

Cantilever wall analysis

Input data

Project

Date : 2.11.2005

Material of structure

Unit weight $\gamma = 23.00 \text{ kN/m}^3$

Analysis of concrete structures carried out according to the standard CSN 73 1201 R.

Concrete : Concrete B 20

Compressive strength $R_{bd} = 11.50 \text{ MPa}$

Tensile strength $R_{btd} = 0.90 \text{ MPa}$

Elastic modulus $E_b = 27000.00 \text{ MPa}$

Longitudinal steel : Reinf.bars 10 216 E

Tensile strength $R_{sd} = 190.00 \text{ MPa}$

Compressive strength $R_{scd} = 190.00 \text{ MPa}$

Elastic modulus $E_s = 210000.00 \text{ MPa}$


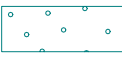

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	5.00
3	2.50	5.00
4	2.50	5.80
5	2.00	5.80
6	2.00	5.60
7	-1.60	5.60
8	-1.60	5.00
9	-0.60	5.00
10	-0.20	0.00

The origin [0,0] is located at the most upper right point of the wall.

Wall section area = 4.56 m^2 .

Basic soil parametres

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]	γ_{su} [kN/m ³]	δ [°]
1	Gravelly silt, consistency soft		29.00	8.00	19.00	9.00	0.00
2	Well graded sand		31.50	0.00	17.50	7.50	0.00
3	Gravelly clay		27.00	10.00	19.50	9.50	0.00

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

Gravelly silt, consistency soft

Unit weight : $\gamma = 19,00 \text{ kN/m}^3$

Stress-state : effective

Angle of intern. friction : $\varphi_{ef} = 29,00^\circ$

Cohesion of soil : $c_{ef} = 8,00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 0,00^\circ$
 Soil : cohesionless
 Saturated unit weight : $\gamma_{sat} = 19,00 \text{ kN/m}^3$

Well graded sand

Unit weight : $\gamma = 17,50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of intern. friction : $\varphi_{ef} = 31,50^\circ$
 Cohesion of soil : $c_{ef} = 0,00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 0,00^\circ$
 Soil : cohesionless
 Saturated unit weight : $\gamma_{sat} = 17,50 \text{ kN/m}^3$

Gravelly clay

Unit weight : $\gamma = 19,50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of intern. friction : $\varphi_{ef} = 27,00^\circ$
 Cohesion of soil : $c_{ef} = 10,00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 0,00^\circ$
 Soil : cohesionless
 Saturated unit weight : $\gamma_{sat} = 19,50 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	2.30	Gravelly silt, consistency soft	
2	1.70	Well graded sand	
3	-	Gravelly clay	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Resistance on front face of the structure

Resistance on front face of the structure: at rest
 Soil on front face of the structure - Gravelly silt, consistency soft
 Soil thickness in front of structure $h = 0.50 \text{ m}$
 Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force		Name	Fx [kN/m]	Fz [kN/m]	M [kNm/m]	x [m]	z [m]
	new	change						
1	YES		Applied force No. 1	-30.00	0.00	0.00	-0.10	-0.20

Analysis settings

Active earth pressure calculation - Coulomb (CSN 730037)
 Passive earth pressure calculation - Caquot-Kerisel (CSN 730037)
 Standard for concrete structures - CSN 73 1201 R

Analysis carried out according to CSN 730037 standard (with reduction of soil input parameters).
The wall is free to move. Active earth pressure is therefore assumed.

Verification No. 1

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	-1.34	104.88	1.80	1.000
FF resistance	-1.32	-0.17	0.00	0.00	1.000
Weight - earth wedge	0.00	-2.00	99.17	2.44	1.000
Active pressure	104.50	-1.64	121.18	3.19	1.000
Applied force No. 1	30.00	-5.80	0.00	1.50	1.000

Verification of complete wall

Check for overturning stability

Resisting moment $M_{res} = 735.07$ kNm/m

Overturning moment $M_{ovr} = 345.56$ kNm/m

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 154.46$ kN/m

Active horizontal force $H_{act} = 117.17$ kN/m

Wall for slip is SATISFACTORY

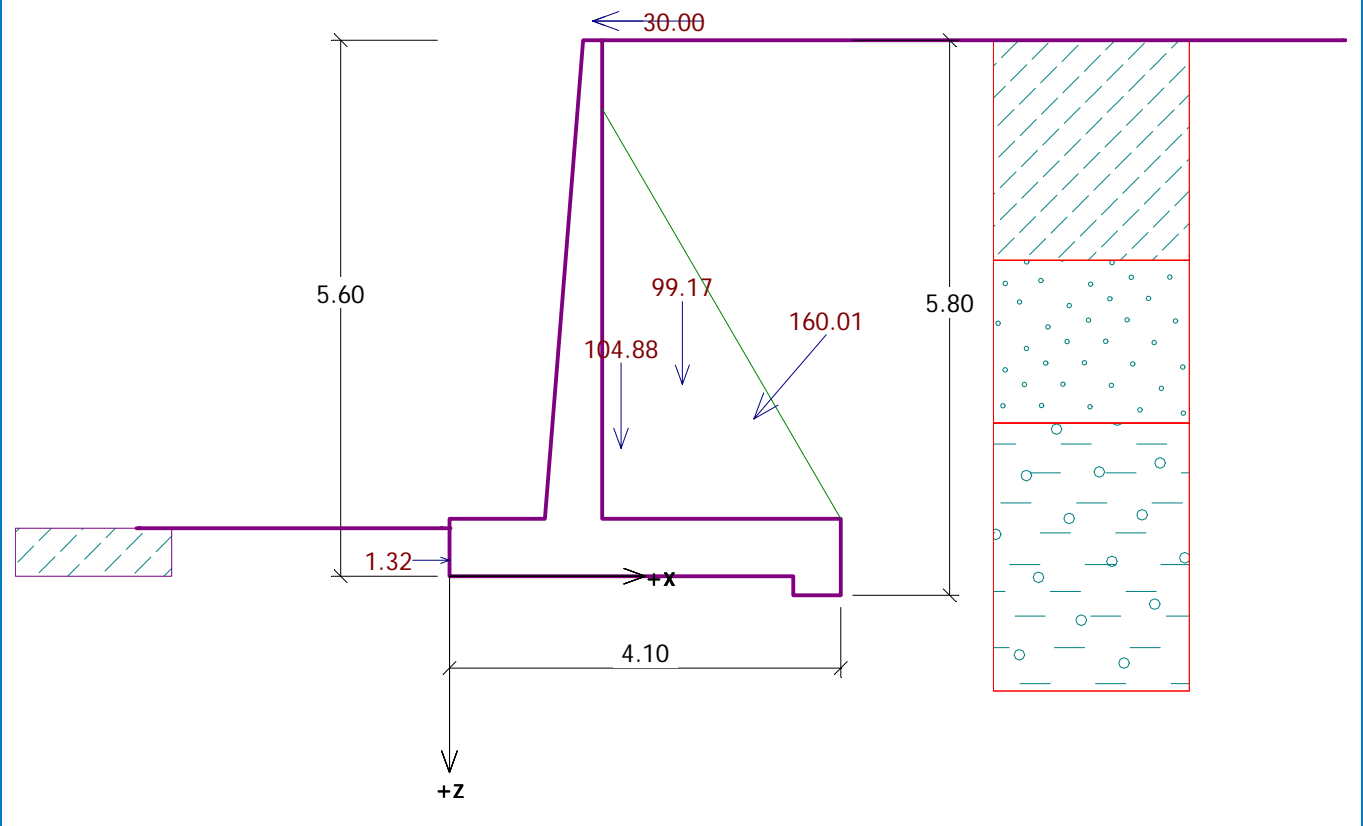
Forces acting at the center of footing bottom

Overall moment $M = 195.52$ kNm/m

Normal force $N = 331.33$ kN/m

Shear force $Q = 116.88$ kN/m

Overall check - WALL is SATISFACTORY



Bearing capacity of foundation soil

Forces acting at the center of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	195.52	331.33	116.88	0.63	116.49

Bearing capacity of foundation soil check

Eccentricity verification

Max. eccentricity of normal force $e = 630.3 \text{ mm}$

Maximum allowable eccentricity $e_{alw} = 1354.6 \text{ mm}$

Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification

Max. stress at footing bottom $\sigma = 116.49 \text{ kPa}$

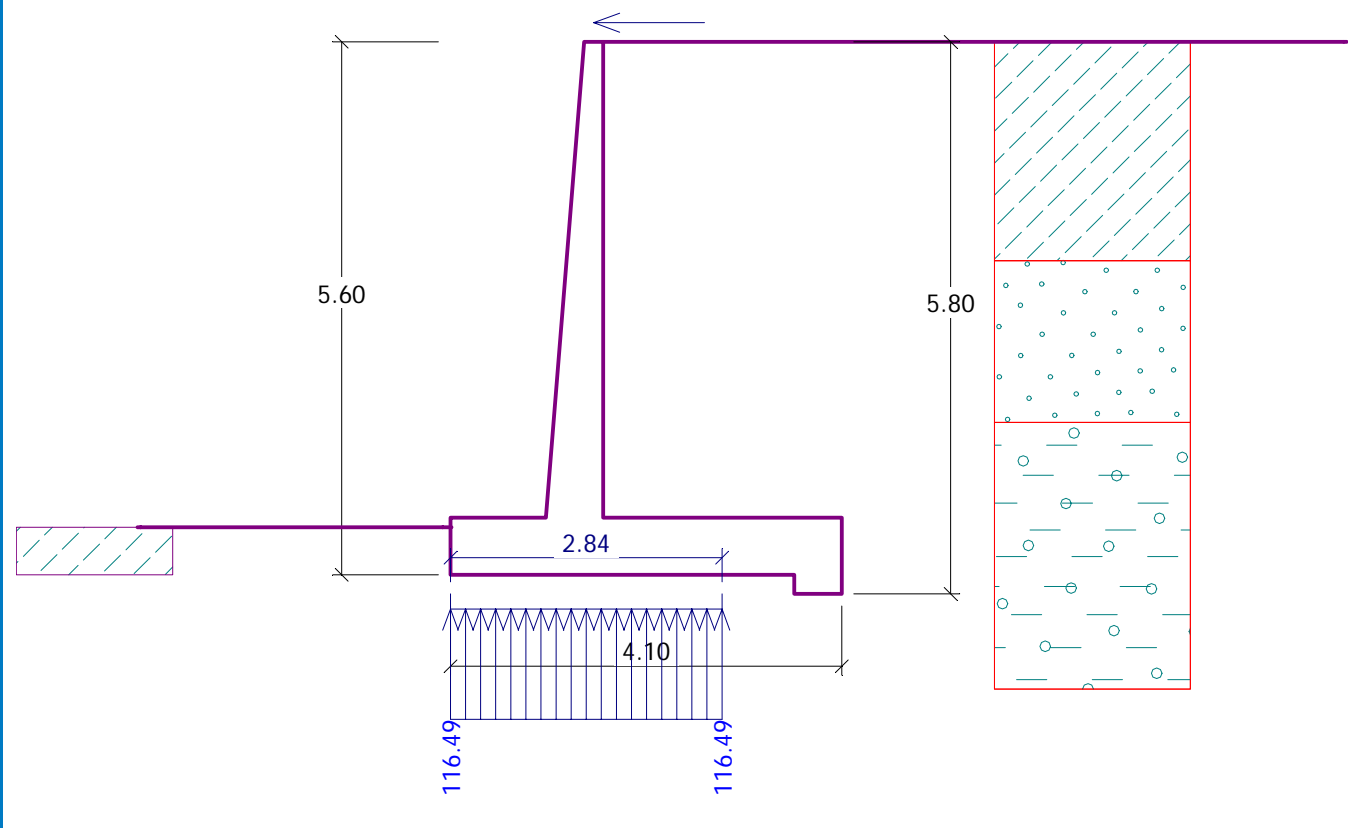
Bearing capacity of foundation soil $R_d = 180.00 \text{ kPa}$

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Name : Bearing cap.

Stage : 1



Dimensioning No. 1

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	-2.08	45.98	0.38	1.000
Pressure at rest	128.36	-1.65	0.00	0.60	1.000
Applied force No. 1	30.00	-5.20	0.00	0.50	1.000

Wall stem check

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

Reinforcement and dimensions of the cross-section

Bar diameter = 20.0 mm

Number of bars = 14.00

Reinforcement cover = 30.0 mm

Cross-section width = 1.00 m

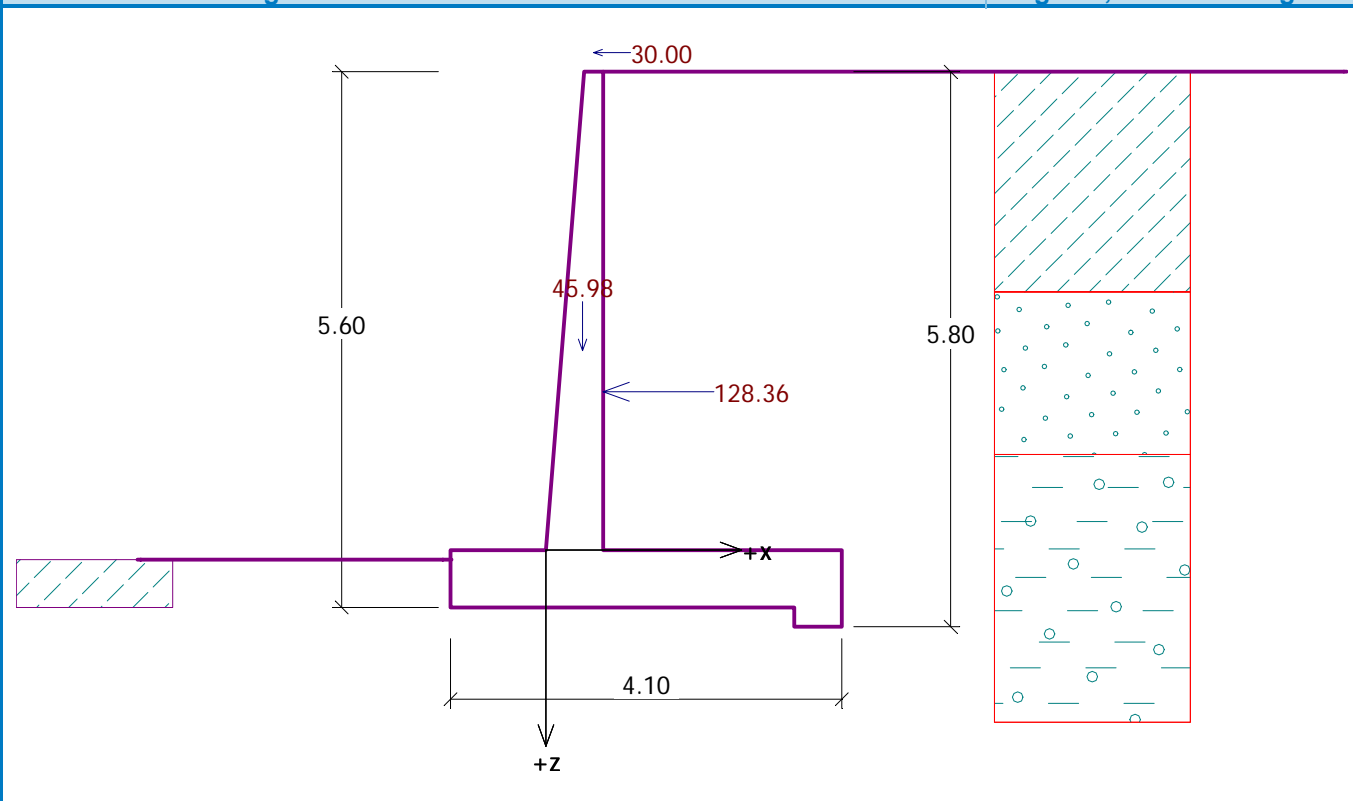
Cross-section depth = 0.60 m

Reinforcement ratio $\mu_{st} = 0.73 \% > 0.16 \% = \mu_{st,min}$

Position of neutral axis $x_u = 0.07 m < 0.30 m = x_{u,lim}$

Ultimate moment $M_u = 424.06 kNm > 364.40 kNm = M_d$

Cross-section is SATISFACTORY.



Dimensioning No. 2

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	-1.34	104.88	1.80	1.000
FF resistance	-1.32	-0.17	0.00	0.00	1.000
Weight - earth wedge	0.00	-2.00	99.17	2.44	1.000
Active pressure	104.50	-1.64	121.18	3.19	1.000
Applied force No. 1	30.00	-5.80	0.00	1.50	1.000

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 = 16.0 mm

Number of bars = 6.00

Reinforcement cover = 30.0 mm

Cross-section width = 1.00 m

Cross-section depth = 0.60 m

Reinforcement ratio $\mu_{st} = 0.20 \% > 0.16 \% = \mu_{st,min}$

Position of neutral axis $x_u = 0.02 m < 0.30 m = x_{u,lim}$

Ultimate moment $M_u = 122.64 kNm > 58.24 kNm = M_d$

Cross-section is SATISFACTORY.