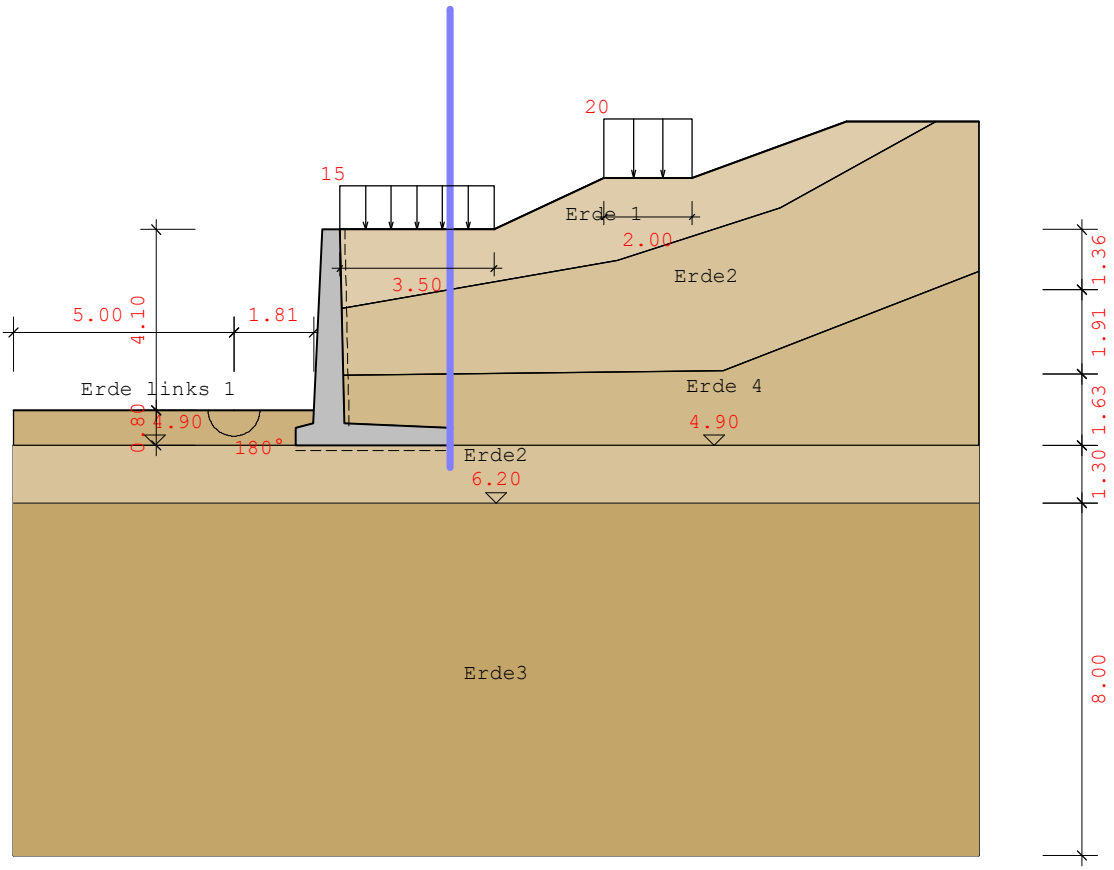
LIMES Retaining wall V:18.0 16052018

File: Winkelstützmauer_3
Project name:
Winkelstützmauer

System A



Used standards:

DIN EN 1997-1, Design: DIN EN 1992-1-1

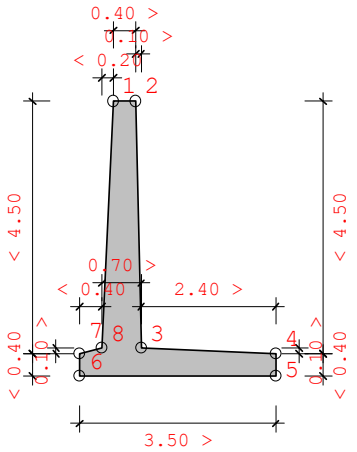
Partial safety factor for actions and loadings:

Design situations:	BS-P(1q)	BS-T(2)	BS-A(3)
STR/GEO-2: Verification for the nominal limit states:			
permanent, general:	1.35	1.20	1.10
unfavorable variable:	1.50	1.30	1.10
permanent, earth pressure at rest:	1.20	1.10	1.00
EQU: Proof of equilibrium			
favorable, permanent:	0.90	0.90	0.95
unfavorable, permanent	1.10	1.05	1.00

favorable, variable:	0.00	0.00	0.00
unfavorable, variable:	1.50	1.25	1.00
GEO-3: Serviceability (Slip circle)			
Dead load:	1.00	1.00	1.00
unfavorable, variable:	1.30	1.20	1.00
STR,GEO-2: Resistances (slip, base failure, design)			
Earth resistance:	1.40	1.30	1.20
Slip resistance:	1.10	1.10	1.10
GEO-3: Geotechnical properties (Slip circle)			
tan phi':	1.25	1.15	1.10
Cohesion c':	1.25	1.15	1.10

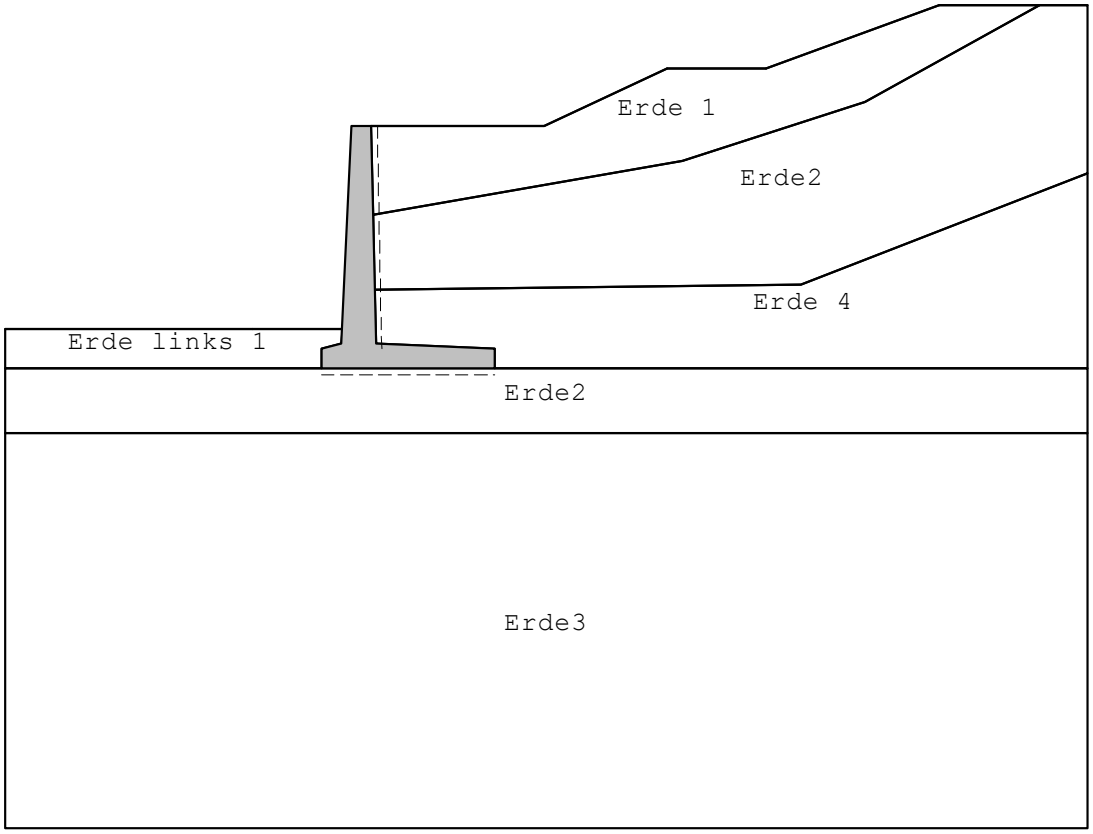
Printout of the input:

Wall geometry:



No.	x [m]	z [m]
1	-0.400	0.000
2	0.000	0.000
3	0.100	4.400
4	2.500	4.500
5	2.500	4.900
6	-1.000	4.900
7	-1.000	4.500
8	-0.600	4.400

Soil layers:



Soil layer parameters:

Weight backfill: 18.00 [kN/m3]
Consider backfill: No
Angle of skin friction: self-defined: 20.00

Name	phi[°]	delta	Cohesion	gamma	gamma'	Es
Erde 1	35.00	23.00	0.00	18.00	11.00	0
Erde2	27.50	20.00	0.00	19.00	9.00	6000
Erde 4	33.00	31.00	0.00	20.00	11.00	0
Erde links 1	32.50	-22.00	0.00	18.00	10.00	65000
Erde2	27.50	20.00	0.00	19.00	9.00	6000
Erde3	32.50	20.00	0.00	19.00	0.00	10000

Loads:

Units ... Strip load [kN/m2], Line load [kN/m]

Load type	BS	x1 [m]	z1 [m]	b [m]	q1	q2	Redistri.	ph [kN/m]	S' [kN/m]
Block	BS-P(1q)	0.00	0.00	3.50	15.00	15.00	Constant	-	-
Block	BS-P(1q)	6.00	-1.17	2.00	20.00	20.00	Constant	-	-

Results:

Earth pressure:

Earth pressure options:

```
 Load calculation iterative:          No
 Consider cohesion          acc. to classical approach
     (kach=2*(sqrt(kah))*cos(delta)
                                        Earth pressure analysis according to
Culman
 Calculation of                     active earth pressure
 Earth pressure approach at:                At the vertical section
 Considering of earth resistance?    with 30%
 Consoles existing?                No
 Angle of skin friction:                self-defined: 20.00
```

Earth pressure coefficient:

No.	Name	φ[°]	δ[°]	α[°]	β[°]
1	Erde 1	35.00	23.00	-1.30	0.00
2	Erde2	27.50	20.00	-1.30	0.00
3	Erde 4	33.00	31.00	-1.30	0.00
4	Erde 4	33.00	31.00	0.00	0.00
5	Erde2	27.50	20.00	0.00	0.00
6	Erde3	32.50	20.00	0.00	0.00
7	Erde2	27.50	20.00	-1.30	25.08
8	Erde 4	33.00	31.00	-1.30	25.08
9	Erde 4	33.00	31.00	0.00	25.08
10	Erde2	27.50	20.00	0.00	25.08
11	Erde3	32.50	20.00	0.00	25.08
12	Erde 1	35.00	23.00	0.00	0.00
13	Erde2	27.50	20.00	-1.30	20.09
14	Erde 4	33.00	31.00	-1.30	20.09
15	Erde 4	33.00	31.00	0.00	20.09
16	Erde2	27.50	20.00	0.00	20.09
17	Erde3	32.50	20.00	0.00	20.09
18	Erde links 1	32.50	-22.00	0.00	0.00
19	Erde 1	35.00	20.00	0.00	0.00
20	Erde 4	33.00	20.00	0.00	0.00
21	Erde 1	35.00	20.00	0.00	25.08
22	Erde 4	33.00	20.00	0.00	25.08
23	Erde 1	35.00	20.00	0.00	20.09
24	Erde 4	33.00	20.00	0.00	20.09

No.	Kah	Kach	K0h	Kph	Kpch
1	0.231	---	---	---	---
2	0.313	---	---	---	---
3	0.234	---	---	---	---
4	0.228	---	---	---	---
5	0.307	---	---	---	---
6	0.254	---	---	---	---

7	0.568	---	---	---	---
8	0.369	---	---	---	---
9	0.359	---	---	---	---
10	0.554	---	---	---	---
11	0.392	---	---	---	---
12	0.225	---	---	---	---
13	0.456	---	---	---	---
14	0.321	---	---	---	---
15	0.313	---	---	---	---
16	0.446	---	---	---	---
17	0.343	---	---	---	---
18	---	---	---	7.254	---
19	0.230	---	---	---	---
20	0.249	---	---	---	---
21	0.339	---	---	---	---
22	0.381	---	---	---	---
23	0.303	---	---	---	---
24	0.335	---	---	---	---

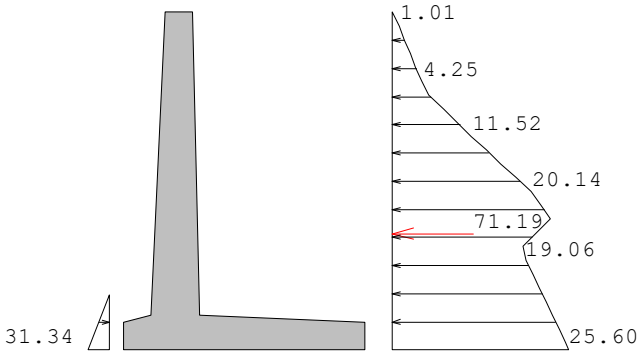
Earth pressure redistribution:

Distribution: No redistribution

Characteristical horizontal rate of the earth pressure (not redistributed):

z-Koo[m]	eh[kN/m2]
4.100	0.000
4.900	31.338
4.900	0.000

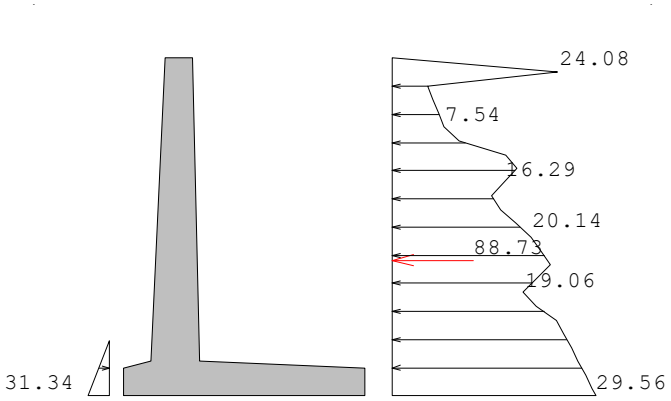
BS-P(1g):



z-Koo[m]	eh[kN/m2]
-0.000	0.000
0.200	1.012

0.400	1.822
0.600	2.632
0.800	3.442
1.000	4.252
1.200	5.306
1.400	7.596
1.600	9.482
1.800	11.519
2.000	13.645
2.200	15.743
2.400	18.030
2.600	20.144
2.800	21.703
3.000	23.056
3.200	20.967
3.400	19.055
3.600	19.423
3.800	20.426
4.000	21.408
4.200	22.370
4.400	23.289
4.600	24.334
4.800	25.178
4.900	25.601
4.900	0.000

BS-P(1q):



z-Koo[m]	eh[kN/m2]
-0.000	0.000
0.200	24.082
0.400	5.140
0.600	5.941
0.800	6.742
1.000	7.543
1.200	9.738

1.400	16.517
1.600	18.174
1.800	16.290
2.000	14.508
2.200	15.743
2.400	18.030
2.600	20.144
2.800	21.703
3.000	23.056
3.200	20.967
3.400	19.055
3.600	20.975
3.800	23.944
4.000	24.963
4.200	26.056
4.400	27.039
4.600	28.112
4.800	29.074
4.900	29.555
4.900	0.000

ULS and SLS design:

Standard: DIN EN 1992-1-1
Concrete wall: C25/30
Concrete floor: C25/30
Reinforcement: B500M
Concrete weight: 25.00 kN/m3
Reinforcement center distance hb, wall: 5.00 cm
Reinforcement center distance hb, base: 5.00 cm
Reinforcement center distance ht, wall: 5.00 cm
Reinforcement center distance ht, base: 5.00 cm

Design options:

Consider earth resistance: Yes
Consider compaction earth pressure: No
Consider load on excavation side: No
Consider weight of backfill: No
Consider earth pressure due to soil weight: Yes
Consider loadings right: Yes
Consider user-defined earth pressures: No
Consider hydrostatic pressure due to groundwate on right sider: Yes
Consider hydrostatic pressure due to groundwater: Yes
Consider user-defined loading due to water on right side: No
Design of the wall with earth pressure at rest: No

Requirements class: Class E
Structural member: Beam
Structure type:
Building construction/Building construction
Exposure classes:
XC4: Alternating wet and dry

XD2: Wet, rarely dry
XS1: Saline air but no contact to sea water

ULS design:

Minimum longitudinal reinforcement	No
Min. shear force reinforcement	No
Design of the wall as compression mem	No
Design of the spur as compression mem	No

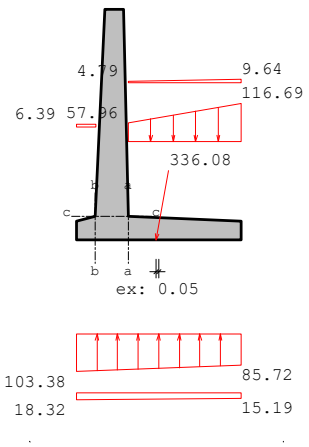
SLS design:

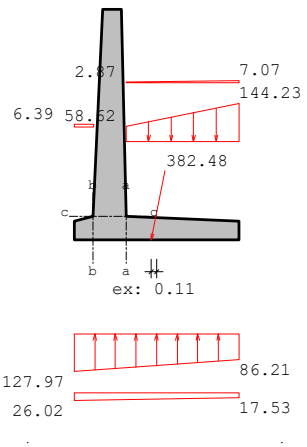
Final crack - direct crack width computation

Minimum reinforcement: Individual cra	Yes
Calculated crack width	0.30 mm
Limiting diameter top	16.00 mm
Limiting diameter bottom	16.00 mm

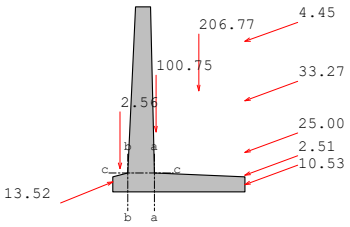
Material coefficients:

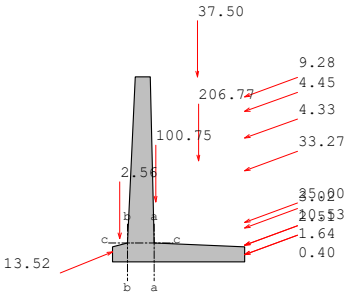
	permanent/transient	Accidental	Coefficient acc. for
Concrete	1.50	1.20	0.85
Reinforcemen	1.15	1.00	





BS BS-P(1g), BS-P(1q), Stresses acting on wall system:



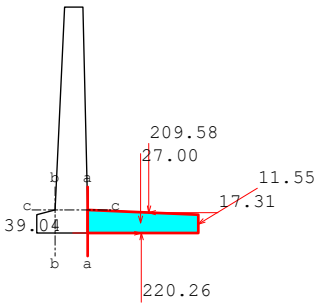


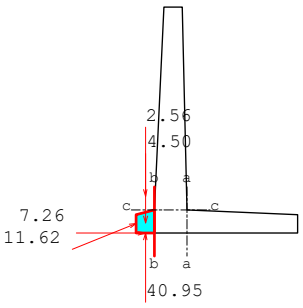
BS BS-P(1g), BS-P(1q), Forces acting on wall system:

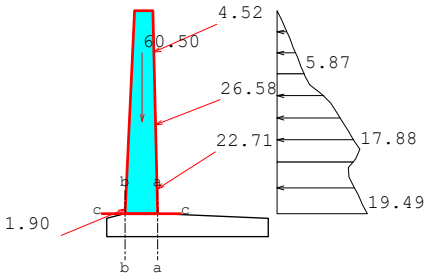
Design sections:
relating to 1m wall width

No.	Position	xm[m]	zm[m]	d[cm]
a-a	Floor level	0.10	4.65	50.00
b-b	Floor level	-0.60	4.65	50.00
c-c	Wall	-0.25	4.40	70.00

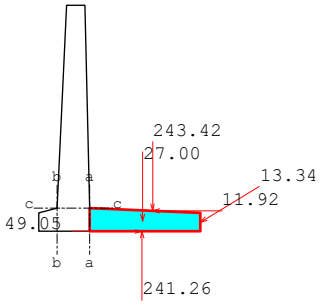
Design sections: BS-P(1)

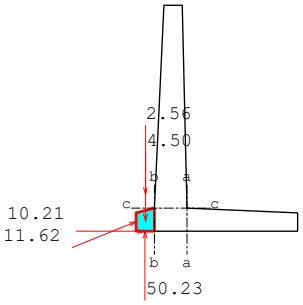


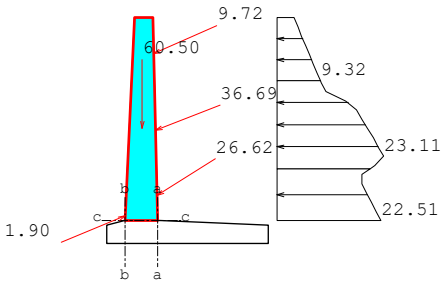




BS-P(1g), Stress resultants







BS-P(1q), Stress resultants

γG ... Partial safety factor - GZ1B permanent actions
γQ ... Partial safety factor - GZ1B variable actions
Mkg ... Characteristical permanent moment
Mkq ... Characteristical variable moment
Md ... Design moment Md

```
Nkg      ... Characteristical permanent normal force
Nkq      ... Characteristical variable normal force
Nd       ... Design normal force
Qkg      ... Characteristical permanent shear force
Qkq      ... Characteristical variable shear force
Qd       ... Design shear force
Md = Mkg*γG + Mkq*γQ
Nd = Nkg*γG + Nkq*γQ
Qd = Qkg*γG + Qkq*γQ

psi1        ... Combination coefficient for frequent loading
psi2        ... Combination coefficient for quasi, permanent loading
M,Q,N_rare  ... characteristic stress resultants, rare loading
M,Q,N_freq  ... characteristic stress resultants, frequent loading
M,Q,N_quasi ... characteristic stress resultants, quasi, permanent loading

 M_rare   = Mkg+ Mkq
 M_freq   = Mkg+ Mkq*psi1
 M_quasi  = Mkg+ Mkq*psi2
```

Stress resultants due to ULS

No.	γG	γQ	Mkg	Mkq	Md	Nkg	Nkq	Nd
a-a	1.35	1.50	-54.06	-37.10	-128.62	11.83	13.86	36.76
b-b	1.35	1.50	6.36	1.16	10.31	-18.03	-2.95	-28.77
c-c	1.35	1.50	63.16	36.45	139.94	-83.44	-7.90	-124.50

No.	Qkg	Qkq	Qd
a-a	22.27	13.76	50.70
b-b	38.24	9.29	65.56
c-c	-46.32	-17.46	-88.72

Stress resultants SLS

No.	psi1	psi2	γG	γQ	M,rare	M,freq	M,quasi
a-a	0.75	0.20	1.35	1.50	-91.15	-81.88	-61.48
b-b	0.75	0.20	1.35	1.50	7.51	7.22	6.59
c-c	0.75	0.20	1.35	1.50	99.61	90.49	70.45

No.	N,rare	N,freq	N,quasi	Q,rare	Q,freq	Q,quasi
a-a	25.69	22.22	14.60	36.03	32.59	25.02
b-b	-20.98	-20.25	-18.62	47.53	45.21	40.10
c-c	-91.34	-89.37	-85.02	-63.78	-59.42	-49.81

Necessary longitudinal reinforcement due to ULS and SLS:

```
aso  [cm2]          ... Required longitudinal reinforcement top
asu  [cm2]          ... Required longitudinal reinforcement bottom
epsz[o/oo]          ... Steel strain
epsd[o/oo]          ... Concrete compressive strain
```

zi[m] ... Inner lever arm

No.	aso	asu	epsz	epsd	zi
a-a	7.14	0.00	11.23	-1.09	0.44
b-b	0.00	0.17	11.15	-0.39	0.44
c-c	0.00	3.53	10.84	-0.88	0.63

Necessary shear reinforcement due to ULS and SLS:

ass[cm2/m] ... Required shear reinforcement, under 90°
VRdct[kN] ... Shear force capacity of the bending reinforcement
VRdmax[kN] ... Shear force capacity of the compressive strut
vsd [kN] ... Decisive shear force
VRd,s[kN] ... Shear force capacity of the shear reinforcement component
rho[%] ... Percentage of reinforcement longitudinal
theta[°] ... Compression strut inclination asccording to DAfStb/H.425

No.	ass	vsd	VRdct	VRdmax	VRd,s	rho	theta
a-a	0.00	50.70	165.47	1965.63	0.00	0.159	45.0
b-b	0.00	65.56	172.55	1965.63	0.00	0.004	45.0
c-c	0.00	88.72	218.63	3028.12	0.00	0.054	45.0

Soil mechanic analysis of the overall stability:

relating to 1m wall width

Verification of the static equilibrium in EQU:

Nodal point at the lowest left corner of the wall:
x=-1.00 z=4.90 [m]

P ... Value of the load vector [kN]
Pv ... Vertical component of P [kN]
Ph ... Horizontal component of P [kN]
WEQU ... Actions in EQU favorable=favorable unfavorable=unfavorable
WSTR ... Actions in STR favorable=favorable unfavorable=unfavorable
Type ... Type of loading variable=Q, permanent=G, passive earth pressure=Ep
gamma ... Partial safety factores in EQU and STR
M,k ... characteristic moment about the wall node
M,EQU ... Moment about the wall node, increased by partial safety factor

BS-P(1q):

P[kN]	Type	x-pos	z-pos	Pv[kN]	Ph[kN]	WEQU	γEQU	M,k	M,EQU
2.56	G	-0.81	4.28	2.56	0.00	favorab	0.90	0.49	0.45
13.52	GEp	-1.00	4.63	-5.06	-12.54	favorab	0.90	3.34	3.01
4.45	G	2.50	0.91	1.52	4.18	unfavor	1.10	-11.35	-12.49
9.28	Q	2.50	0.53	3.18	8.73	unfavor	1.50	-27.04	-40.56
33.27	G	2.50	2.48	11.38	31.26	unfavor	1.10	-35.86	-39.44
4.33	Q	2.50	1.62	1.48	4.07	unfavor	1.50	-8.17	-12.25
25.00	G	2.50	3.86	8.55	23.49	favorab	0.90	5.38	4.85
3.02	Q	2.50	4.00	1.03	2.84	favorab	0.00	1.07	0.00
2.51	G	2.50	4.45	0.86	2.35	favorab	0.90	1.94	1.75
0.40	Q	2.50	4.45	0.14	0.38	favorab	0.00	0.31	0.00
10.53	G	2.50	4.70	3.60	9.90	favorab	0.90	10.65	9.59
1.64	Q	2.50	4.70	0.56	1.54	favorab	0.00	1.65	0.00

100.75	G	0.14	3.31	100.75	0.00	favorab	0.90	115.15	103.63
37.50	Q	1.25	0.00	37.50	0.00	favorab	0.00	84.37	0.00
206.77	G	1.28	2.21	206.77	0.00	favorab	0.90	471.34	424.21
				374.81	76.20			613.29	442.72

Md, favorable= 547.47 >= Md,unfavorable=104.75 ... Verification achieved

e= sum_Mk/sum_Pv= 613.29/374.81= 1.64 vorh_e=bl/2-e= 0.11 m

Bottom pressure in GEO-2:

BS-P(1q):

P[kN]	Type	x-pos	z-pos	Pv[kN]	Ph[kN]	γSTR	Rvd	Rhd
2.56	G	-0.81	4.28	2.56	0.00	1.00	2.56	0.00
13.52	GEp	-1.00	4.63	-5.06	-12.54	-	0.00	0.00
4.45	G	2.50	0.91	1.52	4.18	1.35	2.06	5.65
9.28	Q	2.50	0.53	3.18	8.73	1.50	4.76	13.09
33.27	G	2.50	2.48	11.38	31.26	1.35	15.36	42.20
4.33	Q	2.50	1.62	1.48	4.07	1.50	2.22	6.10
25.00	G	2.50	3.86	8.55	23.49	1.35	11.54	31.71
3.02	Q	2.50	4.00	1.03	2.84	1.50	1.55	4.26
2.51	G	2.50	4.45	0.86	2.35	1.35	1.16	3.18
0.40	Q	2.50	4.45	0.14	0.38	1.50	0.21	0.56
10.53	G	2.50	4.70	3.60	9.90	1.35	4.86	13.36
1.64	Q	2.50	4.70	0.56	1.54	1.50	0.84	2.31
100.75	G	0.14	3.31	100.75	0.00	1.35	136.01	0.00
37.50	Q	1.25	0.00	37.50	0.00	1.50	56.25	0.00
206.77	G	1.28	2.21	206.77	0.00	1.00	206.77	0.00
				374.81	76.20		446.15	122.42

Characteristic resultant Rk=382.48 kN of Rvk=374.81 Rhk=76.20
The resultant load in STR without Ep Rd=462.64 kN ... Rv,d=446.15 Rh,d=122.42

Embedment depth: 0.80 m
Settlement sensibility: Settlement sensitive structural component
Cohesive soil? Non cohesive soil
User-defined admissible stress: No
reduced width b' b'= 2* (b/2- e) e...Eccentricity

LF BS-P(1q)
Inclination of the base pressure resultant H/V=76.20 kN /374.81 kN = 0.20
ANALYSIS NOT POSSIBLE: Inclination of the base pressure resultant > 0.2

Lateral buckling analysis for EQU, permanent loads

```
Length of the the foundation bottom edge b:   3.500 m
Admissible eccentricity for dead load b/6:    0.583 m

Rk [kN]   ... Resulting characteristical loading
Asohl [%] ... Overpressed floor level
```

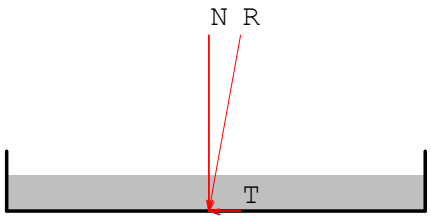
BS	Rk[kN]	exis.e[m]	adm.e[m]	Abase[%]	Verifi. complied
BS-P(1g)	336.08	0.05	0.58	100.00	Yes

Lateral buckling analysis for EQU, permanent and variable loads

```
Admissible eccentricity b/3:    1.167 m

Rk [kN]   ... Resulting characteristical loading
Asohl [%] ... Overpressed floor level
```

BS	Rk[kN]	exis.e[m]	adm.e[m]	Abase[%]	Verifi. complied
BS-P(1q)	382.48	0.11	1.17	100.00	Yes

Slip verification by GEO-2:



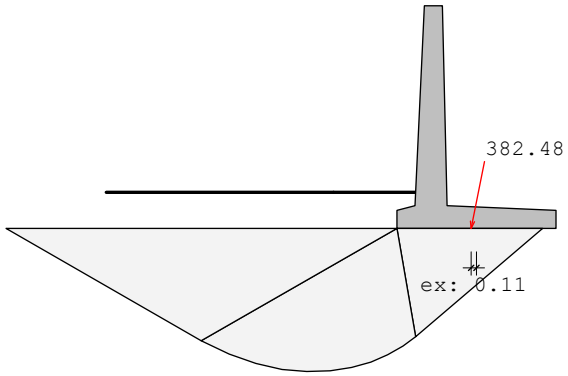

```
 Sliding safety:

floor level friction coefficient:                    seated equal to phi
Consider earth resistance:              with 50%
weighted phi of the surrounding soil layer:  27.50 °
Inclination of floor level:                          0.00 °

Ep[kN]   ... Earth resistance without reduction
Epk[kN]  ... Characteristical, mobilized value of the earth resistance
γEpk     ... Partial safety factor - earth resistance
Epd[kN]  ... Design value of earth resistance

Rtd[kN]  ... Design value of the sliding resistance
Rtk[kN]  ... Characteristical sliding resistance
γGl      ... Partial safety factor - limit state GZ1B

Nk[kN]   ... Vertical acting component of the characteristical stress
δSk[°]   ... Chara. value of the angle of skin friction in the floor level
```

```
Td[kN]   ... Design value of the stress parallel to the floor level
TGk[kN]  ... Due to permanent loads
TQk[kN]  ... Due to live loads
γG       ... Partial safety factor - permanent actions GZ1B
γE0g     ... Partial safety factor - earth pressure at rest GZ1B
γQ       ... Partial safety factor - unfavorable variable actions GZ1B
```

BS-P(1q):

```
Epk = Ep*0.50= 41.78*0.50 = 20.89 kN
Epd = Epk/γEp = 20.89/1.40 = 14.92 kN
Rtk = Nk*tanδSk = 379.88*tan(27.50°) = 197.75 kN
Rtd = Rtk/γGl = 197.75/1.10 = 179.77 kN
Td = TGk*γG + TQk*γQ = 71.19*1.35 + 17.54*1.50 = 122.42 kN
Td <= Rtd + Epd      122.42<=179.77+14.92
... Analysis fulfilled BS-P(1q)
```

Base failure analysis by GEO-2:



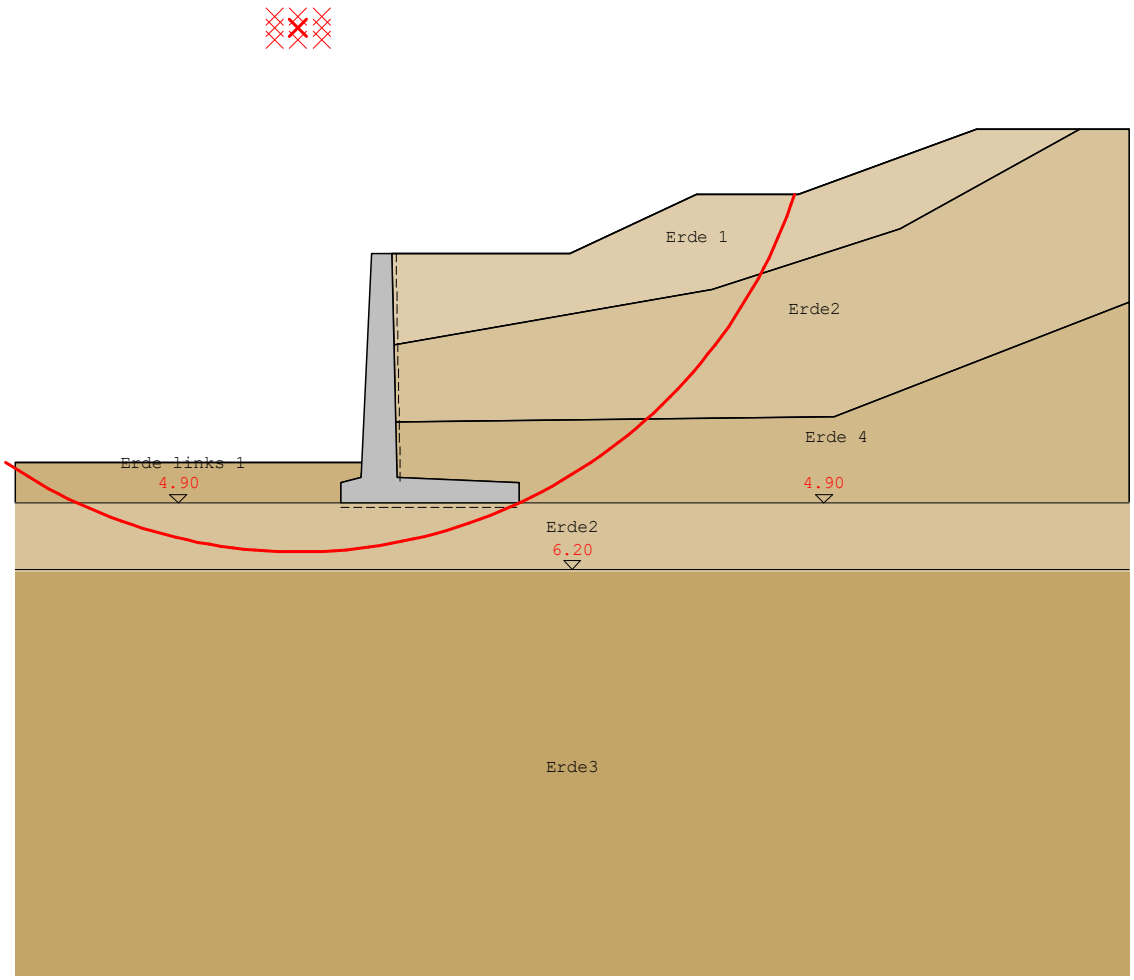

```
Fracture body, LC 1(q)
```

Base failure resistance formula:

```
Rnk  =a'*b'* [γ2*b'*Nb + (γ1*d+q) *Nd + c*Nc]  ... DIN 4017

A strip foundation is assumed.
 b' = b-2eb
Nb = Nb0 * νb * ib * λb * ξb
Nd = Nd0 * νd * id * λd * ξd
Nc = Nc0 * νc * ic * λc * ξc

 Ground slope at excavation side:   0.00 °
 Inclination of floor level:        0.00 °
 Consider earth resistance:  no
 Nk    ... Characteristical stress vertical to the foundation floor
 Tk    ... Characteristical stress parallel to the foundation floor
 Epk   ... Unrelieved earth resistance
 Bk    ... Soil reaction ( Bk= Factor[%]*Epk )
```

```
 delta ... Load inclination tan(delta)= Tk/Nk
 Rnk   ... Characteristical base failure resistance
 Rnd   ... Design value of the base failure resistance = Rnk / Safety

 BS     Form    Inclin.  Structural streGround incli. Base incli.  Design force
 ------------------------------------------------------------------------------
BS-P( νc: 1.00  ic: 0.56   Nc0: 29.24     λc: 1.00     ξc: 1.00      N: 519.42
      νd: 1.00  id: 0.59   Nd0: 17.62     λd: 1.00     ξd: 1.00      T: 122.42
      νb: 1.00  ib: 0.45    Nb0: 9.45     λb: 1.00     ξb: 1.00      eb: 0.14
     |delta|=13.15°  <=  φk=29.62°
     Nd=NG,k*γG + NQ,k*γQ = 335.99*1.35 + 43.89*1.50= 519.42 kN
     Td=TG,k*γG + TQ,k*γQ = 71.19*1.35 + 17.54*1.50= 122.42 kN
     Rnk=1.00*3.21* [19.00*3.21*4.25 +
                     (18.00*0.80+0.00) *10.35 +
                     0.00*16.45]= 1312.20 kN

     Rnd= Rnk / γGr= 1312.20/1.40= 937.29 kN
          Rnd >= Nd ... Verification complied


  Verification of the design situation BS-P(1q) achieved
```

Slip circle analysis by GEO-3:



Slip circle with minimum safety

Number of examined circles: 956
Grid spacing of the center of circles: x:0.46 m z:0.23 m

Relevant slip circle:

BS	x-Coo[m]	z-Koo[m]	Radius[m]	Rd	Ed	Rd/Ed	fulfill
BS-P(1g)	-1.84	-4.44	10.30	371.76	280.77	1.32	Yes
BS-P(1q)	-1.84	-4.44	10.30	423.95	348.23	1.22	Yes

Settlement analysis in SLS

```
Settlement in the left (A) and right point (B) at the bottom edge of the wall.
A gaping joint exists, if the resultant of the base pressure is within the core.

 User-def. embedment depth:      None      calculated depth:  0.80 m
 set limiting depth:       None      calculated depth:  7.00 m

    BS      Point A[cm]   Point B[cm]    Gaping joint:
 ------------------------------------------------------------
 BS-P(1q)          3.43          2.31     not existing
```

Overview of the analyses

Overview safety verifications overall stability

Verification of the static equilibrium in EQU:

BS-P(1q):

```
   Md, favorable= 547.47 >= Md,unfavorable=104.75  ... Verification achieved
   e= sum_Mk/sum_Pv= 613.29/374.81= 1.64    vorh_e=bl/2-e= 0.11 m
```

Bottom pressure in GEO-2:

```
LF BS-P(1q)
  Inclination of the base pressure resultant H/V=76.20 kN /374.81 kN = 0.20
  ANALYSIS NOT POSSIBLE: Inclination of the base pressure resultant > 0.2
```

Lateral buckling analysis for EQU, permanent and variable loads

```
    BS       Rk[kN]   exis.e[m]  adm.e[m]   Abase[%]  Verifi. complied
 ------------------------------------------------------------------------
 BS-P(1q)      382.48      0.11      1.17      100.00        Yes
```

Lateral buckling analysis for EQU, permanent loads

```
    BS       Rk[kN]   exis.e[m]  adm.e[m]   Abase[%]  Verifi. complied
 ------------------------------------------------------------------------
 BS-P(1g)      336.08      0.05      0.58      100.00        Yes
```

Slip verification by GEO-2:

```
 Td <= Rtd + Epd      122.42<=179.77+14.92 ... Analysis fulfilled BS-P(1q)
```

Base failure analysis by GEO-2:

```
  BS-P(1q):  Rnd >= Nd = 937.29>=519.42 ... Verification ok

  Verification of the design situation BS-P(1q) achieved
```

Slip circle analysis by GEO-3:

```
  Relevant slip circle:
   BS    x-Coo[m] z-Koo[m]  Radius[m]     Rd         Ed      Rd/Ed fulfill
 ------------------------------------------------------------------------
BS-P(1g)    -1.84    -4.44      10.30     371.76     280.77   1.32   Yes
BS-P(1q)    -1.84    -4.44      10.30     423.95     348.23   1.22   Yes
```

Necessary longitudinal reinforcement due to ULS and SLS: (LF BS-P(1))

```
No.      aso        asu       epsz       epsd        zi
-----------------------------------------------------------
```

a-a	7.14	0.00	11.23	-1.09	0.44
b-b	0.00	0.17	11.15	-0.39	0.44
c-c	0.00	3.53	10.84	-0.88	0.63

Necessary shear reinforcement due to ULS and SLS: (LF BS-P(1))

No.	ass	vsd	VRdct	VRdmax	VRd,s	rho	theta
a-a	0.00	50.70	165.47	1965.63	0.00	0.159	45.0
b-b	0.00	65.56	172.55	1965.63	0.00	0.004	45.0
c-c	0.00	88.72	218.63	3028.12	0.00	0.054	45.0