Abutment verification

Input data

Project

Date : 29.10.2015

Settings

(input for current task)

Materials and standards

Abutment : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0,333
Verification methodology : Safety factors (ASD)

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	1,50	[–]
Safety factor for sliding resistance :	SF_s =	1,50	[–]
Safety factor for bearing capacity :	SF_b =	1,00	[–]

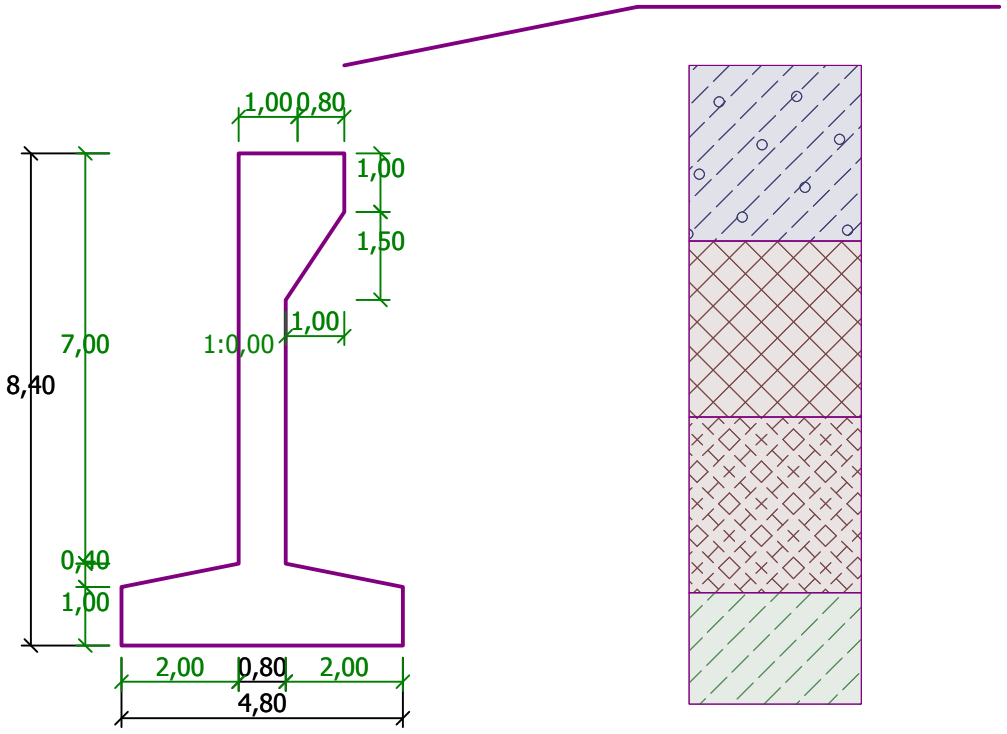
Geometry of structure

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 : Geometria 1 | **Stage - analysis : 1 - 0**



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

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_{ctm} = 2,20	MPa

Longitudinal steel : B500

Yield strength	f_{yk} = 500,00	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

Soil No. 2

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/m3

Soil No. 3
Unit weight : γ = 19,00 kN/m3
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/m3

Soil No. 4
Unit weight : γ = 19,00 kN/m3
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/m3

Load case, bridge load

Type of load case : construction state.

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3,00	Soil No. 1	
2	3,00	Soil No. 2	
3	3,00	Soil No. 3	
4	-	Soil No. 4	

Foundation

Type of foundation : soil from geological profile

Terrain profile

Terrain behind construction has the slope 1: 5,00 (slope angle is 11,31 °).
Embankment height is 1,00 m, embankment length is 5,00 m.

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 the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.

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	-2,51	59,38	3,47	1,000
Active pressure	172,56	-2,43	195,45	3,96	1,000

Abutment check

Verification for slip has not been performed.

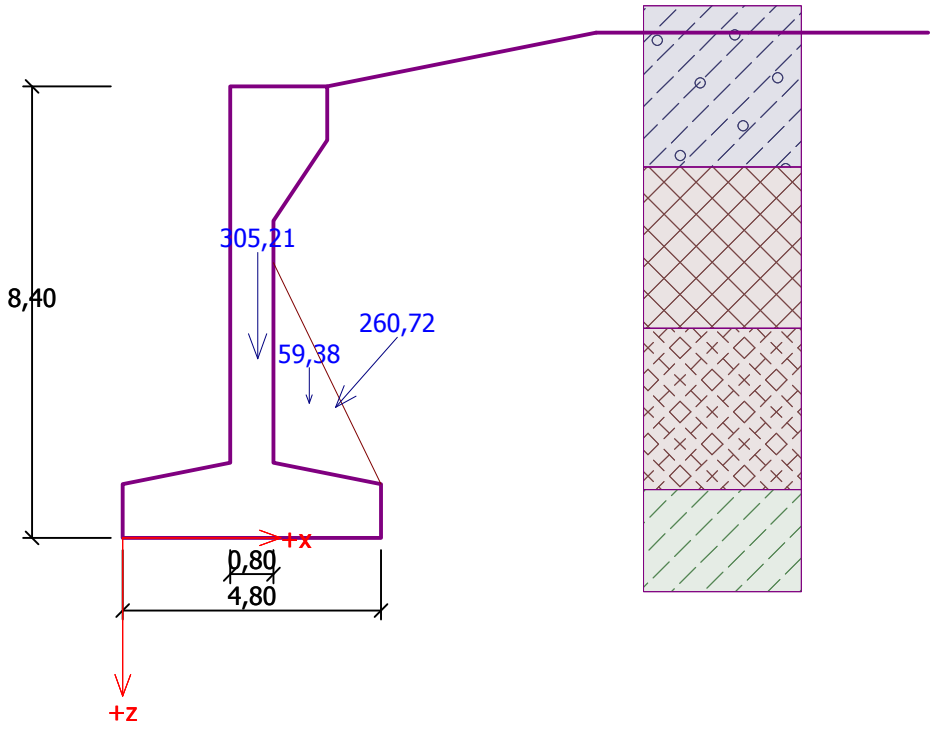
Check for overturning stability

Resisting moment M_{res} = 1615,54 kNm/m
Overturning moment M_{ovr} = 388,16 kNm/m

Safety factor = 4,16 > 1,50
Wall for overturning is SATISFACTORY

Overall check - ABUTMENT is SATISFACTORY

Name : Verificação	Stage - analysis : 1 - 1



Bearing capacity of foundation soil (Stage of construction 1)

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	17,14	518,55	159,77	0,007	109,54

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	17,14	518,55	159,77

Verification of foundation soil

Eccentricity verification
Max. eccentricity of normal force e = 0,007
Maximum allowable eccentricity e_{alw} = 0,333

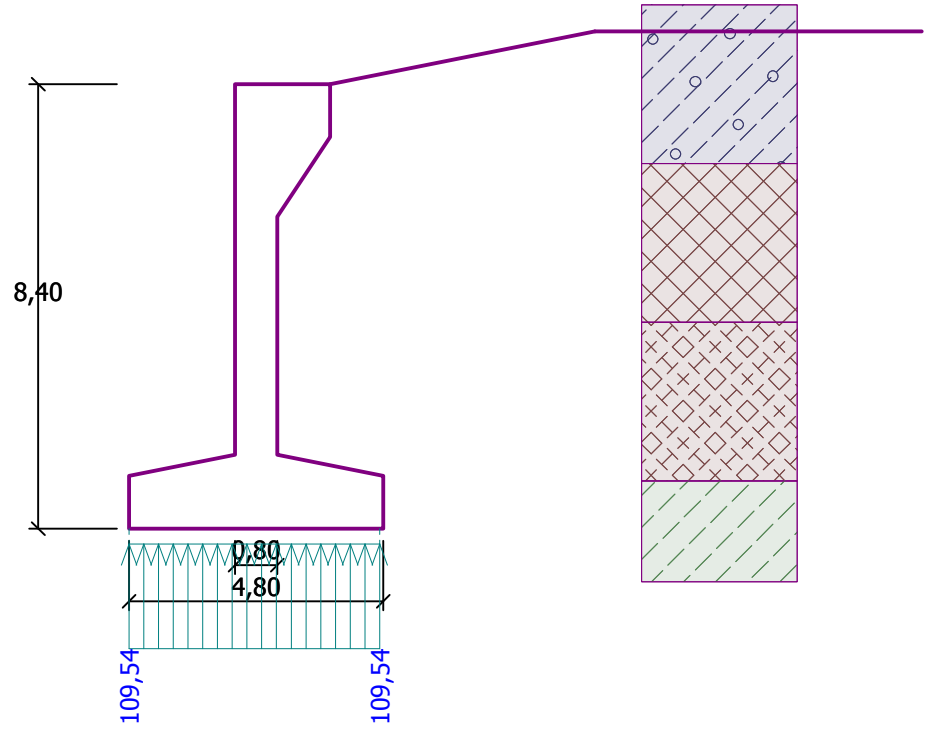
Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom σ = 109,54 kPa
Bearing capacity of foundation soil R_d = 240,00 kPa

Safety factor = 2,19 > 1,00
Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Name : Cap. de carga | **Stage - analysis : 1 - -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	87,83	-1,76	23,54	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

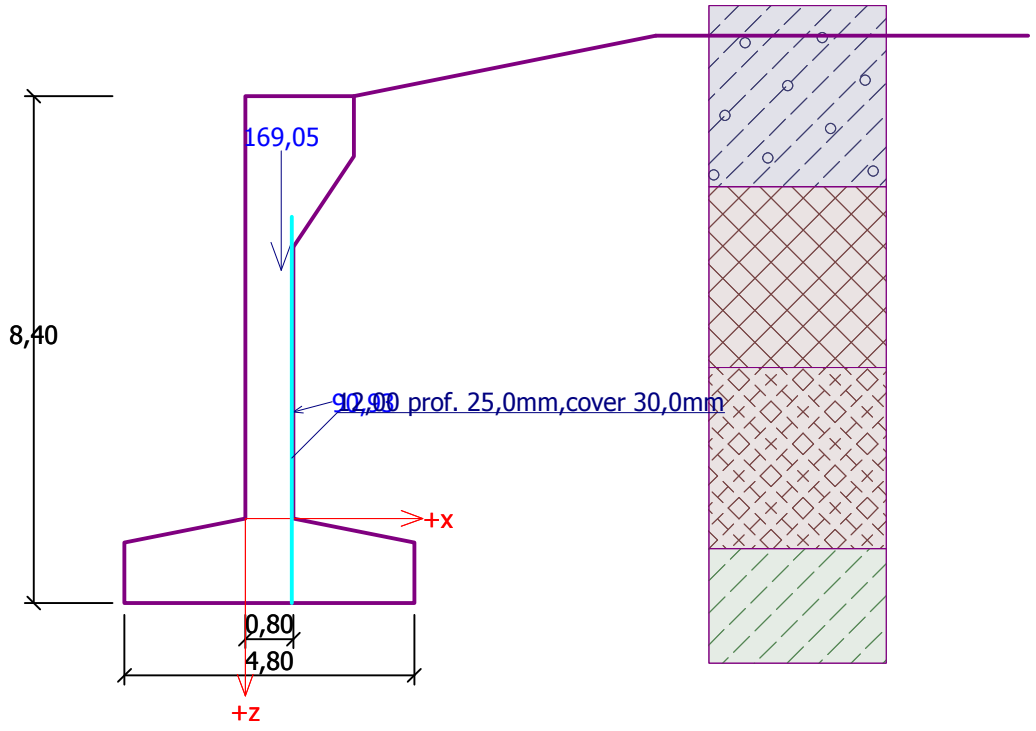
Internal forces : M = 112,19 kNm/m; N = -192,58 kN/m; V = 87,83 kN/m
Cross-section depth h = 0,80 m

Dimensioning of abutment stem - results:

Reinforcement ratio	ρ	=	0,74	%	>	0,13	%	=	ρ_{min}
Position of neutral axis	x	=	0,50	m					
Ultimate shear force	V_{Rd}	=	366,18	kN/m	>	87,83	kN/m	=	V_{Ed}
Ultimate compressive force	N_{Rd}	=	3152,34	kN/m	>	192,58	kN/m	=	N_{Ed}
Ultimate moment	M_{Rd}	=	1836,48	kNm/m	>	112,19	kNm/m	=	M_{Ed}

Cross-section is SATISFACTORY.

Name : Dimensionando	Stage - analysis : 1 - 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	3,00	Soil No. 1	
2	3,00	Soil No. 2	
3	3,00	Soil No. 3	
4	-	Soil No. 4	

Foundation

Type of foundation : soil from geological profile

Terrain profile

Terrain behind construction has the slope 1: 5,00 (slope angle is 11,31 °).
Embankment height is 1,00 m, embankment length is 5,00 m.

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 the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.

Verification 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	-3,81	332,81	2,58	1,000
Weight - earth wedge	0,00	-2,51	59,38	3,47	1,000
Active pressure	224,88	-2,66	249,09	3,92	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} = 3099,22 kNm/m
Overturning moment M_{ovr} = 644,78 kNm/m

Safety factor = 4,81 > 1,50
Wall for overturning is SATISFACTORY

Overall check - ABUTMENT is SATISFACTORY

Bearing capacity of foundation soil (Stage of construction 2)

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	33,47	1036,62	217,48	0,007	218,91

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	33,47	1036,62	217,48

Verification of foundation soil

Eccentricity verification
Max. eccentricity of normal force $e = 0,007$
Maximum allowable eccentricity $e_{alw} = 0,333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity
Max. stress at footing bottom $\sigma = 218,91$ kPa
Bearing capacity of foundation soil $R_d = 240,00$ kPa

Safety factor = 1,10 > 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	128,68	-2,07	34,48	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 = 118,41 kNm/m; N = -709,41 kN/m; V = 138,68 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	=	0,67 m				
Ultimate shear force	V_{Rd}	=	443,70 kN/m	>	138,68 kN/m	=	V_{Ed}
Ultimate compressive force	N_{Rd}	=	6692,26 kN/m	>	709,41 kN/m	=	N_{Ed}
Ultimate moment	M_{Rd}	=	1116,99 kNm/m	>	118,41 kNm/m	=	M_{Ed}

Cross-section is SATISFACTORY.