Abutment verification

Input data

Project

Date : 3/10/2010

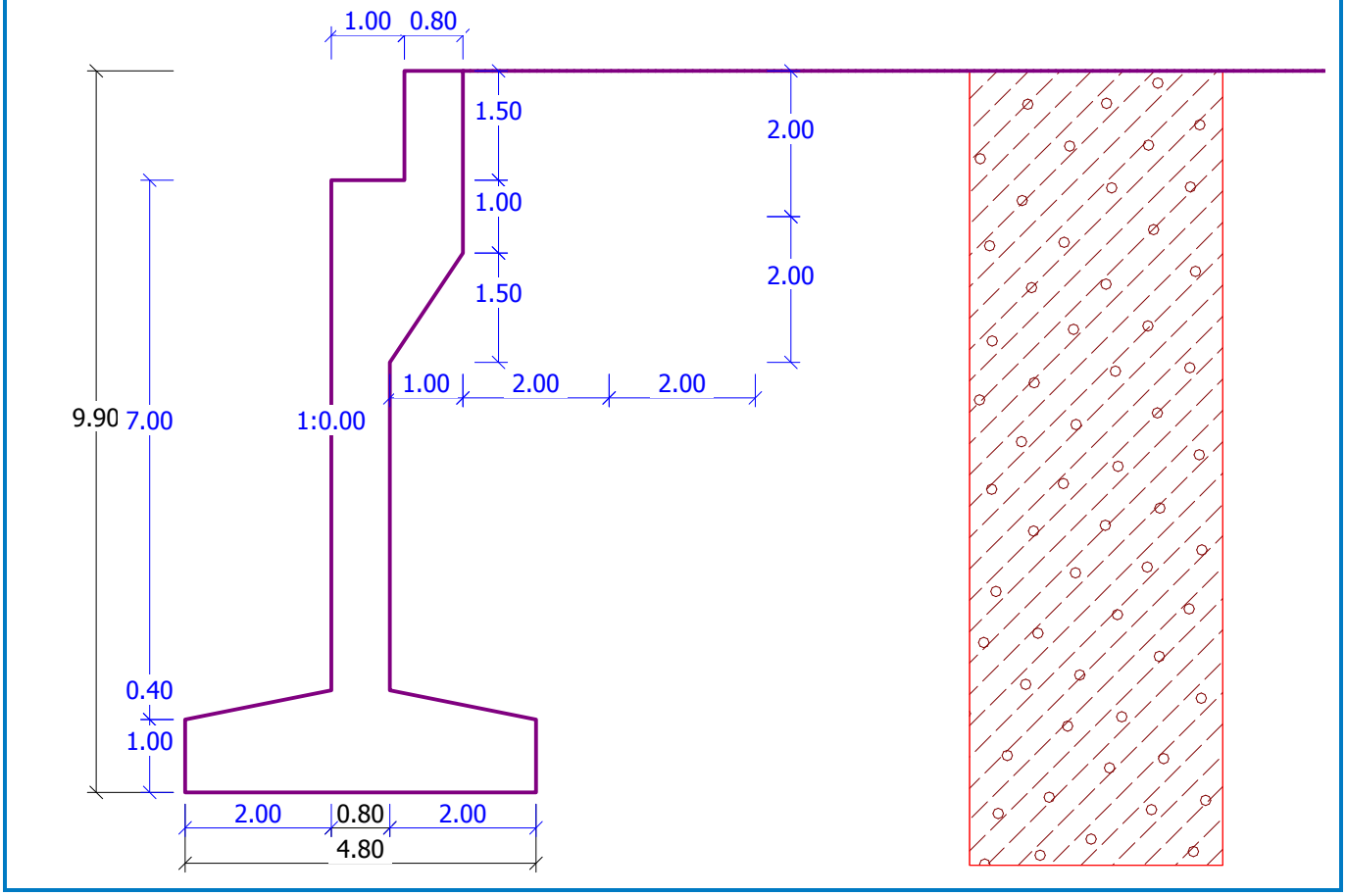
Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	1.50
2	0.00	2.50
3	-1.00	4.00
4	-1.00	8.50
5	1.00	8.90
6	1.00	9.90
7	-3.80	9.90
8	-3.80	8.90
9	-1.80	8.50
10	-1.80	1.50
11	-0.80	1.50

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 13.27 m^2.

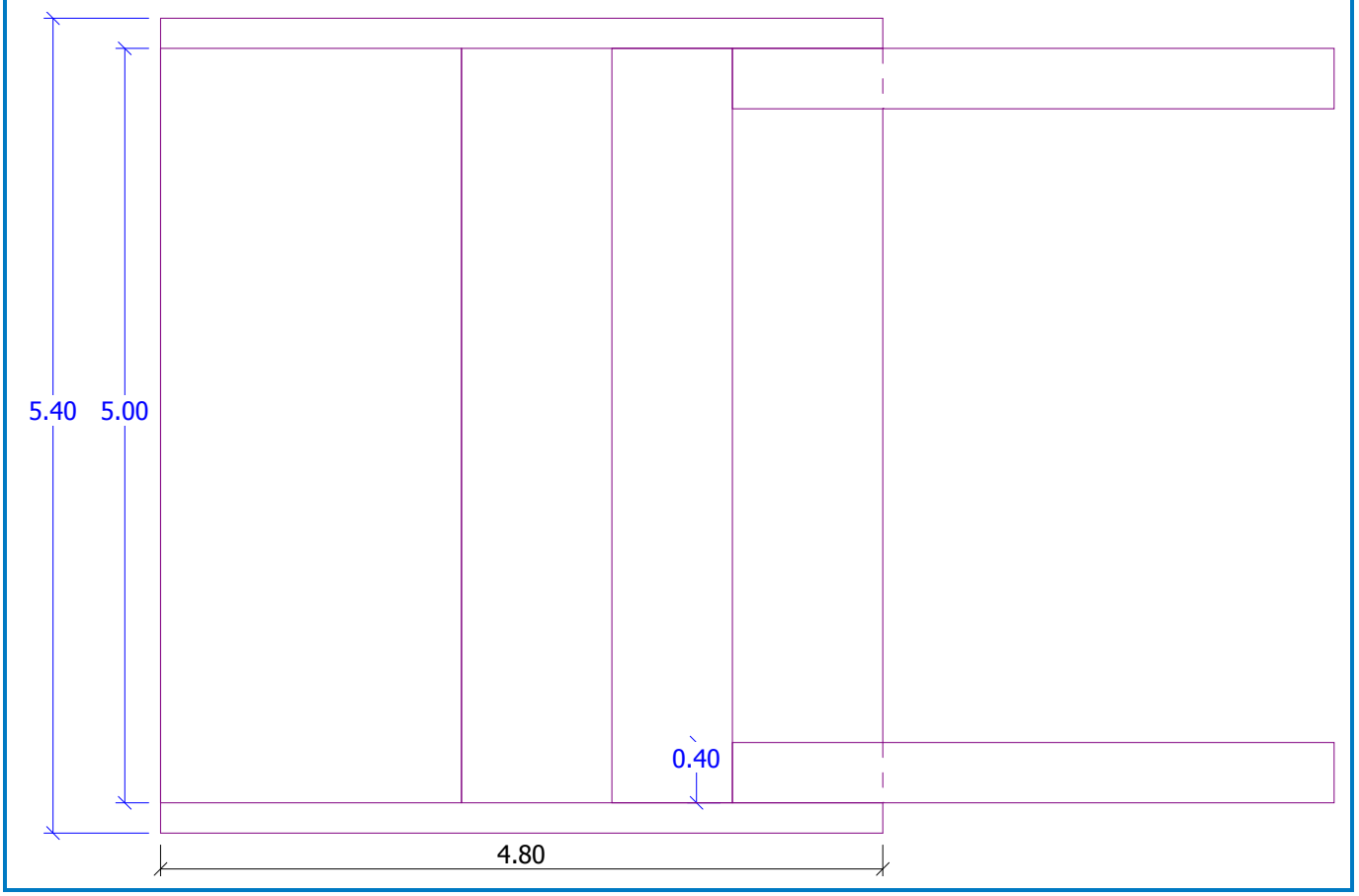
Length of bridge abutment = 5.00 m
Length of abutment foundation = 5.40 m

Name : Geometry 1 **Stage : 1**



Geometry plane view

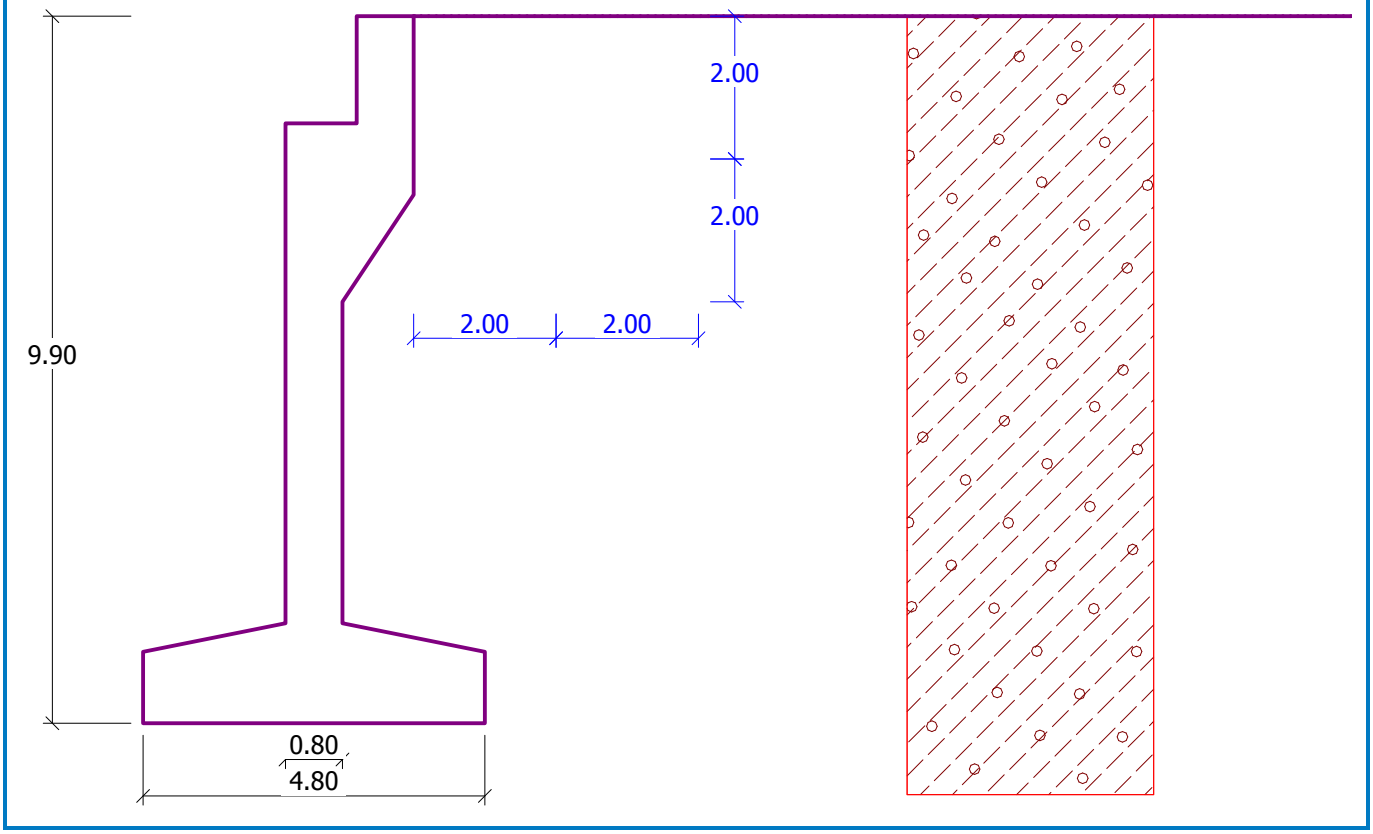
Name : Geometry 2 | **Stage : 1**



Abutment wingwalls - hinged symmetric

Wingwall thickness	= 0.40	m
Length of wingwall behind closure wall	= 4.00	m
Wingwall height	= 4.00	m
Dist. of wingwall cut from c.w.	= 2.00	m
Depth of wingwall cut	= 4.00	m

Name : Wings **Stage : 1**



Material of structure

Unit weight γ = 23.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992 1-1 (EC2).

Concrete : C 20/25

Cylinder compressive strength	f_{ck}	= 20.00	MPa
Tensile strength	f_{ct}	= 2.20	MPa
Elasticity modulus	E_{cm}	= 29000.00	MPa

Longitudinal steel : B500

Yield strength	f_{yk}	= 500.00	MPa
Elasticity modulus	E	= 200000.00	MPa

Soil parameters

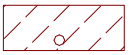
Soil No. 1

Unit weight :	γ =	19.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	φ_{ef} =	29.00 °
Cohesion of soil :	c_{ef} =	8.00 kPa
Angle of friction struc.-soil :	δ =	15.00 °
Soil :	cohesionless	
Saturated unit weight :	γ_{sat} =	19.00 kN/m^3

Load case, bridge load

Type of load case : construction state.

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	-	Soil No. 1	

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 is not considered.

Global settings

Active earth pressure calculation - Coulomb
Passive earth pressure calculation - Caqout-Kerisel
Standard for concrete structures - EN 1992 1-1 (EC2)

Settings of the stage of construction

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 = 1.00

Verification No. 1 (Stage of construction 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	-3.33	305.21	2.51	1.000
Weight - earth wedge	0.00	-2.27	47.80	3.47	1.000
Active pressure	191.36	-2.54	230.40	3.89	1.000

Abutment check

Verification for slip has not been performed.

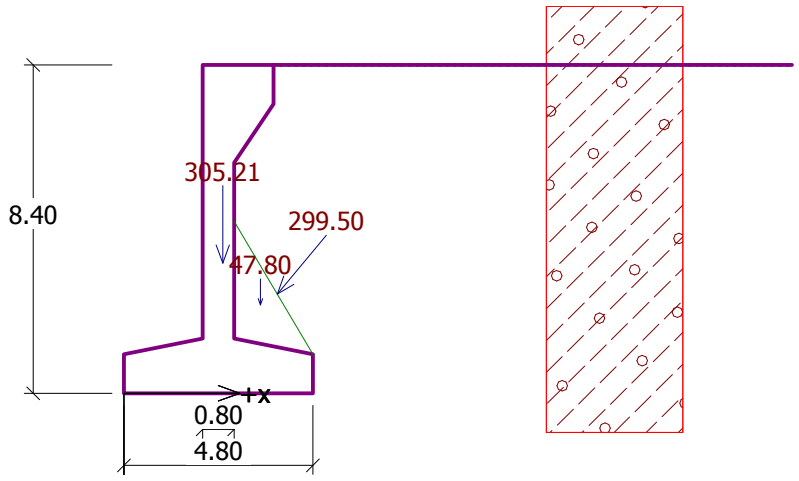
Check for overturning stability
Resisting moment M_{res} = 1693.49 kNm/m
Overturning moment M_{ovr} = 450.38 kNm/m

Safety factor = 3.76 > 1.50
Wall for overturning is SATISFACTORY

Forces acting at the centre of footing bottom
Overall moment M = 53.36 kNm/m
Normal force N = 540.20 kN/m
Shear force Q = 177.19 kN/m

Overall check - ABUTMENT is SATISFACTORY

Name : Verification	Stage : 1; Analysis : 1



Bearing capacity of foundation soil (Stage of construction 1)

Forces acting at the centre of the footing bottom

Numbe	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	53.36	540.20	177.19	0.10	117.37

Bearing capacity of foundation soil check

Eccentricity verification
Max. eccentricity of normal force e = 98.8 mm
Maximum allowable eccentricity e_{alw} = 1584.0 mm

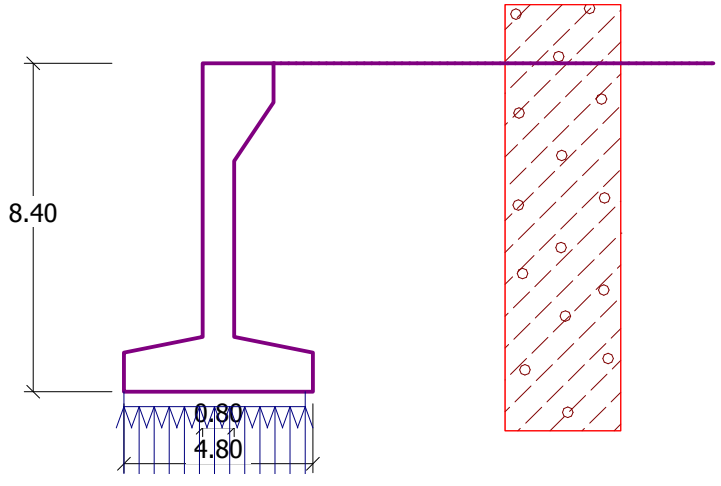
Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification
Max. stress at footing bottom σ = 117.37 kPa
Bearing capacity of foundation soil R_d = 240.00 kPa

Safety factor = 2.04 > 1.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Name : Bearing cap.	Stage : 1



Dimensioning No. 1 (Stage of construction 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	-4.11	169.05	0.60	1.000
Active pressure	73.01	-1.75	19.56	0.80	1.000

Dimensioning of abutment stem - input data:

Construction joint is designed from steel-reinforced concrete; design width 1m.

Bar diameter = 25.0 mm
Number of bars = 12
Reinforcement cover = 30.0 mm

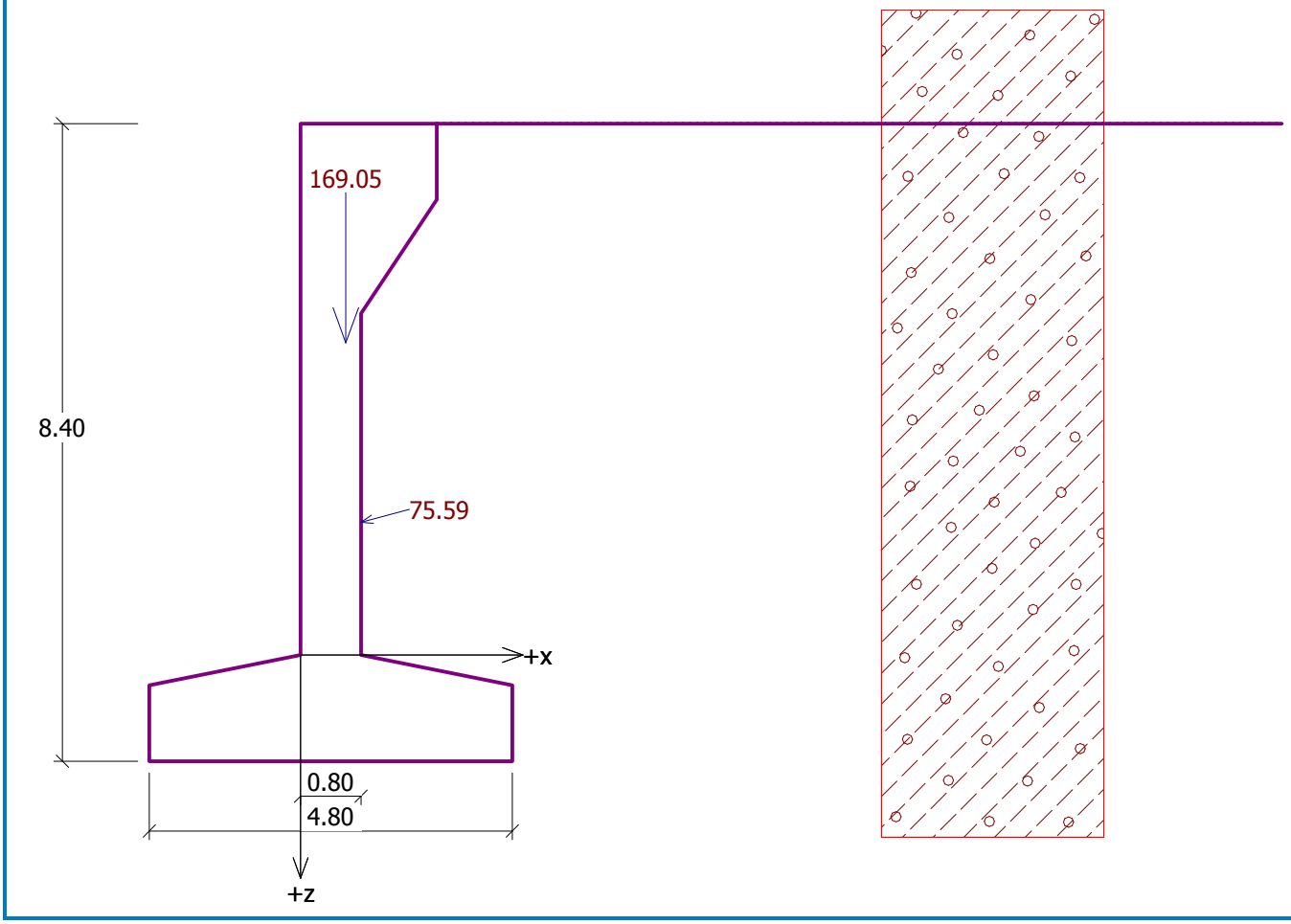
Internal forces : M = 86.44 kNm/m; N = -188.61 kN/m; Q = 73.01 kN/m
Cross-section depth h = 0.80 m

Dimensioning of abutment stem - results:

Reinforcement ratio	ρ	=	0.74 %	>	0.13 %	=	ρ_{min}
Position of neutral axis	x	=	0.46 m				
Ultimate normal force	N_{Rd}	=	-3184.36 kN/m	>	-188.61 kN/m	=	N_{Ed}
Ultimate moment	M_{Rd}	=	1459.47 kNm/m	>	86.44 kNm/m	=	M_{Ed}

Cross-section is SATISFACTORY.

Name : Dimensioning | **Stage : 1**



Input data (Stage of construction 2)

Load case, bridge load

Type of load case : service state.

Forces generated by bridge

Vertical force F_s = 2000.00 kN
Horizontal force F_v = 0.00 kN
Location a_1 = 0.30 m
Depth v = 0.10 m

Forces due to transition slab

Vertical force F_s = 120.00 kN
Horizontal force F_v = -50.00 kN
Location a_2 = 0.20 m

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	-	Soil No. 1	

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 is not considered.

Settings of analysis

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 = 1.00

Verification No. 1 (Stage of construction 2)

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	1.39	0.00	29.00	8.00	19.00	15.00	0.313	
2	0.11	0.00	29.00	8.00	19.00	15.00	0.313	
3	1.00	0.00	29.00	8.00	19.00	15.00	0.313	
4	1.50	-33.69	29.00	8.00	19.00	15.00	0.117	
5	1.50	0.00	29.00	8.00	19.00	15.00	0.313	
6	3.00	30.50	29.00	8.00	19.00	29.00	0.684	
7	0.40	30.50	29.00	8.00	19.00	29.00	0.684	
8	1.00	0.00	29.00	8.00	19.00	15.00	0.313	

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	0.00	0.00	0.00	0.00	0.00	0.00
	1.39	26.38	0.00	0.00	0.00	0.00
2	1.39	26.38	0.00	0.00	0.00	0.00
	1.50	28.50	0.00	0.66	0.64	0.17

Layer No.	Start [m] End [m]	σ_z [kPa]	σ_w [kPa]	Pressure [kPa]	Hor. comp. [kPa]	Vert. comp. [kPa]
3	1.50	28.50	0.00	0.66	0.64	0.17
	2.50	47.50	0.00	6.61	6.39	1.71
4	2.50	47.50	0.00	0.00	0.00	0.00
	4.00	76.00	0.00	0.00	0.00	0.00
5	4.00	76.00	0.00	15.54	15.01	4.02
	5.50	104.59	0.00	24.49	23.65	6.34
6	5.50	104.59	0.00	64.50	32.74	55.58
	8.50	161.50	0.00	103.41	52.48	89.10
7	8.50	161.50	0.00	103.41	52.48	89.10
	8.90	169.10	0.00	108.60	55.12	93.58
8	8.90	169.10	0.00	44.68	43.16	11.56
	9.90	188.10	0.00	50.63	48.91	13.10

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	-3.81	332.81	2.58	1.000
Weight - earth wedge	0.00	-2.27	47.80	3.47	1.000
Active pressure	191.36	-2.54	230.40	3.89	1.000
Abutment wingwalls	0.00	-8.00	54.28	5.50	1.000
Bridge reactions	0.00	-8.50	400.00	2.30	1.000
Appr. plate react.	10.00	-9.90	24.00	3.60	1.000

Abutment check

Verification for slip has not been performed.

Check for overturning stability

Resisting moment M_{res} = 2988.68 kNm/m
Overturning moment M_{ovr} = 542.04 kNm/m

Safety factor = 5.51 > 1.50
Wall for overturning is SATISFACTORY

Forces acting at the centre of footing bottom

Overall moment M = -25.99 kNm/m
Normal force N = 1008.60 kN/m
Shear force Q = 186.45 kN/m

Overall check - ABUTMENT is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 2)

Forces acting at the centre of the footing bottom

Numbe	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	-25.99	1008.60	186.45	0.00	210.13

Bearing capacity of foundation soil check

Eccentricity verification

Max. eccentricity of normal force e = 0.0 mm
Maximum allowable eccentricity e_{alw} = 1584.0 mm

Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification

Max. stress at footing bottom σ = 210.13 kPa
Bearing capacity of foundation soil R_d = 240.00 kPa

Safety factor = 1.14 > 1.00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Dimensioning No. 1 (Stage of construction 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	-4.62	196.65	0.71	1.000
Active pressure	108.57	-2.03	29.09	0.83	1.000
Abutment wingwalls	0.00	-6.60	54.28	3.50	1.000
Bridge reactions	0.00	-7.10	400.00	0.30	1.000
Appr. plate react.	10.00	-8.50	24.00	1.60	1.000

Dimensioning of abutment stem - input data:

Construction joint is designed from steel-reinforced concrete; design width 1m.

Bar diameter = 25.0 mm
Number of bars = 12
Reinforcement cover = 30.0 mm

Internal forces : M = 74.43 kNm/m; N = -704.02 kN/m; Q = 118.57 kN/m
Cross-section depth h = 0.80 m

Dimensioning of abutment stem - results:

Reinforcement ratio ρ = 0.74 % > 0.13 % = ρ_{min}
Position of neutral axis x = 0.60 m
Ultimate normal force N_{Rd} = -6317.44 kN/m > -704.02 kN/m = N_{Ed}
Ultimate moment M_{Rd} = 667.91 kNm/m > 74.43 kNm/m = M_{Ed}

Cross-section is SATISFACTORY.