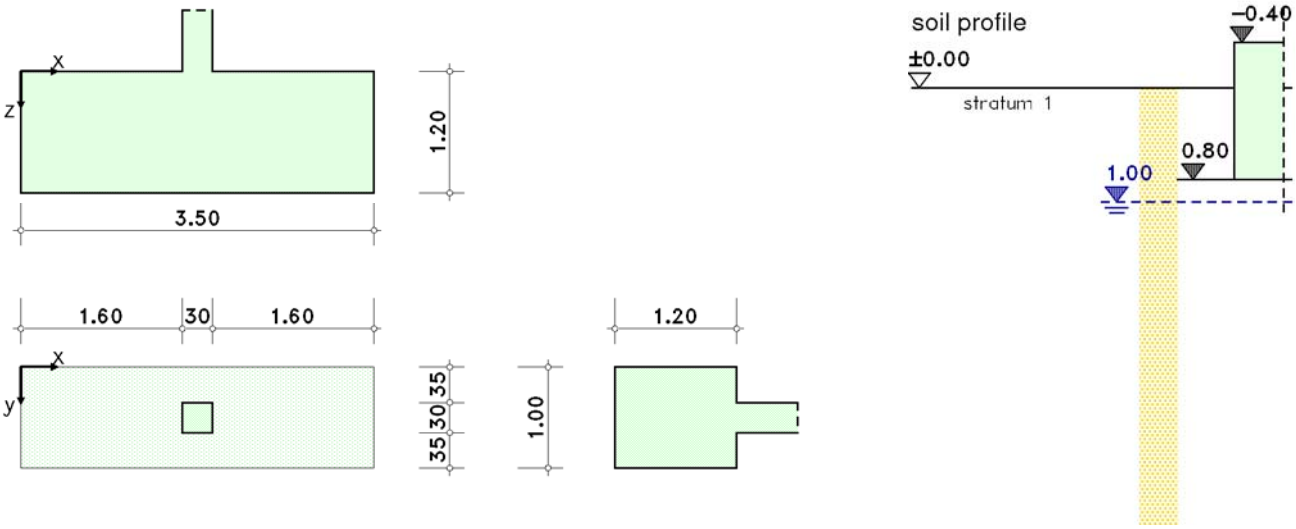
4H-FUND version: 12/2022-1a

isolated foundation

reinf. concr. design acc. to DIN EN 1992-1-1:2011-01 with NA-Deutschland(DIN EN 1992-1-1/NA:2013-04)
external stability acc. to DIN EN 1997-1:2014-03 with NA-Deutschland
additional rules acc. to DIN 1054:2021-04 , DIN 4017:2006-03 and DIN 4019:2015-05

scale 1:75



concrete strength class C30/37
steel class B500A

1. soil situation

the anchoring depth of the foundation is t = 0.80 m.
the ground water level (below top edge soil) is at t_w = 1.00 m.

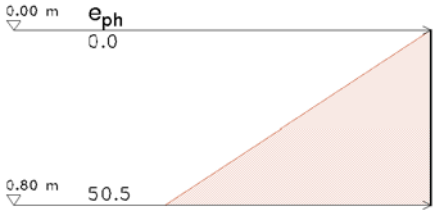
1.1. designation and characteristic values of soil strata

stratum	z m	γ kN/m³	γ' kN/m³	φ °	c_k kN/m²	E_m MN/m²	δ_p °
stratum 1	0.00	19.00	11.00	32.5	---	10.00	auto

z - levelan top edge der stratum γ - unit weight γ' - unit weight of submerged soil φ - friction angle
c_k - char. cohesion of the dained soil E_m - mean compression modulus δ_p - angle of wall friction on the passive side

1.2. char. passive earth pressure

Der passive earth pressure wird for ebene Gleitflächen ermittelt.
angle of wall friction $\delta = 0.00 \cdot \varphi'_k$



$\Sigma(\gamma \cdot h)$ Summe soilgewicht in der betrachteten Tiefe
K_{pgh} coeff. of earth pressure acc. to [1] clause 6.2.1, Gl.(7) (formulation acc. to Müller-Breslau)
e_{ph} horiz. Erddruckordinate

z m	$\Sigma(\gamma \cdot h)$ kN/m²	K_{pgh} -	e_{ph} kN/m²
0.00	0.00	3.322	0.00
0.80	15.20	3.322	50.50

the resultant maximum passive earth pressure is E_{phg} = 20.20 kN/m, at z_s = 0.53 m.

2. loading

2.1. Structure of action effects

On the left-hand side, the action effects and load cases are shown in a tree structure. The right-hand side shows their characteristics of the superposition.

used symbols: action load case

1: permanent loads	**permanent loads**
1: Ständig	additive

On the left-hand side, the action effects and load cases are shown in a tree structure. The right-hand side shows their characteristics of the superposition.

2: live loads	**other transient action effects**
4: Nutzlast	additive
3: wind loads	**transient wind loads**
7: wind +x-direction	alternative in group A
8: wind -x-direction	alternative in group A
4: snowlast	**transient snow loads**
9: snow	additive

2.2. snow Norddeutsches Tiefland

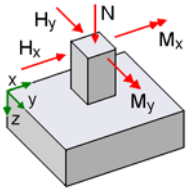
Der load case 9 wird entprechend [2], NDP zu 4.3(1), alternative auch als außergewöhnliche action berücksichtigt

2.3. Design calculation situation of load cases for external stability

loadc.	notation	BS-P	BS-T
1	Ständig	x	
4	Nutzlast	x	
7	wind +x-direction	x	
8	wind -x-direction	x	
9	snow	x	

2.4. Characteristic column load

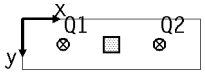
point of application in column centroid auf top edge foundation slab



loadc.	Nst kN	Hx,st kN	Hy,st kN	Mx,st kNm	My,st kNm
1	200.00	0.00	0.00	0.00	0.00
4	100.00	0.00	0.00	0.00	25.00
7	0.00	36.00	0.00	0.00	-30.00
8	0.00	-36.00	0.00	0.00	30.00
9	80.00	0.00	0.00	0.00	25.00

2.5. additional point and line loads

load case 4: Nutzlast

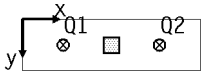


point loads

Nr	x cm	y cm	Qv kN	Qx kN	Qy kN	Mx kNm	My kNm
1	80.0	50.0	-1.00	0.00	0.00	0.00	0.00
2	270.0	50.0	5.00	0.00	0.00	0.00	0.00

2.6. additional point and line loads

load case 7: wind +x-direction

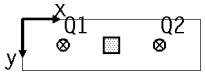


point loads

Nr	x cm	y cm	Qv kN	Qx kN	Qy kN	Mx kNm	My kNm
1	80.0	50.0	-27.00	0.00	0.00	0.00	0.00
2	270.0	50.0	27.00	0.00	0.00	0.00	0.00

2.7. additional point and line loads

load case 8: wind -x-direction



point loads

Nr	x cm	y cm	Qv kN	Qx kN	Qy kN	Mx kNm	My kNm
1	80.0	50.0	27.00	0.00	0.00	0.00	0.00
2	270.0	50.0	-27.00	0.00	0.00	0.00	0.00

2.8. Einschränkungen for die loadkombination

- mindestens **ein load case der führenden action muß ungünstig wirken.**
- Folgende loadfälle wirken **immer ungünstig: 1**

2.9. dead load

Das Gewicht der foundation slab wird with γ_E = 25.00 kN/m³ berücksichtigt.
no earth load in action.

the resultant of dead load in the floor joint is $N_{0,deadl,k}$ = 105.00 kN.

Das dead load wird im load case 1 with berücksichtigt.

3. design calculation of foundation slab

3.1. partial safety factors for material

design situat.	γ_c	γ_s
permanent and transient	1.50	1.15
außergewöhnlich	1.30	1.00

3.2. design values of reinforced concrete design

Die Mobilisierung des passive earth pressurees wird vernachlässigt.

3.2.1. factorization of load case combinations

LK	design situat.	factorization
1	permanent and transient	1.35·Lf1+1.5·Lf4
2	permanent and transient	1.35·Lf1+1.5·Lf4+0.6·1.5·Lf7
3	permanent and transient	1.35·Lf1+1.5·Lf4+0.5·1.5·Lf9
4	permanent and transient	1.35·Lf1+1.5·Lf4+0.6·1.5·Lf7+0.5·1.5·Lf9
5	permanent and transient	1.35·Lf1+1.5·Lf4+0.6·1.5·Lf8
6	permanent and transient	1.35·Lf1+1.5·Lf4+0.6·1.5·Lf8+0.5·1.5·Lf9
7	permanent and transient	1.35·Lf1+1.5·Lf7
8	permanent and transient	1.35·Lf1+0.8·1.5·Lf4+1.5·Lf7
9	permanent and transient	1.35·Lf1+1.5·Lf7+0.5·1.5·Lf9
10	permanent and transient	1.35·Lf1+0.8·1.5·Lf4+1.5·Lf7+0.5·1.5·Lf9
11	permanent and transient	1.35·Lf1+1.5·Lf8
12	permanent and transient	1.35·Lf1+0.8·1.5·Lf4+1.5·Lf8
13	permanent and transient	1.35·Lf1+1.5·Lf8+0.5·1.5·Lf9
14	permanent and transient	1.35·Lf1+0.8·1.5·Lf4+1.5·Lf8+0.5·1.5·Lf9
15	permanent and transient	1.35·Lf1+1.5·Lf9
16	permanent and transient	1.35·Lf1+0.8·1.5·Lf4+1.5·Lf9
17	permanent and transient	1.35·Lf1+0.6·1.5·Lf7+1.5·Lf9
18	permanent and transient	1.35·Lf1+0.8·1.5·Lf4+0.6·1.5·Lf7+1.5·Lf9
19	permanent and transient	1.35·Lf1+0.6·1.5·Lf8+1.5·Lf9
20	permanent and transient	1.35·Lf1+0.8·1.5·Lf4+0.6·1.5·Lf8+1.5·Lf9
21	außergewöhnlich	Lf1+0.7·Lf4+2.3·Lf9
22	außergewöhnlich	Lf1+0.2·Lf7+2.3·Lf9
23	außergewöhnlich	Lf1+0.5·Lf4+0.2·Lf7+2.3·Lf9
24	außergewöhnlich	Lf1+0.2·Lf8+2.3·Lf9
25	außergewöhnlich	Lf1+0.5·Lf4+0.2·Lf8+2.3·Lf9
26	außergewöhnlich	Lf1+2.3·Lf9
27	außergewöhnlich	Lf1+0.5·Lf4+2.3·Lf9

3.2.2. column load

increasing factor for flex. mom.: $\Delta M_{St,TH.II.O} = M_{St} \cdot$ **20%**
(for the consideration of increase of moments from non-linear effects)

LK	$N_{St,d}$ kN	$H_{x,St,d}$ kN	$H_{y,St,d}$ kN	$M_{x,St,d}$ kNm	$M_{y,St,d}$ kNm
1	420.00	0.00	0.00	0.00	45.00
2	420.00	32.40	0.00	0.00	12.60
3	480.00	0.00	0.00	0.00	67.50
4	480.00	32.40	0.00	0.00	35.10
5	420.00	-32.40	0.00	0.00	77.40
6	480.00	-32.40	0.00	0.00	99.90
7	270.00	54.00	0.00	0.00	-54.00
8	390.00	54.00	0.00	0.00	-18.00
9	330.00	54.00	0.00	0.00	-31.50
10	450.00	54.00	0.00	0.00	4.50
11	270.00	-54.00	0.00	0.00	54.00
12	390.00	-54.00	0.00	0.00	90.00
13	330.00	-54.00	0.00	0.00	76.50
14	450.00	-54.00	0.00	0.00	112.50

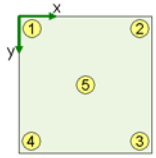
LK	$N_{St,d}$ kN	$H_{x,St,d}$ kN	$H_{y,St,d}$ kN	$M_{x,St,d}$ kNm	$M_{y,St,d}$ kNm
15	390.00	0.00	0.00	0.00	45.00
16	510.00	0.00	0.00	0.00	81.00
17	390.00	32.40	0.00	0.00	12.60
18	510.00	32.40	0.00	0.00	48.60
19	390.00	-32.40	0.00	0.00	77.40
20	510.00	-32.40	0.00	0.00	113.40
21	454.00	0.00	0.00	0.00	90.00
22	384.00	7.20	0.00	0.00	61.80
23	434.00	7.20	0.00	0.00	76.80
24	384.00	-7.20	0.00	0.00	76.20
25	434.00	-7.20	0.00	0.00	91.20
26	384.00	0.00	0.00	0.00	69.00
27	434.00	0.00	0.00	0.00	84.00

3.2.3. point loads

LK	x	y	N,d,z	Q,d,x	Q,d,y	M,d,x	M,d,y
-	cm	cm	kN	kN	kN	kNm	kNm
1	80.0	50.0	-1.50	0.00	0.00	0.00	0.00
1	270.0	50.0	7.50	0.00	0.00	0.00	0.00
2	80.0	50.0	-25.80	0.00	0.00	0.00	0.00
2	270.0	50.0	31.80	0.00	0.00	0.00	0.00
3	80.0	50.0	-1.50	0.00	0.00	0.00	0.00
3	270.0	50.0	7.50	0.00	0.00	0.00	0.00
4	80.0	50.0	-25.80	0.00	0.00	0.00	0.00
4	270.0	50.0	31.80	0.00	0.00	0.00	0.00
5	80.0	50.0	22.80	0.00	0.00	0.00	0.00
5	270.0	50.0	-16.80	0.00	0.00	0.00	0.00
6	80.0	50.0	22.80	0.00	0.00	0.00	0.00
6	270.0	50.0	-16.80	0.00	0.00	0.00	0.00
7	80.0	50.0	-40.50	0.00	0.00	0.00	0.00
7	270.0	50.0	40.50	0.00	0.00	0.00	0.00
8	80.0	50.0	-41.70	0.00	0.00	0.00	0.00
8	270.0	50.0	46.50	0.00	0.00	0.00	0.00
9	80.0	50.0	-40.50	0.00	0.00	0.00	0.00
9	270.0	50.0	40.50	0.00	0.00	0.00	0.00
10	80.0	50.0	-41.70	0.00	0.00	0.00	0.00
10	270.0	50.0	46.50	0.00	0.00	0.00	0.00
11	80.0	50.0	40.50	0.00	0.00	0.00	0.00
11	270.0	50.0	-40.50	0.00	0.00	0.00	0.00
12	80.0	50.0	39.30	0.00	0.00	0.00	0.00
12	270.0	50.0	-34.50	0.00	0.00	0.00	0.00
13	80.0	50.0	40.50	0.00	0.00	0.00	0.00
13	270.0	50.0	-40.50	0.00	0.00	0.00	0.00
14	80.0	50.0	39.30	0.00	0.00	0.00	0.00
14	270.0	50.0	-34.50	0.00	0.00	0.00	0.00
16	80.0	50.0	-1.20	0.00	0.00	0.00	0.00
16	270.0	50.0	6.00	0.00	0.00	0.00	0.00
17	80.0	50.0	-24.30	0.00	0.00	0.00	0.00
17	270.0	50.0	24.30	0.00	0.00	0.00	0.00
18	80.0	50.0	-25.50	0.00	0.00	0.00	0.00
18	270.0	50.0	30.30	0.00	0.00	0.00	0.00
19	80.0	50.0	24.30	0.00	0.00	0.00	0.00
19	270.0	50.0	-24.30	0.00	0.00	0.00	0.00
20	80.0	50.0	23.10	0.00	0.00	0.00	0.00
20	270.0	50.0	-18.30	0.00	0.00	0.00	0.00
21	80.0	50.0	-0.70	0.00	0.00	0.00	0.00
21	270.0	50.0	3.50	0.00	0.00	0.00	0.00
22	80.0	50.0	-5.40	0.00	0.00	0.00	0.00
22	270.0	50.0	5.40	0.00	0.00	0.00	0.00
23	80.0	50.0	-5.90	0.00	0.00	0.00	0.00
23	270.0	50.0	7.90	0.00	0.00	0.00	0.00
24	80.0	50.0	5.40	0.00	0.00	0.00	0.00
24	270.0	50.0	-5.40	0.00	0.00	0.00	0.00
25	80.0	50.0	4.90	0.00	0.00	0.00	0.00
25	270.0	50.0	-2.90	0.00	0.00	0.00	0.00
27	80.0	50.0	-0.50	0.00	0.00	0.00	0.00
27	270.0	50.0	2.50	0.00	0.00	0.00	0.00

3.3. base pressure

determination of base pressures assuming linear soil stresses and elimination of tension
stress in the corner points: σ_1 to σ_4, stress in centroid: σ_5



LK	σ1	σ2	σ3	σ4	σ5
	kN/m²	kN/m²	kN/m²	kN/m²	kN/m²
1	180.07	144.36	144.36	180.07	162.21
2	122.54	201.89	201.89	122.54	162.21
3	208.23	150.48	150.48	208.23	179.36
4	150.70	208.01	208.01	150.70	179.36
5	237.59	86.83	86.83	237.59	162.21
6	265.76	92.96	92.96	265.76	179.36
7	21.77	213.52	213.52	21.77	117.64
8	71.70	234.90	234.90	71.70	153.30
9	49.93	219.64	219.64	49.93	134.79
10	99.87	241.02	241.02	99.87	170.44
11	213.52	21.77	21.77	213.52	117.64
12	263.46	43.14	43.14	263.46	153.30
13	241.68	27.89	27.89	241.68	134.79
14	291.62	49.26	49.26	**291.62**	170.44

LK	σ1 kN/m²	σ2 kN/m²	σ3 kN/m²	σ4 kN/m²	σ5 kN/m²
15	173.97	129.89	129.89	173.97	151.93
16	223.91	151.26	151.26	223.91	187.59
17	116.44	187.41	187.41	116.44	151.93
18	166.38	208.79	208.79	166.38	187.59
19	231.50	72.36	72.36	231.50	151.93
20	281.44	93.74	93.74	281.44	187.59
21	202.64	118.39	118.39	202.64	160.51
22	160.73	118.70	118.70	160.73	139.71
23	181.53	127.61	127.61	181.53	154.57
24	186.29	93.13	93.13	186.29	139.71
25	207.10	102.04	102.04	207.10	154.57
26	173.51	105.92	105.92	173.51	139.71
27	194.32	114.82	114.82	194.32	154.57

3.4. Design calculation for bending

3.4.1. longitudinal reinforcement in x-direction

reinforcement edge distance top/bottom h_{so}/h_{su} = 7.0/7.0 cm

moments in design calculation sections

LK	x = 175.0 cm 1) kNm	x = 80.0 cm kNm	x = 270.0 cm kNm	LK	x = 175.0 cm 1) kNm	x = 80.0 cm kNm	x = 270.0 cm kNm
1	190.28	43.79	34.11	15	178.50	41.64	29.68
2	180.89	28.19	49.71	16	244.32	56.92	37.22
3	225.53	52.27	36.60	17	169.12	26.03	45.28
4	193.64	36.66	52.21	18	208.68	41.32	52.82
5	225.92	59.39	18.50	19	214.14	57.24	14.08
6	261.17	67.87	21.00	20	**279.96**	72.52	21.61
7	167.38	-1.32	50.69	21	226.49	53.19	30.34
8	197.20	13.96	58.23	22	180.18	40.81	29.41
9	180.13	7.15	53.19	23	207.60	47.18	32.55
10	209.95	22.44	60.72	24	196.02	47.74	22.47
11	167.40	50.69	**-1.32**	25	223.44	54.11	25.61
12	233.22	65.98	6.22	26	188.10	44.28	25.94
13	202.65	59.17	1.18	27	215.52	50.64	29.08
14	268.47	74.45	8.71				

1) rounded moment below column centre

Design calculation for LK 7: $\varepsilon_o/\varepsilon_u$ = 26.55/-0.06‰ **min $A_{s,o}$ = 0.0 cm²**

Design calculation for LK 20: $\varepsilon_o/\varepsilon_u$ = -0.89/26.60‰ **min $A_{s,u}$ = 5.5 cm²**

3.4.2. longitudinal reinforcement in y-direction

reinforcement edge distance top/bottom h_{so}/h_{su} = 5.0/5.0 cm

moments in design calculation sections

LK	y = 50.0 cm 1) kNm	LK	y = 50.0 cm 1) kNm	LK	y = 50.0 cm 1) kNm	LK	y = 50.0 cm 1) kNm
1	37.50	8	34.73	15	34.13	22	33.60
2	37.50	9	28.88	16	**45.23**	23	38.22
3	42.75	10	39.98	17	34.13	24	33.60
4	42.75	11	23.63	18	45.23	25	38.22
5	37.50	12	34.73	19	34.13	26	33.60
6	42.75	13	28.88	20	45.22	27	38.22
7	23.62	14	39.98	21	40.08		

1) rounded moment below column centre

Design calculation for LK 16: $\varepsilon_o/\varepsilon_u$ = -0.17/26.09‰ **min $A_{s,u}$ = 0.9 cm²**

3.4.3. selected reinforcement in x-direction

top B500A, gleichmäßig zu verteilen
1 Ø 12 = 1.1 cm² (non-structurally reinforced)

bottom B500A, gleichmäßig zu verteilen
20 Ø 12 = 22.6 > 5.5 cm²

3.4.4. selected reinforcement in y-direction

bottom B500A, gleichmäßig zu verteilen
6 Ø 12 = 6.8 > 0.9 cm²

$\varepsilon_o/\varepsilon_u$ - strains in extreme fibres (top/bottom)

3.5. punching shear calculation

3.5.1. action within the basic control perimeter

$v_{Ed,crit} = \beta \cdot V_{Ed,red} / (u_{crit} \cdot d)$
$V_{Ed,red} = V_{Ed} - \Delta V_{Ed}$
$\Delta V_{Ed} = A_{crit} (\sigma_{Ed,gd,m} - g_{Ed,slab})$
$\beta = 1 + k \cdot M_{Ed} / V_{Ed} \cdot u_{crit} / W_{crit} \geq 1.10$
$W_{crit} = \int |e| \, dl$ mit dl: differential of perimeter
e : distance of dl to axis of M_{Ed}

coefficient for the calculation of shear stresses from moment action
(acc. to [3], table 6.1)
$c_1 = c_2 = 0.3 \Rightarrow k_x = k_y = 0.6$

calculated values of basic control perimeter

LK	a_{crit} cm	a/d -	u_{crit} m	A_{crit} m²	$W_{crit,y}$ m²	LK	a_{crit} cm	a/d -	u_{crit} m	A_{crit} m²	$W_{crit,y}$ m²
1	27.9	0.25	2.95	0.670	0.8778	15	27.9	0.25	2.95	0.670	0.8778
2	31.4	0.28	3.17	0.775	1.0117	16	26.8	0.23	2.88	0.637	0.8353
3	26.8	0.23	2.88	0.637	0.8353	17	31.9	0.28	3.21	0.793	1.0349
4	29.1	0.25	3.03	0.704	0.9214	18	28.5	0.25	2.99	0.687	0.8995
5	25.6	0.22	2.81	0.604	0.7938	19	25.6	0.22	2.81	0.604	0.7938
6	25.6	0.22	2.81	0.604	0.7938	20	25.1	0.22	2.78	0.589	0.7735
7	25.6	0.22	2.81	0.604	0.7938	21	25.6	0.22	2.81	0.604	0.7938
8	31.4	0.28	3.17	0.775	1.0117	22	26.8	0.23	2.88	0.637	0.8353
9	28.5	0.25	2.99	0.687	0.8995	23	26.2	0.23	2.85	0.621	0.8144
10	31.4	0.28	3.17	0.775	1.0117	24	25.6	0.22	2.81	0.604	0.7938
11	25.6	0.22	2.81	0.604	0.7938	25	25.6	0.22	2.81	0.604	0.7938
12	25.1	0.22	2.78	0.589	0.7735	26	26.2	0.23	2.85	0.621	0.8144
13	25.1	0.22	2.78	0.589	0.7735	27	25.6	0.22	2.81	0.604	0.7938
14	24.5	0.22	2.74	0.573	0.7534						

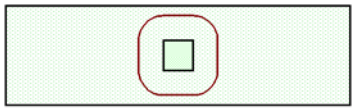
decisive shear stress within the basic control perimeter

LK	V_{Ed} kN	$\sigma_{Ed,gd,m}$ kN/m²	ΔV_{Ed} kN	$M_{Ed,y,Sp}$ kNm	β -	$v_{Ed,crit}$ N/mm²
1	420.00	121.80	81.64	-45.00	1.22	0.122
2	420.00	121.80	94.39	-12.60	1.10	0.099
3	480.00	138.96	88.51	-67.50	1.29	0.154
4	480.00	138.96	97.87	-35.10	1.14	0.127
5	420.00	121.81	73.63	-77.40	1.39	0.150
6	480.00	138.96	84.00	-99.90	1.44	0.178
7	270.00	77.21	46.67	54.00	1.43	0.099
8	390.00	112.88	87.48	18.00	1.10	0.092
9	330.00	94.36	64.84	31.50	1.19	0.093
10	450.00	130.03	100.77	-4.50	1.10	0.106
11	270.00	77.21	46.67	-54.00	1.43	0.099
12	390.00	112.89	66.44	-90.00	1.50	0.153
13	330.00	94.36	55.54	-76.50	1.50	0.130
14	450.00	130.04	74.50	-112.50	1.55	0.186
15	390.00	111.51	74.74	-45.00	1.23	0.115
16	510.00	147.19	93.76	-81.00	1.33	0.168
17	390.00	111.51	88.44	-12.60	1.10	0.091
18	510.00	147.19	101.15	-48.60	1.19	0.143
19	390.00	111.52	67.41	-77.40	1.42	0.143
20	510.00	147.20	86.64	-113.40	1.48	0.198
21	454.00	130.61	78.95	-90.00	1.42	0.166
22	384.00	109.80	69.94	-61.80	1.33	0.127
23	434.00	124.67	77.37	-76.80	1.37	0.151
24	384.00	109.80	66.37	-76.20	1.42	0.141
25	434.00	124.67	75.36	-91.20	1.45	0.162
26	384.00	109.80	68.14	-69.00	1.38	0.134
27	434.00	124.67	75.36	-84.00	1.41	0.158

ΔV_{Ed} - resultant of ground pressure $M_{Ed,x,Sp}/M_{Ed,y,Sp}$ - moments concerning centre of control perimeter
β - load increase factor from eccentric load $v_{Ed,crit}$ - decisive shear stress within the basic control perimeter

3.5.2. Punching shear resistance within the basic control perimeter

$v_{Rd,c} = C_{Rd,c} \cdot k \cdot (100 \cdot \rho_{l,tension} \cdot f_{ck})^{1/3} \cdot 2 \cdot d/a \geq v_{min} \cdot 2 \cdot d/a$ [N/mm²]
$C_{Rd,c} = 0.15/\gamma_c$
$k = 1 + \text{sqrt}(200/d) \leq 2.0$ with d [mm]
$\rho_{l,tension,max}$ = minimum from (0.02, $0.5 \cdot f_{cd}/f_{yd}$)
$\rho_{l,tension} = \text{sqrt}(\rho_{lx,tension} \cdot \rho_{ly,tension}) \leq \rho_{l,tension,max}$
$v_{min} = 0.0375/\gamma_c \cdot k^{3/2} \cdot f_{ck}^{1/2}$ for d ≥ 800 mm



mean effective depth

$d_m = (113 + 115)/2 = 114$ cm

scale factor

$k = 1 + \text{sqrt}(200/1140) = 1.42 < 2$

longitudinal reinf. ratio of the anchored tension reinf.

mean of the tension reinforcement to the distance 3d from the column

$a_{s,x,3d} = 22.6/1 = 22.62$ cm²/m
$a_{s,y,3d} = 6.8/3.5 = 1.94$ cm²/m
$\rho_{lx,tension} = 22.62/113 \cdot 10^{-2} = 0.002$
$\rho_{ly,tension} = 1.94/115 \cdot 10^{-2} = 0.00017$
$\rho_{l,tension} = \text{sqrt}(0.002 \cdot 0.00017) = 0.00058$

3.5.2.1. Permanent and transient design situation (LK 20)

$C_{Rd,c} = 0.15/1.5 = 0.1$
$\rho_{l,tension,max}$ = minimum from (0.02, $0.5 \cdot 17/434.78$) = 0.0195 > 0.0006
$v_{min} \cdot 2 \cdot d/a = 0.0375/1.5 \cdot 1.42^{3/2} \cdot 30^{0.5} \cdot 2 \cdot 114/25.1 = 2.104$ N/mm²
$v_{Rd,c} = 0.1 \cdot 1.42 \cdot (100 \cdot 0.00058 \cdot 30)^{1/3} \cdot 2 \cdot 114/25.1 = 1.552$ N/mm² < 2.104 N/mm² ⇒ $v_{Rd,c} = 2.104$ N/mm²

0.198 N/mm² < 2.104 N/mm² ⇒ no additional reinforcement required

3.5.2.2. Accidental design situation (LK 21)

$C_{Rd,c} = 0.15/1.3 = 0.115$
$\rho_{l,tension,max}$ = minimum from (0.02, $0.5 \cdot 19.62/500$) = 0.0196 > 0.0006
$v_{min} \cdot 2 \cdot d/a = 0.0375/1.3 \cdot 1.42^{3/2} \cdot 30^{0.5} \cdot 2 \cdot 114/25.7 = 2.374$ N/mm²
$v_{Rd,c} = 0.115 \cdot 1.42 \cdot (100 \cdot 0.00058 \cdot 30)^{1/3} \cdot 2 \cdot 114/25.7 = 1.751$ N/mm² < 2.374 N/mm² ⇒ $v_{Rd,c} = 2.374$ N/mm²

0.166 N/mm² < 2.374 N/mm² ⇒ no additional reinforcement required

4. External stability - verification of design resistance (ULS)

4.1. partial safety factors auf der actionsseite

acc. to [4] table A 2.1

4.2. partial safety factors auf der resistance side

acc. to [4] tables A 2.2 and A 2.3

4.3. design values overturning (EQU)

Die Mobilisierung des passive earth pressurees wird vernachlässigt.

4.3.1. factorization of load case combinations

LK	design situat.	factorization
1	BS-P	1.1 Lf1+1.5 Lf4
2	BS-P	1.1 Lf1+1.5 Lf4+0.6 1.5 Lf7
3	BS-P	1.1 Lf1+1.5 Lf4+0.5 1.5 Lf9
4	BS-P	1.1 Lf1+1.5 Lf4+0.6 1.5 Lf7+0.5 1.5 Lf9
5	BS-P	1.1 Lf1+1.5 Lf4+0.6 1.5 Lf8
6	BS-P	1.1 Lf1+1.5 Lf4+0.6 1.5 Lf8+0.5 1.5 Lf9
7	BS-P	1.1 Lf1+1.5 Lf7
8	BS-P	1.1 Lf1+0.8 1.5 Lf4+1.5 Lf7
9	BS-P	1.1 Lf1+1.5 Lf7+0.5 1.5 Lf9
10	BS-P	1.1 Lf1+0.8 1.5 Lf4+1.5 Lf7+0.5 1.5 Lf9
11	BS-P	1.1 Lf1+1.5 Lf8
12	BS-P	1.1 Lf1+0.8 1.5 Lf4+1.5 Lf8
13	BS-P	1.1 Lf1+1.5 Lf8+0.5 1.5 Lf9
14	BS-P	1.1 Lf1+0.8 1.5 Lf4+1.5 Lf8+0.5 1.5 Lf9
15	BS-P	1.1 Lf1+1.5 Lf9
16	BS-P	1.1 Lf1+0.8 1.5 Lf4+1.5 Lf9
17	BS-P	1.1 Lf1+0.6 1.5 Lf7+1.5 Lf9
18	BS-P	1.1 Lf1+0.8 1.5 Lf4+0.6 1.5 Lf7+1.5 Lf9
19	BS-P	1.1 Lf1+0.6 1.5 Lf8+1.5 Lf9
20	BS-P	1.1 Lf1+0.8 1.5 Lf4+0.6 1.5 Lf8+1.5 Lf9
21	BS-A	2.3 Lf9

4.3.2. column load

LK	$N_{St,d}$ kN	$H_{x,St,d}$ kN	$H_{y,St,d}$ kN	$M_{x,St,d}$ kNm	$M_{y,St,d}$ kNm
1	370.00	0.00	0.00	0.00	37.50
2	370.00	32.40	0.00	0.00	10.50
3	430.00	0.00	0.00	0.00	56.25
4	430.00	32.40	0.00	0.00	29.25
5	370.00	-32.40	0.00	0.00	64.50
6	430.00	-32.40	0.00	0.00	83.25
7	220.00	54.00	0.00	0.00	-45.00
8	340.00	54.00	0.00	0.00	-15.00
9	280.00	54.00	0.00	0.00	-26.25
10	400.00	54.00	0.00	0.00	3.75
11	220.00	-54.00	0.00	0.00	45.00
12	340.00	-54.00	0.00	0.00	75.00
13	280.00	-54.00	0.00	0.00	63.75
14	400.00	-54.00	0.00	0.00	93.75
15	340.00	0.00	0.00	0.00	37.50
16	460.00	0.00	0.00	0.00	67.50
17	340.00	32.40	0.00	0.00	10.50
18	460.00	32.40	0.00	0.00	40.50
19	340.00	-32.40	0.00	0.00	64.50
20	460.00	-32.40	0.00	0.00	94.50
21	184.00	0.00	0.00	0.00	57.50

4.3.3. point loads

LK	x	y	N,d,z	Q,d,x	Q,d,y	M,d,x	M,d,y
-	cm	cm	kN	kN	kN	kNm	kNm
1	80.0	50.0	-1.50	0.00	0.00	0.00	0.00
1	270.0	50.0	7.50	0.00	0.00	0.00	0.00
2	80.0	50.0	-25.80	0.00	0.00	0.00	0.00
2	270.0	50.0	31.80	0.00	0.00	0.00	0.00
3	80.0	50.0	-1.50	0.00	0.00	0.00	0.00
3	270.0	50.0	7.50	0.00	0.00	0.00	0.00
4	80.0	50.0	-25.80	0.00	0.00	0.00	0.00
4	270.0	50.0	31.80	0.00	0.00	0.00	0.00
5	80.0	50.0	22.80	0.00	0.00	0.00	0.00
5	270.0	50.0	-16.80	0.00	0.00	0.00	0.00
6	80.0	50.0	22.80	0.00	0.00	0.00	0.00
6	270.0	50.0	-16.80	0.00	0.00	0.00	0.00
7	80.0	50.0	-40.50	0.00	0.00	0.00	0.00
7	270.0	50.0	40.50	0.00	0.00	0.00	0.00
8	80.0	50.0	-41.70	0.00	0.00	0.00	0.00
8	270.0	50.0	46.50	0.00	0.00	0.00	0.00
9	80.0	50.0	-40.50	0.00	0.00	0.00	0.00
9	270.0	50.0	40.50	0.00	0.00	0.00	0.00
10	80.0	50.0	-41.70	0.00	0.00	0.00	0.00
10	270.0	50.0	46.50	0.00	0.00	0.00	0.00
11	80.0	50.0	40.50	0.00	0.00	0.00	0.00
11	270.0	50.0	-40.50	0.00	0.00	0.00	0.00
12	80.0	50.0	39.30	0.00	0.00	0.00	0.00
12	270.0	50.0	-34.50	0.00	0.00	0.00	0.00
13	80.0	50.0	40.50	0.00	0.00	0.00	0.00
13	270.0	50.0	-40.50	0.00	0.00	0.00	0.00
14	80.0	50.0	39.30	0.00	0.00	0.00	0.00
14	270.0	50.0	-34.50	0.00	0.00	0.00	0.00
16	80.0	50.0	-1.20	0.00	0.00	0.00	0.00
16	270.0	50.0	6.00	0.00	0.00	0.00	0.00
17	80.0	50.0	-24.30	0.00	0.00	0.00	0.00
17	270.0	50.0	24.30	0.00	0.00	0.00	0.00
18	80.0	50.0	-25.50	0.00	0.00	0.00	0.00
18	270.0	50.0	30.30	0.00	0.00	0.00	0.00
19	80.0	50.0	24.30	0.00	0.00	0.00	0.00
19	270.0	50.0	-24.30	0.00	0.00	0.00	0.00
20	80.0	50.0	23.10	0.00	0.00	0.00	0.00
20	270.0	50.0	-18.30	0.00	0.00	0.00	0.00

4.4. verification against overturning (EQU)

LK	decisive edge	M_{dst} kNm	M_{stb} kNm	μ -
1	---	0.00	831.48	0.00
2	y (right)	112.23	888.78	0.13
3	---	0.00	917.73	0.00
4	y (right)	112.23	1012.53	0.11
5	y (left)	111.87	831.48	0.13
6	y (left)	111.87	917.73	0.12
7	y (right)	187.05	587.13	**0.32**
8	y (right)	187.05	828.45	0.23
9	y (right)	187.05	710.88	0.26
10	y (right)	187.05	952.20	0.20
11	y (left)	186.45	587.13	0.32
12	y (left)	186.45	782.61	0.24
13	y (left)	186.45	673.38	0.28
14	y (left)	186.45	868.86	0.21
15	---	0.00	759.63	0.00
16	---	0.00	955.11	0.00
17	y (right)	112.23	834.63	0.13
18	y (right)	112.23	1075.95	0.10
19	y (left)	111.87	759.63	0.15
20	y (left)	111.87	955.11	0.12
21	---	0.00	264.50	0.00

$\mu_{max} = 0.32 < 1.0$ **⇒ verification against overturning successful**

4.5. design values base failure (GEO-2)

the assumed mobilised passive earth pressure is $e_{phg,mob} = 0.50 \cdot e_{phg}$.

4.5.1. factorization of load case combinations

LK	design situat.	factorization
1	BS-P	1.35 Lf1+1.5 Lf4
2	BS-P	1.35 Lf1+1.5 Lf4+0.6 1.5 Lf7
3	BS-P	1.35 Lf1+1.5 Lf4+0.5 1.5 Lf9
4	BS-P	1.35 Lf1+1.5 Lf4+0.6 1.5 Lf7+0.5 1.5 Lf9
5	BS-P	1.35 Lf1+1.5 Lf4+0.6 1.5 Lf8
6	BS-P	1.35 Lf1+1.5 Lf4+0.6 1.5 Lf8+0.5 1.5 Lf9
7	BS-P	1.35 Lf1+1.5 Lf7
8	BS-P	1.35 Lf1+0.8 1.5 Lf4+1.5 Lf7
9	BS-P	1.35 Lf1+1.5 Lf7+0.5 1.5 Lf9
10	BS-P	1.35 Lf1+0.8 1.5 Lf4+1.5 Lf7+0.5 1.5 Lf9
11	BS-P	1.35 Lf1+1.5 Lf8
12	BS-P	1.35 Lf1+0.8 1.5 Lf4+1.5 Lf8
13	BS-P	1.35 Lf1+1.5 Lf8+0.5 1.5 Lf9
14	BS-P	1.35 Lf1+0.8 1.5 Lf4+1.5 Lf8+0.5 1.5 Lf9
15	BS-P	1.35 Lf1+1.5 Lf9
16	BS-P	1.35 Lf1+0.8 1.5 Lf4+1.5 Lf9
17	BS-P	1.35 Lf1+0.6 1.5 Lf7+1.5 Lf9
18	BS-P	1.35 Lf1+0.8 1.5 Lf4+0.6 1.5 Lf7+1.5 Lf9
19	BS-P	1.35 Lf1+0.6 1.5 Lf8+1.5 Lf9
20	BS-P	1.35 Lf1+0.8 1.5 Lf4+0.6 1.5 Lf8+1.5 Lf9

LK	design situat.	factorization
21	BS-A	2.3· Lf9

4.5.2. column load

LK	$N_{St,d}$ kN	$H_{x,St,d}$ kN	$H_{y,St,d}$ kN	$M_{x,St,d}$ kNm	$M_{y,St,d}$ kNm
1	420.00	0.00	0.00	0.00	37.50
2	420.00	32.40	0.00	0.00	10.50
3	480.00	0.00	0.00	0.00	56.25
4	480.00	32.40	0.00	0.00	29.25
5	420.00	-32.40	0.00	0.00	64.50
6	480.00	-32.40	0.00	0.00	83.25
7	270.00	54.00	0.00	0.00	-45.00
8	390.00	54.00	0.00	0.00	-15.00
9	330.00	54.00	0.00	0.00	-26.25
10	450.00	54.00	0.00	0.00	3.75
11	270.00	-54.00	0.00	0.00	45.00
12	390.00	-54.00	0.00	0.00	75.00
13	330.00	-54.00	0.00	0.00	63.75
14	450.00	-54.00	0.00	0.00	93.75
15	390.00	0.00	0.00	0.00	37.50
16	510.00	0.00	0.00	0.00	67.50
17	390.00	32.40	0.00	0.00	10.50
18	510.00	32.40	0.00	0.00	40.50
19	390.00	-32.40	0.00	0.00	64.50
20	510.00	-32.40	0.00	0.00	94.50
21	184.00	0.00	0.00	0.00	57.50

associated characteristic values

LK	$N_{St,k}$ kN	$H_{x,St,k}$ kN	$H_{y,St,k}$ kN	$M_{x,St,k}$ kNm	$M_{y,St,k}$ kNm
1	300.00	0.00	0.00	0.00	25.00
2	300.00	36.00	0.00	0.00	-5.00
3	380.00	0.00	0.00	0.00	50.00
4	380.00	36.00	0.00	0.00	20.00
5	300.00	-36.00	0.00	0.00	55.00
6	380.00	-36.00	0.00	0.00	80.00
7	200.00	36.00	0.00	0.00	-30.00
8	300.00	36.00	0.00	0.00	-5.00
9	280.00	36.00	0.00	0.00	-5.00
10	380.00	36.00	0.00	0.00	20.00
11	200.00	-36.00	0.00	0.00	30.00
12	300.00	-36.00	0.00	0.00	55.00
13	280.00	-36.00	0.00	0.00	55.00
14	380.00	-36.00	0.00	0.00	80.00
15	280.00	0.00	0.00	0.00	25.00
16	380.00	0.00	0.00	0.00	50.00
17	280.00	36.00	0.00	0.00	-5.00
18	380.00	36.00	0.00	0.00	20.00
19	280.00	-36.00	0.00	0.00	55.00
20	380.00	-36.00	0.00	0.00	80.00
21	80.00	0.00	0.00	0.00	25.00

4.5.3. point loads

LK -	x cm	y cm	$N,d,_z$ kN	$Q,d,_x$ kN	$Q,d,_y$ kN	$M,d,_x$ kNm	$M,d,_y$ kNm
1	80.0	50.0	-1.50	0.00	0.00	0.00	0.00
1	270.0	50.0	7.50	0.00	0.00	0.00	0.00
2	80.0	50.0	-25.80	0.00	0.00	0.00	0.00
2	270.0	50.0	31.80	0.00	0.00	0.00	0.00
3	80.0	50.0	-1.50	0.00	0.00	0.00	0.00
3	270.0	50.0	7.50	0.00	0.00	0.00	0.00
4	80.0	50.0	-25.80	0.00	0.00	0.00	0.00
4	270.0	50.0	31.80	0.00	0.00	0.00	0.00
5	80.0	50.0	22.80	0.00	0.00	0.00	0.00
5	270.0	50.0	-16.80	0.00	0.00	0.00	0.00
6	80.0	50.0	22.80	0.00	0.00	0.00	0.00
6	270.0	50.0	-16.80	0.00	0.00	0.00	0.00
7	80.0	50.0	-40.50	0.00	0.00	0.00	0.00
7	270.0	50.0	40.50	0.00	0.00	0.00	0.00
8	80.0	50.0	-41.70	0.00	0.00	0.00	0.00
8	270.0	50.0	46.50	0.00	0.00	0.00	0.00
9	80.0	50.0	-40.50	0.00	0.00	0.00	0.00
9	270.0	50.0	40.50	0.00	0.00	0.00	0.00
10	80.0	50.0	-41.70	0.00	0.00	0.00	0.00
10	270.0	50.0	46.50	0.00	0.00	0.00	0.00
11	80.0	50.0	40.50	0.00	0.00	0.00	0.00
11	270.0	50.0	-40.50	0.00	0.00	0.00	0.00
12	80.0	50.0	39.30	0.00	0.00	0.00	0.00
12	270.0	50.0	-34.50	0.00	0.00	0.00	0.00
13	80.0	50.0	40.50	0.00	0.00	0.00	0.00
13	270.0	50.0	-40.50	0.00	0.00	0.00	0.00
14	80.0	50.0	39.30	0.00	0.00	0.00	0.00
14	270.0	50.0	-34.50	0.00	0.00	0.00	0.00
16	80.0	50.0	-1.20	0.00	0.00	0.00	0.00
16	270.0	50.0	6.00	0.00	0.00	0.00	0.00
17	80.0	50.0	-24.30	0.00	0.00	0.00	0.00
17	270.0	50.0	24.30	0.00	0.00	0.00	0.00
18	80.0	50.0	-25.50	0.00	0.00	0.00	0.00
18	270.0	50.0	30.30	0.00	0.00	0.00	0.00
19	80.0	50.0	24.30	0.00	0.00	0.00	0.00
19	270.0	50.0	-24.30	0.00	0.00	0.00	0.00
20	80.0	50.0	23.10	0.00	0.00	0.00	0.00

LK	x	y	N,d,z	Q,d,x	Q,d,y	M,d,x	M,d,y
-	cm	cm	kN	kN	kN	kNm	kNm
20	270.0	50.0	-18.30	0.00	0.00	0.00	0.00

associated characteristic values

LK	x	y	N,k,z	Q,k,x	Q,k,y	M,k,x	M,k,y
-	cm	cm	kN	kN	kN	kNm	kNm
1	80.0	50.0	-1.00	0.00	0.00	0.00	0.00
1	270.0	50.0	5.00	0.00	0.00	0.00	0.00
2	80.0	50.0	-28.00	0.00	0.00	0.00	0.00
2	270.0	50.0	32.00	0.00	0.00	0.00	0.00
3	80.0	50.0	-1.00	0.00	0.00	0.00	0.00
3	270.0	50.0	5.00	0.00	0.00	0.00	0.00
4	80.0	50.0	-28.00	0.00	0.00	0.00	0.00
4	270.0	50.0	32.00	0.00	0.00	0.00	0.00
5	80.0	50.0	26.00	0.00	0.00	0.00	0.00
5	270.0	50.0	-22.00	0.00	0.00	0.00	0.00
6	80.0	50.0	26.00	0.00	0.00	0.00	0.00
6	270.0	50.0	-22.00	0.00	0.00	0.00	0.00
7	80.0	50.0	-27.00	0.00	0.00	0.00	0.00
7	270.0	50.0	27.00	0.00	0.00	0.00	0.00
8	80.0	50.0	-28.00	0.00	0.00	0.00	0.00
8	270.0	50.0	32.00	0.00	0.00	0.00	0.00
9	80.0	50.0	-27.00	0.00	0.00	0.00	0.00
9	270.0	50.0	27.00	0.00	0.00	0.00	0.00
10	80.0	50.0	-28.00	0.00	0.00	0.00	0.00
10	270.0	50.0	32.00	0.00	0.00	0.00	0.00
11	80.0	50.0	27.00	0.00	0.00	0.00	0.00
11	270.0	50.0	-27.00	0.00	0.00	0.00	0.00
12	80.0	50.0	26.00	0.00	0.00	0.00	0.00
12	270.0	50.0	-22.00	0.00	0.00	0.00	0.00
13	80.0	50.0	27.00	0.00	0.00	0.00	0.00
13	270.0	50.0	-27.00	0.00	0.00	0.00	0.00
14	80.0	50.0	26.00	0.00	0.00	0.00	0.00
14	270.0	50.0	-22.00	0.00	0.00	0.00	0.00
16	80.0	50.0	-1.00	0.00	0.00	0.00	0.00
16	270.0	50.0	5.00	0.00	0.00	0.00	0.00
17	80.0	50.0	-27.00	0.00	0.00	0.00	0.00
17	270.0	50.0	27.00	0.00	0.00	0.00	0.00
18	80.0	50.0	-28.00	0.00	0.00	0.00	0.00
18	270.0	50.0	32.00	0.00	0.00	0.00	0.00
19	80.0	50.0	27.00	0.00	0.00	0.00	0.00
19	270.0	50.0	-27.00	0.00	0.00	0.00	0.00
20	80.0	50.0	26.00	0.00	0.00	0.00	0.00
20	270.0	50.0	-22.00	0.00	0.00	0.00	0.00

4.6. verification of safety against base failure

4.6.1. loading and substituting dimensions

LK	$N_{0,k}$	$M_{0,x,k}$	$M_{0,y,k}$	a'	b'	$H_{a',k}$	$H_{b',k}$
	kN	kNm	kNm	m	m	kN	kN
1	409.00	0.00	19.30	3.41	1.00	0.00	0.00
2	409.00	0.00	-102.51	3.00	1.00	25.90	0.00
3	489.00	0.00	44.30	3.32	1.00	0.00	0.00
4	489.00	0.00	-77.51	3.18	1.00	25.90	0.00
5	409.00	0.00	141.11	2.81	1.00	-25.90	0.00
6	489.00	0.00	166.11	2.82	1.00	-25.90	0.00
7	305.00	0.00	-121.81	2.70	1.00	25.90	0.00
8	409.00	0.00	-102.51	3.00	1.00	25.90	0.00
9	385.00	0.00	-96.81	3.00	1.00	25.90	0.00
10	489.00	0.00	-77.51	3.18	1.00	25.90	0.00
11	305.00	0.00	121.81	2.70	1.00	-25.90	0.00
12	409.00	0.00	141.11	2.81	1.00	-25.90	0.00
13	385.00	0.00	146.81	2.74	1.00	-25.90	0.00
14	489.00	0.00	166.11	2.82	1.00	-25.90	0.00
15	385.00	0.00	25.00	3.37	1.00	0.00	0.00
16	489.00	0.00	44.30	3.32	1.00	0.00	0.00
17	385.00	0.00	-96.81	3.00	1.00	25.90	0.00
18	489.00	0.00	-77.51	3.18	1.00	25.90	0.00
19	385.00	0.00	146.81	2.74	1.00	-25.90	0.00
20	489.00	0.00	166.11	2.82	1.00	-25.90	0.00
21	185.00	0.00	25.00	3.23	1.00	0.00	0.00

4.6.2. decisive soil parameters

determination of the decisive values by method of weighted average
values beyond the base to top edge of soil: γ_1, φ_1, c_1
values below the base up to depth (d_s) of the sliding clod: γ_2, φ_2, c_2

LK	γ_1 kN/m³	φ_1 °	c_1 kN/m²	d_s m	γ_2 kN/m³	φ_2 °	c_2 kN/m²
1	19.00	32.50	---	1.73	11.92	32.50	---
2	19.00	32.50	---	1.73	11.92	32.50	---
3	19.00	32.50	---	1.73	11.92	32.50	---
4	19.00	32.50	---	1.73	11.92	32.50	---
5	19.00	32.50	---	1.73	11.92	32.50	---
6	19.00	32.50	---	1.73	11.92	32.50	---
7	19.00	32.50	---	1.73	11.92	32.50	---
8	19.00	32.50	---	1.73	11.92	32.50	---
9	19.00	32.50	---	1.73	11.92	32.50	---
10	19.00	32.50	---	1.73	11.92	32.50	---
11	19.00	32.50	---	1.73	11.92	32.50	---
12	19.00	32.50	---	1.73	11.92	32.50	---
13	19.00	32.50	---	1.73	11.92	32.50	---
14	19.00	32.50	---	1.73	11.92	32.50	---
15	19.00	32.50	---	1.73	11.92	32.50	---
16	19.00	32.50	---	1.73	11.92	32.50	---
17	19.00	32.50	---	1.73	11.92	32.50	---
18	19.00	32.50	---	1.73	11.92	32.50	---
19	19.00	32.50	---	1.73	11.92	32.50	---
20	19.00	32.50	---	1.73	11.92	32.50	---
21	19.00	32.50	---	1.73	11.92	32.50	---

4.6.3. values of design resistance, shape, load inclination and depth

basic values of design resistance values N_{b0},N_{d0},N_{c0} acc. to [5]
shape factors ν_b,ν_d,ν_c acc. to [5], tab.2
load inclination factors i_b,i_d,i_c acc. to [5], tab.3

LK	N_{b0} -	N_{d0} -	N_{c0} -	ν_b -	ν_d -	ν_c -	i_b -	i_d -	i_c -
1	15.03	24.58	---	0.912	1.158	---	1.000	1.000	---
2	15.03	24.58	---	0.900	1.179	---	0.863	0.921	---
3	15.03	24.58	---	0.910	1.162	---	1.000	1.000	---
4	15.03	24.58	---	0.906	1.169	---	0.885	0.935	---
5	15.03	24.58	---	0.893	1.191	---	0.862	0.921	---
6	15.03	24.58	---	0.894	1.190	---	0.884	0.934	---
7	15.03	24.58	---	0.889	1.199	---	0.818	0.893	---
8	15.03	24.58	---	0.900	1.179	---	0.863	0.921	---
9	15.03	24.58	---	0.900	1.179	---	0.855	0.917	---
10	15.03	24.58	---	0.906	1.169	---	0.885	0.935	---
11	15.03	24.58	---	0.889	1.199	---	0.818	0.893	---
12	15.03	24.58	---	0.893	1.191	---	0.862	0.921	---
13	15.03	24.58	---	0.890	1.196	---	0.854	0.916	---
14	15.03	24.58	---	0.894	1.190	---	0.884	0.934	---
15	15.03	24.58	---	0.911	1.159	---	1.000	1.000	---
16	15.03	24.58	---	0.910	1.162	---	1.000	1.000	---
17	15.03	24.58	---	0.900	1.179	---	0.855	0.917	---
18	15.03	24.58	---	0.906	1.169	---	0.885	0.935	---
19	15.03	24.58	---	0.890	1.196	---	0.854	0.916	---
20	15.03	24.58	---	0.894	1.190	---	0.884	0.934	---
21	15.03	24.58	---	0.907	1.166	---	1.000	1.000	---

4.6.4. ultimate load and allowable load

characteristic design bearing capacity $R_{n,k} = a' \cdot b' \cdot (\gamma_2 \cdot b' \cdot N_{b0} \cdot \nu_b \cdot i_b + \gamma_1 \cdot t \cdot N_{d0} \cdot \nu_d \cdot i_d + c_2 \cdot N_{c0} \cdot \nu_c \cdot i_c)$
design value of resistance $R_{n,d} = R_{n,k}/\gamma_{Gr}$
the degree of utilization is $\mu = N_d/R_{n,d}$

LK	$R_{n,k}$ kN	$\gamma_{R,v}$ -	$R_{n,d}$ kN	N_d kN	μ -
1	2029.79	1.40	1449.85	567.75	0.39
2	1634.92	1.40	1167.80	567.75	0.49
3	1981.80	1.40	1415.57	627.75	0.44
4	1756.82	1.40	1254.87	627.75	0.50
5	1539.49	1.40	1099.63	567.75	0.52
6	1570.82	1.40	1122.01	627.75	0.56
7	1432.90	1.40	1023.50	411.75	0.40
8	1634.92	1.40	1167.80	536.55	0.46
9	1623.74	1.40	1159.81	471.75	0.41
10	1756.82	1.40	1254.87	596.55	0.48
11	1432.90	1.40	1023.50	411.75	0.40
12	1539.49	1.40	1099.63	536.55	0.49
13	1493.18	1.40	1066.55	471.75	0.44
14	1570.82	1.40	1122.01	596.55	0.53
15	2010.17	1.40	1435.84	531.75	0.37
16	1981.80	1.40	1415.57	656.55	0.46
17	1623.74	1.40	1159.81	531.75	0.46
18	1756.82	1.40	1254.87	656.55	0.52
19	1493.18	1.40	1066.55	531.75	0.50
20	1570.82	1.40	1122.01	656.55	**0.59**
21	1932.55	1.20	1610.46	289.00	0.18

μ_{max} = 0.59 < 1.0 ⇒ **design bearing capacity sufficient**

4.7. design values slippage (GEO-2)

the assumed mobilised passive earth pressure is $e_{phg,mob} = 1.00 \cdot e_{phg}$.

design values of applied loads see base failure.

4.8. verification of safety against sliding

slip resistance in case of consolidated soil $R_{t,k} = N_{0,k} \tan(\delta_s)$
design value of slip resistance $R_{t,d} = R_{t,k}/\gamma_{R,h}$
design value of mobilised passive earth pressure $E_{p,d} = E_{p,k,mob}/\gamma_{R,e}$
the degree of utilization is $\mu = (R_{t,d}+E_{p,d})/H_{Res,d}$

angle of base friction (for raue base area) δ_s = 32.5°

LK	$N_{0,k}$ kN	$R_{t,k}$ kN	$\gamma_{R,h}$ -	$\gamma_{R,e}$ -	$R_{t,d}$ kN	$E_{p,d}$ kN	$H_{Res,d}$ kN	μ -
1	409.00	---	1.10	1.40	---	---	0.00	---
2	409.00	260.56	1.10	1.40	236.87	14.43	32.40	0.13
3	489.00	---	1.10	1.40	---	---	0.00	---
4	489.00	311.53	1.10	1.40	283.21	14.43	32.40	0.11
5	409.00	260.56	1.10	1.40	236.87	14.43	32.40	0.13
6	489.00	311.53	1.10	1.40	283.21	14.43	32.40	0.11
7	305.00	194.31	1.10	1.40	176.64	14.43	54.00	**0.28**
8	409.00	260.56	1.10	1.40	236.87	14.43	54.00	0.21
9	385.00	245.27	1.10	1.40	222.97	14.43	54.00	0.23
10	489.00	311.53	1.10	1.40	283.21	14.43	54.00	0.18
11	305.00	194.31	1.10	1.40	176.64	14.43	54.00	0.28
12	409.00	260.56	1.10	1.40	236.87	14.43	54.00	0.21
13	385.00	245.27	1.10	1.40	222.97	14.43	54.00	0.23
14	489.00	311.53	1.10	1.40	283.21	14.43	54.00	0.18
15	385.00	---	1.10	1.40	---	---	0.00	---
16	489.00	---	1.10	1.40	---	---	0.00	---
17	385.00	245.27	1.10	1.40	222.97	14.43	32.40	0.14
18	489.00	311.53	1.10	1.40	283.21	14.43	32.40	0.11
19	385.00	245.27	1.10	1.40	222.97	14.43	32.40	0.14
20	489.00	311.53	1.10	1.40	283.21	14.43	32.40	0.11
21	185.00	---	1.10	1.20	---	---	0.00	---

μ_{max} = 0.28 < 1.0 ⇒ **slip resistance sufficient**

5. External stability - verification of serviceability

5.1. design values limitation of gaping joint under permanent load

Die Mobilisierung des passive earth pressurees wird vernachlässigt.

5.1.1. factorization of load case combinations

LK	factorization
1	Lf1

5.1.2. column load

LK	$N_{St,d}$ kN	$H_{x,St,d}$ kN	$H_{y,St,d}$ kN	$M_{x,St,d}$ kNm	$M_{y,St,d}$ kNm
1	200.00	0.00	0.00	0.00	0.00

5.2. limitation of gaping joint under permanent load

no eccentric loading ⇒ verification is not necessary.

5.3. design values limitation of gaping joint under total load

Die Mobilisierung des passive earth pressurees wird vernachlässigt.

5.3.1. factorization of load case combinations

LK	factorization
1	Lf1+Lf4
2	Lf1+Lf4+Lf7
3	Lf1+Lf4+Lf9
4	Lf1+Lf4+Lf7+Lf9
5	Lf1+Lf4+Lf8
6	Lf1+Lf4+Lf8+Lf9
7	Lf1+Lf7
8	Lf1+Lf7+Lf9
9	Lf1+Lf8
10	Lf1+Lf8+Lf9
11	Lf1+Lf9

5.3.2. column load

increasing factor for flex. mom.: $\Delta M_{St,TH.II.O} = M_{St} \cdot 20\%$
(for the consideration of increase of moments from non-linear effects)

LK	$N_{St,d}$ kN	$H_{x,St,d}$ kN	$H_{y,St,d}$ kN	$M_{x,St,d}$ kNm	$M_{y,St,d}$ kNm
1	300.00	0.00	0.00	0.00	25.00
2	300.00	36.00	0.00	0.00	-5.00
3	380.00	0.00	0.00	0.00	50.00
4	380.00	36.00	0.00	0.00	20.00
5	300.00	-36.00	0.00	0.00	55.00
6	380.00	-36.00	0.00	0.00	80.00
7	200.00	36.00	0.00	0.00	-30.00
8	280.00	36.00	0.00	0.00	-5.00
9	200.00	-36.00	0.00	0.00	30.00
10	280.00	-36.00	0.00	0.00	55.00
11	280.00	0.00	0.00	0.00	25.00

5.3.3. point loads

LK -	x cm	y cm	N,d,z kN	Q,d,x kN	Q,d,y kN	M,d,x kNm	M,d,y kNm
1	80.0	50.0	-1.00	0.00	0.00	0.00	0.00
1	270.0	50.0	5.00	0.00	0.00	0.00	0.00
2	80.0	50.0	-28.00	0.00	0.00	0.00	0.00
2	270.0	50.0	32.00	0.00	0.00	0.00	0.00
3	80.0	50.0	-1.00	0.00	0.00	0.00	0.00
3	270.0	50.0	5.00	0.00	0.00	0.00	0.00
4	80.0	50.0	-28.00	0.00	0.00	0.00	0.00
4	270.0	50.0	32.00	0.00	0.00	0.00	0.00
5	80.0	50.0	26.00	0.00	0.00	0.00	0.00
5	270.0	50.0	-22.00	0.00	0.00	0.00	0.00
6	80.0	50.0	26.00	0.00	0.00	0.00	0.00
6	270.0	50.0	-22.00	0.00	0.00	0.00	0.00
7	80.0	50.0	-27.00	0.00	0.00	0.00	0.00
7	270.0	50.0	27.00	0.00	0.00	0.00	0.00
8	80.0	50.0	-27.00	0.00	0.00	0.00	0.00
8	270.0	50.0	27.00	0.00	0.00	0.00	0.00
9	80.0	50.0	27.00	0.00	0.00	0.00	0.00
9	270.0	50.0	-27.00	0.00	0.00	0.00	0.00
10	80.0	50.0	27.00	0.00	0.00	0.00	0.00
10	270.0	50.0	-27.00	0.00	0.00	0.00	0.00

5.4. limitation of gaping joint under total load

LK	$N_{0,k}$ kN/m	$M_{0,x,k}$ kNm/m	$M_{0,y,k}$ kNm/m	e_x m	e_y m	$(e_x/b_x)^2 + (e_y/b_y)^2$ -
1	409.00	0.00	19.30	0.05	0.00	0.000
2	409.00	0.00	-105.20	-0.26	0.00	0.005
3	489.00	0.00	44.30	0.09	0.00	0.001
4	489.00	0.00	-80.20	-0.16	0.00	0.002
5	409.00	0.00	143.80	0.35	0.00	0.010
6	489.00	0.00	168.80	0.35	0.00	0.010
7	305.00	0.00	-124.50	-0.41	0.00	0.014
8	385.00	0.00	-99.50	-0.26	0.00	0.005
9	305.00	0.00	124.50	0.41	0.00	0.014
10	385.00	0.00	149.50	0.39	0.00	0.012
11	385.00	0.00	25.00	0.06	0.00	0.000

$((e_x/b_x)^2 + (e_y/b_y)^2)_{max} = 0.014 < 1/9$

⇒ the decisive resultant is located in the 2. core area,
sc. no gaping joint beyond centroid.

5.5. verification against displacement in base area

the verification is rated as successful, if the passive earth pressure remains unconsidered in the verification of safety against sliding (s.a.).

LK	$N_{0,k}$ kN	$R_{t,k}$ kN	$\gamma_{R,h}$ -	$R_{t,d}$ kN	$H_{Res,d}$ kN	μ -
1	409.00	---	1.10	---	0.00	---
2	409.00	260.56	1.10	236.87	32.40	0.14
3	489.00	---	1.10	---	0.00	---
4	489.00	311.53	1.10	283.21	32.40	0.11
5	409.00	260.56	1.10	236.87	32.40	0.14
6	489.00	311.53	1.10	283.21	32.40	0.11
7	305.00	194.31	1.10	176.64	54.00	**0.31**
8	409.00	260.56	1.10	236.87	54.00	0.23
9	385.00	245.27	1.10	222.97	54.00	0.24
10	489.00	311.53	1.10	283.21	54.00	0.19
11	305.00	194.31	1.10	176.64	54.00	0.31

LK	$N_{0,k}$ kN	$R_{t,k}$ kN	$\gamma_{R,h}$ -	$R_{t,d}$ kN	$H_{Res,d}$ kN	μ -
12	409.00	260.56	1.10	236.87	54.00	0.23
13	385.00	245.27	1.10	222.97	54.00	0.24
14	489.00	311.53	1.10	283.21	54.00	0.19
15	385.00	---	1.10	---	0.00	---
16	489.00	---	1.10	---	0.00	---
17	385.00	245.27	1.10	222.97	32.40	0.15
18	489.00	311.53	1.10	283.21	32.40	0.11
19	385.00	245.27	1.10	222.97	32.40	0.15
20	489.00	311.53	1.10	283.21	32.40	0.11

$\mu_{max} = 0.31 < 1.0$ ⇒ **verification against displacement in base area successful**

5.6. design values settlement

Die Mobilisierung des passive earth pressurees wird vernachlässigt.

5.6.1. factorization of load case combinations

LK	factorization
1	Lf1+Lf4
2	Lf1+Lf4+Lf7
3	Lf1+Lf4+Lf9
4	Lf1+Lf4+Lf7+Lf9
5	Lf1+Lf4+Lf8
6	Lf1+Lf4+Lf8+Lf9
7	Lf1+Lf7
8	Lf1+Lf7+Lf9
9	Lf1+Lf8
10	Lf1+Lf8+Lf9
11	Lf1+Lf9

5.6.2. column load

LK	$N_{St,d}$ kN	$H_{x,St,d}$ kN	$H_{y,St,d}$ kN	$M_{x,St,d}$ kNm	$M_{y,St,d}$ kNm
1	300.00	0.00	0.00	0.00	25.00
2	300.00	36.00	0.00	0.00	-5.00
3	380.00	0.00	0.00	0.00	50.00
4	380.00	36.00	0.00	0.00	20.00
5	300.00	-36.00	0.00	0.00	55.00
6	380.00	-36.00	0.00	0.00	80.00
7	200.00	36.00	0.00	0.00	-30.00
8	280.00	36.00	0.00	0.00	-5.00
9	200.00	-36.00	0.00	0.00	30.00
10	280.00	-36.00	0.00	0.00	55.00
11	280.00	0.00	0.00	0.00	25.00

5.6.3. point loads

LK -	x cm	y cm	N,d,z kN	Q,d,x kN	Q,d,y kN	M,d,x kNm	M,d,y kNm
1	80.0	50.0	-1.00	0.00	0.00	0.00	0.00
1	270.0	50.0	5.00	0.00	0.00	0.00	0.00
2	80.0	50.0	-28.00	0.00	0.00	0.00	0.00
2	270.0	50.0	32.00	0.00	0.00	0.00	0.00
3	80.0	50.0	-1.00	0.00	0.00	0.00	0.00
3	270.0	50.0	5.00	0.00	0.00	0.00	0.00
4	80.0	50.0	-28.00	0.00	0.00	0.00	0.00
4	270.0	50.0	32.00	0.00	0.00	0.00	0.00
5	80.0	50.0	26.00	0.00	0.00	0.00	0.00
5	270.0	50.0	-22.00	0.00	0.00	0.00	0.00
6	80.0	50.0	26.00	0.00	0.00	0.00	0.00
6	270.0	50.0	-22.00	0.00	0.00	0.00	0.00
7	80.0	50.0	-27.00	0.00	0.00	0.00	0.00
7	270.0	50.0	27.00	0.00	0.00	0.00	0.00
8	80.0	50.0	-27.00	0.00	0.00	0.00	0.00
8	270.0	50.0	27.00	0.00	0.00	0.00	0.00
9	80.0	50.0	27.00	0.00	0.00	0.00	0.00
9	270.0	50.0	-27.00	0.00	0.00	0.00	0.00
10	80.0	50.0	27.00	0.00	0.00	0.00	0.00
10	270.0	50.0	-27.00	0.00	0.00	0.00	0.00

5.7. settlements

determination of settlement by use of closed formulas acc. to [6]

allowable maximum settlement perm $s_{max} = 5.0$ cm
allowable obliquity about the x-axis perm $\alpha_x = 0.5$ °
allowable obliquity about the y-axis perm $\alpha_y = 0.5$ °

5.7.1. determination from settlement causing contact pressure and limiting depth

mean settlement causing contact pressure $\sigma_0' = \sigma_0 - \sigma_a$, if $2 \cdot \sigma_a > \sigma_0$ then $\sigma_0' = \sigma_0$
the limiting depth d_s results from $d_s = z$, if $\sigma_B(z) = 0.2 \cdot \sigma_0(z)$ below significant point.

unloading from excavation due to foundation depth $\sigma_a = 15.20$ kN/m²

LK	$N_{0,k}$ kN	$M_{0,x,k}$ kNm	$M_{0,y,k}$ kNm	σ_0 kN/m²	σ_0' kN/m²	d_s m
1	409.00	0.00	19.30	116.86	101.66	3.20
2	409.00	0.00	-105.20	116.86	101.66	3.20
3	489.00	0.00	44.30	139.71	124.51	3.53
4	489.00	0.00	-80.20	139.71	124.51	3.53
5	409.00	0.00	143.80	116.86	101.66	3.20
6	489.00	0.00	168.80	139.71	124.51	3.53
7	305.00	0.00	-124.50	87.14	71.94	2.69
8	385.00	0.00	-99.50	110.00	94.80	3.10
9	305.00	0.00	124.50	87.14	71.94	2.69
10	385.00	0.00	149.50	110.00	94.80	3.10
11	385.00	0.00	25.00	110.00	94.80	3.10

5.7.2. determination of settlement values and settlement parts per soil stratum

coefficient f for settlement below significant point acc. to [7], vol. 2, tab. 4
coefficients f_x/f_y for obliquity of a rigid foundation acc. to [8], fig. 19
settlement parts from centrical load $s_{m,i} = \sigma_0' \cdot b_y \cdot (f_i - f_{i-1})/E_{m,i}$
settlement parts from $M_{0,y}$ $s_{x,i} = b_x/2 \cdot M_{0,y}/(E_{m,i} \cdot b_y \cdot b_x^2) \cdot (f_{x,i} - f_{x,i-1})$
settlement parts from $M_{0,x}$ $s_{y,i} = b_y/2 \cdot M_{0,x}/(E_{m,i} \cdot b_x \cdot b_y^2) \cdot (f_{y,i} - f_{y,i-1})$

LK 1:
σ_0' = 101.66 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = 19.30 kNm

level m	z m	f -	f_x -	f_y -	s_m cm	s_x cm	s_y cm
1.00	0.20	0.186	0.551	1.644	0.19	0.02	0.00
4.00	3.20	1.043	2.266	4.626	0.87	0.05	0.00

LK 2:
σ_0' = 101.66 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = -105.20 kNm

level m	z m	f -	f_x -	f_y -	s_m cm	s_x cm	s_y cm
1.00	0.20	0.186	0.551	1.644	0.19	-0.08	0.00
4.00	3.20	1.043	2.266	4.626	0.87	-0.26	0.00

LK 3:
σ_0' = 124.51 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = 44.30 kNm

level m	z m	f -	f_x -	f_y -	s_m cm	s_x cm	s_y cm
1.00	0.20	0.186	0.551	1.644	0.23	0.03	0.00
4.33	3.53	1.074	2.268	4.626	1.11	0.11	0.00

LK 4:
σ_0' = 124.51 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = -80.20 kNm

level m	z m	f -	f_x -	f_y -	s_m cm	s_x cm	s_y cm
1.00	0.20	0.186	0.551	1.644	0.23	-0.06	0.00
4.33	3.53	1.074	2.268	4.626	1.11	-0.20	0.00

LK 5:
σ_0' = 101.66 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = 143.80 kNm

level m	z m	f -	f_x -	f_y -	s_m cm	s_x cm	s_y cm
1.00	0.20	0.186	0.551	1.644	0.19	0.11	0.00
4.00	3.20	1.043	2.266	4.626	0.87	0.35	0.00

LK 6:
σ_0' = 124.51 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = 168.80 kNm

level m	z m	f -	f_x -	f_y -	s_m cm	s_x cm	s_y cm
1.00	0.20	0.186	0.551	1.644	0.23	0.13	0.00
4.33	3.53	1.074	2.268	4.626	1.11	0.41	0.00

LK 7:
σ_0' = 71.94 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = -124.50 kNm

level m	z m	f -	f_x -	f_y -	s_m cm	s_x cm	s_y cm
1.00	0.20	0.186	0.551	1.644	0.13	-0.10	0.00
3.49	2.69	0.984	2.264	4.625	0.57	-0.30	0.00

LK 8:
σ_0' = 94.80 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = -99.50 kNm

level m	z m	f -	f_x -	f_y -	s_m cm	s_x cm	s_y cm
1.00	0.20	0.186	0.551	1.644	0.18	-0.08	0.00
3.90	3.10	1.031	2.266	4.626	0.80	-0.24	0.00

LK 9:
σ_0' = 71.94 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = 124.50 kNm

level m	z m	f -	f_x -	f_y -	s_m cm	s_x cm	s_y cm
1.00	0.20	0.186	0.551	1.644	0.13	0.10	0.00
3.49	2.69	0.984	2.264	4.625	0.57	0.30	0.00

LK 10:
σ_0' = 94.80 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = 149.50 kNm

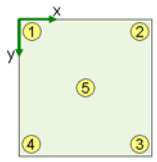
level m	z m	f -	f_x -	f_y -	s_m cm	s_x cm	s_y cm
1.00	0.20	0.186	0.551	1.644	0.18	0.12	0.00
3.90	3.10	1.031	2.266	4.626	0.80	0.37	0.00

LK 11:
σ_0' = 94.80 kN/m²
$M_{0,x}$ = 0.00 kNm
$M_{0,y}$ = 25.00 kNm

level	z	f	f_x	f_y	s_m	s_x	s_y
m	m	-	-	-	cm	cm	cm
1.00	0.20	0.186	0.551	1.644	0.18	0.02	0.00
3.90	3.10	1.031	2.266	4.626	0.80	0.06	0.00

5.7.3. resultant settlements and obliquity per LK

$s_1 = \Sigma(s_{m,i} + s_{x,i} - s_{y,i})$ $s_2 = \Sigma(s_{m,i} - s_{x,i} - s_{y,i})$ $s_3 = \Sigma(s_{m,i} - s_{x,i} + s_{y,i})$ $s_4 = \Sigma(s_{m,i} + s_{x,i} + s_{y,i})$ $s_5 = \Sigma s_{m,i}$
$\tan \alpha_x = 2 \cdot \Sigma s_{y,i} / b_y$ $\tan \alpha_y = 2 \cdot \Sigma s_{x,i} / b_x$



LK	s_1	s_2	s_3	s_4	s_5	s_{max}	α_x	α_y
	cm	cm	cm	cm	cm	cm	°	°
1	1.1	1.0	1.0	1.1	1.1	1.1	**0.0**	0.0
2	0.7	1.4	1.4	0.7	1.1	1.4	0.0	-0.1
3	1.5	1.2	1.2	1.5	1.3	1.5	0.0	0.0
4	1.1	1.6	1.6	1.1	1.3	1.6	0.0	-0.1
5	1.5	0.6	0.6	1.5	1.1	1.5	0.0	0.2
6	1.9	0.8	0.8	1.9	1.3	**1.9**	0.0	**0.2**
7	0.3	1.1	1.1	0.3	0.7	1.1	0.0	-0.1
8	0.7	1.3	1.3	0.7	1.0	1.3	0.0	-0.1
9	1.1	0.3	0.3	1.1	0.7	1.1	0.0	0.1
10	1.5	0.5	0.5	1.5	1.0	1.5	0.0	0.2
11	1.1	0.9	0.9	1.1	1.0	1.1	0.0	0.0

max s_{max} = 1.9 < 5.0 cm max $|\alpha_x|$ = 0.0° < 0.5° max $|\alpha_y|$ = 0.2° < 0.5°

⇒ allowable settlement and obliquity kept

M_{dst} - destabilising moment M_{stb} - stabilising moment N_0 - normal force in foundation joint
M_0 - moment load in centroid of foundation joint a'/b' - substituting widths due to eccentric load with a'>b'
H_a/H_b - horizontal loads in direction of the corresponding widths t - anchoring depth σ_0 - mean normal soil stress
σ_B - soil stress from structural load $\sigma_{\ddot{u}}$ - overburden stress from soil own weight
d_s - limiting depth resp. thickness of compressible stratum below base of foundation z - depth from foundation foot

6. Drehfeder des Systems foundation-soil

determination der Drehfederkonstante with Hilfe des beddingsmodules.
$c_{v,X} = k_s \cdot I_x$
$c_{v,Y} = k_s \cdot I_y$
Abschätzung des beddingsmodules acc. to [9]
$k_s = E_s / (f \cdot (b_x \cdot b_x)^{0.5})$
with Formfaktor f abhängig vom aspect ratio: 1:1 -> f = 0.45, 1:2 -> f 0.42, 1:4 -> f = 0.35

assumption for Korrekturfaktor κ = 1
stiffenerziffer E_s = 1·10000.00 = 10000.00 kN/m²

Formfaktor f = 0.36

beddingsmodul k_s = 14847.85 kN/m³

Trägheitsmoment I_X / I_X = 3.57 / 0.29 kN/m³

Drehfeder about the x-axis **$c_{v,x}$ = 53050.12 kNm**
Drehfeder about the y-axis **$c_{v,y}$ = 4330.62 kNm**

7. summary

all executed verifications and design calculations successful.

longitudinal reinforcement x-direction	= 0.12
min $A_{s,x}$	displacement in der base area
= 5.5 cm²	μ_{max}
longitudinal reinforcement y-direction	= 0.31
min $A_{s,y}$	
= 0.9 cm²	settlement
	s_{max}
overturning	= 1.9 cm
μ_{max}	obliquity
= 0.32	$\alpha_{max,x}$
base failure	= 0.0°
μ_{max}	obliquity
= 0.59	$\alpha_{max,y}$
slip	= 0.2°
μ_{max}	
= 0.28	Drehfeder about the x-axis
	$c_{v,x}$
Klaffende clearance unter perman.er load	= 53050.12 kNm
μ_{exis}	Drehfeder about the y-axis
= 0.00	$c_{v,y}$
Klaffende clearance unter total load	= 4330.62 kNm
μ_{max}	

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