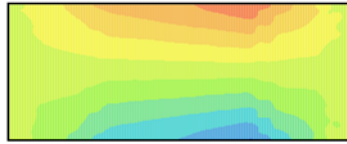
2.4. Ergebnisse Knotenblech

mit $\sigma_{v,R,k} = 250.00 \text{ N/mm}^2$, $\tau_{R,k} = 144.34 \text{ N/mm}^2$, $\gamma_{S/V} = 1.00$, $\gamma_A = 1.00$

2.4.1. Summe M Gurte

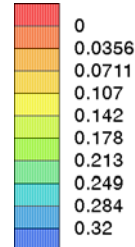
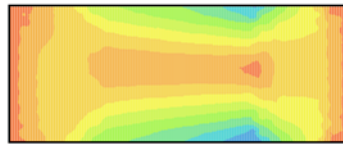
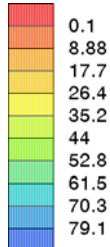
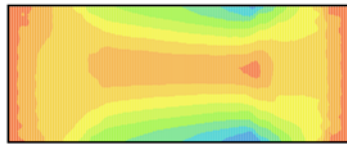
Hauptnormalspannungen σ_1 [N/mm²]
min $\sigma_1 = -35.95 \text{ N/mm}^2$, max $\sigma_1 = 39.18 \text{ N/mm}^2$

Hauptschubspannungen τ_1 [N/mm²]
min $\tau_1 = -36.06 \text{ N/mm}^2$, max $\tau_1 = 39.44 \text{ N/mm}^2$



Vergleichsspannungen σ_v [N/mm²]
min $\sigma_v = 0.07 \text{ N/mm}^2$, max $\sigma_v = 78.75 \text{ N/mm}^2$

Ausnutzung des Knotenblechs U_p
min $U_p = 0.000$, max $U_p = 0.315$



Ausnutzung des Knotenblechs

Kno	x mm	y mm	σ_1 N/mm ²	τ_1 N/mm ²	σ_v N/mm ²	U_p
147	85.6	-80.0	-35.95	-36.06	72.08	0.288
229	85.8	80.0	39.18	39.44	78.75	0.315

x,y: Knotenkoordinaten; σ, τ : Spannungen; U_p : Gesamtausnutzung des Knotenblechs

Maximale Ausnutzung des Knotenblechs $U_{\max} = 0.31 \leq 1 \Rightarrow$ **Nachweis erfüllt**

2.5. Lochleibungskräfte Gurt links

$p_1 = 50 \text{ mm}$, $e_1 = 10 \text{ mm}$, $e_2 = 10 \text{ mm}$, $p_2 = 25.00 \text{ mm}$, $\alpha_b = 1.00$, $k_1 = 2.50 \Rightarrow F_{b,Rk} = 20.63 \text{ kN}$
 $e_1 = 10 \text{ mm}$, $e_2 = 10 \text{ mm}$, $p_2 = 25 \text{ mm}$, $\alpha_b = 0.56$, $k_1 = 2.50 \Rightarrow F_{b,Rk,Rand} = 11.46 \text{ kN}$

2.5.1. Summe M Gurte

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	0.40	9.17	0.04	11	0.10	16.50	0.01	21	0.38	16.50	0.02
2	0.31	9.17	0.03	12	0.13	16.50	0.01	22	0.47	16.50	0.03
3	0.24	9.17	0.03	13	0.23	16.50	0.01	23	0.57	9.17	0.06
4	0.22	9.17	0.02	14	0.34	16.50	0.02	24	0.48	9.17	0.05
5	0.26	9.17	0.03	15	0.46	16.50	0.03	25	0.42	16.50	0.03
6	0.34	9.17	0.04	16	0.43	9.17	0.05	26	0.39	16.50	0.02
7	0.44	9.17	0.05	17	0.35	16.50	0.02	27	0.40	16.50	0.02
8	0.55	9.17	0.06	18	0.29	16.50	0.02	28	0.44	16.50	0.03
9	0.30	9.17	0.03	19	0.27	16.50	0.02	29	0.51	16.50	0.03
10	0.18	16.50	0.01	20	0.31	16.50	0.02	30	0.59	16.50	0.04

Maximale Ausnutzung der Lochleibungskräfte $U_{\max} = 0.06 \leq 1 \Rightarrow$ **Nachweis erfüllt**

2.6. Lochleibungskräfte Gurt rechts

$p_1 = 50 \text{ mm}$, $e_1 = 10 \text{ mm}$, $e_2 = 10 \text{ mm}$, $p_2 = 25.00 \text{ mm}$, $\alpha_b = 1.00$, $k_1 = 2.50 \Rightarrow F_{b,Rk} = 20.63 \text{ kN}$
 $e_1 = 10 \text{ mm}$, $e_2 = 10 \text{ mm}$, $p_2 = 25 \text{ mm}$, $\alpha_b = 0.56$, $k_1 = 2.50 \Rightarrow F_{b,Rk,Rand} = 11.46 \text{ kN}$

2.6.1. Summe M Gurte

Nr	F _{tot,i} kN	F _{v,Rd} kN	U -	Nr	F _{tot,i} kN	F _{v,Rd} kN	U -	Nr	F _{tot,i} kN	F _{v,Rd} kN	U -
1	0.96	9.17	0.11	11	0.33	16.50	0.02	21	0.66	16.50	0.04
2	0.77	16.50	0.05	12	0.30	16.50	0.02	22	0.85	16.50	0.05
3	0.61	16.50	0.04	13	0.44	16.50	0.03	23	1.07	9.17	0.12
4	0.54	16.50	0.03	14	0.65	16.50	0.04	24	0.99	9.17	0.11
5	0.58	16.50	0.04	15	0.89	16.50	0.05	25	0.84	16.50	0.05
6	0.71	16.50	0.04	16	0.93	9.17	0.10	26	0.74	16.50	0.04
7	0.89	16.50	0.05	17	0.72	16.50	0.04	27	0.73	16.50	0.04
8	1.11	9.17	0.12	18	0.55	16.50	0.03	28	0.80	16.50	0.05
9	0.73	9.17	0.08	19	0.47	16.50	0.03	29	0.93	16.50	0.06
10	0.51	16.50	0.03	20	0.51	16.50	0.03	30	1.11	16.50	0.07

Maximale Ausnutzung der Lochleibungskräfte $U_{\max} = 0.12 \leq 1 \Rightarrow$ **Nachweis erfüllt**

3. Zusammenfassung

Gesamtausnutzung aller Nachweise $U_{\max, \text{Ges}} = 0.895 \leq 1 \Rightarrow$ **ok.**