RAPORT

MBI NDERHYRJEN PER PERFORCIMIN E SKARPATES

"RRUGA GJOKAJ"

VENDNDODHJA:
"GJOKAJ, BASHKIA VORE"

INVESTITOR:
"BASHKIA VORE"

Autore

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Ing. FATMIR NUHAJ Nr.Liç. N 6803/2

Ing. PRINC XHIKA

Tirane, 2021

ABSTRAKT

Ne kete analize kemi te bejme me nje veper infrastrukturore e cila ka pas shkarje dhe shembje te pjesshme te skarpates. Kjo analize mundeson studimin e nga ana gjeoteknike me qellim vleresim e kushteve dhe gjendjes se aktuale.. Metodologjia perfshin prova in-situ (ne terren), teste laboratorike, aplikim te metodave analitike, konsiderimin e parametrave gjeoteknike dhe sizmcitetin e zones. Ngarkesat sizmike jane vleresuar duke u bazuar ne metoda bashkohore si edhe konceptet e perdorura me pare. Ky dokument paraqet nje procedure te mire ezauruar mbi vleresim e qendrueshmerise se skarpates dhe masave te nevojshme per permiresimin e saj. Analiza qe kryhet eshte teresore. Kjo analize kryhet nepermjet modelimit me metoden e elementeve te fundem e cila mundeson zgjidhje efektive dhe saktesi shume te larte.

PERMBAJTJA:

1. GJENDJA FIZIKE AKTUALE E RRUGES (SKARPATES)

1.1. Vendndodhja e rruges

1.2. Te dhena gjeologjike dhe sizmike te bazamentit

1.2.1. Gjeologjia e zones

1.2.2. Aktiviteti sizmik

1.3. Vetite fiziko-mekanike te materialeve te perdorura ne perforcim

1.3.1. Celiku

1.3.2. Betoni

1.3.3. Rezistencat

2. MODELIMI 3D I STRUKTURES

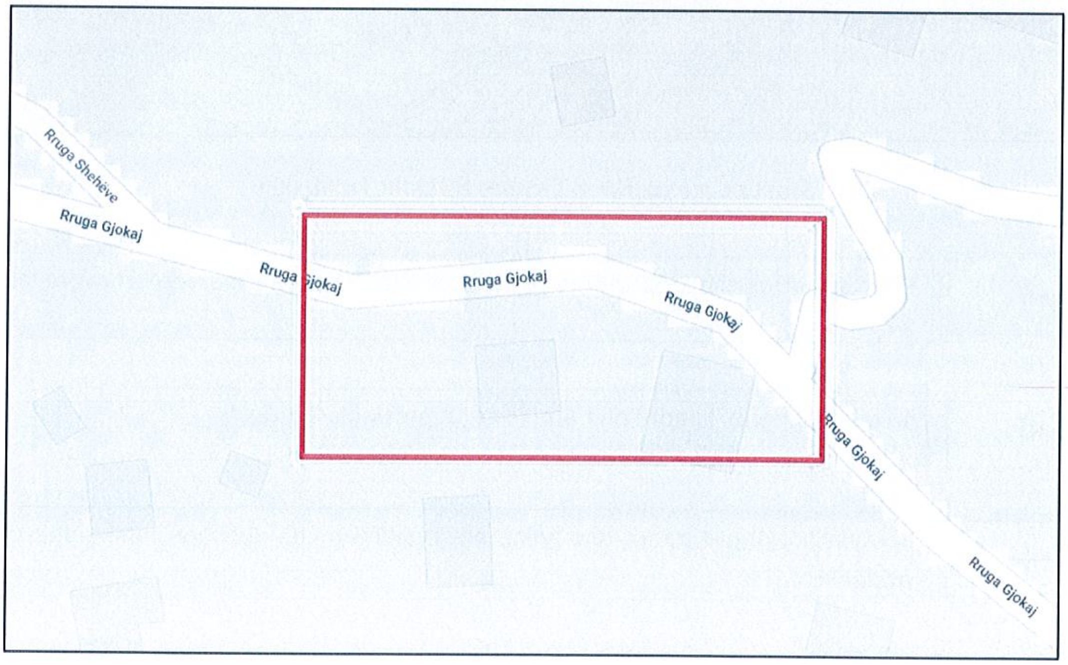
2.1. Imputet e modelit dhe rezultatet

1. GJENDJA FIZIKE AKTUALE E SKARPATES

1.1. VENDNDODHJA E VEPRES RRUGORE

Segmenti rrugor i marre ne studim ndodhet ne fshatin Gjokaj, Bashkia Vore me koordinata 41.363909 : 19.674923.

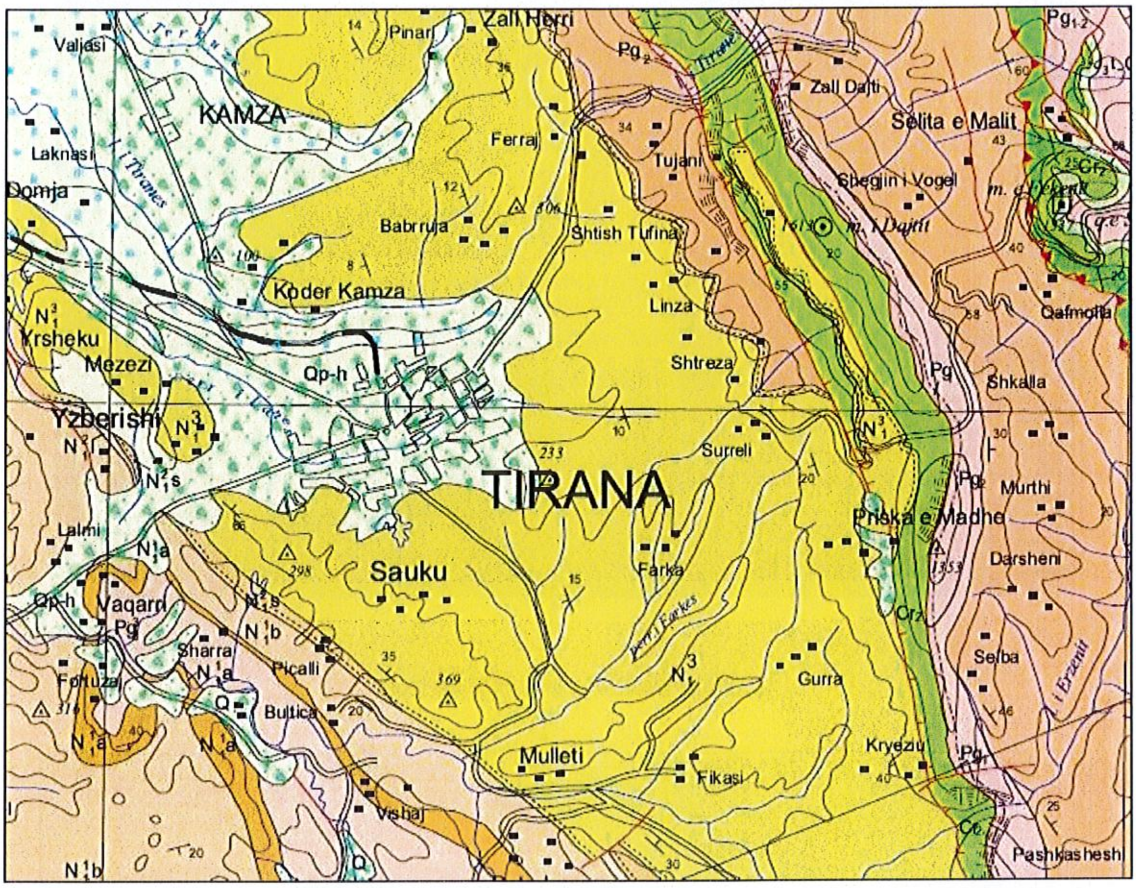
- Vendndodhja e segmentit rrugor



1.2. TE DHENA GJEOLOGJIKE DHE SIZMIKE TE BAZAMENTIT

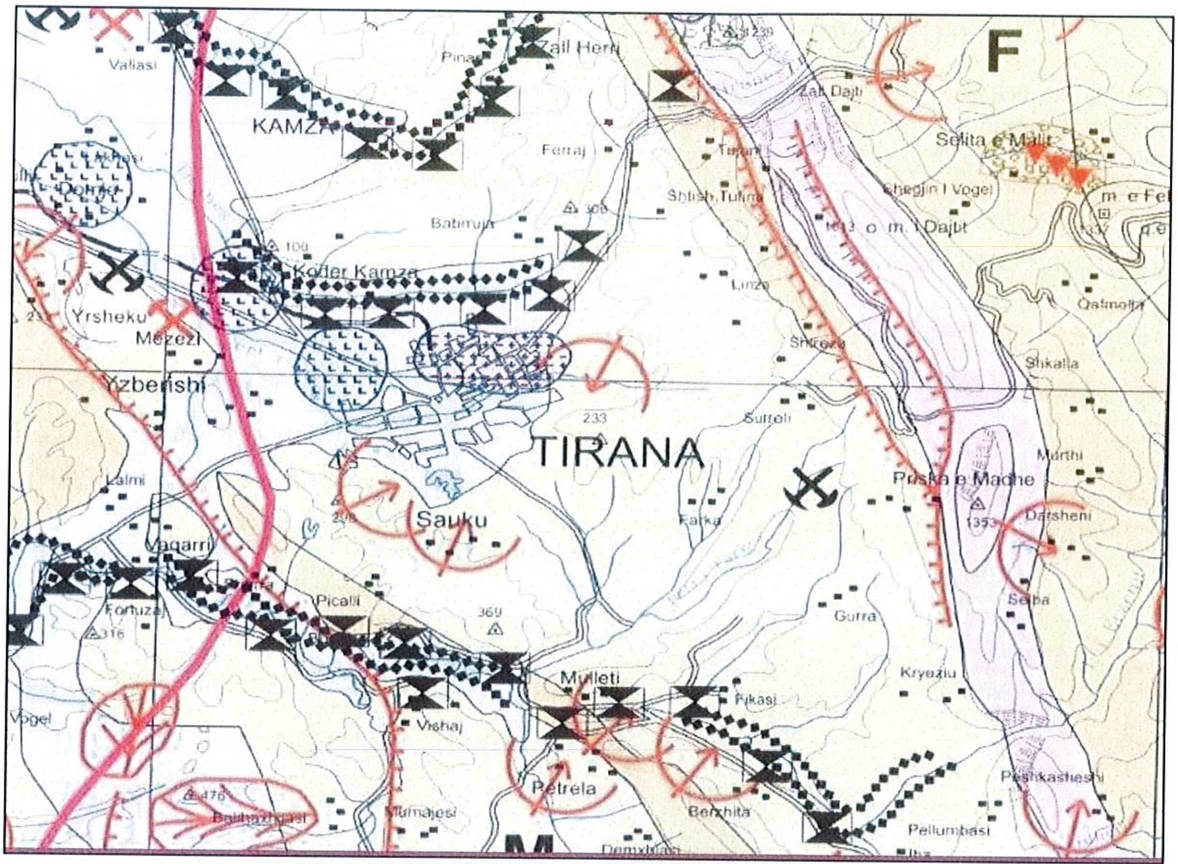
1.1.2. Gjeologjia e zones

Per vepren infrastrukturore ne fjale dhe per qellime te ketij studimi ne lidhje me aftesine mbajtese te skarpates se "Rruges Gjokaj" jane perdorur te dhena te marra nga studime gjeologo-inxhninerike te kryera per sheshe dhe vepra te tjera fqinje, ne largesi jo me shume se 200 metra ne vije ajrore nga zona ne fjale si edhe nga Harta Gjeologjike e Qytetit te Tiranes.



Harta Gjeologjike e Tiranes Shkalla 1:200 000

Qp-h	Pleistocen-Holocen. Depozitime te perziera aluviale-proluviale, rere, zhavore, alevrite
N_1^3	Mioceni siperm. Ranore dhe Argjila ne Depresionin e Tiranes
$N_{1}^{2}s$	Serravalian. Argjila, ranor dhe gelqerore melitotamnie ne zonen Jonike dhe Ultesires Adriatike.



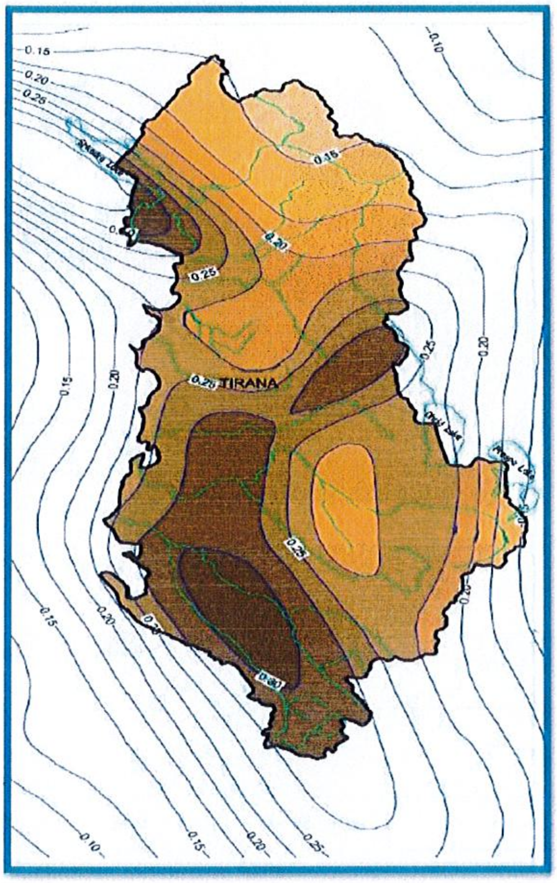
Harta tektonike e Tiranes me Shkalle 1:200 000

F	Depozitimet Flishore (argjila, mergele, ranore)
	Rreshqitje
	Zonat e rreshqitjeve
	Shkeputje aktive

1.2.2. Aktiviteti Sizmik

Mbeshtetur ne Punimet ``Sizmiciteti Sizmotektonika dhe Vleresimi i Riskut Sizmik ne Shqiperi`` (me Autore Aliaj. etj. 2010), Raportin mbi Mikrozonimin Sizmik te Qytetit te Tiranes (Koçiaj etj. 1988) publikuar nga Akademia e Shkencave e Shqiperise dhe ne studime te shumta Inxhiniero Sizmologjike te kryera ne qytetin e Tiranes nga Instituti i Sizmologjise si edhe ne te dhenat e Studimit Gjeologo Inxhinierik, Per zonen e ndertimit, jane percaktuar parametrat sizmike te nevojshem per llogaritjet e kontrollit te struktures.

Ne perfundim, duke studiuar rezultatet e Studimit Gjeologo Inxhinierik dhe atij Inxhiniero Sizmiologjik, për vleresimin e rrezikut sizmik me programin kompjuterik ***SHAKE 2000*** te sheshit te ndërtimit të Objektit ne Tiranë, autoret kane arritur ne ***perfundimet*** e meposhtme:



1. Zona e ndërtimit në studim klasifikohet si truall i kategorisë së II-të sipas KTP-N.2-89, truall i Klases C sipas EC-8, (EC-8, 2004).
2. Sipas Kodit Shqiptar të Projektimit KTP N.2 - 89 parametrat për sheshin konkret të ndërtimit janë: intensitet 7.5 ballë (MSK-64), truall i kategorisë së II-të: $k_E = 0.165$ g, $\beta(T) = 2.0$, dhe shpejtimi spektral maksimal : Sa (T) = 0.165 x 2.0 = 0.330 g, $T_C = 0.4$ sek, $T_D = 1.23$ sek.
3. Parametrat kryesore te rrezikut sizmik të sheshit te ndërtimit në studim në kushte trualli shkëmbor (Vs, 30 = 760 m/sek) jane: për periudhë përsëritje 475 vjet: shpejtimi maksimal PGA = 0.270 g, ndersa shpejtimi spektral në periodën 0.2 sek Sa (0.2 sek) = 0.615 g dhe per perioden 1.0 sek Sa (1.0 sek) = 0.183 g.
4. 4. Sipas Eurokodit 8, spektri elastik i reagimit per shtresen e mbeshtetjes se bazamentit te objektit te studiuar mund te konsiderohet si me poshte: Per probabilitet 10 % / 50 vjet për kategorinë C të truallit sipas EC-8 rezultojnë parametrat: shpejtimi maksimal $a_o = 0.27$ g dhe shpejtimi spektral maksimal Se (T) = 1.162 g, S= 1.15, $T_B = 0.2$ sek, $T_C = 0.6$ sek, dhe $T_D = 2.0$ sek.
5. Per llogaritjen e struktures ne shqyrtim rekomandojme perdorimin e spektrit elastik te reagimit sipas Eurokodit 8 me parametrat e mesiperm, per probabilitetin 10 % / 50 vjet.

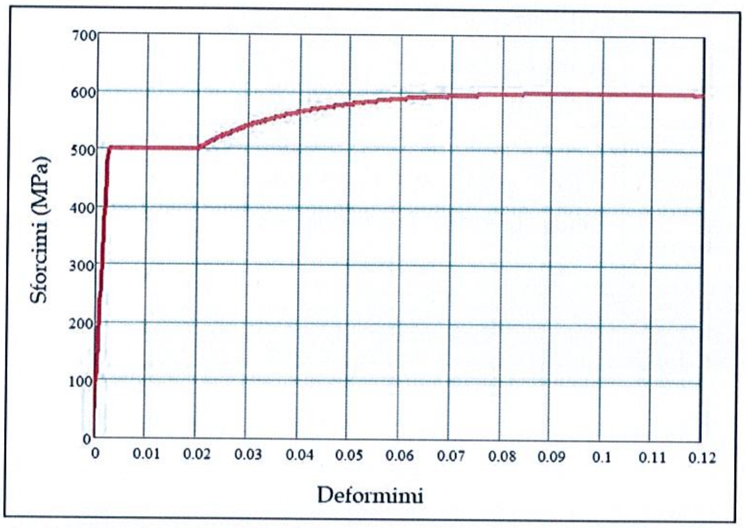
1.3. Vetite fiziko-mekanike te materialeve te perdorura ne godine

Materialet që jane përdorur për strukturën (betoni, çeliku) duhet të plotësojnë të gjitha kriteret e parashikuara në KTP si dhe ato të parashikuara në Eurocode.

1.3.1. Çeliku

Çeliku i armimit duhet të gëzojë veti të mira si në rezistencë ashtu edhe në deformueshmëri (duktilitet) per te permbushur kriteret e performances sizmike. Në elementët parësorë për armaturën e hekurit eshte perdorur celik i tipit B500c.

Çelik B500C, $f_{ys} = 50\ 000\ kN/m^2$, $f_{us} = 60\ 000\ kN/m^2$, $E = 21\ 000\ 000\ kN/m^2$, $\gamma_s = 1.15$, $\varepsilon_{sy} = 0.25\%$, $\varepsilon_{su} \geq 0.10\%$



- *Diagrama sforcim-deformim e çelikut B500C*

Armatura e Zakonshme

Klasa e Celikut te Zakonshem	**B500C**
Rezistenca Karakteristike e Rrjedhshmerise	fyk =500 MPa
Rezistenca Karakteristike e Shkaterrimit	ftk =600 MPa
Moduli i Elasticitetit	Es = 210 000 MPa =210GPa
Koeficienti i Sigurise Parciale te Celikut	γs = 1,15
Rezistenca Llogaritese e Celikut	fyd = fyk / γs = 435 MPa
Rezistenca Llogaritese e Celikut ne Prerje	Fywd = 500 MPa
Koeficienti i Puassonit	v = 0.30

CELIKU PER ARMIMIN E KONSTRUKSIONIT BETON ARME (STEEL FOR REBAR B500C)

Characteristic tensile stress $ftk = 600\ MPa$

Characteristic yield stress $fyk = 500\ MPa$

Characteristic ratio tensile/yield $1.3 \leq (ft/fy)k \leq 1.35$

Elastic Modulus $E = 210$ *Gpa, Elongation* $\geq 12\ \%$

Perberja Kimike (%) per celikun B500C					
C (Karbon)	N (Azot)	P (Fosfor)	S (Squfur)	Cu (Baker)	CEV
0.22	0.012	0.05	0.05	0.80	0.50

1.3.2. Betoni

Ne perputhje me EC2 dhe EC7 betoni i klasës C20/25 do te perdoret per realizimin e murit betonarme per perforcimin e skarpates.

Klasa e Rezistences se Betonit	C20/25 MPa
Rezistenca Karakteristike Cilindrike	fck = 20 MPa
Rezistenca Karakteristike Kubike	Rck = 25 MPa (fck,cube)
Rezistenca Mesatare ne Shtypje (28 ditore)	fcm = fck+8=20+8 = 28 MPa
Rezistenca Mesatare ne Terheqje (≤C50/60)	fctm = 0,3·fck^2/3 = 3,30 MPa
Rezistenca Karakteristike ne Terheqje	f ctk(5%) = 0,7·fctm = 2,31 MPa
Rezistenca Karakteristike ne Terheqje	f ctk(95%) = 1,3·fctm = 4,29 MPa
Moduli Sekant i Elasticitetit te Betonit	Ecm=22[(fcm)/10] ^0,3= 35GPa
Moduli i Elasticitetit (Vlera Llogaritese)	Ecd=Ecm/ γcE =35/1.2=29.4GPa
Koeficientet e Sigurise Parciale te Betonit	γc = 1,5 a= 0,85
Rezistenca Llogaritese ne Shtypje (SLU)	fcd = a·fck / γc = 11,33 MPa
Rezistenca Llogaritese ne Terheqje (SLU)	fctd = fctk(5%) / γc = 1,50 MPa
Koeficienti i Puassonit	v = 0.20
Klasa e ekspozimit UNI EN 206-6	XC2
Klasa e Konsistences	S4

1.3.4. Rezistencat

Rezistencat llogaritese (te projektimit) per betonin dhe celikun jane marre nga reduktimi i rezistencave karakteristike sipas klases se betonit (apo celikut) te perdorur me faktorin e sigurise perkates si me poshte:

Per betonin: $f_{cd} = f_{ck}/\gamma_c$
$f_{cwd} = f_{cwk}/\gamma_c$

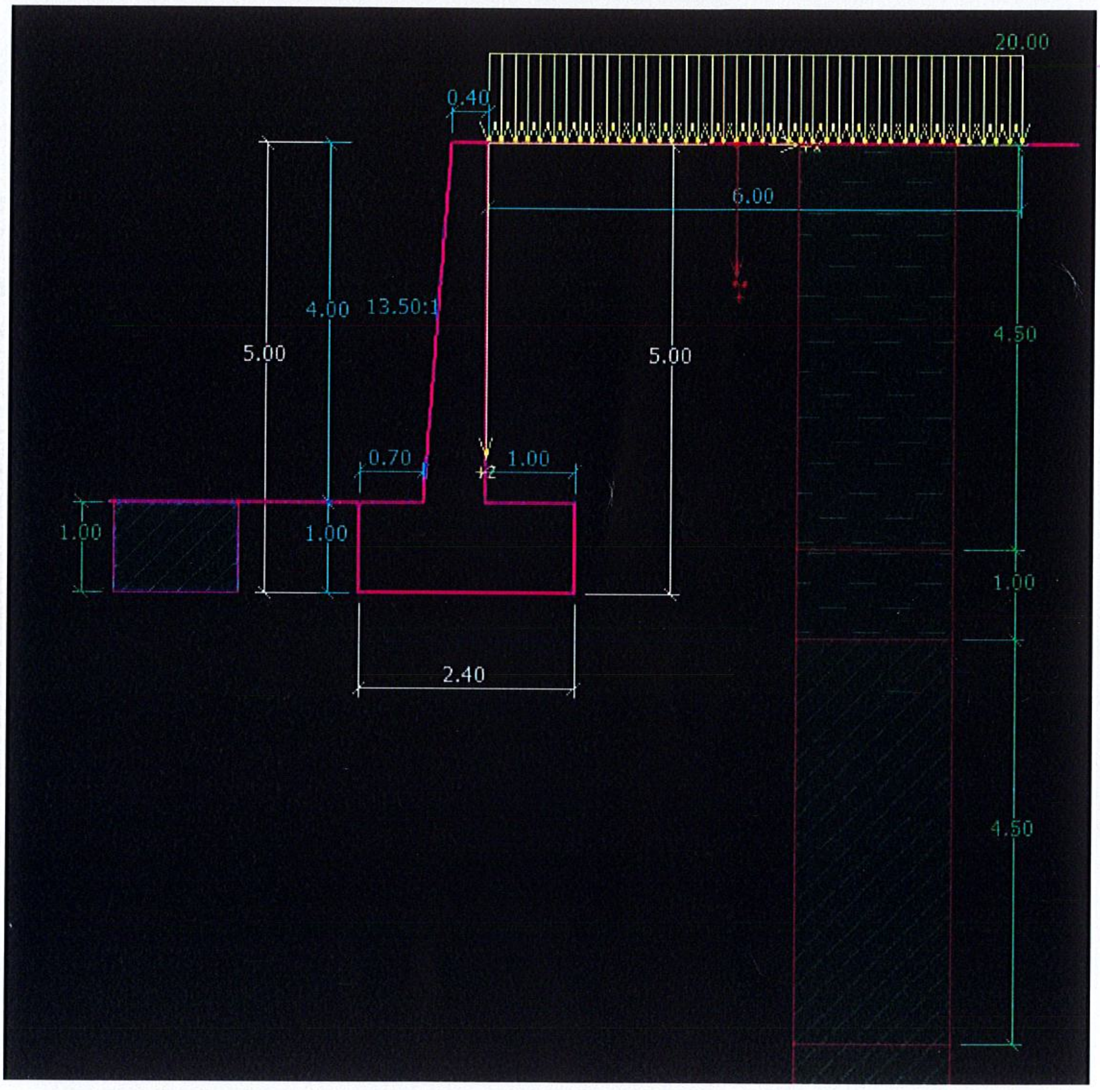
Per celikun: $f_{yd} = f_{yk}/\gamma_s$
$f_{ywd} = f_{ywk}/\gamma_s$

Per muraturen: $f_{md} = f_{mk}/\gamma_m$
$f_{mwd} = f_{mwk}/\gamma_m$

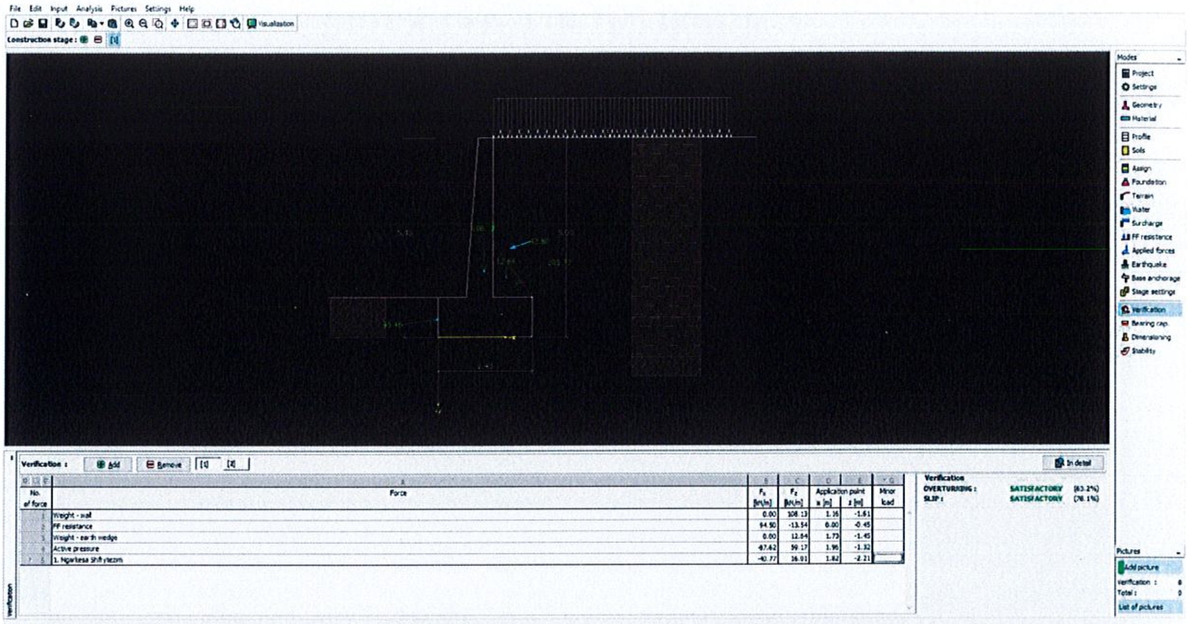
2. MODELIMI 3D I STRUKTURES

2.1. Inputet dhe rezultatet e modelimit

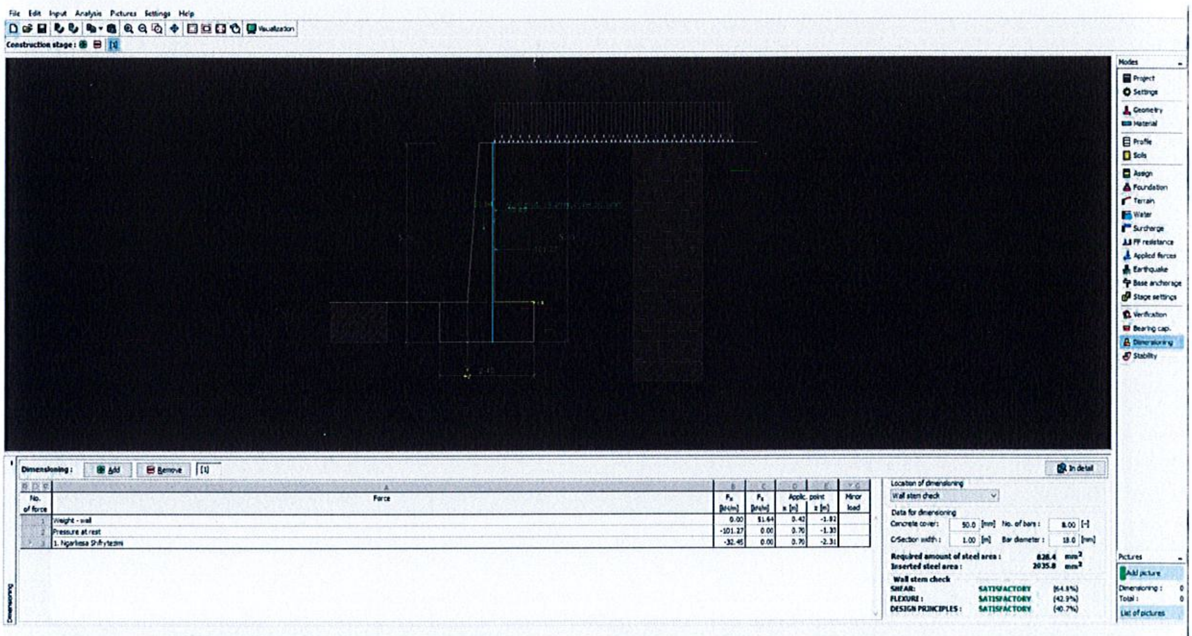
Te gjithe elementet perberes te struktures perfaqesohen ne modelin 3D nepermjet objekteve te cileve u vendosen karakteristikat fiziko mekanike te elementeve reale. Kjo arrihet nepermjet te dhenave qe futen ne program te cilat jane paraqitur me poshte:



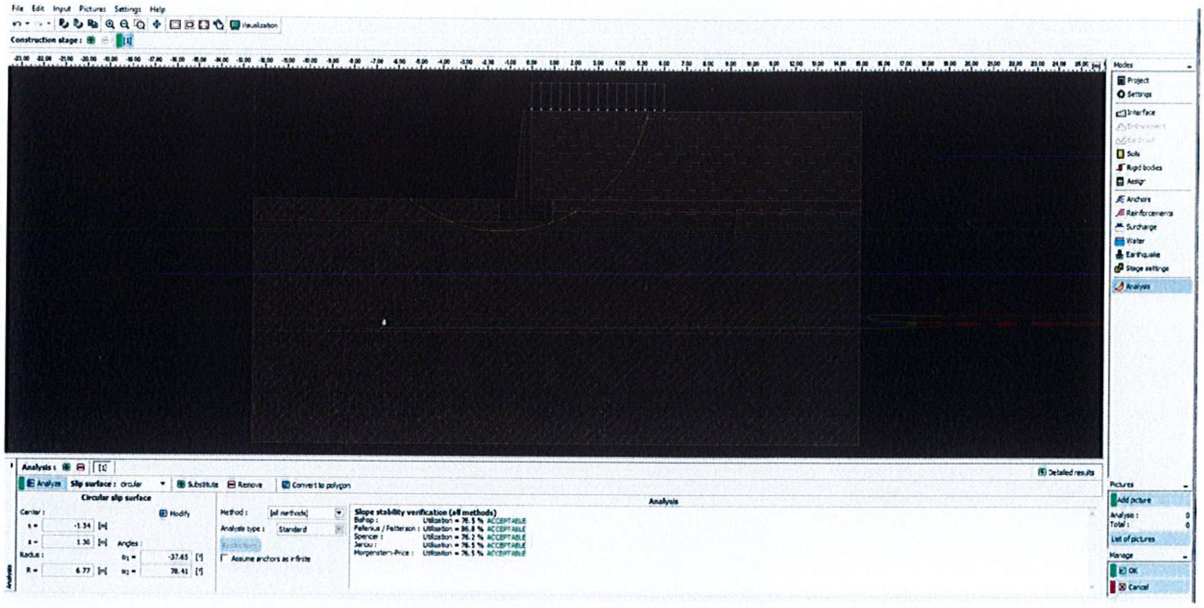
- Modelimi i skarpates sipas EC7



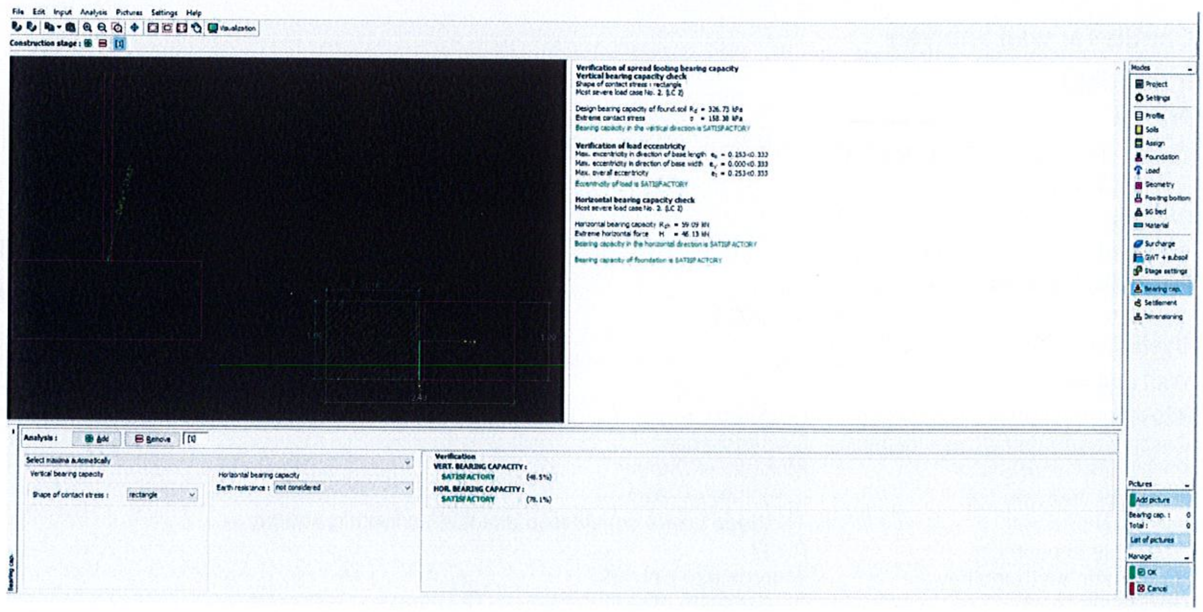
- Verifikimi i qendrueshmerise se murit b/a ndaj permbysjes dhe rreshkitjes



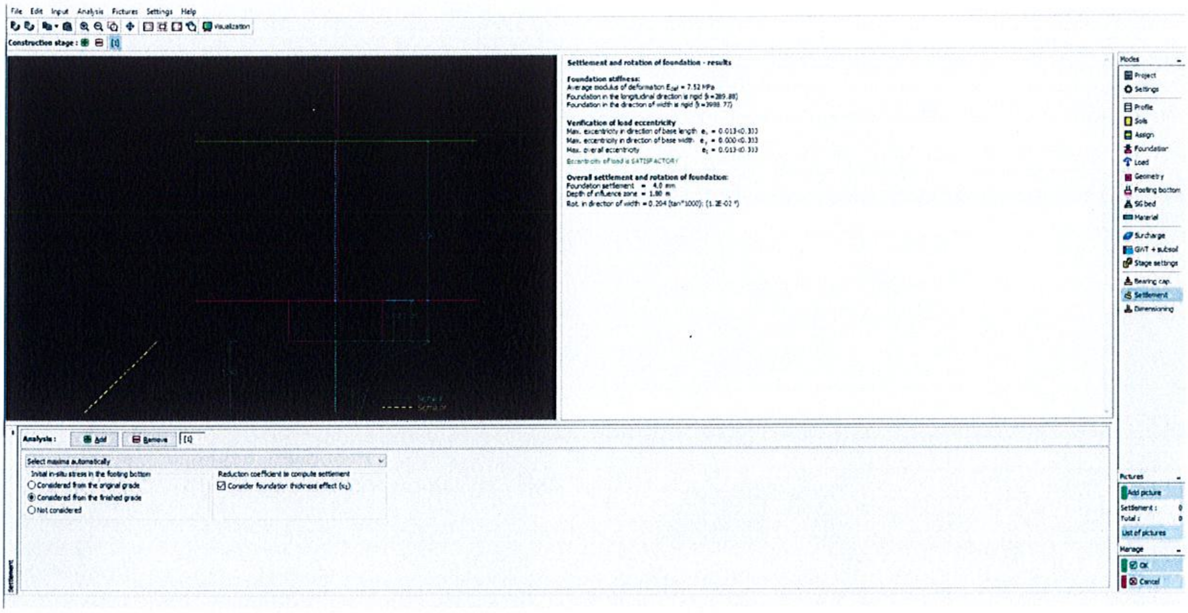
- Dimensionimi dhe llogaritjet per strukturen e murit b/a



- Verifikimi i nderprimit strukture – toke ndaj krijimit te planit te rreshqitjes ne nivel global



- Kontrolli i qendrueshmerise se bazamentit te murit b/a



- Kontrolli i efektit te uljeve ne bazament

Cantilever wall analysis

Input data

Project

Task : Perforcimi i Skarpates Me Mur B/A - Rruga Gjokaj - Bashkia Vore
Date : 8/31/2021

Settings

Standard - EN 1997 - DA3 (2)

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
Allowable eccentricity : 0.333
Verification methodology : according to EN 1997
Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

Partial factors on actions (A)									
Permanent design situation									
		State STR				State GEO			
		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 =					1.00	[–]		

Partial factors for soil parameters (M)			
Permanent design situation			
Partial factor on internal friction :	γ_ϕ =	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.40	[–]

Partial factors for soil parameters (M)		
Permanent design situation		
Partial factor on Poisson's ratio :	γ_v =	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 = 23.56 kN/m³
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 20/25
Cylinder compressive strength f_{ck} = 20.00 MPa
Tensile strength f_{ctm} = 2.20 MPa

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

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	4.00
3	1.00	4.00
4	1.00	5.00
5	-1.40	5.00
6	-1.40	4.00
7	-0.70	4.00
8	-0.40	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 4.59 m².

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	1. Low plasticity clay (CL,CI), consistency firm		17.00	12.00	19.00	9.50	10.00
2	3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8		23.00	28.00	22.00	12.50	10.00
3	2- Low plasticity clay (CL,CI), consistency firm		17.00	14.00	21.00	11.50	10.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	1. Low plasticity clay (CL,CI), consistency firm		cohesive	-	0.40	-	-
2	3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8		cohesive	-	0.35	-	-
3	2- Low plasticity clay (CL,CI), consistency firm		cohesionless	17.00	-	-	-

Soil parameters

1. Low plasticity clay (CL,CI), consistency firm
Unit weight : γ = 19.00 kN/m³

Stress-state : effective
Angle of internal friction : φ_{ef} = 17.00 °
Cohesion of soil : c_{ef} = 12.00 kPa
Angle of friction struc.-soil : δ = 10.00 °
Soil : cohesive
Poisson's ratio : ν = 0.40
Saturated unit weight : γ_{sat} = 19.50 kN/m3

3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8
Unit weight : γ = 22.00 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 23.00 °
Cohesion of soil : c_{ef} = 28.00 kPa
Angle of friction struc.-soil : δ = 10.00 °
Soil : cohesive
Poisson's ratio : ν = 0.35
Saturated unit weight : γ_{sat} = 22.50 kN/m3

2- Low plasticity clay (CL,CI), consistency firm
Unit weight : γ = 21.00 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 17.00 °
Cohesion of soil : c_{ef} = 14.00 kPa
Angle of friction struc.-soil : δ = 10.00 °
Soil : cohesionless
Saturated unit weight : γ_{sat} = 21.50 kN/m3

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	4.50	1. Low plasticity clay (CL,CI), consistency firm	
2	1.00	2- Low plasticity clay (CL,CI), consistency firm	
3	4.50	3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8	
4	-	3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8	

Foundation

Type of foundation : soil from geological profile

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		variable	20.00		0.00	6.00	on terrain

No.	Name
1	1. Ngarkesa Shfrytezimi

Resistance on front face of the structure

Resistance on front face of the structure: passive
Soil on front face of the structure - 3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8

Angle of friction struc.-soil δ = 10.00 °
Soil thickness in front of structure h = 1.00 m

Terrain in front of structure is flat.

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

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	-1.61	108.13	1.16	1.000	1.000	1.350
FF resistance	-94.50	-0.45	-13.54	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-1.45	12.84	1.73	1.000	1.000	1.000
Active pressure	87.62	-1.32	59.17	1.96	1.000	1.000	1.000
1. Ngarkesa Shfrytezimi	40.77	-2.21	16.01	1.82	1.300	1.300	1.300

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 301.26 kNm/m
Overturning moment M_{ovr} = 190.39 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 59.09 kN/m
Active horizontal force H_{act} = 46.13 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 163.96 kPa

Verification No. 2

Forces acting on construction

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	-1.61	108.13	1.16	1.000	1.000	1.350
FF resistance	-94.50	-0.45	-13.54	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-1.45	12.84	1.73	1.000	1.000	1.000
Active pressure	87.62	-1.32	59.17	1.96	1.000	1.000	1.000
1. Ngarkesa Shfrytezimi	40.77	-2.21	16.01	1.82	1.300	1.300	1.300

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 301.26 kNm/m
Overturning moment M_{ovr} = 190.39 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 59.09 kN/m
Active horizontal force H_{act} = 46.13 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 163.96 kPa

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	115.16	225.24	46.13	0.213	163.96
2	113.67	187.40	46.13	0.253	158.38
3	115.16	225.24	46.13	0.213	163.96
4	113.67	187.40	46.13	0.253	158.38

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	5.45	169.49	-30.67
2	5.45	169.49	-30.67

Spread footing verification

Input data

Settings

Standard - EN 1997 - DA3 (2)

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
Allowable eccentricity : 0.333
Verification methodology : according to EN 1997
Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		State STR		State GEO	
		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		
Partial factor on internal friction :	γ_ϕ =	1.25 [–]
Partial factor on effective cohesion :	γ_c =	1.25 [–]
Partial factor on undrained shear strength :	γ_{cu} =	1.40 [–]
Partial factor on unconfined strength :	γ_v =	1.40 [–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	1. Low plasticity clay (CL,CI), consistency firm		17.00	12.00	19.00	9.50	10.00
2	3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8		23.00	28.00	22.00	12.50	10.00
3	2- Low plasticity clay (CL,CI), consistency firm		17.00	14.00	21.00	11.50	10.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	1. Low plasticity clay (CL,CI), consistency firm		cohesive	-	0.40	-	-
2	3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8		cohesive	-	0.35	-	-
3	2- Low plasticity clay (CL,CI), consistency firm		cohesionless	17.00	-	-	-

Soil parameters

1. Low plasticity clay (CL,CI), consistency firm

Unit weight :	γ	=	19.00 kN/m³
Angle of internal friction :	φ_{ef}	=	17.00 °
Cohesion of soil :	c_{ef}	=	12.00 kPa
Oedometric modulus :	E_{oed}	=	6.00 MPa
Saturated unit weight :	γ_{sat}	=	19.50 kN/m³

3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8

Unit weight :	γ	=	22.00 kN/m³
Angle of internal friction :	φ_{ef}	=	23.00 °
Cohesion of soil :	c_{ef}	=	28.00 kPa
Oedometric modulus :	E_{oed}	=	15.00 MPa
Saturated unit weight :	γ_{sat}	=	22.50 kN/m³

2- Low plasticity clay (CL,CI), consistency firm

Unit weight :	γ	=	21.00 kN/m³
Angle of internal friction :	φ_{ef}	=	17.00 °
Cohesion of soil :	c_{ef}	=	14.00 kPa
Oedometric modulus :	E_{oed}	=	8.00 MPa
Saturated unit weight :	γ_{sat}	=	21.50 kN/m³

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	5.00	m
Depth of footing bottom	d	=	1.00	m
Foundation thickness	t	=	1.00	m
Incl. of finished grade	s_1	=	0.00	°
Incl. of footing bottom	s_2	=	0.00	°

Unit weight of soil above foundation = 21.00 kN/m³

Geometry of structure

Foundation type: strip footing

Overall strip footing length	=	3.05	m
Strip footing width (x)	=	2.40	m
Column width in the direction of x	=	0.10	m
Volume of strip footing	=	2.40	m³/m

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

Material of structure

Unit weight γ = 23.56 kN/m³
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 20/25

Cylinder compressive strength	f_{ck}	=	20.00	MPa
Tensile strength	f_{ctm}	=	2.20	MPa
Elasticity modulus	E_{cm}	=	30000.00	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	4.50	1. Low plasticity clay (CL,CI), consistency firm	
2	1.00	2- Low plasticity clay (CL,CI), consistency firm	
3	4.50	3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8	
4	-	3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8	

Load

No.	Load		Name	Type	N [kN/m]	M_y [kNm/m]	H_x [kN/m]
	new	change					
1	YES		LC 1	Design	168.78	69.03	-46.13
2	YES		LC 2	Design	130.94	67.54	-46.13
3	YES		LC 3	Service	113.03	5.45	0.00
4	YES		LC 4	Design	168.78	69.03	-46.13
5	YES		LC 5	Design	130.94	67.54	-46.13
6	YES		LC 6	Service	113.03	5.45	0.00

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	-0.51	0.00	163.96	358.29	45.76	Yes
LC 1	No	-0.47	0.00	168.25	371.34	45.31	Yes
LC 2	Yes	-0.61	0.00	158.38	326.73	48.47	Yes
LC 2	No	-0.55	0.00	159.49	345.32	46.19	Yes
LC 4	Yes	-0.51	0.00	163.96	358.29	45.76	Yes
LC 4	No	-0.47	0.00	168.25	371.34	45.31	Yes
LC 5	Yes	-0.61	0.00	158.38	326.73	48.47	Yes
LC 5	No	-0.55	0.00	159.49	345.32	46.19	Yes

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

Computed self weight of strip foundation G = 56.46 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. 2. (LC 2)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 2.96 m
Length of slip surface l_{sp} = 7.96 m

Design bearing capacity of found.soil R_d = 326.73 kPa
Extreme contact stress σ = 158.38 kPa

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. excentricity in direction of base length e_x = 0.253<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.253<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Most severe load case No. 2. (LC 2)
Earth resistance: not considered

Horizontal bearing capacity R_{dh} = 59.09 kN
Extreme horizontal force H = 46.13 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 = 56.46 kN/m
Computed weight of overburden Z = 0.00 kN/m

Settlement of mid point of longitudinal edge = 3.0 mm
Settlement of mid point of transverse edge 1 = 3.5 mm
Settlement of mid point of transverse edge 2 = 3.1 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} = 7.52 MPa
Foundation in the longitudinal direction is rigid (k=289.88)
Foundation in the direction of width is rigid (k=3988.77)

Verification of load eccentricity

Max. excentricity in direction of base length e_x = 0.013<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.013<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 4.0 mm
Depth of influence zone = 1.80 m

Rotation in direction of width = 0.204 (tan*1000); (1.2E-02 °)

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 = 18.0 mm
Number of bars = 8
Reinforcement cover = 40.0 mm
Cross-section width = 1.00 m

Cross-section depth = 1.00 m

Reinforcement ratio	ρ	=	0.21 %	>	0.13 %	=	ρ_{min}
Position of neutral axis	x	=	0.08 m	<	0.59 m	=	x_{max}
Ultimate moment	M_{Rd}	=	812.36 kNm	>	87.92 kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Spread footing for punching shear failure check

Column normal force = 168.78 kN

Maximum resistance at the column perimeter

Force transmitted into found. soil		=	7.04 kN
Force transmitted by shear strength of SRC		=	161.74 kN
Considered column perimeter	u_0	=	2.00 m
Shear resistance at the column perimeter	$v_{Ed,max}$	=	0.41 MPa
Resistance at the column perimeter	$v_{Rd,max}$	=	2.94 MPa

Critical section without shear reinforcement

Force transmitted into found. soil		=	74.06 kN
Force transmitted by shear strength of SRC		=	94.72 kN
Distance of section from the column		=	0.48 m
Section perimeter	u_{cr}	=	2.00 m
Shear stress at section	v_{Ed}	=	0.08 MPa
Shear resistance of section without shear reinforcement	$v_{Rd,c}$	=	1.10 MPa

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

Spread footing for punching shear is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

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	-1.82	51.64	0.42	1.000	1.350	1.000
Pressure at rest	101.27	-1.33	0.00	0.70	1.000	1.000	1.000
1. Ngarkesa Shfrytezimi	32.45	-2.31	0.00	0.70	1.300	0.000	1.300

Wall stem check

Reinforcement and dimensions of the cross-section
Bar diameter = 18.0 mm
Number of bars = 8
Reinforcement cover = 50.0 mm
Cross-section width = 1.00 m
Cross-section depth = 0.70 m

Reinforcement ratio	ρ	=	0.32 %	>	0.13 %	=	ρ_{min}
Position of neutral axis	x	=	0.08 m	<	0.39 m	=	x_{max}
Ultimate shear force	V_{Rd}	=	221.38 kN	>	143.45 kN	=	V_{Ed}
Ultimate moment	M_{Rd}	=	534.62 kNm	>	229.12 kNm	=	M_{Ed}

Cross-section is SATISFACTORY.

Slope stability analysis

Input data

Project

Settings

Standard - EN 1997 - DA3 (2)

Stability analysis

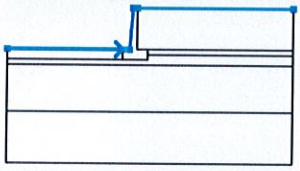
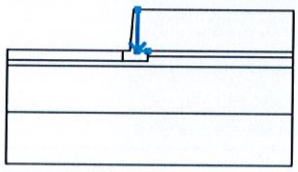
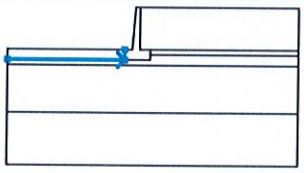
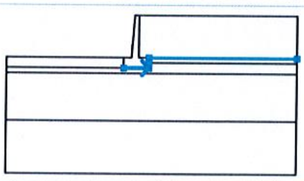
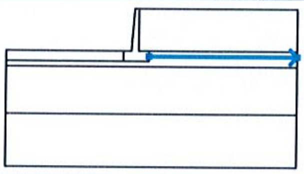
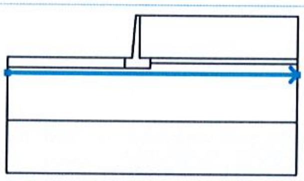
Earthquake analysis : Standard
Verification methodology : according to EN 1997

Design approach : 3 - reduction of actions (GEO, STR) and soil parameters

Partial factors on actions (A)									
Permanent design situation									
		State STR				State GEO			
		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 =					1.00	[–]		

Partial factors for soil parameters (M)			
Permanent design situation			
Partial factor on internal friction :	γ_ϕ =	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.40	[–]

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-12.50	-4.00	-1.40	-4.00	-0.70	-4.00
		-0.40	0.00	0.00	0.00	15.00	0.00
2		0.00	0.00	0.00	-4.00	1.00	-4.00
3		-12.50	-5.00	-1.40	-5.00	-1.40	-4.00
4		-1.40	-5.00	1.00	-5.00	1.00	-4.50
		1.00	-4.00	15.00	-4.00		
5		1.00	-4.50	15.00	-4.50		
6		-12.50	-5.50	15.00	-5.50		
7		-12.50	-10.00	15.00	-10.00		

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
1	1. Low plasticity clay (CL,CI), consistency firm		17.00	12.00	19.00
2	3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8		23.00	28.00	22.00
3	2- Low plasticity clay (CL,CI), consistency firm		17.00	14.00	21.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [–]
1	1. Low plasticity clay (CL,CI), consistency firm		19.50		
2	3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8		22.50		
3	2- Low plasticity clay (CL,CI), consistency firm		21.50		

Soil parameters

1. Low plasticity clay (CL,CI), consistency firm

Unit weight : γ = 19.00 kN/m³
Stress-state : effective
Angle of internal friction : φ_{ef} = 17.00 °
Cohesion of soil : c_{ef} = 12.00 kPa
Saturated unit weight : γ_{sat} = 19.50 kN/m³

3. Low plasticity silt (ML,MI), consistency very stiff Sr > 0.8

Unit weight : γ = 22.00 kN/m³
Stress-state : effective
Angle of internal friction : φ_{ef} = 23.00 °
Cohesion of soil : c_{ef} = 28.00 kPa
Saturated unit weight : γ_{sat} = 22.50 kN/m³

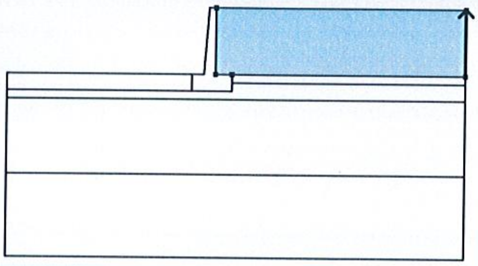
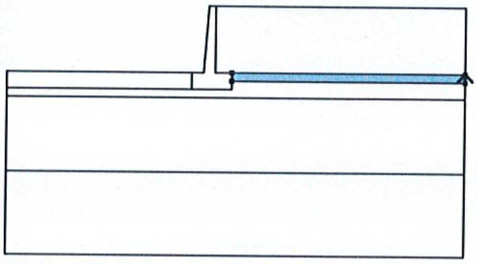
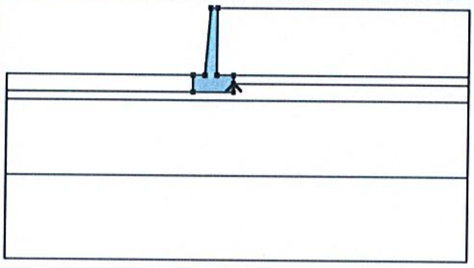
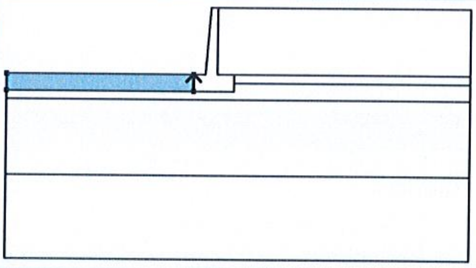
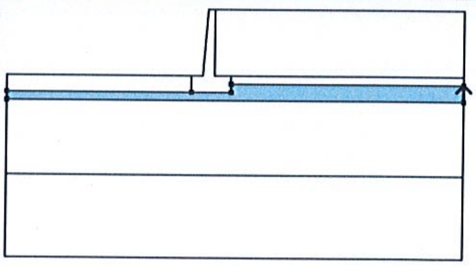
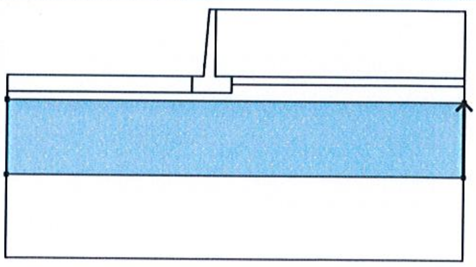
2- Low plasticity clay (CL,CI), consistency firm

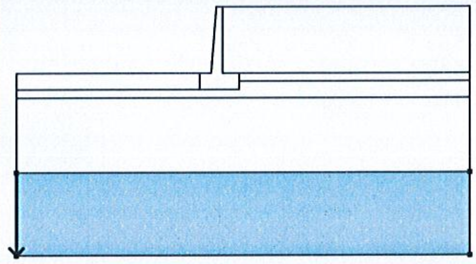
Unit weight : γ = 21.00 kN/m³
Stress-state : effective
Angle of internal friction : φ_{ef} = 17.00 °
Cohesion of soil : c_{ef} = 14.00 kPa
Saturated unit weight : γ_{sat} = 21.50 kN/m³

Rigid bodies

No.	Name	Sample	γ [kN/m³]
1	Wall material		23.56

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		15.00 0.00 1.00	-4.00 0.00 -4.00	15.00 0.00	0.00 -4.00	1. Low plasticity clay (CL,CI), consistency
2		15.00 1.00	-4.50 -4.00	15.00 1.00	-4.00 -4.50	1. Low plasticity clay (CL,CI), consistency
3		1.00 1.00 0.00 -0.70 -1.40	-5.00 -4.00 0.00 -4.00 -5.00	1.00 0.00 -0.40 -1.40	-4.50 -4.00 0.00 -4.00	Wall material
4		-1.40 -12.50	-5.00 -4.00	-1.40 -12.50	-4.00 -5.00	3. Low plasticity silt (ML,MI), consistency
5		15.00 1.00 -1.40 -12.50	-5.50 -4.50 -5.00 -5.50	15.00 1.00 -12.50	-4.50 -5.00 -5.00	2- Low plasticity clay (CL,CI), consistency
6		15.00 -12.50	-10.00 -5.50	15.00 -12.50	-5.50 -10.00	3. Low plasticity silt (ML,MI), consistency

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
7		-12.50	-10.00	-12.50	-15.00	3. Low plasticity silt (ML,MI), consistency
		15.00	-15.00	15.00	-10.00	

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F	q_2	unit
1	strip	variable	on terrain	x = 0.00	l = 6.00		0.00	20.00		kN/m^2

Surcharges

No.	Name
1	1. Ngarkesa Shfrytezimi

Water

Water type : No water

Tensile crack

Tensile crack not inputted.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters								
Center :	x =	-1.34	[m]	Angles :	α_1 =	-37.65	[°]
	z =	1.36	[m]		α_2 =	78.41	[°]
Radius :	R =	6.77	[m]				
Analysis of the slip surface without optimization.							

Slope stability verification (all methods)

Bishop : Utilization = 76.5 % ACCEPTABLE
Fellenius / Petterson : Utilization = 86.8 % ACCEPTABLE
Spencer : Utilization = 76.2 % ACCEPTABLE
Janbu : Utilization = 76.5 % ACCEPTABLE
Morgenstern-Price : Utilization = 76.5 % ACCEPTABLE