САОБРАЋАЈНИ ИНСТИТУТ ЦИП д.о.о.
11000 БЕОГРАД, НЕМАЊИНА 6/IV
тел: 011/3618-134, факс: 011/3618-324, web site: www.sicip.co.rs

2/9.9.6.1 НАСЛОВНА СТРАНА

2/9.9.6 ПРОЈЕКАТ БЕТОНСКЕ КОНСТРУКЦИЈЕ ВОЈНЕ РАМПЕ У ЖЕЛЕЗНИЧКОЈ СТАНИЦИ БАЧКА ТОПОЛА

Инвеститор:	„Инфраструктура Железнице Србије“ а.д. Немањина 6/IV, Београд
Објекат:	Модернизација, реконструкција и изградња пруге Београд - Суботица државна граница (Келебија), деоница пруге Нови Сад - Суботица - државна граница (Келебија), у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Малом Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач,, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град, на катастарским парцелама према списку приложеном у Главној свесци
Врста техничке документације:	**ИДП Идејни пројекат**
Назив и ознака дела пројекта:	**2/9.9.6 Пројекат бетонске конструкције војне рампе у железничкој станици Бачка Топола**
За грађење / извођење радова:	Нова градња и реконструкција
Пројектант:	Саобраћајни институт ЦИП, д.о.о. Немањина 6/ IV, Београд 351-02-02009/2017-07
Одговорно лице пројектанта:	Генерални директор: Милутин Игњатовић, дипл.инж.
Потпис:	Milutin Ignjatović 226692666-01 04943710139 Digitally signed by Milutin Ignjatović 226692666-010494 3710139 Date: 2020.05.22 12:53:11 +02'00'
Одговорни пројектант:	Марина Пешић, дипл.инж. грађ.
Број лиценце:	лиценца бр.310 9562 03
Потпис:	МАРИНА ПЕШИЋ 1003960295024 Digitally signed by МАРИНА ПЕШИЋ 1003960295024 DN: c=RS, cn=МАРИНА ПЕШИЋ 1003960295024 Date: 2020.05.20 13:07:16 +02'00'
Број дела пројекта:	2017-728-КОН-2/9.9.6
Место и датум:	Београд, мај 2020.

2/9.9.6.2. САДРЖАЈ ПРОЈЕКАТ БЕТОНСКЕ КОНСТРУКЦИЈЕ ВОЈНЕ РАМПЕ У ЖЕЛЕЗНИЧКОЈ СТАНИЦИ БАЧКА ТОПОЛА

2/9.9.6.3. РЕШЕЊЕ О ОДРЕЂИВАЊУ ОДГОВОРНОГ ПРОЈЕКТАНТА

На основу члана 128 Закона о планирању и изградњи ("Службени гласник РС", бр. 72/09, 81/09 - исправка, 64/10 - УС, 24/11, 121/12, 42/13 - УС, 50/2013 - УС, 98/2013 - УС, 132/14, 145/14, 83/2018, 31/2019 и 37/2019 -др.закон) и одредби Правилника о садржини, начину и поступку израде и начину вршења контроле техничке документације према класи и намени објеката ("Службени гласник РС" бр 73/2019) као:

О Д Г О В О Р Н И П Р О Ј Е К Т А Н Т

за израду **2/9.9.6 Пројекат бетонске конструкције војне рампе у железничкој станици Бачка Топола**, који је део ИДП - Идејног пројекта Модернизација, реконструкција и изградња пруге Београд - Суботица државна граница (Келебија), деоница пруге Нови Сад - Суботица - државна граница (Келебија), у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Мали Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град, одређује се:

Марина Пешић, дипл.инж. грађ. _____ 310 9562 04

Пројектант:	САОБРАЋАЈНИ ИНСТИТУТ ЦИП д.о.о., Београд Немањина 6/IV 351-02-02009/2017-07
Одговорно лице/заступник:	Генерални директор: Милутин Игњатовић, дипл.инж.
Потпис:	
Број техничке документације:	2017 - 728
Место и датум:	Београд, мај 2020.год.

2/9.9.6.4. ИЗЈАВА ОДГОВОРНОГ ПРОЈЕКТАНТА ПРОЈЕКТА

Одговорни пројектант пројекта **2/9.9.6 Пројекат бетонске конструкције војне рампе у железничкој станици Бачка Топола**, који је део ИДП - Идејног пројекта Модернизација, реконструкција и изградња пруге Београд - Суботица државна граница (Келебија), деоница пруге Нови Сад - Суботица - државна граница (Келебија), у Новом Саду, Кисачу, Степановићеву, Змајеву, Врбасу, Ловћенцу, Мали Иђошу, Бачкој Тополи, Жеднику, Наумовићеву и Суботици, К.О. Нови Сад I, К.О. Нови Сад IV, К.О. Кисач, К.О. Руменка, К.О. Степановићево, К.О. Ченеј, К.О. Бачко Добро Поље, К.О. Врбас, К.О. Врбас - град, К.О. Змајево, К.О. Куцура, К.О. Ловћенац, К.О. Мали Иђош, К.О. Фекетић, К.О. Бачка Топола, К.О. Бачка Топола - Град, К.О. Мали Београд, К.О. Биково, К.О. Доњи Град, К.О. Жедник, К.О. Нови Град, К.О. Палић, К.О. Стари Град

Марина Пешић, дипл.инж. грађ.

И З Ј А В Љ У Ј Е М

1. да је пројекат израђен у складу са Законом о планирању и изградњи, прописима, стандардима и нормативима из области изградње објеката и правилима струке;
2. да је пројекат у свему у складу са начинима за обезбеђење испуњења основних захтева за објекат прописаних елаборатима и студијама

Одговорни пројектант ИДП:	Марина Пешић, дипл.инж. грађ.
Број лиценце:	310 9562 04
Потпис:	Марина Пешић
Број техничке документације:	2017 - 728
Место и датум:	Београд, мај 2020.год.

2/9.9.6.5. ТЕКСТУАЛНА ДОКУМЕНТАЦИЈА

2/9.9.6.5.1. ТЕХНИЧКИ ИЗВЕШТАЈ

ТЕХНИЧКИ ОПИС

уз Идејни пројекат модернизације, реконструкције и изградње пруге Београд-Суботица-државна граница (Келебија), деоница Нови Сад-Суботица-државна граница (Келебија)

Војна рампа у железничкој станици Бачка Топола

Према пројектном задатку ради утовара борбених возила испројектована је бетонска рампа у железничкој станици Бачка Топола.
Рампа је дужине 50m, ширине 20m. На делу ширине од 10m рампа има благи пад због одводњавања а на другом делу од 10m пад је према захтеву 1:10.
Рампу чине зидови паралелни колосеку и управни на њега, као и плоча по којој ће се кретати борбена возила. Зидови рампе су подељени у кампаде дужине од по 5m.
Потпорни зидови рампе паралелно колосеку су различите висине почев од 4.1m на почетку рампе до 1.40m на бочној старни рампе. Темељи зидова су ширине од 3.8m до 2.1m, висине 60cm и 50cm. Изводе се преко слоја мршавог бетона дебљине 10cm испод ког је планиран слој шљунка висине 30cm.
Зидови по висини прате раст рампе али нису закошени већ хоризонтални (што се види у подужним пресецима). Групе од по неколико кампада су на истој висини а следеће су подигнуте за по 1cm у односу на претходне. Растојање врха зида рампе од ГИШ-а је према пројектном задатку 1.1m. Зид је удаљен од осе колосека 1.70m.
Пројектом се предвиђа хидроизолација зидова рампе премазом од битулита.
Плоча рампе је дебљине 40cm. Изводи се на прописано збијеној испуни од песковитог шљунка, а преко слоја мршавог бетона дебљине 10cm. Рачуната је на стално оптерећење од сопствене тежине и на покретно оптерећење од тенка М-84 у више положаја.
Зидови рампе су рачунати као потпорне конструкције оптерећене притиском при збијању у току извођења рампе и покретним оптерећењем. Статички утицаји су срачунати у програму Geo 5. Третирани су стално оптерећење, (сопствена тежина конструкције, мртав терет, притисак земље), и покретно оптерећење од тенка М-84.
Начин извођења зависи од градилишта, односно механизације са којом располаже извођач радова.
За зидове рампе и за плочу предвиђена је марка бетона С30/37. Арматура је В500В.

Уграђени материјали морају бити са атестима и пројектованим квалитетима.

Одговорни пројектант
за конструкцију рампе

ИНЖЕЊЕРСКА КОМОРА СРБИЈЕ
Марина Ф. Пешић
дипл. грађ. инж.
310 9562 04
ОДГОВОРНИ ПРОЈЕКТАНТ

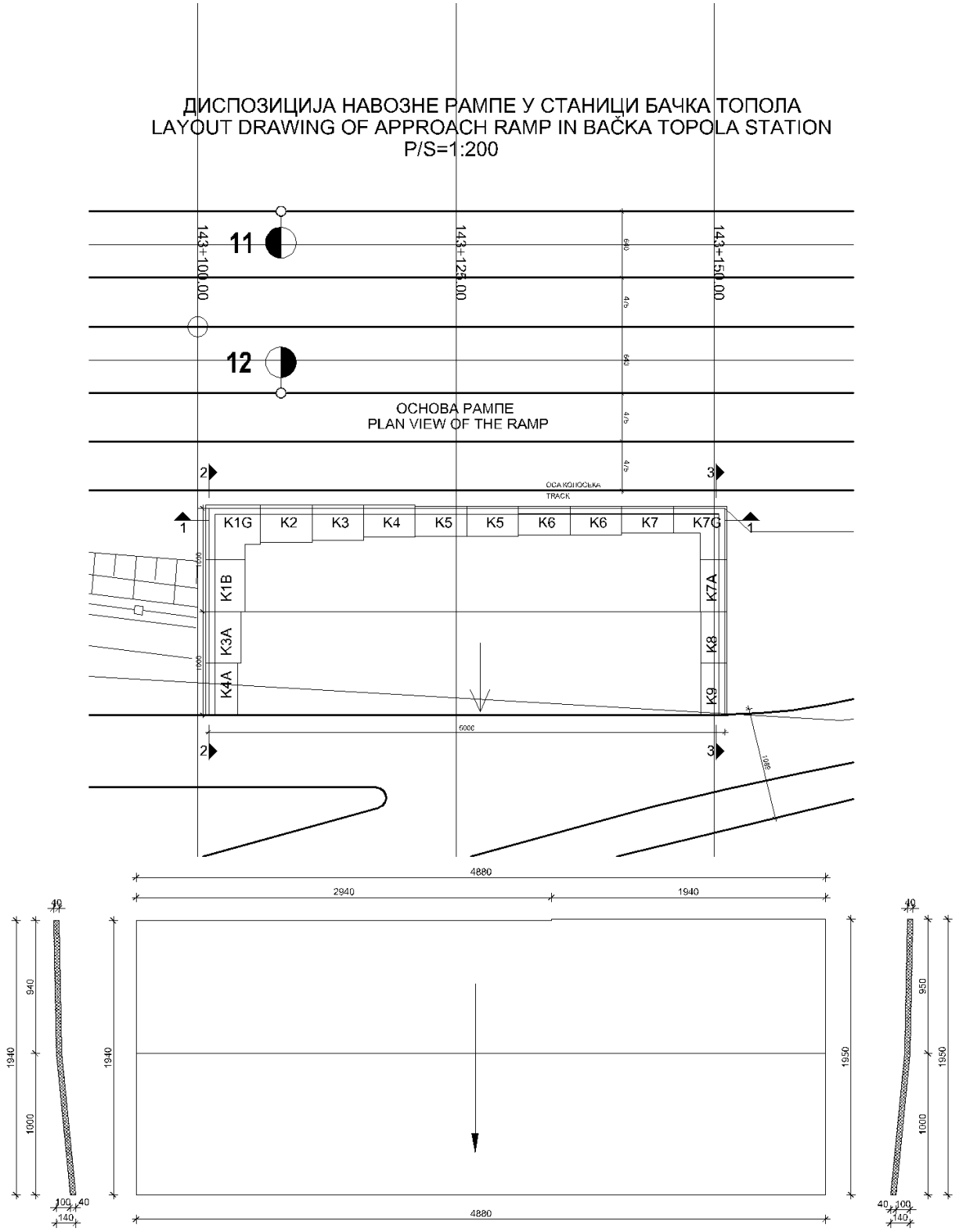
Марина Пешић, дипл.инж.грађ.

Процењена вредност радова на конструкцији рампе ....49 458 600,00 динара

2/9.9.6.6. НУМЕРИЧКА ДОКУМЕНТАЦИЈА

2/9.9.6.6.1. СТАТИЧКИ ПРОРАЧУН

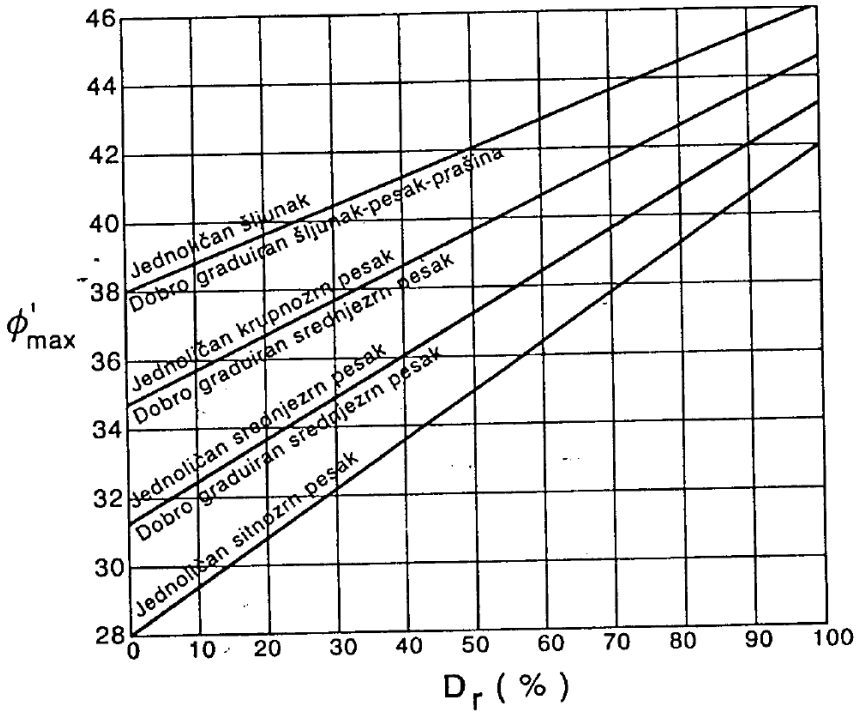
Статички прорачун рампе
km 143+100.00 до km 143+150.00
БАЧКА ТОПОЛА



1. БЕТОНСКА ПЛОЧА

1.1 Анализа оптерећења

Постизање већег угла смичуће отпорности



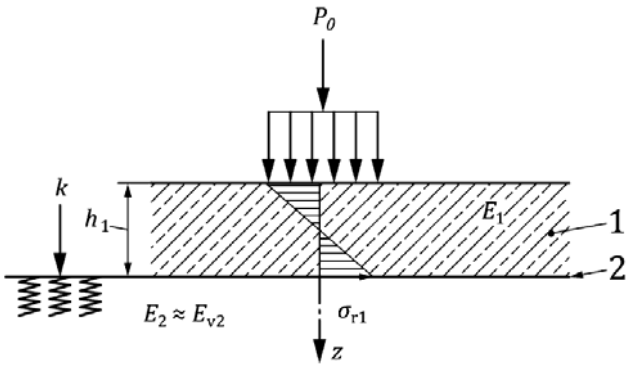
Зависност између релативне збијености и угла смичуће отпорности за крупнозрна тла
Захтевани степен збијености треба да буде око 97%
Модул стишљивости M_v=120 MPa

Минимални захтеви квалитета материјала уграђених у слојеве насипа прописују се вредностима степена збијености D_{pr} величинама модула деформабилности E_{v2}.

Одређивање крутости постељице. EN 16432-1:2017

1.2 Плоча ослоњена диретно на један слој песковитог шљунка

1.2.1. Минимална марка бетона C30/37



$$k = \frac{E_2}{h_1^*} \ [N/mm^3]$$

$$h_1^* = C \cdot h_1 \cdot \sqrt[3]{\frac{E_1}{E_2}} \ [mm]$$

Висина попречног пресека бетона
h_1=400 mm
Модул еластичности бетона C30/37
$E_1=E_{cm}$=32000 N/mm^2
Модул деформабилности песковитог шљунка
$E_2=E_{v2}$=120 N/mm^2

C=0,83 за бетонске слојеве

1.1.2. Евиквалентна висина плоче

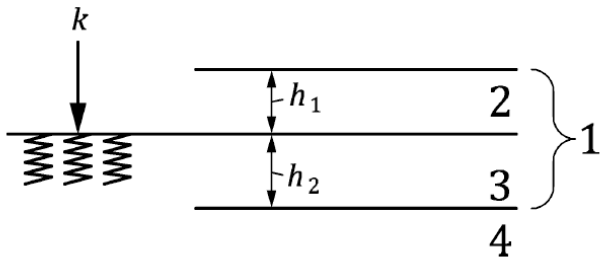
$$h_1^* = C \cdot h_1 \cdot \sqrt[3]{\frac{E_1}{E_2}} = 0,83 \cdot 400 \cdot \sqrt[3]{\frac{32000}{120}} = 2136,95\,mm$$

1.1.3. Крутост постељице

$$k = \frac{E_2}{h_1^*} = \frac{120}{2136,95} = 0,05615\ N/mm^3 = 56154,80\,kN/m^3$$

1.3 Плоча ослоњена диретно на два слоја збијеног песковитог шљунка

1.2.1. Минимална марка бетона C30/37



$$k = \frac{E_3 \cdot h^*}{h_1^* \cdot (h_1^* + h_2)} = [N/mm^3]$$

$$h_1^* = C \cdot h_1 \cdot \sqrt[3]{\frac{E_1}{E_3}}\ [mm]$$

$$h_2^* = C \cdot h_2 \cdot \sqrt[3]{\frac{E_2}{E_3}}\ [mm]$$

Висина попречног пресека бетона
h_1=400 mm
Висина првог слоја песковитог шљунка
h_2=300 mm
Модул еластичности бетона C30/37
$E_1=E_{cm}$=32000 N/mm^2
Модул деформабилности збијеног песковитог шљунка првог слоја
$E_2=E_{v2}$=120 N/mm^2
Модул деформабилности збијеног песковитог шљунка другог слоја
$E_3=E_{v2}$=80 N/mm^2
Коефицијент за бетонске слојеве
C=0,83

1.2.2. Евиквалентна висина плоче

$$h_1^* = C \cdot h_1 \cdot \sqrt[3]{\frac{E_1}{E_3}} = 0,83 \cdot 400 \cdot \sqrt[3]{\frac{32000}{80}} = 2446.20\,mm$$

$$h_2^* = C \cdot h_2 \cdot \sqrt[3]{\frac{E_2}{E_3}} = 0,83 \cdot 300 \cdot \sqrt[3]{\frac{120}{80}} = 285,03\,mm$$

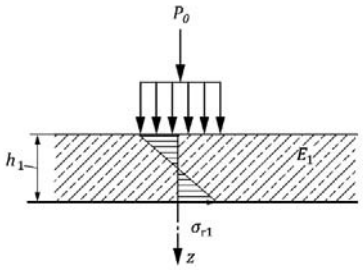
$h^*=h_1^*+h_2^*$=2446,20+285,03=2731,23 mm

1.2.3. Крутост постељице

$$k = \frac{E_3 \cdot h^*}{h_1^* \cdot (h_1^* + h_2)} = \frac{80 \cdot 2731,23}{2446,20 \cdot (2446,20 + 300)} = 0,0360\ N/mm^3 = 36072,03\,kN/m^3$$

1.4. Максимални притисак на плочу

2.1.1 Претопоставка минималне арматуре у плочи:



1.5. Одређивање еластичне дужине

1.5.1. Евквивалентна дебљина пресека

$$h_{II} = \sqrt[3]{\frac{E_1 \cdot h_1^3 + E_2 \cdot h_2^3}{E_1}} = \sqrt[3]{\frac{32000 \cdot 400^3 + 120 \cdot 300^3}{32000}} = 400,21mm$$

1.5.2. Поисонов коефицијент за бетонску плочу

За неиспуцали бетон EN 1992-1-1: μ_1=0,2

3.1.4. Еластична дужина са једним слојем збијеног песковитог шљунка

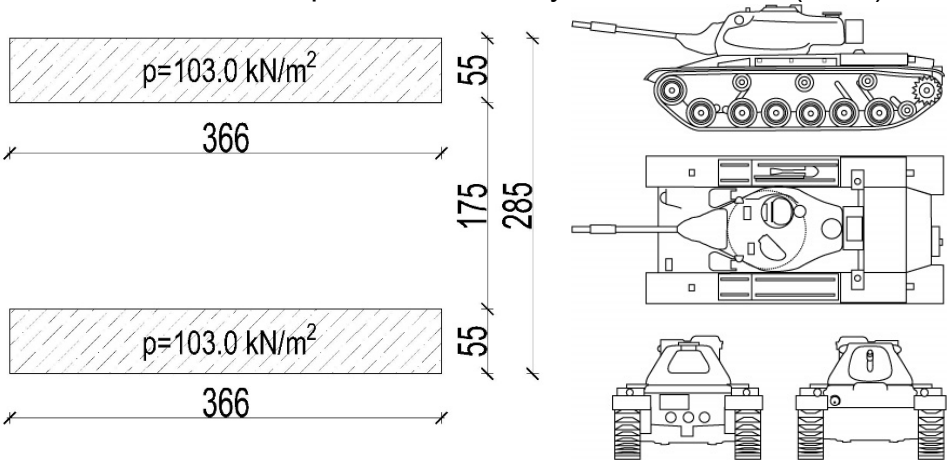
$$L_{el,ploča} = \sqrt[4]{\frac{E_1 \cdot h_{II}^3}{12 \cdot \left(1-\mu_1^2\right) \cdot k}} = \sqrt[4]{\frac{34000 \cdot 400,21^3}{12 \cdot \left(1-0,2^2\right) \cdot 0,056154}} = 1878,24mm$$

1.5.3. Еластична дужина са два слоја збијеног песковитог шљунка

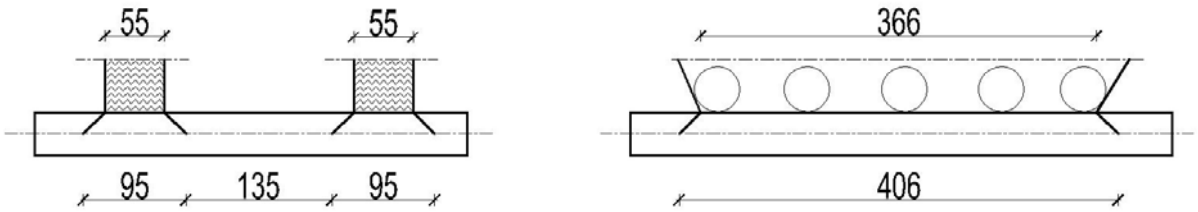
$$L_{el,ploča} = \sqrt[4]{\frac{E_1 \cdot h_{II}^3}{12 \cdot \left(1-\mu_1^2\right) \cdot k}} = \sqrt[4]{\frac{34000 \cdot 400,21^3}{12 \cdot \left(1-0,2^2\right) \cdot 0,036072}} = 1513.31mm$$

1.6. Оптерећење од тенка М-84

1.6.1. Максимално оптерећење на плочу од тенка М-84 (41.5t)



1.6.2. Распростирање оптерећења на плочу



b_1=55 cm, b_2= 95 cm ; a_1=366 cm, a_2=406 cm

p=103 kN/m^2 p_1=53,76 kN/m^2

1.7. Геометрија плоче за димензионисање

5.1.1. Димензије сегметна плоче

a=5.00 m ; b=4.00 m

Analysis using finite element method

Topology

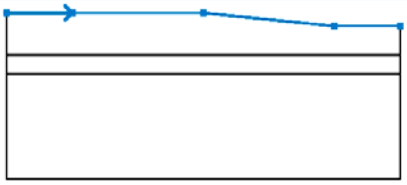
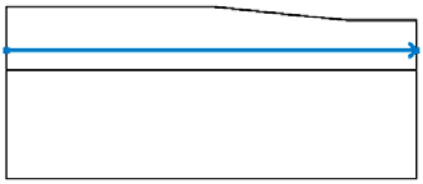
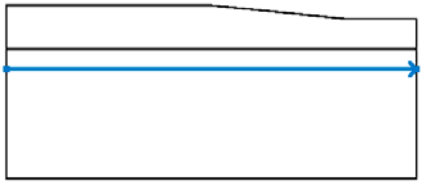
Project

Task : RAMPA BAČKA TOPOLA
Part : PLOČA
Date : 10.7.2019.

Global settings

Project type : Plane strain
Analysis type : Stress
Tunnels : no
Advanced input : no
Detailed results : yes
Concrete structures : EN 1992-1-1 (EC2)

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0,00	0,00	5,00	0,00	15,00	0,00
		25,00	-1,00	30,00	-1,00		
2		0,00	-3,20	30,00	-3,20		
3		0,00	-4,65	30,00	-4,65		

Soil parameters - basic data

No.	Name	Sample	γ [kN/m3]	E [MPa]	ν [–]
1	Peskoviti sljunak 1		19,00	100,00	0,30
2	Peskoviti sljunak 2		19,00	80,00	0,30
3	Les		19,00	7,50	0,30

Soil parameters - data according to model

No.	Material model	c_{ef} [kPa]	φ_{ef} [°]	ψ [°]
1	Mohr - Coulomb	0,00	35,00	0,00

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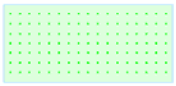
No.	Material model	c_{ef} [kPa]	φ_{ef} [°]	ψ [°]
2	Mohr - Coulomb	0,00	30,00	0,00
3	Mohr - Coulomb	10,00	23,00	0,00

Soil parameters - uplift

No.	Name	Sample	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [–]
1	Peskoviti sljunak 1		19,00		
2	Peskoviti sljunak 2		19,00		
3	Les		19,00		

Soil parameters

Peskoviti sljunak 1

Material model :		Mohr - Coulomb
Unit weight :	γ =	19,00 kN/m³
Poisson's ratio :	ν =	0,30
Elastic modulus :	E =	100,00 MPa
Angle of internal friction :	φ_{ef} =	35,00 °
Cohesion of soil :	c_{ef} =	0,00 kPa
Dilation angle :	ψ =	0,00 °
Saturated unit weight :	γ_{sat} =	19,00 kN/m³

Peskoviti sljunak 2

Material model :		Mohr - Coulomb
Unit weight :	γ =	19,00 kN/m³
Poisson's ratio :	ν =	0,30
Elastic modulus :	E =	80,00 MPa
Angle of internal friction :	φ_{ef} =	30,00 °
Cohesion of soil :	c_{ef} =	0,00 kPa
Dilation angle :	ψ =	0,00 °
Saturated unit weight :	γ_{sat} =	19,00 kN/m³

Les

Material model :		Mohr - Coulomb
Unit weight :	γ =	19,00 kN/m³
Poisson's ratio :	ν =	0,30
Elastic modulus :	E =	7,50 MPa
Angle of internal friction :	φ_{ef} =	23,00 °
Cohesion of soil :	c_{ef} =	10,00 kPa
Dilation angle :	ψ =	0,00 °
Saturated unit weight :	γ_{sat} =	19,00 kN/m³

Rigid bodies

No.	Name	Sample	γ [kN/m³]
1	Rigid body No. 1		25,00

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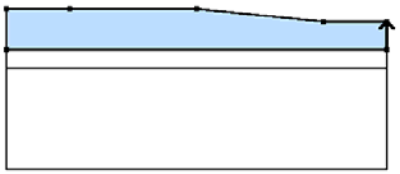
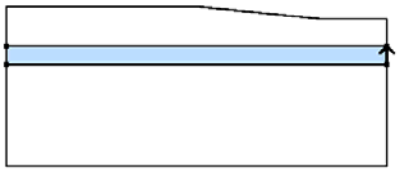
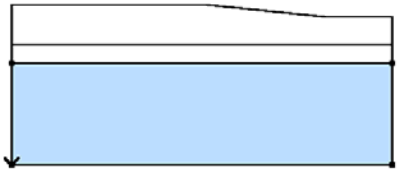
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		30,00	-3,20	30,00	-1,00	Peskoviti sljunak 1
		25,00	-1,00	15,00	0,00	
		5,00	0,00	0,00	0,00	
		0,00	-3,20			
2		30,00	-4,65	30,00	-3,20	Peskoviti sljunak 2
		0,00	-3,20	0,00	-4,65	
3		0,00	-4,65	0,00	-12,65	Les
		30,00	-12,65	30,00	-4,65	

Free points

No.	Location x [m]	z [m]	No.	Location x [m]	z [m]	No.	Location x [m]	z [m]	No.	Location x [m]	z [m]
1	5,00	-0,20	2	15,00	-0,20	3	25,00	-1,20			

Free lines

No.	Type of line	Mode of input	Lines topology
1	segment		Origin (5,00; -0,20) [m] , end (15,00; -0,20) [m]
2	segment		Origin (15,00; -0,20) [m] , end (25,00; -1,20) [m]

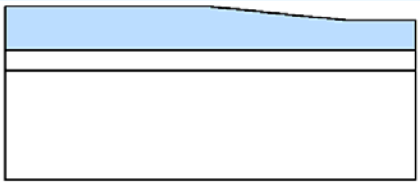
Mesh generation

Mesh generation parameters
Element edge length : 1,00 [m]
Mesh smoothing : yes
Generate multinode elements : yes

Mesh generation result
Finite element mesh was successfully generated.
Number of nodes 2241
Number of elements 1391 (region 739, beam 163, interface 489)

Input data (Stage of construction 1)

Assignment and activation

No.	Region	Active / inactive	Assigned soil
1		Active	Peskoviti sljunak 1

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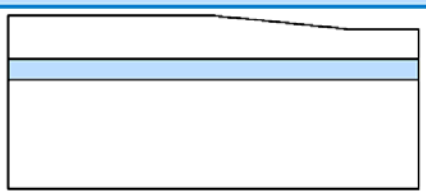
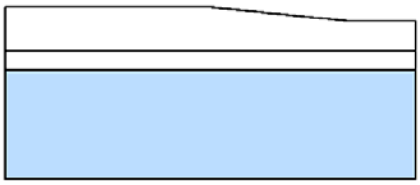
No.	Region	Active / inactive	Assigned soil
2		Active	Peskoviti sljunak 2
3		Active	Les

Beams

No.	Location	Support [m]		Include self weight	Cross-section	Material	Contacts	
		Start pt.	End pt.				left	right
1	Free line No. 1	⊢	⊢	Yes	1,00 (b) x 0,40 (h) m	C 30/37	(not inputted)	(not inputted)
2	Free line No. 2	⊢	⊢	Yes	1,00 (b) x 0,40 (h) m	C 30/37	(not inputted)	(not inputted)

No.	Cross-section		Material	
	I_y [m⁴/m]	A [m²/m]	E [MPa]	G [MPa]
1	5,33E-03	4,00E-01	33000,00	13750,00
2	5,33E-03	4,00E-01	33000,00	13750,00

Line supports

No.	Location	Support	
		Direction X	Direction Z
A1	Mesh line No. 11	fixed	free
A2	Mesh line No. 9	fixed	free
A3	Mesh line No. 6	fixed	free
A4	Mesh line No. 13	fixed	free
A5	Mesh line No. 8	fixed	free
A6	Mesh line No. 1	fixed	free
A7	Mesh line No. 12	fixed	fixed
A1 up to A7 - automatically generated line supports along model edges			

Water

Water type : No water

Analysis settings

General

Method :	Newton - Raphson
Stiffness matrix change :	after each iteration
Max. number of iterations for one calc. step :	100
Initial calculation step :	0,25
Displacement error :	0,0100
Imbalanced forces error :	0,0100
Energy error :	0,0100
Respect material interfaces :	no

Newton - Raphson

Relaxation factor of calculation step :	2
Maximum number of relaxations of calculation step :	2
Min. number of iterations for one calc. step :	1

Line search

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Solution method :	iterate no
Line search limit - minimum :	0,100
Line search limit - maximum :	1,000
Plasticity	
Return mapping error :	0,00100
Max. number of iterations for one plast. step :	20

Results (Stage of construction 1)

Stress analysis was successfully completed.
Analysis settings : **standard**
Attained loading = 100,00 %
Extremes

Stress (extremes)

	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
Sigma $_{Z, tot.}$ [kPa]	15,00	0,00	0,00	2,27	-12,65	243,38
Sigma $_{Z, eff.}$ [kPa]	15,00	0,00	0,00	2,27	-12,65	243,38
Sigma $_{X, tot.}$ [kPa]	22,62	-0,76	1,20	2,27	-12,65	104,25
Sigma $_{X, eff.}$ [kPa]	22,62	-0,76	1,20	2,27	-12,65	104,25
Tau $_{XZ}$ [kPa]	25,17	-2,24	-11,18	5,42	-0,99	9,56
Sigma $_{m, tot.}$ [kPa]	7,28	0,00	1,19	2,27	-12,65	150,64
Sigma $_{m, eff.}$ [kPa]	7,28	0,00	1,19	2,27	-12,65	150,64
Sigma $_{eq.}$ [kPa]	7,28	0,00	0,34	2,27	-12,65	80,31
Sigma $_{1, tot.}$ [kPa]	22,62	-0,76	1,17	2,27	-12,65	104,25
Sigma $_{1, eff.}$ [kPa]	22,62	-0,76	1,17	2,27	-12,65	104,25
Sigma $_{2, tot.}$ [kPa]	7,28	0,00	1,49	2,27	-12,65	243,38
Sigma $_{2, eff.}$ [kPa]	7,28	0,00	1,49	2,27	-12,65	243,38
Sigma $_{3, tot.}$ [kPa]	7,28	0,00	0,82	2,27	-12,65	104,29
Sigma $_{3, eff.}$ [kPa]	7,28	0,00	0,82	2,27	-12,65	104,29

Strain (extremes)

	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
Epsilon $_{eq.}$ [%]	7,28	0,00	0,00	2,27	-12,65	2,78
Epsilon $_{eq., pl.}$ [%]	0,00	-3,20	0,00	30,00	-1,00	0,07
Epsilon $_{X}$ [%]	30,00	-1,00	-0,04	30,00	-5,16	0,06
Epsilon $_{Z}$ [%]	4,18	0,00	-0,03	2,27	-12,65	2,41
Gamma $_{XZ}$ [%]	19,98	-12,65	-0,11	5,42	-0,99	0,05
Epsilon $_{X, pl.}$ [%]	30,00	-1,00	-0,04	4,18	0,00	0,03
Epsilon $_{Z, pl.}$ [%]	4,18	0,00	-0,03	30,00	-1,00	0,03
Gamma $_{XZ, pl.}$ [%]	25,00	-1,20	-0,02	7,23	-0,20	0,02
Epsilon $_{vol.}$ [%]	30,00	-1,00	0,00	2,27	-12,65	2,41
Epsilon $_{vol., pl.}$ [%]	30,00	-1,00	0,00	0,00	-3,20	0,00
Epsilon $_{1}$ [%]	30,00	-1,00	-0,04	30,00	-5,16	0,06
Epsilon $_{2}$ [%]	7,28	0,00	0,00	2,27	-12,65	2,41
Epsilon $_{3}$ [%]	0,00	-3,20	0,00	0,00	-3,20	0,00

Pore pressures (extremes)

	Location		Max
	x [m]	z [m]	
Pore pressure u [kPa]	0,00	-3,20	0,00

Distributions on beams (extremes)

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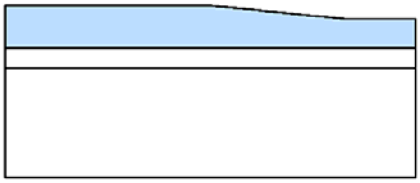
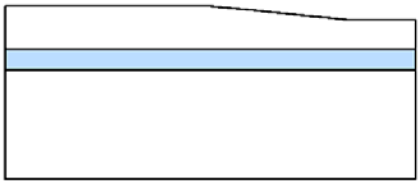
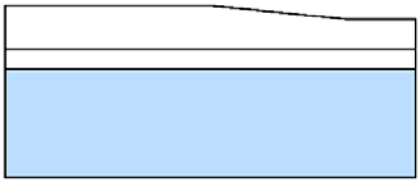
	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
N [kN/m]	14,15	-0,20	-76,7	25,00	-1,20	-11,6
M [kNm/m]	5,00	-0,20	0,0	13,27	-0,20	22,8
Q [kN/m]	15,00	-0,20	-7,7	5,00	-0,20	6,2

Input data (Stage of construction 2)

Assignment and activation

No.	Region	Active / inactive	Assigned soil
1		Active	Peskoviti sljunak 1
2		Active	Peskoviti sljunak 2
3		Active	Les

Beams

No.	Beam		Location	Support [m]		Include self weight	Cross-sectio	Material	Contacts	
	new	modified		Start pt.	End pt.				left	right
1	No	No	Free line No. 1	⊢	⊢	Yes	without modification	without modification	(not inputted)	(not inputted)
2	No	No	Free line No. 2	⊢	⊢	Yes	without modification	without modification	(not inputted)	(not inputted)

No.	Cross-section		Material	
	I_y [m⁴/m]	A [m²/m]	E [MPa]	G [MPa]
1	5,33E-03	4,00E-01	33000,00	13750,00
2	5,33E-03	4,00E-01	33000,00	13750,00

Line supports

No.	Line support		Location	Support	
	new	modified		Direction X	Direction Z
A1	Yes		Mesh line No. 11	fixed	free
A2	Yes		Mesh line No. 9	fixed	free
A3	Yes		Mesh line No. 6	fixed	free
A4	Yes		Mesh line No. 13	fixed	free
A5	Yes		Mesh line No. 8	fixed	free
A6	Yes		Mesh line No. 1	fixed	free
A7	Yes		Mesh line No. 12	fixed	fixed
A1 up to A7 - automatically generated line supports along model edges					

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Beam loads

No.	Beam load new	Beam load change	Beam	Type of load	Direction	Angle α [°]	Origin x [m]	Length l [m]	Magnitude f, m, q, q_1	Magnitude q_2	Magnitude unit
1	Yes		Beam "Ploca"	distr. uniform on beam segment	pendicular to beam	0,00	0,00	3,66	53,76		[kN/m²]

Water

Water type : No water

Analysis settings

General

Method :	Newton - Raphson
Stiffness matrix change :	after each iteration
Max. number of iterations for one calc. step :	100
Initial calculation step :	0,25
Displacement error :	0,0100
Imbalanced forces error :	0,0100
Energy error :	0,0100
Respect material interfaces :	no

Newton - Raphson

Relaxation factor of calculation step :	2
Maximum number of relaxations of calculation step :	2
Min. number of iterations for one calc. step :	1

Line search

Solution method :	iterate no
Line search limit - minimum :	0,100
Line search limit - maximum :	1,000

Plasticity

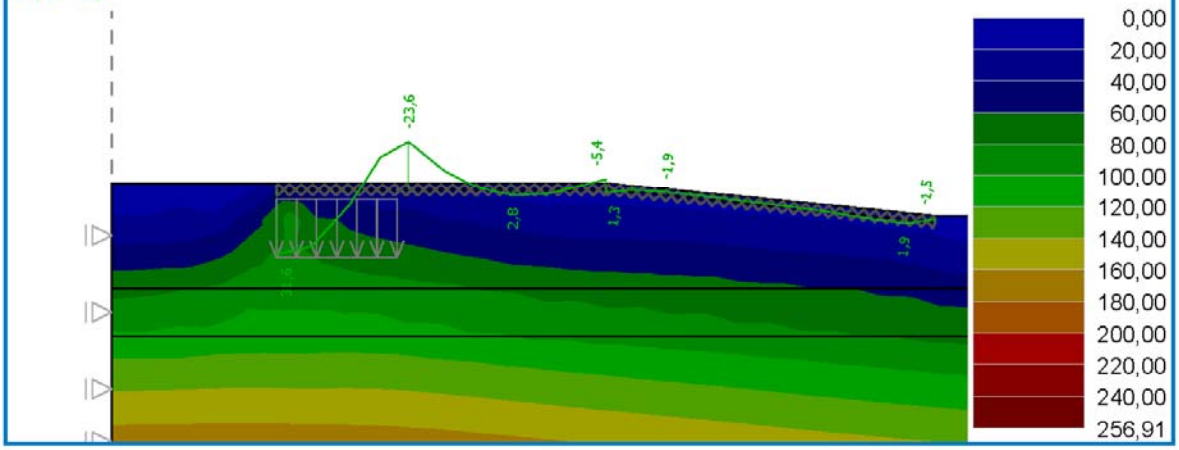
Return mapping error :	0,00100
Max. number of iterations for one plast. step :	20

Results (Stage of construction 2)

Stress analysis was successfully completed.
Analysis settings : **standard**
Attained loading = 100,00 %

Name : Analysis	Stage : 2

Results : overall; variable : Sigma $_{z, eff.}$; range : <0,00; 256,91> kPa
Q [kN/m]



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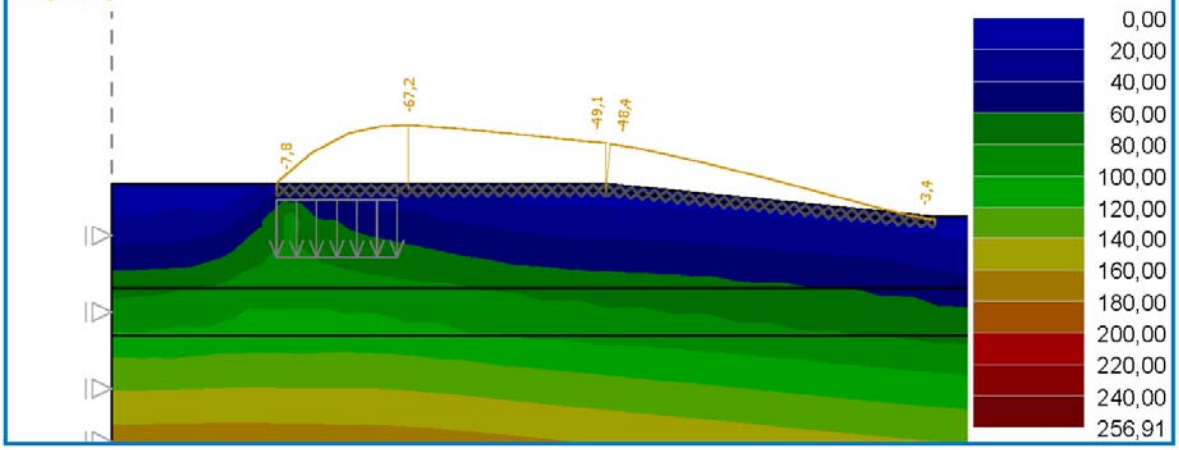
Name : Analysis | Stage : 2

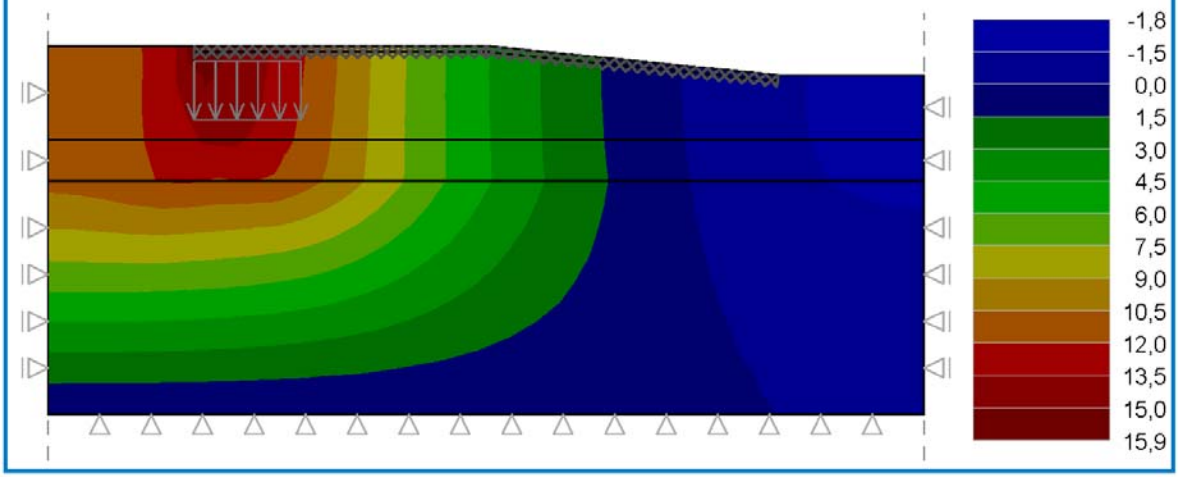
Results : overall; variable : Sigma $_{Z,\ eff.}$; range : <0,00; 256,91> kPa

N+ [kN/m]



Name : Analysis | Stage : 2

Results : overall; variable : Settlement d $_{Z}$; range : <-1,8; 15,9> mm



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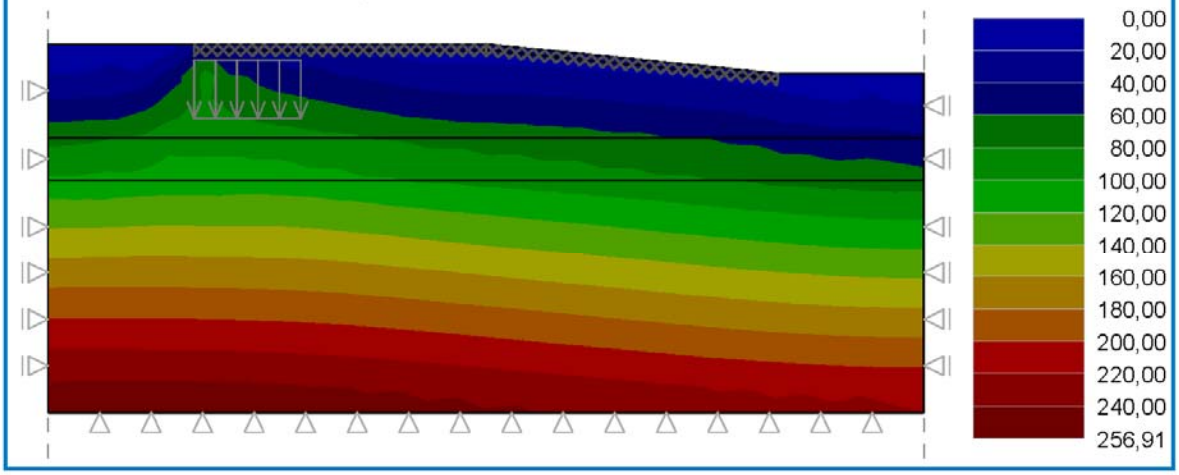
Name : Analysis | Stage : 2

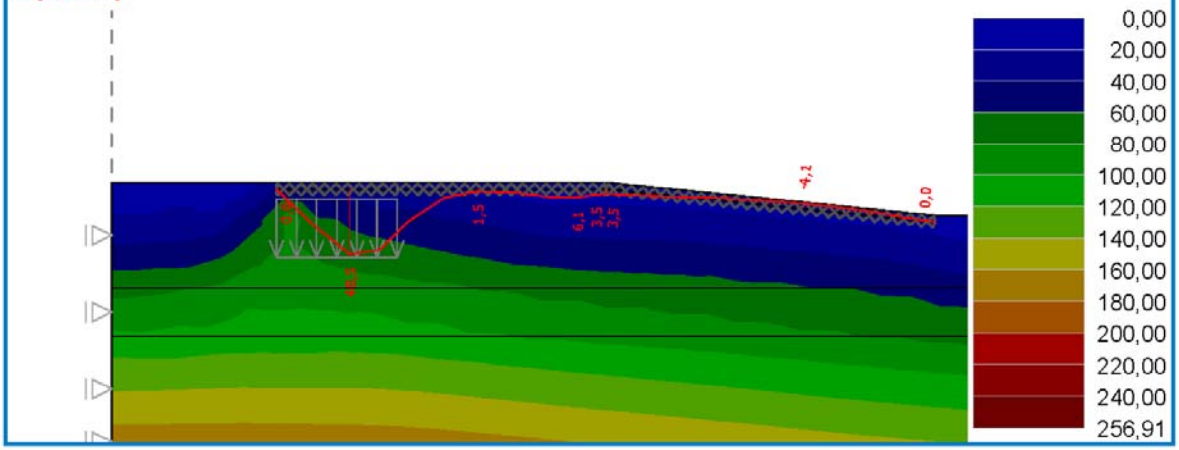
Results : overall; variable : Sigma $_{Z, eff.}$; range : <0,00; 256,91> kPa



Name : Analysis | Stage : 2

Results : overall; variable : Sigma $_{Z, eff.}$; range : <0,00; 256,91> kPa

M [kNm/m]



Extremes

Displacements (extremes)

	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
Displacements x [m]	10,78	-4,65	-3,5	9,49	0,00	1,3
Displacements z [m]	30,00	-1,73	-1,8	5,00	-0,20	15,9

Stress (extremes)

	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
Sigma $_{Z, tot.}$ [kPa]	7,28	0,00	0,00	2,27	-12,65	256,91
Sigma $_{Z, eff.}$ [kPa]	7,28	0,00	0,00	2,27	-12,65	256,91
Sigma $_{X, tot.}$ [kPa]	22,62	-0,76	0,64	2,27	-12,65	109,93
Sigma $_{X, eff.}$ [kPa]	22,62	-0,76	0,64	2,27	-12,65	109,93
Tau $_{XZ}$ [kPa]	24,42	-2,30	-8,67	5,42	-0,99	26,10
Sigma $_{m, tot.}$ [kPa]	15,00	0,00	0,92	2,27	-12,65	158,96

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	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
Sigma m, eff. [kPa]	15,00	0,00	0,92	2,27	-12,65	158,96
Sigma eq. [kPa]	13,33	0,00	0,29	2,27	-12,65	84,83
Sigma 1, tot. [kPa]	22,62	-0,76	0,63	2,27	-12,65	109,93
Sigma 1, eff. [kPa]	22,62	-0,76	0,63	2,27	-12,65	109,93
Sigma 2, tot. [kPa]	13,33	0,00	1,26	2,27	-12,65	256,91
Sigma 2, eff. [kPa]	13,33	0,00	1,26	2,27	-12,65	256,91
Sigma 3, tot. [kPa]	15,00	0,00	0,63	2,27	-12,65	110,05
Sigma 3, eff. [kPa]	15,00	0,00	0,63	2,27	-12,65	110,05

Strain (extremes)

	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
Epsilon eq. [%]	15,00	0,00	0,00	2,27	-12,65	2,94
Epsilon eq., pl. [%]	0,00	-3,20	0,00	4,18	0,00	0,28
Epsilon X [%]	5,85	-4,65	-0,10	4,18	0,00	0,12
Epsilon Z [%]	5,00	0,00	-0,13	2,27	-12,65	2,55
Gamma XZ [%]	17,99	-12,65	-0,19	4,40	-1,18	0,19
Epsilon X, pl. [%]	6,32	-3,20	-0,07	4,18	0,00	0,11
Epsilon Z, pl. [%]	5,00	0,00	-0,13	6,32	-3,20	0,07
Gamma XZ, pl. [%]	5,00	0,00	-0,04	4,18	0,00	0,16
Epsilon vol. [%]	5,00	0,00	-0,02	2,27	-12,65	2,54
Epsilon vol., pl. [%]	5,00	0,00	-0,02	0,00	-3,20	0,00
Epsilon 1 [%]	4,18	0,00	-0,14	30,00	-6,03	0,08
Epsilon 2 [%]	15,00	0,00	0,00	2,27	-12,65	2,55
Epsilon 3 [%]	0,00	-3,20	0,00	0,00	-3,20	0,00

Pore pressures (extremes)

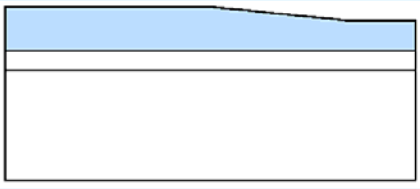
	Location		Max
	x [m]	z [m]	
Pore pressure u [kPa]	0,00	-3,20	0,00

Distributions on beams (extremes)

	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
N [kN/m]	9,01	-0,20	-67,2	25,00	-1,20	-3,4
M [kNm/m]	20,98	-0,80	-4,1	7,23	-0,20	48,5
Q [kN/m]	9,01	-0,20	-23,6	5,00	-0,20	31,6

Input data (Stage of construction 3)

Assignment and activation

No.	Region	Active / inactive	Assigned soil
1		Active	Peskoviti sljunak 1 

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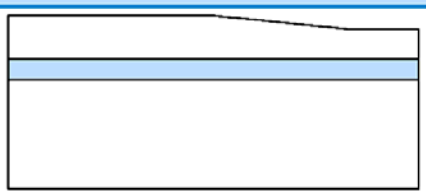
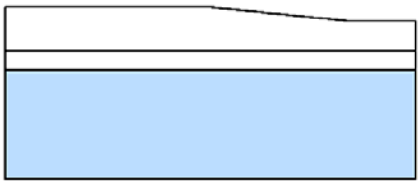
No.	Region	Active / inactive	Assigned soil
2		Active	Peskoviti sljunak 2
3		Active	Les

Beams

No.	Beam		Location	Support [m]		Include self weight	Cross-sectio	Material	Contacts	
	new	modified		Start pt.	End pt.				left	right
1	No	No	Free line No. 1	⊢	⊢	Yes	without modification	without modification	(not inputted)	(not inputted)
2	No	No	Free line No. 2	⊢	⊢	Yes	without modification	without modification	(not inputted)	(not inputted)

No.	Cross-section		Material	
	I_y [m⁴/m]	A [m²/m]	E [MPa]	G [MPa]
1	5,33E-03	4,00E-01	33000,00	13750,00
2	5,33E-03	4,00E-01	33000,00	13750,00

Line supports

No.	Line support		Location	Support	
	new	modified		Direction X	Direction Z
A1	Yes		Mesh line No. 11	fixed	free
A2	Yes		Mesh line No. 9	fixed	free
A3	Yes		Mesh line No. 6	fixed	free
A4	Yes		Mesh line No. 13	fixed	free
A5	Yes		Mesh line No. 8	fixed	free
A6	Yes		Mesh line No. 1	fixed	free
A7	Yes		Mesh line No. 12	fixed	fixed
A1 up to A7 - automatically generated line supports along model edges					

Beam loads

No.	Beam load		Beam	Type of load	Direction	Angle	Origin	Length	Magnitude		
	new	change				α [°]	x [m]	l [m]	f, m, q, q_1	q_2	unit
1	No	No	Beam "Ploca"	distr. uniform on beam segment	pendicular to beam	0,00	0,00	3,66	53,76		[kN/m²]
2	Yes		Beam "Ploca"	distr. uniform on beam segment	in the direction of global Z-axis	0,00	6,35	3,66	53,76		[kN/m²]

Water

Water type : No water

Analysis settings

General

Method : Newton - Raphson

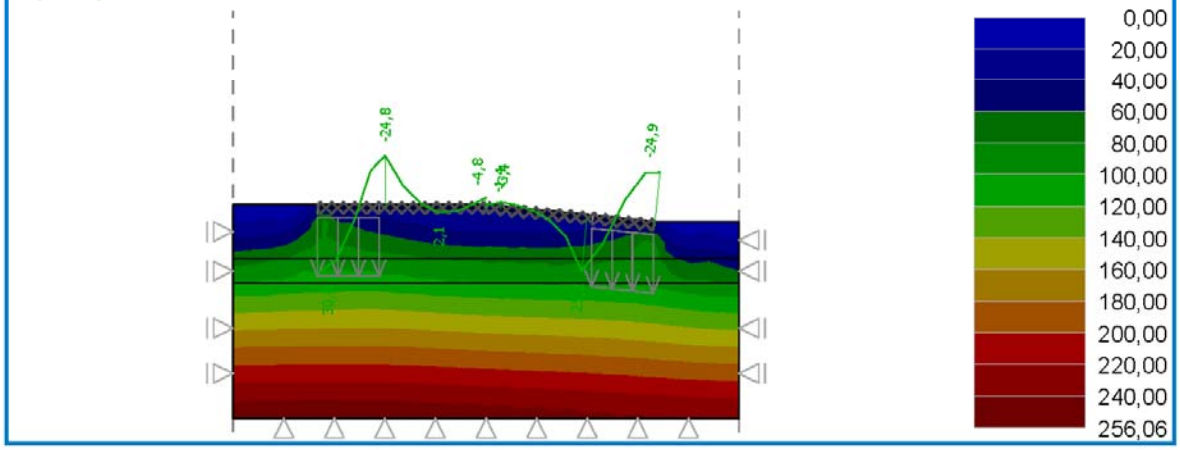
Stiffness matrix change :	after each iteration
Max. number of iterations for one calc. step :	100
Initial calculation step :	0,25
Displacement error :	0,0100
Imbalanced forces error :	0,0100
Energy error :	0,0100
Respect material interfaces :	no
Newton - Raphson	
Relaxation factor of calculation step :	2
Maximum number of relaxations of calculation step :	2
Min. number of iterations for one calc. step :	1
Line search	
Solution method :	iterate no
Line search limit - minimum :	0,100
Line search limit - maximum :	1,000
Plasticity	
Return mapping error :	0,00100
Max. number of iterations for one plast. step :	20

Results (Stage of construction 3)

Stress analysis was successfully completed.
Analysis settings : **standard**
Attained loading = 100,00 %

Name : Analysis | **Stage : 3**

Results : overall; variable : Sigma $_{z, eff.}$; range : <0,00; 256,06> kPa
Q [kN/m]



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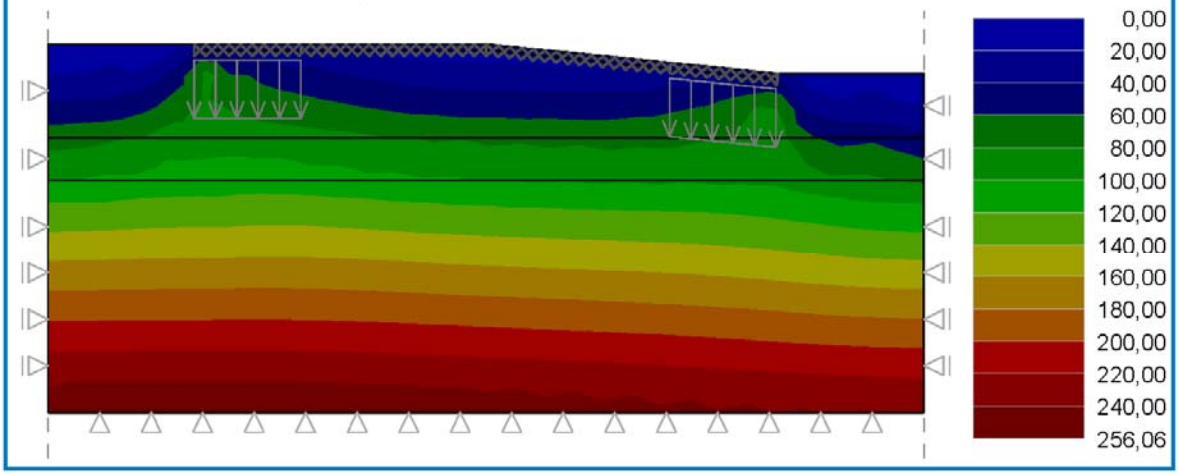
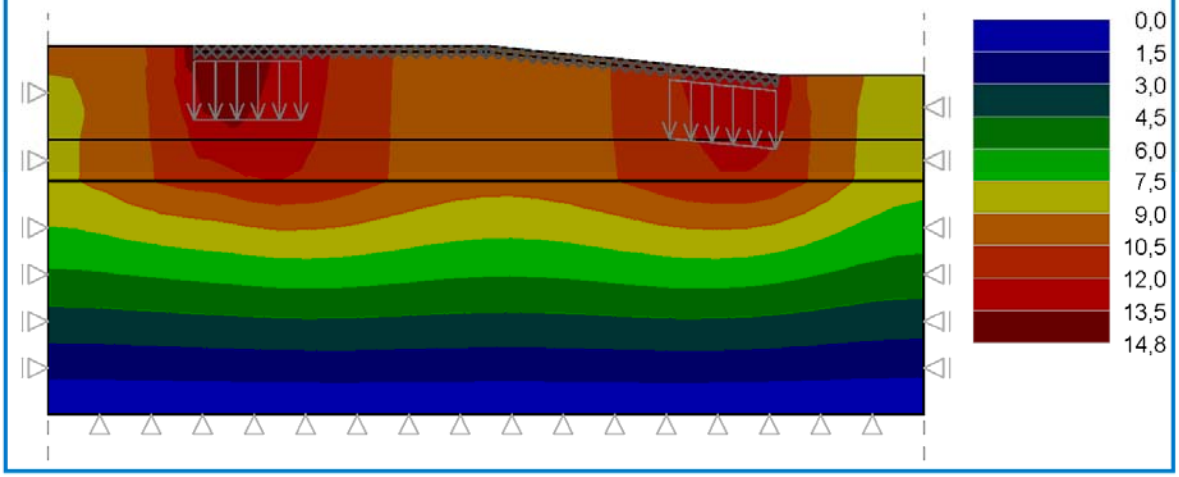
Name : Analysis | Stage : 3

Results : overall; variable : Sigma $_{z, eff.}$; range : <0,00; 256,06> kPa



Name : Analysis | Stage : 3

Results : overall; variable : Settlement d $_{z}$; range : <0,0; 14,8> mm



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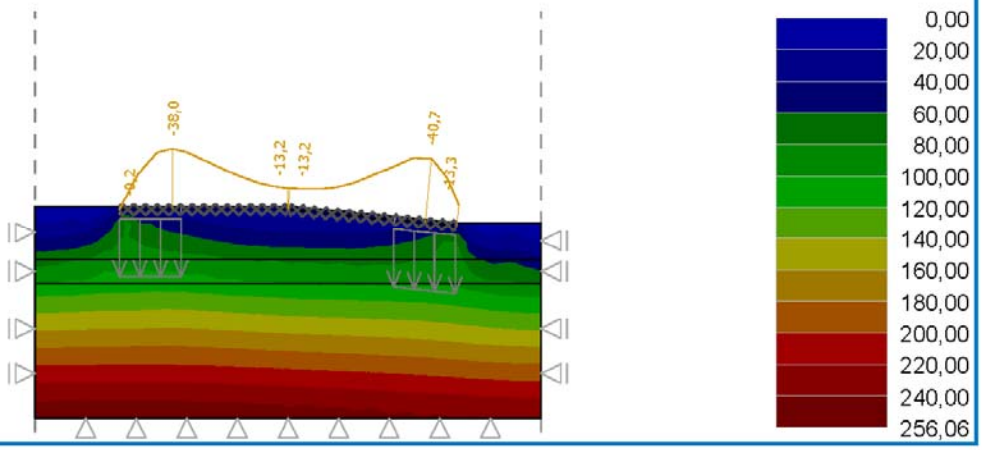
Name : Analysis | Stage : 3

Results : overall; variable : Sigma $_{Z, eff.}$; range : <0,00; 256,06> kPa

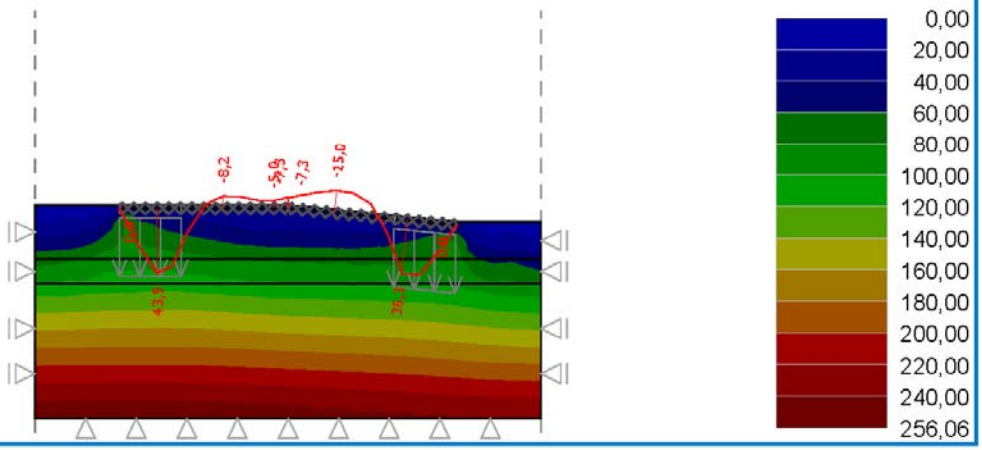
N+ [kN/m]



Name : Analysis | Stage : 3

Results : overall; variable : Sigma $_{Z, eff.}$; range : <0,00; 256,06> kPa

M [kNm/m]



Extremes

Displacements (extremes)

	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
Displacements x [m]	4,18	0,00	-2,1	26,04	-1,00	1,4
Displacements z [m]	1,50	-12,65	0,0	5,00	-0,20	14,8

Stress (extremes)

	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
Sigma $_{Z, tot.}$ [kPa]	7,28	0,00	0,00	2,27	-12,65	256,06
Sigma $_{Z, eff.}$ [kPa]	7,28	0,00	0,00	2,27	-12,65	256,06
Sigma $_{X, tot.}$ [kPa]	15,00	0,00	0,38	2,27	-12,65	109,70
Sigma $_{X, eff.}$ [kPa]	15,00	0,00	0,38	2,27	-12,65	109,70
Tau $_{XZ}$ [kPa]	25,17	-2,24	-28,23	4,35	-2,44	21,44
Sigma $_{m, tot.}$ [kPa]	15,00	0,00	0,71	2,27	-12,65	158,50

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	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
Sigma m, eff. [kPa]	15,00	0,00	0,71	2,27	-12,65	158,50
Sigma eq. [kPa]	9,49	0,00	0,46	2,27	-12,65	84,49
Sigma 1, tot. [kPa]	15,00	0,00	0,38	2,27	-12,65	109,70
Sigma 1, eff. [kPa]	15,00	0,00	0,38	2,27	-12,65	109,70
Sigma 2, tot. [kPa]	15,00	0,00	1,26	2,27	-12,65	256,06
Sigma 2, eff. [kPa]	15,00	0,00	1,26	2,27	-12,65	256,06
Sigma 3, tot. [kPa]	15,00	0,00	0,49	2,27	-12,65	109,73
Sigma 3, eff. [kPa]	15,00	0,00	0,49	2,27	-12,65	109,73

Strain (extremes)

	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
Epsilon eq. [%]	9,49	0,00	0,00	2,27	-12,65	2,93
Epsilon eq., pl. [%]	1,47	-3,20	0,00	4,18	0,00	0,25
Epsilon X [%]	30,00	-1,00	-0,10	4,18	0,00	0,10
Epsilon Z [%]	5,00	0,00	-0,12	2,27	-12,65	2,54
Gamma XZ [%]	25,17	-2,24	-0,16	4,40	-1,18	0,18
Epsilon X, pl. [%]	30,00	-1,00	-0,10	5,00	0,00	0,10
Epsilon Z, pl. [%]	5,00	0,00	-0,12	30,00	-1,00	0,09
Gamma XZ, pl. [%]	26,04	-1,00	-0,09	4,18	0,00	0,16
Epsilon vol. [%]	5,00	0,00	-0,03	2,27	-12,65	2,54
Epsilon vol., pl. [%]	5,00	0,00	-0,03	0,00	-3,20	0,00
Epsilon 1 [%]	4,18	0,00	-0,13	30,00	-5,16	0,10
Epsilon 2 [%]	9,49	0,00	0,00	2,27	-12,65	2,54
Epsilon 3 [%]	0,00	-3,20	0,00	0,00	-3,20	0,00

Pore pressures (extremes)

	Location		Max
	x [m]	z [m]	
Pore pressure u [kPa]	0,00	-3,20	0,00

Distributions on beams (extremes)

	Location		Min	Location		Max
	x [m]	z [m]		x [m]	z [m]	
N [kN/m]	23,13	-1,01	-40,7	5,00	-0,20	-0,2
M [kNm/m]	17,75	-0,47	-15,0	7,23	-0,20	43,9
Q [kN/m]	25,00	-1,20	-24,9	5,00	-0,20	30,8

2. Одређивање заштиног слоја

Прорачун заштитног слоја рађен је према нормама EN 1992-1-1:2004

Уз помоћ Еврокод апликације са претпоставком усвојеног пречника арматуре Ø16, елемента изложености XC4 и веку трајања објекта (50 година).

Eurocode Applied.com

Free online calculation tools for structural design according to Eurocodes

Project:	Модернизација железничке пруге Београд Суботица
Subject:	Пројекат бетонске конструкције војне рампе
Designer:	
Date:	

Eurocode 2

Concrete nominal cover for reinforcement and prestressing steel

Description:
Calculation of required nominal concrete cover cnom for reinforcement steel and prestressing steel
According to:
EN 1992-1-1:2004+AC2:2010 Section 4.4
Supported National Annexes:
Nationally Defined Parameters (NDPs) automatically filled for supported countries

Input

Concrete characteristic strength	f_{ck} =	30	MPa
Type of reinforcement / tendon	=	Reinforcement bar ▼	
Maximum diameter of reinforcement / tendon	Φ =	16	mm
Environment exposure class	=	XC4 ▼	

Exposure classes related to environmental conditions in accordance with EN 206-1

X0	No risk of corrosion or attack (Very dry: Concrete inside buildings with very low air humidity)	XD1	Chlorides - Moderate humidity (surfaces exposed to airborne chlorides)
XC1	Carbonation - Dry or permanently wet (Interior of buildings with very low air humidity, permanently submerged in water)	XD2	Chlorides - Wet or rarely dry (swimming pools, exposure to industrial waters containing chlorides)
XC2	Carbonation - Wet, rarely dry (long-term water contact, many foundations)	XD3	Chlorides - Cyclic wet & dry (bridge parts exposed to spray containing chlorides, pavements, car park slabs)
XC3	Carbonation - Moderate humidity (Interior of buildings with moderate or high air humidity, external concrete sheltered from rain)	XS1	Sea water - Airborne salts not in direct contact with sea water (structures near to or on the coast)
XC4	Carbonation - Cyclic wet & dry (concrete subject to water contact not within exposure class XC2)	XS2	Sea water - Permanently submerged (parts of marine structures)
		XS3	Sea water - Tidal splash & spray zones (parts of marine structures)

Design working life	=	50	years
Member with slab geometry	=	No ▼	
Concrete cast against uneven surface			

= None ▾

Special quality control of the concrete production	=	No ▾
Nominal aggregate size greater than 32 mm	=	No ▾

Nationally Defined Parameters

Nationally Defined Parameters	=	CEN default ▾

Results

Nominal concrete cover $c_{nom} = 40.0$ mm

Notes

1. Minimum cover may be reduced or increased for special conditions such as a) use of stainless steel, b) coating protection, c) uneven surfaces other than the ones examined, d) abrasion on the concrete surface, e) air entrainment of more than 4%, f) fabrication subjected to quality assurance system or accurate monitoring g) in-situ concrete placed against an existing concrete surface. For more information see EN1992-1-1 sections 4.4.1.2(7) to (13), 4.4.1.3(3) and the National Annex.

Details

Input Data

- Concrete characteristic strength: f_{ck} = 30 MPa
- Type of reinforcement / tendon: = Reinforcement bar
- Maximum diameter of reinforcement / tendon: Φ = 16 mm
- Environment exposure class: = XC4
- Design working life: = 50 years
- Member with slab geometry: = No
- Concrete cast against uneven surface: = None
- Special quality control of the concrete production: = No
- Nominal aggregate size greater than 32 mm: = No

Nationally Defined Parameters

- Nationally Defined Parameters: = CEN default

Calculation of structural class

The structural class is calculated according to the rules specified in *EN1992-1-1 Table 4.3N*:

- The initial structural class is S4 (corresponding to the reference design working life of 50 years)
- The next working life class that is applicable for the structure is 50 years
- The minimum structural class is S1

Therefore the structural class is S4.

Calculation of concrete cover for durability

For reinforcement steel the minimum cover for durability $c_{min,dur}$ is calculated in accordance with *EN1992-1-1 Table 4.4N*.

For structural class S4 and exposure class XC4 the minimum cover for durability $c_{min,dur}$ is equal to $c_{min,dur}$ = 30.0 mm.

Calculation of concrete cover for bond

The minimum cover for bond $c_{min,b}$ is calculated in accordance with *EN1992-1-1 §4.4.1.2(3)* .

For reinforcement bars the minimum cover for bond is calculated in accordance with *EN1992-1-1 Table 4.2N* as: $c_{min,b} = 1.0 \cdot \Phi$, where Φ is the diameter of the reinforcement bar (or equivalent diameter of bundled bars).

Therefore minimum cover for bond is $c_{min,b}$ = 16.0 mm.

Calculation of minimum concrete cover

According to *EN1992-1-1 §4.4.1.2(2)P* the greater value of concrete cover satisfying the requirements for both bond and durability is used:

$$c_{min} = \max \{c_{min,b}, c_{min,dur} + \Delta c_{dur,y} - \Delta c_{dur,st} - \Delta c_{dur,add}, 10 \text{ mm}\}$$

According to *EN1992-1-1 §4.4.1.2(6)* the additive safety element is $\Delta c_{dur,y}$ = 0.0 mm.

The following modification factors are not applicable:

- Reduction of minimum cover for use of stainless steel $\Delta c_{dur,st}$ = 0 mm
- Reduction of minimum cover for use of additional protection $\Delta c_{dur,add}$ = 0 mm.

Therefore the minimum concrete cover is calculated as:

$$c_{min} = \max \{16.0 \text{ mm}, 30.0 \text{ mm} + 0.0 \text{ mm} - 0 \text{ mm} - 0 \text{ mm}, 10 \text{ mm}\} = 30.0 \text{ mm}$$

Calculation of nominal concrete cover

The nominal concrete cover c_{nom} is calculated by adding to the minimum cover c_{min} the allowance for deviation Δc_{dev}.

According to *EN1992-1-1 §4.4.1.3*, the allowance for deviation is Δc_{dev} = 10.0 mm.

The required nominal concrete cover is:

$$c_{nom} = c_{min} + \Delta c_{dev} = 30.0 \text{ mm} + 10.0 \text{ mm} = 40.0 \text{ mm}$$

Therefore the required nominal concrete cover is c_{nom} = 40.0 mm.

3. Димензинисање

Димензионисање се врши на основу максималног утицаја на плочу и положаја оптерећења.

3.1. Макисмални утицај на плочу у доњој зони

M_{Ed}=48,50 kN
N_{Ed}=3,00 kN
V_{Ed}=31,60 kN

3.2. Карактеристике плоче

Висина пресека : h=40 cm
Ширина пресека: b=100 cm
Заштитни слој бетона: c=4.0 cm
Статичка висина пресека: d= 35 cm

3.3. Материјал плоче

Бетон: C30/37
Карактеристика чврстоћа бетона на притисак старог 28 дана: f_{ck}=30.00 N/mm^2
Коефицијент сигурности за бетон: γ_c=1,50
Арматура: B500B
Граница развлачења: f_{yk}=500 N/mm^2
Коефицијент сигурности за арматуру: γ_s=1,15

3.4 Прорачун

$$f_{cd}=\frac{f_{ck}}{\gamma_c}=\frac{3.0}{1{,}5}=2.0\,kN/cm^2;\ f_{yd}=\frac{f_{yk}}{\gamma_s}=\frac{50}{1{,}15}=43{,}48\,kN/cm^2$$

Коефицијент армирања

$$\mu_{Ed}=\frac{M_{Ed}}{b\cdot d^2\cdot f_{cd}}=\frac{48{,}50\cdot 100}{100\cdot 35^2\cdot 2.0}=0{,}0197;\ \zeta=0{,}983,\ \varepsilon_{s1}=20‰\ ,\ \varepsilon_c=-1.0‰\ ,$$

Потребна арматура у доњој зони у X правцу

$$A_{s1}=\frac{M_{Ed}}{\zeta\cdot d\cdot f_{yd}}=\frac{48{,}50\cdot 100}{0{,}983\cdot 35\cdot 43{,}48}=3{,}24\,cm^2;$$

Минимална арматура за пресек

$$A_{s1.min}=0.60\cdot\frac{b\cdot d}{f_{yk}}=0.6\cdot\frac{100\cdot 35}{500}=4{,}20\ cm^2$$

$$A_{s1.min}=0.0015\cdot b\cdot d=0.0015\cdot 100\cdot 35=5.25\,cm^2$$

3.5. Макисмални утицај на плочу у горњој зони

M_{Ed}=15.00 kN
N_{Ed}=40.70 kN
V_{Ed}=24.90 kN

3.2. Карактеристике плоче

Висина пресека : h=40 cm
Ширина пресека: b=100 cm
Заштитни слој бетона: c=4.0 cm
Статичка висина пресека: d= 31 cm

3.3. Материјал плоче

Бетон: C30/37
Карактеристика чврстоћа бетона на притисак старог 28 дана: f_{ck}=30.00 N/mm^2
Коефицијент сигурности за бетон: γ_c=1,50
Арматура: B500B
Граница развлачења: f_{yk}=500 N/mm^2
Коефицијент сигурности за арматуру: γ_s=1,15

3.4 Прорачун

$$f_{cd} = \frac{f_{ck}}{\gamma_c} = \frac{3.0}{1{,}5} = 2.0\,kN/cm^2;\ f_{yd} = \frac{f_{yk}}{\gamma_s} = \frac{50}{1{,}15} = 43{,}48\,kN/cm^2$$

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{15.00 \cdot 100}{100 \cdot 31^2 \cdot 2.0} = 0{,}0078\ ;\ \zeta{=}0{,}990,\ \varepsilon_{s1}{=}20‰\ ,\ \varepsilon_c{=}{-}0{,}6‰\ ,$$

Потребна арматура у доњој зони у X правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{15{,}00 \cdot 100}{0{,}990 \cdot 31 \cdot 43{,}48} = 1{,}12\,cm^2;$$

Минимална арматура за пресек

$$A_{s1.min} = 0.60 \cdot \frac{b \cdot d}{f_{yk}} = 0.6 \cdot \frac{100 \cdot 31}{500} = 3{,}72\ cm^2$$

$$A_{s1.min} = 0.0015 \cdot b \cdot d = 0.0015 \cdot 100 \cdot 31 = 4.65\,cm^2$$

Срачунао:

Ненад Д. Станисављевић, дипл. инж. грађ.

ИНЖЕЊЕРСКА КОМОРА СРБИЈЕ
Ненад Д. Станисављевић
310 0771 16
ОДГОВОРНИ ПРОЈЕКТАНТ

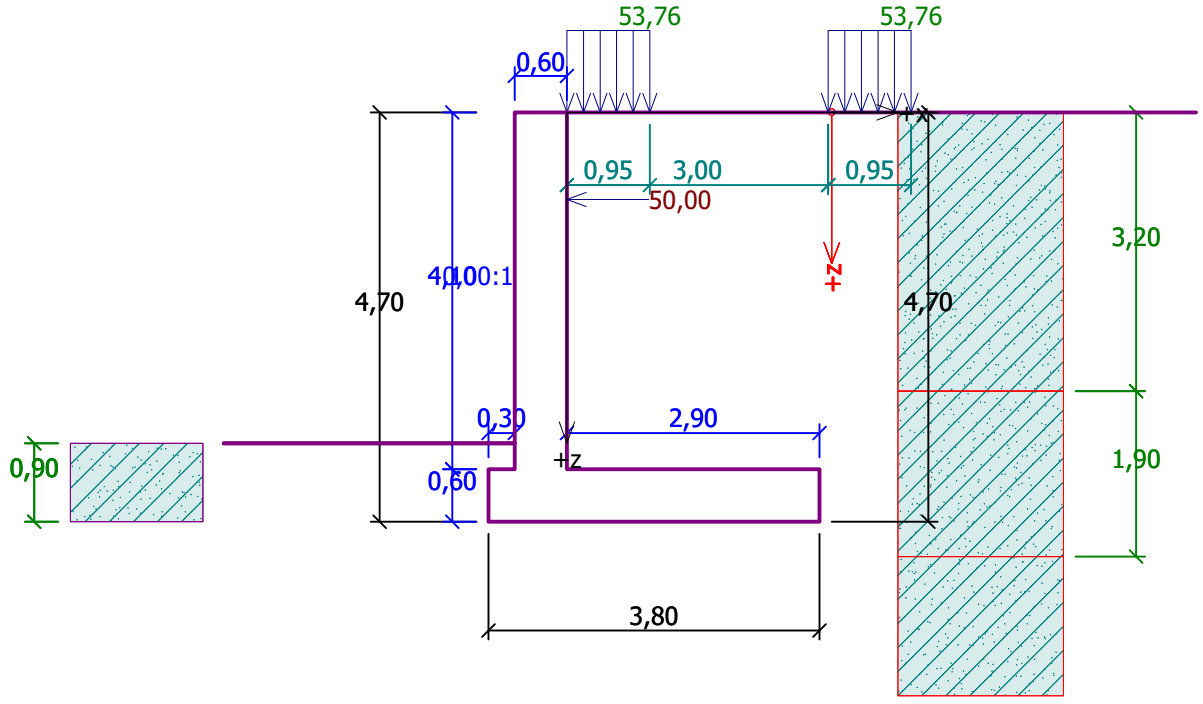
Cantilever wall analysis

Input data

Project

Task : RAMPA BACKA TOPOLA
Descript. : KAMPADA K1, h=4.1m
Date : 27.5.2019.

Name : Project **Stage : 1**



Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : 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
Base key : The base key is considered as inclined footing bottom
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

		Combination 1		Combination 2	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	γ_G =	1,35 [–]	1,00 [–]	1,00 [–]	1,00 [–]
Variable actions :	γ_Q =	1,50 [–]	0,00 [–]	1,30 [–]	0,00 [–]
Water load :	γ_w =	1,35 [–]		1,00 [–]	

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1,00	[–]	1,25	[–]
Partial factor on effective cohesion :	γ_c =	1,00	[–]	1,25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1,00	[–]	1,40	[–]
Partial factor on Poisson's ratio :	γ_v =	1,00	[–]	1,00	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0,70	[–]
Factor for frequent value :	ψ_1 =	0,50	[–]
Factor for quasi-permanent value :	ψ_2 =	0,30	[–]

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37
Cylinder compressive strength f_{ck} = 30,00 MPa
Tensile strength f_{ct} = 2,90 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500,00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0,00	0,00
2	0,00	4,10
3	2,90	4,10
4	2,90	4,70
5	-0,90	4,70
6	-0,90	4,10
7	-0,60	4,10
8	-0,60	0,00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 4,74 m^2.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	peskoviti sljunak1		35,00	0,00	19,00	9,00	17,50
2	peskoviti sljunak 2		30,00	0,00	19,00	9,00	15,00
3	les		23,00	10,00	19,00	9,00	11,50
4	sljunak		30,00	0,00	19,00	9,00	17,50

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

Soil parameters

peskoviti sljunak1

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

peskoviti sljunak 2

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	15,00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

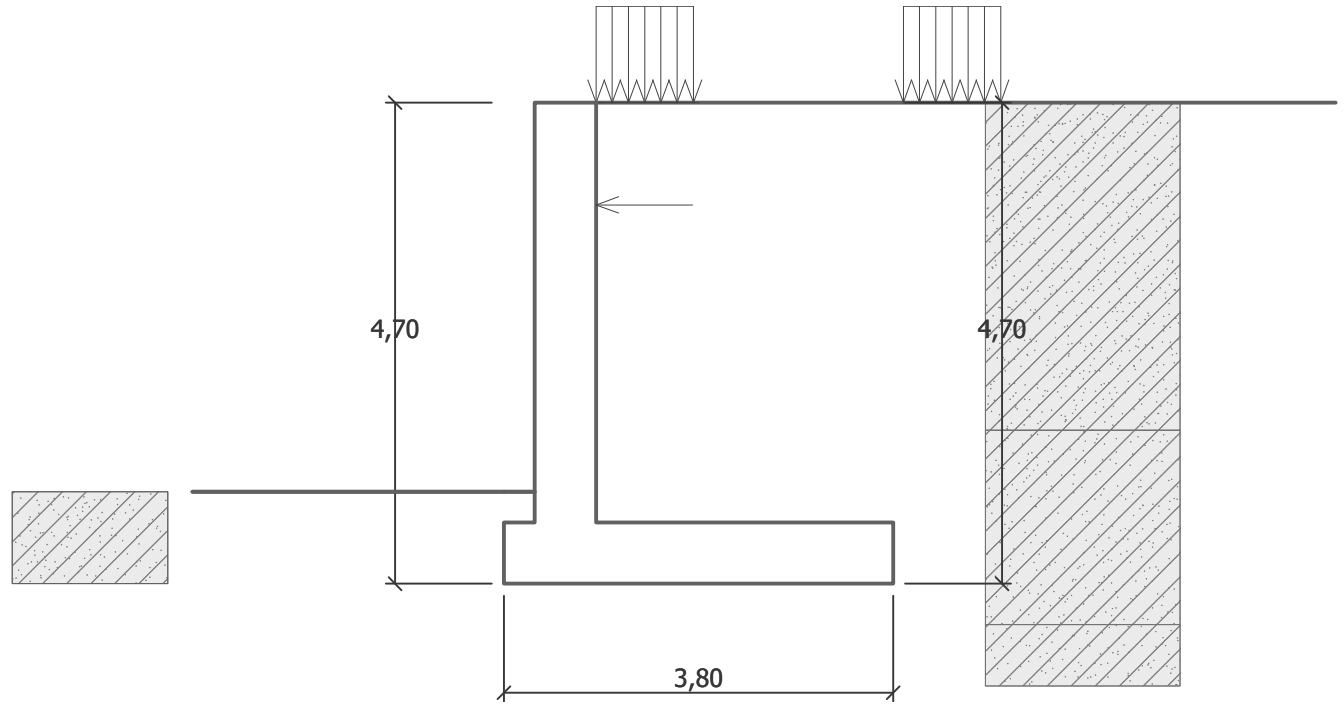
les

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	23,00 °
Cohesion of soil :	c_{ef}	=	10,00 kPa
Angle of friction struc.-soil :	δ	=	11,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

sljunak

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

Name : Soils | **Stage : 1**



Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3,20	peskoviti sljunak1	
2	1,90	peskoviti sljunak 2	
3	-	les	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		permanent	53,76		0,00	0,95	on terrain
2	YES		permanent	53,76		3,00	0,95	on terrain

No.	Name
1	tenk 1
2	tenk 2

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - les
Angle of friction struc.-soil $\delta = 11,50\ °$

Soil thickness in front of structure h = 0,90 m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force modification	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	YES		zbijanje	permanent	-50,00	0,00	0,00	0,00	1,00

Settings of the stage of construction

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

Verification No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,52	118,50	1,23	1,000	1,000	1,350
FF resistance	-54,85	-0,39	-11,11	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-2,24	140,78	1,91	1,000	1,000	1,350
Active pressure	61,73	-1,51	89,10	3,10	1,000	1,350	1,350
tenk 1	2,10	-4,47	4,14	1,74	1,350	1,000	1,350
tenk 2	11,52	-1,48	16,52	3,12	1,000	1,350	1,350
tenk 1	0,00	-4,70	38,41	1,26	1,000	1,000	1,350
zbijanje	50,00	-3,70	0,00	0,90	1,350	1,350	1,350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 799,90 kNm/m
Overturning moment M_{ovr} = 351,74 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 250,17 kN/m
Active horizontal force H_{act} = 113,65 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 211,60 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,52	118,50	1,23	1,000	1,000	1,000
FF resistance	-40,81	-0,38	-6,70	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-2,24	140,78	1,91	1,000	1,000	1,000
Active pressure	76,87	-1,52	89,46	3,10	1,000	1,000	1,000
tenk 1	3,07	-4,48	4,79	1,73	1,000	1,000	1,000
tenk 2	15,92	-1,75	19,50	2,99	1,000	1,000	1,000
tenk 1	0,00	-4,70	38,41	1,26	1,000	1,000	1,000
zbijanje	50,00	-3,70	0,00	0,90	1,000	1,000	1,000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 806,92 kNm/m
Overturning moment M_{ovr} = 328,03 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 186,94 kN/m
Active horizontal force H_{act} = 105,04 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 171,04 kPa

Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	337,65	538,95	114,38	0,63	211,60
2	298,18	433,31	113,65	0,77	176,55

Bearing capacity of foundation soil check

Eccentricity verification
Max. eccentricity of normal force e = 773,4 mm
Maximum allowable eccentricity e_{alw} = 1254,0 mm

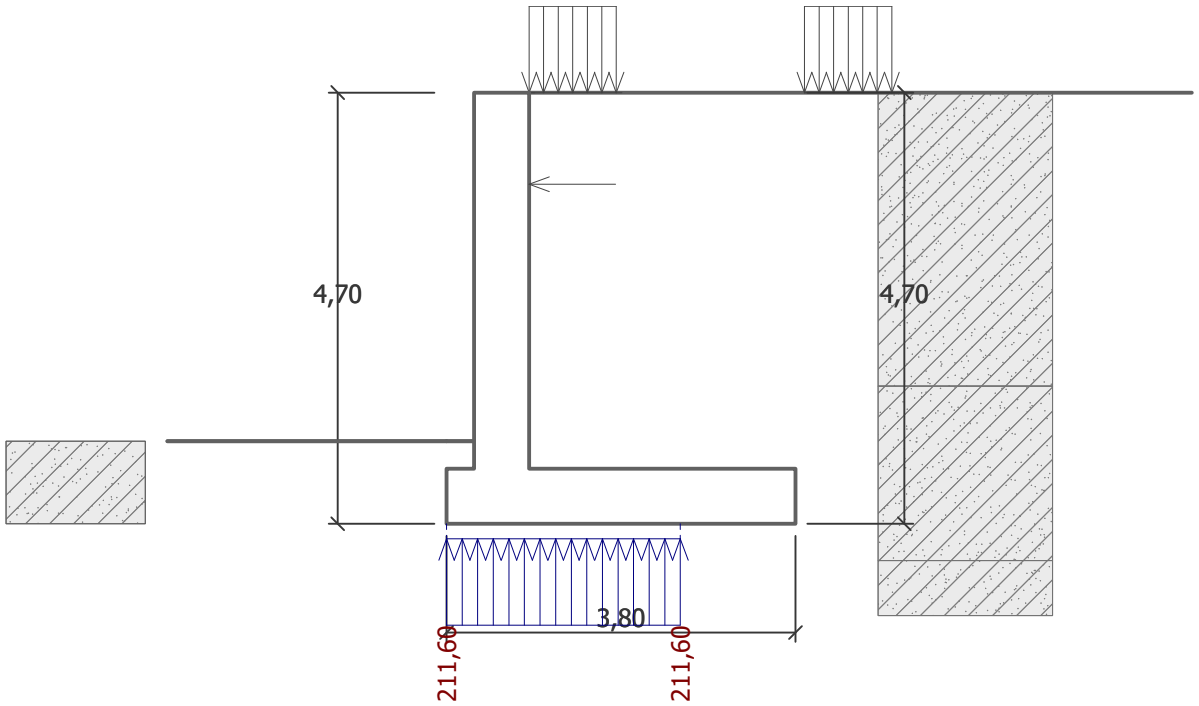
Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification
Max. stress at footing bottom σ = 211,60 kPa
Bearing capacity of foundation soil R_d = 236,03 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 - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,30	43,50	2,35	1,350
Weight - earth wedge	0,00	-2,24	140,78	1,91	1,350
Active pressure	61,73	-1,51	89,10	3,10	1,350
tenk 1	2,10	-4,47	4,14	1,74	1,350
tenk 2	11,52	-1,48	16,52	3,12	1,350
Contact tractions	0,00	0,00	-314,94	1,87	1,000
Gravity surch. 1	0,00	-4,70	38,68	1,26	1,350

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,30	43,50	2,35	1,000
Weight - earth wedge	0,00	-2,24	140,78	1,91	1,000
Active pressure	76,87	-1,52	89,46	3,10	1,000
tenk 1	3,07	-4,48	4,79	1,73	1,000
tenk 2	15,92	-1,75	19,50	2,99	1,000
Contact tractions	0,00	0,00	-225,52	1,78	1,000
Gravity surch. 1	0,00	-4,70	38,68	1,26	1,000

Back wall jump check

Reinforcement and dimensions of the cross-section
Bar diameter = 16,0 mm
Number of bars = 11
Reinforcement cover = 30,0 mm
Cross-section width = 1,00 m

Cross-section depth = 0,60 m

Reinforcement ratio	ρ	=	0,39	%	>	0,15	%	= ρ_{min}
Position of neutral axis	x	=	0,06	m	<	0,35	m	= x_{max}
Ultimate shear force	V_{Rd}	=	245,17	kN	>	134,23	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	517,30	kNm	>	309,26	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

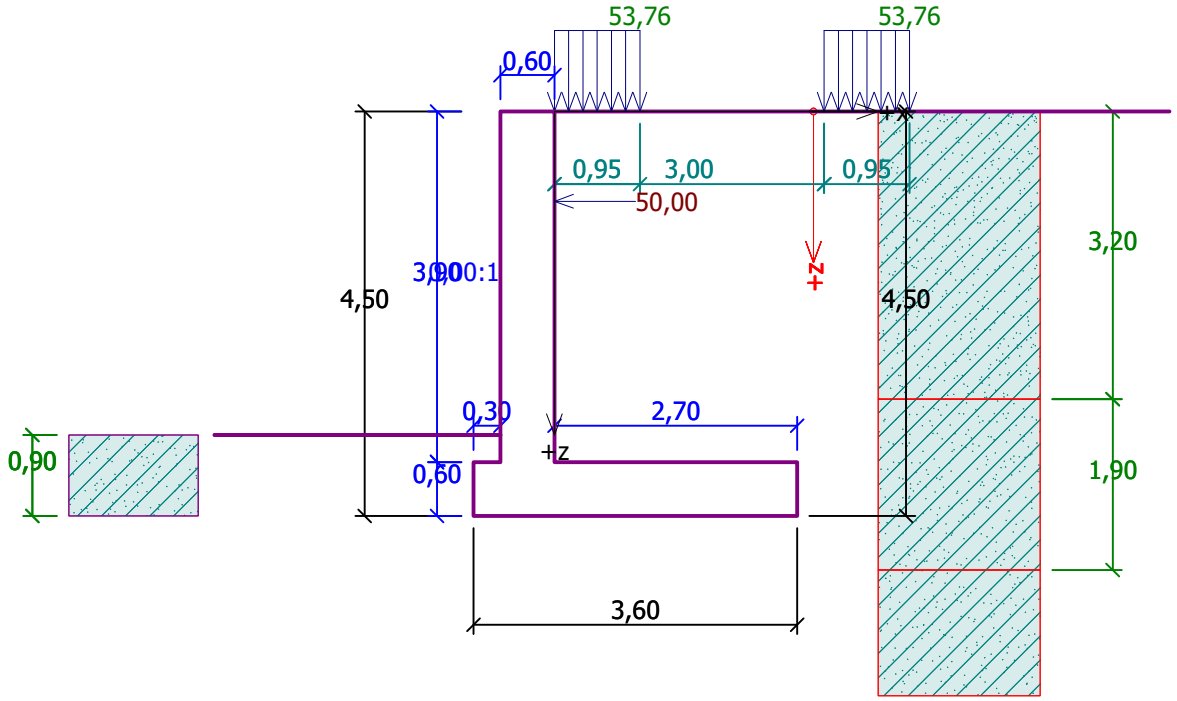
Cantilever wall analysis

Input data

Project

Task : RAMPA BACKA TOPOLA
Descript. : KAMPADA K2, h=3.9m
Date : 22.5.2019.

Name : Project **Stage : 1**



Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : 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
Base key : The base key is considered as inclined footing bottom
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]	1,00	[–]	1,00	[–]
Variable actions :	γ_Q =	1,50	[–]	0,00	[–]	1,30	[–]	0,00	[–]
Water load :	γ_w =	1,35	[–]			1,00	[–]		

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1,00	[–]	1,25	[–]
Partial factor on effective cohesion :	γ_c =	1,00	[–]	1,25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1,00	[–]	1,40	[–]
Partial factor on Poisson's ratio :	γ_v =	1,00	[–]	1,00	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0,70	[–]
Factor for frequent value :	ψ_1 =	0,50	[–]
Factor for quasi-permanent value :	ψ_2 =	0,30	[–]

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37
Cylinder compressive strength f_{ck} = 30,00 MPa
Tensile strength f_{ct} = 2,90 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500,00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0,00	0,00
2	0,00	3,90
3	2,70	3,90
4	2,70	4,50
5	-0,90	4,50
6	-0,90	3,90
7	-0,60	3,90
8	-0,60	0,00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 4,50 m^2.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	peskoviti sljunak1		35,00	0,00	19,00	9,00	17,50
2	peskoviti sljunak 2		30,00	0,00	19,00	9,00	15,00
3	les		23,00	10,00	19,00	9,00	11,50
4	sljunak		30,00	0,00	19,00	9,00	17,50

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

Soil parameters

peskoviti sljunak1

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

peskoviti sljunak 2

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	15,00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

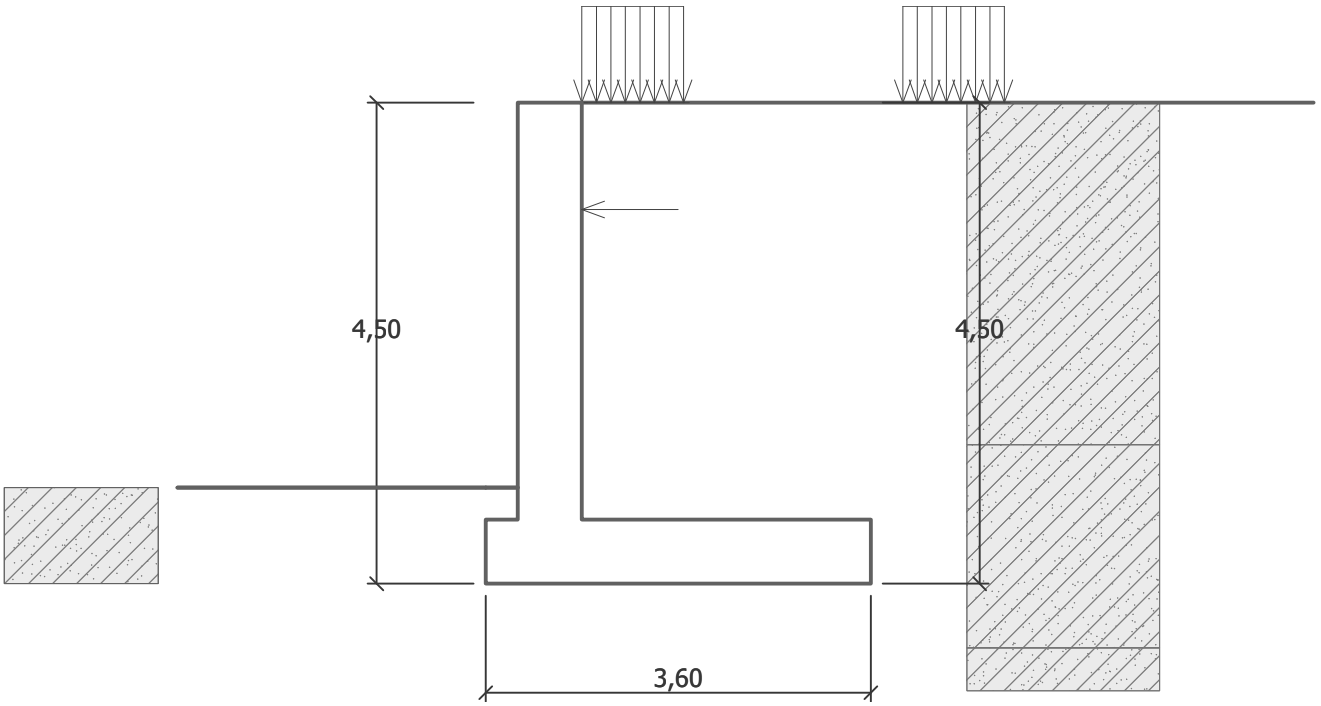
les

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	23,00 °
Cohesion of soil :	c_{ef}	=	10,00 kPa
Angle of friction struc.-soil :	δ	=	11,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

sljunak

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

Name : Soils | **Stage : 1**



Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3,20	peskoviti sljunak1	
2	1,90	peskoviti sljunak 2	
3	-	les	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		permanent	53,76		0,00	0,95	on terrain
2	YES		permanent	53,76		3,00	0,95	on terrain

No.	Name
1	tenk 1
2	tenk 2

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - les
Angle of friction struc.-soil $\delta = 21,33$ °

Soil thickness in front of structure h = 0,90 m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force modification	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	YES		zbijanje	permanent	-50,00	0,00	0,00	0,00	1,00

Settings of the stage of construction

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

Verification No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,47	112,50	1,18	1,000	1,000	1,350
FF resistance	-58,98	-0,38	-22,97	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-2,15	123,37	1,84	1,000	1,000	1,350
Active pressure	56,01	-1,45	80,48	2,94	1,000	1,350	1,350
tenk 1	3,07	-4,19	6,02	1,69	1,350	1,000	1,350
tenk 2	11,01	-1,31	15,14	3,01	1,000	1,350	1,350
tenk 1	0,00	-4,50	33,86	1,21	1,000	1,000	1,350
zbijanje	50,00	-3,50	0,00	0,90	1,350	1,350	1,350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 694,91 kNm/m
Overturning moment M_{ovr} = 326,80 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 220,48 kN/m
Active horizontal force H_{act} = 102,07 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 199,51 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,47	112,50	1,18	1,000	1,000	1,000
FF resistance	-43,24	-0,38	-13,50	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-2,15	123,37	1,84	1,000	1,000	1,000
Active pressure	69,85	-1,46	80,81	2,94	1,000	1,000	1,000
tenk 1	4,48	-4,19	6,96	1,69	1,000	1,000	1,000
tenk 2	15,25	-1,58	18,13	2,88	1,000	1,000	1,000
tenk 1	0,00	-4,50	33,86	1,21	1,000	1,000	1,000
zbijanje	50,00	-3,50	0,00	0,90	1,000	1,000	1,000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 701,34 kNm/m
Overturning moment M_{ovr} = 303,51 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 167,27 kN/m
Active horizontal force H_{act} = 96,34 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 164,83 kPa

Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	287,54	478,40	103,15	0,60	199,51
2	253,02	381,88	102,07	0,75	166,89

Bearing capacity of foundation soil check

Eccentricity verification
Max. eccentricity of normal force e = 749,8 mm
Maximum allowable eccentricity e_{alw} = 1188,0 mm

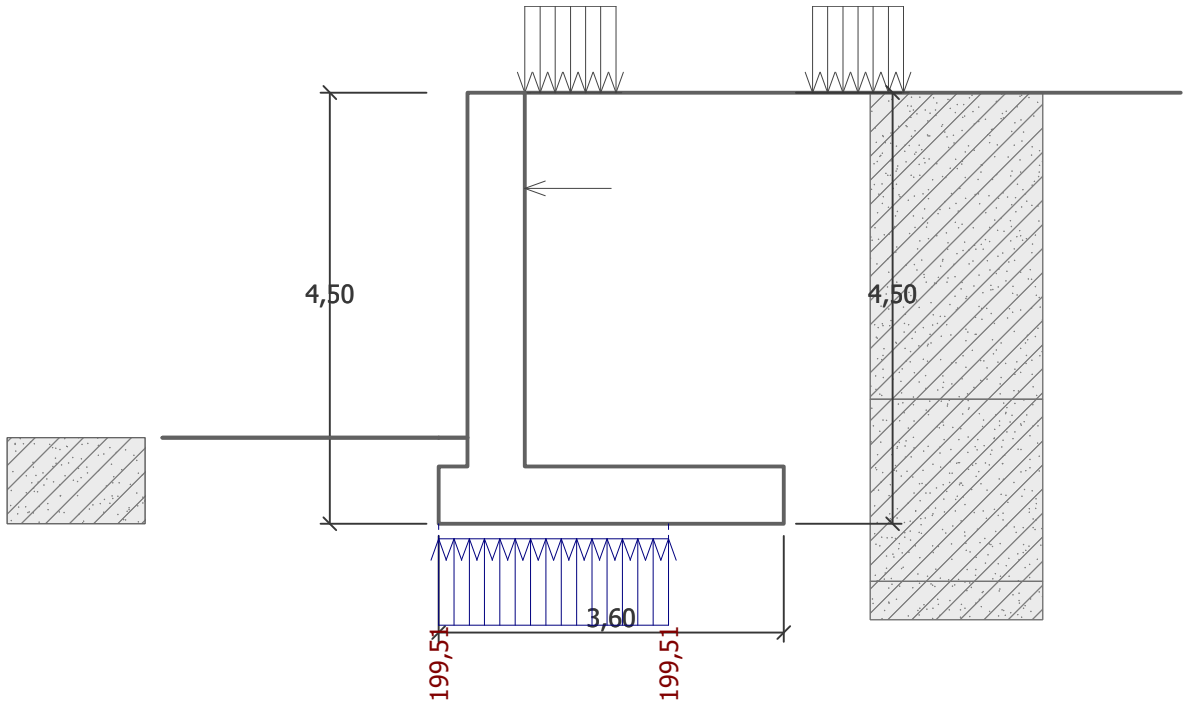
Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification
Max. stress at footing bottom σ = 199,51 kPa
Bearing capacity of foundation soil R_d = 230,70 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 - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,30	40,50	2,25	1,350
Weight - earth wedge	0,00	-2,15	123,37	1,84	1,350
Active pressure	56,01	-1,45	80,48	2,94	1,350
tenk 1	3,07	-4,19	6,02	1,69	1,350
tenk 2	11,01	-1,31	15,14	3,01	1,350
Contact tractions	0,00	0,00	-268,94	1,80	1,000
Gravity surch. 1	0,00	-4,50	34,13	1,22	1,350

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,30	40,50	2,25	1,000
Weight - earth wedge	0,00	-2,15	123,37	1,84	1,000
Active pressure	69,85	-1,46	80,81	2,94	1,000
tenk 1	4,48	-4,19	6,96	1,69	1,000
tenk 2	15,25	-1,58	18,13	2,88	1,000
Contact tractions	0,00	0,00	-191,36	1,70	1,000
Gravity surch. 1	0,00	-4,50	34,13	1,22	1,000

Back wall jump check

Reinforcement and dimensions of the cross-section
Bar diameter = 16,0 mm
Number of bars = 11
Reinforcement cover = 30,0 mm
Cross-section width = 1,00 m

Cross-section depth = 0,60 m

Reinforcement ratio	ρ	=	0,39	%	>	0,15	%	=	ρ_{min}
Position of neutral axis	x	=	0,06	m	<	0,35	m	=	x_{max}
Ultimate shear force	V_{Rd}	=	245,17	kN	>	135,59	kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	517,30	kNm	>	274,59	kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

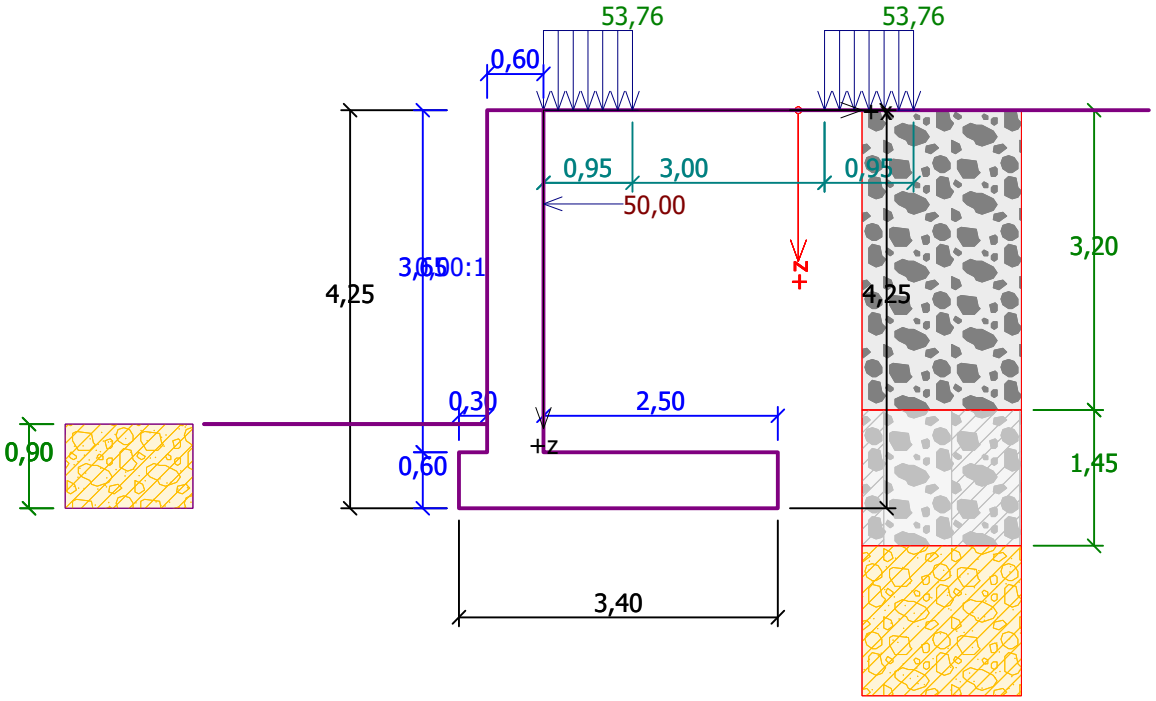
Cantilever wall analysis

Input data

Project

Task : RAMPA BACKA TOPOLA
Descript. : KAMPADA K3, h=3.65m
Date : 16.5.2019.

Name : Project **Stage : 1**



Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : 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
Base key : The base key is considered as inclined footing bottom
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]	1,00	[–]	1,00	[–]
Variable actions :	γ_Q =	1,50	[–]	0,00	[–]	1,30	[–]	0,00	[–]
Water load :	γ_w =	1,35	[–]			1,00	[–]		

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1,00	[–]	1,25	[–]
Partial factor on effective cohesion :	γ_c =	1,00	[–]	1,25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1,00	[–]	1,40	[–]
Partial factor on Poisson's ratio :	γ_v =	1,00	[–]	1,00	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0,70	[–]
Factor for frequent value :	ψ_1 =	0,50	[–]
Factor for quasi-permanent value :	ψ_2 =	0,30	[–]

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37
Cylinder compressive strength f_{ck} = 30,00 MPa
Tensile strength f_{ct} = 2,90 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500,00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0,00	0,00
2	0,00	3,65
3	2,50	3,65
4	2,50	4,25
5	-0,90	4,25
6	-0,90	3,65
7	-0,60	3,65
8	-0,60	0,00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 4,23 m^2.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	peskoviti sljunak1		35,00	0,00	19,00	9,00	17,50
2	peskoviti sljunak 2		30,00	0,00	19,00	9,00	15,00
3	les		23,00	10,00	19,00	9,00	11,50
4	sljunak		30,00	0,00	19,00	9,00	17,50

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

Soil parameters

peskoviti sljunak1

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

peskoviti sljunak 2

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	15,00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

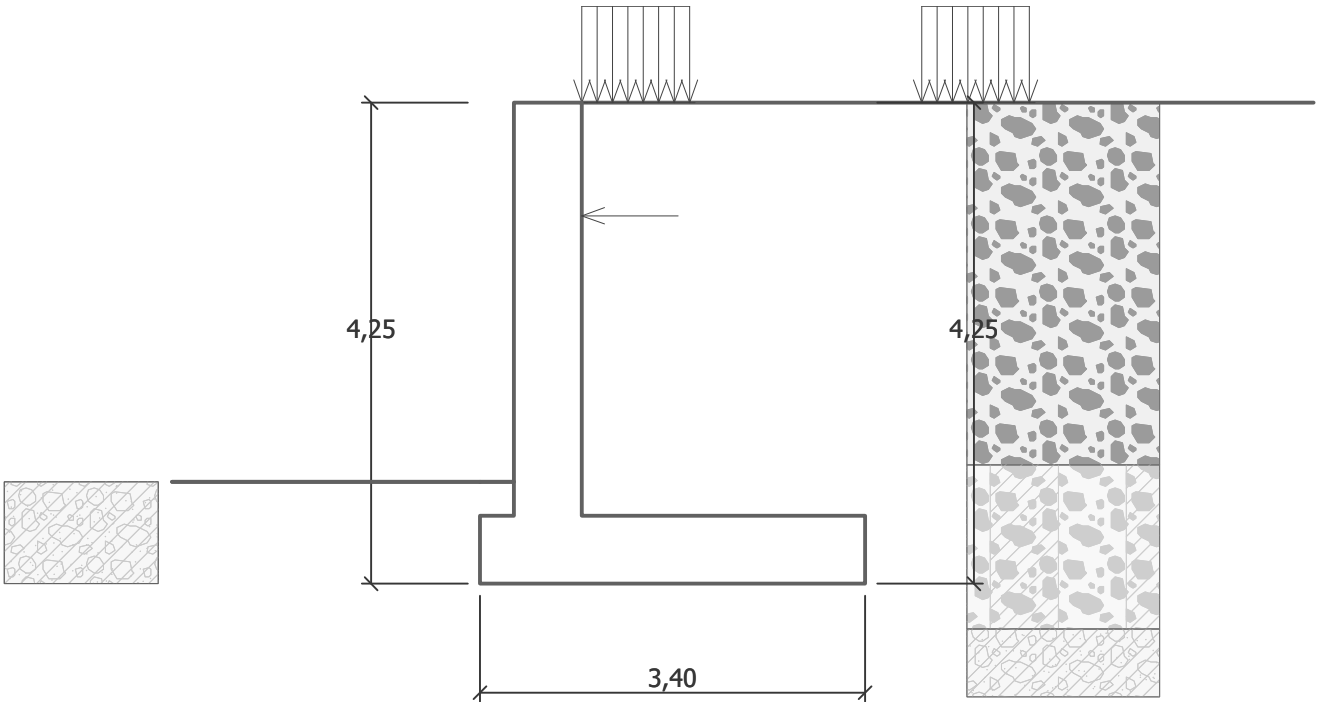
les

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	23,00 °
Cohesion of soil :	c_{ef}	=	10,00 kPa
Angle of friction struc.-soil :	δ	=	11,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

sljunak

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

Name : Soils | **Stage : 1**



Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3,20	peskoviti sljunak1	
2	1,45	peskoviti sljunak 2	
3	-	les	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		permanent	53,76		0,00	0,95	on terrain
2	YES		permanent	53,76		3,00	0,95	on terrain

No.	Name
1	tenk 1
2	tenk 2

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - les
Angle of friction struc.-soil $\delta = 21,33$ °

Soil thickness in front of structure h = 0,90 m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force modification	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	YES		zbijanje	permanent	-50,00	0,00	0,00	0,00	1,00

Settings of the stage of construction

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

Verification No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,40	105,75	1,13	1,000	1,000	1,350
FF resistance	-58,98	-0,38	-22,97	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-2,04	106,60	1,77	1,000	1,000	1,350
Active pressure	49,21	-1,37	70,32	2,79	1,000	1,350	1,350
tenk 1	3,73	-3,89	7,26	1,67	1,350	1,000	1,350
tenk 2	10,38	-1,14	13,56	2,90	1,000	1,350	1,350
tenk 1	0,00	-4,25	30,87	1,19	1,000	1,000	1,350
zbijanje	50,00	-3,25	0,00	0,90	1,350	1,350	1,350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 595,03 kNm/m
Overturning moment M_{ovr} = 295,89 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 196,73 kN/m
Active horizontal force H_{act} = 92,69 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 193,44 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,40	105,75	1,13	1,000	1,000	1,000
FF resistance	-43,24	-0,38	-13,50	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-2,04	106,60	1,77	1,000	1,000	1,000
Active pressure	61,52	-1,38	70,61	2,79	1,000	1,000	1,000
tenk 1	5,43	-3,89	8,38	1,66	1,000	1,000	1,000
tenk 2	14,45	-1,41	16,57	2,77	1,000	1,000	1,000
tenk 1	0,00	-4,25	30,87	1,19	1,000	1,000	1,000
zbijanje	50,00	-3,25	0,00	0,90	1,000	1,000	1,000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 600,83 kNm/m
Overturning moment M_{ovr} = 272,65 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 150,24 kN/m
Active horizontal force H_{act} = 88,15 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 161,21 kPa

Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	253,89	428,42	94,00	0,59	193,44
2	224,69	340,75	92,69	0,75	164,73

Bearing capacity of foundation soil check

Eccentricity verification
Max. eccentricity of normal force e = 747,1 mm
Maximum allowable eccentricity e_{alw} = 1122,0 mm

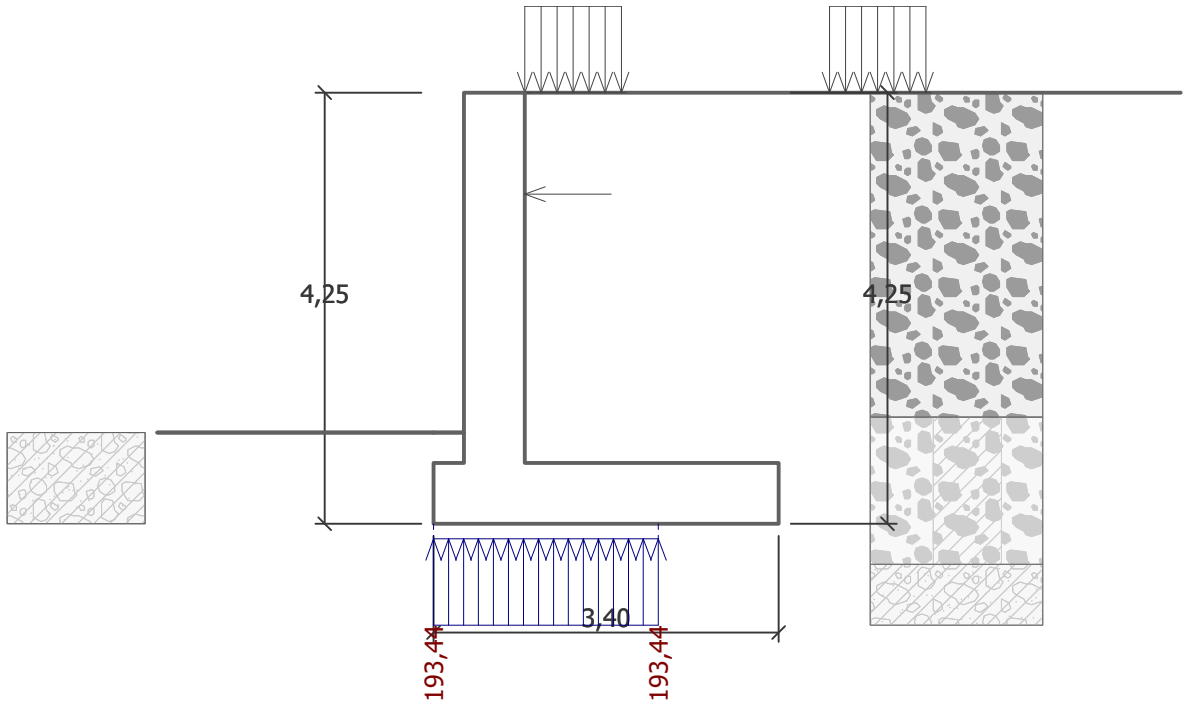
Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification
Max. stress at footing bottom σ = 193,44 kPa
Bearing capacity of foundation soil R_d = 222,25 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 - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-1,40	105,75	1,13	1,350
FF resistance	-58,98	-0,38	-22,97	0,07	1,000
Weight - earth wedge	0,00	-2,04	106,60	1,77	1,350
Active pressure	49,21	-1,37	70,32	2,79	1,350
tenk 1	3,73	-3,89	7,26	1,67	1,350
tenk 2	10,38	-1,14	13,56	2,90	1,350
tenk 1	0,00	-4,25	30,87	1,19	1,350
zbijanje	50,00	-3,25	0,00	0,90	1,350

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-1,40	105,75	1,13	1,000
FF resistance	-43,24	-0,38	-13,50	0,07	1,000
Weight - earth wedge	0,00	-2,04	106,60	1,77	1,000
Active pressure	61,52	-1,38	70,61	2,79	1,000
tenk 1	5,43	-3,89	8,38	1,66	1,000
tenk 2	14,45	-1,41	16,57	2,77	1,000
tenk 1	0,00	-4,25	30,87	1,19	1,000
zbijanje	50,00	-3,25	0,00	0,90	1,000

Front wall jump check

Foundation thickness is greater than twice the offset of the front wall jump. Reinforcement is not required.

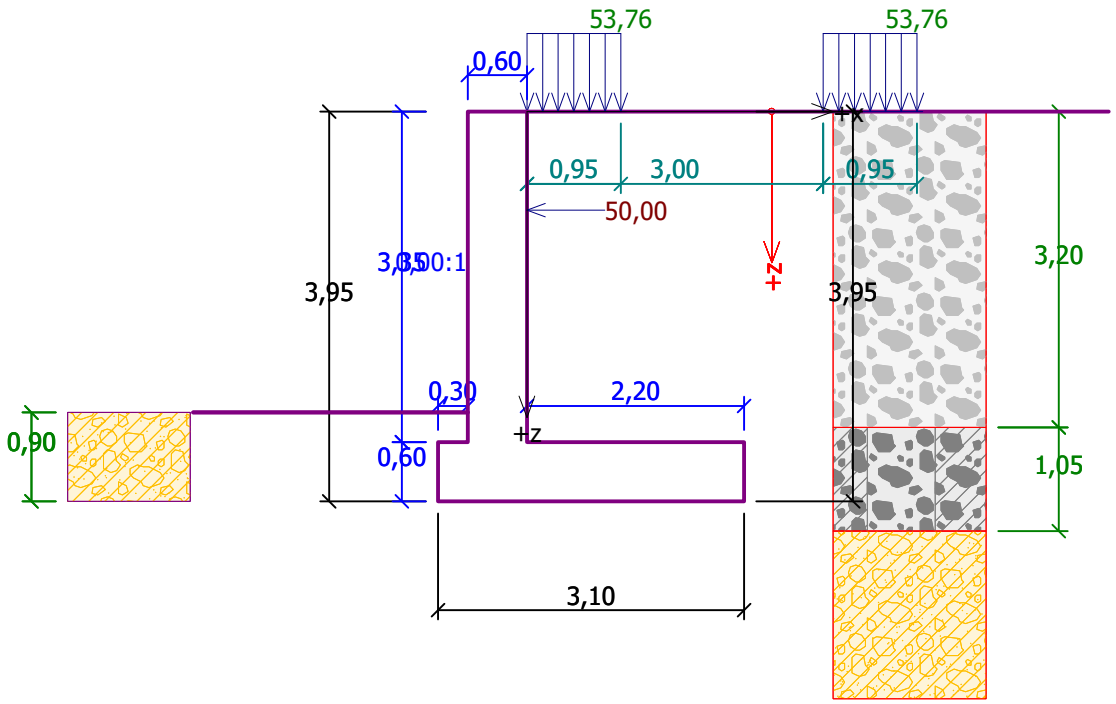
Cantilever wall analysis

Input data

Project

Task : RAMPA BACKA TOPOLA
Descript. : KAMPADA K4, h=3.35m
Date : 22.5.2019.

Name : Project **Stage : 1**



Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : 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
Base key : The base key is considered as inclined footing bottom
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]	1,00	[–]	1,00	[–]
Variable actions :	γ_Q =	1,50	[–]	0,00	[–]	1,30	[–]	0,00	[–]
Water load :	γ_w =	1,35	[–]			1,00	[–]		

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1,00	[–]	1,25	[–]
Partial factor on effective cohesion :	γ_c =	1,00	[–]	1,25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1,00	[–]	1,40	[–]
Partial factor on Poisson's ratio :	γ_v =	1,00	[–]	1,00	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0,70	[–]
Factor for frequent value :	ψ_1 =	0,50	[–]
Factor for quasi-permanent value :	ψ_2 =	0,30	[–]

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37
Cylinder compressive strength f_{ck} = 30,00 MPa
Tensile strength f_{ct} = 2,90 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500,00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0,00	0,00
2	0,00	3,35
3	2,20	3,35
4	2,20	3,95
5	-0,90	3,95
6	-0,90	3,35
7	-0,60	3,35
8	-0,60	0,00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 3,87 m^2.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	peskoviti sljunak1		35,00	0,00	19,00	9,00	17,50
2	peskoviti sljunak 2		30,00	0,00	19,00	9,00	15,00
3	les		23,00	10,00	19,00	9,00	11,50
4	sljunak		30,00	0,00	19,00	9,00	17,50

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

Soil parameters

peskoviti sljunak1

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

peskoviti sljunak 2

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	15,00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

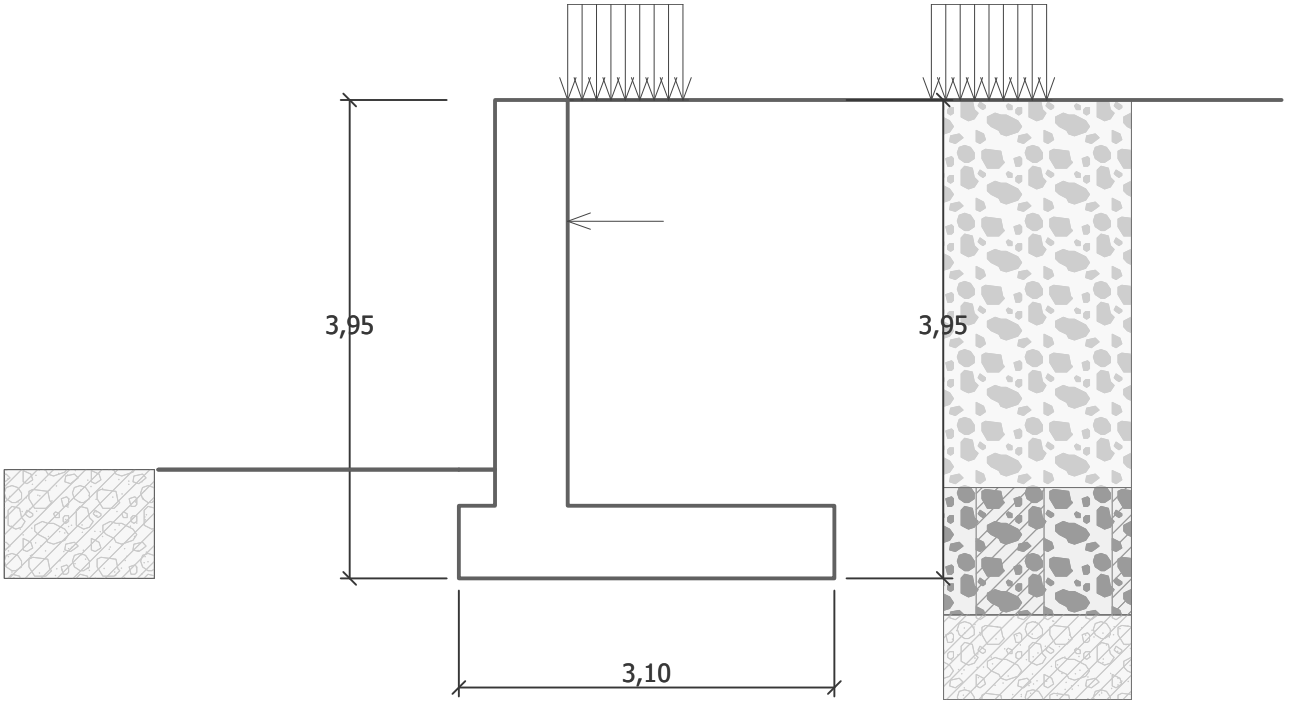
les

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	23,00 °
Cohesion of soil :	c_{ef}	=	10,00 kPa
Angle of friction struc.-soil :	δ	=	11,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

sljunak

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

Name : Soils | **Stage : 1**



Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3,20	peskoviti sljunak1	
2	1,05	peskoviti sljunak 2	
3	-	les	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		permanent	53,76		0,00	0,95	on terrain
2	YES		permanent	53,76		3,00	0,95	on terrain

No.	Name
1	tenk 1
2	tenk 2

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - les
Angle of friction struc.-soil $\delta = 21,33$ °

Soil thickness in front of structure h = 0,90 m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force modification	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	YES		zbijanje	permanent	-50,00	0,00	0,00	0,00	1,00

Settings of the stage of construction

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

Verification No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,33	96,75	1,06	1,000	1,000	1,350
FF resistance	-58,98	-0,38	-22,97	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-1,91	84,26	1,66	1,000	1,000	1,350
Active pressure	41,58	-1,29	59,03	2,55	1,000	1,350	1,350
tenk 1	5,21	-3,47	10,06	1,60	1,350	1,000	1,350
tenk 2	9,34	-0,93	11,19	2,72	1,000	1,350	1,350
tenk 1	0,00	-3,95	24,06	1,12	1,000	1,000	1,350
zbijanje	50,00	-2,95	0,00	0,90	1,350	1,350	1,350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 469,93 kNm/m
Overturning moment M_{ovr} = 263,21 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 165,67 kN/m
Active horizontal force H_{act} = 82,48 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 191,64 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,33	96,75	1,06	1,000	1,000	1,000
FF resistance	-43,24	-0,38	-13,50	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-1,91	84,26	1,66	1,000	1,000	1,000
Active pressure	52,16	-1,29	59,28	2,55	1,000	1,000	1,000
tenk 1	7,58	-3,47	11,61	1,60	1,000	1,000	1,000
tenk 2	13,16	-1,20	14,24	2,59	1,000	1,000	1,000
tenk 1	0,00	-3,95	24,06	1,12	1,000	1,000	1,000
zbijanje	50,00	-2,95	0,00	0,90	1,000	1,000	1,000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 474,59 kNm/m
Overturning moment M_{ovr} = 240,62 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 127,80 kN/m
Active horizontal force H_{act} = 79,66 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 163,62 kPa

Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	219,11	362,24	84,30	0,60	191,64
2	195,87	286,95	82,48	0,77	171,00

Bearing capacity of foundation soil check

Eccentricity verification
Max. eccentricity of normal force e = 772,5 mm
Maximum allowable eccentricity e_{alw} = 1023,0 mm

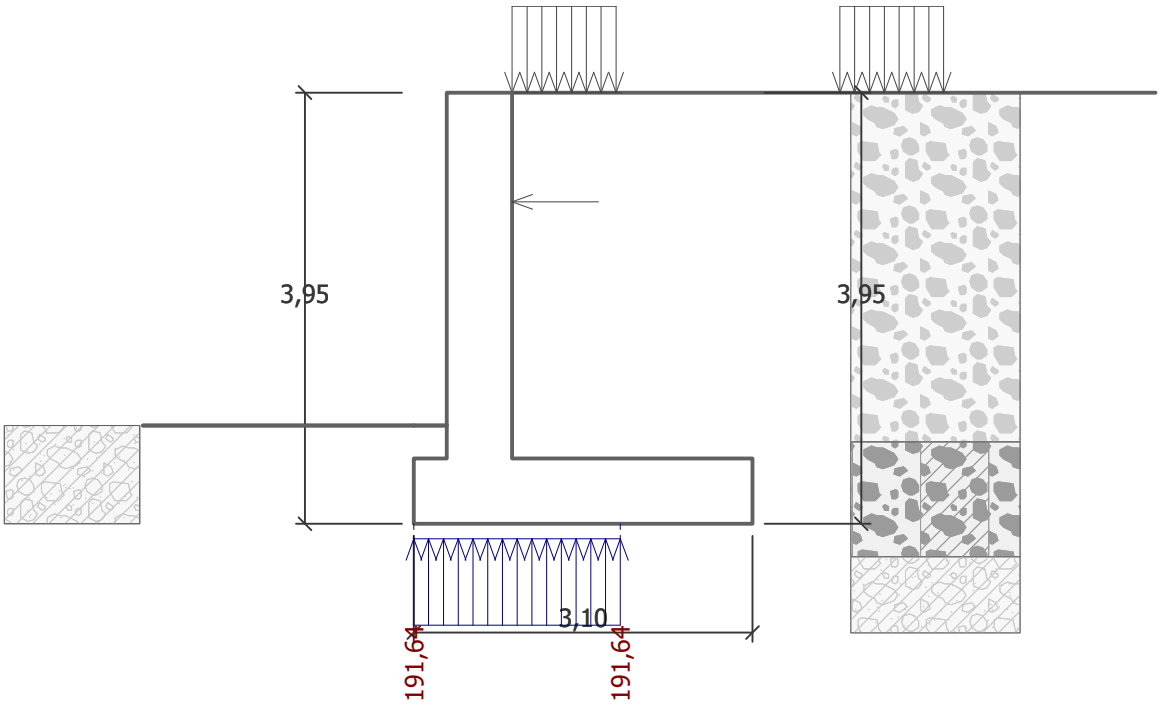
Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification
Max. stress at footing bottom σ = 191,64 kPa
Bearing capacity of foundation soil R_d = 211,30 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 - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,30	33,00	2,00	1,350
Weight - earth wedge	0,00	-1,91	84,26	1,66	1,350
Active pressure	41,58	-1,29	59,03	2,55	1,350
tenk 1	5,21	-3,47	10,06	1,60	1,350
tenk 2	9,34	-0,93	11,19	2,72	1,350
Contact tractions	0,00	0,00	-168,78	1,55	1,000
Gravity surch. 1	0,00	-3,95	24,33	1,13	1,350

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,30	33,00	2,00	1,000
Weight - earth wedge	0,00	-1,91	84,26	1,66	1,000
Active pressure	52,16	-1,29	59,28	2,55	1,000
tenk 1	7,58	-3,47	11,61	1,60	1,000
tenk 2	13,16	-1,20	14,24	2,59	1,000
Contact tractions	0,00	0,00	-115,19	1,45	1,000
Gravity surch. 1	0,00	-3,95	24,33	1,13	1,000

Back wall jump check

Reinforcement and dimensions of the cross-section
Bar diameter = 14,0 mm
Number of bars = 11
Reinforcement cover = 30,0 mm
Cross-section width = 1,00 m

Cross-section depth = 0,60 m

Reinforcement ratio	ρ	=	0,30	%	>	0,15	%	=	ρ_{min}
Position of neutral axis	x	=	0,05	m	<	0,35	m	=	x_{max}
Ultimate shear force	V_{Rd}	=	224,48	kN	>	130,73	kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	400,94	kNm	>	202,10	kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

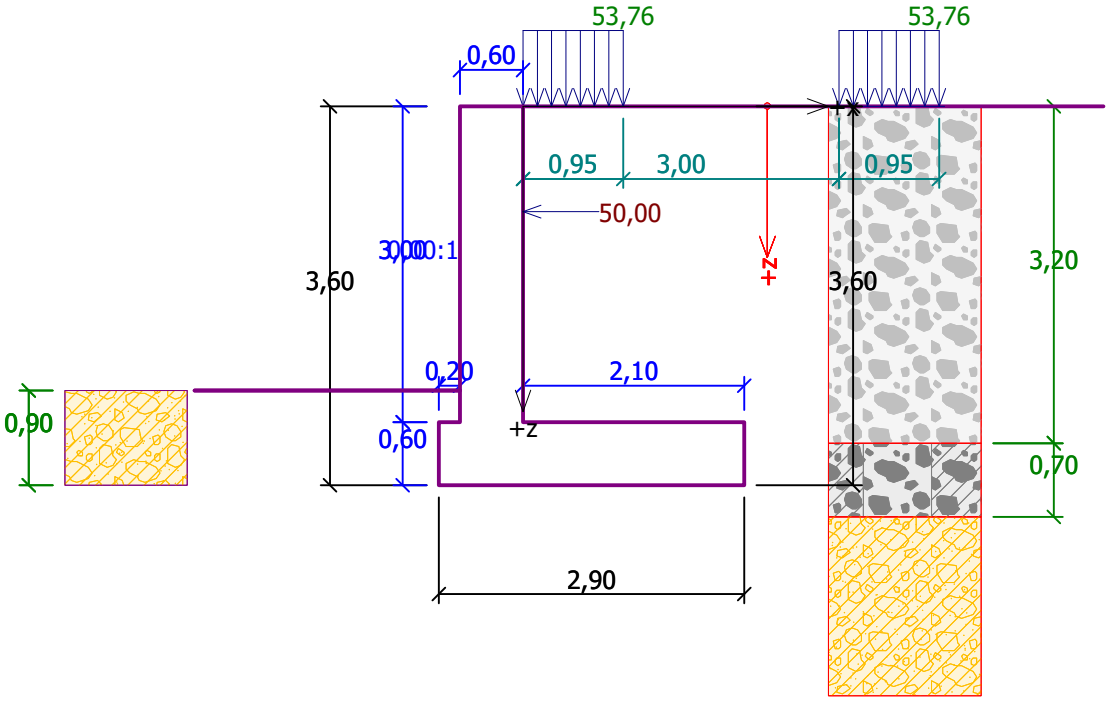
Cantilever wall analysis

Input data

Project

Task : RAMPA BACKA TOPOLA
Descript. : KAMPADA K5, h=3.00m
Date : 29.5.2019.

Name : Project **Stage : 1**



Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : 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
Base key : The base key is considered as inclined footing bottom
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]	1,00	[–]	1,00	[–]
Variable actions :	γ_Q =	1,50	[–]	0,00	[–]	1,30	[–]	0,00	[–]
Water load :	γ_w =	1,35	[–]			1,00	[–]		

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1,00	[–]	1,25	[–]
Partial factor on effective cohesion :	γ_c =	1,00	[–]	1,25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1,00	[–]	1,40	[–]
Partial factor on Poisson's ratio :	γ_v =	1,00	[–]	1,00	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0,70	[–]
Factor for frequent value :	ψ_1 =	0,50	[–]
Factor for quasi-permanent value :	ψ_2 =	0,30	[–]

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37
Cylinder compressive strength f_{ck} = 30,00 MPa
Tensile strength f_{ct} = 2,90 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500,00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0,00	0,00
2	0,00	3,00
3	2,10	3,00
4	2,10	3,60
5	-0,80	3,60
6	-0,80	3,00
7	-0,60	3,00
8	-0,60	0,00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 3,54 m^2.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	peskoviti sljunak1		35,00	0,00	19,00	9,00	17,50
2	peskoviti sljunak 2		30,00	0,00	19,00	9,00	15,00
3	les		23,00	10,00	19,00	9,00	11,50
4	sljunak		30,00	0,00	19,00	9,00	17,50

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

Soil parameters

peskoviti sljunak1

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

peskoviti sljunak 2

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	15,00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

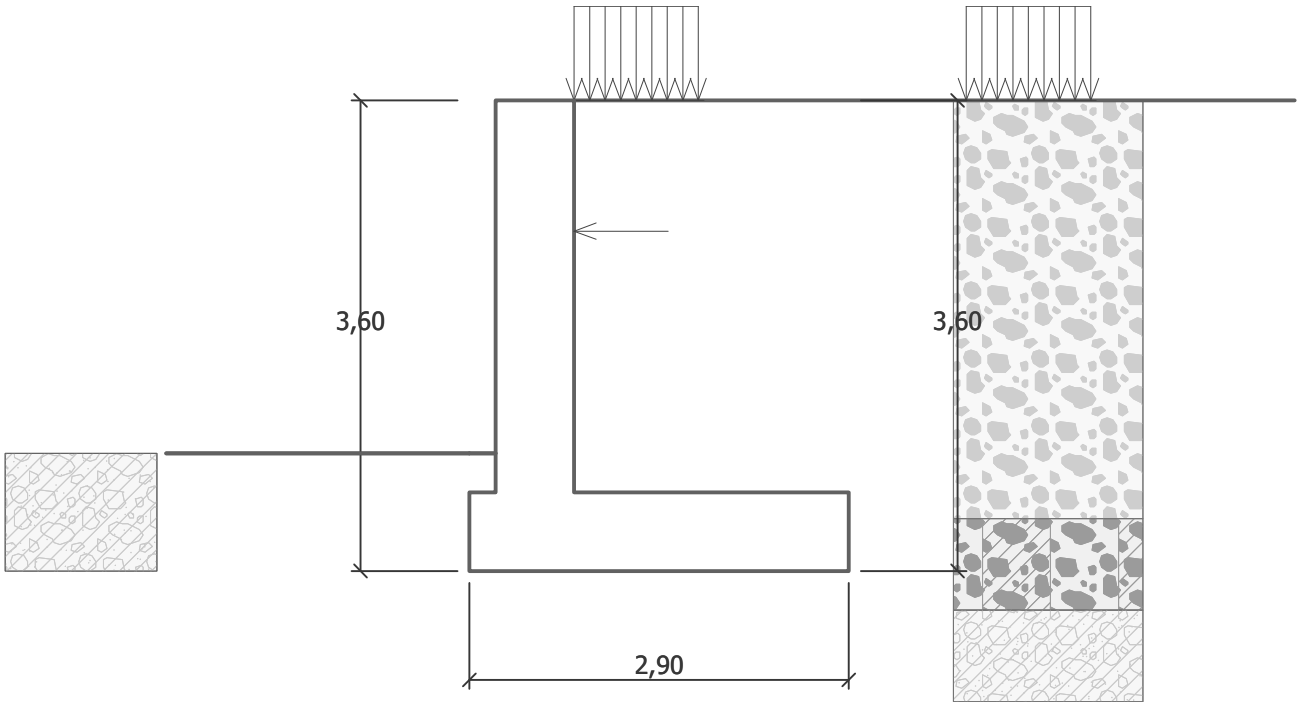
les

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	23,00 °
Cohesion of soil :	c_{ef}	=	10,00 kPa
Angle of friction struc.-soil :	δ	=	11,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

sljunak

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

Name : Soils	Stage : 1



Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3,20	peskoviti sljunak1	
2	0,70	peskoviti sljunak 2	
3	-	les	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		permanent	53,76		0,00	0,95	on terrain
2	YES		permanent	53,76		3,00	0,95	on terrain

No.	Name
1	tenk 1
2	tenk 2

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - les
Angle of friction struc.-soil $\delta = 21,33$ °

Soil thickness in front of structure h = 0,90 m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force modification	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	YES		zbijanje	permanent	-50,00	0,00	0,00	0,00	1,00

Settings of the stage of construction

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

Verification No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,22	88,50	0,97	1,000	1,000	1,350
FF resistance	-58,98	-0,38	-22,97	0,05	1,000	1,000	1,000
Weight - earth wedge	0,00	-1,80	75,19	1,54	1,000	1,000	1,350
Active pressure	33,46	-1,19	47,40	2,41	1,000	1,350	1,350
tenk 1	4,18	-3,20	8,04	1,55	1,350	1,000	1,350
tenk 2	8,52	-0,80	9,69	2,60	1,000	1,350	1,350
tenk 1	0,00	-3,60	28,93	1,07	1,000	1,000	1,350
zbijanje	50,00	-2,60	0,00	0,80	1,350	1,350	1,350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 387,15 kNm/m
Overturning moment M_{ovr} = 217,80 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 147,08 kN/m
Active horizontal force H_{act} = 69,37 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 186,59 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-1,22	88,50	0,97	1,000	1,000	1,000
FF resistance	-43,24	-0,38	-13,50	0,05	1,000	1,000	1,000
Weight - earth wedge	0,00	-1,80	75,19	1,54	1,000	1,000	1,000
Active pressure	42,16	-1,20	47,64	2,41	1,000	1,000	1,000
tenk 1	6,08	-3,21	9,27	1,54	1,000	1,000	1,000
tenk 2	12,21	-1,05	12,75	2,48	1,000	1,000	1,000
tenk 1	0,00	-3,60	28,93	1,07	1,000	1,000	1,000
zbijanje	50,00	-2,60	0,00	0,80	1,000	1,000	1,000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 392,20 kNm/m
Overturning moment M_{ovr} = 196,30 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 114,91 kN/m
Active horizontal force H_{act} = 67,21 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

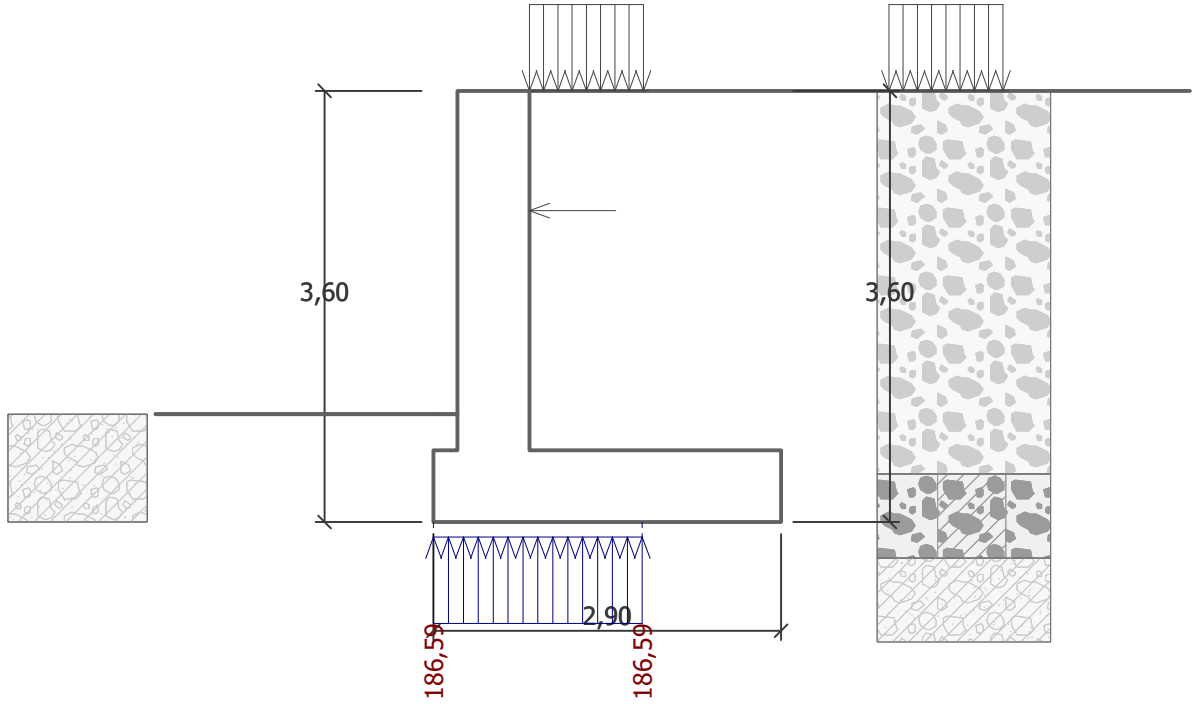
Maximum stress in footing bottom : 157,97 kPa

Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	188,22	324,98	70,84	0,58	186,59
2	167,26	254,75	69,37	0,74	166,65

Name : Bearing cap. **Stage : 1**



Spread footing verification

Input data

Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10,0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
Analysis of uplift : Standard
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)							
Permanent design situation							
		Combination 1				Combination 2	
		Unfavourable		Favourable		Unfavourable	Favourable
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]	1,00 [–]	1,00 [–]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1,00	[–]	1,25	[–]
Partial factor on effective cohesion :	γ_c =	1,00	[–]	1,25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1,00	[–]	1,40	[–]
Partial factor on unconfined strength :	γ_v =	1,00	[–]	1,40	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	peskoviti sljunak1		35,00	0,00	19,00	9,00	17,50
2	peskoviti sljunak 2		30,00	0,00	19,00	9,00	15,00
3	les		23,00	10,00	19,00	9,00	11,50
4	sljunak		30,00	0,00	19,00	9,00	17,50

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

Soil parameters

peskoviti sljunak1

Unit weight : γ = 19,00 kN/m³
Angle of internal friction : φ_{ef} = 35,00 °
Cohesion of soil : c_{ef} = 0,00 kPa
Oedometric modulus : E_{oed} = 40,00 MPa
Saturated unit weight : γ_{sat} = 19,00 kN/m³

peskoviti sljunak 2

Unit weight : γ = 19,00 kN/m³
Angle of internal friction : φ_{ef} = 30,00 °
Cohesion of soil : c_{ef} = 0,00 kPa
Oedometric modulus : E_{oed} = 40,00 MPa
Saturated unit weight : γ_{sat} = 19,00 kN/m³

les

Unit weight :	γ	=	19,00 kN/m^3
Angle of internal friction :	φ_{ef}	=	23,00 °
Cohesion of soil :	c_{ef}	=	10,00 kPa
Oedometric modulus :	E_{oed}	=	5,00 MPa
Saturated unit weight :	γ_{sat}	=	19,00 kN/m^3

sljunak

Unit weight :	γ	=	19,00 kN/m^3
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Oedometric modulus :	E_{oed}	=	40,00 MPa
Saturated unit weight :	γ_{sat}	=	19,00 kN/m^3

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	3,60 m
Depth of footing bottom	d	=	0,90 m
Foundation thickness	t	=	0,60 m
Incl. of finished grade	s_1	=	0,00 °
Incl. of footing bottom	s_2	=	0,00 °

Unit weight of soil above foundation = 19,00 kN/m^3

Geometry of structure

Foundation type: strip footing

Overall strip footing length	=	3,05 m
Strip footing width (x)	=	2,90 m
Column width in the direction of x	=	2,90 m
Volume of strip footing	=	1,74 m^3/m

Inserted loading is considered per unit length of continuous footing span.

Sand-gravel bed

Soil used for the SG pad - sljunak

SG pad overhangs foundation	d_{sp}	=	0,40 m
Sand-gravel pad depth	h_{sp}	=	0,30 m

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37

Cylinder compressive strength	f_{ck}	=	30,00 MPa
Tensile strength	f_{ct}	=	2,90 MPa
Elasticity modulus	E_{cm}	=	33000,00 MPa

Longitudinal steel : B500

Yield strength	f_{yk}	=	500,00 MPa

Transverse steel: B500

Yield strength	f_{yk}	=	500,00 MPa

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3,20	peskoviti sljunak1	
2	0,70	peskoviti sljunak 2	
3	-	les	

Load

No.	Load new	Load change	Name	Type	N [kN/m]	M_y [kNm/m]	H_x [kN/m]
1	YES		LC 1	Service	265,52	145,71	-70,84
2	YES		LC 2	Design	265,52	145,71	-70,84
3	YES		LC 3	Service	195,29	125,63	-69,37
4	YES		LC 4	Design	195,29	125,63	-69,37

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	Self w. in favor	e_x [m]	e_y [m]	σ [kPa]	R_d [kPa]	Utilization [%]	Is satisfied
LC 1	Yes	-0,61	0,00	183,74	205,40	89,45	Yes
LC 1	No	-0,61	0,00	183,74	205,40	89,45	Yes
LC 2	Yes	-0,61	0,00	183,74	349,36	52,59	Yes
LC 2	No	-0,58	0,00	186,45	359,80	51,82	Yes
LC 3	Yes	-0,70	0,00	159,28	179,36	88,80	Yes
LC 3	No	-0,70	0,00	159,28	179,36	88,80	Yes
LC 4	Yes	-0,70	0,00	159,28	303,30	52,52	Yes
LC 4	No	-0,66	0,00	160,45	318,77	50,34	Yes

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

Computed self weight of strip foundation $G = 43,50$ kN/m
Computed weight of overburden $Z = 0,00$ kN/m

Vertical bearing capacity check

Shape of contact stress : rectangle
Most severe load case No. 1. (LC 1)

Parameters of slip surface below foundation:
Depth of slip surface $z_{sp} = 3,73$ m
Length of slip surface $l_{sp} = 10,21$ m

Design bearing capacity of found.soil $R_d = 205,40$ kPa
Extreme contact stress $\sigma = 183,74$ kPa

Bearing capacity in the vertical direction is SATISFACTORY

Horizontal bearing capacity check

Most severe load case No. 3. (LC 3)

Earth resistance: not considered
Friction angle foundation-footing bottom ψ = 30,00 °
Cohesion foundation-footing bottom a = 0,00 kPa
Horizontal bearing capacity R_{dh} = 110,29 kN
Extreme horizontal force H = 69,37 kN

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 = 43,50 kN/m
Computed weight of overburden Z = 0,00 kN/m
Settlement of mid point of longitudinal edge = 20,2 mm
Settlement of mid point of transverse edge 1 = 33,5 mm
Settlement of mid point of transverse edge 2 = -5,0 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} = 7,70 MPa
Foundation in the longitudinal direction is rigid (k=37,95)
Foundation in the direction of width is rigid (k=925,62)

Overall settlement and rotation of foundation:
Foundation settlement = 22,0 mm
Depth of influence zone = 3,83 m
Rotation in direction of width = 13,272 (tan*1000)

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

Foundation thickness is greater than double max.offset, reinforcement is not required.

Spread footing for punching shear failure check

Length of the critical section is equal to zero.
Spread footing for punching shear is SATISFACTORY

Dimensioning No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0,00	-1,50	44,98	0,30	1,000	1,350	1,000
FF resistance	-13,68	-0,14	-5,34	0,00	1,000	1,000	1,000
Pressure at rest	36,43	-1,00	0,00	0,60	1,350	1,000	1,350
tenk 1	12,27	-2,38	0,00	0,60	1,350	1,000	1,350
tenk 2	5,94	-1,23	0,00	0,60	1,350	1,000	1,350
zbijanje	50,00	-2,00	0,00	0,60	1,350	1,000	1,350

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0,00	-1,50	44,98	0,30	1,000	1,000	1,000
FF resistance	-9,85	-0,14	-3,08	0,00	1,000	1,000	1,000
Pressure at rest	43,68	-1,00	0,00	0,60	1,000	1,000	1,000
tenk 1	14,71	-2,38	0,00	0,60	1,000	1,000	1,000
tenk 2	7,13	-1,23	0,00	0,60	1,000	1,000	1,000
zbijanje	50,00	-2,00	0,00	0,60	1,000	1,000	1,000

Wall stem check

Reinforcement and dimensions of the cross-section

Bar diameter = 14,0 mm
Number of bars = 11
Reinforcement cover = 30,0 mm
Cross-section width = 1,00 m
Cross-section depth = 0,60 m

Reinforcement ratio	ρ	=	0,30	%	>	0,15	%	= ρ_{min}
Position of neutral axis	x	=	0,05	m	<	0,35	m	= x_{max}
Ultimate shear force	V_{Rd}	=	224,48	kN	>	127,58	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	400,94	kNm	>	229,82	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

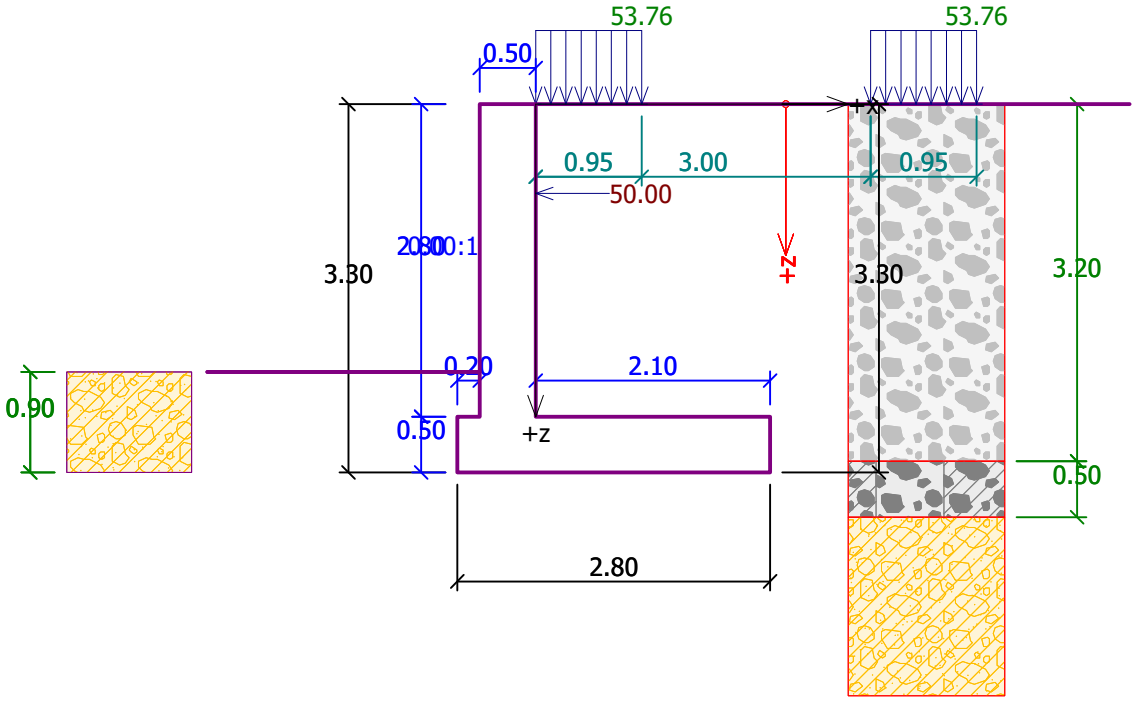
Cantilever wall analysis

Input data

Project

Task : RAMPA BACKA TOPOLA
Descript. : KAMPADA K6, h=2.80m
Date : 29-May-19

Name : Project **Stage : 1**



Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : 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
Base key : The base key is considered as inclined footing bottom
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

		Combination 1		Combination 2	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	γ_G =	1.35 [–]	1.00 [–]	1.00 [–]	1.00 [–]
Variable actions :	γ_Q =	1.50 [–]	0.00 [–]	1.30 [–]	0.00 [–]
Water load :	γ_w =	1.35 [–]		1.00 [–]	

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.00	[–]	1.40	[–]
Partial factor on Poisson's ratio :	γ_v =	1.00	[–]	1.00	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0.70	[–]
Factor for frequent value :	ψ_1 =	0.50	[–]
Factor for quasi-permanent value :	ψ_2 =	0.30	[–]

Material of structure

Unit weight γ = 25.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37
Cylinder compressive strength f_{ck} = 30.00 MPa
Tensile strength f_{ct} = 2.90 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500.00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	2.80
3	2.10	2.80
4	2.10	3.30
5	-0.70	3.30
6	-0.70	2.80
7	-0.50	2.80
8	-0.50	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 2.80 m^2.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	peskoviti sljunak1		35.00	0.00	19.00	9.00	17.50
2	peskoviti sljunak 2		30.00	0.00	19.00	9.00	15.00
3	les		23.00	10.00	19.00	9.00	11.50
4	sljunak		30.00	0.00	19.00	9.00	17.50

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

Soil parameters

peskoviti sljunak1

Unit weight :	γ	=	19.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	17.50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19.00 kN/m^3

peskoviti sljunak 2

Unit weight :	γ	=	19.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	15.00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19.00 kN/m^3

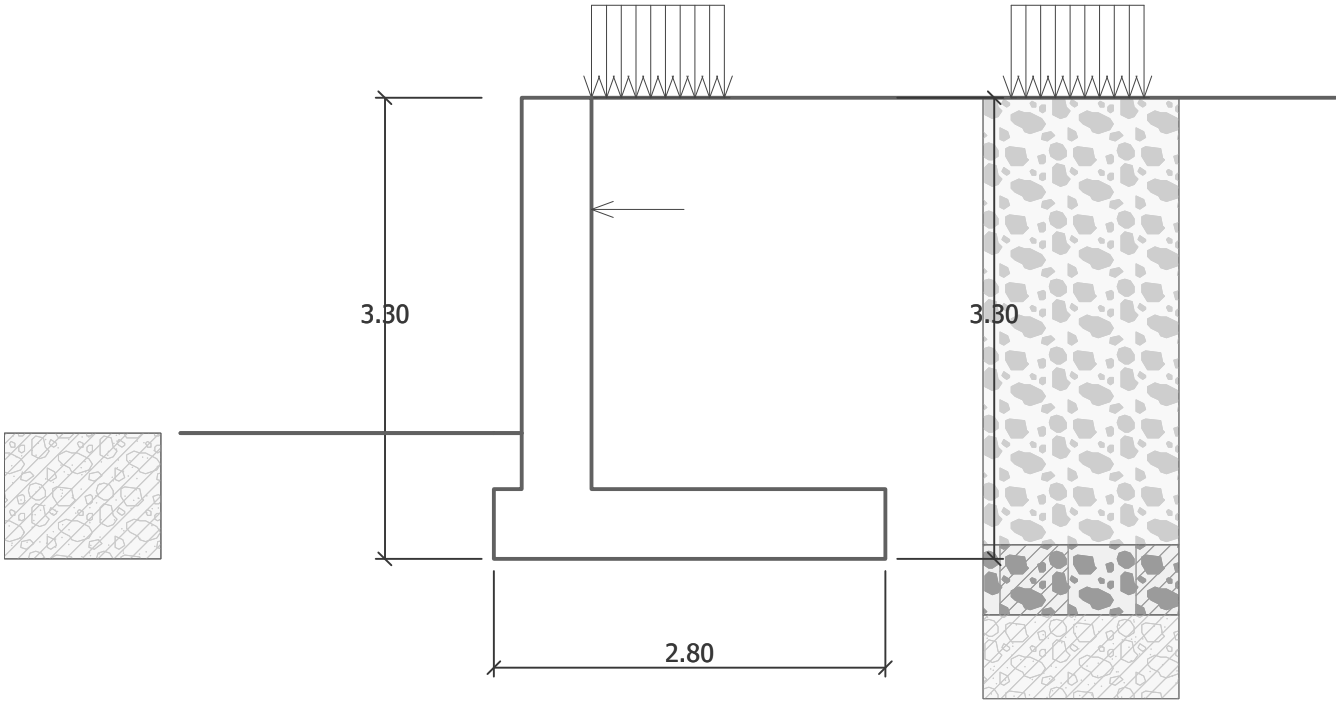
les

Unit weight :	γ	=	19.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	23.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Angle of friction struc.-soil :	δ	=	11.50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19.00 kN/m^3

sljunak

Unit weight :	γ	=	19.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	17.50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19.00 kN/m^3

Name : Soils	Stage : 1



Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3.20	peskoviti sljunak1	
2	0.50	peskoviti sljunak 2	
3	-	les	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		permanent	53.76		0.00	0.95	on terrain
2	YES		permanent	53.76		3.00	0.95	on terrain

No.	Name
1	tenk 1
2	tenk 2

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - les
Angle of friction struc.-soil $\delta = 21.33$ °

Soil thickness in front of structure h = 0.90 m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force modification	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	YES		zbijanje	permanent	-50.00	0.00	0.00	0.00	0.80

Settings of the stage of construction

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

Verification No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.07	70.00	0.93	1.000	1.000	1.350
FF resistance	-58.97	-0.38	-22.96	0.07	1.000	1.000	1.000
Weight - earth wedge	0.00	-1.65	72.95	1.45	1.000	1.000	1.350
Active pressure	27.33	-1.12	40.94	2.34	1.000	1.350	1.350
tenk 1	2.98	-3.00	5.72	1.50	1.350	1.000	1.350
tenk 2	7.40	-0.72	8.93	2.52	1.000	1.350	1.350
tenk 1	0.00	-3.30	34.53	1.02	1.000	1.000	1.350
zbijanje	50.00	-2.50	0.00	0.70	1.350	1.350	1.350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 334.17 kNm/m
Overturning moment M_{ovr} = 194.22 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 131.39 kN/m
Active horizontal force H_{act} = 58.40 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 176.65 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.07	70.00	0.93	1.000	1.000	1.000
FF resistance	-43.24	-0.38	-13.49	0.07	1.000	1.000	1.000
Weight - earth wedge	0.00	-1.65	72.95	1.45	1.000	1.000	1.000
Active pressure	34.58	-1.12	41.18	2.34	1.000	1.000	1.000
tenk 1	4.33	-3.01	6.61	1.50	1.000	1.000	1.000
tenk 2	10.97	-0.95	11.99	2.41	1.000	1.000	1.000
tenk 1	0.00	-3.30	34.53	1.02	1.000	1.000	1.000
zbijanje	50.00	-2.50	0.00	0.70	1.000	1.000	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 340.11 kNm/m
Overturning moment M_{ovr} = 170.72 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 103.35 kN/m
Active horizontal force H_{act} = 56.65 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 147.80 kPa

Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	167.54	291.69	59.44	0.57	176.65
2	149.67	227.57	58.40	0.74	160.75

Bearing capacity of foundation soil check

Eccentricity verification
Max. eccentricity of normal force e = 740.2 mm
Maximum allowable eccentricity e_{alw} = 924.0 mm

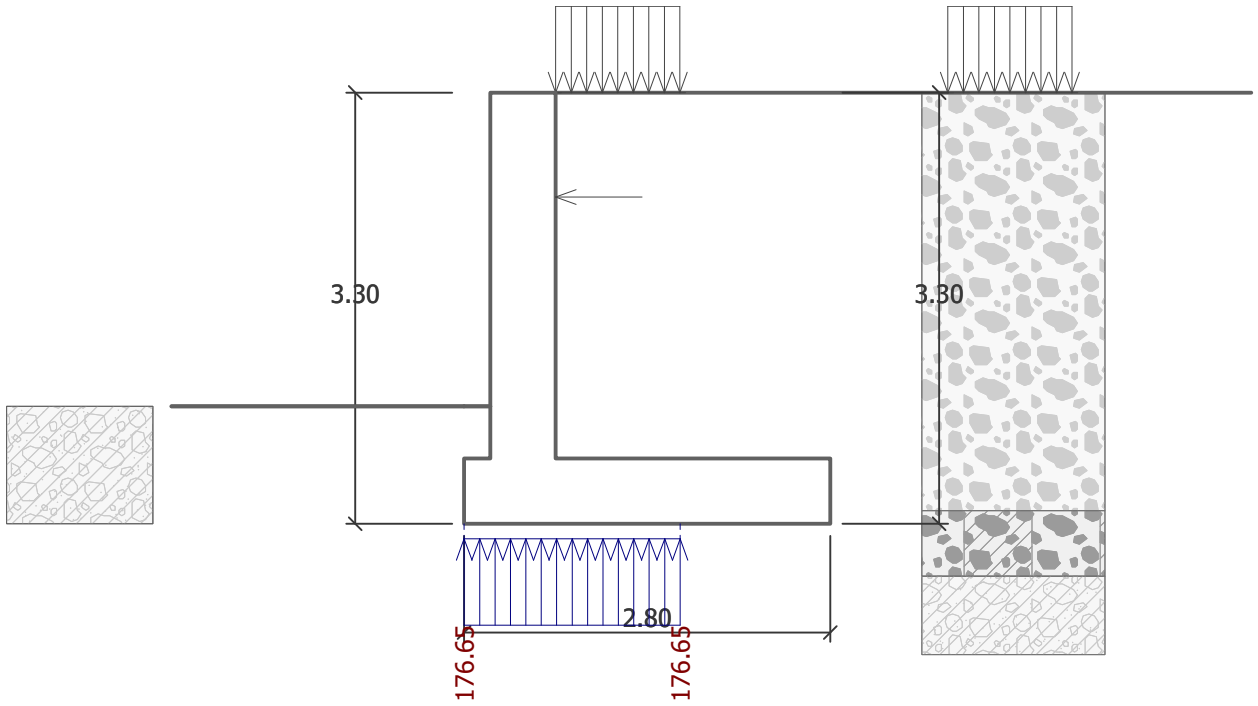
Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification
Max. stress at footing bottom σ = 176.65 kPa
Bearing capacity of foundation soil R_d = 177.19 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 - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.40	34.98	0.25	1.000	1.350	1.000
FF resistance	-19.57	-0.18	-7.64	0.00	1.000	1.000	1.000
Pressure at rest	31.73	-0.93	0.00	0.50	1.350	1.000	1.350
tenk 1	12.28	-2.19	0.00	0.50	1.350	1.000	1.350
tenk 2	5.48	-1.13	0.00	0.50	1.350	1.000	1.350
zbijanje	50.00	-2.00	0.00	0.50	1.350	1.000	1.350

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.40	34.98	0.25	1.000	1.000	1.000
FF resistance	-14.15	-0.18	-4.43	0.00	1.000	1.000	1.000
Pressure at rest	38.05	-0.93	0.00	0.50	1.000	1.000	1.000
tenk 1	14.73	-2.19	0.00	0.50	1.000	1.000	1.000
tenk 2	6.57	-1.13	0.00	0.50	1.000	1.000	1.000
zbijanje	50.00	-2.00	0.00	0.50	1.000	1.000	1.000

Wall stem check

Reinforcement and dimensions of the cross-section
Bar diameter = 14.0 mm
Number of bars = 11
Reinforcement cover = 30.0 mm
Cross-section width = 1.00 m
Cross-section depth = 0.50 m

Reinforcement ratio ρ = 0.37 % > 0.15 % = ρ_{min}

Position of neutral axis	x	=	0.05	m	<	0.29	m	= x_{max}
Ultimate shear force	V_{Rd}	=	204.60	kN	>	114.75	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	327.32	kNm	>	214.10	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

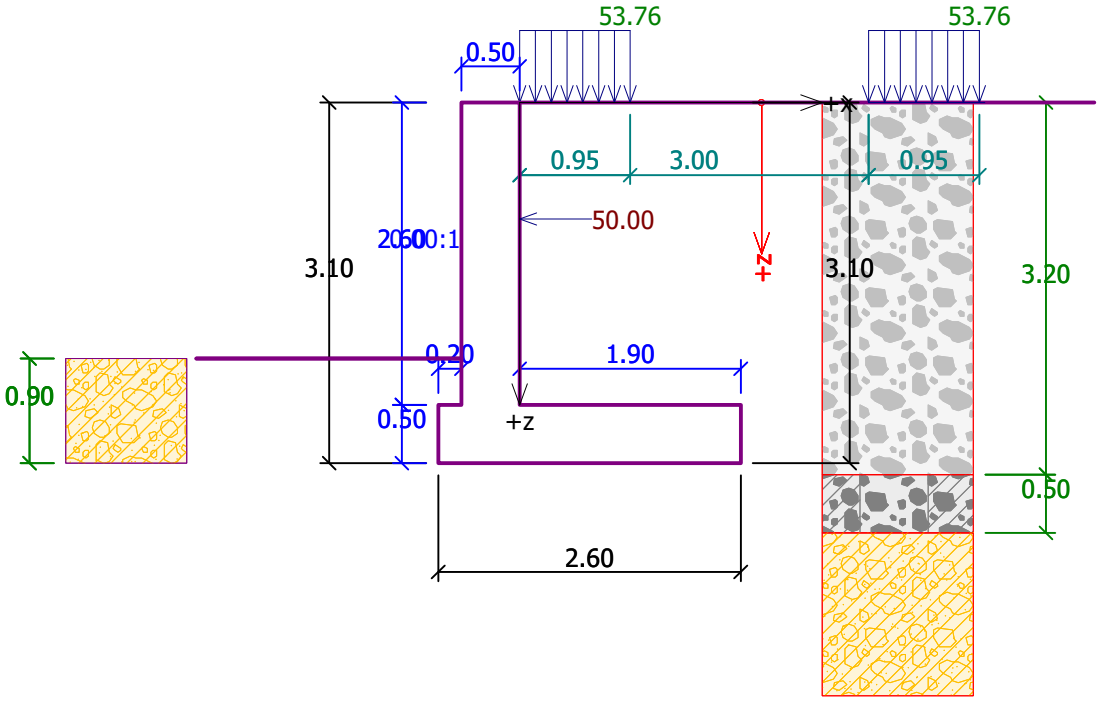
Cantilever wall analysis

Input data

Project

Task : RAMPA BACKA TOPOLA
Descript. : KAMPADA K7, h=2.60m
Date : 26-Jun-19

Name : Project | **Stage : 1**



Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : 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
Base key : The base key is considered as inclined footing bottom
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]	1.30	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]			1.00	[–]		

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.00	[–]	1.40	[–]
Partial factor on Poisson's ratio :	γ_v =	1.00	[–]	1.00	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0.70	[–]
Factor for frequent value :	ψ_1 =	0.50	[–]
Factor for quasi-permanent value :	ψ_2 =	0.30	[–]

Material of structure

Unit weight γ = 25.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37
Cylinder compressive strength f_{ck} = 30.00 MPa
Tensile strength f_{ct} = 2.90 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500.00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	2.60
3	1.90	2.60
4	1.90	3.10
5	-0.70	3.10
6	-0.70	2.60
7	-0.50	2.60
8	-0.50	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 2.60 m^2.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	peskoviti sljunak1		35.00	0.00	19.00	9.00	17.50
2	peskoviti sljunak 2		30.00	0.00	19.00	9.00	15.00
3	les		23.00	10.00	19.00	9.00	11.50
4	sljunak		30.00	0.00	19.00	9.00	17.50

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

Soil parameters

peskoviti sljunak1

Unit weight :	γ	=	19.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	17.50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19.00 kN/m^3

peskoviti sljunak 2

Unit weight :	γ	=	19.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	15.00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19.00 kN/m^3

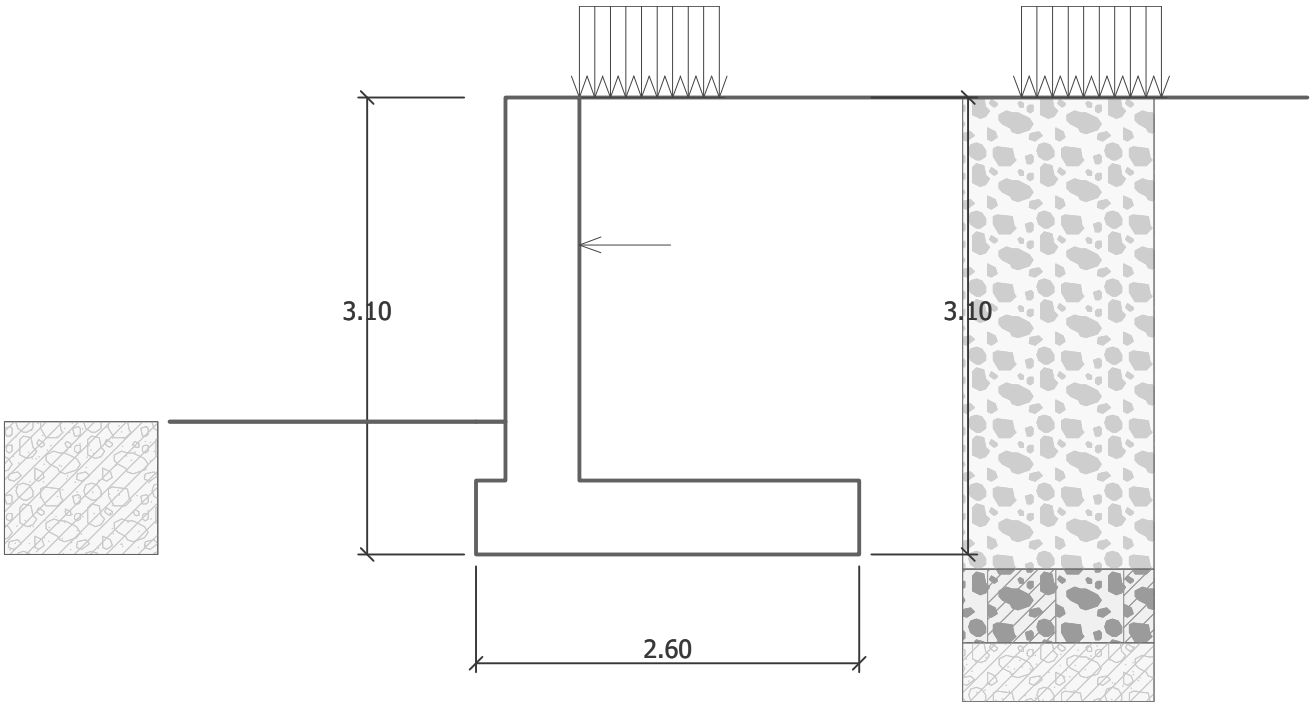
les

Unit weight :	γ	=	19.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	23.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Angle of friction struc.-soil :	δ	=	11.50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19.00 kN/m^3

sljunak

Unit weight :	γ	=	19.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	17.50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19.00 kN/m^3

Name : Soils | **Stage : 1**



Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	3.20	peskoviti sljunak1	
2	0.50	peskoviti sljunak 2	
3	-	les	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		permanent	53.76		0.00	0.95	on terrain
2	YES		permanent	53.76		3.00	0.95	on terrain

No.	Name
1	tenk 1
2	tenk 2

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - les
Angle of friction struc.-soil $\delta = 21.33$ °

Soil thickness in front of structure h = 0.90 m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force modification	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	YES		zbijanje	permanent	-50.00	0.00	0.00	0.00	1.00

Settings of the stage of construction

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

Verification No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.02	65.00	0.88	1.000	1.000	1.350
FF resistance	-58.97	-0.38	-22.96	0.07	1.000	1.000	1.000
Weight - earth wedge	0.00	-1.56	60.43	1.37	1.000	1.000	1.350
Active pressure	23.76	-1.07	35.43	2.17	1.000	1.000	1.350
tenk 1	4.09	-2.71	7.85	1.45	1.350	1.000	1.350
tenk 2	6.47	-0.60	7.17	2.40	1.000	1.350	1.350
tenk 1	0.00	-3.10	29.38	0.97	1.000	1.000	1.350
zbijanje	50.00	-2.10	0.00	0.70	1.350	1.350	1.350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 276.57 kNm/m
Overturning moment M_{ovr} = 163.38 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 129.41 kN/m
Active horizontal force H_{act} = 45.11 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 165.68 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-1.02	65.00	0.88	1.000	1.000	1.000
FF resistance	-43.24	-0.38	-13.49	0.07	1.000	1.000	1.000
Weight - earth wedge	0.00	-1.56	60.43	1.37	1.000	1.000	1.000
Active pressure	30.12	-1.06	35.67	2.18	1.000	1.000	1.000
tenk 1	5.94	-2.71	9.06	1.45	1.000	1.000	1.000
tenk 2	9.85	-0.82	10.28	2.28	1.000	1.000	1.000
tenk 1	0.00	-3.10	29.38	0.97	1.000	1.000	1.000
zbijanje	50.00	-2.10	0.00	0.70	1.000	1.000	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 281.80 kNm/m
Overturning moment M_{ovr} = 144.86 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 109.97 kN/m
Active horizontal force H_{act} = 52.68 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 140.73 kPa

Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	135.46	254.14	54.86	0.53	165.68
2	122.51	184.81	45.11	0.69	151.27

Bearing capacity of foundation soil check

Eccentricity verification
Max. eccentricity of normal force e = 688.3 mm
Maximum allowable eccentricity e_{alw} = 858.0 mm

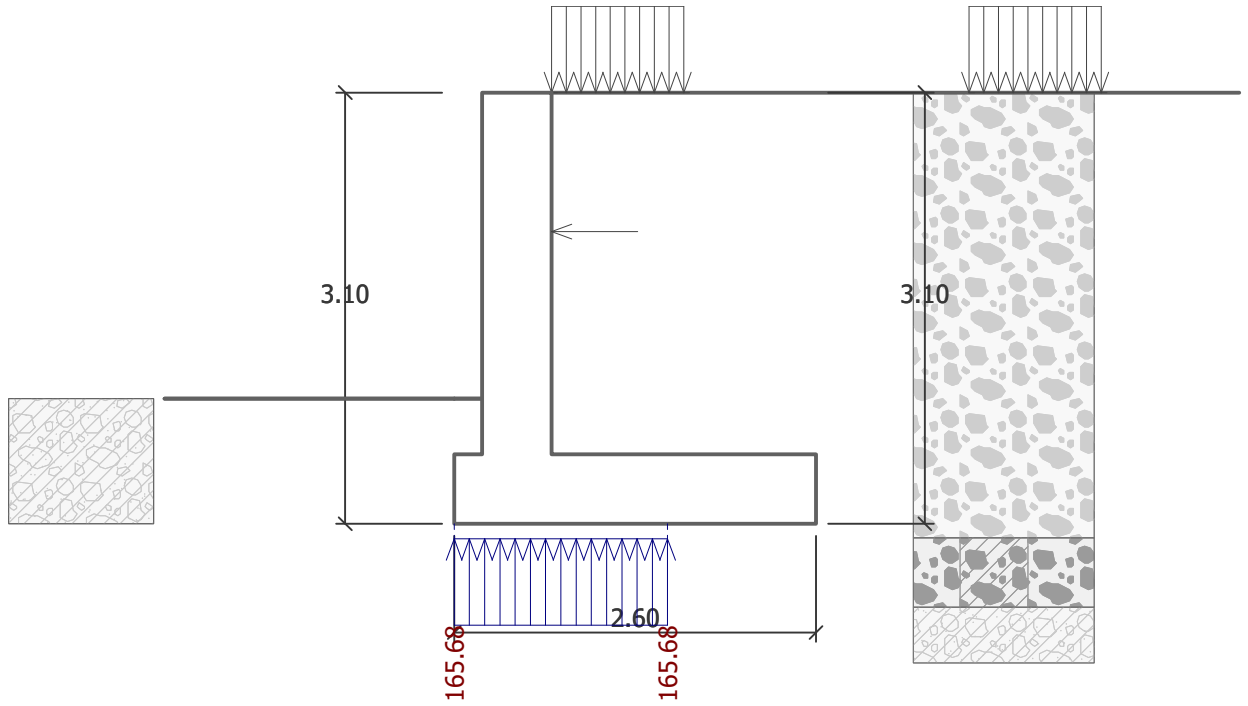
Eccentricity of the normal force is SATISFACTORY

Footing bottom bearing capacity verification
Max. stress at footing bottom σ = 165.68 kPa
Bearing capacity of foundation soil R_d = 172.53 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 - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.30	32.48	0.25	1.000	1.350	1.000
FF resistance	-19.57	-0.18	-7.64	0.00	1.000	1.000	1.000
Pressure at rest	27.36	-0.87	0.00	0.50	1.350	1.000	1.350
tenk 1	12.29	-2.01	0.00	0.50	1.350	1.000	1.350
tenk 2	5.00	-1.03	0.00	0.50	1.350	1.000	1.350
zbijanje	50.00	-1.60	0.00	0.50	1.350	1.000	1.350

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. moment	Coeff. norm.force	Coeff. shear for.
Weight - wall	0.00	-1.30	32.48	0.25	1.000	1.000	1.000
FF resistance	-14.15	-0.18	-4.43	0.00	1.000	1.000	1.000
Pressure at rest	32.80	-0.87	0.00	0.50	1.000	1.000	1.000
tenk 1	14.73	-2.01	0.00	0.50	1.000	1.000	1.000
tenk 2	6.00	-1.03	0.00	0.50	1.000	1.000	1.000
zbijanje	50.00	-1.60	0.00	0.50	1.000	1.000	1.000

Wall stem check

Reinforcement and dimensions of the cross-section
Bar diameter = 14.0 mm
Number of bars = 11
Reinforcement cover = 30.0 mm
Cross-section width = 1.00 m
Cross-section depth = 0.50 m

Reinforcement ratio ρ = 0.37 % > 0.15 % = ρ_{min}

Position of neutral axis	x	=	0.05	m	<	0.29	m	= x_{max}
Ultimate shear force	V_{Rd}	=	204.60	kN	>	108.20	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	327.32	kNm	>	174.67	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

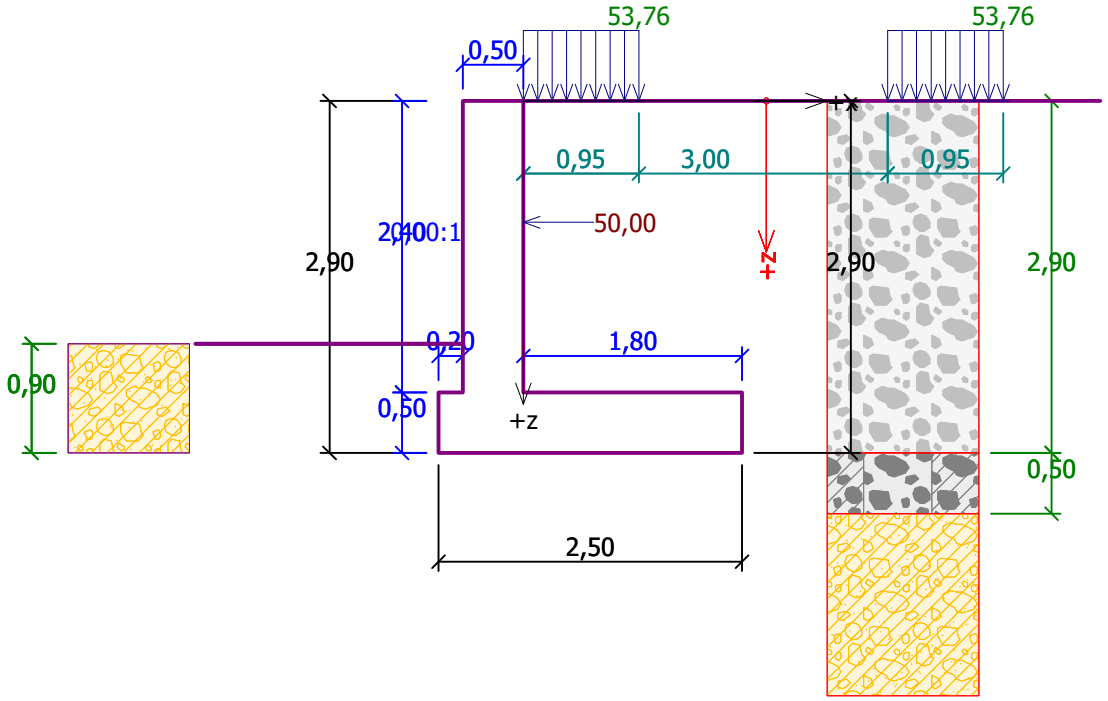
Cantilever wall analysis

Input data

Project

Task : RAMPA BACKA TOPOLA
Descript. : KAMPADA K8, h=2.40m
Date : 7.8.2019.

Name : Project	Stage : 1



Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : 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
Base key : The base key is considered as inclined footing bottom
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)								
Permanent design situation								
		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]	1,00	[–]	1,00	[–]
Variable actions :	γ_Q =	1,50	[–]	0,00	[–]	1,30	[–]	0,00	[–]
Water load :	γ_w =	1,35	[–]			1,00	[–]		

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1,00	[–]	1,25	[–]
Partial factor on effective cohesion :	γ_c =	1,00	[–]	1,25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1,00	[–]	1,40	[–]
Partial factor on Poisson's ratio :	γ_v =	1,00	[–]	1,00	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0,70	[–]
Factor for frequent value :	ψ_1 =	0,50	[–]
Factor for quasi-permanent value :	ψ_2 =	0,30	[–]

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37
Cylinder compressive strength f_{ck} = 30,00 MPa
Tensile strength f_{ct} = 2,90 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500,00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0,00	0,00
2	0,00	2,40
3	1,80	2,40
4	1,80	2,90
5	-0,70	2,90
6	-0,70	2,40
7	-0,50	2,40
8	-0,50	0,00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 2,45 m^2.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	peskoviti sljunak1		35,00	0,00	19,00	9,00	17,50
2	peskoviti sljunak 2		30,00	0,00	19,00	9,00	15,00
3	les		23,00	10,00	19,00	9,00	11,50
4	sljunak		30,00	0,00	19,00	9,00	17,50

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

Soil parameters

peskoviti sljunak1

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

peskoviti sljunak 2

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	15,00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

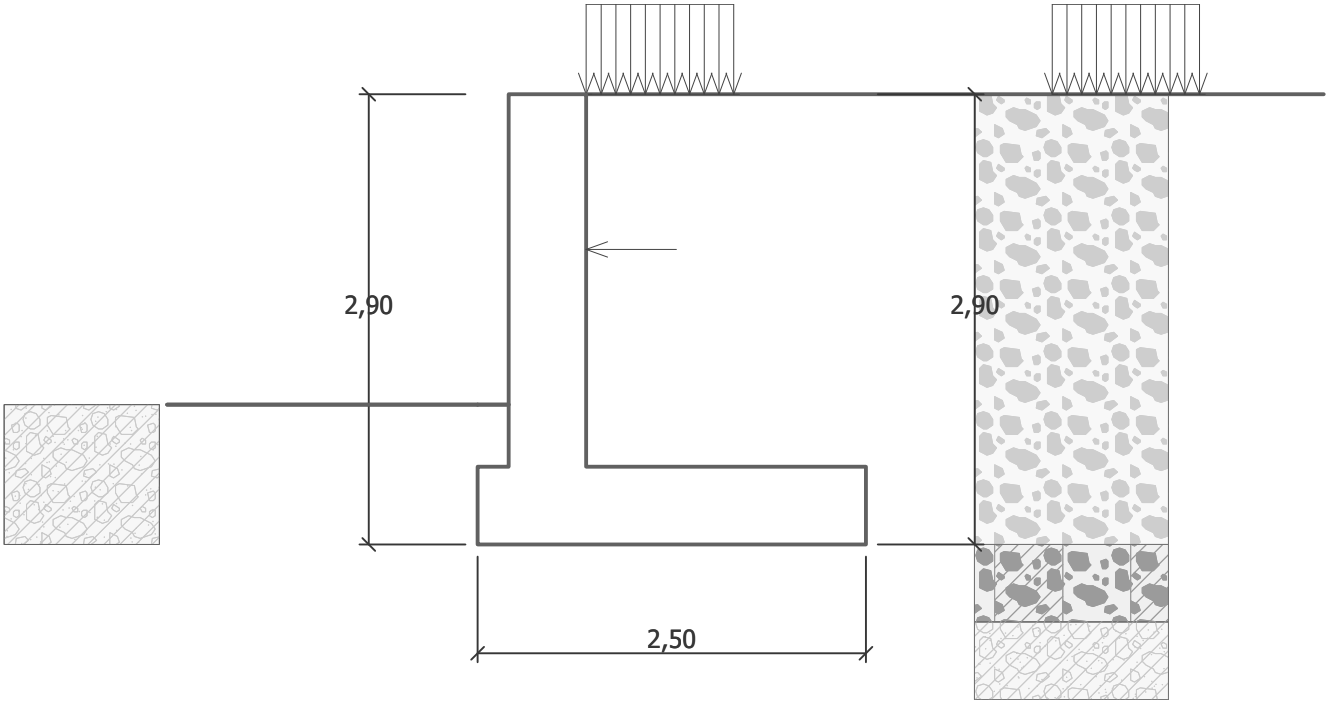
les

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	23,00 °
Cohesion of soil :	c_{ef}	=	10,00 kPa
Angle of friction struc.-soil :	δ	=	11,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

sljunak

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

Name : Soils	Stage : 1



Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	2,90	peskoviti sljunak1	
2	0,50	peskoviti sljunak 2	
3	-	les	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m2]	Mag.2 [kN/m2]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		permanent	53,76		0,00	0,95	on terrain
2	YES		permanent	53,76		3,00	0,95	on terrain

No.	Name
1	tenk 1
2	tenk 2

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - les
Angle of friction struc.-soil $\delta = 21,33$ °

Soil thickness in front of structure h = 0,90 m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force modification	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	YES		zbijanje	permanent	-50,00	0,00	0,00	0,00	1,00

Settings of the stage of construction

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

Verification No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-0,96	61,25	0,86	1,000	1,000	1,350
FF resistance	-58,97	-0,38	-22,96	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-1,49	53,59	1,34	1,000	1,000	1,350
Active pressure	20,74	-1,00	30,35	2,11	1,000	1,000	1,350
tenk 1	4,04	-2,51	7,76	1,45	1,350	1,000	1,350
tenk 2	5,95	-0,51	5,93	2,35	1,000	1,350	1,350
tenk 1	0,00	-2,90	29,60	0,98	1,000	1,000	1,350
zbijanje	50,00	-1,90	0,00	0,70	1,350	1,350	1,350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 245,05 kNm/m
Overturning moment M_{ovr} = 143,16 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 117,36 kN/m
Active horizontal force H_{act} = 41,34 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 153,50 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-0,96	61,25	0,86	1,000	1,000	1,000
FF resistance	-43,24	-0,38	-13,49	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-1,49	53,59	1,34	1,000	1,000	1,000
Active pressure	26,30	-1,00	30,56	2,11	1,000	1,000	1,000
tenk 1	5,87	-2,52	8,96	1,45	1,000	1,000	1,000
tenk 2	9,18	-0,72	9,05	2,24	1,000	1,000	1,000
tenk 1	0,00	-2,90	29,60	0,98	1,000	1,000	1,000
zbijanje	50,00	-1,90	0,00	0,70	1,000	1,000	1,000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 250,24 kNm/m
Overturning moment M_{ovr} = 126,18 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 100,56 kN/m
Active horizontal force H_{act} = 48,11 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

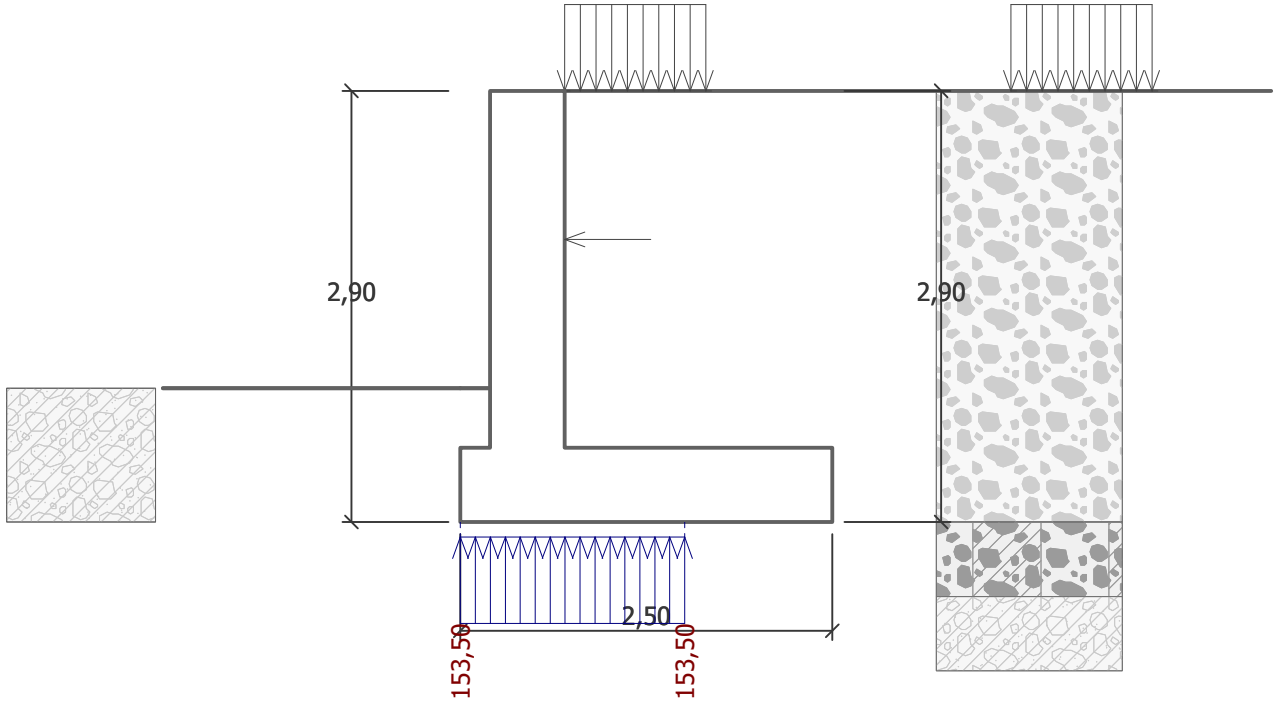
Maximum stress in footing bottom : 129,88 kPa

Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	114,81	231,50	50,01	0,50	153,50
2	104,18	167,60	41,34	0,64	138,91

Name : Bearing cap. **Stage : 1**



Spread footing verification

Input data

Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10,0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
Analysis of uplift : Standard
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)							
Permanent design situation							
		Combination 1				Combination 2	
		Unfavourable		Favourable		Unfavourable	Favourable
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]	1,00 [–]	1,00 [–]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1,00	[–]	1,25	[–]
Partial factor on effective cohesion :	γ_c =	1,00	[–]	1,25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1,00	[–]	1,40	[–]
Partial factor on unconfined strength :	γ_v =	1,00	[–]	1,40	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	peskoviti sljunak1		35,00	0,00	19,00	9,00	17,50
2	peskoviti sljunak 2		30,00	0,00	19,00	9,00	15,00
3	les		23,00	10,00	19,00	9,00	11,50
4	sljunak		30,00	0,00	19,00	9,00	17,50

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

Soil parameters

peskoviti sljunak1

Unit weight : γ = 19,00 kN/m³
Angle of internal friction : φ_{ef} = 35,00 °
Cohesion of soil : c_{ef} = 0,00 kPa
Oedometric modulus : E_{oed} = 40,00 MPa
Saturated unit weight : γ_{sat} = 19,00 kN/m³

peskoviti sljunak 2

Unit weight : γ = 19,00 kN/m³
Angle of internal friction : φ_{ef} = 30,00 °
Cohesion of soil : c_{ef} = 0,00 kPa
Oedometric modulus : E_{oed} = 40,00 MPa
Saturated unit weight : γ_{sat} = 19,00 kN/m³

les

Unit weight :	γ	=	19,00 kN/m^3
Angle of internal friction :	φ_{ef}	=	23,00 °
Cohesion of soil :	c_{ef}	=	10,00 kPa
Oedometric modulus :	E_{oed}	=	5,00 MPa
Saturated unit weight :	γ_{sat}	=	19,00 kN/m^3

sljunak

Unit weight :	γ	=	19,00 kN/m^3
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Oedometric modulus :	E_{oed}	=	40,00 MPa
Saturated unit weight :	γ_{sat}	=	19,00 kN/m^3

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	2,90 m
Depth of footing bottom	d	=	0,90 m
Foundation thickness	t	=	0,50 m
Incl. of finished grade	s_1	=	0,00 °
Incl. of footing bottom	s_2	=	0,00 °

Unit weight of soil above foundation = 19,00 kN/m^3

Geometry of structure

Foundation type: strip footing

Overall strip footing length	=	3,05 m
Strip footing width (x)	=	2,50 m
Column width in the direction of x	=	2,50 m
Volume of strip footing	=	1,25 m^3/m

Inserted loading is considered per unit length of continuous footing span.

Sand-gravel bed

Soil used for the SG pad - sljunak

SG pad overhangs foundation	d_{sp}	=	0,40 m
Sand-gravel pad depth	h_{sp}	=	0,30 m

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37

Cylinder compressive strength	f_{ck}	=	30,00 MPa
Tensile strength	f_{ct}	=	2,90 MPa
Elasticity modulus	E_{cm}	=	33000,00 MPa

Longitudinal steel : B500

Yield strength	f_{yk}	=	500,00 MPa

Transverse steel: B500

Yield strength	f_{yk}	=	500,00 MPa

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	2,90	peskoviti sljunak1	
2	0,50	peskoviti sljunak 2	
3	-	les	

Load

No.	Load new	Load change	Name	Type	N [kN/m]	M_y [kNm/m]	H_x [kN/m]
1	YES		LC 1	Service	182,01	89,80	-50,01
2	YES		LC 2	Design	182,01	89,80	-50,01
3	YES		LC 3	Service	118,11	83,51	-41,34
4	YES		LC 4	Design	118,11	83,51	-41,34

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	Self w. in favor	e_x [m]	e_y [m]	σ [kPa]	R_d [kPa]	Utilization [%]	Is satisfied
LC 1	Yes	-0,54	0,00	149,84	195,82	76,52	Yes
LC 1	No	-0,54	0,00	149,84	195,82	76,52	Yes
LC 2	Yes	-0,54	0,00	149,84	333,80	44,89	Yes
LC 2	No	-0,51	0,00	151,91	344,38	44,11	Yes
LC 3	Yes	-0,70	0,00	135,17	170,31	79,36	Yes
LC 3	No	-0,70	0,00	135,17	170,31	79,36	Yes
LC 4	Yes	-0,70	0,00	135,17	287,46	47,02	Yes
LC 4	No	-0,65	0,00	133,56	305,32	43,74	Yes

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

Computed self weight of strip foundation $G = 31,25$ kN/m
Computed weight of overburden $Z = 0,00$ kN/m

Vertical bearing capacity check

Shape of contact stress : rectangle
Most severe load case No. 3. (LC 3)

Parameters of slip surface below foundation:
Depth of slip surface $z_{sp} = 3,25$ m
Length of slip surface $l_{sp} = 8,94$ m

Design bearing capacity of found.soil $R_d = 170,31$ kPa
Extreme contact stress $\sigma = 135,17$ kPa

Bearing capacity in the vertical direction is SATISFACTORY

Horizontal bearing capacity check

Most severe load case No. 3. (LC 3)

Earth resistance: not considered
Friction angle foundation-footing bottom ψ = 30,00 °
Cohesion foundation-footing bottom a = 0,00 kPa

Horizontal bearing capacity R_{dh} = 68,99 kN
Extreme horizontal force H = 41,34 kN

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 = 31,25 kN/m
Computed weight of overburden Z = 0,00 kN/m

Settlement of mid point of longitudinal edge = 12,0 mm
Settlement of mid point of transverse edge 1 = 20,9 mm
Settlement of mid point of transverse edge 2 = -3,6 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} = 10,91 MPa
Foundation in the longitudinal direction is rigid (k=24,20)
Foundation in the direction of width is rigid (k=378,14)

Overall settlement and rotation of foundation:
Foundation settlement = 13,1 mm
Depth of influence zone = 3,29 m

Rotation in direction of width = 9,790 (tan*1000)

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

Foundation thickness is greater than double max.offset, reinforcement is not required.

Spread footing for punching shear failure check

Length of the critical section is equal to zero.
Spread footing for punching shear is SATISFACTORY

Dimensioning No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,25	22,50	1,60	1,350
Weight - earth wedge	0,00	-1,49	53,59	1,34	1,350
Active pressure	20,74	-1,00	30,35	2,11	1,350
tenk 1	4,04	-2,51	7,76	1,45	1,350
tenk 2	5,95	-0,51	5,93	2,35	1,350
Contact tractions	0,00	0,00	-110,40	1,22	1,000
Gravity surch. 1	0,00	-2,90	29,87	0,98	1,350

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,25	22,50	1,60	1,000
Weight - earth wedge	0,00	-1,49	53,59	1,34	1,000
Active pressure	26,30	-1,00	30,56	2,11	1,000
tenk 1	5,87	-2,52	8,96	1,45	1,000
tenk 2	9,18	-0,72	9,05	2,24	1,000
Contact tractions	0,00	0,00	-78,76	1,16	1,000
Gravity surch. 1	0,00	-2,90	29,87	0,98	1,000

Back wall jump check

Reinforcement and dimensions of the cross-section

Bar diameter = 14,0 mm
Number of bars = 11
Reinforcement cover = 30,0 mm
Cross-section width = 1,00 m
Cross-section depth = 0,50 m

Reinforcement ratio	ρ	=	0,37	%	>	0,15	%	= ρ_{min}
Position of neutral axis	x	=	0,05	m	<	0,29	m	= x_{max}
Ultimate shear force	V_{Rd}	=	204,60	kN	>	92,11	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	327,32	kNm	>	106,41	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

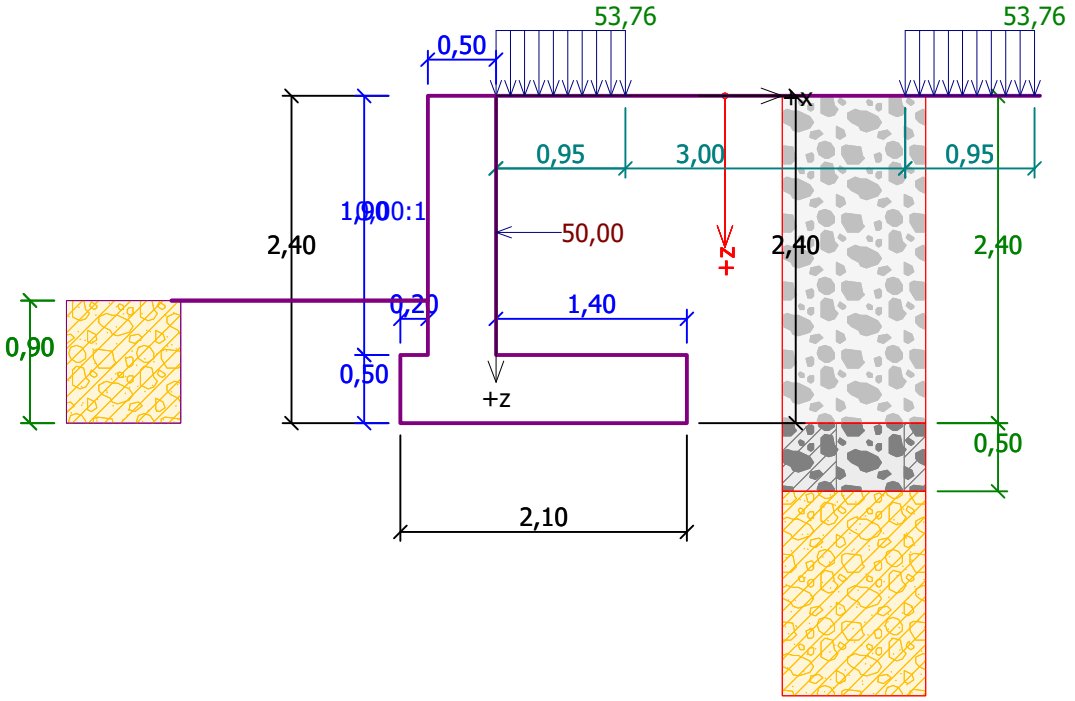
Cantilever wall analysis

Input data

Project

Task : RAMPA BACKA TOPOLA
Descript. : KAMPADA K9, h=1.90m
Date : 7.8.2019.

Name : Project	Stage : 1



Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : 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
Base key : The base key is considered as inclined footing bottom
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)								
Permanent design situation								
		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]	1,00	[–]	1,00	[–]
Variable actions :	γ_Q =	1,50	[–]	0,00	[–]	1,30	[–]	0,00	[–]
Water load :	γ_w =	1,35	[–]			1,00	[–]		

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1,00	[–]	1,25	[–]
Partial factor on effective cohesion :	γ_c =	1,00	[–]	1,25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1,00	[–]	1,40	[–]
Partial factor on Poisson's ratio :	γ_v =	1,00	[–]	1,00	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	ψ_0 =	0,70	[–]
Factor for frequent value :	ψ_1 =	0,50	[–]
Factor for quasi-permanent value :	ψ_2 =	0,30	[–]

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37
Cylinder compressive strength f_{ck} = 30,00 MPa
Tensile strength f_{ct} = 2,90 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500,00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0,00	0,00
2	0,00	1,90
3	1,40	1,90
4	1,40	2,40
5	-0,70	2,40
6	-0,70	1,90
7	-0,50	1,90
8	-0,50	0,00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 2,00 m^2.

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
1	peskoviti sljunak1		35,00	0,00	19,00	9,00	17,50
2	peskoviti sljunak 2		30,00	0,00	19,00	9,00	15,00
3	les		23,00	10,00	19,00	9,00	11,50
4	sljunak		30,00	0,00	19,00	9,00	17,50

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

Soil parameters

peskoviti sljunak1

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

peskoviti sljunak 2

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	15,00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

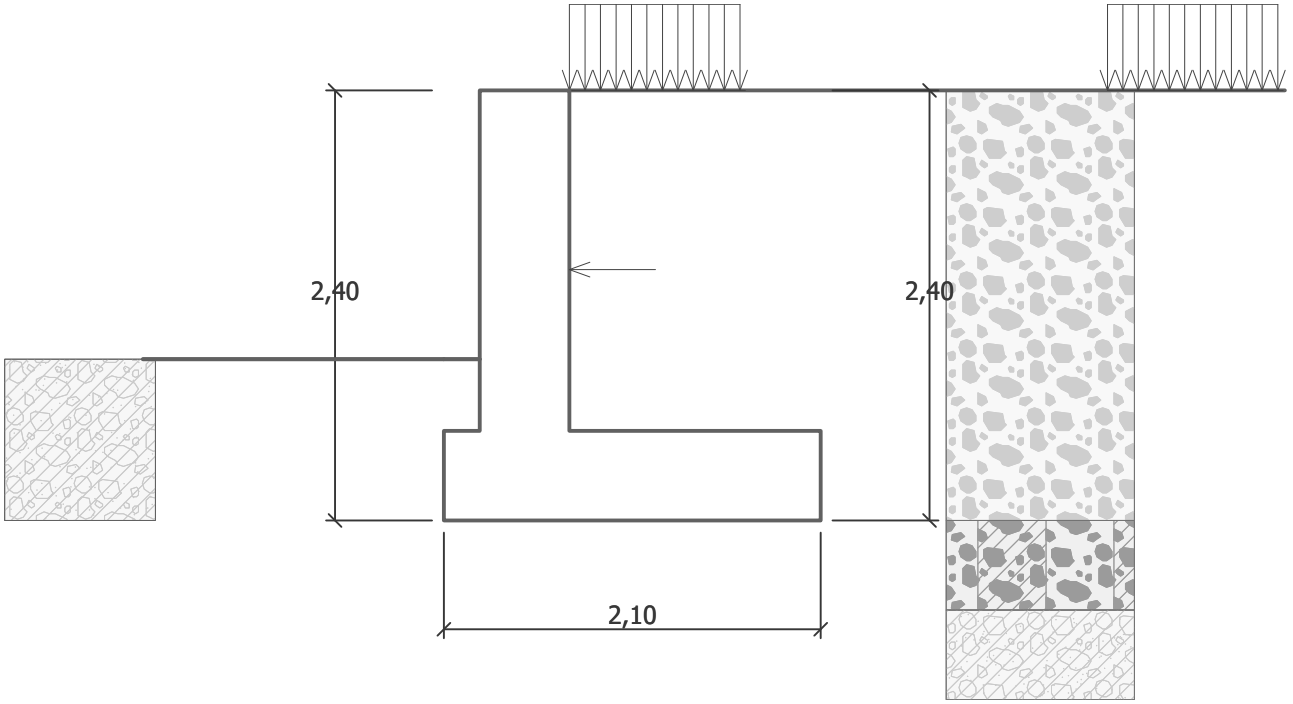
les

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	23,00 °
Cohesion of soil :	c_{ef}	=	10,00 kPa
Angle of friction struc.-soil :	δ	=	11,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

sljunak

Unit weight :	γ	=	19,00 kN/m3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Angle of friction struc.-soil :	δ	=	17,50 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	19,00 kN/m3

Name : Soils | **Stage : 1**



Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	2,40	peskoviti sljunak1	
2	0,50	peskoviti sljunak 2	
3	-	les	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	YES		permanent	53,76		0,00	0,95	on terrain
2	YES		permanent	53,76		3,00	0,95	on terrain

No.	Name
1	tenk 1
2	tenk 2

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - les
Angle of friction struc.-soil $\delta = 21,33$ °

Soil thickness in front of structure h = 0,90 m

Terrain in front of structure is flat.

Applied forces acting on the structure

No.	Force new	Force modification	Name	Action	F_x [kN/m]	F_z [kN/m]	M [kNm/m]	x [m]	z [m]
1	YES		zbijanje	permanent	-50,00	0,00	0,00	0,00	1,00

Settings of the stage of construction

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

Verification No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-0,82	50,00	0,76	1,000	1,000	1,350
FF resistance	-58,97	-0,38	-22,96	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-1,28	32,69	1,20	1,000	1,000	1,350
Active pressure	14,09	-0,83	19,36	1,80	1,000	1,350	1,350
tenk 1	5,66	-1,88	10,86	1,38	1,350	1,000	1,350
tenk 2	4,08	-0,28	1,82	2,09	1,000	1,350	1,350
tenk 1	0,00	-2,40	22,09	0,91	1,000	1,000	1,350
zbijanje	50,00	-1,40	0,00	0,70	1,350	1,350	1,350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 154,71 kNm/m
Overturning moment M_{ovr} = 99,14 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 84,92 kN/m
Active horizontal force H_{act} = 38,71 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 132,56 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0,00	-0,82	50,00	0,76	1,000	1,000	1,000
FF resistance	-43,24	-0,38	-13,49	0,07	1,000	1,000	1,000
Weight - earth wedge	0,00	-1,28	32,69	1,20	1,000	1,000	1,000
Active pressure	17,88	-0,83	19,52	1,80	1,000	1,000	1,000
tenk 1	8,22	-1,88	12,54	1,38	1,000	1,000	1,000
tenk 2	6,83	-0,45	5,02	1,99	1,000	1,000	1,000
tenk 1	0,00	-2,40	22,09	0,91	1,000	1,000	1,000
zbijanje	50,00	-1,40	0,00	0,70	1,000	1,000	1,000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 158,89 kNm/m
Overturning moment M_{ovr} = 86,92 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 71,90 kN/m
Active horizontal force H_{act} = 39,69 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

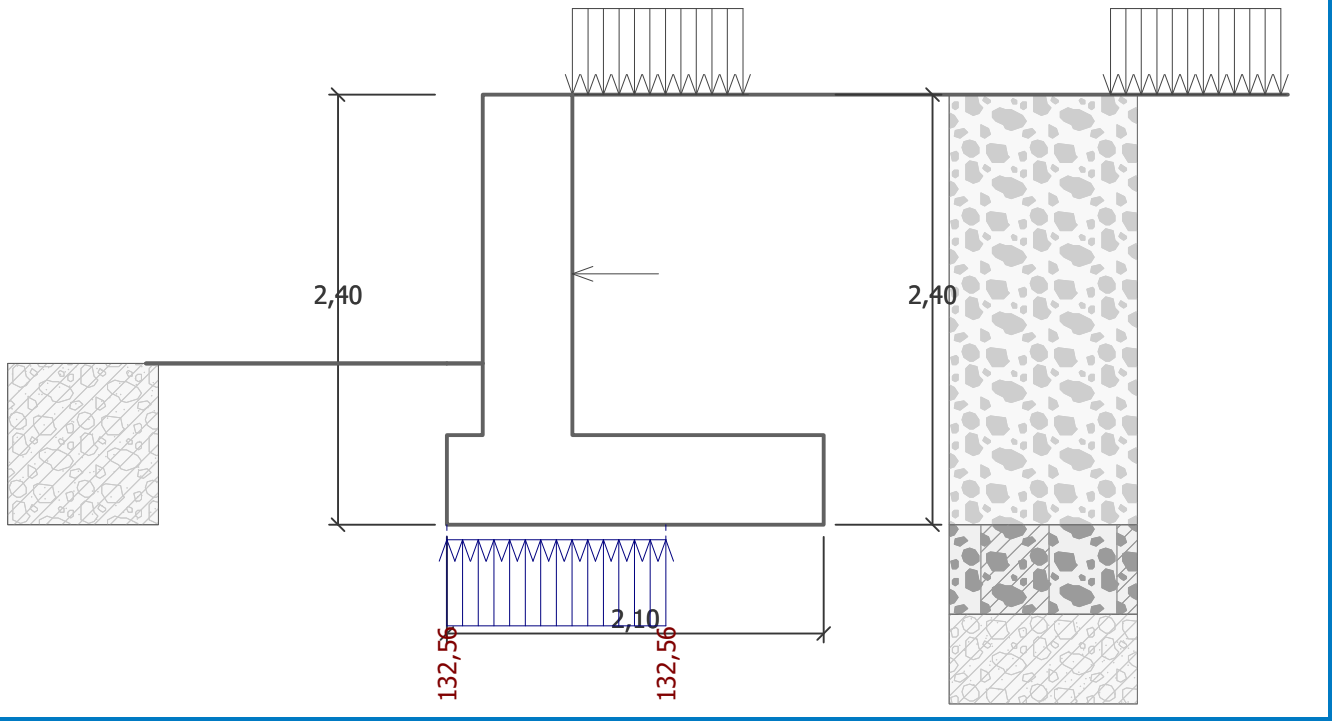
Maximum stress in footing bottom : 114,46 kPa

Bearing capacity of foundation soil

Forces acting at the centre of the footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [m]	Stress [kPa]
1	71,15	161,75	40,69	0,44	132,56
2	64,28	121,27	38,71	0,58	124,56

Name : Bearing cap. **Stage : 1**



Spread footing verification

Input data

Settings

Standard - EN 1997 - DA1

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10,0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
Analysis of uplift : Standard
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)							
Permanent design situation							
		Combination 1				Combination 2	
		Unfavourable		Favourable		Unfavourable	Favourable
Permanent actions :	γ_G =	1,35	[–]	1,00	[–]	1,00 [–]	1,00 [–]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1,00	[–]	1,25	[–]
Partial factor on effective cohesion :	γ_c =	1,00	[–]	1,25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1,00	[–]	1,40	[–]
Partial factor on unconfined strength :	γ_v =	1,00	[–]	1,40	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	peskoviti sljunak1		35,00	0,00	19,00	9,00	17,50
2	peskoviti sljunak 2		30,00	0,00	19,00	9,00	15,00
3	les		23,00	10,00	19,00	9,00	11,50
4	sljunak		30,00	0,00	19,00	9,00	17,50

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

Soil parameters

peskoviti sljunak1

Unit weight : γ = 19,00 kN/m³
Angle of internal friction : φ_{ef} = 35,00 °
Cohesion of soil : c_{ef} = 0,00 kPa
Oedometric modulus : E_{oed} = 40,00 MPa
Saturated unit weight : γ_{sat} = 19,00 kN/m³

peskoviti sljunak 2

Unit weight : γ = 19,00 kN/m³
Angle of internal friction : φ_{ef} = 30,00 °
Cohesion of soil : c_{ef} = 0,00 kPa
Oedometric modulus : E_{oed} = 40,00 MPa
Saturated unit weight : γ_{sat} = 19,00 kN/m³

les

Unit weight :	γ	=	19,00 kN/m^3
Angle of internal friction :	φ_{ef}	=	23,00 °
Cohesion of soil :	c_{ef}	=	10,00 kPa
Oedometric modulus :	E_{oed}	=	5,00 MPa
Saturated unit weight :	γ_{sat}	=	19,00 kN/m^3

sljunak

Unit weight :	γ	=	19,00 kN/m^3
Angle of internal friction :	φ_{ef}	=	30,00 °
Cohesion of soil :	c_{ef}	=	0,00 kPa
Oedometric modulus :	E_{oed}	=	40,00 MPa
Saturated unit weight :	γ_{sat}	=	19,00 kN/m^3

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	2,40 m
Depth of footing bottom	d	=	0,90 m
Foundation thickness	t	=	0,50 m
Incl. of finished grade	s_1	=	0,00 °
Incl. of footing bottom	s_2	=	0,00 °

Unit weight of soil above foundation = 19,00 kN/m^3

Geometry of structure

Foundation type: strip footing

Overall strip footing length	=	3,05 m
Strip footing width (x)	=	2,10 m
Column width in the direction of x	=	0,10 m
Volume of strip footing	=	1,05 m^3/m

Inserted loading is considered per unit length of continuous footing span.

Sand-gravel bed

Soil used for the SG pad - sljunak

SG pad overhangs foundation	d_{sp}	=	0,40 m
Sand-gravel pad depth	h_{sp}	=	0,30 m

Material of structure

Unit weight γ = 25,00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 30/37

Cylinder compressive strength	f_{ck}	=	30,00 MPa
Tensile strength	f_{ct}	=	2,90 MPa
Elasticity modulus	E_{cm}	=	33000,00 MPa

Longitudinal steel : B500

Yield strength	f_{yk}	=	500,00 MPa

Transverse steel: B500

Yield strength	f_{yk}	=	500,00 MPa

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	2,40	peskoviti sljunak1	
2	0,50	peskoviti sljunak 2	
3	-	les	

Load

No.	Load new	Load change	Name	Type	N [kN/m]	M_y [kNm/m]	H_x [kN/m]
1	YES		LC 1	Service	120,30	50,81	-40,69
2	YES		LC 2	Design	120,30	50,81	-40,69
3	YES		LC 3	Service	79,82	44,93	-38,71
4	YES		LC 4	Design	79,82	44,93	-38,71

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	Self w. in favor	e_x [m]	e_y [m]	σ [kPa]	R_d [kPa]	Utilization [%]	Is satisfied
LC 1	Yes	-0,44	0,00	132,56	183,15	72,38	Yes
LC 1	No	-0,44	0,00	132,56	183,15	72,38	Yes
LC 2	Yes	-0,44	0,00	132,56	311,35	42,58	Yes
LC 2	No	-0,40	0,00	136,36	328,40	41,52	Yes
LC 3	Yes	-0,53	0,00	116,62	156,27	74,63	Yes
LC 3	No	-0,53	0,00	116,62	156,27	74,63	Yes
LC 4	Yes	-0,53	0,00	116,62	263,80	44,21	Yes
LC 4	No	-0,47	0,00	117,74	290,06	40,59	Yes

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

Computed self weight of strip foundation $G = 26,25$ kN/m
Computed weight of overburden $Z = 15,20$ kN/m

Vertical bearing capacity check

Shape of contact stress : rectangle
Most severe load case No. 3. (LC 3)

Parameters of slip surface below foundation:
Depth of slip surface $z_{sp} = 2,75$ m
Length of slip surface $l_{sp} = 7,57$ m

Design bearing capacity of found.soil $R_d = 156,27$ kPa
Extreme contact stress $\sigma = 116,62$ kPa

Bearing capacity in the vertical direction is SATISFACTORY

Horizontal bearing capacity check

Most severe load case No. 3. (LC 3)

Earth resistance: not considered
Friction angle foundation-footing bottom ψ = 30,00 °
Cohesion foundation-footing bottom a = 0,00 kPa

Horizontal bearing capacity R_{dh} = 56,01 kN
Extreme horizontal force H = 38,71 kN

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 = 26,25 kN/m
Computed weight of overburden Z = 15,20 kN/m

Settlement of mid point of longitudinal edge = 8,6 mm
Settlement of mid point of transverse edge 1 = 16,1 mm
Settlement of mid point of transverse edge 2 = -2,4 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} = 11,71 MPa
Foundation in the longitudinal direction is rigid (k=38,04)
Foundation in the direction of width is rigid (k=352,25)

Overall settlement and rotation of foundation:
Foundation settlement = 9,8 mm
Depth of influence zone = 2,96 m

Rotation in direction of width = 8,818 (tan*1000)

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 = 16,0 mm
Number of bars = 4
Reinforcement cover = 40,0 mm
Cross-section width = 1,00 m
Cross-section depth = 0,50 m

Reinforcement ratio ρ = 0,18 % > 0,15 % = ρ_{min}
Position of neutral axis x = 0,02 m < 0,28 m = x_{max}
Ultimate moment M_{Rd} = 155,00 kNm > 62,17 kNm = M_{Ed}

Cross-section is SATISFACTORY.

Spread footing for punching shear failure check

Column normal force = 120,30 kN

Maximum resistance at the column perimetr

Force transmitted into found. soil		=	5,73	kN
Force transmitted by shear strength of SRC		=	114,57	kN
Considered column perimeter	u_0	=	1,36	m
Shear resistance at the column perimeter	$v_{Ed,max}$	=	0,93	MPa
Resistance at the column perimetr	$v_{Rd,max}$	=	4,22	MPa

Critical section without shear reinforcement

Force transmitted into found. soil		=	70,46	kN
Force transmitted by shear strength of SRC		=	49,84	kN
Distance of section from the column		=	0,57	m
Section perimeter	u_{cr}	=	2,00	m
Shear stress at section	v_{Ed}	=	0,10	MPa
Shear resistance of section without shear reinforcement	$v_{Rd,c}$	=	0,66	MPa

$v_{Ed} < v_{Rd,c}$ => Reinforcement is not required

Spread footing for punching shear is SATISFACTORY

Dimensioning No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,25	17,50	1,40	1,350
Weight - earth wedge	0,00	-1,28	32,69	1,20	1,350
Active pressure	14,09	-0,83	19,36	1,80	1,350
tenk 1	5,66	-1,88	10,86	1,38	1,350
tenk 2	4,08	-0,28	1,82	2,09	1,350
Contact tractions	0,00	0,00	-61,68	1,08	1,000
Gravity surch. 1	0,00	-2,40	22,36	0,91	1,350

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0,00	-0,25	17,50	1,40	1,000
Weight - earth wedge	0,00	-1,28	32,69	1,20	1,000
Active pressure	17,88	-0,83	19,52	1,80	1,000
tenk 1	8,22	-1,88	12,54	1,38	1,000
tenk 2	6,83	-0,45	5,02	1,99	1,000
Contact tractions	0,00	0,00	-43,75	1,03	1,000
Gravity surch. 1	0,00	-2,40	22,36	0,91	1,000

Back wall jump check

Reinforcement and dimensions of the cross-section

Bar diameter	=	14,0	mm
Number of bars	=	11	
Reinforcement cover	=	30,0	mm
Cross-section width	=	1,00	m
Cross-section depth	=	0,50	m

Reinforcement ratio ρ = 0,37 % > 0,15 % = ρ_{min}

Position of neutral axis	x	=	0,05	m	<	0,29	m	= x_{max}
Ultimate shear force	V_{Rd}	=	204,60	kN	>	79,51	kN	= V_{Ed}
Ultimate moment	M_{Rd}	=	327,32	kNm	>	63,60	kNm	= M_{Ed}

Cross-section is SATISFACTORY.

3. ДИМЕНЗИОНИСАЊЕ ЗИДОВА

3.1. Зид висине h=4,10m

Утицај у зиду-унутрашња страна

Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,39	%	>0,15	%	=	ρmin
Position of neutral axis	x	=	0,06	m	<0,35	m	=	xmax
Ultimate shear force	VRd	=	245,17	kN	>180,12	kN	=	VEd
Ultimate moment	MRd	=	517,30	kNm	**>410,53**	**kNm**	**=**	**MEd**
Reinforcement ratio	ρ	=	0,39	%	>0,15	%	=	ρmin

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{410,53 \cdot 100}{100 \cdot 55^2 \cdot 2.0} = 0,068 \; ; \; \zeta = 0,962$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{410,53 \cdot 100}{0,962 \cdot 55 \cdot 43,48} = 17,84\,cm^2$$

Утицај у стопи-доња зона

Foundation thickness is greater than twice the offset of the front wall jump. Reinforcement is not required.

Минимална арматура

$$A_{s1},min \geq 0,015xbxd = 8,25\,cm^2$$

Утицај у стопи-горња зона

Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,39	%	> 0,15	%	=	ρmin
Position of neutral axis	x	=	0,06	m	< 0,35	m	=	xmax
Ultimate shear force	VRd	=	245,17	kN	> 134,23	kN	=	VEd
Ultimate moment	MRd	=	517,30	kNm	> **309,26**	**kNm**	**=**	**MEd**
Reinforcement ratio	ρ	=	0,39	%	> 0,15	%	=	ρmin

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{309,26 \cdot 100}{100 \cdot 54^2 \cdot 2.0} = 0,053 \; ; \; \zeta = 0,970$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{309,26 \cdot 100}{0,970 \cdot 54 \cdot 43,48} = 13,58\,cm^2$$

3.2. Зид висине h=3,90m

Утицај у зиду-унутрашња страна

Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,39	%	>0,15	%	=	ρmin
Position of neutral axis	x	=	0,06	m	<0,35	m	=	xmax
Ultimate shear force	VRd	=	245,17	kN	>168,69	kN	=	VEd
Ultimate moment	MRd	=	517,30	kNm	**>372,51**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{372,51 \cdot 100}{100 \cdot 55^2 \cdot 2.0} = 0,062\,;\ \zeta=0,966$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{372,51 \cdot 100}{0,966 \cdot 55 \cdot 43,48} = 16,12\,cm^2$$

Утицај у стопи-доња зона

Foundation thickness is greater than twice the offset of the front wall jump. Reinforcement is not required.

Reinforcement and dimensions of the cross-section

Минимална арматура

$$A_{s1},min \geq 0,015xbxd = 8,25\,cm^2$$

Утицај у стопи-горња зона

Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,39	%	> 0,15	%	=	ρmin
Position of neutral axis	x	=	0,06	m	< 0,35	m	=	xmax
Ultimate shear force	VRd	=	245,17	kN	> 135,59	kN	=	VEd
Ultimate moment	MRd	=	517,30	kNm	> **274,59**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{274,59 \cdot 100}{100 \cdot 54^2 \cdot 2.0} = 0,047\,;\ \zeta=0,971$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{274,59 \cdot 100}{0,971 \cdot 54 \cdot 43,48} = 12,04\,cm^2$$

3.3. Зид висине h=3,65m

Утицај у зиду-унутрашња страна

Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,39	%	>0,15	%	=	ρmin
Position of neutral axis	x	=	0,06	m	<0,35	m	=	xmax
Ultimate shear force	VRd	=	245,17	kN	>155,95	kN	=	VEd
Ultimate moment	MRd	=	517,30	kNm	**>329,01**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{329.01 \cdot 100}{100 \cdot 55^2 \cdot 2.0} = 0,054 \; ; \; \zeta = 0,970$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{329.01 \cdot 100}{0,970 \cdot 55 \cdot 43,48} = 13,76\,cm^2$$

Утицај у стопи-доња зона

Reinforcement and dimensions of the cross-section

Foundation thickness is greater than twice the offset of the front wall jump. Reinforcement is not required.

Минимална арматура

$$A_{s1},min \geq 0,015xbxd = 8,25\,cm^2$$

Утицај у стопи-горња зона

Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,39	%	> 0,15	%	=	ρmin
Position of neutral axis	x	=	0,06	m	< 0,35	m	=	xmax
Ultimate shear force	VRd	=	245,17	kN	> 131,88	kN	=	VEd
Ultimate moment	MRd	=	517,30	kNm	> **240,21**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{240,21 \cdot 100}{100 \cdot 54^2 \cdot 2.0} = 0,041; \; \zeta = 0,975$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{240,21 \cdot 100}{0,975 \cdot 54 \cdot 43,48} = 10,49\,cm^2$$

3.4. Зид висине h=3,35m

Утицај у зиду-унутрашња страна

Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,22	%	>0,15	%	=	ρmin
Position of neutral axis	x	=	0,03	m	<0,35	m	=	xmax
Ultimate shear force	VRd	=	217,62	kN	>141,62	kN	=	VEd
Ultimate moment	MRd	=	294,28	kNm	**>280,84**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{280.84 \cdot 100}{100 \cdot 55^2 \cdot 2.0} = 0{,}046 \; ; \; \zeta = 0{,}971$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{280.84 \cdot 100}{0{,}971 \cdot 55 \cdot 43{,}48} = 12.09\,cm^2$$

Утицај у стопи-доња зона

Reinforcement and dimensions of the cross-section

Foundation thickness is greater than twice the offset of the front wall jump. Reinforcement is not required.

Минимална арматура

$$A_{s1},min \geq 0{,}015xbxd = 8{,}25\,cm^2$$

Утицај у стопи-горња зона

Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,30	%	> 0,15	%	=	ρmin
Position of neutral axis	x	=	0,05	m	< 0,35	m	=	xmax
Ultimate shear force	VRd	=	224,48	kN	> 120,65	kN	=	VEd
Ultimate moment	MRd	=	400,94	kNm	> **199,61**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{199.61 \cdot 100}{100 \cdot 54^2 \cdot 2.0} = 0.034 \; ; \; \zeta = 0{,}977$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{199.61 \cdot 100}{0{,}977 \cdot 54 \cdot 43{,}48} = 8.70\,cm^2$$

3.5. Зид висине h=3.00m

Утицај у зиду-унутрашња страна

Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,30	%	>0,15	%	=	ρmin
Position of neutral axis	x	=	0,05	m	<0,35	m	=	xmax
Ultimate shear force	VRd	=	224,48	kN	>127,58	kN	=	VEd
Ultimate moment	MRd	=	400,94	kNm	**>229,82**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{229.82 \cdot 100}{100 \cdot 45^2 \cdot 2.0} = 0.057\,;\ \zeta{=}0{,}968$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{229.82 \cdot 100}{0.968 \cdot 45 \cdot 43.48} = 12.13\,cm^2$$

Утицај у стопи-доња зона

Reinforcement and dimensions of the cross-section

Foundation thickness is greater than twice the offset of the front wall jump. Reinforcement is not required.

Минимална арматура

$$A_{s1},min \geq 0{,}015xbxd = 6{,}75\,cm^2$$

Утицај у стопи-горња зона

Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,30	%	>0,15	%	=	ρmin
Position of neutral axis	x	=	0,05	m	<0,35	m	=	xmax
Ultimate shear force	VRd	=	224,48	kN	>114,94	kN	=	VEd
Ultimate moment	MRd	=	400,94	kNm	**>170,27**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{170.27 \cdot 100}{100 \cdot 45^2 \cdot 2.0} = 0.042\,;\ \zeta{=}0{,}973$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{170{,}27 \cdot 100}{0{,}973 \cdot 45 \cdot 43{,}48} = 8.94\,cm^2$$

3.8. Зид висине h=2.40m

Утицај у зиду-унутрашња страна
Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,37	%	>0,15	%	=	ρmin
Position of neutral axis	x	=	0,05	m	<0,29	m	=	xmax
Ultimate shear force	VRd	=	204,60	kN	>102,04	kN	=	VEd
Ultimate moment	MRd	=	327,32	kNm	**>149,99**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{149.99 \cdot 100}{100 \cdot 45^2 \cdot 2.0} = 0.037\,;\ \zeta{=}0{,}987$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{149.99 \cdot 100}{0{,}987 \cdot 45 \cdot 43{,}48} = 7.77\,cm^2$$

Утицај у стопи-доња зона
Reinforcement and dimensions of the cross-section
Foundation thickness is greater than twice the offset of the front wall jump. Reinforcement is not required.

Минимална арматура

$$A_{s1},min \geq 0{,}015xbxd = 6{,}75\,cm^2$$

Утицај у стопи-горња зона
Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,37	%	>0,15	%	=	ρmin
Position of neutral axis	x	=	0,05	m	<0,29	m	=	xmax
Ultimate shear force	VRd	=	204,60	kN	>92,11	kN	=	VEd
Ultimate moment	MRd	=	327,32	kNm	**>106,41**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{106.41 \cdot 100}{100 \cdot 44^2 \cdot 2.0} = 0.027\,;\ \zeta{=}0{,}991$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{106{,}41 \cdot 100}{0{,}991 \cdot 44 \cdot 43{,}48} = 5.61 cm^2$$

Минимална арматура

$$A_{s1},min \geq 0{,}015xbxd = 6{,}60\,cm^2$$

3.9. Зид висине h=1.90m

Утицај у зиду-унутрашња страна
Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,37	%	>0,15	%	=	ρmin
Position of neutral axis	x	=	0,05	m	<0,29	m	=	xmax
Ultimate shear force	VRd	=	204,60	kN	>88,35	kN	=	VEd
Ultimate moment	MRd	=	327,32	kNm	**>93,25**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{93.25 \cdot 100}{100 \cdot 45^2 \cdot 2.0} = 0.023\,;\ \zeta{=}0{,}982$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{93.25 \cdot 100}{0{,}982 \cdot 45 \cdot 43{,}48} = 4.85\,cm^2$$

Минимална арматура

$$A_{s1},min \geq 0{,}015xbxd = 6{,}75\,cm^2$$

Утицај у стопи-доња зона
Reinforcement and dimensions of the cross-section
Foundation thickness is greater than twice the offset of the front wall jump. Reinforcement is not required.

Минимална арматура

$$A_{s1},min \geq 0{,}015xbxd = 6{,}75\,cm^2$$

Утицај у стопи-горња зона
Reinforcement and dimensions of the cross-section

Reinforcement ratio	ρ	=	0,37	%	> 0,15	%	=	ρmin
Position of neutral axis	x	=	0,05	m	< 0,29	m	=	xmax
Ultimate shear force	VRd	=	204,60	kN	> 79,51	kN	=	VEd
Ultimate moment	MRd	=	327,32	kNm	> **63,60**	**kNm**	**=**	**MEd**

Коефицијент армирања

$$\mu_{Ed} = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}} = \frac{63.60 \cdot 100}{100 \cdot 44^2 \cdot 2.0} = 0.016\,;\ \zeta{=}0{,}994$$

Потребна арматура у горњој зони у Y правцу

$$A_{s1} = \frac{M_{Ed}}{\zeta \cdot d \cdot f_{yd}} = \frac{63.60 \cdot 100}{0{,}994 \cdot 44 \cdot 43{,}48} = 3.34\,cm^2$$

Минимална арматура

$$A_{s1},min \geq 0{,}015xbxd = 6{,}60\,cm^2$$

Срачунала:

Марина Пешић, дипл. инж. грађ.

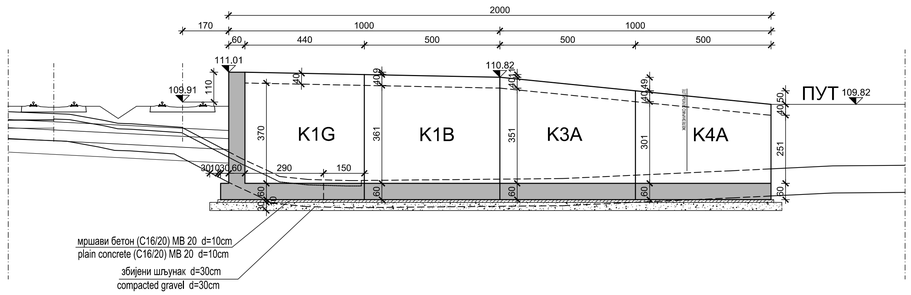
2/9.9.6.7. ГРАФИЧКА ДОКУМЕНТАЦИЈА

САДРЖАЈ ГРАФИЧКЕ ДОКУМЕНТАЦИЈЕ

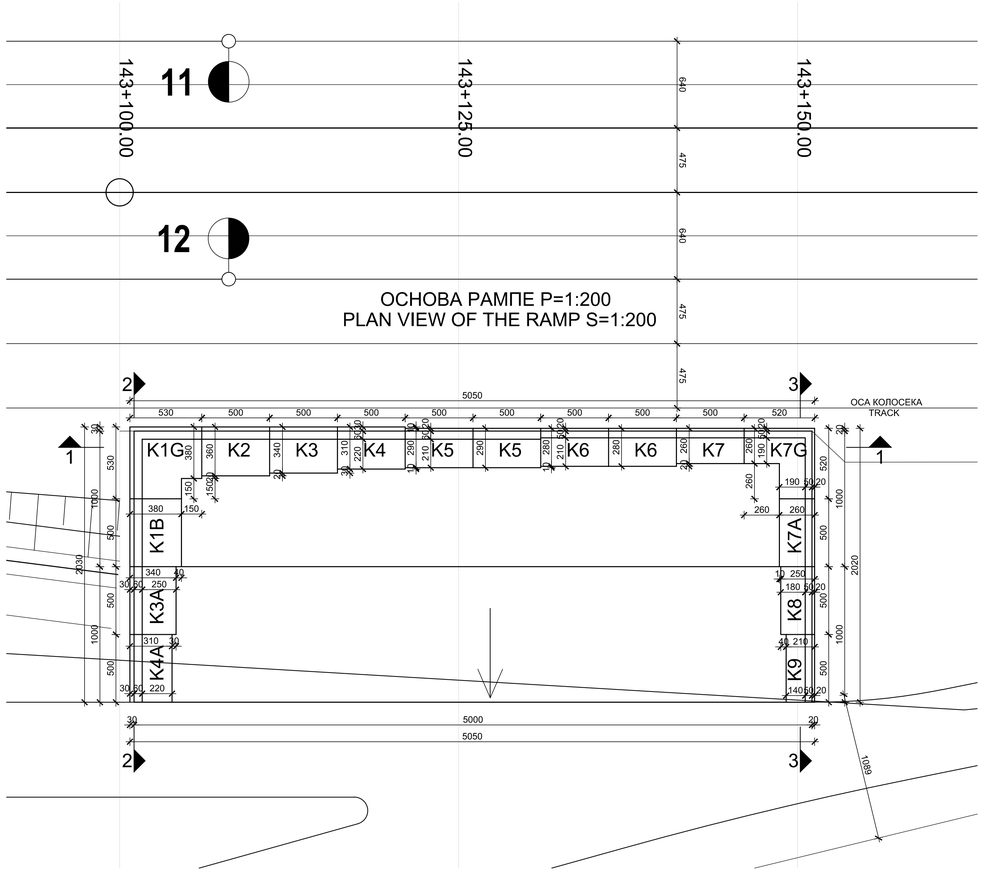
Цртеж	Назив цртежа	Размера
2/9.9.6.7.Ц01	Диспозиција војне рампе у железничкој станици Бачка Топола	1:100 1:50

ДИСПОЗИЦИЈА ВОЈНЕ РАМПЕ У ЖЕЛЕЗНИЧКОЈ СТАНИЦИ БАЧКА ТОПОЛА
DISPOSITION OF THE MILITARY RAMP IN BAČKA TOPOLA RAILWAY STATION
P/S=1:200

ПОПРЕЧНИ ПРЕСЕК 2-2 P=1:100
ПОЧЕТАК РАМПЕ km 143+100

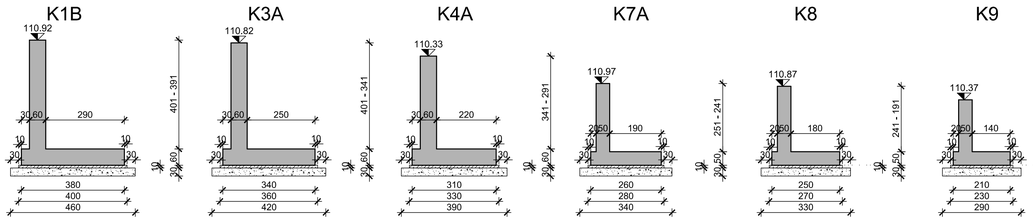


ПОПРЕЧНИ ПРЕСЕК 3-3 P=1:100
КРАЈ РАМПЕ km 143+150

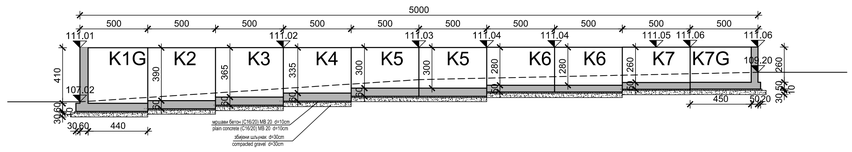


ОСНОВА РАМПЕ P=1:200
PLAN VIEW OF THE RAMP S=1:200

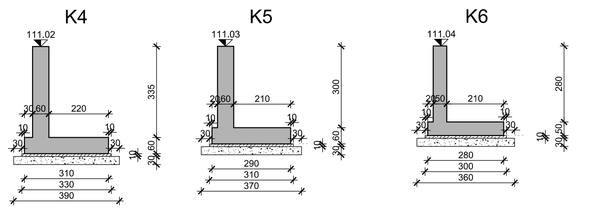
ПОПРЕЧНИ ПРЕСЕК ЗИДОВА P=1:100
CROSS SECTION OF WALLS S=1:100



ПОДУЖНИ ПРЕСЕК 1-1
LONGITUDINAL SECTION 1-1
P/S=1:200



ПОПРЕЧНИ ПРЕСЕК ЗИДОВА P=1:100
CROSS SECTION OF WALLS S=1:100



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Број/Number	Датум / Date	Опис / Description
03		
02		
01		

Ревизиони блок: / Revision block:

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лиценца број: / license No.: **310 9562 04**

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Објекат: /Structure:
МОДЕРНИЗАЦИЈА ЖЕЛЕЗНИЧКЕ ПРУГЕ
БЕОГРАД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
ДЕОНИЦА НОВИ САД - СУБОТИЦА - ДРЖАВНА ГРАНИЦА (КЕЛЕБИЈА)
MODERNIZATION OF
BELGRADE - SUBOTICA - STATE BORDER (KELEBIJA) RAILWAY LINE
SECTION: NOVI SAD - SUBOTICA - STATE BORDER (KELEBIJA)

Део пројекта: / Part of Design:
ПРОЈЕКАТ БЕТОНСКЕ КОНСТРУКЦИЈЕ ВОЈНЕ РАМПЕ У ЖЕЛЕЗНИЧКОЈ СТАНИЦИ БАЧКА ТОПОЛА
DESIGN OF CONCRETE STRUCTURE FOR MILITARY RAMP IN BAČKA TOPOLA RAILWAY STATION

Цртеж / Drawing:
ДИСПОЗИЦИЈА ВОЈНЕ РАМПЕ У ЖЕЛЕЗНИЧКОЈ СТАНИЦИ БАЧКА ТОПОЛА
DISPOSITION OF THE MILITARY RAMP IN BAČKA TOPOLA RAILWAY STATION

Размера: Scale: 1:100 1:200

Фаза пројекта: Design phase: **ПГД / PBD**

Датум/Date: **12.2018.**

Цртеж бр. Drawing No.: **2017-728-КОН-2/9.9.6.7-Ц01**