

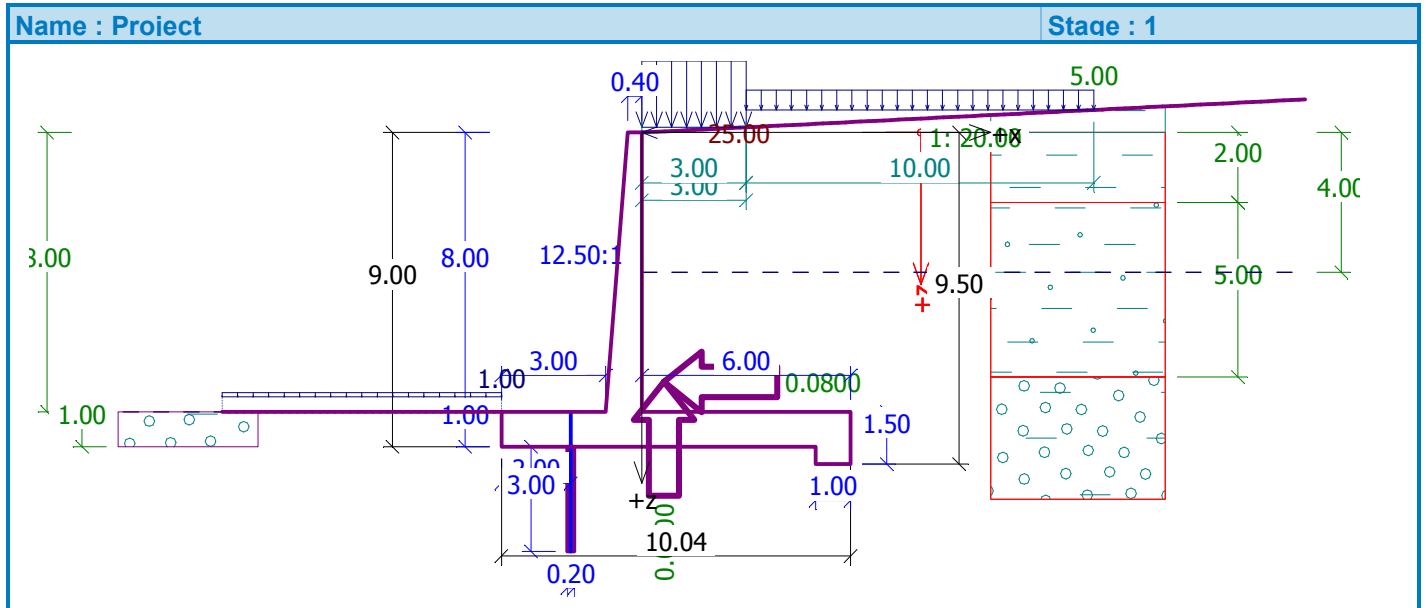


Cantilever wall analysis

Input data

Project

Task : Cantilever Wall
Part : v.1.2
Descript. : Cantilever Earth Retaining Wall of 8 m High with Water Pressure & Earthquake Actions
Author : Dr. Costas Sachpazis
Customer : A.K.C. Construction SA
Date : 07-Dec-13



Material of structure

Unit weight $\gamma = 24.00 \text{ kN/m}^3$

Analysis of concrete structures carried out according to the standard EN 1992 1-1 (EC2).

Concrete : C 40/50

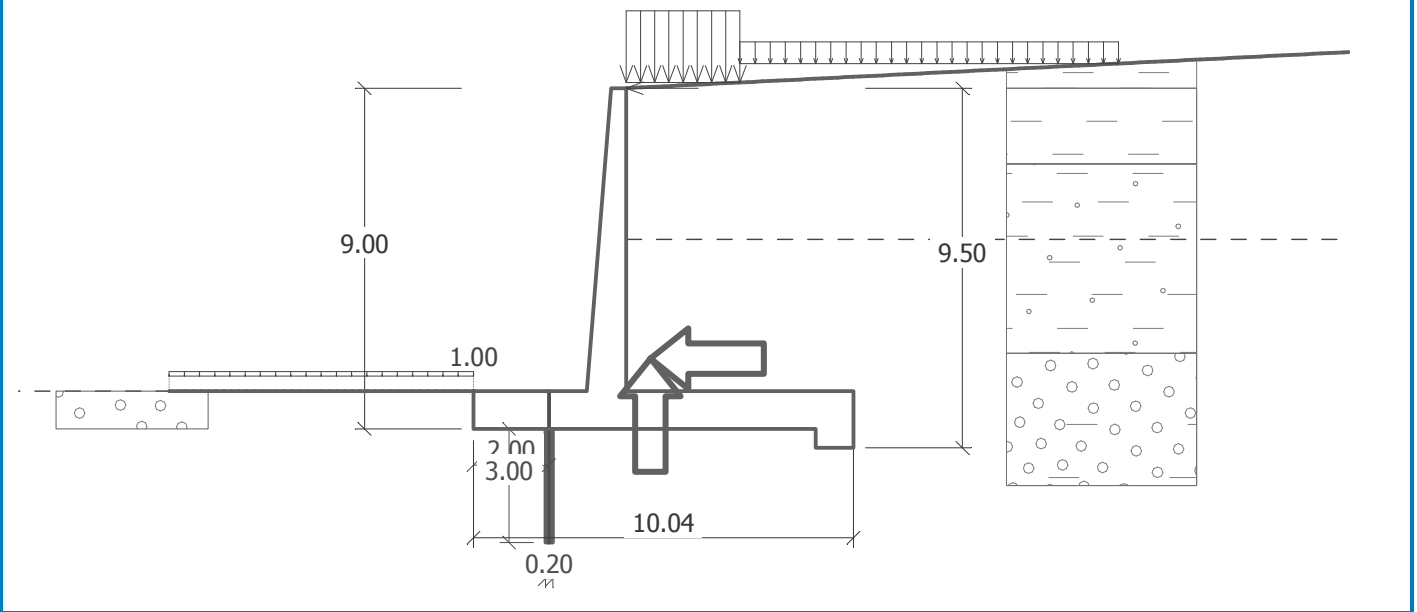
Longitudinal steel : B500

Name : Material	Stage : 1
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Name : Material

Stage : 1



Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	8.00
3	6.00	8.00
4	6.00	9.00
5	6.00	9.50
6	5.00	9.50
7	5.00	9.00
8	-4.04	9.00
9	-4.04	8.00
10	-1.04	8.00
11	-0.40	0.00

The origin [0,0] is located at the most upper right point of the wall.
 Wall section area = 16.30 m².

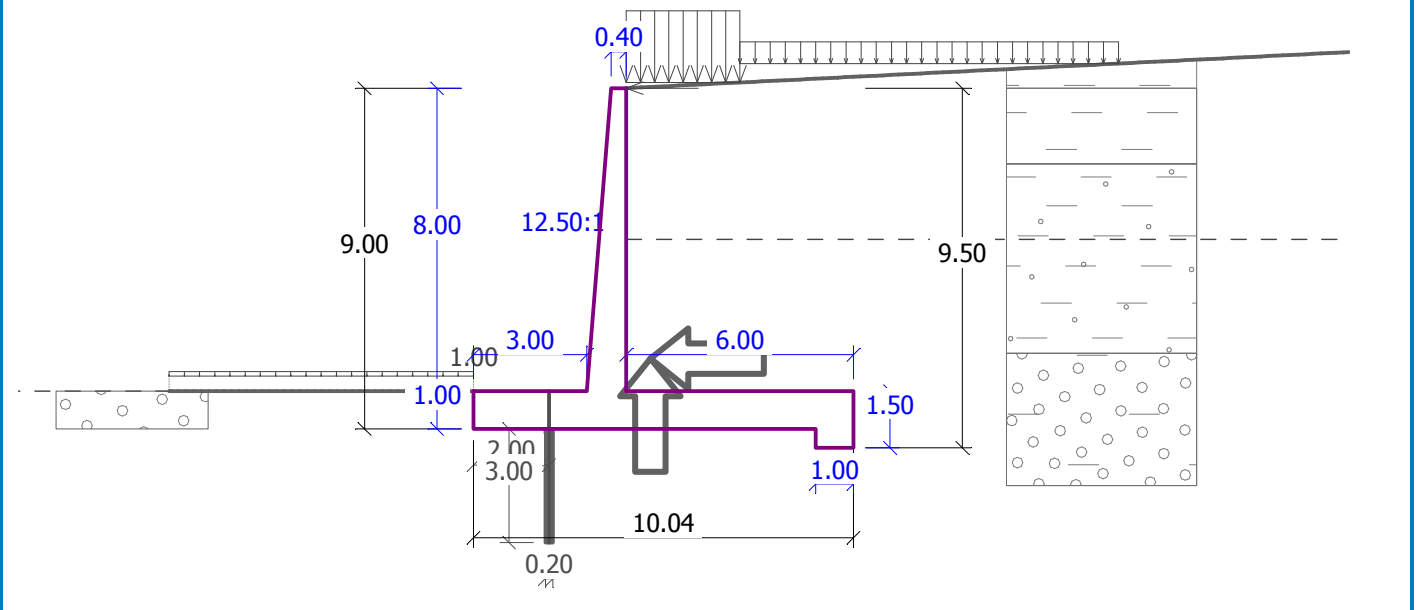
Name : Geometry

Stage : 1



Name : Geometry

Stage : 1



Basic soil parameters

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]
1	High plasticity clay (CH,CV,CE), consistency soft		15.00	5.00	20.50	11.00	12.00
2	Sandy clay (CS), consistency stiff $S_r < 0.8$		24.50	33.00	18.50	9.00	18.00
3	Clayey gravel (GC)		30.00	6.00	19.50	10.00	24.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	ϕ [°]	ν [-]	OCR [-]	K_r [-]
1	High plasticity clay (CH,CV,CE), consistency soft		cohesive	-	0.42	-	-
2	Sandy clay (CS), consistency stiff $S_r < 0.8$		cohesive	-	0.35	-	-
3	Clayey gravel (GC)		cohesionless	30.00	-	-	-

Soil parameters

High plasticity clay (CH,CV,CE), consistency soft

Unit weight : $\gamma = 20.50$ kN/m³
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 15.00$ °
 Cohesion of soil : $c_{ef} = 5.00$ kPa
 Angle of friction struc.-soil : $\delta = 12.00$ °
 Soil : cohesive
 Poisson's ratio : $\nu = 0.42$
 Saturated unit weight : $\gamma_{sat} = 21.00$ kN/m³

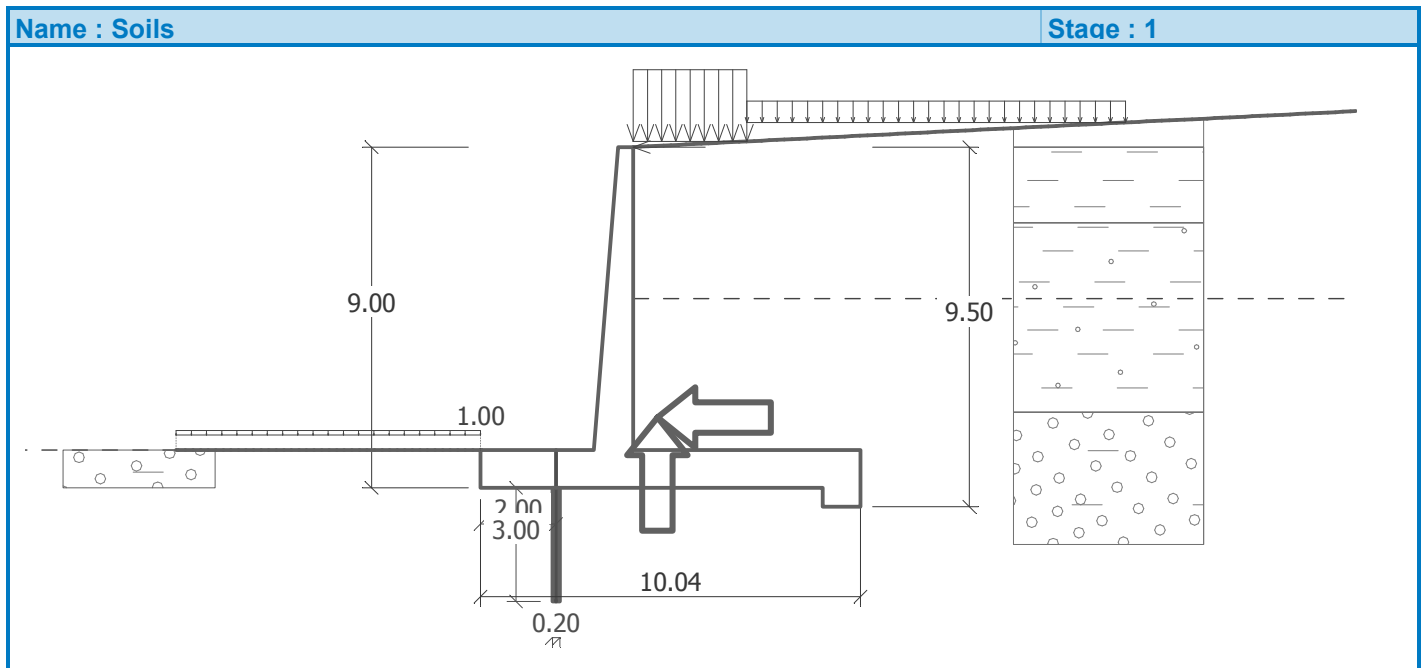


Sandy clay (CS), consistency stiff $S_r < 0.8$

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 24.50^\circ$
 Cohesion of soil : $c_{ef} = 33.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 18.00^\circ$
 Soil : cohesive
 Poisson's ratio : $\nu = 0.35$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Clayey gravel (GC)

Unit weight : $\gamma = 19.50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 6.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 24.00^\circ$
 Soil : cohesionless
 Saturated unit weight : $\gamma_{sat} = 20.00 \text{ kN/m}^3$



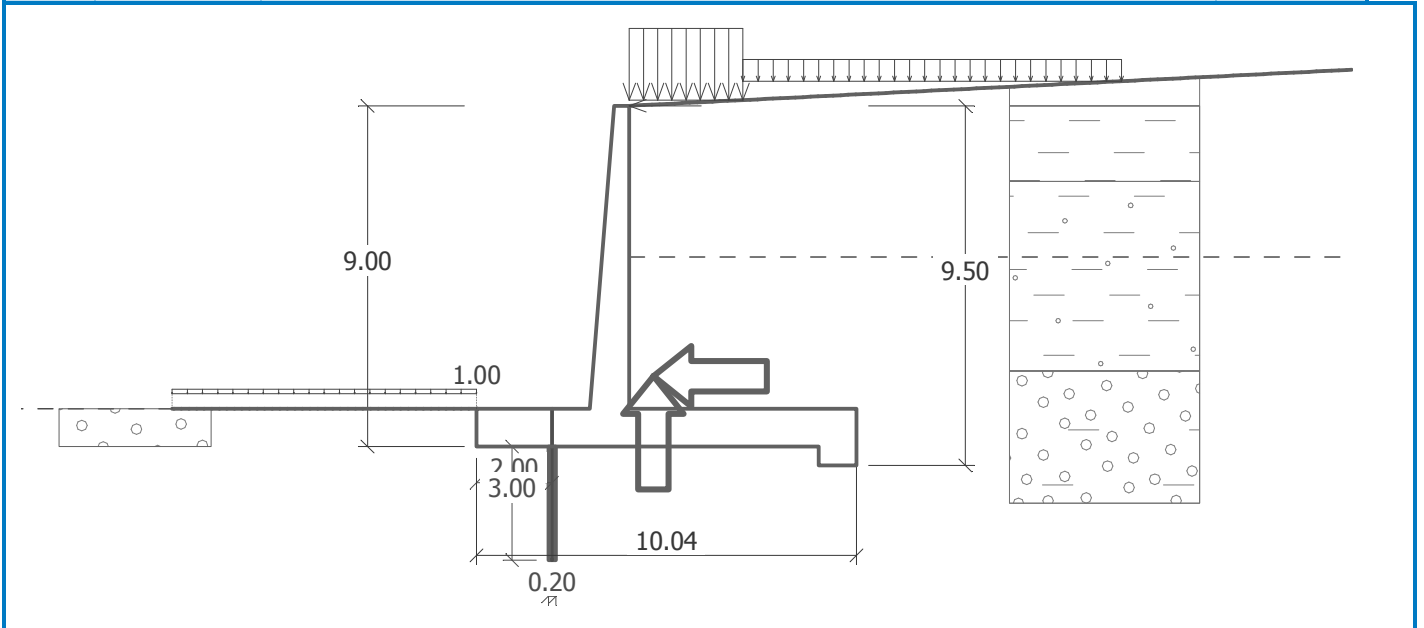
Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	2.00	High plasticity clay (CH,CV,CE), consistency soft	
2	5.00	Sandy clay (CS), consistency stiff $S_r < 0.8$	
3	-	Clayey gravel (GC)	

Name : Profile and assignment **Stage : 1**



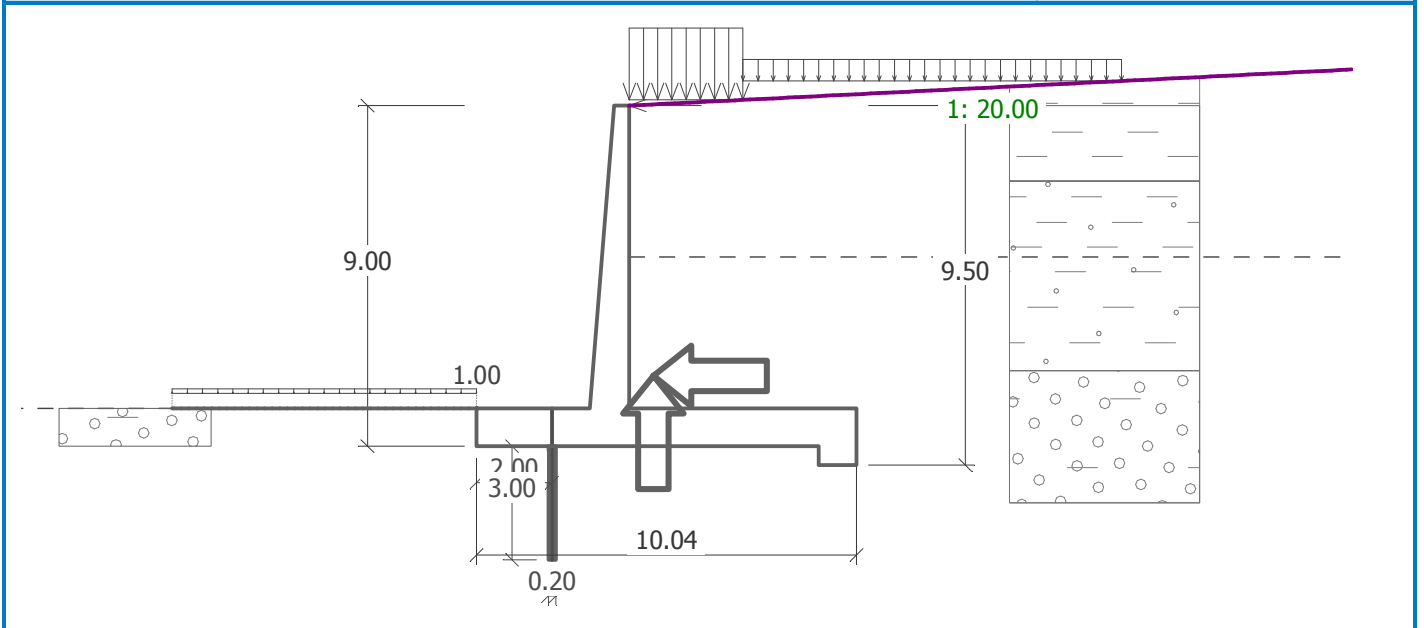
No.	Layer [m]	Assigned soil	Pattern
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Terrain profile

Terrain behind construction has the slope 1: 20.00 (slope angle is 2.86 °).

Name : Terrain	Stage : 1
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Water influence

GWT behind the structure lies at a depth of 4.00 m

GWT in front of the structure lies at a depth of 8.00 m

Subgrade at the heel is not permeable.

Uplift in foot. bottom due to different pressures is considered as linear.

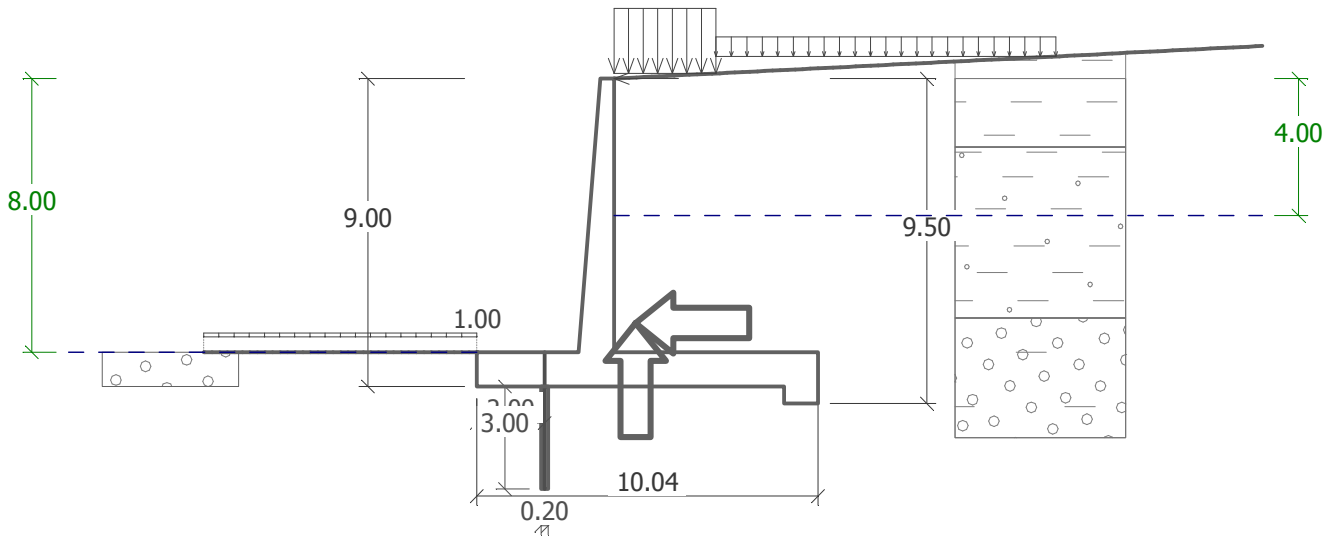
The evolution of tensile cracks is considered in the analyses. Depth of cracks is 0.30 m.

Name : Water	Stage : 1
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Name : Water

Stage : 1

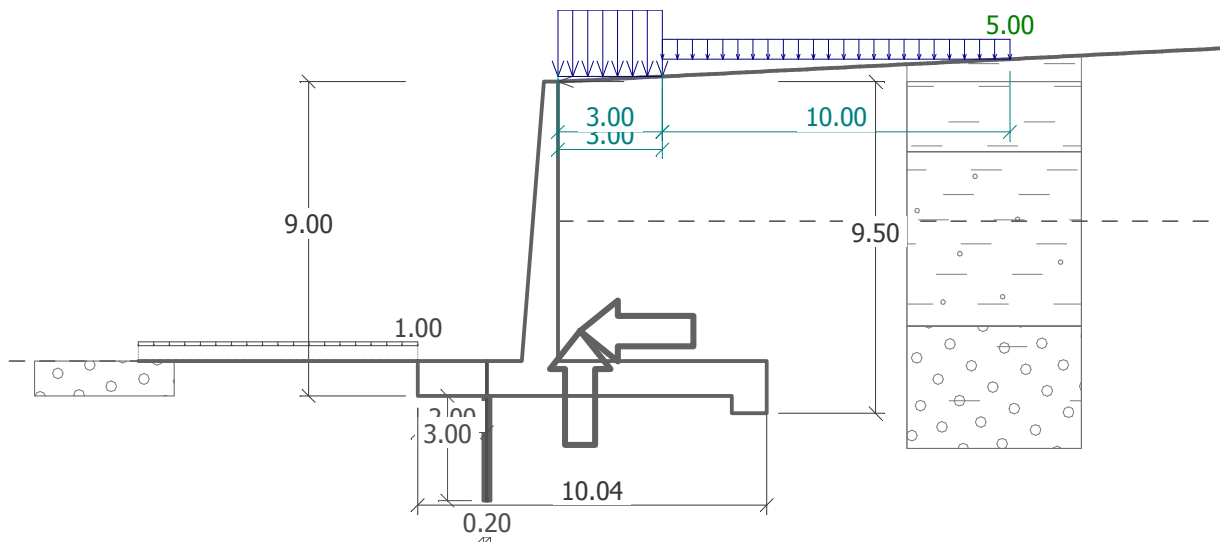


Inserted surface loads

No.	Surcharge new	Surcharge change	Type	Name	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		Strip	Traffic Surcharge	16.70		0.00	3.00	on terrain
2	YES		Strip	General Surcharge	5.00		3.00	10.00	on terrain

Name : Surcharge

Stage : 1

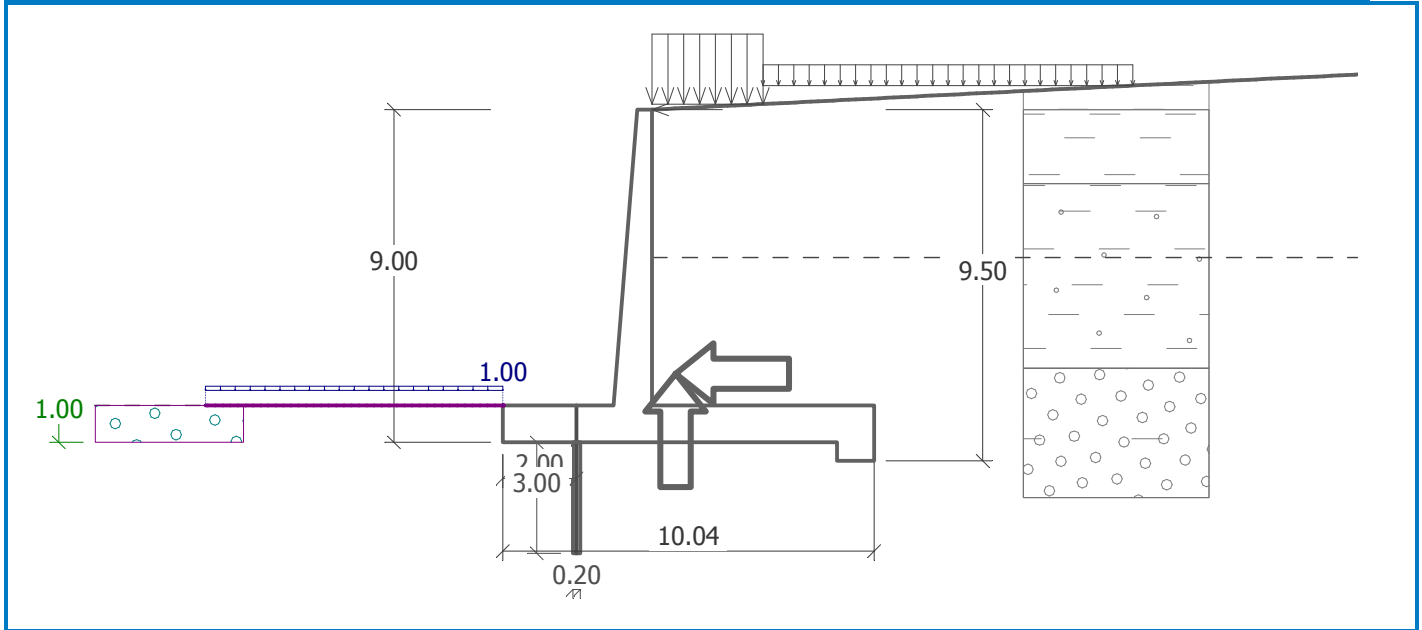


Resistance on front face of the structure

Resistance on front face of the structure: at rest
 Soil on front face of the structure - Clayey gravel (GC)
 Soil thickness in front of structure $h = 1.00$ m
 Terrain surcharge $f = 1.00$ kN/m²
 Terrain in front of structure is flat.

Name : FF resistance

Stage : 1

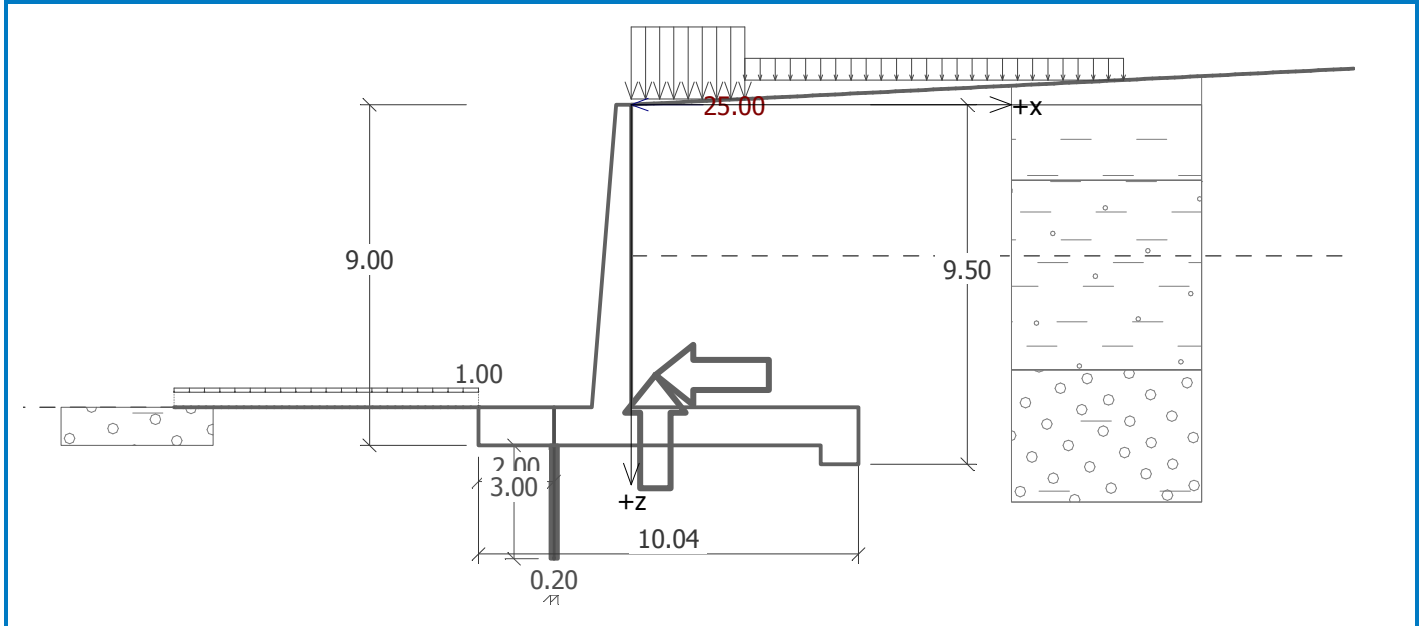


Applied forces acting on the structure

No.	Force new	change	Name	Fx [kN/m]	Fz [kN/m]	M [kNm/m]	x [m]	z [m]
1	YES		Force No. 1	-25.00	0.00	0.00	0.00	0.00

Name : Applied forces

Stage : 1



Earthquake

Horizontal seismic coefficient $K_h = 0.0800$
 Vertical seismic coefficient $K_v = 0.0400$
 Coeff. to compute point of application $k.H = 0.66$
 Water below the GWT is free.
 Unit weight of soil skeleton $G_s = 2.50$.

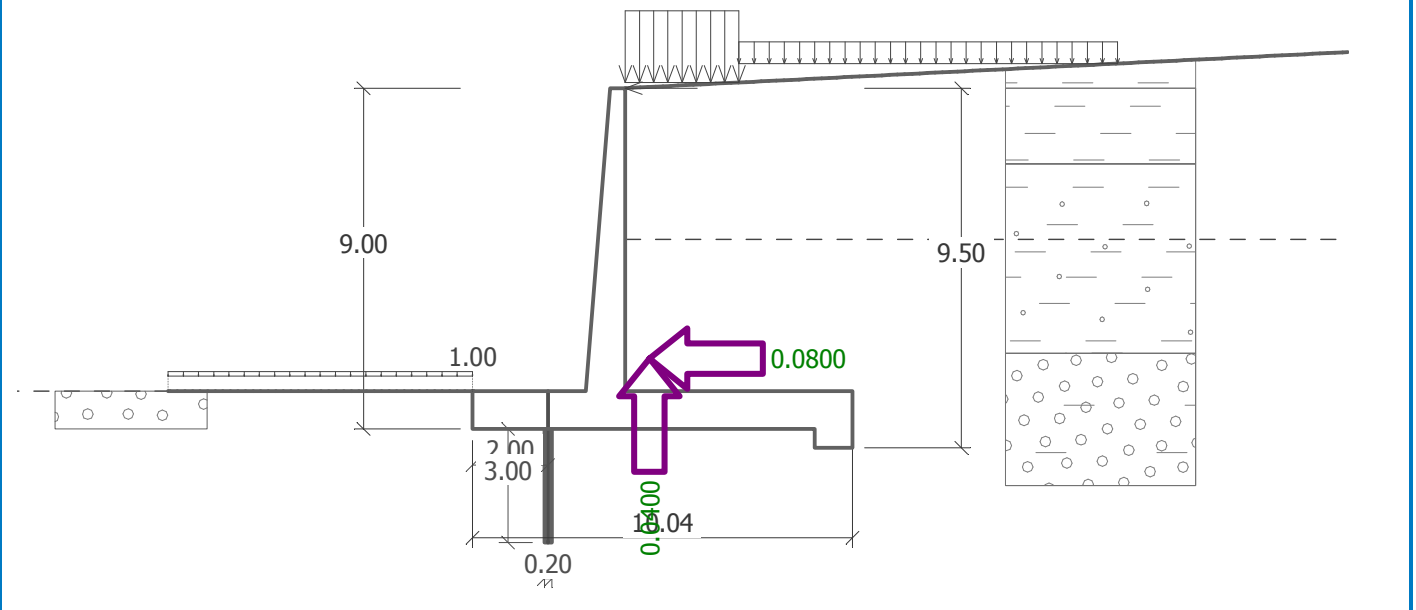
Name : Earthquake

Stage : 1



Name : Earthquake

Stage : 1



Base anchorage

Geometry

- Spacing $x = 2.00$ m
- Depth $h = 3.00$ m
- Hole diameter $d = 0.20$ m
- Spacing of holes $v = 1.00$ m

Pull out resistance is derived from parameters

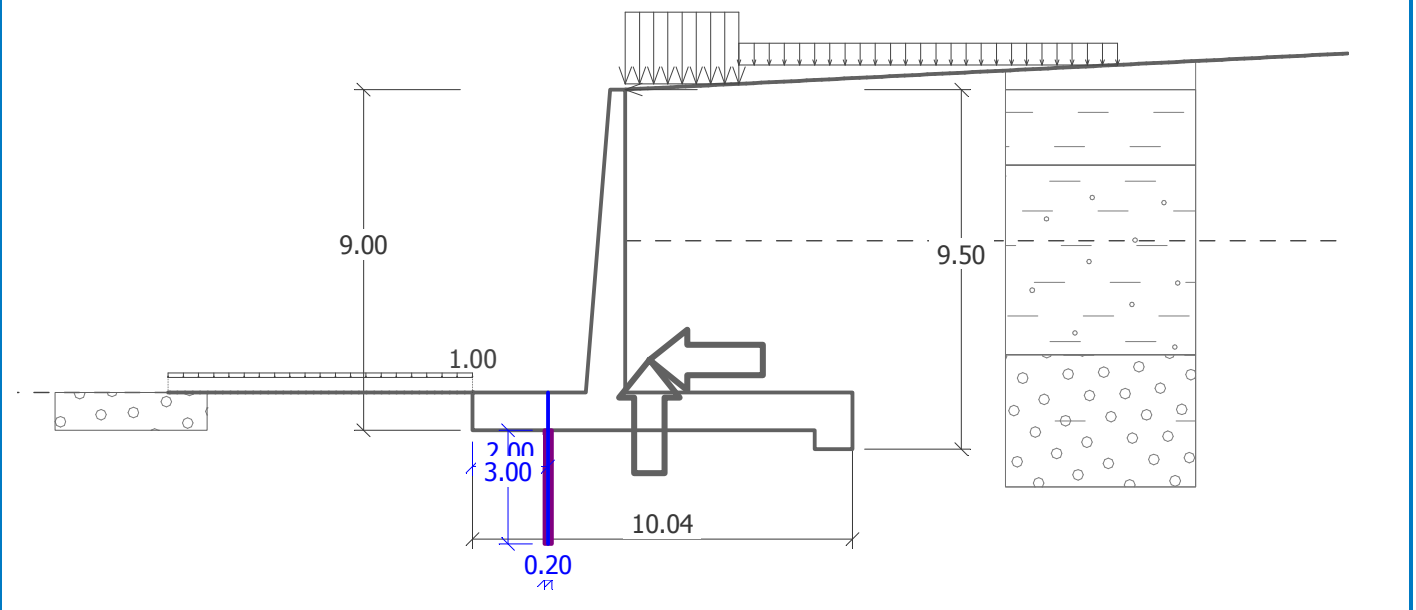
- Ultimate bond $a = 20.00$ kPa
- Safety factor $SF_e = 1.50$

Strength of reinforcement is derived from parameters

- Bar diameter $d_s = 25.0$ mm
- Ultimate strength $f_y = 500.00$ MPa
- Safety factor $SF_t = 1.50$

Name : Base anchorage

Stage : 1



Analysis settings

Active earth pressure calculation - Coulomb (CSN 730037)

W: www.geodomi.com, E: info@geodomi.com



Passive earth pressure calculation - Caquot-Kerisel (CSN 730037)
Earthquake analysis theory - Mononobe-Okabe
Standard for concrete structures - EN 1992 1-1 (EC2)
Analysis carried out according to classical theory (safety factor)

Safety factor for slip = 1.50
Safety factor for overturning = 1.50
Factor of safety for bearing capacity = 1.50
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1

Pressure at rest on front face of the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m ³]	K_r	Comment
1	1.00	0.00	30.00	6.00	10.00	0.500	

Pressure at rest distribution on front face of the structure

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	0.00	0.00	0.00	0.00	0.00
	1.00	10.00	0.00	5.00	5.00	0.00

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m ³]	δ_d [°]	K_a	Comment
1	0.29	31.14	15.00	5.00	20.50	15.00	0.908	
2	1.77	31.14	15.00	5.00	20.50	15.00	0.908	
3	2.00	31.14	24.50	33.00	18.50	24.50	0.786	
4	3.00	31.14	24.50	33.00	9.00	24.50	0.786	
5	1.00	31.14	30.00	6.00	10.00	30.00	0.735	
6	1.00	0.00	30.00	6.00	10.00	24.00	0.307	
7	0.50	0.00	30.00	6.00	10.00	24.00	0.307	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00	0.00	0.00	0.00
	0.23	5.92	0.00	0.00	0.00	0.00
2	0.23	5.92	0.00	0.00	0.00	0.00
	2.00	42.16	0.00	32.90	22.80	23.72
3	2.00	42.16	0.00	1.76	0.99	1.45
	4.00	79.16	0.00	30.85	17.41	25.47
4	4.00	79.16	0.00	30.85	17.41	25.47
	7.00	106.16	30.00	52.08	29.39	42.99
5	7.00	106.16	30.00	72.69	35.08	63.66
	8.00	116.16	40.00	80.04	38.63	70.10
6	8.00	116.16	40.00	29.86	27.28	12.14
	9.00	126.16	40.00	32.93	30.08	13.39



Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
7	9.00	126.16	40.00	32.93	30.08	13.39
	9.50	131.16	40.00	34.47	31.49	14.02

Earthquake effects (active earth pressure) - partial results

Layer No.	Thickness [m]	ϕ_d [°]	ψ [°]	K_a	K_{ae}	$K_{ae}-K_a$	Comment
1	0.29	15.00	4.76	0.908	1.056	0.148	
2	1.77	15.00	4.76	0.908	1.056	0.148	
3	2.00	24.50	4.76	0.781	0.912	0.131	
4	3.00	24.50	7.91	0.781	1.032	0.251	
5	1.00	30.00	7.91	0.733	0.987	0.254	
6	1.00	30.00	7.91	0.307	0.419	0.112	
7	0.50	30.00	7.91	0.307	0.419	0.112	

Earthquake effects (active earth pressure)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_D [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vertical comp. [kPa]
1	-0.06	0.00	125.91	13.86	9.61	10.00
	0.23	5.68	120.23	13.24	9.17	9.55
2	0.23	5.68	120.23	13.24	9.17	9.55
	2.00	40.47	85.44	9.41	6.52	6.78
3	2.00	40.47	85.44	8.41	4.75	6.94
	4.00	75.99	49.92	4.91	2.77	4.06
4	4.00	75.99	49.92	10.93	6.17	9.02
	7.00	101.91	24.00	5.25	2.96	4.34
5	7.00	101.91	24.00	5.36	2.59	4.69
	8.00	111.51	14.40	3.21	1.55	2.82
6	8.00	111.51	14.40	1.44	1.31	0.58
	9.00	121.11	4.80	0.48	0.44	0.19
7	9.00	121.11	4.80	0.48	0.44	0.19
	9.50	125.91	0.00	0.00	0.00	0.00

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00
2	0.23	0.00	0.00
3	2.00	0.00	0.00
4	4.00	0.00	0.00
5	7.00	30.00	0.00
6	8.00	40.00	0.00
7	9.00	40.00	0.00
8	9.50	40.00	0.00

Pressure profile due to surcharge - Tensile crack

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00
2	0.23	0.00	0.00
3	2.00	0.00	0.00
4	4.00	0.00	0.00
5	7.00	30.00	0.00
6	8.00	40.00	0.00
7	9.00	40.00	0.00
8	9.50	40.00	0.00



Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00
2	0.30	3.00	0.00
3	0.30	0.00	0.00

Pressure profile due to surcharge - Traffic Surcharge

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	0.01	0.00	0.00
5	0.01	5.00	5.21
6	0.23	5.00	5.20
7	0.23	5.77	6.01
8	2.00	5.70	5.93
9	2.00	2.81	4.12
10	4.00	2.79	4.08
11	4.00	2.92	4.27
12	5.98	2.89	4.23
13	5.98	0.00	0.00
14	7.00	0.00	0.00
15	8.00	0.00	0.00
16	9.00	0.00	0.00
17	9.50	0.00	0.00

Pressure profile due to surcharge - General Surcharge

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	0.01	0.00	0.00
5	0.23	0.00	0.00
6	0.60	0.00	0.00
7	0.60	1.69	1.76
8	2.00	1.65	1.71
9	2.00	0.81	1.19
10	4.00	0.79	1.16
11	4.00	0.83	1.21
12	5.98	0.80	1.18
13	7.00	0.79	1.16
14	7.00	0.61	1.11
15	8.00	0.60	1.09
16	8.00	1.20	0.53
17	9.00	1.17	0.52
18	9.50	1.16	0.51



Forces acting on construction

Name	F _{hor} [kN/m]	App.Pt. Z [m]	F _{vert} [kN/m]	App.Pt. X [m]	Design coefficient
Weight - wall	0.00	-2.37	285.80	4.47	1.000
Earthq.- constr.	22.86	-2.37	-11.43	4.47	1.000
FF resistance	-2.50	-0.33	0.00	0.00	1.000
Resistance on front face	-0.50	-0.50	0.00	0.00	1.000
Weight - earth wedge	0.00	-4.78	361.68	5.90	1.000
Active pressure	189.68	-2.95	237.07	8.66	1.000
Water pressure	140.00	-1.44	0.00	5.17	1.000
Tensile crack	0.53	-8.82	0.00	5.17	1.000
Uplift pressure	0.00	0.00	-20.00	6.69	1.000
Earthq.- act.pressure	40.85	-5.81	52.48	7.14	1.000
Dynamic water pressure	14.12	-1.70	0.00	5.17	1.000
Traffic Surcharge	22.29	-6.44	28.32	5.75	1.000
General Surcharge	8.75	-4.29	10.23	6.69	1.000
Force No. 1	25.00	-9.00	0.00	4.04	1.000
Base anchorage	0.00	0.00	25.13	2.00	1.000

Verification of complete wall

Check for overturning stability

Resisting moment $M_{res} = 5935.16$ kNm/m

Overturning moment $M_{ovr} = 1486.79$ kNm/m

Safety factor = 3.99 > 1.50

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 626.10$ kN/m

Active horizontal force $H_{act} = 412.31$ kN/m

Safety factor = 1.52 > 1.50

Wall for slip is SATISFACTORY

Forces acting at the centre of footing bottom

Overall moment $M = 526.52$ kNm/m

Normal force $N = 991.01$ kN/m

Shear force $Q = 411.23$ kN/m

Overall check - WALL is SATISFACTORY

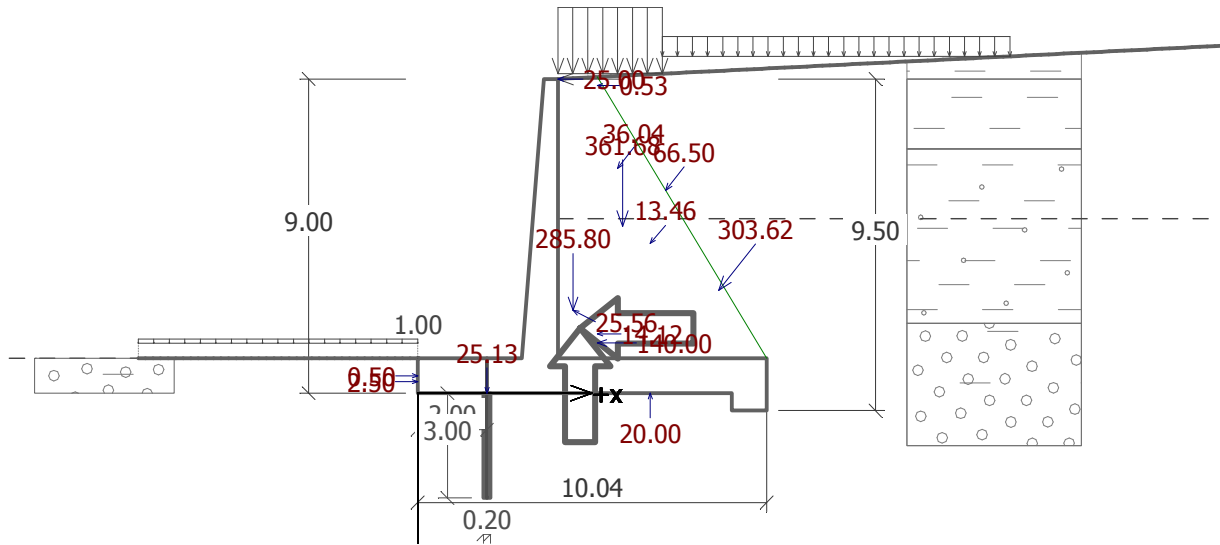
Name : Verification

Stage : 1; Analysis : 1



Name : Verification

Stage : 1; Analysis : 1



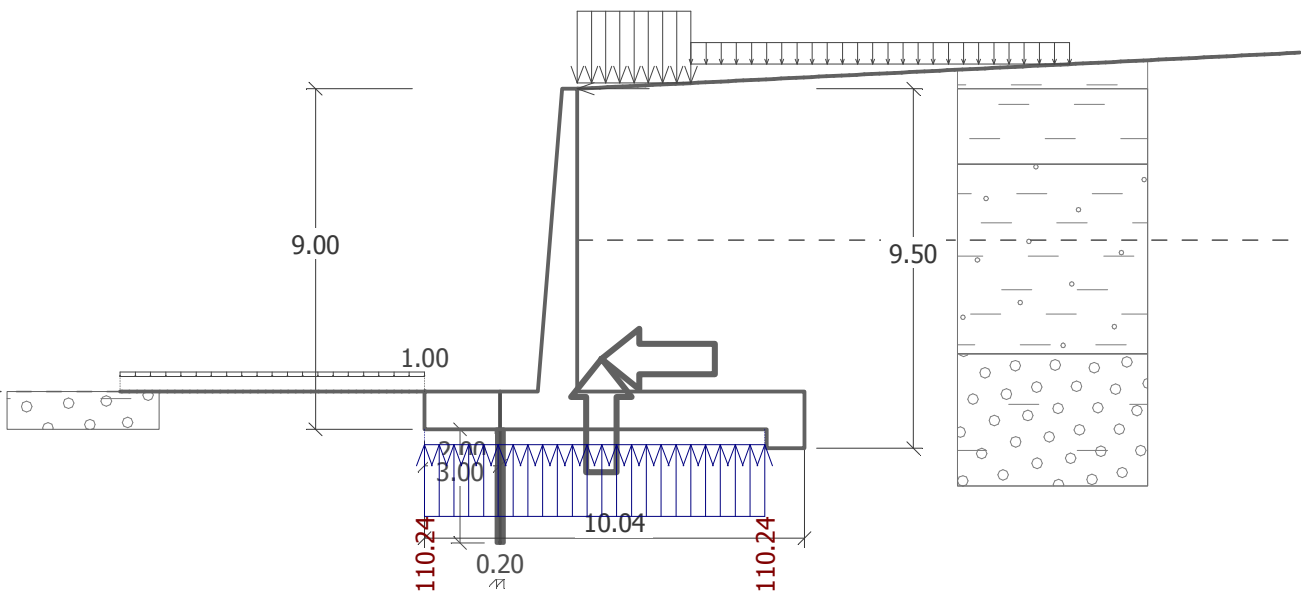
Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

Number	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	526.52	991.01	411.23	0.53	110.24

Name : Bearing cap.

Stage : 1



Spread footing verification

Input data

Basic soil parameters

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]



No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]
1	High plasticity clay (CH,CV,CE), consistency soft		15.00	5.00	20.50	11.00	12.00
2	Sandy clay (CS), consistency stiff $S_r < 0.8$		24.50	33.00	18.50	9.00	18.00
3	Clayey gravel (GC)		30.00	6.00	19.50	10.00	24.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	ϕ [°]	ν [-]	OCR [-]	K_r [-]
1	High plasticity clay (CH,CV,CE), consistency soft		cohesive	-	0.42	-	-
2	Sandy clay (CS), consistency stiff $S_r < 0.8$		cohesive	-	0.35	-	-
3	Clayey gravel (GC)		cohesionless	30.00	-	-	-

Soil parameters

High plasticity clay (CH,CV,CE), consistency soft

Unit weight : $\gamma = 20.50$ kN/m³
 Angle of internal friction : $\phi_{ef} = 15.00$ °
 Cohesion of soil : $c_{ef} = 5.00$ kPa
 Oedometric modulus : $E_{oed} = 4.00$ MPa
 Saturated unit weight : $\gamma_{sat} = 21.00$ kN/m³

Sandy clay (CS), consistency stiff $S_r < 0.8$

Unit weight : $\gamma = 18.50$ kN/m³
 Angle of internal friction : $\phi_{ef} = 24.50$ °
 Cohesion of soil : $c_{ef} = 33.00$ kPa
 Oedometric modulus : $E_{oed} = 16.00$ MPa
 Saturated unit weight : $\gamma_{sat} = 19.00$ kN/m³

Clayey gravel (GC)

Unit weight : $\gamma = 19.50$ kN/m³
 Angle of internal friction : $\phi_{ef} = 30.00$ °
 Cohesion of soil : $c_{ef} = 6.00$ kPa
 Oedometric modulus : $E_{oed} = 67.50$ MPa
 Saturated unit weight : $\gamma_{sat} = 20.00$ kN/m³

Foundation

Foundation type: strip footing

Depth from ground surface $h_z = 9.50$ m
 Depth of footing bottom $d = 1.00$ m
 Foundation thickness $t = 1.00$ m
 Incl. of finished grade $s_1 = 0.00$ °
 Incl. of footing bottom $s_2 = 2.85$ °
 Unit weight of soil above foundation = 19.50 kN/m³



Geometry of structure

Foundation type: strip footing

Overall strip footing length = 10.00 m
 Strip footing width (x) = 10.04 m
 Column width in the direction of x = 0.10 m
 Volume of strip footing = 10.04 m³/m
 Inserted loading is considered per unit length of continuous footing span.

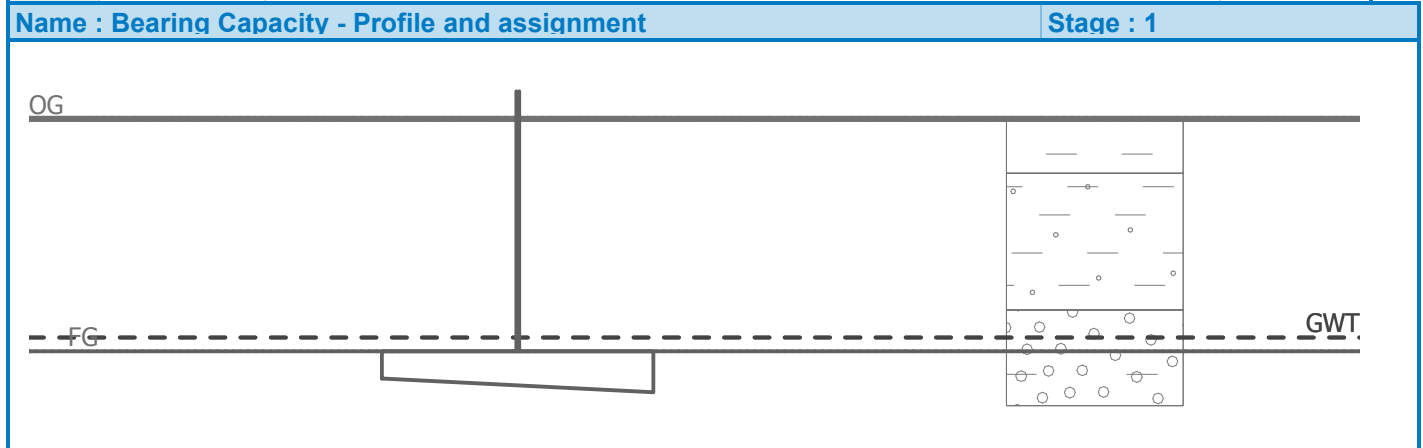
Material of structure

Unit weight $\gamma = 24.00 \text{ kN/m}^3$
 Analysis of concrete structures carried out according to the standard EN 1992 1-1 (EC2).

Concrete : C 40/50
 Longitudinal steel : B500
 Transverse steel: B500

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	2.00	High plasticity clay (CH,CV,CE), consistency soft	
2	5.00	Sandy clay (CS), consistency stiff $S_r < 0.8$	
3	-	Clayey gravel (GC)	



Load

No.	Load		Name	Type	N [kN/m]	M _y [kNm/m]	H _x [kN/m]
	new	change					
1	YES		LC 1	Service	739.40	100.88	-403.02
2	YES		LC 2	Design	739.40	100.88	-403.02

Ground water table

The ground water table is at a depth of 8.00 m from the original terrain.

Analysis settings

Type of analysis - Analysis for drained conditions
 Analysis of vertical bearing capacity - Standard approach
 Analysis of settlement - Analysis using oedometric modulus (CSN 73 1001)
 Bounding of influence zone - by percentage of Sigma, Or



Coeff. of bounding of influence zone = 10.00 %
 Analysis carried out according to classical theory (safety factor)

Factor of safety - vertical bearing capacity = 1.50
 Factor of safety - horizontal bearing capacity = 1.50

Verification No. 1

Analysis of bearing capacity - partial results

$\phi_d = 30.000^\circ$
 $c_d = 6.000 \text{ kPa}$
 $\gamma_{1avg} = 10.000 \text{ kN/m}^3$
 $\gamma_{1avg} = 10.000 \text{ kN/m}^3$
 $b_{ef} = 9.012 \text{ m}$
 $N_d = 18.401$
 $N_c = 30.140$
 $N_b = 15.070$
 $s_d = 1.451$
 $s_c = 1.180$
 $s_b = 0.730$
 $d_d = 1.031$
 $d_c = 1.033$
 $d_b = 1.000$
 $i_d = 0.347$
 $i_c = 0.347$
 $i_b = 0.347$
 $b_d = 0.943$
 $b_c = 0.942$
 $b_b = 0.943$
 $g_d = 1.000$
 $g_c = 1.000$
 $g_b = 1.000$
 $R_d = 324.210 \text{ kPa}$

Analysis carried out with automatic selection of the most unfavourable load cases.
 Computed self weight of strip foundation $G = 240.96 \text{ kN/m}$
 Computed weight of overburden $Z = 0.00 \text{ kN/m}$

Vertical bearing capacity check

Shape of contact stress : rectangle

Parameters of slip surface below foundation:

Depth of slip surface $z_{sp} = 15.86 \text{ m}$

Length of slip surface $l_{sp} = 47.93 \text{ m}$

Design bearing capacity of found.soil $R_d = 324.21 \text{ kPa}$

Extreme contact pressure $\sigma = 108.78 \text{ kPa}$

Factor of safety = 2.98 > 1.50

Bearing capacity in the vertical direction is SATISFACTORY

Horizontal bearing capacity check

Earth resistance: not considered

Friction angle foundation-footing bottom $\psi = 30.00^\circ$

Cohesion foundation-footing bottom $a = 6.00 \text{ kPa}$

Horizontal bearing capacity $R_{dh} = 620.08 \text{ kN}$

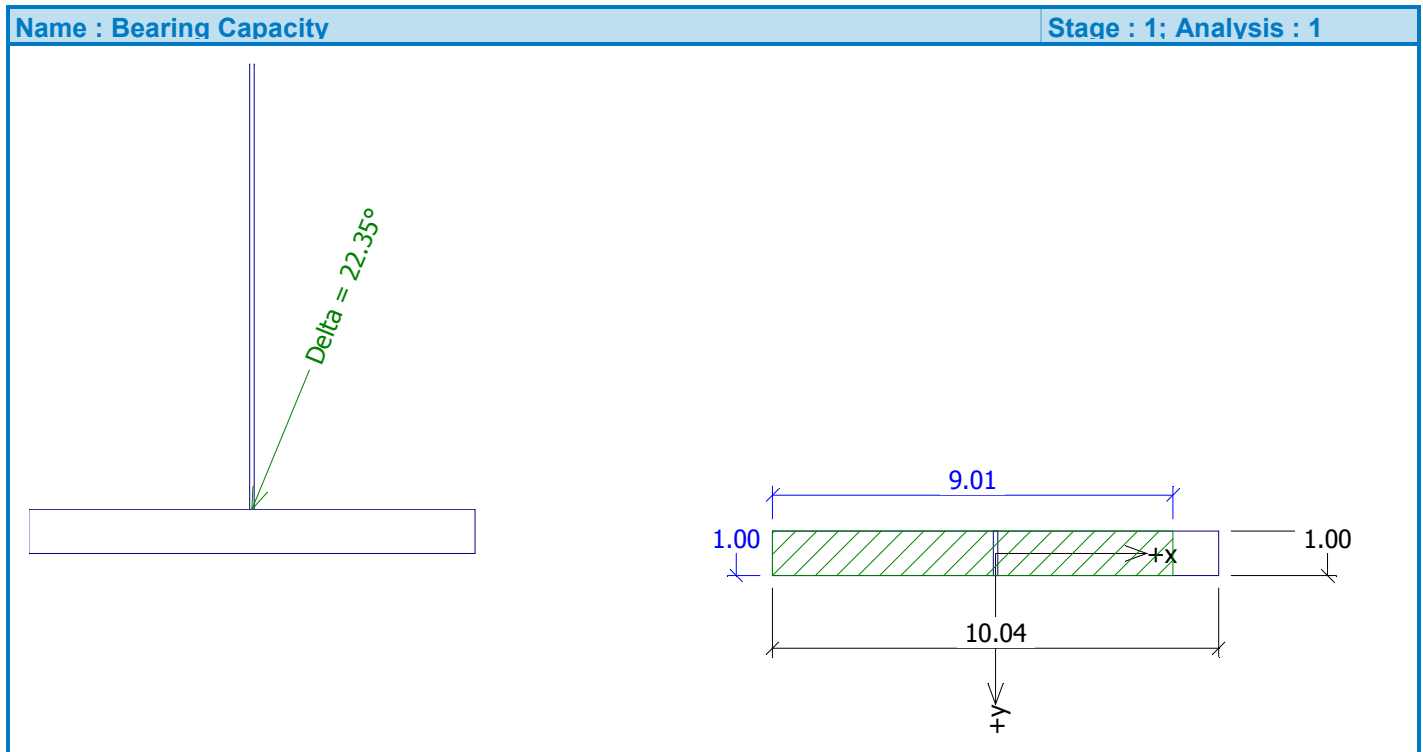
Extreme horizontal force $H = 403.02 \text{ kN}$

Factor of safety = 1.54 > 1.50



Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY



Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
 Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
 Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation $G = 240.96$ kN/m
 Computed weight of overburden $Z = 0.00$ kN/m

Settlement and rotation of foundation - partial results

Layer No.	Start pt. [m]	End pt. [m]	Thickness [m]	E_{def} [MPa]	σ_{or} [kPa]	$\Delta\sigma_z$ [kPa]	Settlement [mm]
1	9.50	9.55	0.05	50.14	168.25	87.65	0.06
2	9.55	9.60	0.05	50.14	168.75	87.65	0.06
3	9.60	9.65	0.05	50.14	169.25	87.64	0.06
4	9.65	9.70	0.05	50.14	169.75	87.63	0.06
5	9.70	9.75	0.05	50.14	170.25	87.62	0.06
6	9.75	9.80	0.05	50.14	170.75	87.61	0.06
7	9.80	9.90	0.10	50.14	171.50	87.56	0.13
8	9.90	10.00	0.10	50.14	172.50	87.45	0.13
9	10.00	10.10	0.10	50.14	173.50	87.28	0.13
10	10.10	10.20	0.10	50.14	174.50	87.08	0.13
11	10.20	10.30	0.10	50.14	175.50	86.88	0.13
12	10.30	10.40	0.10	50.14	176.50	86.73	0.13
13	10.40	10.65	0.25	50.14	178.25	86.22	0.32



Layer No.	Start pt. [m]	End pt. [m]	Thickness [m]	E_{def} [MPa]	σ_{or} [kPa]	$\Delta\sigma_z$ [kPa]	Settlement [mm]
14	10.65	10.90	0.25	50.14	180.75	85.24	0.32
15	10.90	11.15	0.25	50.14	183.25	84.04	0.31
16	11.15	11.40	0.25	50.14	185.75	82.65	0.31
17	11.40	11.65	0.25	50.14	188.25	81.10	0.30
18	11.65	11.90	0.25	50.14	190.75	79.47	0.29
19	11.90	12.40	0.50	50.14	194.50	76.61	0.57
20	12.40	12.90	0.50	50.14	199.50	72.39	0.54
21	12.90	13.40	0.50	50.14	204.50	67.98	0.50
22	13.40	13.90	0.50	50.14	209.50	63.54	0.47
23	13.90	14.40	0.50	50.14	214.50	59.13	0.44
24	14.40	14.90	0.50	50.14	219.50	54.56	0.40
25	14.90	15.90	1.00	50.14	227.00	48.51	0.72
26	15.90	16.90	1.00	50.14	237.00	42.13	0.62
27	16.90	17.90	1.00	50.14	247.00	36.73	0.54
28	17.90	18.90	1.00	50.14	257.00	31.77	0.47
29	18.90	19.59	0.69	50.14	265.46	28.20	0.20

Settlement of mid point of longitudinal edge = 4.1 mm
 Settlement of mid point of transverse edge 1 = 5.2 mm
 Settlement of mid point of transverse edge 2 = 2.9 mm
 (1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:

Computed weighted average modulus of deformation $E_{def} = 50.14$ MPa
 Foundation in the longitudinal direction is deformable ($k=0.69$)
 Foundation in the direction of width is rigid ($k=698.01$)

Overall settlement and rotation of foundation:

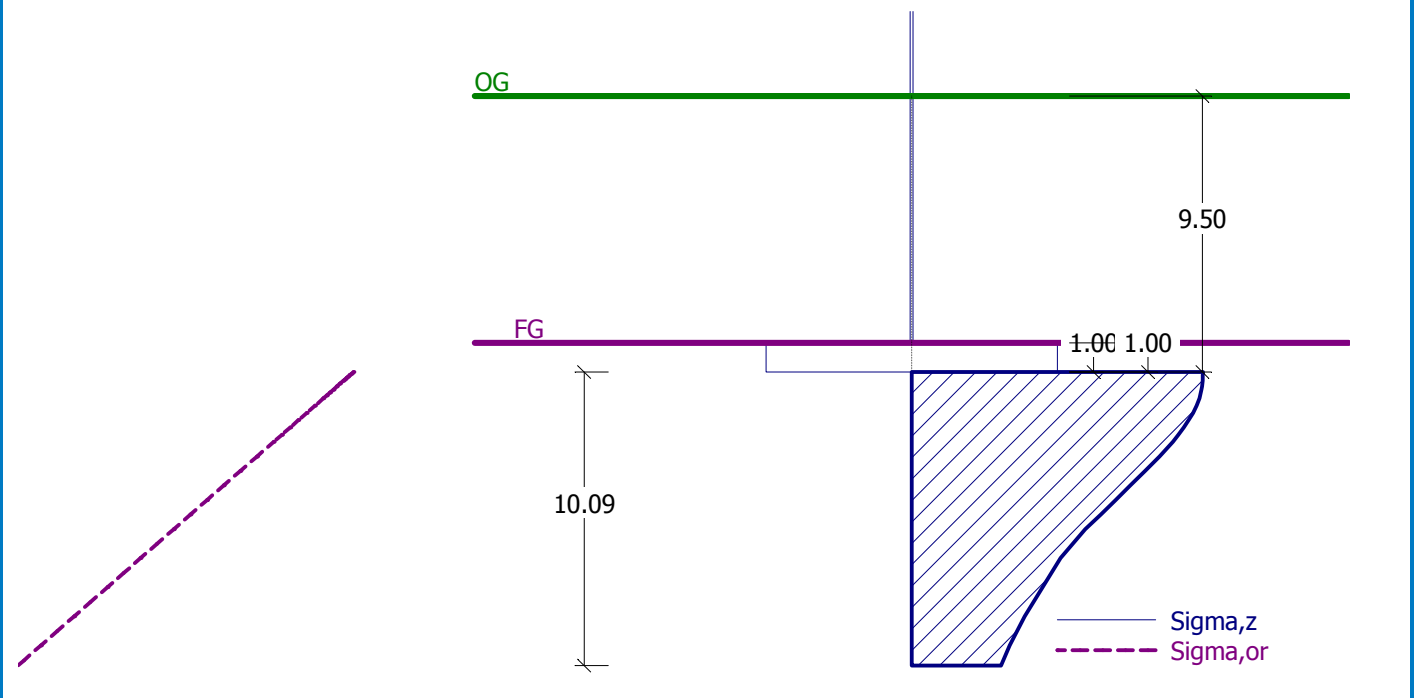
Foundation settlement = 8.5 mm
 Depth of influence zone = 10.09 m
 Rotation in direction of width = 0.230 (\tan^*1000)

Name : Settlement	Stage : 1; Analysis : 1
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Name : Settlement

Stage : 1; Analysis : 1



Dimensioning No. 1

Analysis carried out with automatic selection of the most unfavourable load cases.

Verification of longitudinal reinforcement of foundation in the direction of x

Bar diameter = 25.0 mm
 Number of bars = 8
 Reinforcement cover = 40.0 mm
 Cross-section width = 1.00 m
 Cross-section depth = 1.00 m
 Reinforcement ratio $\rho = 0.41 \% > 0.18 \% = \rho_{min}$

Ultimate moment $M_{Rd} = 1563.09 \text{ kNm} > 1462.57 \text{ kNm} = M_{Ed}$

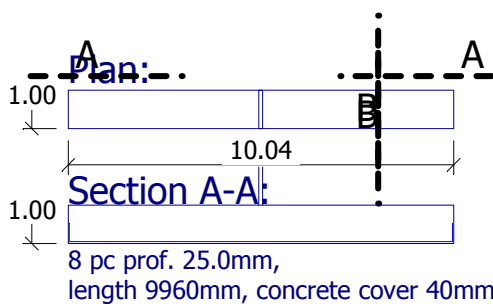
Cross-section is SATISFACTORY.

Spread footing for punching shear failure check

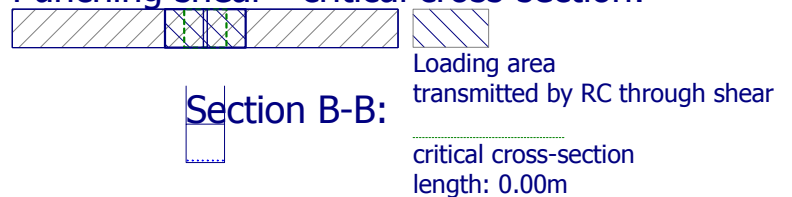
Verification for punching shear has not been performed due to shape of the critical cross-section.

Name : Dimensioning

Stage : 1; Dimensioning : 1



Punching shear - critical cross-section:





Dimensioning No. 1

Pressure at rest on front face of the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m ³]	K_r	Comment
1	1.00	0.00	30.00	6.00	10.00	0.500	

Pressure at rest distribution on front face of the structure

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	0.00	0.00	0.00	0.00	0.00
	1.00	10.00	0.00	5.00	5.00	0.00

Active pressure behind the structure - partial results

Layer No.	Thickness [m]	α [°]	ϕ_d [°]	c_d [kPa]	γ [kN/m ³]	δ_d [°]	K_a	Comment
1	0.29	31.14	15.00	5.00	20.50	15.00	0.908	
2	1.77	31.14	15.00	5.00	20.50	15.00	0.908	
3	2.00	31.14	24.50	33.00	18.50	24.50	0.786	
4	3.00	31.14	24.50	33.00	9.00	24.50	0.786	
5	1.00	31.14	30.00	6.00	10.00	30.00	0.735	
6	1.00	0.00	30.00	6.00	10.00	24.00	0.307	
7	0.50	0.00	30.00	6.00	10.00	24.00	0.307	

Active pressure distribution behind the structure (without surcharge)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00	0.00	0.00	0.00
	0.23	5.92	0.00	0.00	0.00	0.00
2	0.23	5.92	0.00	0.00	0.00	0.00
	2.00	42.16	0.00	32.90	22.80	23.72
3	2.00	42.16	0.00	1.76	0.99	1.45
	4.00	79.16	0.00	30.85	17.41	25.47
4	4.00	79.16	0.00	30.85	17.41	25.47
	7.00	106.16	30.00	52.08	29.39	42.99
5	7.00	106.16	30.00	72.69	35.08	63.66
	8.00	116.16	40.00	80.04	38.63	70.10
6	8.00	116.16	40.00	29.86	27.28	12.14
	9.00	126.16	40.00	32.93	30.08	13.39
7	9.00	126.16	40.00	32.93	30.08	13.39
	9.50	131.16	40.00	34.47	31.49	14.02

Earthquake effects (active earth pressure) - partial results

Layer No.	Thickness [m]	ϕ_d [°]	ψ [°]	K_a	K_{ae}	$K_{ae}-K_a$	Comment
1	0.29	15.00	4.76	0.908	1.056	0.148	
2	1.77	15.00	4.76	0.908	1.056	0.148	
3	2.00	24.50	4.76	0.781	0.912	0.131	
4	3.00	24.50	7.91	0.781	1.032	0.251	
5	1.00	30.00	7.91	0.733	0.987	0.254	



Layer No.	Thickness [m]	ϕ_d [°]	ψ [°]	K_a	K_{ae}	$K_{ae}-K_a$	Comment
6	1.00	30.00	7.91	0.307	0.419	0.112	
7	0.50	30.00	7.91	0.307	0.419	0.112	

Earthquake effects (active earth pressure)

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_D [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vertical comp. [kPa]
1	-0.06	0.00	125.91	13.86	9.61	10.00
	0.23	5.68	120.23	13.24	9.17	9.55
2	0.23	5.68	120.23	13.24	9.17	9.55
	2.00	40.47	85.44	9.41	6.52	6.78
3	2.00	40.47	85.44	8.41	4.75	6.94
	4.00	75.99	49.92	4.91	2.77	4.06
4	4.00	75.99	49.92	10.93	6.17	9.02
	7.00	101.91	24.00	5.25	2.96	4.34
5	7.00	101.91	24.00	5.36	2.59	4.69
	8.00	111.51	14.40	3.21	1.55	2.82
6	8.00	111.51	14.40	1.44	1.31	0.58
	9.00	121.11	4.80	0.48	0.44	0.19
7	9.00	121.11	4.80	0.48	0.44	0.19
	9.50	125.91	0.00	0.00	0.00	0.00

Water pressure distribution

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00
2	0.23	0.00	0.00
3	2.00	0.00	0.00
4	4.00	0.00	0.00
5	7.00	30.00	0.00
6	8.00	40.00	0.00
7	9.00	40.00	0.00
8	9.50	40.00	0.00

Pressure profile due to surcharge - Tensile crack

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00
2	0.30	3.00	0.00
3	0.30	0.00	0.00

Pressure profile due to surcharge - Traffic Surcharge

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	0.01	0.00	0.00



Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
5	0.01	5.00	5.21
6	0.23	5.00	5.20
7	0.23	5.77	6.01
8	2.00	5.70	5.93
9	2.00	2.81	4.12
10	4.00	2.79	4.08
11	4.00	2.92	4.27
12	5.98	2.89	4.23
13	5.98	0.00	0.00
14	7.00	0.00	0.00
15	8.00	0.00	0.00
16	9.00	0.00	0.00
17	9.50	0.00	0.00

Pressure profile due to surcharge - General Surcharge

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	-0.06	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	0.01	0.00	0.00
5	0.23	0.00	0.00
6	0.60	0.00	0.00
7	0.60	1.69	1.76
8	2.00	1.65	1.71
9	2.00	0.81	1.19
10	4.00	0.79	1.16
11	4.00	0.83	1.21
12	5.98	0.80	1.18
13	7.00	0.79	1.16
14	7.00	0.61	1.11
15	8.00	0.60	1.09
16	8.00	1.20	0.53
17	9.00	1.17	0.52
18	9.50	1.16	0.51

Forces acting on construction

Name	F _{hor} [kN/m]	App.Pt. Z [m]	F _{vert} [kN/m]	App.Pt. X [m]	Design coefficient
Weight - wall	0.00	-0.50	144.00	7.04	1.000
Weight - earth wedge	0.00	-4.78	361.68	5.90	1.000
Active pressure	189.68	-2.95	237.07	8.66	1.000
Tensile crack	0.53	-8.82	0.00	5.17	1.000
Dynamic water pressure	14.12	-1.70	0.00	5.17	1.000
Traffic Surcharge	22.29	-6.44	28.32	5.75	1.000
General Surcharge	8.75	-4.29	10.23	6.69	1.000



Name	F_{hor} [kN/m]	App.Pt. Z [m]	F_{vert} [kN/m]	App.Pt. X [m]	Design coefficient
Contact tractions	0.00	0.00	-516.57	6.82	1.000
Gravity surch. 1	0.00	-9.03	18.99	4.61	1.000

Wall stem check

Reinforcement and dimensions of the cross-section

Bar diameter = 25.0 mm

Number of bars = 8

Reinforcement cover = 30.0 mm

Cross-section width = 1.00 m

Cross-section depth = 1.04 m

Reinforcement ratio ρ = 0.39 % > 0.18 % = ρ_{min}

Ultimate moment M_{Rd} = 1648.29 kNm > 1473.33 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Wall check at the construction joint 0.10 m from the wall crest

Reinforcement and dimensions of the cross-section

Bar diameter = 25.0 mm

Number of bars = 8

Reinforcement cover = 30.0 mm

Cross-section width = 1.00 m

Cross-section depth = 0.41 m

Reinforcement ratio ρ = 1.07 % > 0.18 % = ρ_{min}

Ultimate moment M_{Rd} = 569.39 kNm > 2.59 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Front wall jump check

Stress at the footing bottom for wall jump dimensioning is assumed as uniform.

Reinforcement and dimensions of the cross-section

Bar diameter = 25.0 mm

Number of bars = 8

Reinforcement cover = 30.0 mm

Cross-section width = 1.00 m

Cross-section depth = 1.00 m

Reinforcement ratio ρ = 0.41 % > 0.18 % = ρ_{min}

Ultimate moment M_{Rd} = 1580.16 kNm > 614.94 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Back wall jump check

Reinforcement and dimensions of the cross-section

Bar diameter = 25.0 mm

Number of bars = 8

Reinforcement cover = 30.0 mm

Cross-section width = 1.00 m

Cross-section depth = 1.00 m

Reinforcement ratio ρ = 0.41 % > 0.18 % = ρ_{min}

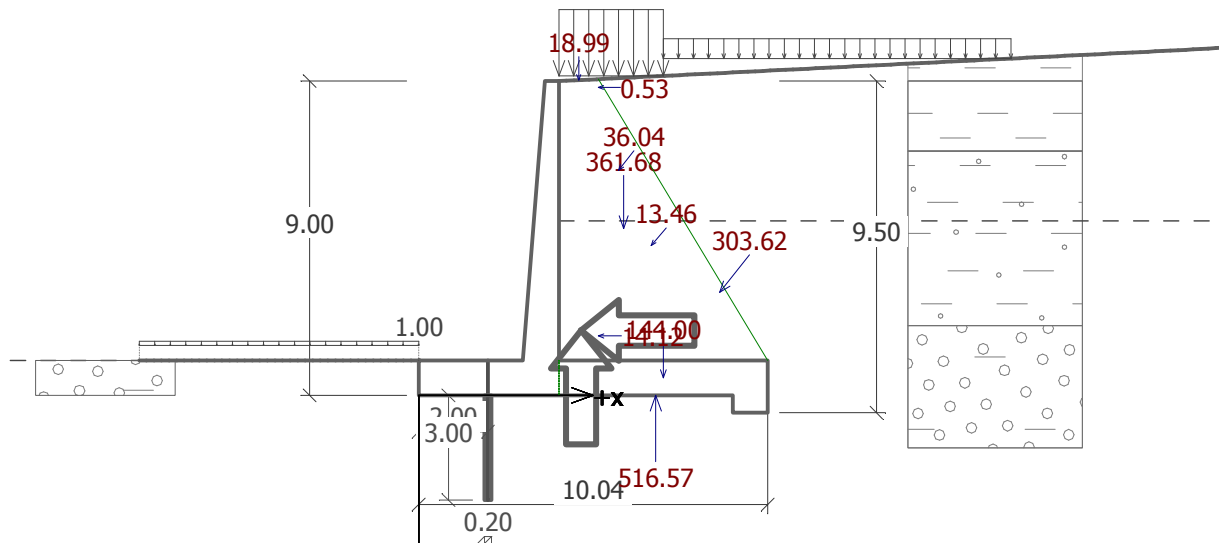
Ultimate moment M_{Rd} = 1580.16 kNm > 307.86 kNm = M_{Ed}

Cross-section is SATISFACTORY.



Name : Dimensioning

Stage : 1; Dimensioning : 1

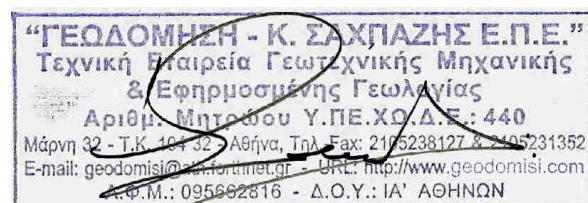


We are kindly remaining at your disposal for any further information and/or clarifications on telephone numbers: +30-210-5238127, +30-210-5711263, +30-210-5711898, Fax: +30-210-5711461, and Mobile phone: +30-6936425722, e-mail: costas@sachpazis.info & csachpazis@tee.gr, URL: <http://www.geodomi.com>.

Yours Sincerely,

Athens, 07 December - 2013

On behalf of and for Geodomi Ltd.



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