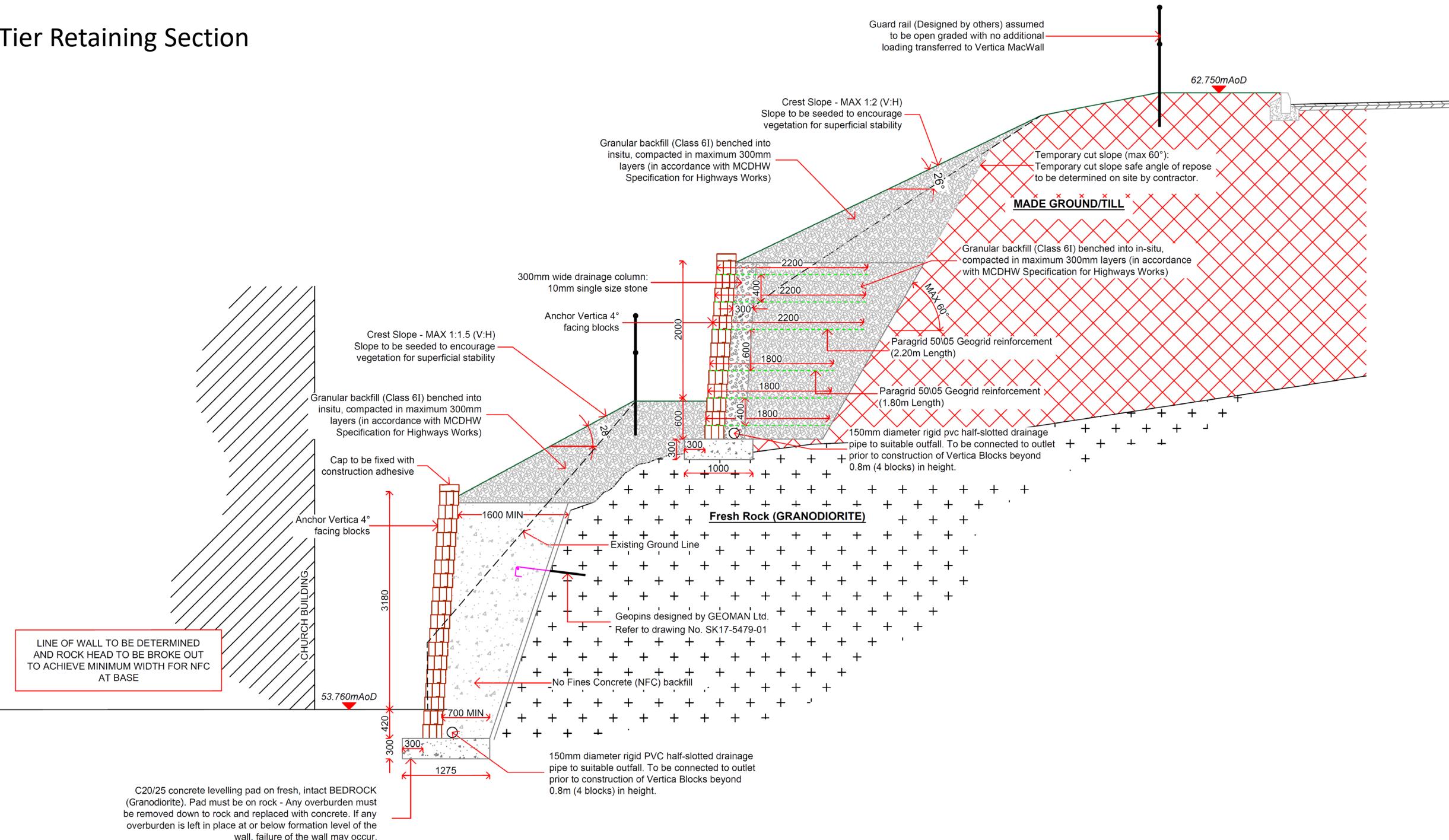
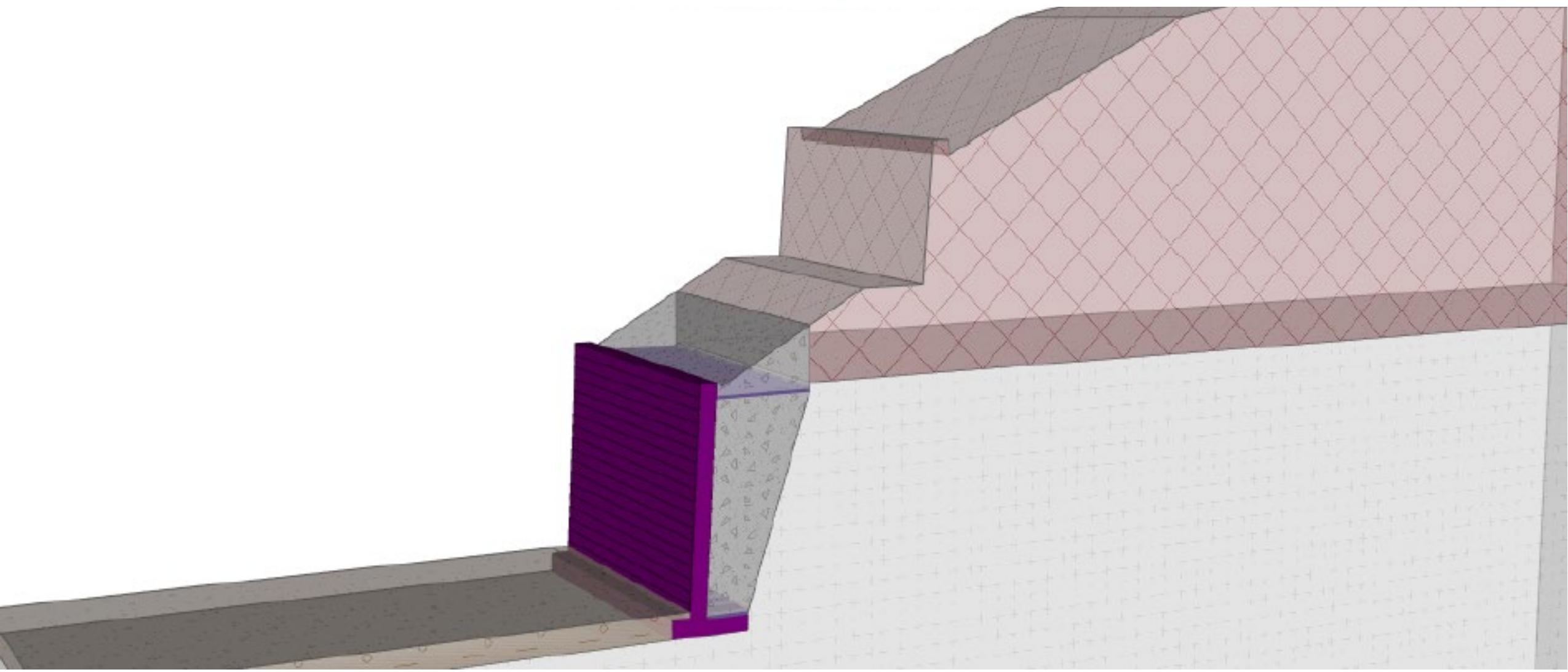


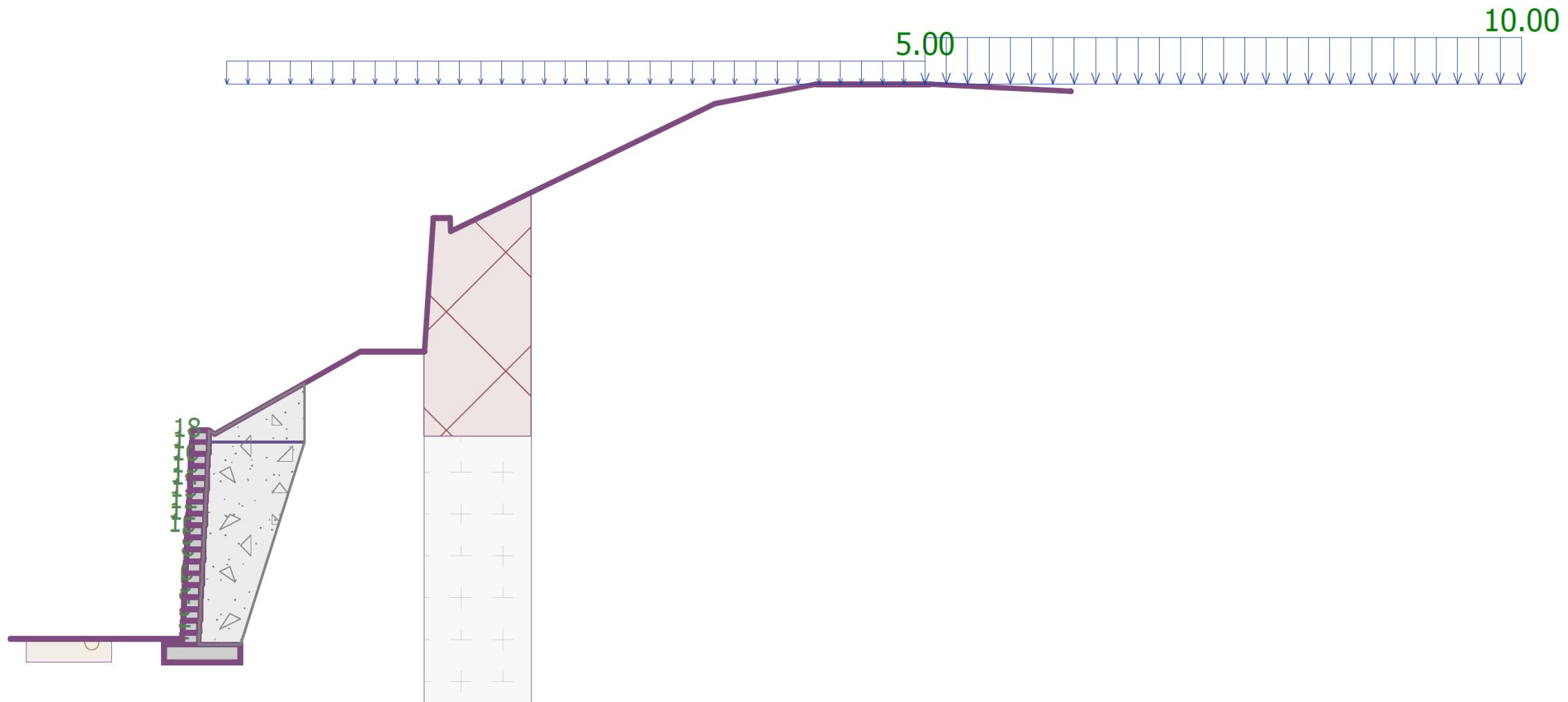
Dominican Chapel, Newry, Northern Ireland

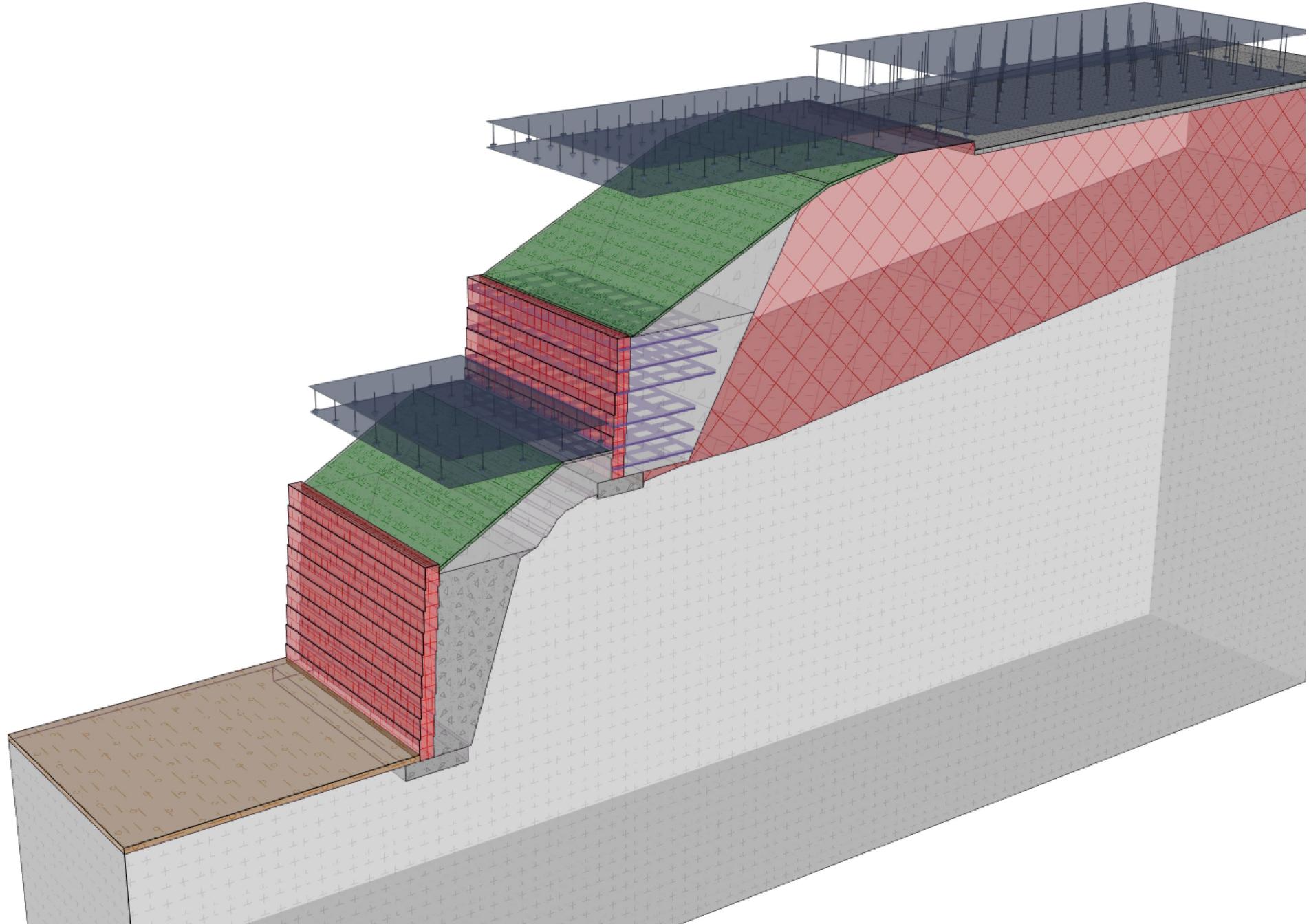
- Construction Period:2017
- The aim of this project was to create a link between the Chapel at the toe of the slope and the Garden at the top. A walk way had to be included at the top of the retaining walls.
- This was a very difficult site to accommodate this, due to the limited space available and original steep slope on site.
- MacWalls where constructed using hydraulics bound aggregate backfill material and Stabilisure Ground Improvement methods.
- Erosions mats were also used to encourage vegetation growth and allow space for the access path.

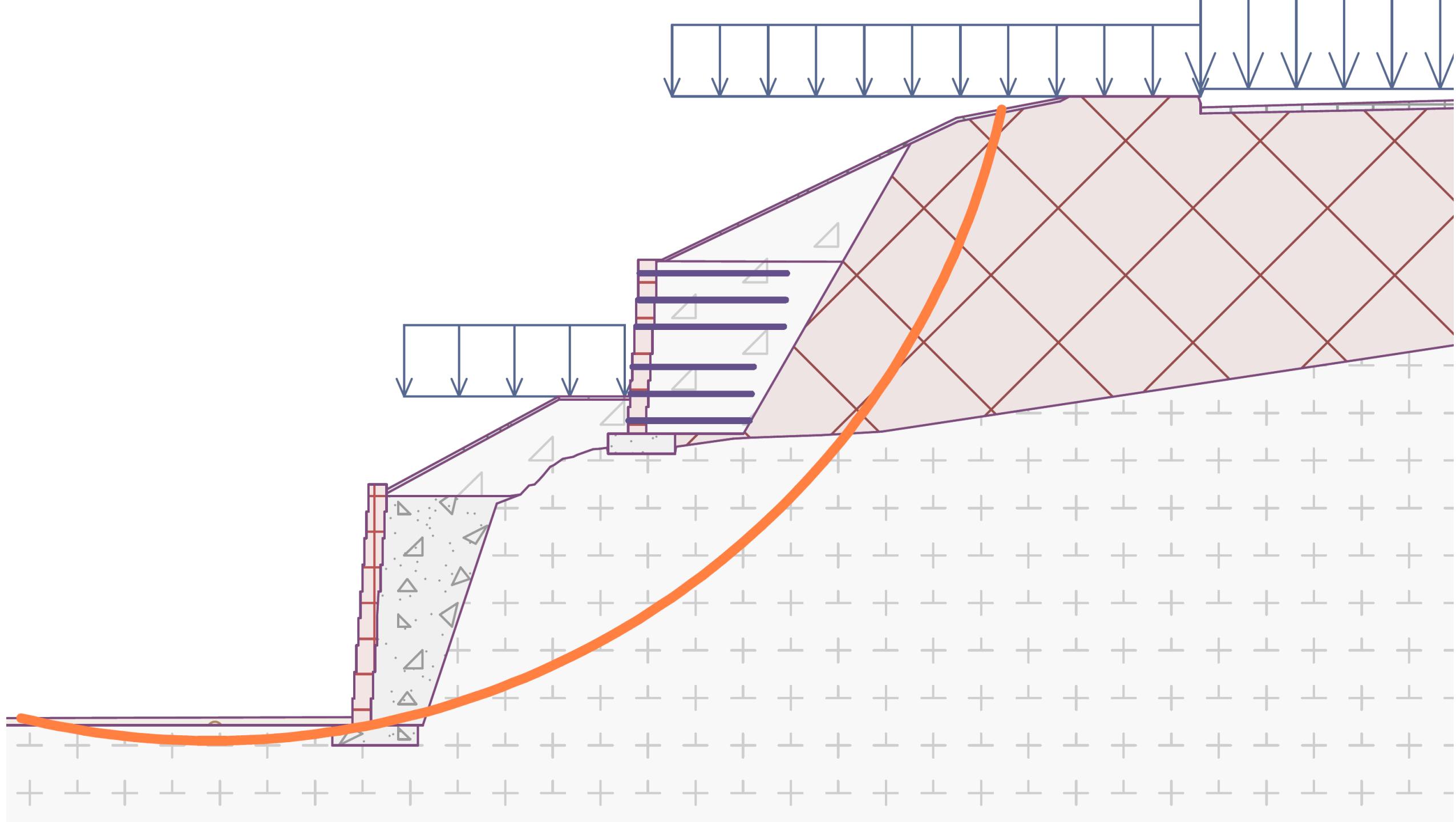
2-Tier Retaining Section



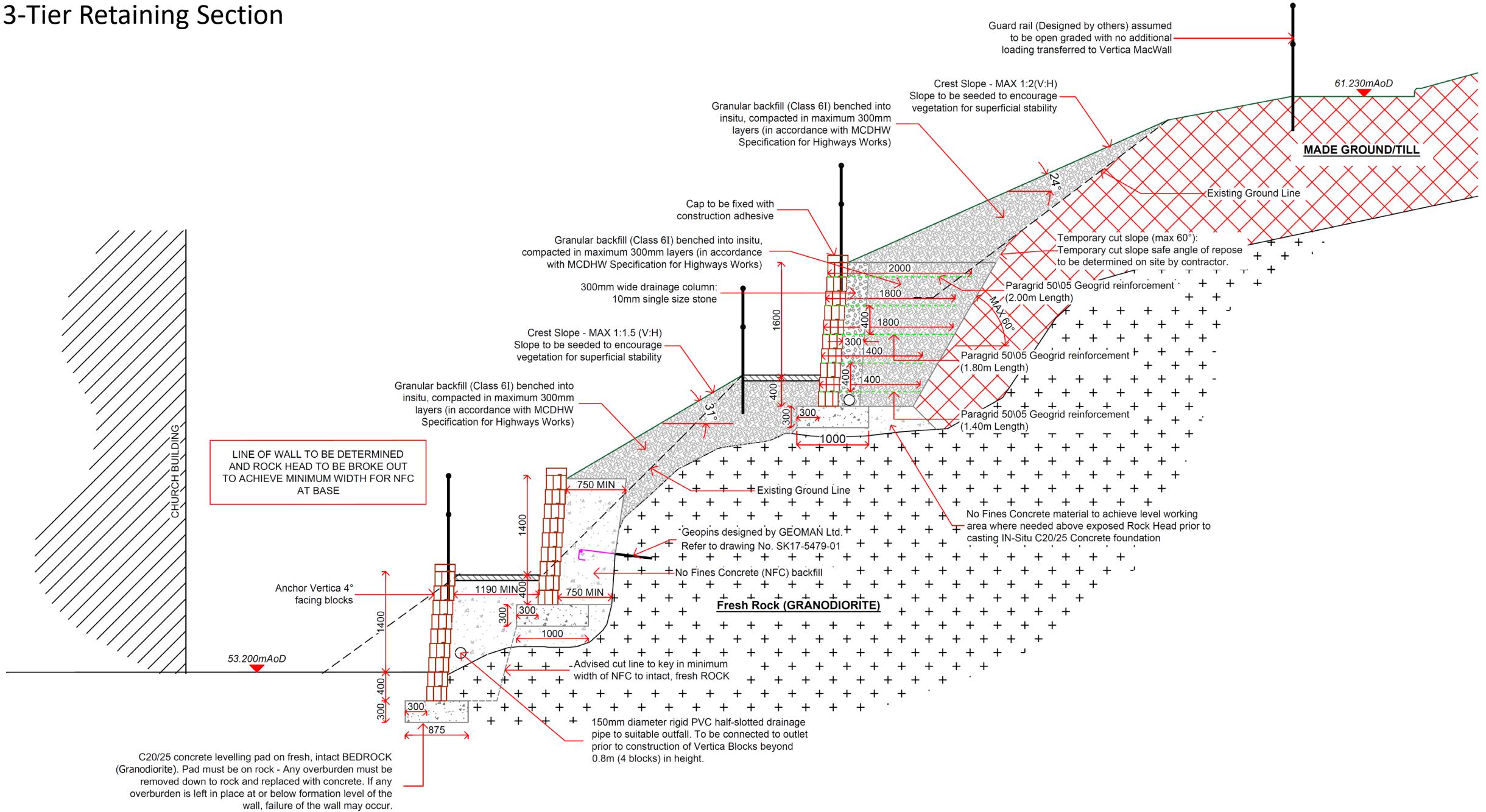






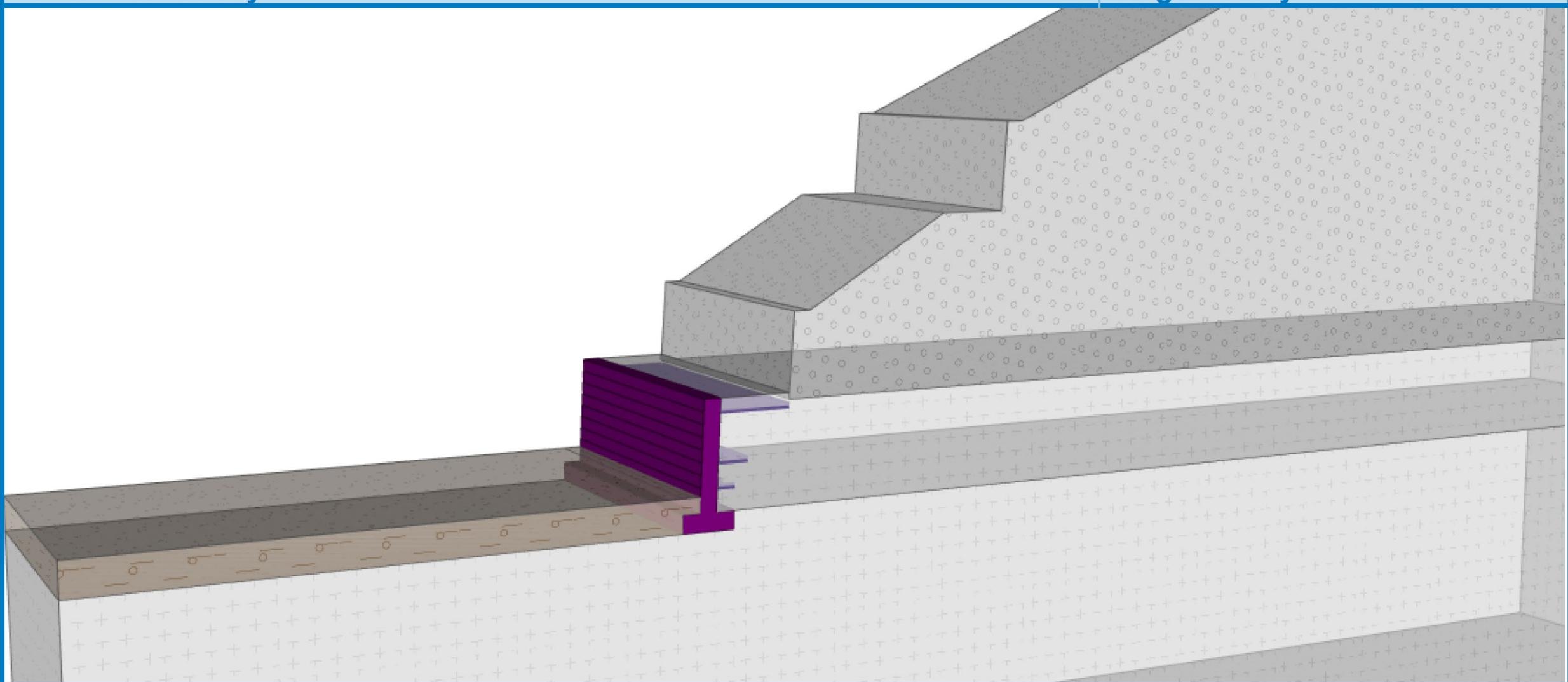


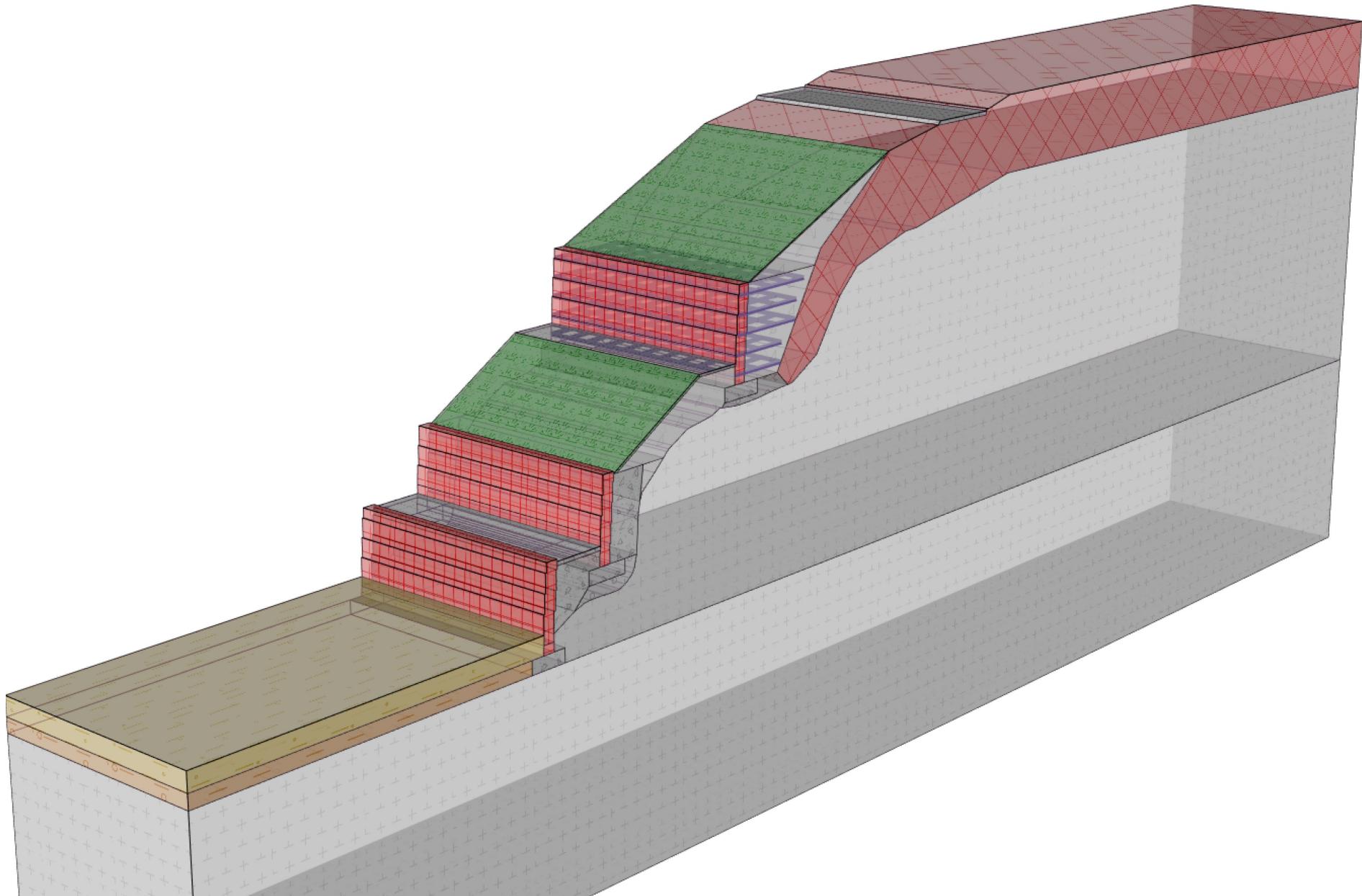
3-Tier Retaining Section



Name : Geometry

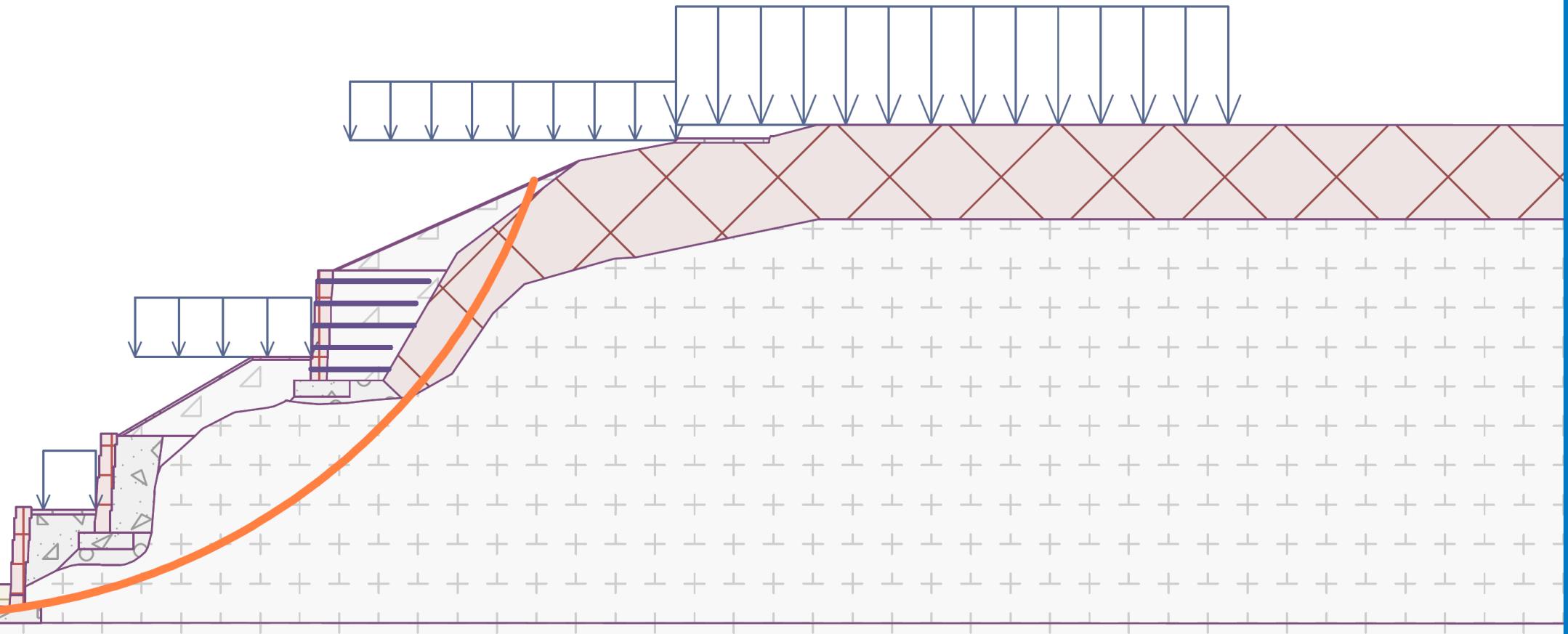
Stage - analysis : 1 - 0





Name : Analysis

Stage - analysis : 1 - 1











GEOMAN Ltd.
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Dominican Chapel, Newry
Section 1-1
17-5479

Analysis of reinforced slopes

Input data

Project

Task : Vertica MacWall Design
 Part : Section 1-1
 Description : Internal Verification of MacWall with NFC Fill
 Customer : Maccaferri Ltd.
 Author : Liam K. D.
 Date : 08/08/2017
 Project ID : Dominican Chapel, Newry
 Project number : 17-5479

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
 Allowable eccentricity : 0.333
 Internal stability : Standard - straight slip surface
 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	
Permanent actions :	$\gamma_G =$	1.35	[$-$]	1.00	[$-$]
Variable actions :	$\gamma_Q =$	1.50	[$-$]	0.00	[$-$]
Water load :	$\gamma_w =$	1.35	[$-$]		
				1.00	[$-$]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[$-$]	1.25	[$-$]
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[$-$]	1.25	[$-$]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[$-$]	1.40	[$-$]
Partial factor on Poisson's ratio :	$\gamma_v =$	1.00	[$-$]	1.00	[$-$]

Partial factors for variable actions					
Permanent design situation					
Factor for combination value :		$\psi_0 =$		0.70	[$-$]
Factor for frequent value :		$\psi_1 =$		0.50	[$-$]
Factor for quasi-permanent value :		$\psi_2 =$		0.30	[$-$]

Stability analysis

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 :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]	
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]	
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]		

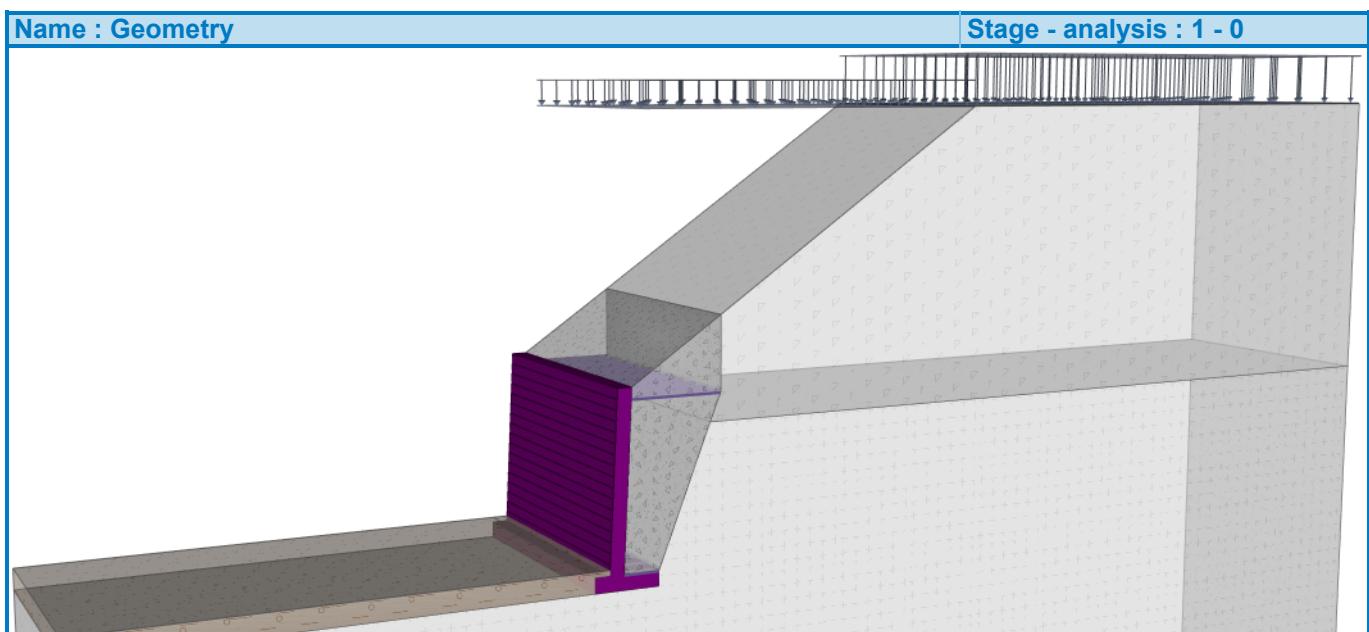
Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[-]	1.25	[-]	
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[-]	1.25	[-]	
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[-]	1.40	[-]	

Geometry of structure

Number of blocks $n = 17$
 Block height $h = 0.20 \text{ m}$
 Block width $b = 0.28 \text{ m}$
 Block offset $o_1 = 0.01 \text{ m}$

Structure foundation

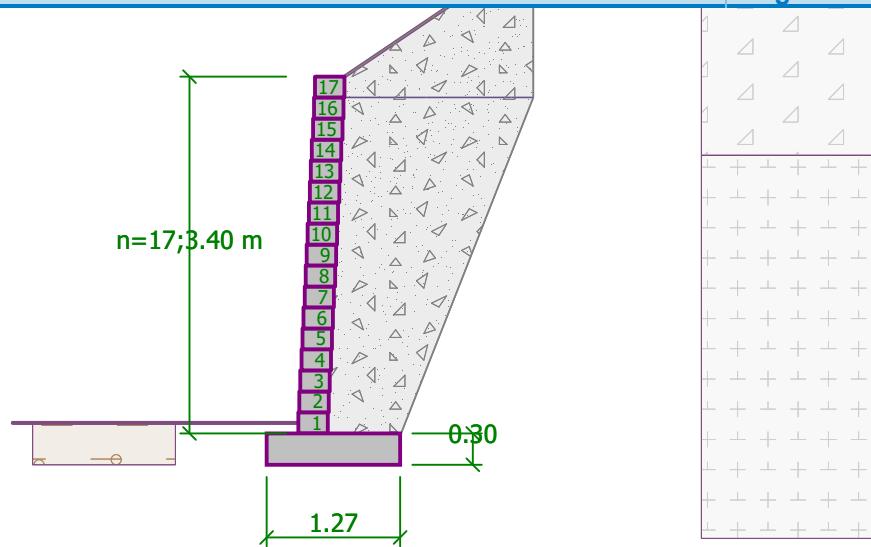
Foundation width $b_b = 1.27 \text{ m}$
 Foundation height $l_b = 0.30 \text{ m}$
 Foundation offset $a_b = 0.30 \text{ m}$





Name : Geometry

Stage - analysis : 1 - 0



Material

Block material

Unit weight γ = 20.00 kN/m³

Cohesion c = 0.00 kPa

Friction f = 0.533

Shear bearing capacity of joint R_s = 0.00 kN/m

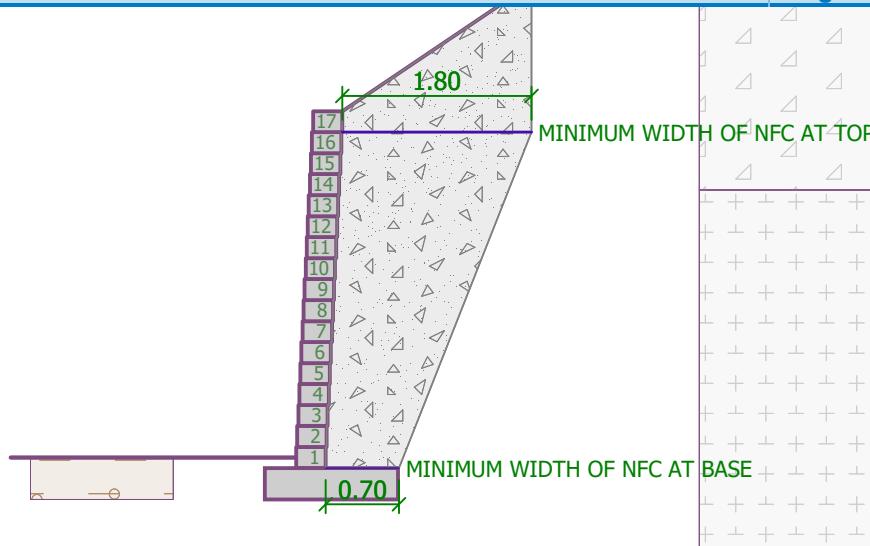
Reinforced soil - No Fines Concrete

Reinforcement

Total number of input reinforcements : 2.

Name : NFC Widths

Stage - analysis : 1 - 0



Soil parameters

No Fines Concrete

Unit weight : γ = 18.00 kN/m³

Angle of internal friction : ϕ_{ef} = 45.00 °

Cohesion of soil : c_{ef} = 30.00 kPa

Angle of friction struc.-soil : δ = 24.50 °



Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Class 6I

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 35.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 21.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Firm silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 30.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 17.00^\circ$

Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Firm to Stiff slightly silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 32.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 19.00^\circ$

Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Type 1

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 35.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 21.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Fresh Rock (Granodiorite)

Unit weight : $\gamma = 22.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 45.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 31.50^\circ$

Saturated unit weight : $\gamma_{sat} = 22.00 \text{ kN/m}^3$

Made Ground

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 32.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 17.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	0.75	Class 6I	
2	-	Fresh Rock (Granodiorite)	



Terrain profile

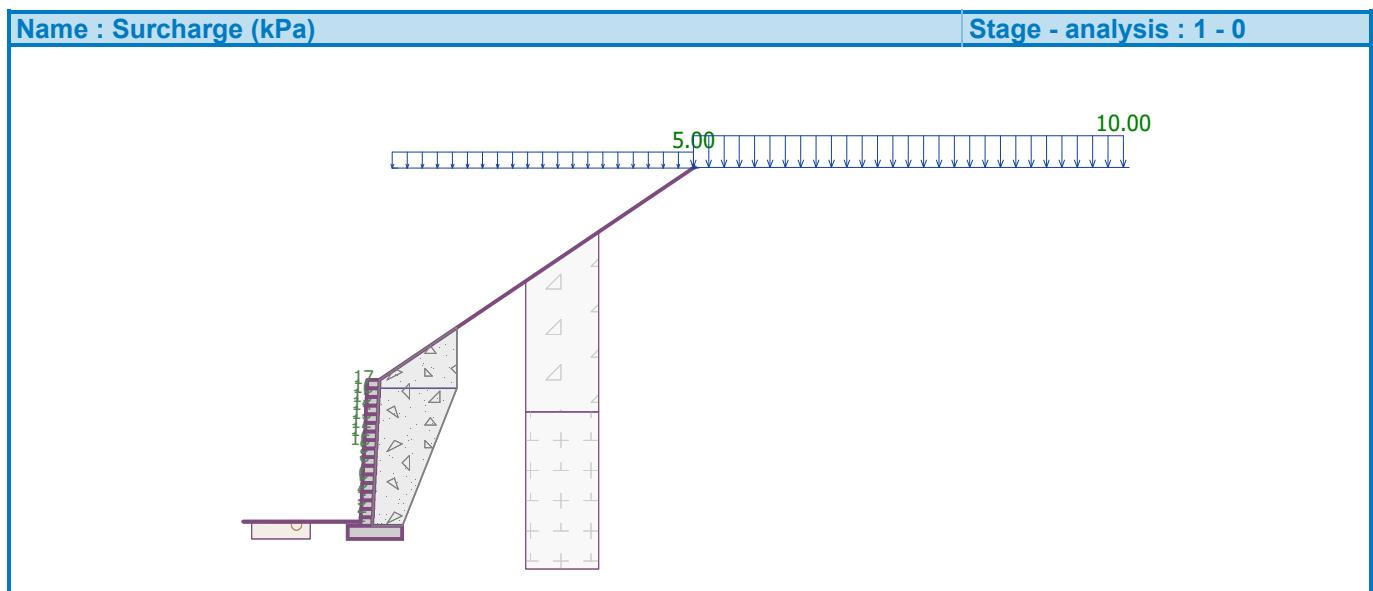
Terrain behind construction has the slope 1: 1.48 (slope angle is 34.00 °). Embankment height is 4.94 m, embankment length is 7.32 m.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		variable	5.00		0.30	7.00	on terrain
2	Yes		variable	10.00		7.30	10.00	on terrain
No.	Name							
1	5kPa Load							
2	10kPa Load							



Resistance on front face of the structure

Resistance on front face of the structure: not considered

Soil on front face of the structure - Firm to Stiff slightly silty sandy gravelly CLAY

Soil thickness in front of structure h = 0.40 m

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent

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 - reinforced soil	0.00	-2.46	105.31	1.42	1.000	1.000	1.350
Active pressure	25.15	-1.93	12.15	1.13	1.350	1.350	1.000
5kPa Load	6.75	-3.56	1.95	1.93	1.500	1.500	1.500



Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
10kPa Load	8.42	-2.74	3.01	1.50	1.500	1.500	1.500
Weight - wall	0.00	-2.00	19.04	0.52	1.000	1.000	1.350
5kPa Load	0.00	-4.41	7.50	1.79	0.000	0.000	1.500

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment M_{res} = 190.41 kNm/m

Oversetting moment M_{ovr} = 136.28 kNm/m

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force H_{res} = 148.19 kN/m

Active horizontal force H_{act} = 56.71 kN/m

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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 - reinforced soil	0.00	-2.46	105.31	1.42	1.000	1.000	1.000
Active pressure	47.84	-2.07	15.46	1.13	1.000	1.000	1.000
5kPa Load	9.68	-3.08	2.03	1.66	1.300	1.300	1.300
10kPa Load	12.94	-2.74	3.12	1.44	1.300	1.300	1.300
Weight - wall	0.00	-2.00	19.04	0.52	1.000	1.000	1.000
5kPa Load	0.00	-4.41	7.50	1.79	0.000	0.000	1.300

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment M_{res} = 187.17 kNm/m

Oversetting moment M_{ovr} = 184.00 kNm/m

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force H_{res} = 117.21 kN/m

Active horizontal force H_{act} = 77.24 kN/m

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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	-2.00	19.04	0.52	1.000	1.000	1.350



Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - earth wedge	0.00	-1.11	15.11	0.85	1.000	1.000	1.350
Active pressure	4.33	-0.73	7.03	1.17	1.000	1.000	1.350
5kPa Load	0.49	-0.94	1.70	0.98	0.000	0.000	1.500
10kPa Load	0.61	-0.80	1.16	1.17	0.000	0.000	1.500
Reinforcement	-19.17	-0.30	0.00	0.88	1.000	1.000	1.000
Reinforcement	-19.17	-3.50	0.00	1.60	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 103.76$ kNm/m
Overturning moment $M_{ovr} = 3.15$ kNm/m

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 79.52$ kN/m
Active horizontal force $H_{act} = 4.33$ kN/m

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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	-2.00	19.04	0.52	1.000	1.000	1.000
Weight - earth wedge	0.00	-1.11	15.11	0.85	1.000	1.000	1.000
Active pressure	16.41	-0.90	20.26	1.12	1.000	1.000	1.000
5kPa Load	1.33	-0.94	1.94	0.98	1.300	0.000	1.300
10kPa Load	2.00	-0.96	2.70	0.99	1.300	0.000	1.300
Reinforcement	-19.17	-0.30	0.00	0.88	1.000	1.000	1.000
Reinforcement	-19.17	-3.50	0.00	1.60	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 124.16$ kNm/m
Overturning moment $M_{ovr} = 18.94$ kNm/m

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 81.87$ kN/m
Active horizontal force $H_{act} = 16.41$ kN/m

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**



No. 2

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	-1.70	19.04	0.22	1.000	1.000	1.350
Active pressure	0.00	-3.40	0.00	0.44	1.000	1.000	1.000
5kPa Load	0.00	-3.40	1.17	0.36	0.000	0.000	1.500
10kPa Load	0.00	-3.40	0.60	0.30	0.000	0.000	1.500
Reinforcement	-19.17	-3.20	0.00	1.31	1.000	1.000	1.000

Check of construction joint above the most utilized block No.: 0

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 65.53 \text{ kNm/m}$

Overturning moment $M_{ovr} = 0.00 \text{ kNm/m}$

Joint for overturning stability is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 29.32 \text{ kN/m}$

Active horizontal force $H_{act} = 0.00 \text{ kN/m}$

Joint for slip is **SATISFACTORY**

Joint is **SATISFACTORY**

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	-1.70	19.04	0.22	1.000	1.000	1.000
Active pressure	0.26	-0.09	0.10	0.28	1.000	1.000	1.000
5kPa Load	0.43	-0.19	1.40	0.36	0.000	0.000	1.300
10kPa Load	0.99	-0.30	1.89	0.35	0.000	0.000	1.300
Reinforcement	-19.17	-3.20	0.00	1.30	1.000	1.000	1.000

Check of construction joint above the most utilized block No.: 0

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 65.56 \text{ kNm/m}$

Overturning moment $M_{ovr} = 0.02 \text{ kNm/m}$

Joint for overturning stability is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 29.37 \text{ kN/m}$

Active horizontal force $H_{act} = 0.26 \text{ kN/m}$

Joint for slip is **SATISFACTORY**

Joint is **SATISFACTORY**

Bearing capacity of foundation soil

Design load acting at the center of footing bottom



No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kNm/m]	Eccentricity [-]	Stress [kPa]
1	-66.83	60.45	-17.62	0.000	47.60
2	-66.83	60.45	-21.93	0.000	47.60
3	0.00	0.00	0.00	0.000	0.00
4	0.00	0.00	0.00	0.000	0.00

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kNm/m]
1	-74.70	44.04	-32.91
2	-74.45	41.18	-34.01

Verification of foundation soil

Place of verification : bottom of leveling pad

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.000$

Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom $\sigma = 47.60 \text{ kPa}$

Bearing capacity of foundation soil $R_d = 200.00 \text{ kPa}$

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY



Analysis of reinforced slopes

Input data

Project

Task : Reinforced Slope Design
 Part : Section 1-1
 Description : Reinforced slope to be constructed above Wall C
 Customer : Maccaferri Ltd.
 Author : Liam K. D.
 Date : 08/08/2017
 Project ID : Dominican Chapel, Newry
 Project number : 17-5479

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
 Allowable eccentricity : 0.333
 Internal stability : Standard - straight slip surface
 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	
Permanent actions :	$\gamma_G =$	1.35	[$-$]	1.00	[$-$]
Variable actions :	$\gamma_Q =$	1.50	[$-$]	0.00	[$-$]
Water load :	$\gamma_w =$	1.35	[$-$]		
				1.00	[$-$]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[$-$]	1.25	[$-$]
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[$-$]	1.25	[$-$]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[$-$]	1.40	[$-$]
Partial factor on Poisson's ratio :	$\gamma_v =$	1.00	[$-$]	1.00	[$-$]

Partial factors for variable actions					
Permanent design situation					
Factor for combination value :		$\psi_0 =$		0.70	[$-$]
Factor for frequent value :		$\psi_1 =$		0.50	[$-$]
Factor for quasi-permanent value :		$\psi_2 =$		0.30	[$-$]

Stability analysis

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		
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 [–]

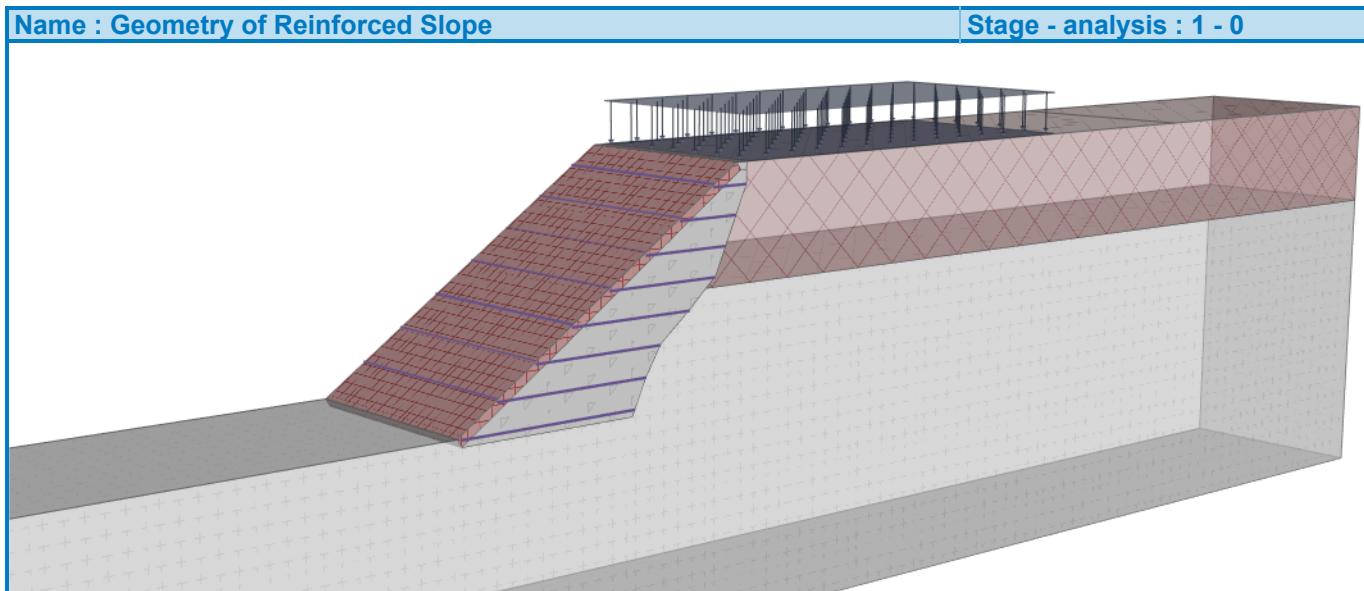
Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	γ_ϕ =	1.00	[–]	1.25	[–]	
Partial factor on effective cohesion :	γ_c =	1.00	[–]	1.25	[–]	
Partial factor on undrained shear strength :	γ_{cu} =	1.00	[–]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

Geometry of structure

Embankment height h_n = 5.01 m

Embankment length l_n = 7.32 m

Cover thickness t_c = 0.20 m



Material

Cover material

Unit weight γ = 15.00 kN/m³

Shear resistance R_s = 0.00 kPa

Reinforced soil - Class 61

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T _{ult} [kN/m]	R _t [kN/m]	C _{ds} [–]	C _i [–]
1	Paragrid 40	Paragrid 40	— — — —	40.00	25.81	0.80	0.90



Reinforcement details

1. Paragrid 40

Short-term char. strength T_{ult} = 40.00 kN/m
 Long-term design strength R_t = 25.81 kN/m
 Overall coeff. of model uncertainty FS_{UNC} = 1.00

Calculate reduction factors

Life time : 120 years

Creep red. factor RF_{CR} = 1.38

Chemistry : pH 4.0-9.0

Durability red. factor RF_D = 1.08

Partical size : $D_{50} < 0.15$ mm

Installation damage red. factor RF_{ID} = 1.04

Reinforcement

No.	Number of reinforcement	Type of reinforcement	Spacing of reinforcement $h_r[m]$	Height of first reinforcement $h[m]$	Reinforcements geometry
1	1	Paragrid 40	0.65	4.55	input coordinates
2	1	Paragrid 40	0.65	3.90	input coordinates
3	1	Paragrid 40	0.65	3.25	input coordinates
4	1	Paragrid 40	0.65	2.60	input coordinates
5	1	Paragrid 40	0.65	1.95	input coordinates
6	1	Paragrid 40	0.65	1.30	input coordinates
7	1	Paragrid 40	0.65	0.65	input coordinates
8	1	Paragrid 40	0.65	0.00	input coordinates

Reinforcement details

Reinforcement No. 1

Reinforcement type : Paragrid 40

Number of reinforcements 1

Reinforcement geometry : input coordinates

First point coordinate : 6.66 m

End point coordinate : 7.60 m

Reinforcement No.	Origin $I_1[m]$	End $I_2[m]$	Height from bottom $h[m]$	Length $l[m]$
1	-0.66	0.28	4.55	0.94

Reinforcement No. 2

Reinforcement type : Paragrid 40

Number of reinforcements 1

Reinforcement geometry : input coordinates

First point coordinate : 5.73 m

End point coordinate : 7.31 m

Reinforcement No.	Origin $I_1[m]$	End $I_2[m]$	Height from bottom $h[m]$	Length $l[m]$
1	-1.59	-0.01	3.90	1.58

Reinforcement No. 3

Reinforcement type : Paragrid 40

Number of reinforcements 1

Reinforcement geometry : input coordinates

First point coordinate : 4.80 m

End point coordinate : 7.02 m



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Reinforcement No.	Origin I ₁ [m]	End I ₂ [m]	Height from bottom h[m]	Length l[m]
1	-2.52	-0.30	3.25	2.22

Reinforcement No. 4

Reinforcement type : Paragrid 40
Number of reinforcements 1
Reinforcement geometry : input coordinates
First point coordinate : 3.83 m
End point coordinate : 6.72 m

Reinforcement No.	Origin I ₁ [m]	End I ₂ [m]	Height from bottom h[m]	Length l[m]
1	-3.49	-0.60	2.60	2.89

Reinforcement No. 5

Reinforcement type : Paragrid 40
Number of reinforcements 1
Reinforcement geometry : input coordinates
First point coordinate : 2.86 m
End point coordinate : 6.00 m

Reinforcement No.	Origin I ₁ [m]	End I ₂ [m]	Height from bottom h[m]	Length l[m]
1	-4.46	-1.32	1.95	3.14

Reinforcement No. 6

Reinforcement type : Paragrid 40
Number of reinforcements 1
Reinforcement geometry : input coordinates
First point coordinate : 1.93 m
End point coordinate : 5.20 m

Reinforcement No.	Origin I ₁ [m]	End I ₂ [m]	Height from bottom h[m]	Length l[m]
1	-5.39	-2.12	1.30	3.27

Reinforcement No. 7

Reinforcement type : Paragrid 40
Number of reinforcements 1
Reinforcement geometry : input coordinates
First point coordinate : 0.97 m
End point coordinate : 4.80 m

Reinforcement No.	Origin I ₁ [m]	End I ₂ [m]	Height from bottom h[m]	Length l[m]
1	-6.35	-2.52	0.65	3.83

Reinforcement No. 8

Reinforcement type : Paragrid 40
Number of reinforcements 1
Reinforcement geometry : input coordinates
First point coordinate : 0.10 m
End point coordinate : 4.50 m

Reinforcement No.	Origin I ₁ [m]	End I ₂ [m]	Height from bottom h[m]	Length l[m]
1	-7.22	-2.82	0.00	4.40

Soil parameters

No Fines Concrete

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$



Angle of internal friction : $\phi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 30.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 24.50^\circ$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Class 6

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 21.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Firm silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 17.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Firm to Stiff slightly silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 32.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 19.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Type 1

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 21.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Fresh Rock (Granodiorite)

Unit weight : $\gamma = 22.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 31.50^\circ$
 Saturated unit weight : $\gamma_{sat} = 22.00 \text{ kN/m}^3$

Made Ground

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 32.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 17.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	2.65	Made Ground	



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No.	Layer [m]	Assigned soil	Pattern
2	-	Fresh Rock (Granodiorite)	

Terrain profile

Terrain behind the structure is flat.

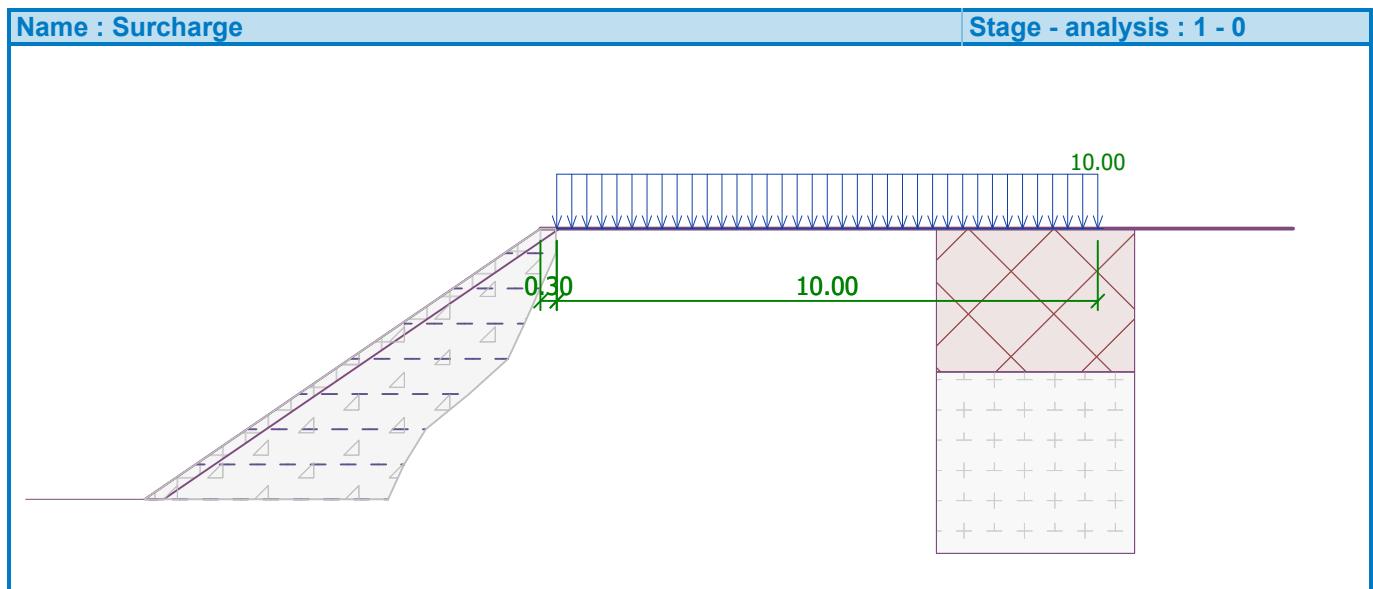
Water influence

Ground water table is not considered.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		variable	10.00		0.30	10.00	on terrain

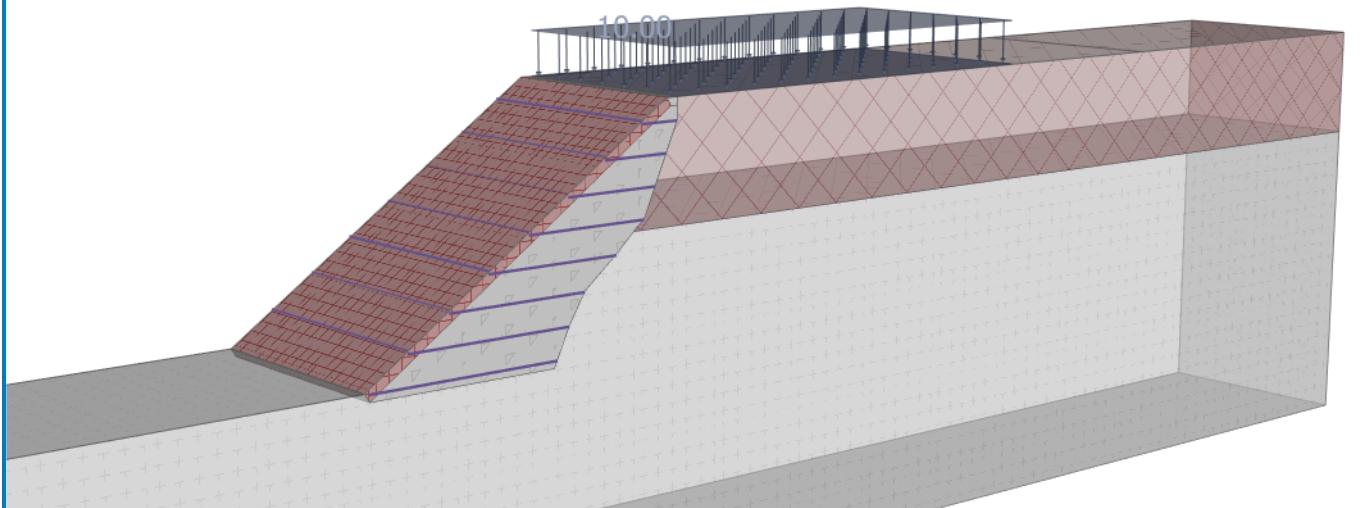
No.	Name
1	10kPa





Name : Surcharge

Stage - analysis : 1 - 0



Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Settings of the stage of construction

Design situation : permanent

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 - reinforced soil	0.00	-1.89	246.83	4.38	1.000	1.000	1.350
Active pressure	7.91	-3.23	1.10	7.19	1.350	1.350	1.000
10kPa	7.46	-3.31	1.32	7.29	1.500	1.500	1.500

Verification of complete wall

Check for overturning stability

Resisting moment $M_{res} = 1106.46 \text{ kNm/m}$

Overturning moment $M_{ovr} = 71.53 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 175.25 \text{ kN/m}$

Active horizontal force $H_{act} = 21.87 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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 - reinforced soil	0.00	-1.89	246.83	4.38	1.000	1.000	1.000
Active pressure	13.99	-2.85	0.30	8.56	1.000	1.000	1.000
10kPa	13.36	-2.80	0.61	8.22	1.300	1.300	1.300



Verification of complete wall

Check for overturning stability

Resisting moment $M_{res} = 1090.43 \text{ kNm/m}$
Overturning moment $M_{ovr} = 88.52 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 138.87 \text{ kN/m}$
Active horizontal force $H_{act} = 31.36 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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	-662.94	336.29	19.10	0.000	74.73
2	-471.78	250.29	21.87	0.000	55.62
3	-444.10	247.92	31.36	0.000	55.09
4	-444.10	247.92	31.36	0.000	55.09

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-487.85	249.24	15.37

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.000$
Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is **SATISFACTORY**

Verification of bearing capacity

Max. stress at footing bottom $\sigma = 74.73 \text{ kPa}$
Bearing capacity of foundation soil $R_d = 200.00 \text{ kPa}$

Bearing capacity of foundation soil is **SATISFACTORY**

Overall verification - bearing capacity of found. soil is **SATISFACTORY**

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of most utilized reinforcement)

Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Active pressure	0.46	-0.15	0.10	0.98	1.000
10kPa	1.48	-0.22	0.33	0.99	1.300
Weight - reinforced soil	0.00	-0.20	5.53	0.64	1.000
10kPa	0.00	-0.46	0.95	1.01	0.000



Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 8)

Inclination of slip surface	= 76.00 °
Overall normal force acting on reinforcement	= 6.06 kN/m
Coefficient of reduction of slip along geo-textile	= 0.80
Resistance along geo-reinforcement	= 3.39 kN/m
Wall resistance	= 0.00 kN/m
Overall bearing capacity of reinforcements	= 0.00 kN/m

Results for the most severe combination - No. 2

Check for slip:

Resisting horizontal force H_{res} = 3.39 kN/m
Active horiz. force H_{act} = 2.39 kN/m

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F_x [kN/m]	Depth $z[m]$	R_t [kN/m]	Utiliz. [%]	T_p [kN/m]	Utiliz. [%]
1	Paragrid 40	-2.22	5.01	25.81	8.62	509.81	0.44
2	Paragrid 40	-3.74	4.37	25.81	14.49	381.72	0.98
3	Paragrid 40	-3.49	3.73	25.81	13.51	280.54	1.24
4	Paragrid 40	-3.19	3.07	25.81	12.37	219.45	1.45
5	Paragrid 40	-2.85	2.42	25.81	11.05	160.38	1.78
6	Paragrid 40	-2.52	1.77	25.81	9.75	91.21	2.76
7	Paragrid 40	-2.21	1.13	25.81	8.55	41.69	5.29
8	Paragrid 40	-1.91	0.48	25.81	7.39	10.53	18.11

Check for tensile strength (reinforcement No.2)

Tension strength R_t = 25.81 kN/m
Force in reinforcement F_x = 3.74 kN/m

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.8)

Pull out resistance T_p = 10.53 kN/m
Force in reinforcement F_x = 1.91 kN/m

Reinforcement for pull out resistance is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY

Global stability analysis No. 1

Slip surface parameters

(slip surface after optimization)

Center S = (-6.81;-6.53) m

Radius r = 11.71 m

Angle α_1 = -9.77 °

α_2 = 56.11 °

Slope stability check (Bishop)

Utilization = 67.08 %

Slope stability is SATISFACTORY



Slope stability analysis

Input data

Project

Task : Vertica MacWall Design
 Part : Section 1-1
 Description : Verification of Global Stability for Entire Section 1-1
 Customer : Maccaferri Ltd.
 Author : Liam K. D.
 Date : 08/08/2017
 Project ID : Dominican Chapel, Newry
 Project number : 17-5479

Settings

Standard - EN 1997 - DA1

Stability analysis

Earthquake analysis : 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		
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]	
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]	
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]		

Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	$\gamma_\phi =$	1.00 [-]		1.25 [-]		
Partial factor on effective cohesion :	$\gamma_c =$	1.00 [-]		1.25 [-]		
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00 [-]		1.40 [-]		

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	0.50	8.35	0.50	8.36	0.50
		8.36	0.70	8.38	0.70	8.38	0.90
		8.39	0.90	8.39	1.10	8.41	1.10
		8.41	1.30	8.42	1.30	8.42	1.50
		8.44	1.50	8.44	1.70	8.45	1.70
		8.45	1.90	8.46	1.90	8.46	2.10
		8.48	2.10	8.48	2.30	8.49	2.30
		8.49	2.50	8.51	2.50	8.51	2.70
		8.52	2.70	8.52	2.90	8.54	2.90
		8.54	3.10	8.55	3.10	8.55	3.30
		8.57	3.30	8.57	3.50	8.58	3.50
		8.58	3.70	8.60	3.70	8.60	4.00
		8.88	4.00	8.88	3.95	8.97	3.95
		16.02	8.77	31.20	8.77		



No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
2		8.35	0.45	8.62	0.45	8.62	0.50
		8.64	0.50	8.64	0.70	8.65	0.70
		8.65	0.90	8.67	0.90	8.67	1.10
		8.68	1.10	8.68	1.30	8.70	1.30
		8.70	1.50	8.71	1.50	8.71	1.70
		8.72	1.70	9.69	1.70	9.71	1.76
		9.72	1.83	9.78	2.26	9.91	2.46
		9.93	2.48	10.16	2.63	10.40	2.71
		10.91	2.96	11.04	3.03	11.10	3.06
		11.30	3.31	11.44	3.36	11.46	3.37
		11.69	3.57	11.96	3.77	12.23	4.02
		12.33	4.09	12.38	4.09	12.64	4.38
		12.80	4.48	12.94	4.57	13.01	4.61
		13.05	4.62	13.15	4.69	13.26	4.80
		13.37	4.87	13.63	5.05	13.85	5.25
		14.01	5.38	14.08	5.45	14.13	5.54
		14.19	5.69	14.27	5.77	14.37	5.89
		14.53	5.97	14.83	6.13	15.83	8.36
		15.94	8.60	16.02	8.77		
3		8.88	3.76	15.94	8.60		
4		14.83	6.13	31.20	6.13		
5		8.88	3.89	8.97	3.95		
6		8.46	1.90	8.72	1.90	8.74	1.90
		8.74	2.10	8.75	2.10	8.75	2.30
		8.77	2.30	8.77	2.50	8.78	2.50
		8.78	2.70	8.80	2.70	8.80	2.90
		8.81	2.90	8.81	3.10	8.83	3.10
		8.83	3.30	8.84	3.30	8.84	3.50
		8.86	3.50	8.86	3.70	8.88	3.70
		8.88	3.76	8.88	3.89	8.88	3.95



No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
7		8.88	3.76	10.65	3.76	11.04	3.03
8		8.72	1.90	8.72	1.70		
9		8.35	0.30	8.62	0.30	8.62	0.31
		9.32	0.31	9.34	0.36	9.34	0.38
		9.36	0.44	9.37	0.50	9.39	0.57
		9.42	0.65	9.47	0.78	9.47	0.85
		9.48	0.95	9.49	0.97	9.50	1.05
		9.53	1.19	9.67	1.64	9.69	1.70
10		0.00	0.00	8.05	0.00	8.05	0.30
		8.35	0.30	8.35	0.45	8.35	0.50
11		8.62	0.45	8.62	0.31		
12		9.32	0.31	9.32	0.30		
13		8.05	0.00	8.32	0.00	9.32	0.00
		9.32	0.30	31.20	0.30		



Soil parameters - effective stress state

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
1	No Fines Concrete		45.00	30.00	18.00
2	Class 61		35.00	0.00	18.00
3	Firm silty sandy gravelly CLAY		30.00	0.00	19.00
4	Firm to Stiff slightly silty sandy gravelly CLAY		32.00	0.00	19.00
5	Type 1		35.00	0.00	18.00
6	Fresh Rock (Granodiorite)		45.00	0.00	22.00
7	Made Ground		32.00	0.00	18.50

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [-]
1	No Fines Concrete		18.00		
2	Class 61		18.00		
3	Firm silty sandy gravelly CLAY		19.00		
4	Firm to Stiff slightly silty sandy gravelly CLAY		19.00		
5	Type 1		18.00		
6	Fresh Rock (Granodiorite)		22.00		



No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [-]
7	Made Ground		18.50		

Soil parameters

No Fines Concrete

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 30.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Class 61

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Firm silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Firm to Stiff slightly silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 32.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Type 1

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Fresh Rock (Granodiorite)

Unit weight : $\gamma = 22.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 22.00 \text{ kN/m}^3$

Made Ground

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 32.00^\circ$



Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Rigid bodies

No.	Name	Sample	γ [kN/m ³]
1	Slope Cover Material		15.00
2	Vertica MacWall		20.00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		31.20	6.13	31.20	8.77	Made Ground
		16.02	8.77	15.94	8.60	
		15.83	8.36	14.83	6.13	
2		8.88	3.89	8.97	3.95	Slope Cover Material
		8.88	3.95			
3		8.88	3.76	15.94	8.60	Slope Cover Material
		16.02	8.77	8.97	3.95	
		8.88	3.89			
4		10.65	3.76	11.04	3.03	Class 61
		11.10	3.06	11.30	3.31	
		11.44	3.36	11.46	3.37	
		11.69	3.57	11.96	3.77	
		12.23	4.02	12.33	4.09	
		12.38	4.09	12.64	4.38	
		12.80	4.48	12.94	4.57	
		13.01	4.61	13.05	4.62	
		13.15	4.69	13.26	4.80	
		13.37	4.87	13.63	5.05	
		13.85	5.25	14.01	5.38	
		14.08	5.45	14.13	5.54	
		14.19	5.69	14.27	5.77	
		14.37	5.89	14.53	5.97	
		14.83	6.13	15.83	8.36	
		15.94	8.60	8.88	3.76	



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
5		8.72	1.90	8.74	1.90	Vertica MacWall
		8.74	2.10	8.75	2.10	
		8.75	2.30	8.77	2.30	
		8.77	2.50	8.78	2.50	
		8.78	2.70	8.80	2.70	
		8.80	2.90	8.81	2.90	
		8.81	3.10	8.83	3.10	
		8.83	3.30	8.84	3.30	
		8.84	3.50	8.86	3.50	
		8.86	3.70	8.88	3.70	
		8.88	3.76	8.88	3.89	
		8.88	3.95	8.88	4.00	
		8.60	4.00	8.60	3.70	
		8.58	3.70	8.58	3.50	
		8.57	3.50	8.57	3.30	
		8.55	3.30	8.55	3.10	
		8.54	3.10	8.54	2.90	
		8.52	2.90	8.52	2.70	
		8.51	2.70	8.51	2.50	
6		8.49	2.50	8.49	2.30	No Fines Concrete
		8.48	2.30	8.48	2.10	
		8.46	2.10	8.46	1.90	
		8.72	1.70	9.69	1.70	
		9.71	1.76	9.72	1.83	
		9.78	2.26	9.91	2.46	
		9.93	2.48	10.16	2.63	
		10.40	2.71	10.91	2.96	
		11.04	3.03	10.65	3.76	
		8.88	3.76	8.88	3.70	
		8.86	3.70	8.86	3.50	
		8.84	3.50	8.84	3.30	
		8.83	3.30	8.83	3.10	
		8.81	3.10	8.81	2.90	
		8.80	2.90	8.80	2.70	
7		8.78	2.70	8.78	2.50	Vertica MacWall
		8.77	2.50	8.77	2.30	
		8.75	2.30	8.75	2.10	
		8.74	2.10	8.74	1.90	
		8.72	1.90	8.62	0.45	
		8.62	0.50	8.64	0.50	
		8.64	0.70	8.65	0.70	
		8.65	0.90	8.67	0.90	
		8.67	1.10	8.68	1.10	
		8.68	1.30	8.70	1.30	
		8.70	1.50	8.71	1.50	
		8.71	1.70	8.72	1.70	
		8.72	1.90	8.46	1.90	
		8.45	1.90	8.45	1.70	
		8.44	1.70	8.44	1.50	



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
8		8.42	1.50	8.42	1.30	
		8.41	1.30	8.41	1.10	
		8.39	1.10	8.39	0.90	
		8.38	0.90	8.38	0.70	
		8.36	0.70	8.36	0.50	
		8.35	0.50			
		8.62	0.31	9.32	0.31	No Fines Concrete
		9.34	0.36	9.34	0.38	
		9.36	0.44	9.37	0.50	
		9.39	0.57	9.42	0.65	
		9.47	0.78	9.47	0.85	
		9.48	0.95	9.49	0.97	
		9.50	1.05	9.53	1.19	
		9.67	1.64	9.69	1.70	
		8.72	1.70	8.71	1.70	
		8.71	1.50	8.70	1.50	
		8.70	1.30	8.68	1.30	
		8.68	1.10	8.67	1.10	
		8.67	0.90	8.65	0.90	
		8.65	0.70	8.64	0.70	
		8.64	0.50	8.62	0.50	
		8.62	0.45			
9		31.20	0.30	31.20	6.13	Fresh Rock (Granodiorite)
		14.83	6.13	14.53	5.97	
		14.37	5.89	14.27	5.77	
		14.19	5.69	14.13	5.54	
		14.08	5.45	14.01	5.38	
		13.85	5.25	13.63	5.05	
		13.37	4.87	13.26	4.80	
		13.15	4.69	13.05	4.62	
		13.01	4.61	12.94	4.57	
		12.80	4.48	12.64	4.38	
		12.38	4.09	12.33	4.09	
		12.23	4.02	11.96	3.77	
		11.69	3.57	11.46	3.37	
		11.44	3.36	11.30	3.31	
		11.10	3.06	11.04	3.03	
		10.91	2.96	10.40	2.71	
		10.16	2.63	9.93	2.48	
		9.91	2.46	9.78	2.26	
		9.72	1.83	9.71	1.76	
		9.69	1.70	9.67	1.64	
		9.53	1.19	9.50	1.05	
		9.49	0.97	9.48	0.95	
		9.47	0.85	9.47	0.78	
		9.42	0.65	9.39	0.57	
		9.37	0.50	9.36	0.44	
		9.34	0.38	9.34	0.36	
		9.32	0.31	9.32	0.30	



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
10		8.62	0.45	8.35	0.45	Vertica MacWall
		8.35	0.30	8.62	0.30	
		8.62	0.31			
11		8.05	0.00	8.05	0.30	Firm to Stiff slightly silty sandy gravelly CLAY
		8.35	0.30	8.35	0.45	
		8.35	0.50	0.00	0.50	
		0.00	0.00			
12		8.32	0.00	9.32	0.00	No Fines Concrete
		9.32	0.30	9.32	0.31	
		8.62	0.31	8.62	0.30	
		8.35	0.30	8.05	0.30	
		8.05	0.00			
13		9.32	0.30	9.32	0.00	Fresh Rock (Granodiorite)
		8.32	0.00	8.05	0.00	
		0.00	0.00	0.00	-5.00	
		31.20	-5.00	31.20	0.30	

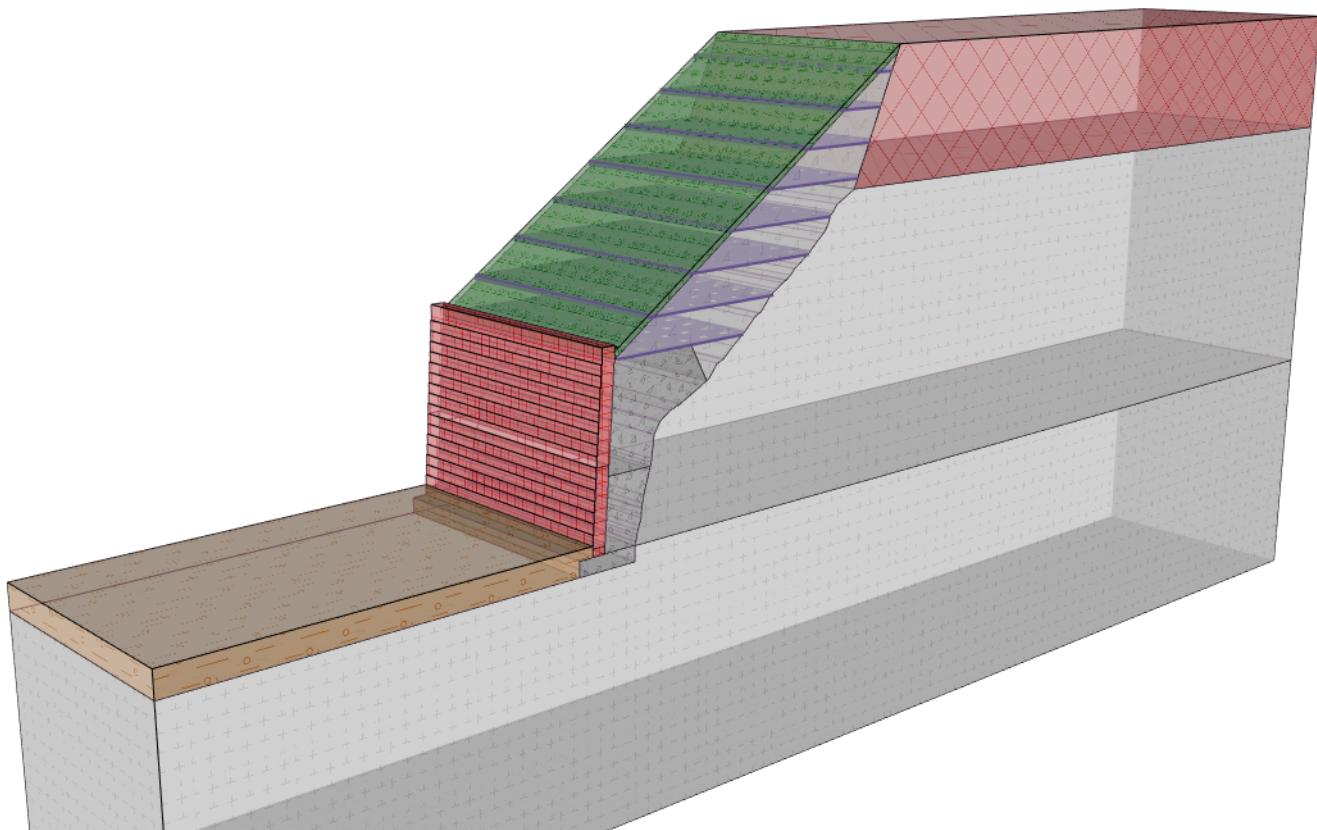


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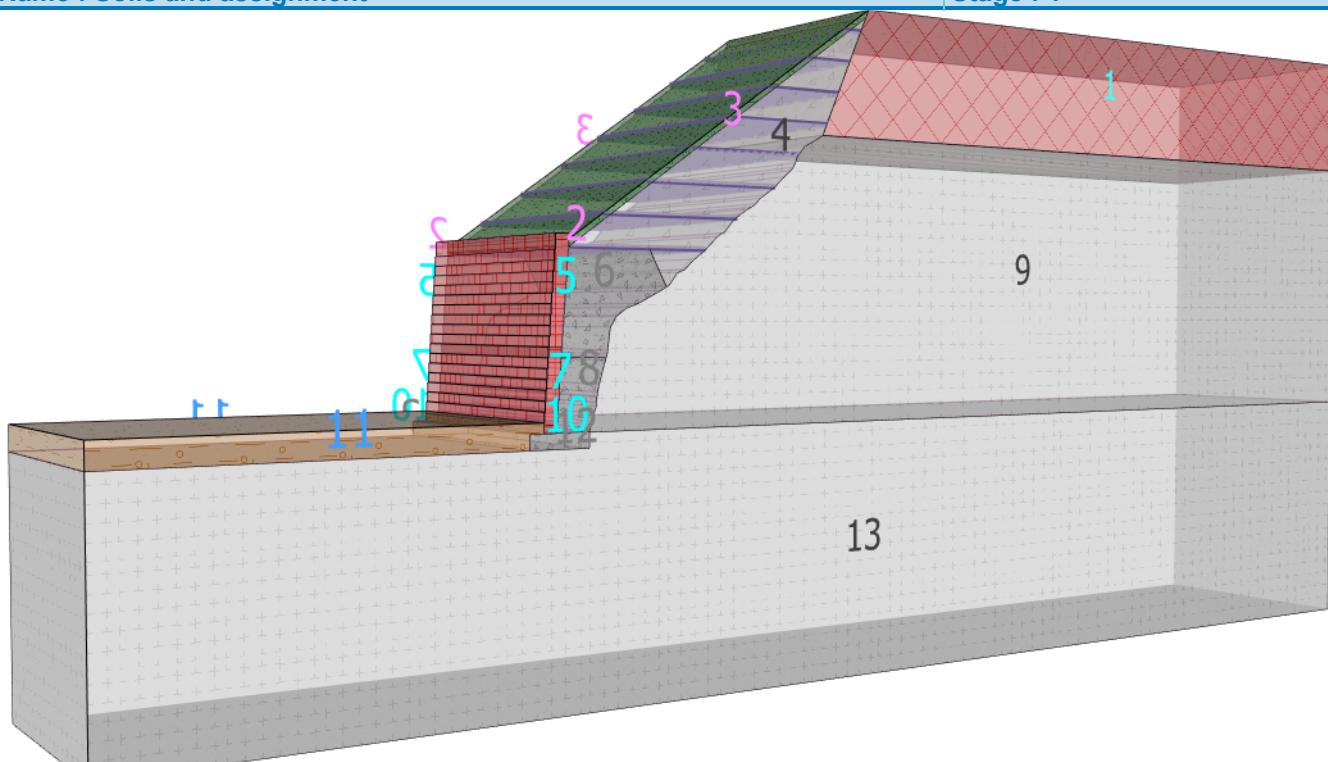
Name : Project Overview

Stage : 1



Name : Soils and assignment

Stage : 1



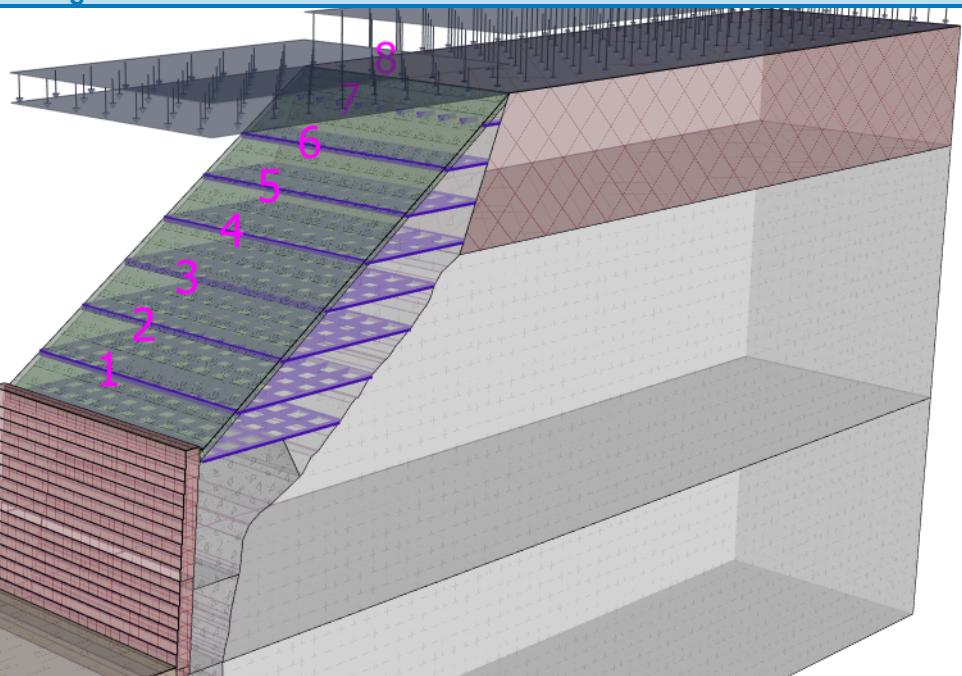
Reinforcements

No.	Point to the left		Point to the right		Length L [m]	Strength R _t [kN/m]	Pull out resist.	End of reinf.
	x [m]	z [m]	x [m]	z [m]				
1	8.93	3.77	11.95	3.77	3.02	50.00	C = 0.80	Free
2	9.64	4.40	12.71	4.40	3.07	50.00	C = 0.80	Free
3	10.60	5.05	13.63	5.05	3.03	50.00	C = 0.80	Free
4	11.58	5.70	14.20	5.70	2.62	50.00	C = 0.80	Free
5	12.50	6.35	14.93	6.35	2.43	50.00	C = 0.80	Free
6	13.45	7.00	15.22	7.00	1.77	50.00	C = 0.80	Free
7	14.40	7.65	15.51	7.65	1.11	50.00	C = 0.80	Free
8	15.34	8.30	15.80	8.30	0.46	50.00	C = 0.80	Free

Name : Reinforcements

Stage : 1

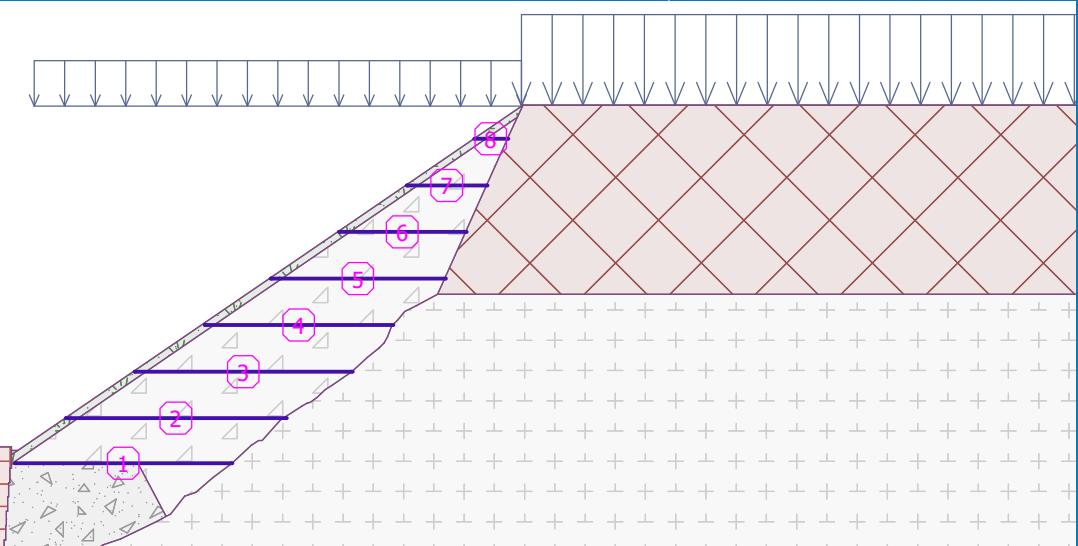
Description : Minimum 50kNm Strength





Name : Reinforcements

Stage : 1



Surcharge

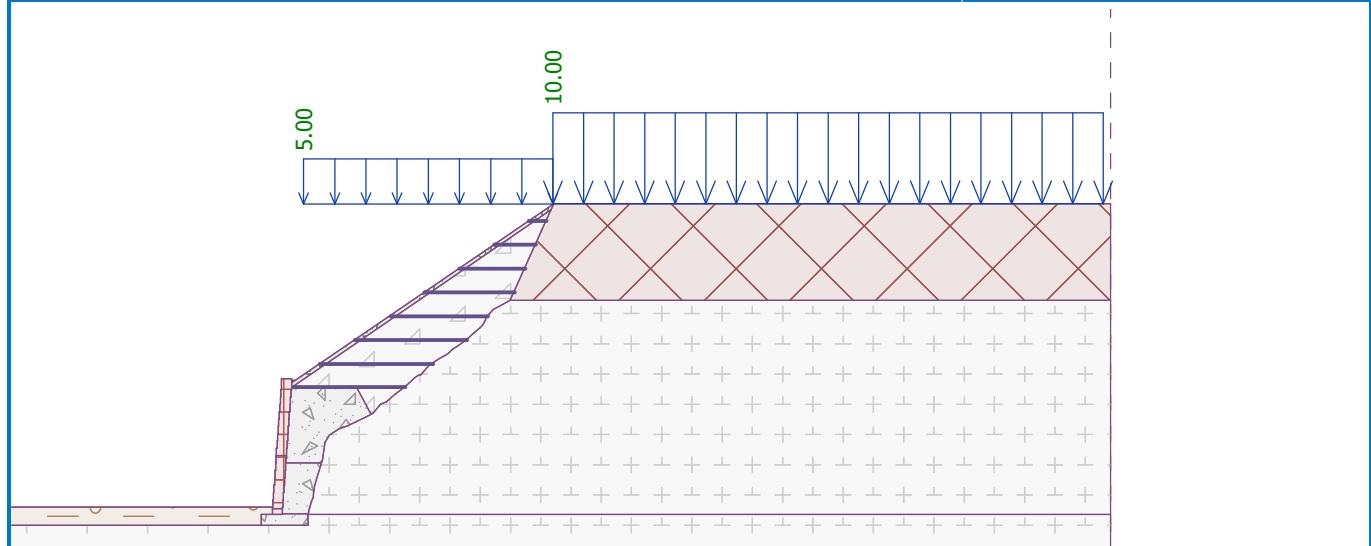
No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	q, q1, f, F	q2	Magnitude	unit
1	strip	variable	on terrain	x = 9.20	l = 6.80		0.00	5.00			kN/m ²
2	strip	variable	on terrain	x = 16.00	l = 15.00		0.00	10.00			kN/m ²

Surcharges

No.	Name
1	5kPa Load
2	10kPa Load

Name : Surcharge

Stage : 1



Water

Water type : No water

Tensile crack

Tensile crack not input.



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 =	6.06 [m]	Angles :	α_1 =	-16.45 [°]
	z =	11.75 [m]		α_2 =	75.28 [°]
Radius :	R =	11.73 [m]			
The slip surface after optimization.					

Reinforcement bearing capacity

Combination 1

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00
7	0.00
8	0.00

Combination 2

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00
7	0.00
8	0.00

Slope stability verification (Bishop)

Combination 1

Sum of active forces : $F_a = 424.37$ kN/m

Sum of passive forces : $F_p = 692.93$ kN/m

Sliding moment : $M_a = 4973.64$ kNm/m

Resisting moment : $M_p = 8121.12$ kNm/m

Utilization : 61.2 %

Slope stability ACCEPTABLE

Combination 2

Sum of active forces : $F_a = 376.03$ kN/m

Sum of passive forces : $F_p = 519.94$ kN/m

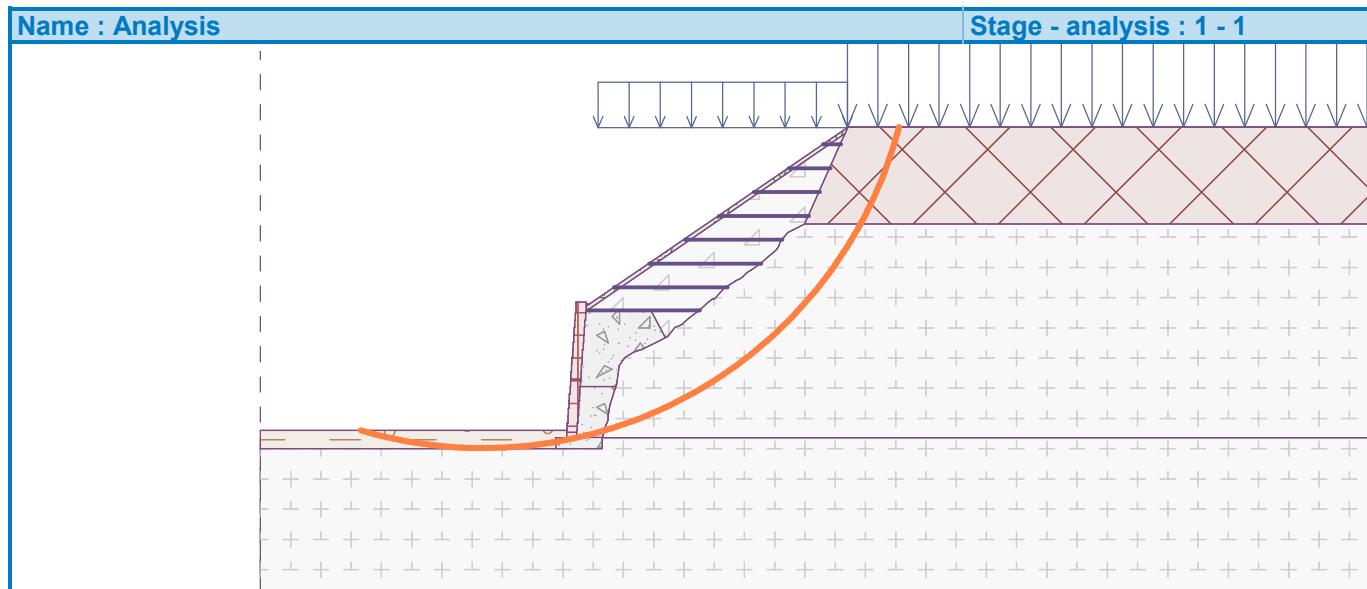
Sliding moment : $M_a = 4410.82$ kNm/m

Resisting moment : $M_p = 6098.87$ kNm/m

Utilization : 72.3 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2



Analysis 2

Circular slip surface

Slip surface parameters					
Center :	x =	6.06 [m]	Angles :	α_1 =	-16.45 [°]
	z =	11.75 [m]		α_2 =	75.28 [°]
Radius :	R =	11.73 [m]	Analysis of the slip surface without optimization.		

Reinforcement bearing capacity

Combination 1

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00
7	0.00
8	0.00

Combination 2

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00
7	0.00
8	0.00

Slope stability verification (all methods)

Combination 1

Bishop : Utilization = 61.3 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 70.0 % **ACCEPTABLE**
 Spencer : Utilization = 61.9 % **ACCEPTABLE**
 Janbu : Utilization = 44.4 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 61.9 % **ACCEPTABLE**



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Combination 2

Bishop : Utilization = 72.3 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 81.8 % **ACCEPTABLE**
Spencer : Utilization = 73.2 % **ACCEPTABLE**
Janbu : Utilization = 54.1 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 73.1 % **ACCEPTABLE**



Analysis of reinforced slopes

Input data

Project

Task : Vertica MacWall Design
 Part : Section 2-2
 Description : Internal Verification of lower tier MacWall with NFC Fill
 Customer : Maccaferri Ltd.
 Author : Liam K. D.
 Date : 08/08/2017
 Project ID : Dominican Chapel, Newry
 Project number : 17-5479

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
 Allowable eccentricity : 0.333
 Internal stability : Standard - straight slip surface
 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	
Permanent actions :	$\gamma_G =$	1.35	[$-$]	1.00	[$-$]
Variable actions :	$\gamma_Q =$	1.50	[$-$]	0.00	[$-$]
Water load :	$\gamma_w =$	1.35	[$-$]		
				1.00	[$-$]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[$-$]	1.25	[$-$]
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[$-$]	1.25	[$-$]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[$-$]	1.40	[$-$]
Partial factor on Poisson's ratio :	$\gamma_v =$	1.00	[$-$]	1.00	[$-$]

Partial factors for variable actions					
Permanent design situation					
Factor for combination value :		$\psi_0 =$		0.70	[$-$]
Factor for frequent value :		$\psi_1 =$		0.50	[$-$]
Factor for quasi-permanent value :		$\psi_2 =$		0.30	[$-$]

Stability analysis

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 :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]	
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]	
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]		

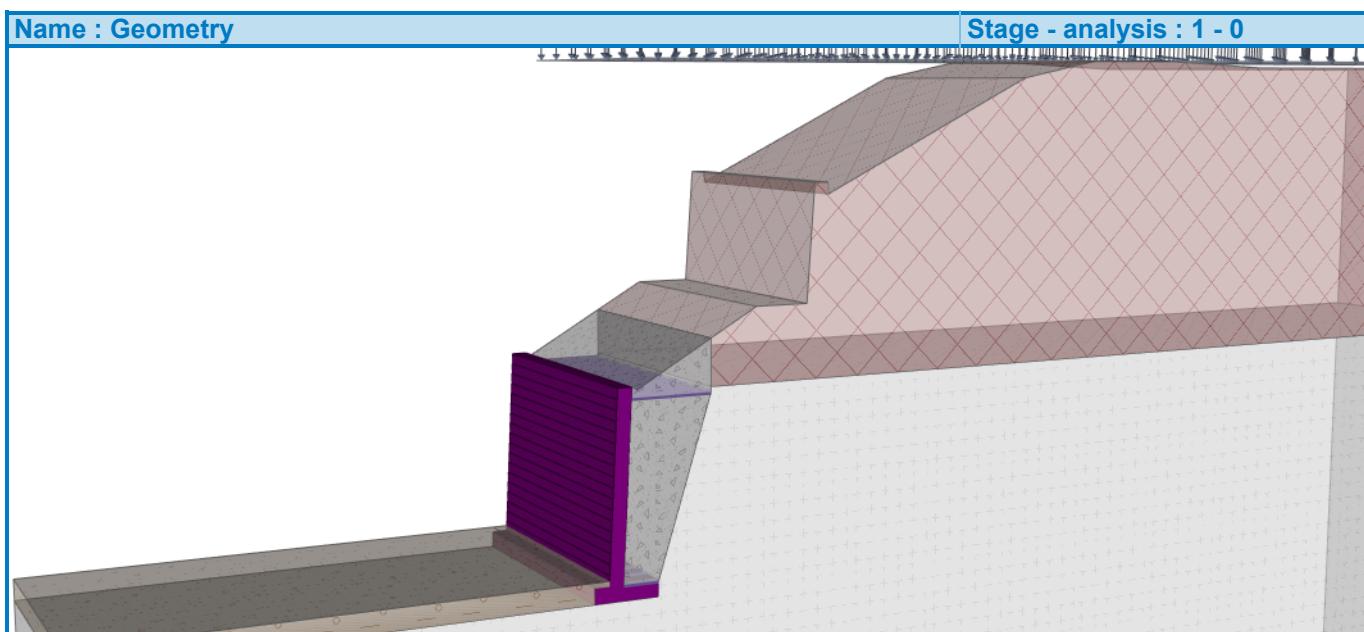
Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[-]	1.25	[-]	
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[-]	1.25	[-]	
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[-]	1.40	[-]	

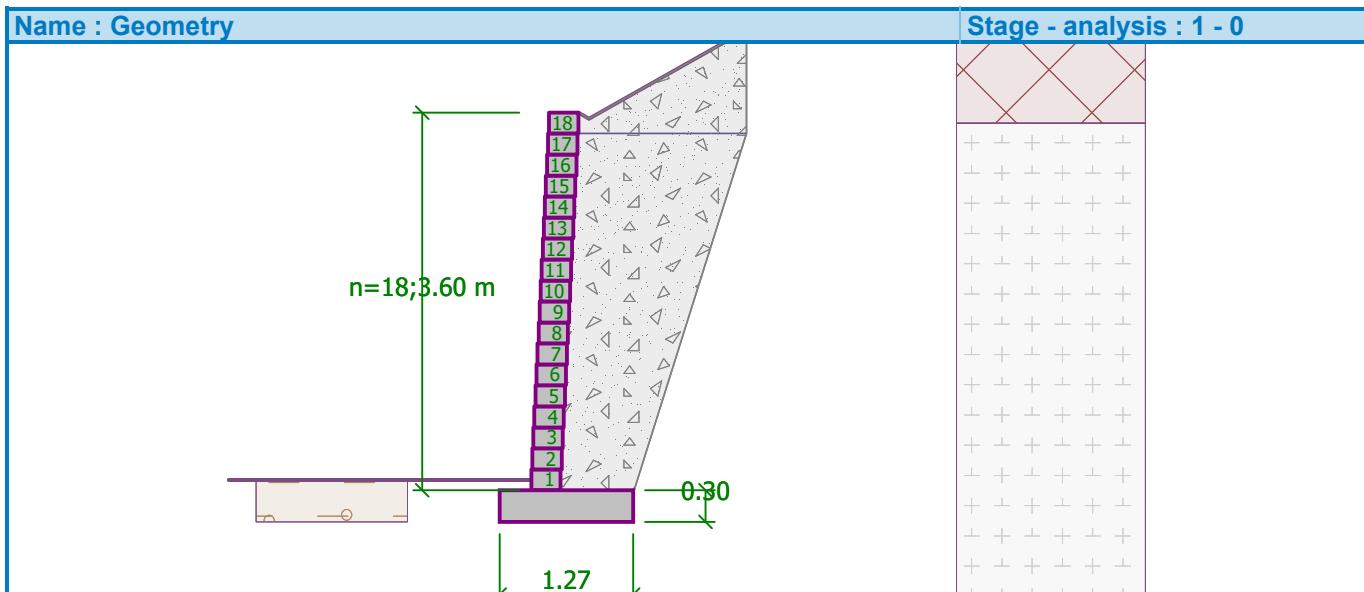
Geometry of structure

Number of blocks $n = 18$
 Block height $h = 0.20 \text{ m}$
 Block width $b = 0.28 \text{ m}$
 Block offset $o_1 = 0.01 \text{ m}$

Structure foundation

Foundation width $b_b = 1.27 \text{ m}$
 Foundation height $l_b = 0.30 \text{ m}$
 Foundation offset $a_b = 0.30 \text{ m}$





Material

Block material

Unit weight γ = 20.00 kN/m³

Cohesion c = 0.00 kPa

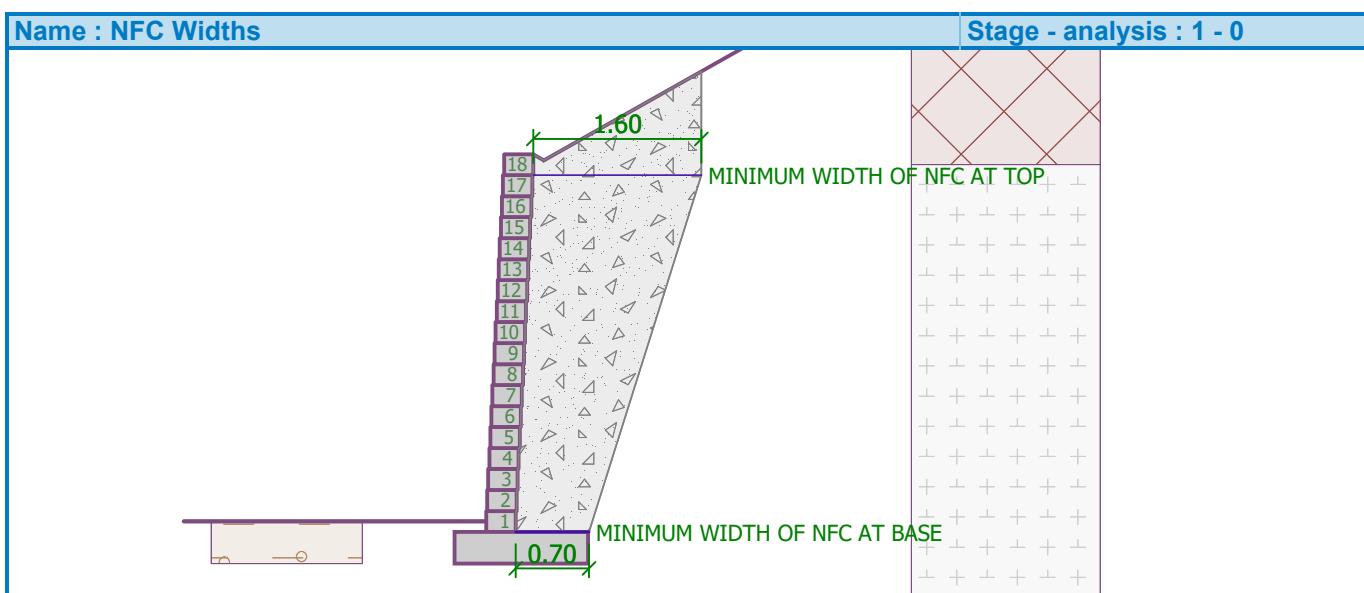
Friction f = 0.533

Shear bearing capacity of joint R_s = 0.00 kN/m

Reinforced soil - No Fines Concrete

Reinforcement

Total number of input reinforcements : 2.



Soil parameters

No Fines Concrete

Unit weight : γ = 18.00 kN/m³

Angle of internal friction : ϕ_{ef} = 45.00 °

Cohesion of soil : c_{ef} = 30.00 kPa

Angle of friction struc.-soil : δ = 24.50 °



Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Class 6I

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 35.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 21.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Firm silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 30.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 17.00^\circ$

Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Firm to Stiff slightly silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 32.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 19.00^\circ$

Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Type 1

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 35.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 21.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Fresh Rock (Granodiorite)

Unit weight : $\gamma = 22.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 45.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 31.50^\circ$

Saturated unit weight : $\gamma_{sat} = 22.00 \text{ kN/m}^3$

Made Ground

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 32.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 17.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	0.10	Made Ground	
2	-	Fresh Rock (Granodiorite)	



Terrain profile

No.	Coordinate x [m]	Depth z [m]
1	0.00	0.00
2	0.10	0.06
3	2.54	-1.32
4	3.61	-1.32
5	3.76	-3.56
6	4.04	-3.56
7	4.05	-3.34
8	8.48	-5.48
9	10.18	-5.81
10	12.09	-5.81
11	14.44	-5.69
12	15.44	-5.69

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

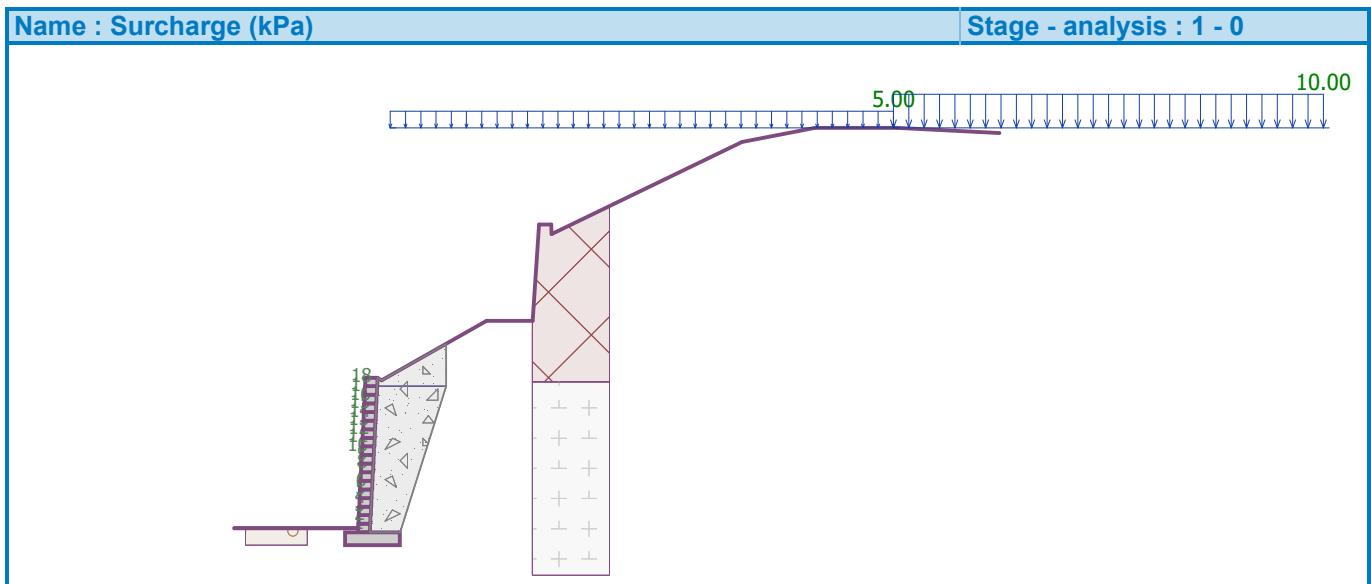
Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		variable	5.00		0.30	11.70	on terrain
2	Yes		variable	10.00		12.00	10.00	on terrain

No.	Name
1	5kPa Load
2	10kPa Load



Resistance on front face of the structure

Resistance on front face of the structure: not considered



Soil on front face of the structure - Firm to Stiff slightly silty sandy gravelly CLAY
Soil thickness in front of structure $h = 0.40 \text{ m}$

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent

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 - reinforced soil	0.00	-2.37	93.08	1.31	1.000	1.000	1.350
Active pressure	24.37	-1.80	14.20	1.34	1.350	1.350	1.000
5kPa Load	6.52	-2.61	3.04	1.58	1.500	1.500	1.500
10kPa Load	3.96	-1.47	2.23	1.31	1.500	1.500	1.500
Weight - wall	0.00	-2.10	20.16	0.53	1.000	1.000	1.350
5kPa Load	0.00	-4.32	6.50	1.70	0.000	0.000	1.500

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment $M_{res} = 169.99 \text{ kNm/m}$
Overturning moment $M_{ovr} = 93.35 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 140.32 \text{ kN/m}$
Active horizontal force $H_{act} = 48.61 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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 - reinforced soil	0.00	-2.37	93.08	1.31	1.000	1.000	1.000
Active pressure	39.47	-1.81	17.08	1.33	1.000	1.000	1.000
5kPa Load	9.65	-2.54	3.35	1.54	1.300	1.300	1.300
10kPa Load	9.97	-2.60	3.42	1.56	1.300	1.300	1.300
Weight - wall	0.00	-2.10	20.16	0.53	1.000	1.000	1.000
5kPa Load	0.00	-4.32	6.50	1.70	0.000	0.000	1.300

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment $M_{res} = 169.15 \text{ kNm/m}$
Overturning moment $M_{ovr} = 137.09 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip



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Section 2-2
17-5479

Resisting horizontal force H_{res} = 111.29 kN/m
Active horizontal force H_{act} = 64.99 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-2.10	20.16	0.53	1.000	1.000	1.350
Weight - earth wedge	0.00	-0.93	11.79	0.84	1.000	1.000	1.350
Active pressure	12.36	-0.89	23.91	1.08	1.350	1.000	1.350
5kPa Load	0.46	-0.94	1.58	0.92	0.000	0.000	1.500
10kPa Load	0.00	-3.90	0.00	0.75	0.000	0.000	1.500
Reinforcement	-19.17	-0.30	0.00	0.88	1.000	1.000	1.000
Reinforcement	-12.97	-3.70	0.00	1.71	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment M_{res} = 109.15 kNm/m
Overturning moment M_{ovr} = 14.84 kNm/m

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 88.01 kN/m
Active horizontal force H_{act} = 12.36 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-2.10	20.16	0.53	1.000	1.000	1.000
Weight - earth wedge	0.00	-0.93	11.79	0.84	1.000	1.000	1.000
Active pressure	23.58	-0.89	33.00	1.06	1.000	1.000	1.000
5kPa Load	1.08	-0.86	1.83	0.92	1.300	0.000	1.300
10kPa Load	0.88	-0.39	0.82	1.18	0.000	1.300	1.300
Reinforcement	-19.17	-0.30	0.00	0.88	1.000	1.000	1.000
Reinforcement	-12.98	-3.70	0.00	1.71	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment M_{res} = 111.56 kNm/m
Overturning moment M_{ovr} = 22.16 kNm/m

Wall for overturning is SATISFACTORY



Check for slip

Resisting horizontal force $H_{res} = 84.96 \text{ kN/m}$

Active horizontal force $H_{act} = 24.73 \text{ kN/m}$

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

No. 2

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	-1.80	20.16	0.23	1.000	1.000	1.350
Active pressure	0.00	-3.60	0.00	0.45	1.000	1.000	1.000
5kPa Load	0.00	-3.60	1.14	0.36	0.000	0.000	1.500
10kPa Load	0.00	-3.60	0.00	0.45	0.000	0.000	1.500
Reinforcement	-13.26	-3.40	0.00	1.38	1.000	1.000	1.000

Check of construction joint above the most utilized block No.: 0

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 49.62 \text{ kNm/m}$

Overturning moment $M_{ovr} = 0.00 \text{ kNm/m}$

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 24.00 \text{ kN/m}$

Active horizontal force $H_{act} = 0.00 \text{ kN/m}$

Joint for slip is SATISFACTORY

Joint is SATISFACTORY

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	-1.80	20.16	0.23	1.000	1.000	1.000
Active pressure	5.39	-0.51	2.07	0.31	1.000	1.000	1.000
5kPa Load	1.31	-0.60	1.36	0.36	1.300	1.300	1.300
10kPa Load	1.05	-0.35	0.41	0.29	1.300	1.300	1.300
Reinforcement	-13.26	-3.40	0.00	1.38	1.000	1.000	1.000

Check of construction joint above the most utilized block No.: 0

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 51.06 \text{ kNm/m}$

Overturning moment $M_{ovr} = 4.23 \text{ kNm/m}$

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 26.33 \text{ kN/m}$



Active horizontal force $H_{act} = 8.45 \text{ kN/m}$

Joint for slip is SATISFACTORY

Joint is SATISFACTORY

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	-53.63	77.80	-14.77	0.000	61.26
2	-53.52	64.23	-19.78	0.000	50.58
3	0.00	0.00	0.00	0.000	0.00
4	0.00	0.00	0.00	0.000	0.00

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-53.65	57.45	-19.32
2	-53.62	55.87	-19.78

Verification of foundation soil

Place of verification : bottom of leveling pad

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.000$

Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom $\sigma = 61.26 \text{ kPa}$

Bearing capacity of foundation soil $R_d = 200.00 \text{ kPa}$

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY



Analysis of reinforced slopes

Input data

Project

Task : Vertica MacWall Design
 Part : Section 2-2
 Description : Internal Verification of upper tier MacWall - MSE
 Customer : Maccaferri Ltd.
 Author : Liam K. D.
 Date : 08/08/2017
 Project ID : Dominican Chapel, Newry
 Project number : 17-5479

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
 Allowable eccentricity : 0.333
 Internal stability : Standard - straight slip surface
 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	
Permanent actions :	$\gamma_G =$	1.35	[$-$]	1.00	[$-$]
Variable actions :	$\gamma_Q =$	1.50	[$-$]	0.00	[$-$]
Water load :	$\gamma_w =$	1.35	[$-$]		
				1.00	[$-$]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[$-$]	1.25	[$-$]
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[$-$]	1.25	[$-$]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[$-$]	1.40	[$-$]
Partial factor on Poisson's ratio :	$\gamma_v =$	1.00	[$-$]	1.00	[$-$]

Partial factors for variable actions					
Permanent design situation					
Factor for combination value :		$\psi_0 =$		0.70	[$-$]
Factor for frequent value :		$\psi_1 =$		0.50	[$-$]
Factor for quasi-permanent value :		$\psi_2 =$		0.30	[$-$]

Stability analysis

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		
Permanent actions :	$\gamma_G =$	1.35	[–]	1.00	[–]	1.00 [–]
Variable actions :	$\gamma_Q =$	1.50	[–]	0.00	[–]	0.00 [–]
Water load :	$\gamma_w =$	1.35	[–]			1.00 [–]

Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[–]	1.25	[–]	
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[–]	1.25	[–]	
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[–]	1.40	[–]	

Geometry of structure

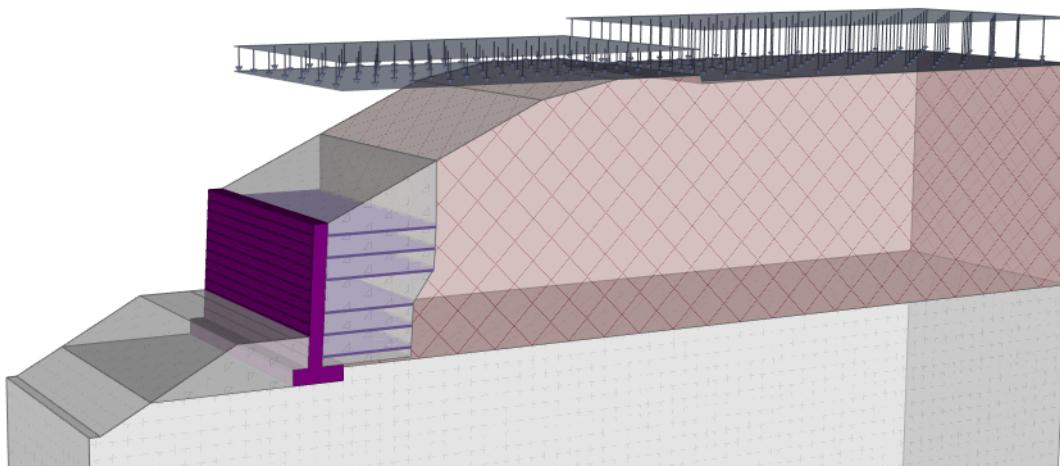
Number of blocks $n = 13$
 Block height $h = 0.20 \text{ m}$
 Block width $b = 0.28 \text{ m}$
 Block offset $o_1 = 0.01 \text{ m}$

Structure foundation

Foundation width $b_b = 1.00 \text{ m}$
 Foundation height $l_b = 0.30 \text{ m}$
 Foundation offset $a_b = 0.30 \text{ m}$

Name : Geometry

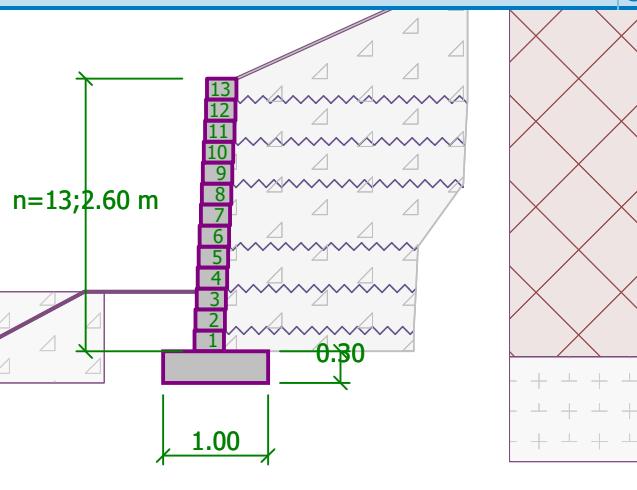
Stage - analysis : 1 - 0





Name : Geometry

Stage - analysis : 1 - 0



Material

Block material

Unit weight γ = 20.00 kN/m³

Cohesion c = 0.00 kPa

Friction f = 0.533

Shear bearing capacity of joint R_s = 0.00 kN/m

Reinforced soil - Class 61

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Reinforcement strength		Coefficient	
				T _{ult} [kN/m]	R _t [kN/m]	C _{ds} [–]	C _i [–]
1	Paragrid - 6th Course	Paragrid 40	~~~~~	40.00	27.19	0.80	0.90
2	Paragrid - 4th Course	Paragrid 40	~~~~~	40.00	27.19	0.80	0.90
3	Paragrid - 3rd Course	Paragrid 40	~~~~~	40.00	27.19	0.80	0.90
4	Paragrid - 2nd Course	Paragrid 40	~~~~~	40.00	27.19	0.80	0.90
5	Paragrid - 1st Course	Paragrid 40	~~~~~	40.00	27.19	0.80	0.90
6	Paragrid - 5th Course	Paragrid 40	~~~~~	40.00	27.19	0.80	0.90

Reinforcement

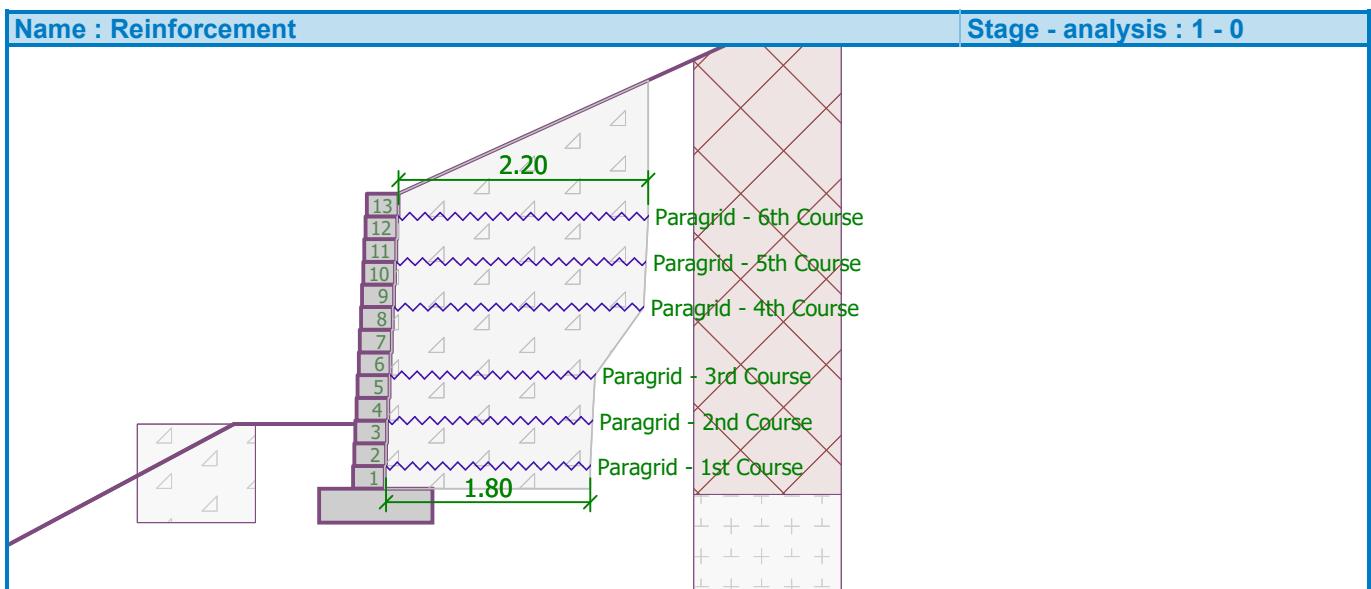
Total number of input reinforcements : 6.

Reinforcement details

Block No.	Type of reinforcement	Origin l ₁ [m]	End l ₂ [m]	Height from bottom h[m]	Length l[m]
2	Paragrid - 1st Course	-0.11	1.69	0.20	1.80
4	Paragrid - 2nd Course	-0.09	1.71	0.60	1.80
6	Paragrid - 3rd Course	-0.07	1.73	1.00	1.80
9	Paragrid - 4th Course	-0.04	2.16	1.60	2.20



Block No.	Type of reinforcement	Origin I ₁ [m]	End I ₂ [m]	Height from bottom h[m]	Length l[m]
11	Paragrid - 5th Course	-0.02	2.18	2.00	2.20
13	Paragrid - 6th Course	0.00	2.20	2.40	2.20



Soil parameters

No Fines Concrete

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 30.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 24.50^\circ$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Made Ground

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 32.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 17.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Class 6I

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 21.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Firm silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Angle of internal friction : $\phi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 17.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$



Firm to Stiff slightly silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 32.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 19.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Type 1

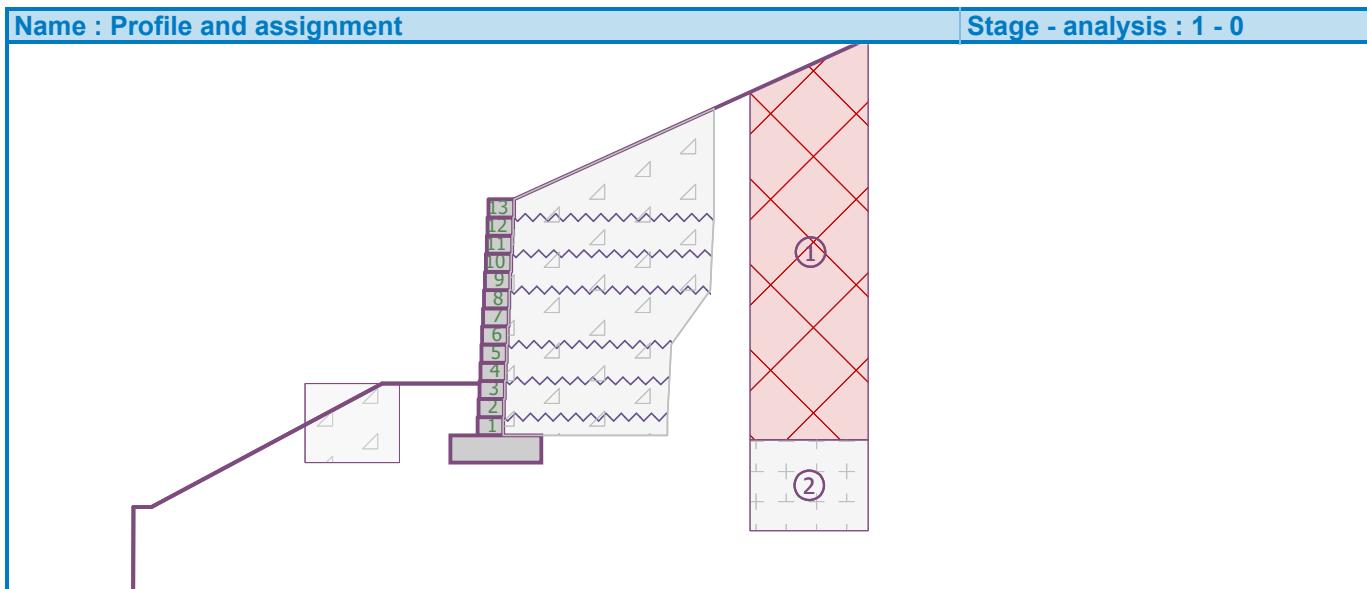
Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 21.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Fresh Rock (Granodiorite)

Unit weight : $\gamma = 22.00 \text{ kN/m}^3$
 Angle of internal friction : $\varphi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Angle of friction struc.-soil : $\delta = 31.50^\circ$
 Saturated unit weight : $\gamma_{sat} = 22.00 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	2.65	Made Ground	
2	-	Fresh Rock (Granodiorite)	



Terrain profile

No.	Coordinate x [m]	Depth z [m]
1	0.00	0.00



No.	Coordinate x [m]	Depth z [m]
2	4.45	-2.02
3	6.14	-2.35
4	8.05	-2.35
5	8.10	-2.19
6	10.40	-2.23
7	11.40	-2.23

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

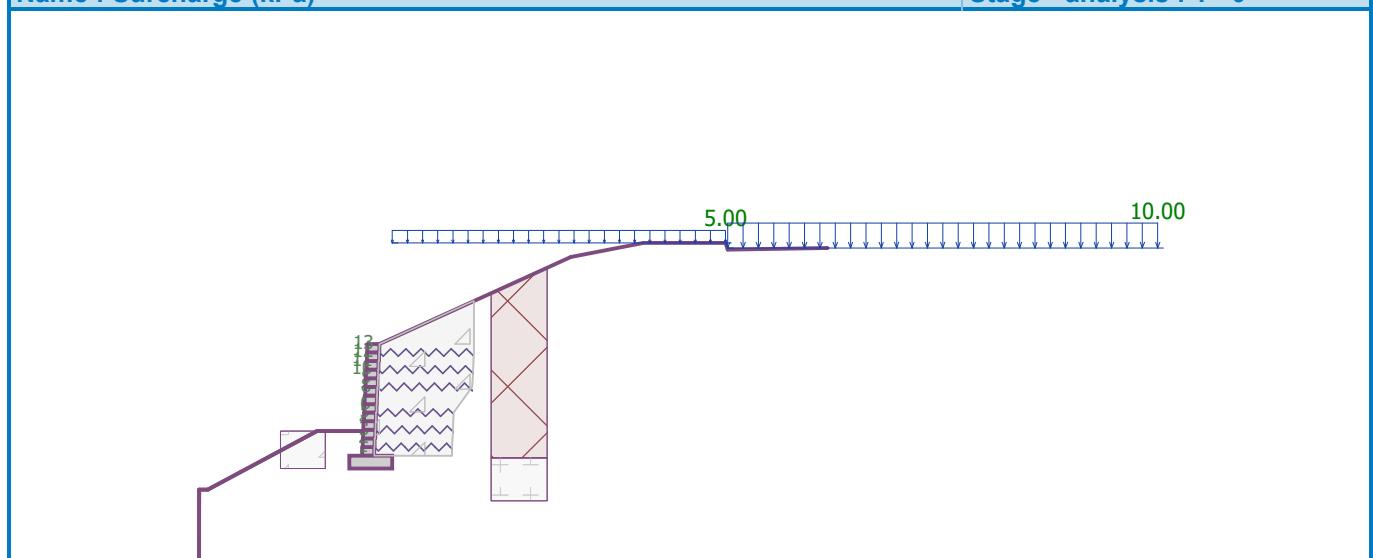
Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		variable	5.00		0.30	7.75	on terrain
2	Yes		variable	10.00		8.10	10.00	on terrain
No.	Name							
1	5kPa Load							
2	10kPa Load							

Name : Surcharge (kPa) Stage - analysis : 1 - 0



Resistance on front face of the structure

Resistance on front face of the structure: not considered

Soil on front face of the structure - Class 61

Soil thickness in front of structure h = 0.87 m

Terrain shape in front of structure

No.	Coordinate x[m]	Depth z[m]
1	0.00	0.00
2	0.00	-0.87



No.	Coordinate x[m]	Depth z[m]
3	-1.07	-0.87
4	-3.61	0.49
5	-3.81	0.49
6	-3.82	3.61
7	-4.82	3.61

Origin [0,0] is located in bottom left edge of construction.
Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

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 - reinforced soil	0.00	-1.90	116.88	1.71	1.000	1.000	1.350
Active pressure	37.89	-1.33	20.22	2.46	1.350	1.350	1.000
5kPa Load	5.48	-2.02	2.56	2.60	1.500	1.500	1.500
10kPa Load	3.14	-0.76	1.97	2.37	0.000	1.500	1.500
Weight - wall	0.00	-1.60	14.56	0.50	1.000	1.000	1.350
5kPa Load	0.00	-3.47	9.50	1.95	0.000	0.000	1.500

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment $M_{res} = 284.03 \text{ kNm/m}$

Overslipping moment $M_{ovr} = 84.52 \text{ kNm/m}$

Wall for overslipping is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 103.43 \text{ kN/m}$

Active horizontal force $H_{act} = 64.08 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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 - reinforced soil	0.00	-1.90	116.88	1.71	1.000	1.000	1.000
Active pressure	52.17	-1.38	21.11	2.46	1.000	1.000	1.000
5kPa Load	7.26	-2.01	2.55	2.60	1.300	1.300	1.300
10kPa Load	6.70	-1.22	2.32	2.40	1.300	1.300	1.300
Weight - wall	0.00	-1.60	14.56	0.50	1.000	1.000	1.000
5kPa Load	0.00	-3.47	9.50	1.95	0.000	0.000	1.300

Verification of complete wall

Place of verification : bottom of leveling pad



Check for overturning stability

Resisting moment $M_{res} = 274.82 \text{ kNm/m}$

Overturning moment $M_{ovr} = 101.81 \text{ kNm/m}$

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 79.43 \text{ kN/m}$

Active horizontal force $H_{act} = 70.32 \text{ kN/m}$

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-1.60	14.56	0.50	1.000	1.000	1.350
Active pressure	25.07	-0.97	9.62	0.61	1.350	1.350	1.000
5kPa Load	3.89	-1.42	1.49	0.63	1.500	1.500	1.500
10kPa Load	0.00	-2.90	0.00	0.70	0.000	0.000	1.500
Reinforcement	-27.19	-0.50	0.00	1.00	1.000	1.000	1.000
Reinforcement	-27.19	-0.90	0.00	1.24	1.000	1.000	1.000
Reinforcement	-27.19	-1.30	0.00	1.47	1.000	1.000	1.000
Reinforcement	-27.19	-1.90	0.00	1.83	1.000	1.000	1.000
Reinforcement	-22.46	-2.30	0.00	2.07	1.000	1.000	1.000
Reinforcement	-12.50	-2.70	0.00	2.31	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 227.09 \text{ kNm/m}$

Overturning moment $M_{ovr} = 40.99 \text{ kNm/m}$

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 164.56 \text{ kN/m}$

Active horizontal force $H_{act} = 39.68 \text{ kN/m}$

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-1.60	14.56	0.50	1.000	1.000	1.000
Active pressure	35.93	-0.97	11.37	0.61	1.000	1.000	1.000
5kPa Load	5.24	-1.44	1.66	0.63	1.300	1.300	1.300
10kPa Load	2.20	-0.39	0.70	0.58	1.300	1.300	1.300
Reinforcement	-27.19	-0.50	0.00	1.00	1.000	1.000	1.000



Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Reinforcement	-27.19	-0.90	0.00	1.24	1.000	1.000	1.000
Reinforcement	-27.19	-1.30	0.00	1.47	1.000	1.000	1.000
Reinforcement	-27.19	-1.90	0.00	1.83	1.000	1.000	1.000
Reinforcement	-22.46	-2.30	0.00	2.07	1.000	1.000	1.000
Reinforcement	-12.50	-2.70	0.00	2.31	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 226.58 \text{ kNm/m}$
Overturning moment $M_{ovr} = 45.69 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 159.94 \text{ kN/m}$
Active horizontal force $H_{act} = 45.61 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

No. 2

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	-0.10	1.12	0.14	1.000	1.000	1.350
Active pressure	0.12	-0.07	0.05	0.28	1.350	1.350	1.350
5kPa Load	0.18	-0.06	0.07	0.28	1.500	1.500	1.500
10kPa Load	0.00	-0.20	0.00	0.28	0.000	0.000	1.500

Check of construction joint above the most utilized block No.: 12

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 0.20 \text{ kNm/m}$
Overturning moment $M_{ovr} = 0.03 \text{ kNm/m}$

Joint for overturning stability is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 0.68 \text{ kN/m}$
Active horizontal force $H_{act} = 0.42 \text{ kN/m}$

Joint for slip is **SATISFACTORY**

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	-0.10	1.12	0.14	1.000	1.000	1.000
Active pressure	0.17	-0.07	0.05	0.28	1.000	1.000	1.000



Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
5kPa Load	0.32	-0.09	0.10	0.28	1.300	1.300	1.300
10kPa Load	0.00	-0.20	0.00	0.28	0.000	0.000	1.300

Check of construction joint above the most utilized block No.: 12

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 0.21 \text{ kNm/m}$

Overturning moment $M_{ovr} = 0.05 \text{ kNm/m}$

Joint for overturning stability is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 0.70 \text{ kN/m}$

Active horizontal force $H_{act} = 0.59 \text{ kN/m}$

Joint for slip is **SATISFACTORY**

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	-34.87	213.67	45.98	0.000	105.63
2	-4.32	157.11	57.91	0.000	77.67
3	13.88	153.73	63.90	0.045	83.45
4	6.00	166.08	63.90	0.018	85.14

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-20.69	161.14	42.02
2	-14.46	150.06	42.02

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.000$

Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is **SATISFACTORY**

Verification of bearing capacity

Max. stress at footing bottom $\sigma = 105.63 \text{ kPa}$

Bearing capacity of foundation soil $R_d = 200.00 \text{ kPa}$

Bearing capacity of foundation soil is **SATISFACTORY**

Overall verification - bearing capacity of found. soil is **SATISFACTORY**



Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of most utilized reinforcement)

Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.80	8.96	-0.09	1.000
Active pressure	28.26	-0.93	11.64	2.19	1.000
5kPa Load	5.39	-1.44	1.64	2.25	1.300
10kPa Load	3.39	-0.60	1.76	2.17	1.300
Weight - reinforced soil	0.00	-1.16	81.24	1.23	1.000
5kPa Load	0.00	-2.25	11.38	1.52	0.000

Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 3)

Inclination of slip surface	= 73.00 °
Overall normal force acting on reinforcement	= 97.29 kN/m
Coefficient of reduction of slip along geo-textile	= 0.80
Resistance along geo-reinforcement	= 54.50 kN/m
Wall resistance	= 4.78 kN/m
Overall bearing capacity of reinforcements	= 0.00 kN/m

Results for the most severe combination - No. 2

Check for slip:

Resisting horizontal force H_{res} = 59.27 kN/m
Active horiz. force H_{act} = 39.68 kN/m

Slip along geotextile is **SATISFACTORY**

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F _x [kN/m]	Depth z[m]	R _t [kN/m]	Utiliz. [%]	T _p [kN/m]	Utiliz. [%]	R _{con} [kN/m]	Utiliz. [%]
1	Paragrid - 1st Course	-7.04	2.40	27.19	25.89	107.24	6.56	13.20	53.32
2	Paragrid - 2nd Course	-6.04	2.00	27.19	22.22	82.81	7.29	12.90	46.82
3	Paragrid - 3rd Course	-6.38	1.60	27.19	23.47	61.54	10.37	12.40	51.46
4	Paragrid - 4th Course	-5.11	1.00	27.19	18.81	52.68	9.71	10.80	47.35
5	Paragrid - 5th Course	-3.19	0.60	27.19	11.74	35.73	8.93	8.70	36.68
6	Paragrid - 6th Course	-2.07	0.20	27.19	7.60	21.93	9.42	6.50	31.78

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 27.19 kN/m
Force in reinforcement F_x = 7.04 kN/m

Reinforcement for tensile strength is **SATISFACTORY**

Check for pull out resistance (reinforcement No.3)

Pull out resistance T_p = 61.54 kN/m
Force in reinforcement F_x = 6.38 kN/m

Reinforcement for pull out resistance is **SATISFACTORY**

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 13.20 kN/m
Force in reinforcement F_x = 7.04 kN/m

Connection strength is **SATISFACTORY**



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Overall verification - reinforcement is SATISFACTORY



Slope stability analysis

Input data

Project

Task : Vertica MacWall Design
 Part : Section 2-2
 Description : Verification of Global Stability for Entire Section 2-2
 Customer : Maccaferri Ltd.
 Author : Liam K. D.
 Date : 08/08/2017
 Project ID : Dominican Chapel, Newry
 Project number : 17-5479

Settings

Standard - EN 1997 - DA1

Stability analysis

Earthquake analysis : 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		
Permanent actions :	$\gamma_G =$	1.35	[$-$]	1.00	[$-$]	1.00 [$-$] 1.00 [$-$]
Variable actions :	$\gamma_Q =$	1.50	[$-$]	0.00	[$-$]	1.30 [$-$] 0.00 [$-$]
Water load :	$\gamma_w =$	1.35	[$-$]			1.00 [$-$]

Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[$-$]	1.25	[$-$]	
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[$-$]	1.25	[$-$]	
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[$-$]	1.40	[$-$]	

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		18.20	9.54	30.00	9.87		
2		10.35	4.36	10.35	4.47	10.35	4.66
		11.37	4.66	12.85	7.23	13.87	9.00
		14.57	9.33	16.10	9.63	16.24	9.71
		18.06	9.71	18.16	9.71	18.20	9.61
		18.20	9.54	18.20	9.45	20.50	9.50
		30.00	9.71				



No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
3		5.53	0.42	5.53	0.70	5.56	0.70
		5.56	1.10	5.59	1.10	5.59	1.50
		5.62	1.50	5.62	1.90	5.65	1.90
		5.65	2.30	5.68	2.30	5.68	2.70
		5.71	2.70	5.71	3.10	5.74	3.10
		5.74	3.50	5.77	3.50	5.77	3.90
		6.04	3.90	6.04	3.83	8.61	5.22
		9.68	5.22	9.68	5.46	9.71	5.46
		9.71	5.86	9.74	5.86	9.74	6.26
		9.77	6.26	9.77	6.66	9.80	6.66
		9.80	7.26	10.07	7.26	10.15	7.26
		14.55	9.38	16.24	9.71		
4		10.20	7.24	13.87	9.00		
5		10.07	7.23	10.10	7.24	10.15	7.26
6		9.92	4.66	9.92	4.86	9.92	5.06
		9.95	5.06	9.95	5.26	9.95	5.46
		9.98	5.46	9.98	5.66	9.98	5.86
		10.01	5.86	10.01	6.26	10.04	6.26
		10.04	6.66	10.07	6.66	10.07	7.06
		10.07	7.23	10.07	7.26		
7		10.10	7.24	10.20	7.24	12.85	7.23
8		0.00	0.30	5.23	0.30	5.23	0.00
		6.51	0.00	6.51	0.30	6.58	0.30
		7.69	3.62	8.04	3.75	8.17	3.89
		8.25	3.90	8.31	3.96	8.38	4.04
		8.48	4.17	8.54	4.20	8.67	4.29
		8.83	4.32	8.89	4.35	9.12	4.43
		9.22	4.44	9.33	4.45	9.35	4.36
		10.35	4.36	10.36	4.47	11.21	4.59
		11.47	4.60	11.88	4.62	12.53	4.64
		13.43	4.69	20.50	5.76	30.00	7.20



No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
9		8.61	5.22	8.62	5.17		
10		6.04	3.77	8.62	5.17	9.68	5.17
		9.68	5.22				
11		9.65	4.66	9.65	5.06	9.68	5.06
		9.68	5.17				
12		9.35	4.36	9.35	4.66	9.65	4.66
		9.92	4.66	10.35	4.66		
13		5.81	0.30	5.81	0.70	5.84	0.70
		5.84	1.10	5.87	1.10	5.87	1.50
		5.90	1.50	5.90	1.90	5.92	2.30
		5.95	2.30	5.95	2.70	5.98	2.70
		5.98	3.10	6.01	3.10	6.01	3.50
		6.04	3.50	6.04	3.73	6.04	3.77
		6.04	3.83				
14		6.04	3.73	7.88	3.73	8.04	3.75
15		0.00	0.41	5.53	0.42	5.53	0.30



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No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
16		5.23	0.30	5.53	0.30	5.81	0.30
		6.51	0.30				

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
1	No Fines Concrete		45.00	30.00	18.00
2	Class 6I		35.00	0.00	18.00
3	Firm silty sandy gravelly CLAY		30.00	0.00	19.00
4	Firm to Stiff slightly silty sandy gravelly CLAY		32.00	0.00	19.00
5	Type 1		35.00	0.00	18.00
6	Fresh Rock (Granodiorite)		45.00	0.00	22.00
7	Made Ground		32.00	0.00	18.50

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [-]
1	No Fines Concrete		18.00		
2	Class 6I		18.00		
3	Firm silty sandy gravelly CLAY		19.00		



No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [-]
4	Firm to Stiff slightly silty sandy gravelly CLAY		19.00		
5	Type 1		18.00		
6	Fresh Rock (Granodiorite)		22.00		
7	Made Ground		18.50		

Soil parameters

No Fines Concrete

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 30.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Class 6I

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Firm silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Firm to Stiff slightly silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 32.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Type 1

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Fresh Rock (Granodiorite)



Unit weight : $\gamma = 22.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 22.00 \text{ kN/m}^3$

Made Ground

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 32.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Rigid bodies

No.	Name	Sample	γ [kN/m ³]
1	Vertica MacWall		20.00
2	Slope Cover Material		15.00
3	Other		20.00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		18.20	9.45	20.50	9.50	Other
		30.00	9.71	30.00	9.87	
		18.20	9.54			
2		10.20	7.24	13.87	9.00	Slope Cover Material
		14.57	9.33	16.10	9.63	
		16.24	9.71	14.55	9.38	
		10.15	7.26	10.10	7.24	
3		12.85	7.23	13.87	9.00	Class 6I
		10.20	7.24			



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
4		10.07	7.23	10.10	7.24	Slope Cover Material
		10.15	7.26	10.07	7.26	
5		9.68	5.17	9.68	5.22	Other
		8.61	5.22	8.62	5.17	
6		9.92	4.66	9.92	4.86	Vertical MacWall
		9.92	5.06	9.95	5.06	
		9.95	5.26	9.95	5.46	
		9.98	5.46	9.98	5.66	
		9.98	5.86	10.01	5.86	
		10.01	6.26	10.04	6.26	
		10.04	6.66	10.07	6.66	
		10.07	7.06	10.07	7.23	
		10.07	7.26	9.80	7.26	
		9.80	6.66	9.77	6.66	
		9.77	6.26	9.74	6.26	
		9.74	5.86	9.71	5.86	
		9.71	5.46	9.68	5.46	
		9.68	5.22	9.68	5.17	
		9.68	5.06	9.65	5.06	
		9.65	4.66			
7		10.35	4.66	11.37	4.66	Class 6I
		12.85	7.23	10.20	7.24	
		10.10	7.24	10.07	7.23	
		10.07	7.06	10.07	6.66	
		10.04	6.66	10.04	6.26	
		10.01	6.26	10.01	5.86	
		9.98	5.86	9.98	5.66	
		9.98	5.46	9.95	5.46	
		9.95	5.26	9.95	5.06	
		9.92	5.06	9.92	4.86	
		9.92	4.66			



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
8		10.36	4.47	11.21	4.59	Made Ground
		11.47	4.60	11.88	4.62	
		12.53	4.64	13.43	4.69	
		20.50	5.76	30.00	7.20	
		30.00	9.71	20.50	9.50	
		18.20	9.45	18.20	9.54	
		18.20	9.61	18.16	9.71	
		18.06	9.71	16.24	9.71	
		16.10	9.63	14.57	9.33	
		13.87	9.00	12.85	7.23	
		11.37	4.66	10.35	4.66	
		10.35	4.47	10.35	4.36	
9		9.92	4.66	9.65	4.66	No Fines Concrete
		9.35	4.66	9.35	4.36	
		10.35	4.36	10.35	4.47	
		10.35	4.66			
10		6.04	3.77	8.62	5.17	Slope Cover Material
		8.61	5.22	6.04	3.83	
11		7.88	3.73	8.04	3.75	Class 6I
		8.17	3.89	8.25	3.90	
		8.31	3.96	8.38	4.04	
		8.48	4.17	8.54	4.20	
		8.67	4.29	8.83	4.32	
		8.89	4.35	9.12	4.43	
		9.22	4.44	9.33	4.45	
		9.35	4.36	9.35	4.66	
		9.65	4.66	9.65	5.06	
		9.68	5.06	9.68	5.17	
		8.62	5.17	6.04	3.77	
		6.04	3.73			
		5.81	0.30	5.81	0.70	
12		5.84	0.70	5.84	1.10	Vertica MacWall
		5.87	1.10	5.87	1.50	
		5.90	1.50	5.90	1.90	
		5.92	2.30	5.95	2.30	
		5.95	2.70	5.98	2.70	
		5.98	3.10	6.01	3.10	
		6.01	3.50	6.04	3.50	
		6.04	3.73	6.04	3.77	
		6.04	3.83	6.04	3.90	
		5.77	3.90	5.77	3.50	



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
13		5.74	3.50	5.74	3.10	No Fines Concrete
		5.71	3.10	5.71	2.70	
		5.68	2.70	5.68	2.30	
		5.65	2.30	5.65	1.90	
		5.62	1.90	5.62	1.50	
		5.59	1.50	5.59	1.10	
		5.56	1.10	5.56	0.70	
		5.53	0.70	5.53	0.42	
		5.53	0.30			
		6.51	0.30	6.58	0.30	
14		7.69	3.62	8.04	3.75	Firm to Stiff slightly silty sandy gravelly CLAY
		7.88	3.73	6.04	3.73	
		6.04	3.50	6.01	3.50	
		6.01	3.10	5.98	3.10	
		5.98	2.70	5.95	2.70	
		5.95	2.30	5.92	2.30	
		5.90	1.90	5.90	1.50	
		5.87	1.50	5.87	1.10	
		5.84	1.10	5.84	0.70	
		5.81	0.70	5.81	0.30	
15		5.53	0.30	5.53	0.42	No Fines Concrete
		0.00	0.41	0.00	0.30	
		5.23	0.30			
16		20.50	5.76	13.43	4.69	Fresh Rock (Granodiorite)
		12.53	4.64	11.88	4.62	
		11.47	4.60	11.21	4.59	
		10.36	4.47	10.35	4.36	
		9.35	4.36	9.33	4.45	
		9.22	4.44	9.12	4.43	
		8.89	4.35	8.83	4.32	
		8.67	4.29	8.54	4.20	
		8.48	4.17	8.38	4.04	
		8.31	3.96	8.25	3.90	
		8.17	3.89	8.04	3.75	
		7.69	3.62	6.58	0.30	
		6.51	0.30	6.51	0.00	
		5.23	0.00	5.23	0.30	
		0.00	0.30	0.00	-5.00	



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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
		30.00	-5.00	30.00	7.20	

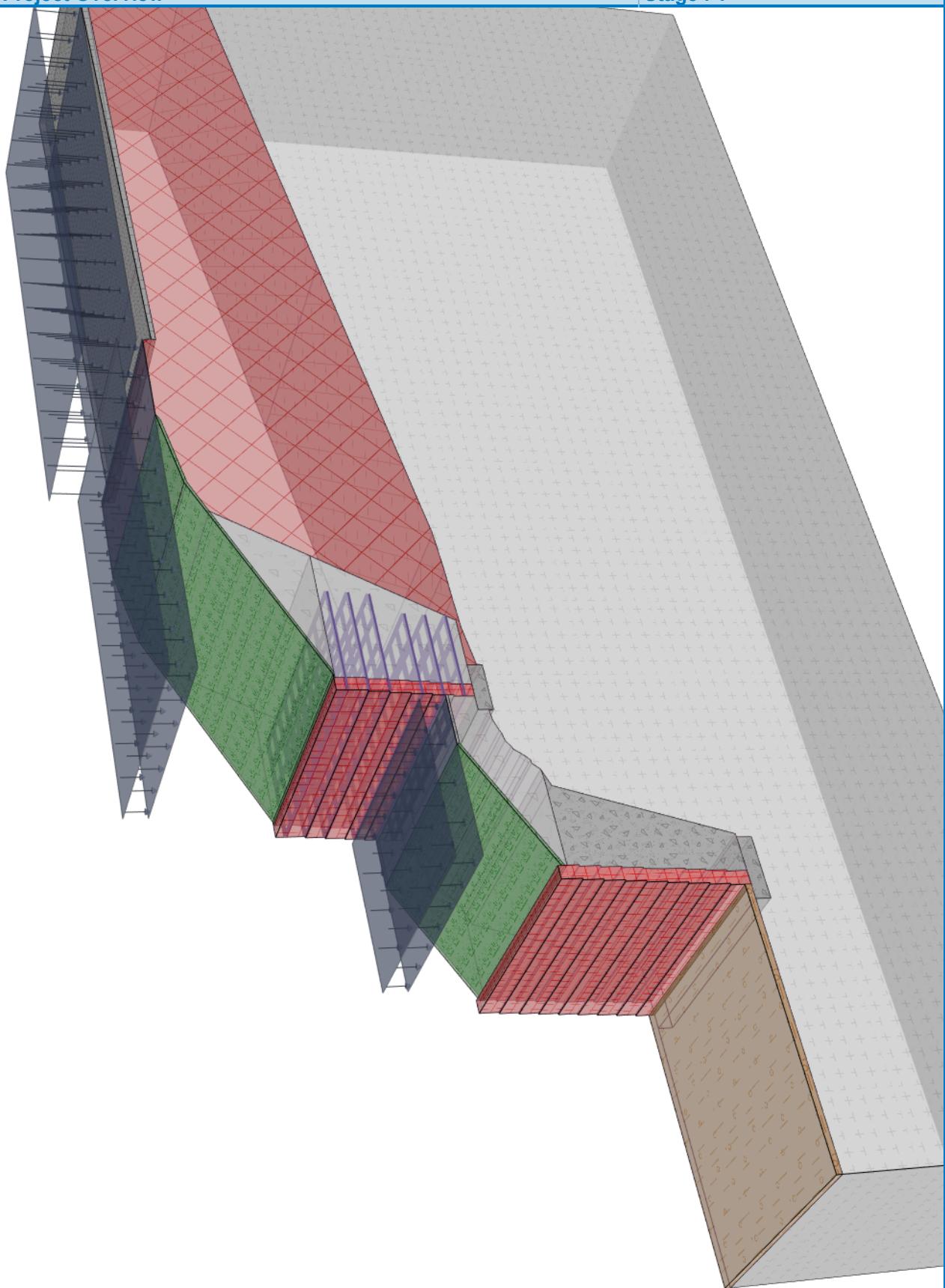


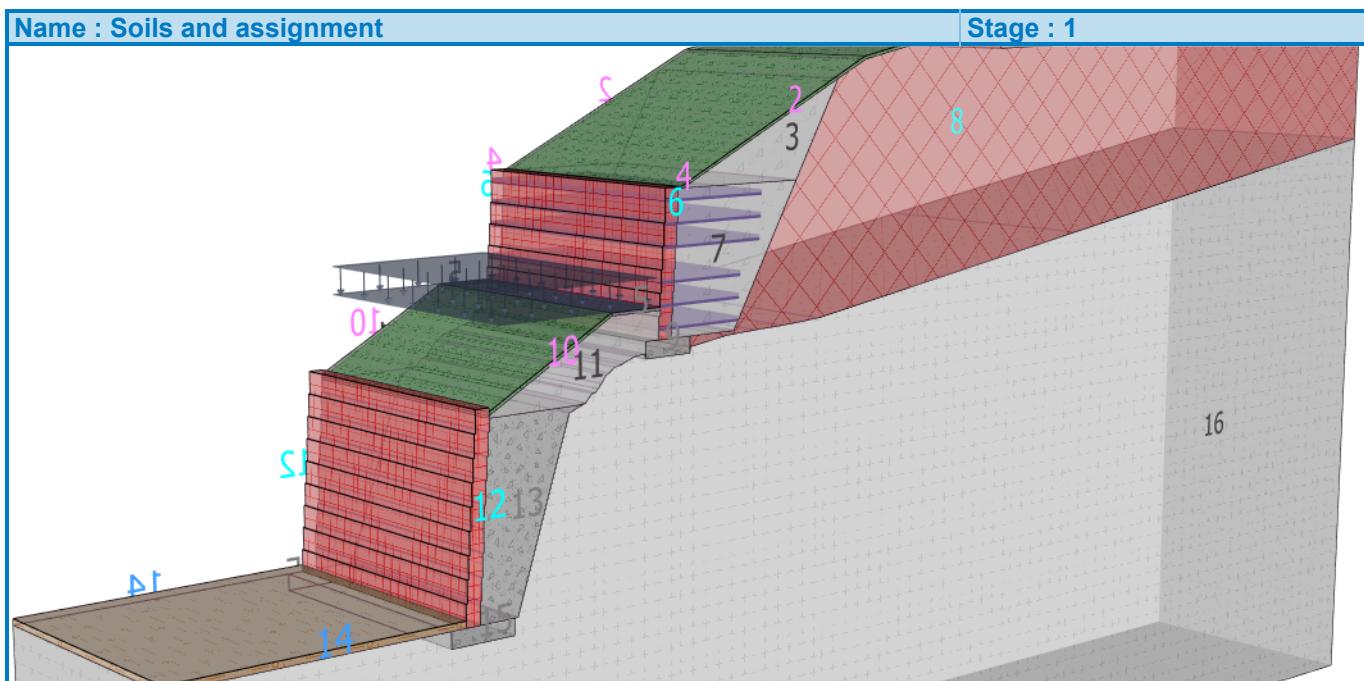
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Section 2-2
17-5479

Name : Project Overview

Stage : 1





Reinforcements

No.	Point to the left		Point to the right		Length L [m]	Strength R _t [kN/m]	Pull out resist.	End of reinf.
No.	x [m]	z [m]	x [m]	z [m]	L [m]	R _t [kN/m]		
1	9.82	7.06	12.02	7.06	2.20	50.00	C = 0.80	Fixed
2	9.80	6.66	12.00	6.66	2.20	50.00	C = 0.80	Fixed
3	9.77	6.26	11.97	6.26	2.20	50.00	C = 0.80	Fixed
4	9.72	5.66	11.52	5.66	1.80	50.00	C = 0.80	Fixed
5	9.69	5.26	11.49	5.26	1.80	50.00	C = 0.80	Fixed
6	9.66	4.86	11.46	4.86	1.80	50.00	C = 0.80	Fixed

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	q, q ₁ , f, F	Magnitude q ₂	unit
1	strip	variable	on terrain	x = 6.30	l = 3.30		0.00	5.00		kN/m ²
2	strip	variable	on terrain	x = 10.30	l = 7.90		0.00	5.00		kN/m ²
3	strip	variable	on terrain	x = 18.20	l = 10.00		0.00	10.00		kN/m ²

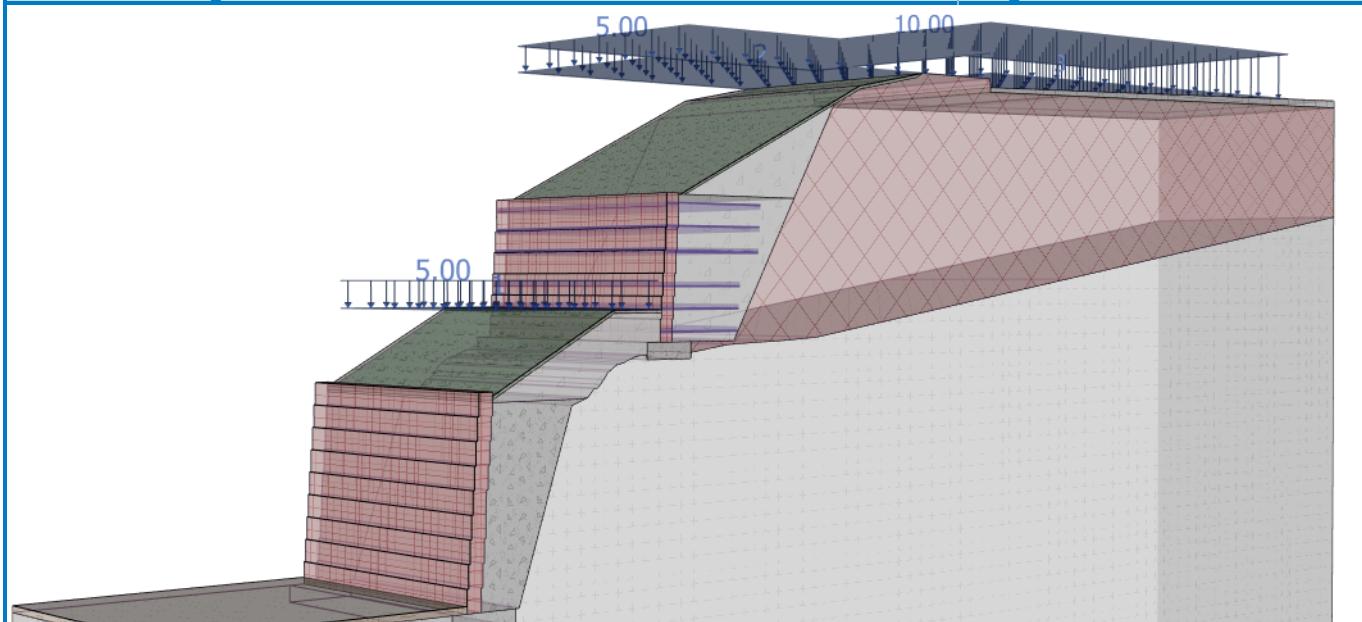
Surcharges

No.	Name
1	5kPan Load - 01
2	5kPan Load - 02
3	10kPan Load



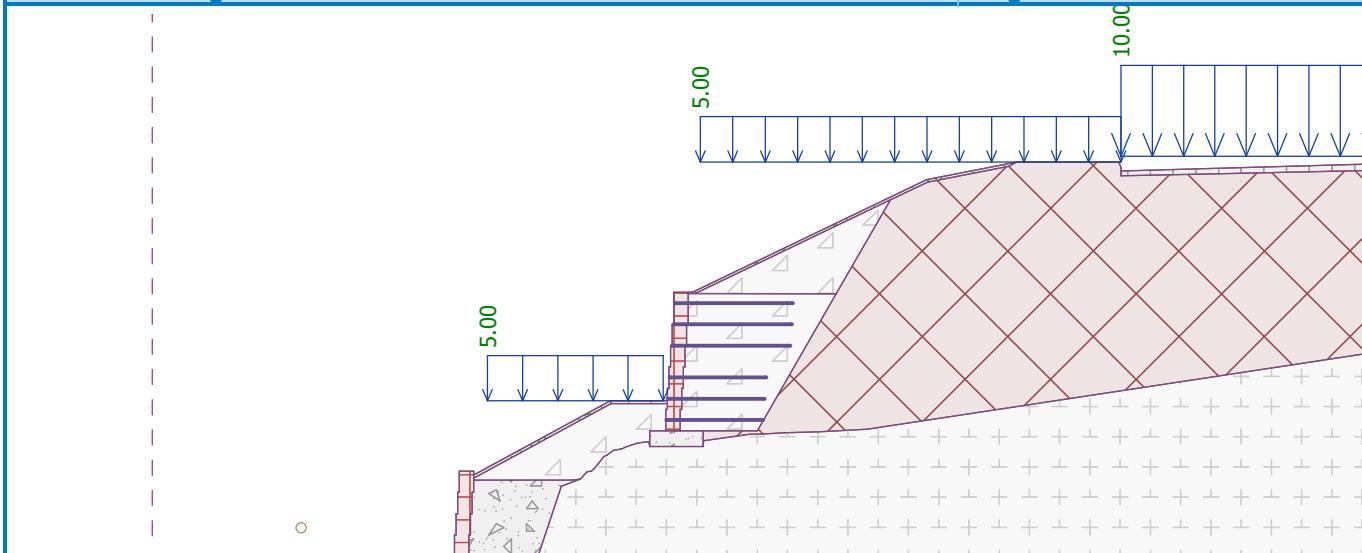
Name : Surcharge

Stage : 1



Name : Surcharge

Stage : 1



Water

Water type : No water

Tensile crack

Tensile crack not input.

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 =	3.44 [m]	Angles :	α_1 =	-14.34 [°]
	z =	11.64 [m]		α_2 =	79.02 [°]
Radius :	R =	11.59 [m]			

The slip surface after optimization.

Reinforcement bearing capacity

Combination 1

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00

Combination 2

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00

Slope stability verification (Bishop)

Combination 1

Sum of active forces : $F_a = 481.94$ kN/m

Sum of passive forces : $F_p = 764.78$ kN/m

Sliding moment : $M_a = 5715.82$ kNm/m

Resisting moment : $M_p = 9070.32$ kNm/m

Utilization : 63.0 %

Slope stability ACCEPTABLE

Combination 2

Sum of active forces : $F_a = 391.73$ kN/m

Sum of passive forces : $F_p = 530.19$ kN/m

Sliding moment : $M_a = 4540.21$ kNm/m

Resisting moment : $M_p = 6144.94$ kNm/m

Utilization : 73.9 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2

Analysis 2

Circular slip surface

Slip surface parameters					
Center :	x =	3.43 [m]	Angles :	α_1 =	-13.64 [°]
	z =	12.16 [m]		α_2 =	77.35 [°]
Radius :	R =	12.09 [m]			

The slip surface after optimization.

Reinforcement bearing capacity

Combination 1

Reinforcement Bearing capacity [kN/m]

1	0.00
---	------



2	0.00
3	0.00
4	0.00
5	0.00
6	0.00

Combination 2

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00

Slope stability verification (Bishop)

Combination 1

Sum of active forces : $F_a = 387.44 \text{ kN/m}$

Sum of passive forces : $F_p = 613.35 \text{ kN/m}$

Sliding moment : $M_a = 3979.03 \text{ kNm/m}$

Resisting moment : $M_p = 6299.11 \text{ kNm/m}$

Utilization : 63.2 %

Slope stability ACCEPTABLE

Combination 2

Sum of active forces : $F_a = 410.92 \text{ kN/m}$

Sum of passive forces : $F_p = 555.89 \text{ kN/m}$

Sliding moment : $M_a = 4968.03 \text{ kNm/m}$

Resisting moment : $M_p = 6720.76 \text{ kNm/m}$

Utilization : 73.9 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2

Analysis 3

Circular slip surface

Slip surface parameters					
Center :	x =	3.43 [m]	Angles :	$\alpha_1 =$	-13.64 [°]
	z =	12.16 [m]		$\alpha_2 =$	77.35 [°]
Radius :	R =	12.09 [m]	Analysis of the slip surface without optimization.		

Reinforcement bearing capacity

Combination 1

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00

Combination 2

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00



6

0.00

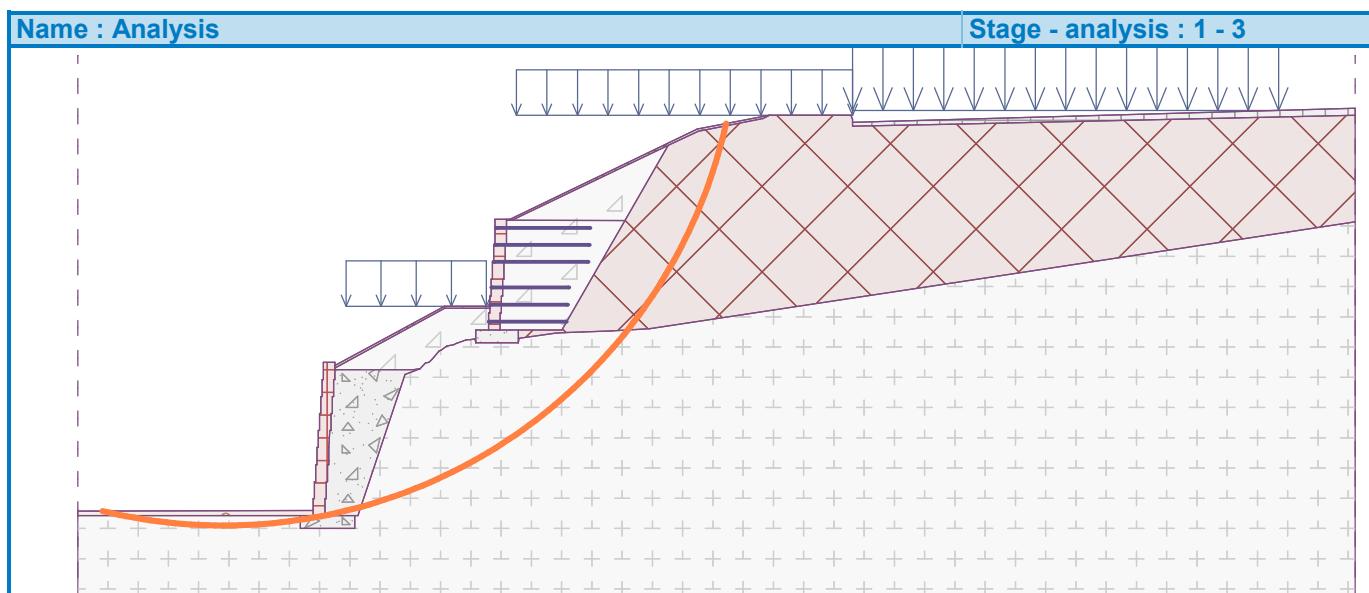
Slope stability verification (all methods)

Combination 1

Bishop : Utilization = 62.9 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 71.1 % **ACCEPTABLE**
Spencer : Utilization = 61.8 % **ACCEPTABLE**
Janbu : Utilization = 48.1 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 61.8 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 73.9 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 82.7 % **ACCEPTABLE**
Spencer : Utilization = 73.1 % **ACCEPTABLE**
Janbu : Utilization = 58.6 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 73.1 % **ACCEPTABLE**





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Dominican Chapel, Newry
Section 3-3
17-5479

Analysis of reinforced slopes

Input data

Project

Task : Vertica MacWall Design
 Part : Section 3-3
 Description : Verification of lower tier MacWall with NFC Fill
 Customer : Maccaferri Ltd.
 Author : Liam K. D.
 Date : 08/08/2017
 Project ID : Dominican Chapel, Newry
 Project number : 17-5479

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
 Allowable eccentricity : 0.333
 Internal stability : Standard - straight slip surface
 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	
Permanent actions :	$\gamma_G =$	1.35	[\cdot]	1.00	[\cdot]
Variable actions :	$\gamma_Q =$	1.50	[\cdot]	0.00	[\cdot]
Water load :	$\gamma_w =$	1.35	[\cdot]		
				1.00	[\cdot]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[\cdot]	1.25	[\cdot]
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[\cdot]	1.25	[\cdot]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[\cdot]	1.40	[\cdot]
Partial factor on Poisson's ratio :	$\gamma_v =$	1.00	[\cdot]	1.00	[\cdot]

Partial factors for variable actions					
Permanent design situation					
Factor for combination value :		$\psi_0 =$		0.70	[\cdot]
Factor for frequent value :		$\psi_1 =$		0.50	[\cdot]
Factor for quasi-permanent value :		$\psi_2 =$		0.30	[\cdot]

Stability analysis

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 :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]	
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]	
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]		

Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[-]	1.25	[-]	
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[-]	1.25	[-]	
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[-]	1.40	[-]	

Geometry of structure

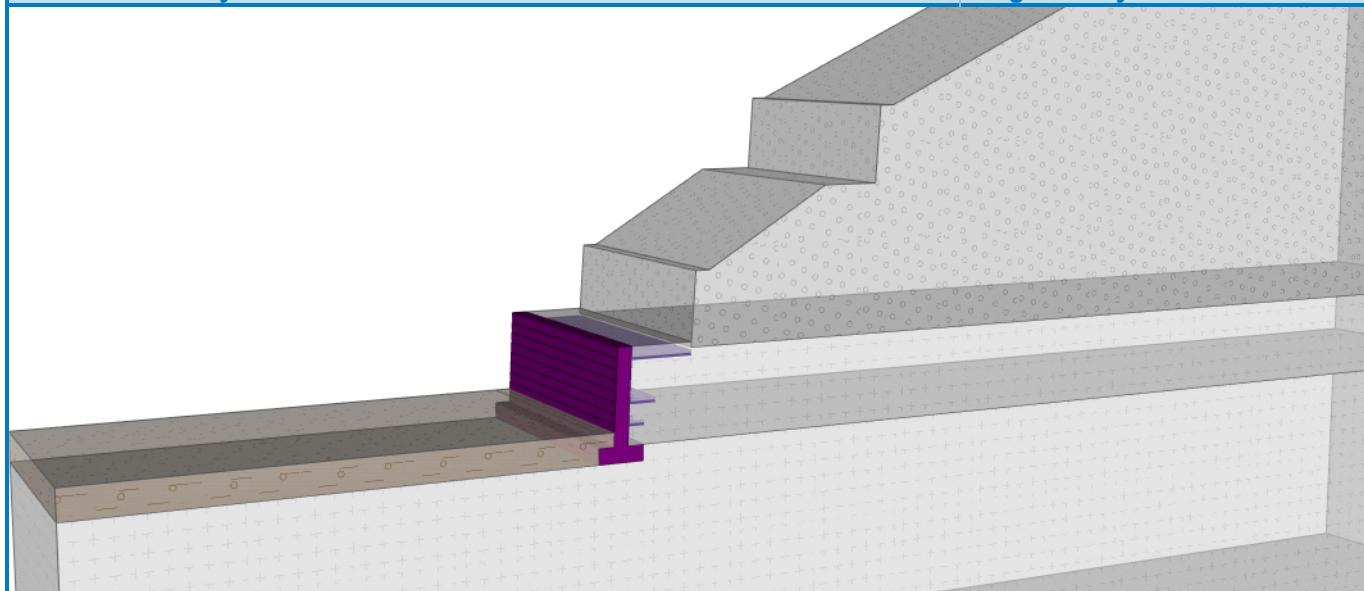
Number of blocks $n = 9$
 Block height $h = 0.20 \text{ m}$
 Block width $b = 0.28 \text{ m}$
 Block offset $o_1 = 0.01 \text{ m}$

Structure foundation

Foundation width $b_b = 0.88 \text{ m}$
 Foundation height $l_b = 0.30 \text{ m}$
 Foundation offset $a_b = 0.30 \text{ m}$

Name : Geometry

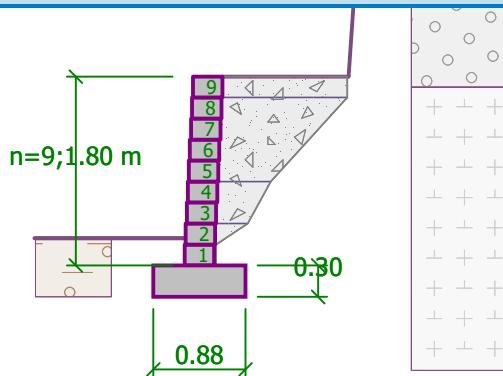
Stage - analysis : 1 - 0





Name : Geometry

Stage - analysis : 1 - 0



Material

Block material

Unit weight γ = 20.00 kN/m³

Cohesion c = 0.00 kPa

Friction f = 0.533

Shear bearing capacity of joint R_s = 0.00 kN/m

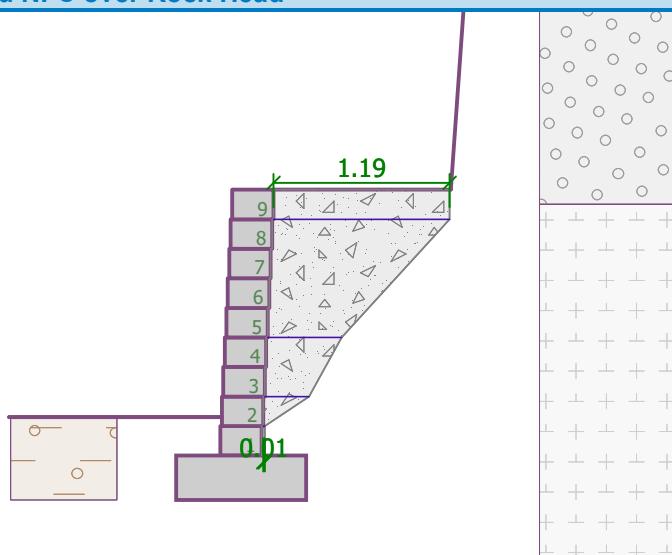
Reinforced soil - No Fines Concrete

Reinforcement

Total number of input reinforcements : 4.

Name : Assumed NFC over Rock Head

Stage - analysis : 1 - 0



Soil parameters

No Fines Concrete

Unit weight : γ = 18.00 kN/m³

Angle of internal friction : ϕ_{ef} = 45.00 °

Cohesion of soil : c_{ef} = 30.00 kPa

Angle of friction struc.-soil : δ = 24.50 °



Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Class 6I

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 35.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 21.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Firm silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 30.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 17.00^\circ$

Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Firm to Stiff slightly silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 32.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 19.00^\circ$

Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Type 1

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 35.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 21.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Fresh Rock (Granodiorite)

Unit weight : $\gamma = 22.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 45.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 31.50^\circ$

Saturated unit weight : $\gamma_{sat} = 22.00 \text{ kN/m}^3$

Made Ground

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 32.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 17.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	0.10	Type 1	
2	-	Fresh Rock (Granodiorite)	



Terrain profile

No.	Coordinate x [m]	Depth z [m]
1	0.00	0.00
2	1.20	0.00
3	1.29	-1.29
4	1.56	-1.29
5	4.00	-2.75
6	5.09	-2.75
7	5.19	-4.21
8	5.47	-4.21
9	9.93	-6.31
10	11.65	-6.64
11	13.35	-6.64
12	13.45	-6.75
13	14.24	-6.96
14	15.24	-6.96

Origin [0,0] is located in upper right edge of construction.

Positive coordinate +z has downward direction.

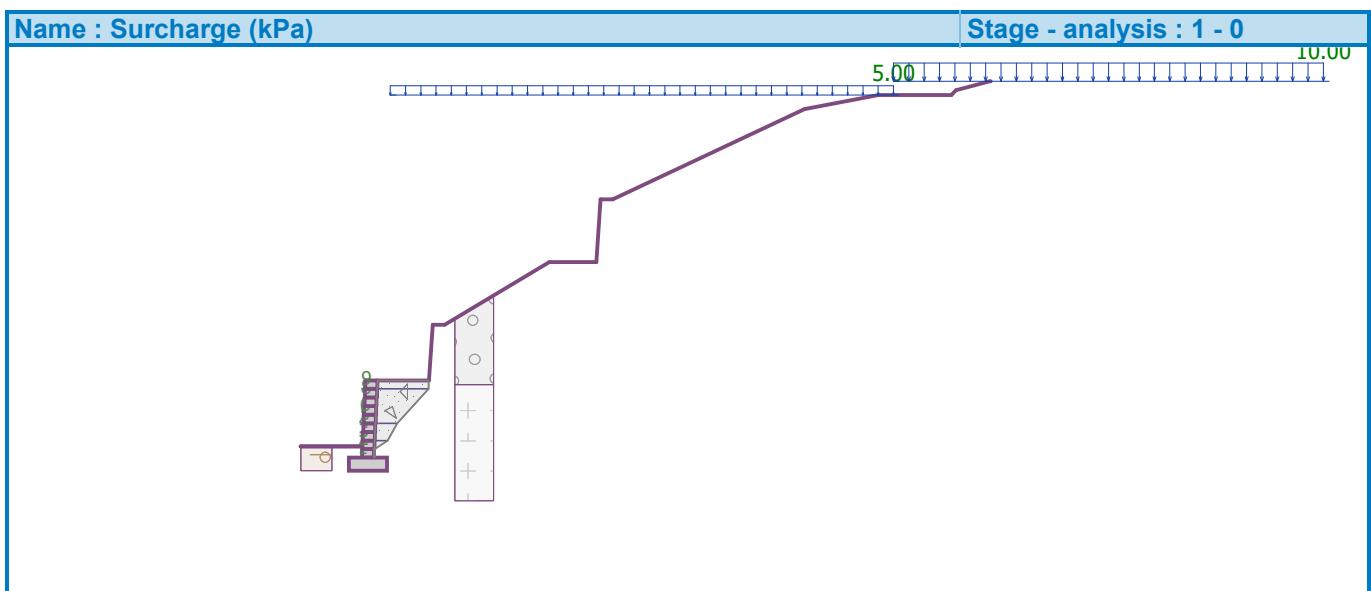
Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		variable	5.00		0.30	11.70	on terrain
2	Yes		variable	10.00		12.00	10.00	on terrain

No.	Name
1	5kPa Load
2	10kPa Load





Resistance on front face of the structure

Resistance on front face of the structure: not considered

Soil on front face of the structure - Firm to Stiff slightly silty sandy gravelly CLAY

Soil thickness in front of structure $h = 0.56 \text{ m}$

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent

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 - reinforced soil	0.00	-1.23	26.89	0.95	1.000	1.000	1.350
Weight - earth wedge	0.00	-0.56	0.46	0.78	1.000	1.000	1.350
Active pressure	12.74	-0.66	11.79	1.02	1.350	1.350	1.350
5kPa Load	1.63	-1.01	1.01	1.13	1.500	1.500	1.500
10kPa Load	0.91	-0.38	0.86	0.88	0.000	1.500	1.500
Weight - wall	0.00	-1.20	10.08	0.48	1.000	1.000	1.350
5kPa Load	0.00	-2.10	4.45	1.41	0.000	0.000	1.500

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment $M_{res} = 48.83 \text{ kNm/m}$

Overturning moment $M_{ovr} = 13.79 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 56.14 \text{ kN/m}$

Active horizontal force $H_{act} = 21.00 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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 - reinforced soil	0.00	-1.23	26.89	0.95	1.000	1.000	1.000
Weight - earth wedge	0.00	-0.56	0.46	0.78	1.000	1.000	1.000
Active pressure	18.66	-0.70	12.87	1.02	1.000	1.000	1.000
5kPa Load	3.17	-1.09	0.99	1.11	1.300	1.300	1.300
10kPa Load	3.76	-1.10	1.16	1.12	1.300	1.300	1.300
Weight - wall	0.00	-1.20	10.08	0.48	1.000	1.000	1.000
5kPa Load	0.00	-2.10	4.45	1.41	0.000	0.000	1.300

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment $M_{res} = 47.08 \text{ kNm/m}$



Overturning moment $M_{ovr} = 22.96 \text{ kNm/m}$

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 42.47 \text{ kN/m}$

Active horizontal force $H_{act} = 27.68 \text{ kN/m}$

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Warning - allowable range of input data exceeded during pressure analysis!

The analysis is carried out with the modified value of structure inclination α .

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	-1.20	10.08	0.48	1.000	1.000	1.350
Active pressure	0.00	-2.10	0.00	0.66	1.000	1.000	1.000
5kPa Load	0.00	-2.10	0.61	0.61	0.000	0.000	1.500
10kPa Load	0.00	-2.10	0.00	0.66	0.000	0.000	1.500
Reinforcement	-0.17	-1.10	0.00	1.11	1.000	1.000	1.000
Reinforcement	-3.24	-1.90	0.00	1.35	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 11.19 \text{ kNm/m}$

Overturning moment $M_{ovr} = 0.00 \text{ kNm/m}$

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 13.49 \text{ kN/m}$

Active horizontal force $H_{act} = 0.00 \text{ kN/m}$

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

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	-1.20	10.08	0.48	1.000	1.000	1.000
Active pressure	0.00	-2.10	0.00	0.66	1.000	1.000	1.000
5kPa Load	0.00	-2.10	0.73	0.61	0.000	0.000	1.300
10kPa Load	0.00	-2.10	0.01	0.58	0.000	0.000	1.300
Reinforcement	-0.16	-1.10	0.00	1.11	1.000	1.000	1.000
Reinforcement	-3.24	-1.90	0.00	1.35	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability



Resisting moment $M_{res} = 11.18 \text{ kNm/m}$
Overturning moment $M_{ovr} = 0.00 \text{ kNm/m}$

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 11.47 \text{ kN/m}$
Active horizontal force $H_{act} = 0.00 \text{ kN/m}$

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

No. 2

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	-0.90	10.08	0.18	1.000	1.000	1.350
Active pressure	0.00	-1.80	0.00	0.36	1.000	1.000	1.000
5kPa Load	0.00	-1.80	0.50	0.31	0.000	0.000	1.500
10kPa Load	0.00	-1.80	0.00	0.36	0.000	0.000	1.500
Reinforcement	-9.34	-0.40	0.00	0.39	1.000	1.000	1.000
Reinforcement	-10.11	-0.80	0.00	0.51	1.000	1.000	1.000
Reinforcement	-5.27	-1.60	0.00	0.74	1.000	1.000	1.000

Check of construction joint above the most utilized block No.: 0

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 22.07 \text{ kNm/m}$
Overturning moment $M_{ovr} = 0.00 \text{ kNm/m}$

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 30.09 \text{ kN/m}$
Active horizontal force $H_{act} = 0.00 \text{ kN/m}$

Joint for slip is SATISFACTORY

Joint is SATISFACTORY

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	-0.90	10.08	0.18	1.000	1.000	1.000
Active pressure	0.00	-1.80	0.00	0.36	1.000	1.000	1.000
5kPa Load	0.00	-1.80	0.61	0.31	0.000	0.000	1.300
10kPa Load	0.00	-1.80	0.00	0.36	0.000	0.000	1.300
Reinforcement	-9.34	-0.40	0.00	0.39	1.000	1.000	1.000
Reinforcement	-10.10	-0.80	0.00	0.51	1.000	1.000	1.000
Reinforcement	-5.27	-1.60	0.00	0.74	1.000	1.000	1.000

Check of construction joint above the most utilized block No.: 0

Place of verification : bottom of blocks



Check for overturning stability

Resisting moment $M_{res} = 22.07 \text{ kNm/m}$

Overturning moment $M_{ovr} = 0.00 \text{ kNm/m}$

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 30.08 \text{ kN/m}$

Active horizontal force $H_{act} = 0.00 \text{ kN/m}$

Joint for slip is SATISFACTORY

Joint is SATISFACTORY

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	-7.04	14.52	-3.41	0.000	16.50
2	-6.75	10.08	-3.41	0.000	11.45
3	0.00	0.00	0.00	0.000	0.00
4	0.00	0.00	0.00	0.000	0.00

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-6.85	10.69	-3.41
2	-6.75	10.08	-3.41

Verification of foundation soil

Place of verification : bottom of leveling pad

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.000$

Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom $\sigma = 16.50 \text{ kPa}$

Bearing capacity of foundation soil $R_d = 200.00 \text{ kPa}$

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY



Analysis of reinforced slopes

Input data

Project

Task : Vertica MacWall Design
 Part : Section 3-3
 Description : Verification of Middle tier MacWall with NFC Fill
 Customer : Maccaferri Ltd.
 Author : Liam K. D.
 Date : 08/08/2017
 Project ID : Dominican Chapel, Newry
 Project number : 17-5479

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
 Allowable eccentricity : 0.333
 Internal stability : Standard - straight slip surface
 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	
Permanent actions :	$\gamma_G =$	1.35	[$-$]	1.00	[$-$]
Variable actions :	$\gamma_Q =$	1.50	[$-$]	0.00	[$-$]
Water load :	$\gamma_w =$	1.35	[$-$]		
				1.00	[$-$]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[$-$]	1.25	[$-$]
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[$-$]	1.25	[$-$]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[$-$]	1.40	[$-$]
Partial factor on Poisson's ratio :	$\gamma_v =$	1.00	[$-$]	1.00	[$-$]

Partial factors for variable actions					
Permanent design situation					
Factor for combination value :		$\psi_0 =$		0.70	[$-$]
Factor for frequent value :		$\psi_1 =$		0.50	[$-$]
Factor for quasi-permanent value :		$\psi_2 =$		0.30	[$-$]

Stability analysis

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 :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]	
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]	
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]		

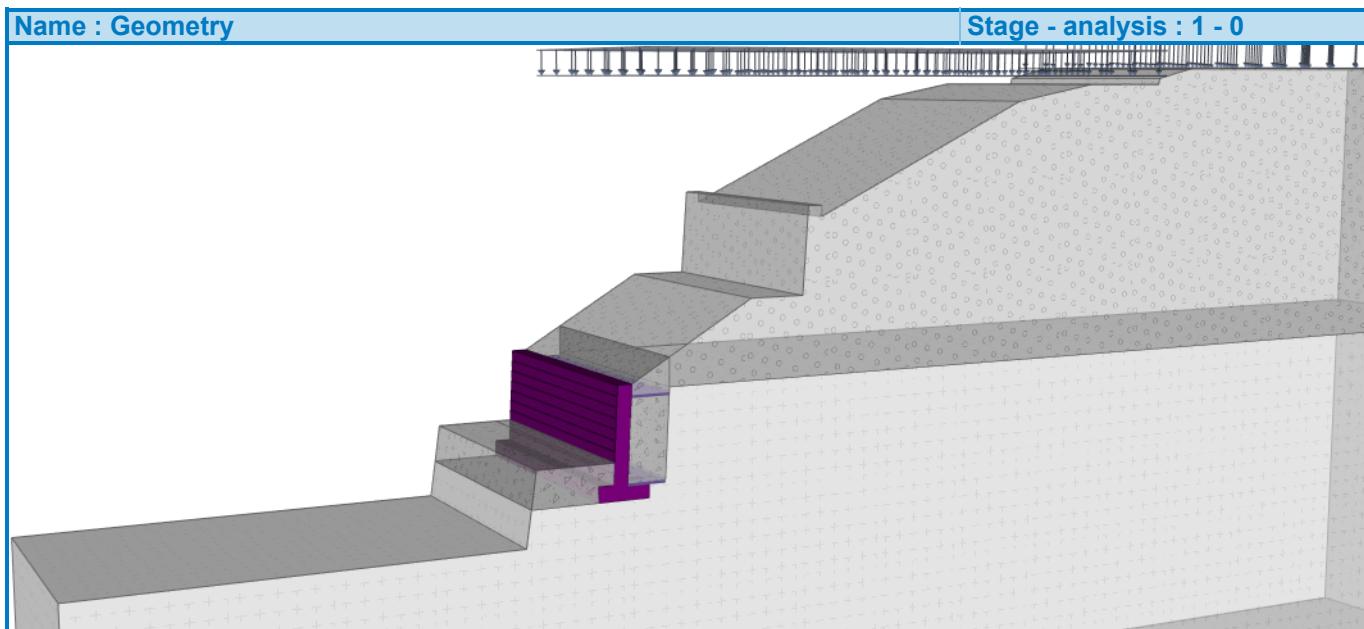
Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[-]	1.25	[-]	
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[-]	1.25	[-]	
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[-]	1.40	[-]	

Geometry of structure

Number of blocks $n = 9$
 Block height $h = 0.20 \text{ m}$
 Block width $b = 0.28 \text{ m}$
 Block offset $o_1 = 0.01 \text{ m}$

Structure foundation

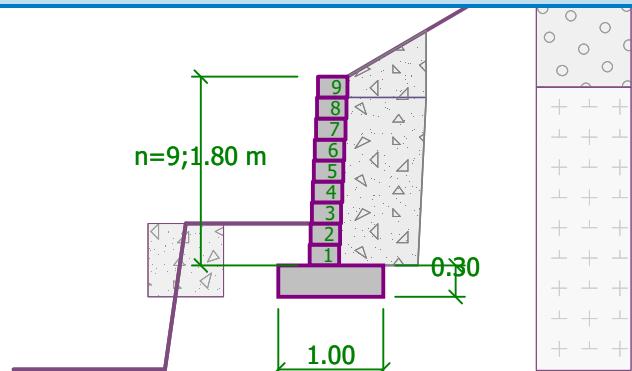
Foundation width $b_b = 1.00 \text{ m}$
 Foundation height $l_b = 0.30 \text{ m}$
 Foundation offset $a_b = 0.30 \text{ m}$





Name : Geometry

Stage - analysis : 1 - 0



Material

Block material

Unit weight γ = 20.00 kN/m³

Cohesion c = 0.00 kPa

Friction f = 0.533

Shear bearing capacity of joint R_s = 0.00 kN/m

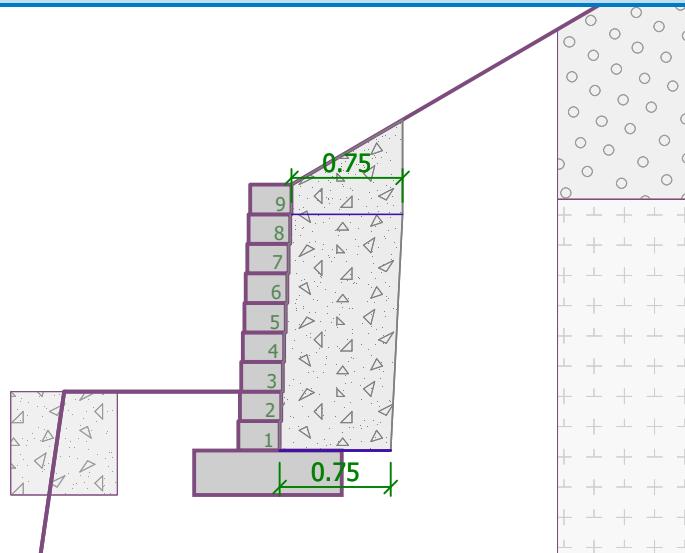
Reinforced soil - No Fines Concrete

Reinforcement

Total number of input reinforcements : 2.

Name : Minimum NFC Fill

Stage - analysis : 1 - 0



Soil parameters

No Fines Concrete

Unit weight : γ = 18.00 kN/m³

Angle of internal friction : ϕ_{ef} = 45.00 °

Cohesion of soil : c_{ef} = 30.00 kPa

Angle of friction struc.-soil : δ = 24.50 °



Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Class 6I

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 35.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 21.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Firm silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 30.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 17.00^\circ$

Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Firm to Stiff slightly silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 32.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 19.00^\circ$

Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Type 1

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 35.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 21.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Fresh Rock (Granodiorite)

Unit weight : $\gamma = 22.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 45.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 31.50^\circ$

Saturated unit weight : $\gamma_{sat} = 22.00 \text{ kN/m}^3$

Made Ground

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 32.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 17.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	0.10	Type 1	
2	-	Fresh Rock (Granodiorite)	



Terrain profile

No.	Coordinate x [m]	Depth z [m]
1	0.00	0.00
2	2.43	-1.42
3	3.52	-1.42
4	3.63	-3.08
5	3.91	-3.08
6	3.91	-2.87
7	8.36	-4.97
8	10.08	-5.29
9	11.79	-5.29
10	11.82	-5.41
11	12.67	-5.62
12	13.67	-5.62

Origin [0,0] is located in upper right edge of construction.
Positive coordinate +z has downward direction.

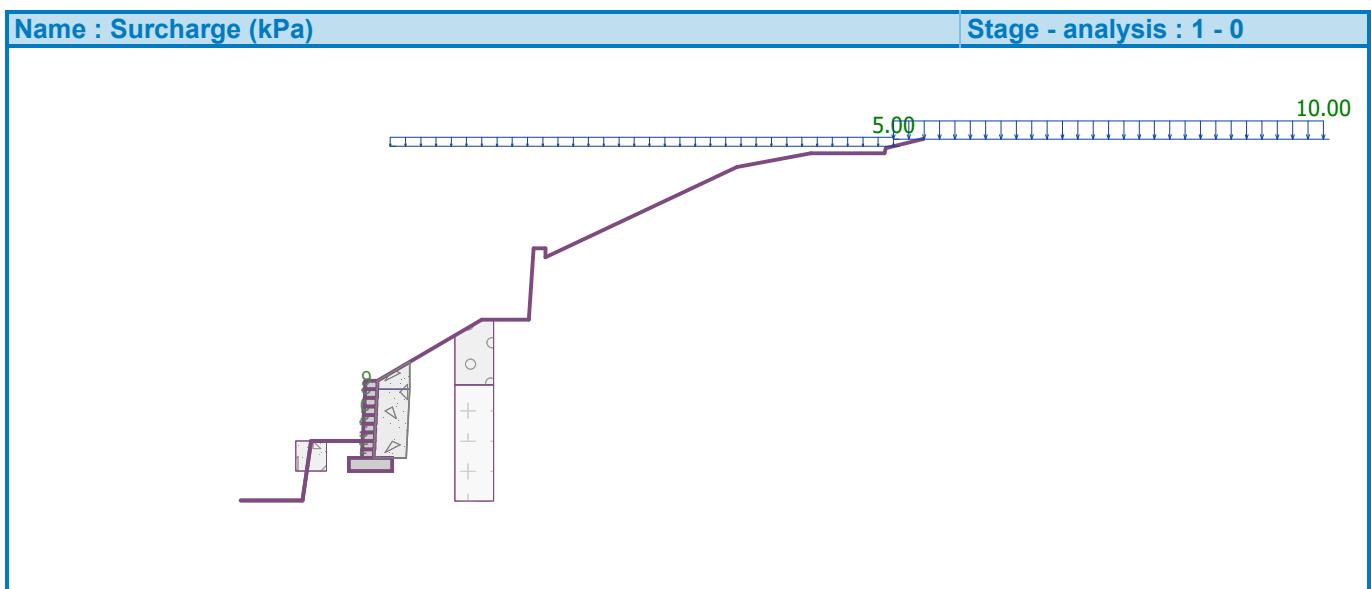
Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		variable	5.00		0.30	11.70	on terrain
2	Yes		variable	10.00		12.00	10.00	on terrain

No.	Name
1	5kPa Load
2	10kPa Load



Resistance on front face of the structure

Resistance on front face of the structure: not considered



Soil on front face of the structure - No Fines Concrete
Soil thickness in front of structure $h = 0.70 \text{ m}$

Terrain shape in front of structure

No.	Coordinate x[m]	Depth z[m]
1	0.00	0.00
2	0.00	-0.70
3	-1.19	-0.70
4	-1.39	0.69
5	-2.39	0.69

Origin [0,0] is located in bottom left edge of construction.
Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

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 - reinforced soil	0.00	-1.12	32.80	0.93	1.000	1.000	1.350
Active pressure	17.60	-0.86	16.02	1.33	1.350	1.350	1.350
5kPa Load	2.64	-1.39	2.19	1.35	1.500	1.500	1.500
10kPa Load	0.00	-2.54	0.00	1.41	0.000	0.000	1.500
Weight - wall	0.00	-1.20	10.08	0.48	1.000	1.000	1.350
5kPa Load	0.00	-2.41	2.25	1.19	0.000	0.000	1.500

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment $M_{res} = 68.46 \text{ kNm/m}$
Overturning moment $M_{ovr} = 26.04 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 67.80 \text{ kN/m}$
Active horizontal force $H_{act} = 27.72 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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 - reinforced soil	0.00	-1.12	32.80	0.93	1.000	1.000	1.000
Active pressure	25.36	-0.91	18.25	1.33	1.000	1.000	1.000
5kPa Load	3.77	-1.37	2.50	1.35	1.300	1.300	1.300
10kPa Load	2.35	-0.72	1.73	1.32	1.300	1.300	1.300
Weight - wall	0.00	-1.20	10.08	0.48	1.000	1.000	1.000



Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
5kPa Load	0.00	-2.41	2.25	1.19	0.000	0.000	1.300

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment $M_{res} = 66.94 \text{ kNm/m}$

Overturning moment $M_{ovr} = 31.91 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 53.31 \text{ kN/m}$

Active horizontal force $H_{act} = 33.31 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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	-1.20	10.08	0.48	1.000	1.000	1.350
Weight - earth wedge	0.00	-0.75	5.14	0.74	1.000	1.000	1.350
Active pressure	0.00	-2.10	0.00	0.66	1.000	1.000	1.000
5kPa Load	0.00	-2.10	0.60	0.85	0.000	0.000	1.500
10kPa Load	0.00	-2.10	0.00	0.66	0.000	0.000	1.500
Reinforcement	-19.17	-0.30	0.00	0.88	1.000	1.000	1.000
Reinforcement	-4.25	-1.90	0.00	1.14	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 22.46 \text{ kNm/m}$

Overturning moment $M_{ovr} = 0.00 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 38.64 \text{ kN/m}$

Active horizontal force $H_{act} = 0.00 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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	-1.20	10.08	0.48	1.000	1.000	1.000
Weight - earth wedge	0.00	-0.75	5.14	0.74	1.000	1.000	1.000



Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Active pressure	0.09	-0.35	0.12	0.99	1.000	1.000	1.000
5kPa Load	0.06	-0.39	0.69	0.85	0.000	0.000	1.300
10kPa Load	0.00	-2.10	0.00	0.66	0.000	0.000	1.300
Reinforcement	-19.17	-0.30	0.00	0.88	1.000	1.000	1.000
Reinforcement	-4.24	-1.90	0.00	1.14	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 22.57 \text{ kNm/m}$
Overturning moment $M_{ovr} = 0.03 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 35.69 \text{ kN/m}$
Active horizontal force $H_{act} = 0.09 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

No. 2

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	-0.90	10.08	0.18	1.000	1.000	1.350
Active pressure	0.00	-1.80	0.00	0.36	1.000	1.000	1.000
5kPa Load	0.00	-1.80	0.54	0.32	0.000	0.000	1.500
10kPa Load	0.00	-1.80	0.00	0.36	0.000	0.000	1.500
Reinforcement	-5.08	-1.60	0.00	0.74	1.000	1.000	1.000

Check of construction joint above the most utilized block No.: 0

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 9.94 \text{ kNm/m}$
Overturning moment $M_{ovr} = 0.00 \text{ kNm/m}$

Joint for overturning stability is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 10.45 \text{ kN/m}$
Active horizontal force $H_{act} = 0.00 \text{ kN/m}$

Joint for slip is **SATISFACTORY**

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	-0.90	10.08	0.18	1.000	1.000	1.000



Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Active pressure	0.00	-1.80	0.00	0.36	1.000	1.000	1.000
5kPa Load	0.00	-1.80	0.64	0.32	0.000	0.000	1.300
10kPa Load	0.00	-1.80	0.00	0.36	0.000	0.000	1.300
Reinforcement	-5.07	-1.60	0.00	0.74	1.000	1.000	1.000

Check of construction joint above the most utilized block No.: 0

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 9.93 \text{ kNm/m}$

Overturning moment $M_{ovr} = 0.00 \text{ kNm/m}$

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 10.44 \text{ kN/m}$

Active horizontal force $H_{act} = 0.00 \text{ kN/m}$

Joint for slip is SATISFACTORY

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	9.83	59.23	27.14	0.161	84.83
2	10.91	56.30	27.14	0.188	87.63
3	6.22	57.04	22.36	0.106	70.24
4	4.23	73.54	22.36	0.056	80.38

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	3.02	54.01	16.30
2	3.85	51.76	16.30

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.188$

Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom $\sigma = 87.63 \text{ kPa}$

Bearing capacity of foundation soil $R_d = 200.00 \text{ kPa}$

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY



Analysis of reinforced slopes

Input data

Project

Task : Vertica MacWall Design
 Part : Section 3-3
 Description : Verification of Middle tier MacWall MSE
 Customer : Maccaferri Ltd.
 Author : Liam K. D.
 Date : 08/08/2017
 Project ID : Dominican Chapel, Newry
 Project number : 17-5479

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
 Allowable eccentricity : 0.333
 Internal stability : Standard - straight slip surface
 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	
Permanent actions :	$\gamma_G =$	1.35	[$-$]	1.00	[$-$]
Variable actions :	$\gamma_Q =$	1.50	[$-$]	0.00	[$-$]
Water load :	$\gamma_w =$	1.35	[$-$]		
				1.00	[$-$]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[$-$]	1.25	[$-$]
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[$-$]	1.25	[$-$]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[$-$]	1.40	[$-$]
Partial factor on Poisson's ratio :	$\gamma_v =$	1.00	[$-$]	1.00	[$-$]

Partial factors for variable actions					
Permanent design situation					
Factor for combination value :		$\psi_0 =$		0.70	[$-$]
Factor for frequent value :		$\psi_1 =$		0.50	[$-$]
Factor for quasi-permanent value :		$\psi_2 =$		0.30	[$-$]

Stability analysis

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 :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]	
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]	
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]		

Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	$\gamma_\phi =$	1.00	[-]	1.25	[-]	
Partial factor on effective cohesion :	$\gamma_c =$	1.00	[-]	1.25	[-]	
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00	[-]	1.40	[-]	

Geometry of structure

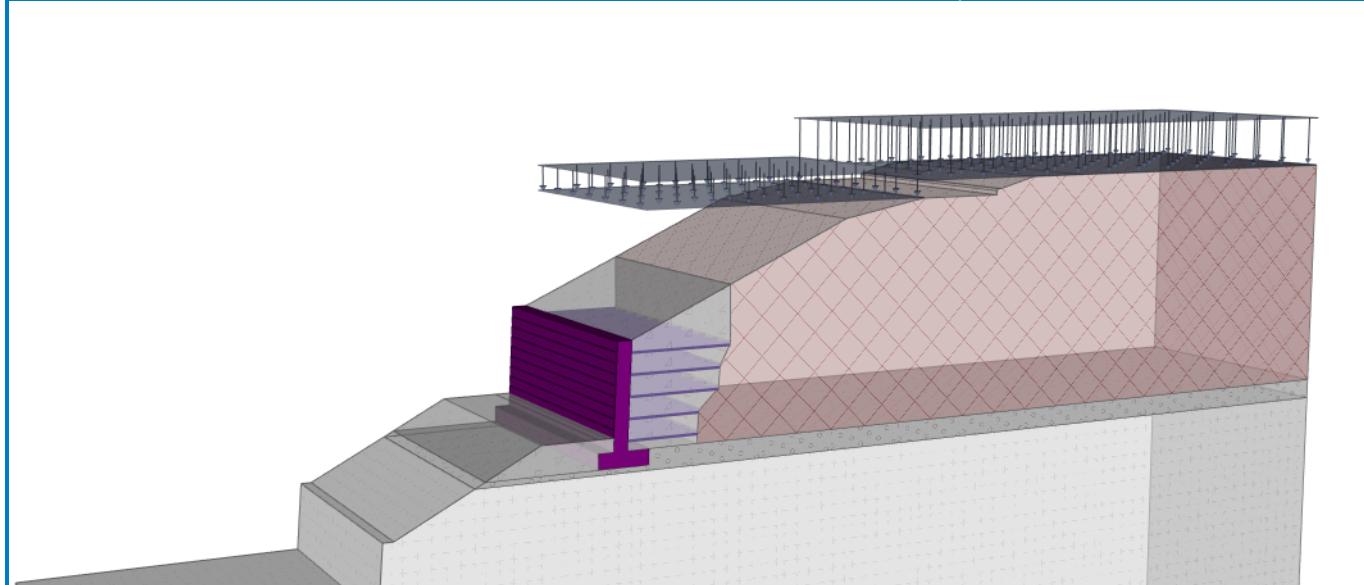
Number of blocks $n = 10$
 Block height $h = 0.20 \text{ m}$
 Block width $b = 0.28 \text{ m}$
 Block offset $o_1 = 0.01 \text{ m}$

Structure foundation

Foundation width $b_b = 1.00 \text{ m}$
 Foundation height $l_b = 0.30 \text{ m}$
 Foundation offset $a_b = 0.30 \text{ m}$

Name : Geometry

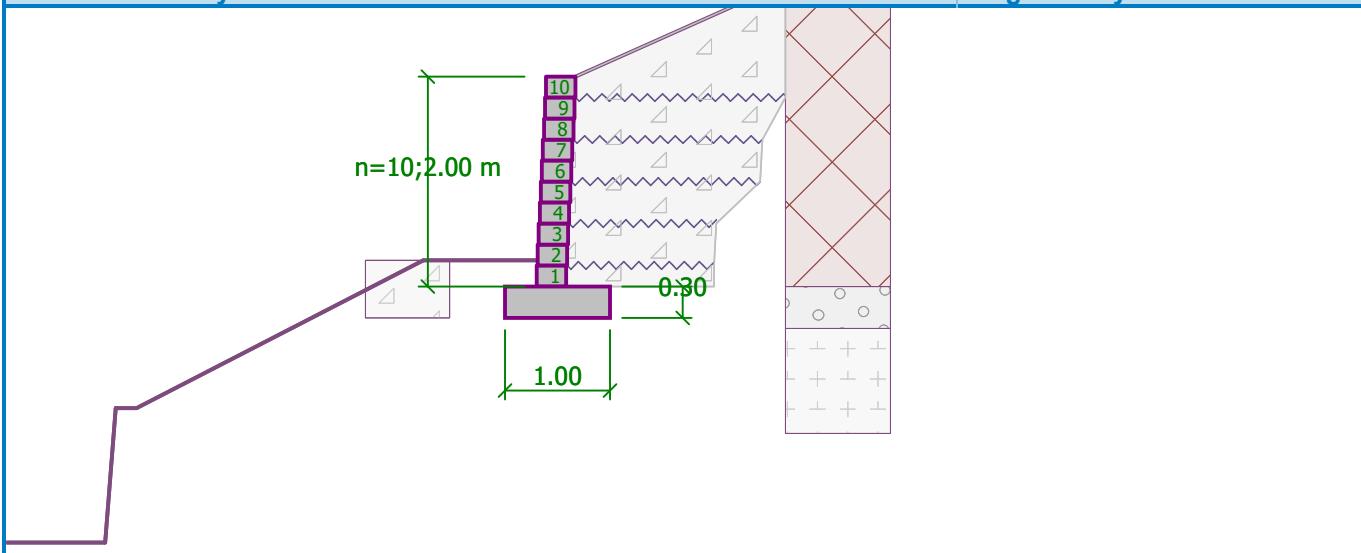
Stage - analysis : 1 - 0





Name : Geometry

Stage - analysis : 1 - 0



Material

Block material

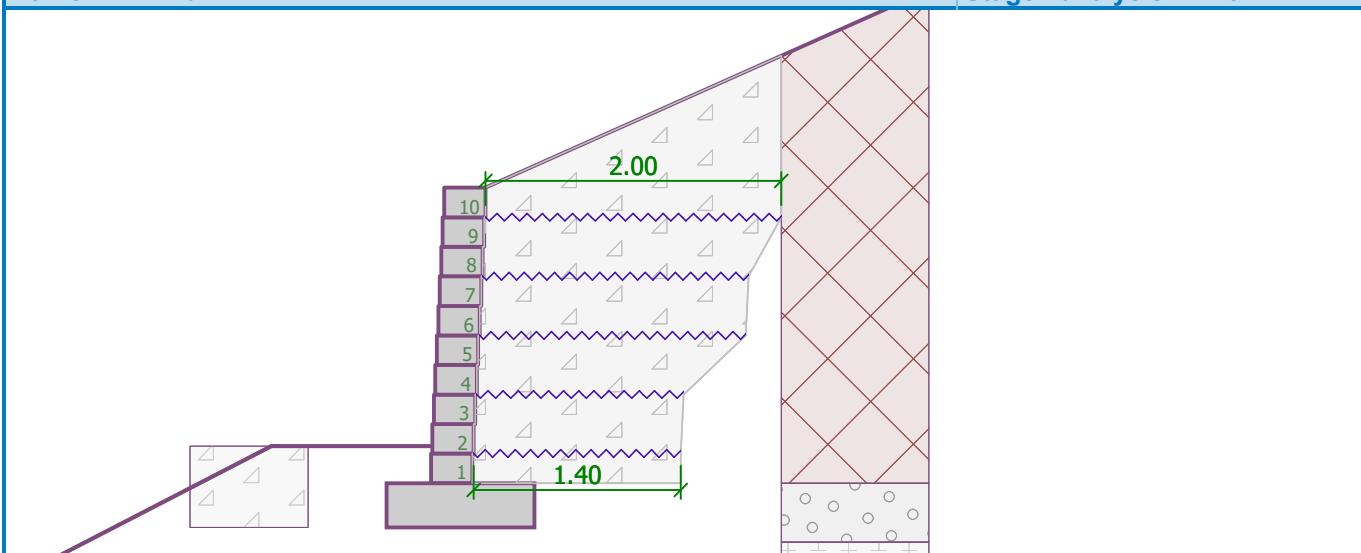
Unit weight γ = 20.00 kN/m³
Cohesion c = 0.00 kPa
Friction f = 0.533
Shear bearing capacity of joint R_s = 0.00 kN/m
Reinforced soil - Class 61

Reinforcement

Total number of input reinforcements : 5.

Name : Minimum NFC Fill

Stage - analysis : 1 - 0



Soil parameters

No Fines Concrete

Unit weight : γ = 18.00 kN/m³
Angle of internal friction : ϕ_{ef} = 45.00 °
Cohesion of soil : c_{ef} = 30.00 kPa
Angle of friction struc.-soil : δ = 24.50 °



Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Class 6I

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 35.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 21.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Firm silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 30.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 17.00^\circ$

Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Firm to Stiff slightly silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 32.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 19.00^\circ$

Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Type 1

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 35.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 21.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Fresh Rock (Granodiorite)

Unit weight : $\gamma = 22.00 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 45.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 31.50^\circ$

Saturated unit weight : $\gamma_{sat} = 22.00 \text{ kN/m}^3$

Made Ground

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$

Angle of internal friction : $\varphi_{ef} = 32.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$

Angle of friction struc.-soil : $\delta = 17.00^\circ$

Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	2.00	Made Ground	
2	0.40	Type 1	



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No.	Layer [m]	Assigned soil	Pattern
3	-	Fresh Rock (Granodiorite)	

Terrain profile

No.	Coordinate x [m]	Depth z [m]
1	0.00	0.00
2	4.46	-1.99
3	6.17	-2.31
4	7.89	-2.31
5	7.89	-2.39
6	7.92	-2.43
7	7.99	-2.43
8	8.77	-2.64
9	9.77	-2.64

Origin [0,0] is located in upper right edge of construction.

Positive coordinate +z has downward direction.

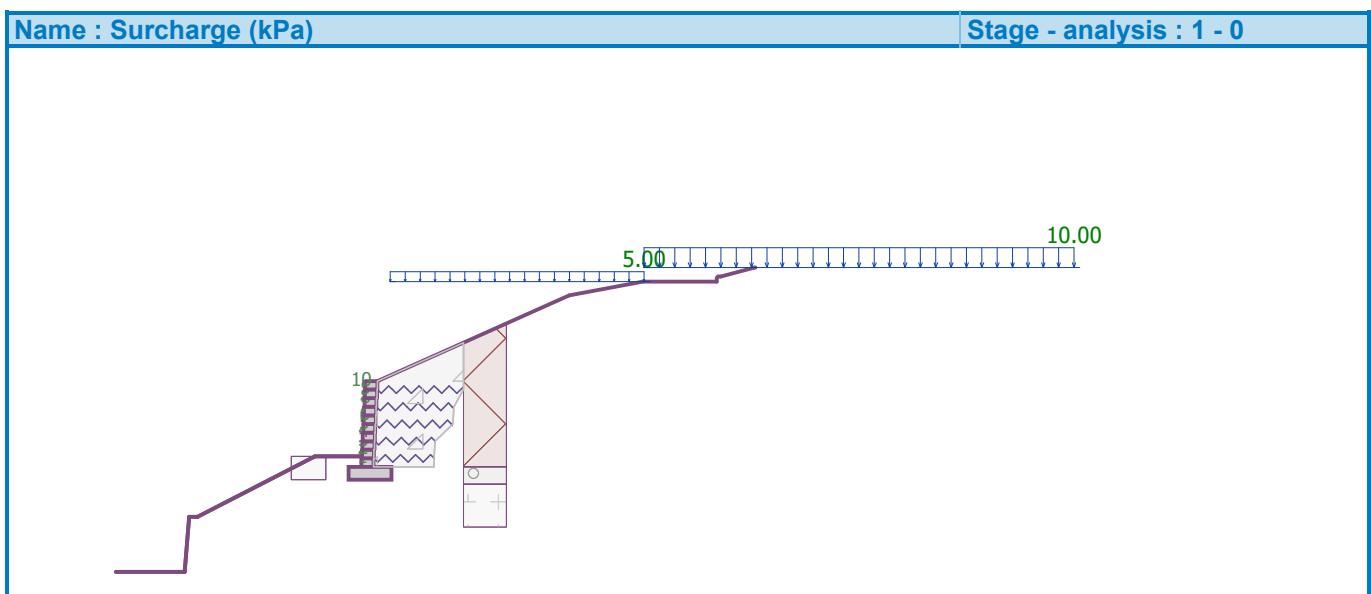
Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m ²]	Mag.2 [kN/m ²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		variable	5.00		0.30	5.90	on terrain
2	Yes		variable	10.00		6.20	10.00	on terrain

No.	Name
1	5kPa Load
2	10kPa Load





Resistance on front face of the structure

Resistance on front face of the structure: not considered

Soil on front face of the structure - Class 6

Soil thickness in front of structure $h = 0.55 \text{ m}$

Terrain shape in front of structure

No.	Coordinate x[m]	Depth z[m]
1	0.00	0.00
2	0.00	-0.55
3	-1.09	-0.55
4	-3.82	0.86
5	-4.02	0.86
6	-4.12	2.14
7	-5.12	2.14

Origin [0,0] is located in bottom left edge of construction.

Positive coordinate +z has downward direction.

Settings of the stage of construction

Design situation : permanent

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 - reinforced soil	0.00	-1.57	80.72	1.54	1.000	1.000	1.350
Active pressure	22.73	-0.85	12.50	1.93	1.350	1.350	1.350
5kPa Load	5.31	-1.65	1.91	2.08	1.500	1.500	1.500
10kPa Load	4.93	-1.02	2.11	1.91	1.500	1.500	1.500
Weight - wall	0.00	-1.30	11.20	0.49	1.000	1.000	1.350
5kPa Load	0.00	-2.81	8.50	1.82	0.000	0.000	1.500

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment $M_{res} = 174.56 \text{ kNm/m}$

Overturning moment $M_{ovr} = 46.77 \text{ kNm/m}$

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 71.76 \text{ kN/m}$

Active horizontal force $H_{act} = 46.04 \text{ kN/m}$

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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 - reinforced soil	0.00	-1.57	80.72	1.54	1.000	1.000	1.000



Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Active pressure	31.11	-0.88	12.88	1.92	1.000	1.000	1.000
5kPa Load	7.12	-1.66	1.75	2.05	1.300	1.300	1.300
10kPa Load	8.41	-1.36	2.19	1.96	1.300	1.300	1.300
Weight - wall	0.00	-1.30	11.20	0.49	1.000	1.000	1.000
5kPa Load	0.00	-2.81	8.50	1.82	0.000	0.000	1.300

Verification of complete wall

Place of verification : bottom of leveling pad

Check for overturning stability

Resisting moment $M_{res} = 165.00$ kNm/m
Overturning moment $M_{ovr} = 57.68$ kNm/m

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 54.95$ kN/m
Active horizontal force $H_{act} = 51.29$ kN/m

Wall for slip is **SATISFACTORY**

Overall check - WALL is **SATISFACTORY**

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	-1.30	11.20	0.49	1.000	1.000	1.350
Weight - earth wedge	0.00	-0.70	4.60	0.74	1.000	1.000	1.350
Active pressure	14.87	-0.77	14.69	0.85	1.350	1.350	1.350
5kPa Load	2.65	-1.16	2.05	0.80	1.500	1.500	1.500
10kPa Load	0.63	-0.13	0.24	1.00	0.000	1.500	1.500
Reinforcement	-27.19	-0.50	0.00	0.99	1.000	1.000	1.000
Reinforcement	-27.19	-0.90	0.00	1.22	1.000	1.000	1.000
Reinforcement	-27.19	-1.30	0.00	1.45	1.000	1.000	1.000
Reinforcement	-18.45	-1.70	0.00	1.67	1.000	1.000	1.000
Reinforcement	-13.07	-2.10	0.00	1.90	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 160.41$ kNm/m
Overturning moment $M_{ovr} = 20.14$ kNm/m

Wall for overturning is **SATISFACTORY**

Check for slip

Resisting horizontal force $H_{res} = 140.42$ kN/m
Active horizontal force $H_{act} = 24.99$ kN/m

Wall for slip is **SATISFACTORY**



Overall check - WALL is SATISFACTORY

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	-1.30	11.20	0.49	1.000	1.000	1.000
Weight - earth wedge	0.00	-0.70	4.60	0.74	1.000	1.000	1.000
Active pressure	19.50	-0.77	15.68	0.85	1.000	1.000	1.000
5kPa Load	3.66	-1.19	2.31	0.80	1.300	1.300	1.300
10kPa Load	2.93	-0.61	2.42	0.87	1.300	1.300	1.300
Reinforcement	-27.19	-0.50	0.00	0.99	1.000	1.000	1.000
Reinforcement	-27.19	-0.90	0.00	1.22	1.000	1.000	1.000
Reinforcement	-27.19	-1.30	0.00	1.45	1.000	1.000	1.000
Reinforcement	-18.45	-1.70	0.00	1.67	1.000	1.000	1.000
Reinforcement	-13.07	-2.10	0.00	1.90	1.000	1.000	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 159.53$ kNm/m

Overturning moment $M_{ovr} = 23.04$ kNm/m

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 134.15$ kN/m

Active horizontal force $H_{act} = 28.07$ kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

No. 2

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	-0.10	1.12	0.14	1.000	1.000	1.350
Active pressure	0.10	-0.07	0.04	0.28	1.350	1.350	1.350
5kPa Load	0.18	-0.06	0.07	0.28	1.500	1.500	1.500
10kPa Load	0.00	-0.20	0.00	0.28	0.000	0.000	1.500

Check of construction joint above the most utilized block No.: 9

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 0.20$ kNm/m

Overturning moment $M_{ovr} = 0.03$ kNm/m

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 0.68$ kN/m

Active horizontal force $H_{act} = 0.41$ kN/m



Joint for slip is SATISFACTORY

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	-0.10	1.12	0.14	1.000	1.000	1.000
Active pressure	0.13	-0.07	0.04	0.28	1.000	1.000	1.000
5kPa Load	0.34	-0.09	0.11	0.28	1.300	1.300	1.300
10kPa Load	0.00	-0.20	0.00	0.28	0.000	0.000	1.300

Check of construction joint above the most utilized block No.: 9

Place of verification : bottom of blocks

Check for overturning stability

Resisting moment $M_{res} = 0.21 \text{ kNm/m}$

Overturning moment $M_{ovr} = 0.05 \text{ kNm/m}$

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 0.69 \text{ kN/m}$

Active horizontal force $H_{act} = 0.57 \text{ kN/m}$

Joint for slip is SATISFACTORY

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	-36.01	150.98	37.43	0.000	95.56
2	-14.69	106.77	37.43	0.000	67.58
3	-2.18	103.10	42.75	0.000	65.25
4	-10.25	114.15	42.75	0.000	72.25

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-26.85	110.53	26.71
2	-20.65	102.03	26.71

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.000$

Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom $\sigma = 95.56 \text{ kPa}$

Bearing capacity of foundation soil $R_d = 200.00 \text{ kPa}$

Bearing capacity of foundation soil is SATISFACTORY



Overall verification - bearing capacity of found. soil is SATISFACTORY

Verification of slip on georeinforcement No. 1

Forces acting on construction (verification of most utilized reinforcement)

Name	F _{hor} [kN/m]	App.Pt. z [m]	F _{vert} [kN/m]	App.Pt. x [m]	Design coefficient
Weight - wall	0.00	-0.70	7.84	-0.10	1.000
Active pressure	15.95	-0.73	7.03	1.90	1.000
5kPa Load	5.58	-1.32	1.33	1.93	1.300
10kPa Load	6.21	-1.02	1.87	1.91	1.300
Weight - reinforced soil	0.00	-1.06	61.69	1.09	1.000
5kPa Load	0.00	-2.01	10.75	1.45	0.000

Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 2)

Inclination of slip surface	= 66.00 °
Overall normal force acting on reinforcement	= 72.87 kN/m
Coefficient of reduction of slip along geo-textile	= 0.80
Resistance along geo-reinforcement	= 40.82 kN/m
Wall resistance	= 4.18 kN/m
Overall bearing capacity of reinforcements	= 0.00 kN/m

Results for the most severe combination - No. 2

Check for slip:

Resisting horizontal force H_{res} = 45.00 kN/m
Active horiz. force H_{act} = 31.27 kN/m

Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Calculated forces and strength of reinforcements

No.	Name	F _x [kN/m]	Depth z[m]	R _t [kN/m]	Utiliz. [%]	T _p [kN/m]	Utiliz. [%]	R _{con} [kN/m]	Utiliz. [%]
1	Paragrid 40 - 1.8	-5.44	1.80	27.19	20.01	61.88	8.79	12.70	42.83
2	Paragrid 40 - 1.4	-4.48	1.40	27.19	16.49	43.68	10.27	12.40	36.16
3	Paragrid 40 - 1.0	-3.68	1.00	27.19	13.54	44.02	8.36	10.80	34.09
4	Paragrid 40 - 0.6	-2.88	0.60	27.19	10.61	28.59	10.08	8.70	33.14
5	Paragrid 30 - 0.2	-1.76	0.20	20.19	8.71	21.07	8.34	6.50	27.05

Check for tensile strength (reinforcement No.1)

Tension strength R_t = 27.19 kN/m
Force in reinforcement F_x = 5.44 kN/m

Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance (reinforcement No.2)

Pull out resistance T_p = 43.68 kN/m
Force in reinforcement F_x = 4.48 kN/m

Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength (reinforcement No.1)

Connection strength R_{con} = 12.70 kN/m
Force in reinforcement F_x = 5.44 kN/m

Connection strength is SATISFACTORY



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Section 3-3
17-5479

Overall verification - reinforcement is SATISFACTORY



Slope stability analysis

Input data

Project

Task : Vertica MacWall Design
 Part : Section 3-3
 Description : Verification of Global Stability for Entire Section 3-3
 Customer : Maccaferri Ltd.
 Author : Liam K. D.
 Date : 08/08/2017
 Project ID : Dominican Chapel, Newry
 Project number : 17-5479

Settings

Standard - EN 1997 - DA1

Stability analysis

Earthquake analysis : 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		
Permanent actions :	$\gamma_G =$	1.35 [-]	Favourable	1.00 [-]	1.00 [-]	
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]	
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]		

Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	$\gamma_\phi =$	1.00 [-]		1.25 [-]		
Partial factor on effective cohesion :	$\gamma_c =$	1.00 [-]		1.25 [-]		
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00 [-]		1.40 [-]		

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	0.70	8.36	0.70	8.36	1.10
		8.39	1.10	8.39	1.50	8.42	1.50
		8.42	1.90	8.45	1.90	8.45	2.10
		8.73	2.10	8.73	2.05	9.91	2.05
		9.91	2.24	9.93	2.64	9.96	2.64
		9.96	3.04	9.99	3.04	9.99	3.44
		10.28	3.44	10.28	3.39	12.73	4.83
		13.82	4.83	13.82	5.00	13.83	5.40
		13.86	5.40	13.86	5.80	13.89	5.80
		13.89	6.20	13.92	6.20	13.92	6.40
		14.19	6.40	18.65	8.39	20.36	8.71
		22.08	8.71	22.09	8.79	22.11	8.83
		22.18	8.83	22.96	9.04	38.81	9.03



No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
2		20.36	8.71	20.43	8.79	22.09	8.79
3		15.10	4.40	16.26	6.40	16.44	6.71
		18.55	8.31	18.65	8.39		
4		14.24	6.40	18.55	8.31		
5		8.33	0.30	8.62	0.30	8.62	0.50
		8.62	0.66	9.18	0.95	9.45	1.04
		9.60	1.06	9.96	1.06	10.02	1.05
		10.32	1.05	10.43	1.06	10.58	1.12
		10.71	1.21	10.79	1.29	10.84	1.37
		10.91	1.64	10.96	2.34	10.96	2.39
		10.97	2.46	11.01	2.68	11.07	2.84
		11.14	2.90	11.43	3.15	11.69	3.39
		11.79	3.49	11.84	3.53	11.94	3.58
		12.38	3.81	12.43	3.82	12.54	3.84
		12.76	3.87	13.02	3.91	13.12	3.93
		13.31	4.01	13.33	4.03	13.38	4.03
		13.41	4.02	13.67	3.99	13.93	3.97
		14.45	3.99	14.91	4.04	15.13	4.06
		15.43	4.08	15.58	4.09	16.35	4.52
		17.09	5.62	17.66	6.15	19.28	6.61
		19.67	6.63	22.96	7.32	38.81	7.32
6		14.19	6.40	14.24	6.40	16.26	6.40
7		14.08	4.40	14.09	4.80	14.09	5.00
		14.12	5.00	14.12	5.40	14.15	5.40
		14.15	5.80	14.19	6.20	14.19	6.40



No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
8		12.73	4.83	12.74	4.78		
9		13.79	4.40	13.79	4.78	13.79	4.80
		13.82	4.80	13.82	4.83		
10		10.37	3.39	12.74	4.78	13.79	4.78
11		13.49	4.10	14.49	4.10	14.49	4.40
12		13.41	4.02	13.49	4.10	13.49	4.40
		13.79	4.40	14.06	4.40	14.08	4.40
		14.49	4.40	15.10	4.40	15.43	4.08
13		10.28	3.39	10.37	3.39	11.11	3.39
		11.69	3.39				
14		11.01	2.68	11.11	3.39		
15		10.16	1.64	10.16	2.04	10.19	2.04
		10.19	2.44	10.22	2.44	10.22	2.84
		10.25	2.84	10.25	3.24	10.28	3.24
		10.28	3.39				



No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
16		8.73	2.05	8.73	1.97		
17		8.62	0.66	8.63	1.10	8.67	1.10
		8.68	1.49	8.70	1.50	8.70	1.90
		8.73	1.90	8.73	1.97	9.90	1.97
		9.91	2.05				
18		9.88	1.64	9.88	1.84	9.90	1.97
19		9.58	1.34	10.58	1.34	10.58	1.64
20		9.18	0.95	9.58	1.34	9.58	1.64
		9.88	1.64	10.16	1.64	10.58	1.64
		10.91	1.64				
21		0.00	-0.01	8.03	0.00	8.03	0.30
		8.33	0.30	8.35	0.50	8.36	0.70
22		8.35	0.50	8.62	0.50		
23		0.00	0.30	8.03	0.30		



No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
24		8.62	0.30	8.91	0.30	8.91	0.00
		38.81	-0.01				
25		8.03	0.00	8.91	0.00		

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [kPa]	γ [kN/m³]
1	No Fines Concrete		45.00	30.00	18.00
2	Class 6I		35.00	0.00	18.00
3	Firm silty sandy gravelly CLAY		30.00	0.00	19.00
4	Firm to Stiff slightly silty sandy gravelly CLAY		32.00	0.00	19.00
5	Type 1		35.00	0.00	18.00
6	Fresh Rock (Granodiorite)		45.00	0.00	22.00
7	Made Ground		32.00	0.00	18.50

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [-]
1	No Fines Concrete		18.00		
2	Class 6I		18.00		



No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [-]
3	Firm silty sandy gravelly CLAY		19.00		
4	Firm to Stiff slightly silty sandy gravelly CLAY		19.00		
5	Type 1		18.00		
6	Fresh Rock (Granodiorite)			22.00	
7	Made Ground			18.50	

Soil parameters

No Fines Concrete

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 45.00^\circ$
 Cohesion of soil : $c_{ef} = 30.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Class 6

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Firm silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Firm to Stiff slightly silty sandy gravelly CLAY

Unit weight : $\gamma = 19.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 32.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 19.00 \text{ kN/m}^3$

Type 1

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 35.00^\circ$



Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 18.00 \text{ kN/m}^3$

Fresh Rock (Granodiorite)

Unit weight : $\gamma = 22.00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 45.00^\circ$
Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 22.00 \text{ kN/m}^3$

Made Ground

Unit weight : $\gamma = 18.50 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 32.00^\circ$
Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 18.50 \text{ kN/m}^3$

Rigid bodies

No.	Name	Sample	γ [kN/m ³]
1	Vertica MacWall		20.00
2	Slope Cover Material		15.00
3	Other		20.00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		20.43	8.79	20.36	8.71	Other
		22.08	8.71	22.09	8.79	
2		14.24	6.40	18.55	8.31	Slope Cover Material
		18.65	8.39	14.19	6.40	
3		16.26	6.40	16.44	6.71	Class 6I
		18.55	8.31	14.24	6.40	



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
4		13.79	4.78	13.79	4.80	Other
		13.82	4.80	13.82	4.83	
		12.73	4.83	12.74	4.78	
5		14.06	4.40	14.08	4.40	Vertical MacWall
		14.09	4.80	14.09	5.00	
		14.12	5.00	14.12	5.40	
		14.15	5.40	14.15	5.80	
		14.19	6.20	14.19	6.40	
		13.92	6.40	13.92	6.20	
		13.89	6.20	13.89	5.80	
		13.86	5.80	13.86	5.40	
		13.83	5.40	13.82	5.00	
		13.82	4.83	13.82	4.80	
		13.79	4.80	13.79	4.78	
		13.79	4.40			
6		14.49	4.40	15.10	4.40	Class 6I
		16.26	6.40	14.24	6.40	
		14.19	6.40	14.19	6.20	
		14.15	5.80	14.15	5.40	
		14.12	5.40	14.12	5.00	
		14.09	5.00	14.09	4.80	
		14.08	4.40			
7		14.08	4.40	14.06	4.40	No Fines Concrete
		13.79	4.40	13.49	4.40	
		13.49	4.10	14.49	4.10	
		14.49	4.40			
8		15.43	4.08	15.58	4.09	Made Ground
		16.35	4.52	17.09	5.62	
		17.66	6.15	19.28	6.61	
		19.67	6.63	22.96	7.32	
		38.81	7.32	38.81	9.03	
		22.96	9.04	22.18	8.83	
		22.11	8.83	22.09	8.79	
		22.08	8.71	20.36	8.71	
		18.65	8.39	18.55	8.31	
		16.44	6.71	16.26	6.40	
		15.10	4.40			
9		15.10	4.40	14.49	4.40	Type 1
		14.49	4.10	13.49	4.10	
		13.41	4.02	13.67	3.99	
		13.93	3.97	14.45	3.99	
		14.91	4.04	15.13	4.06	
		15.43	4.08			



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
10		10.37	3.39	12.74	4.78	Slope Cover Material
		12.73	4.83	10.28	3.39	
11		11.11	3.39	11.69	3.39	Class 6I
		11.79	3.49	11.84	3.53	
		11.94	3.58	12.38	3.81	
		12.43	3.82	12.54	3.84	
		12.76	3.87	13.02	3.91	
		13.12	3.93	13.31	4.01	
		13.33	4.03	13.38	4.03	
		13.41	4.02	13.49	4.10	
		13.49	4.40	13.79	4.40	
		13.79	4.78	12.74	4.78	
12		10.37	3.39			Class 6I
		11.01	2.68	11.07	2.84	
		11.14	2.90	11.43	3.15	
13		11.69	3.39	11.11	3.39	
		9.90	1.97	9.91	2.05	
14		8.73	2.05	8.73	1.97	Other
		10.16	1.64	10.16	2.04	
		10.19	2.04	10.19	2.44	
		10.22	2.44	10.22	2.84	
		10.25	2.84	10.25	3.24	
		10.28	3.24	10.28	3.39	
		10.28	3.44	9.99	3.44	
		9.99	3.04	9.96	3.04	
		9.96	2.64	9.93	2.64	
		9.91	2.24	9.91	2.05	
15		9.90	1.97	9.88	1.84	Vertica MacWall
		9.88	1.64			
		10.58	1.64	10.91	1.64	
		10.96	2.34	10.96	2.39	
		10.97	2.46	11.01	2.68	
		11.11	3.39	10.37	3.39	
		10.28	3.39	10.28	3.24	
		10.25	3.24	10.25	2.84	
		10.22	2.84	10.22	2.44	
		10.19	2.44	10.19	2.04	
		10.16	2.04	10.16	1.64	



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
16		10.16	1.64	9.88	1.64	No Fines Concrete
		9.58	1.64	9.58	1.34	
		10.58	1.34	10.58	1.64	
17		10.58	1.64	10.58	1.34	Type 1
		9.58	1.34	9.18	0.95	
		9.45	1.04	9.60	1.06	
		9.96	1.06	10.02	1.05	
		10.32	1.05	10.43	1.06	
		10.58	1.12	10.71	1.21	
		10.79	1.29	10.84	1.37	
		10.91	1.64			
18		9.58	1.34	9.58	1.64	No Fines Concrete
		9.88	1.64	9.88	1.84	
		9.90	1.97	8.73	1.97	
		8.73	1.90	8.70	1.90	
		8.70	1.50	8.68	1.49	
		8.67	1.10	8.63	1.10	
		8.62	0.66	9.18	0.95	
19		8.62	0.50	8.62	0.66	Vertica MacWall
		8.63	1.10	8.67	1.10	
		8.68	1.49	8.70	1.50	
		8.70	1.90	8.73	1.90	
		8.73	1.97	8.73	2.05	
		8.73	2.10	8.45	2.10	
		8.45	1.90	8.42	1.90	
		8.42	1.50	8.39	1.50	
		8.39	1.10	8.36	1.10	
		8.36	0.70	8.35	0.50	
20		8.03	0.30	8.33	0.30	Firm silty sandy gravelly CLAY
		8.35	0.50	8.36	0.70	
		0.00	0.70	0.00	0.30	
21		8.35	0.50	8.33	0.30	Vertica MacWall
		8.62	0.30	8.62	0.50	
22		8.91	0.00	8.91	0.30	No Fines Concrete
		8.62	0.30	8.33	0.30	
		8.03	0.30	8.03	0.00	



No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
23		8.91	0.30	8.91	0.00	Fresh Rock (Granodiorite)
		38.81	-0.01	38.81	7.32	
		22.96	7.32	19.67	6.63	
		19.28	6.61	17.66	6.15	
		17.09	5.62	16.35	4.52	
		15.58	4.09	15.43	4.08	
		15.13	4.06	14.91	4.04	
		14.45	3.99	13.93	3.97	
		13.67	3.99	13.41	4.02	
		13.38	4.03	13.33	4.03	
		13.31	4.01	13.12	3.93	
		13.02	3.91	12.76	3.87	
		12.54	3.84	12.43	3.82	
		12.38	3.81	11.94	3.58	
		11.84	3.53	11.79	3.49	
		11.69	3.39	11.43	3.15	
		11.14	2.90	11.07	2.84	
		11.01	2.68	10.97	2.46	
		10.96	2.39	10.96	2.34	
		10.91	1.64	10.84	1.37	
		10.79	1.29	10.71	1.21	
		10.58	1.12	10.43	1.06	
		10.32	1.05	10.02	1.05	
24		9.96	1.06	9.60	1.06	Firm to Stiff slightly silty sandy gravelly CLAY
		9.45	1.04	9.18	0.95	
		8.62	0.66	8.62	0.50	
		8.62	0.30			
		0.00	0.30	0.00	-0.01	
25		8.03	0.00	8.03	0.30	Fresh Rock (Granodiorite)

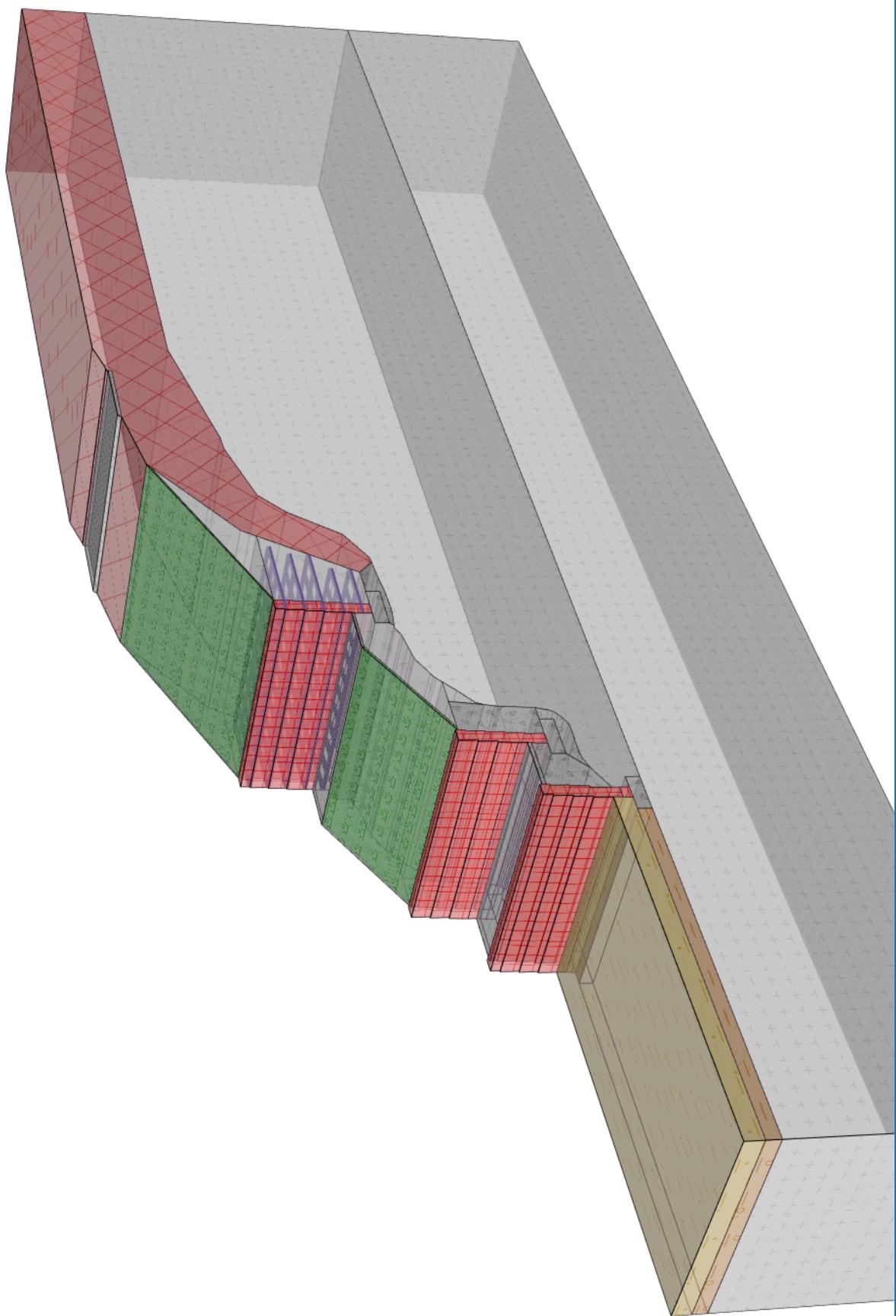


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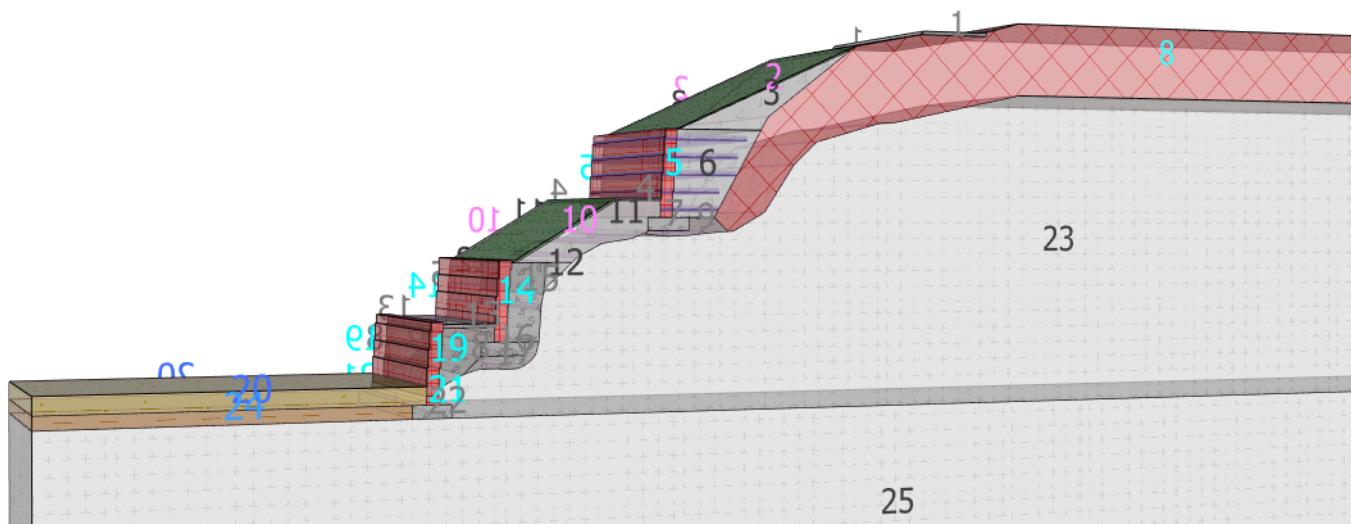
Name : Project Overview

Stage : 1



Name : Soils and assignment

Stage : 1

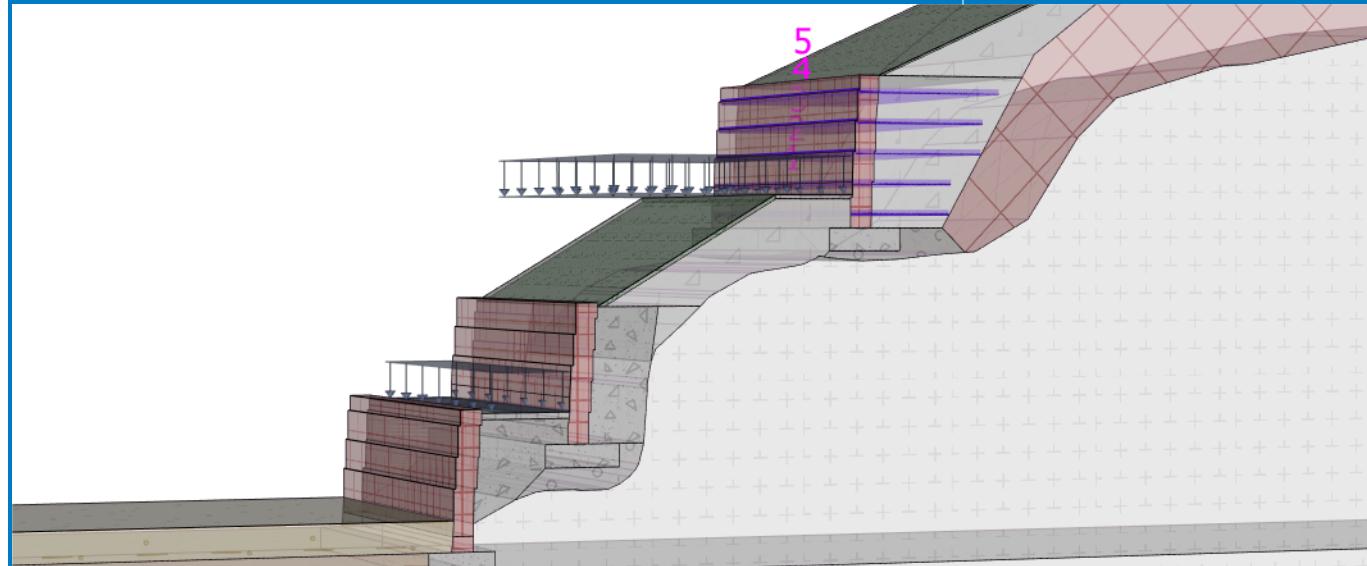


Reinforcements

No.	Point to the left		Point to the right		Length L [m]	Strength R _t [kN/m]	Pull out resist.	End of reinf.
	x [m]	z [m]	x [m]	z [m]				
1	13.80	4.60	15.20	4.60	1.40	50.00	C = 0.80	Fixed
2	13.83	5.00	15.23	5.00	1.40	50.00	C = 0.80	Fixed
3	13.86	5.40	15.66	5.40	1.80	50.00	C = 0.80	Fixed
4	13.89	5.80	15.69	5.80	1.80	50.00	C = 0.80	Fixed
5	13.92	6.20	15.92	6.20	2.00	50.00	C = 0.80	Fixed

Name : Reinforcements

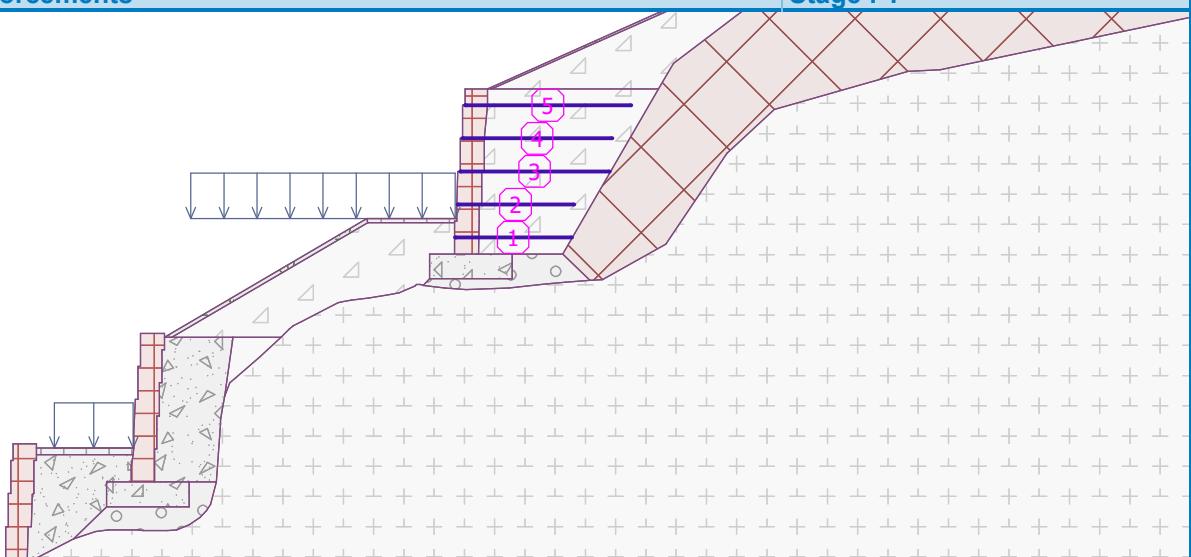
Stage : 1





Name : Reinforcements

Stage : 1



Surcharge

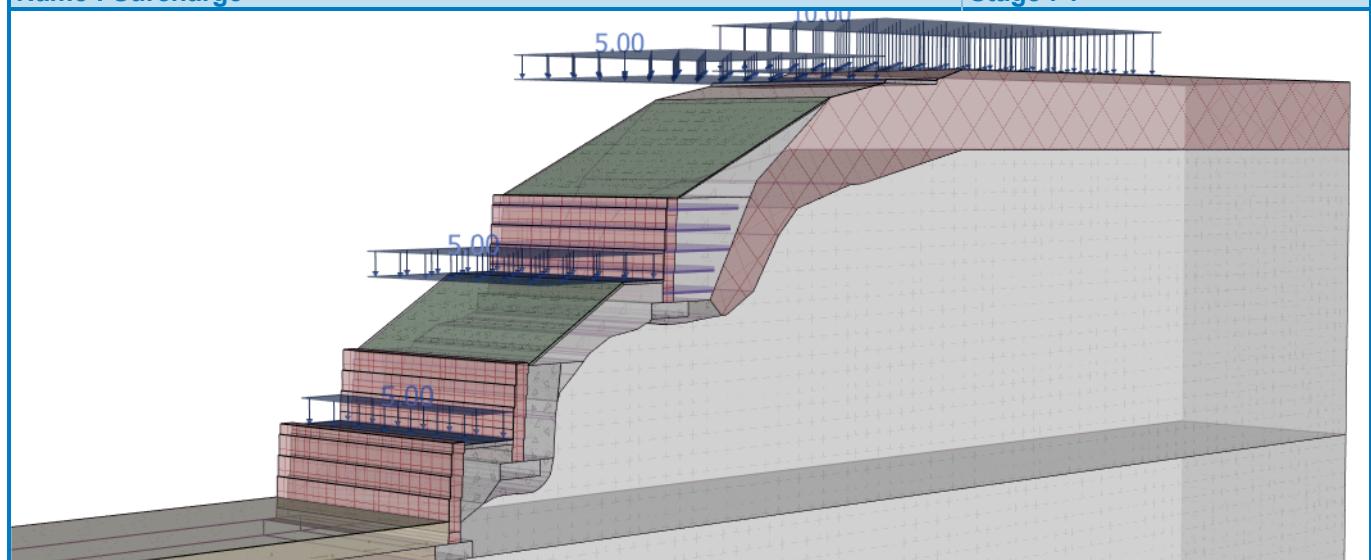
No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	q, q ₁ , f, F	q ₂	Magnitude unit
1	strip	variable	on terrain	x = 8.95	l = 0.95		0.00	5.00		kN/m ²
2	strip	variable	on terrain	x = 10.60	l = 3.20		0.00	5.00		kN/m ²
3	strip	variable	on terrain	x = 14.50	l = 5.90		0.00	5.00		kN/m ²
4	strip	variable	on terrain	x = 20.40	l = 10.00		0.00	10.00		kN/m ²

Surcharges

No.	Name
1	5kPa Load - 01
2	5kPa Load - 02
3	5kPa Load - 03
4	10kPa Load

Name : Surcharge

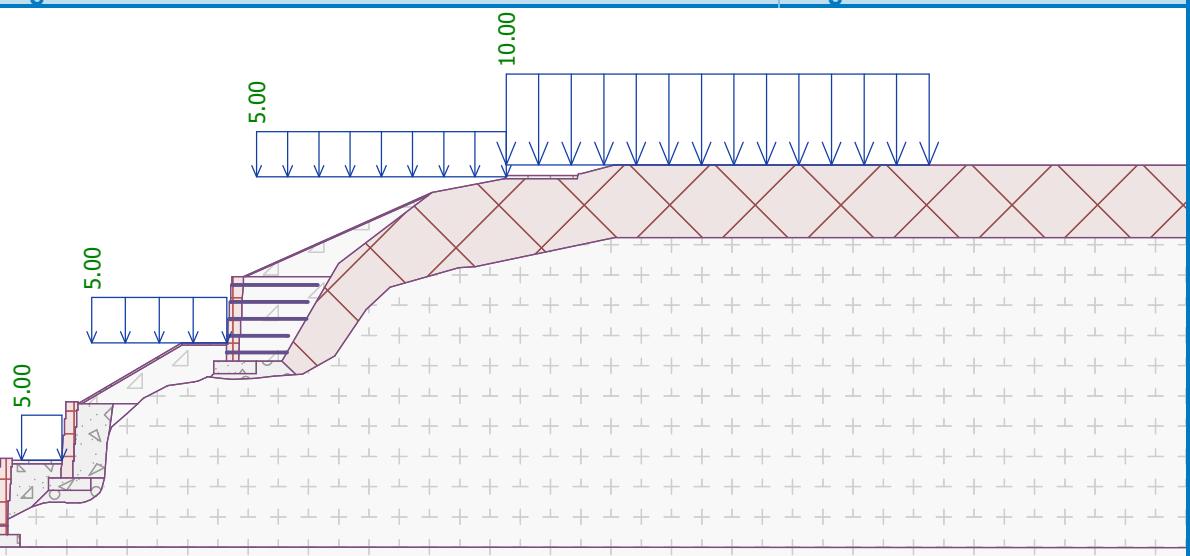
Stage : 1





Name : Surcharge

Stage : 1



Water

Water type : No water

Tensile crack

Tensile crack not input.

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 =	6.86 [m]	Angles :	α_1 =	-17.57 [°]
	z =	11.74 [m]		α_2 =	71.28 [°]
Radius :	R =	11.58 [m]	The slip surface after optimization.		

Reinforcement bearing capacity

Combination 1

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00

Combination 2

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00

Slope stability verification (Bishop)



Combination 1

Sum of active forces : $F_a = 272.76 \text{ kN/m}$
Sum of passive forces : $F_p = 448.97 \text{ kN/m}$
Sliding moment : $M_a = 3264.92 \text{ kNm/m}$
Resisting moment : $M_p = 5374.23 \text{ kNm/m}$
Utilization : 60.8 %

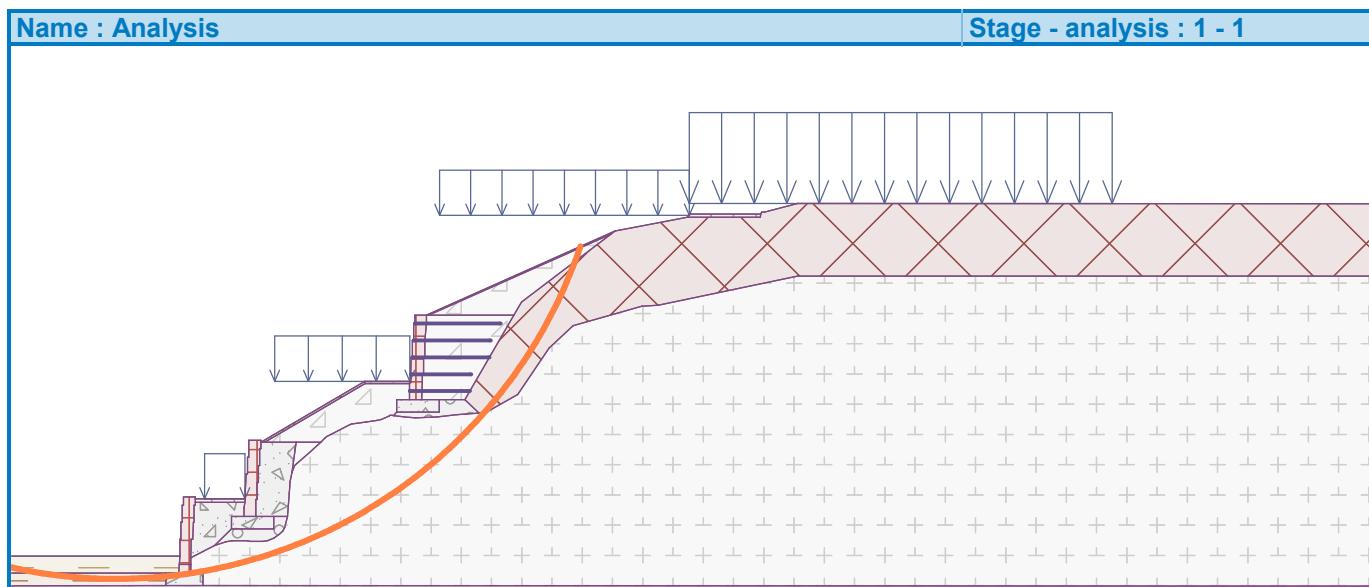
Slope stability ACCEPTABLE

Combination 2

Sum of active forces : $F_a = 257.05 \text{ kN/m}$
Sum of passive forces : $F_p = 364.11 \text{ kN/m}$
Sliding moment : $M_a = 2976.66 \text{ kNm/m}$
Resisting moment : $M_p = 4216.45 \text{ kNm/m}$
Utilization : 70.6 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2



Analysis 2

Circular slip surface

Slip surface parameters					
Center :	x =	6.77 [m]	Angles :	$\alpha_1 =$	-17.15 [°]
	z =	12.30 [m]		$\alpha_2 =$	70.19 [°]
Radius :	R =	12.14 [m]		The slip surface after optimization.	

Reinforcement bearing capacity

Combination 1

Reinforcement Bearing capacity [kN/m]	
1	0.00
2	0.00
3	0.00
4	0.00
5	0.00

Combination 2

Reinforcement Bearing capacity [kN/m]	
1	0.00



1	0.00
2	0.00
3	0.00
4	0.00
5	0.00

Slope stability verification (Bishop)

Combination 1

Sum of active forces : $F_a = 285.32 \text{ kN/m}$

Sum of passive forces : $F_p = 472.76 \text{ kN/m}$

Sliding moment : $M_a = 3224.09 \text{ kNm/m}$

Resisting moment : $M_p = 5342.21 \text{ kNm/m}$

Utilization : 60.4 %

Slope stability ACCEPTABLE

Combination 2

Sum of active forces : $F_a = 269.91 \text{ kN/m}$

Sum of passive forces : $F_p = 380.95 \text{ kN/m}$

Sliding moment : $M_a = 3276.75 \text{ kNm/m}$

Resisting moment : $M_p = 4624.78 \text{ kNm/m}$

Utilization : 70.9 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2

Analysis 3

Circular slip surface

Slip surface parameters					
Center :	x =	6.77 [m]	Angles :	$\alpha_1 =$	-17.15 [°]
	z =	12.30 [m]		$\alpha_2 =$	70.19 [°]
Radius :	R =	12.14 [m]		Analysis of the slip surface without optimization.	

Reinforcement bearing capacity

Combination 1

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00

Combination 2

Reinforcement Bearing capacity [kN/m]

1	0.00
2	0.00
3	0.00
4	0.00
5	0.00

Slope stability verification (all methods)

Combination 1

Bishop : Utilization = 60.5 % **ACCEPTABLE**

Fellenius / Petterson : Utilization = 67.5 % **ACCEPTABLE**

Spencer : Utilization = 60.3 % **ACCEPTABLE**

Janbu : Utilization = 60.4 % **ACCEPTABLE**

Morgenstern-Price : Utilization = 60.4 % **ACCEPTABLE**

Combination 2



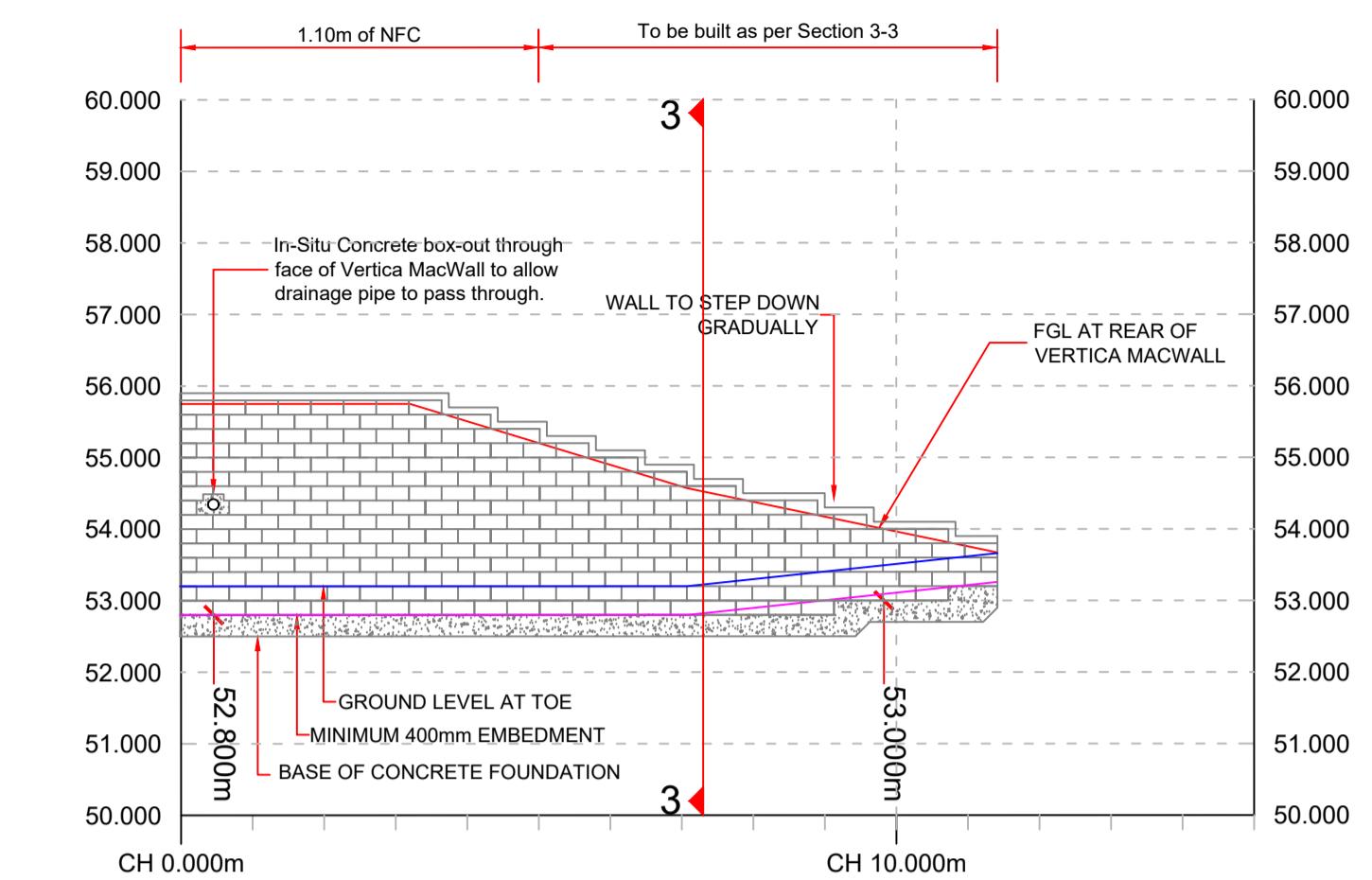
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Bishop : Utilization = 70.9 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 78.5 % **ACCEPTABLE**
Spencer : Utilization = 70.8 % **ACCEPTABLE**
Janbu : Utilization = 71.0 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 71.0 % **ACCEPTABLE**

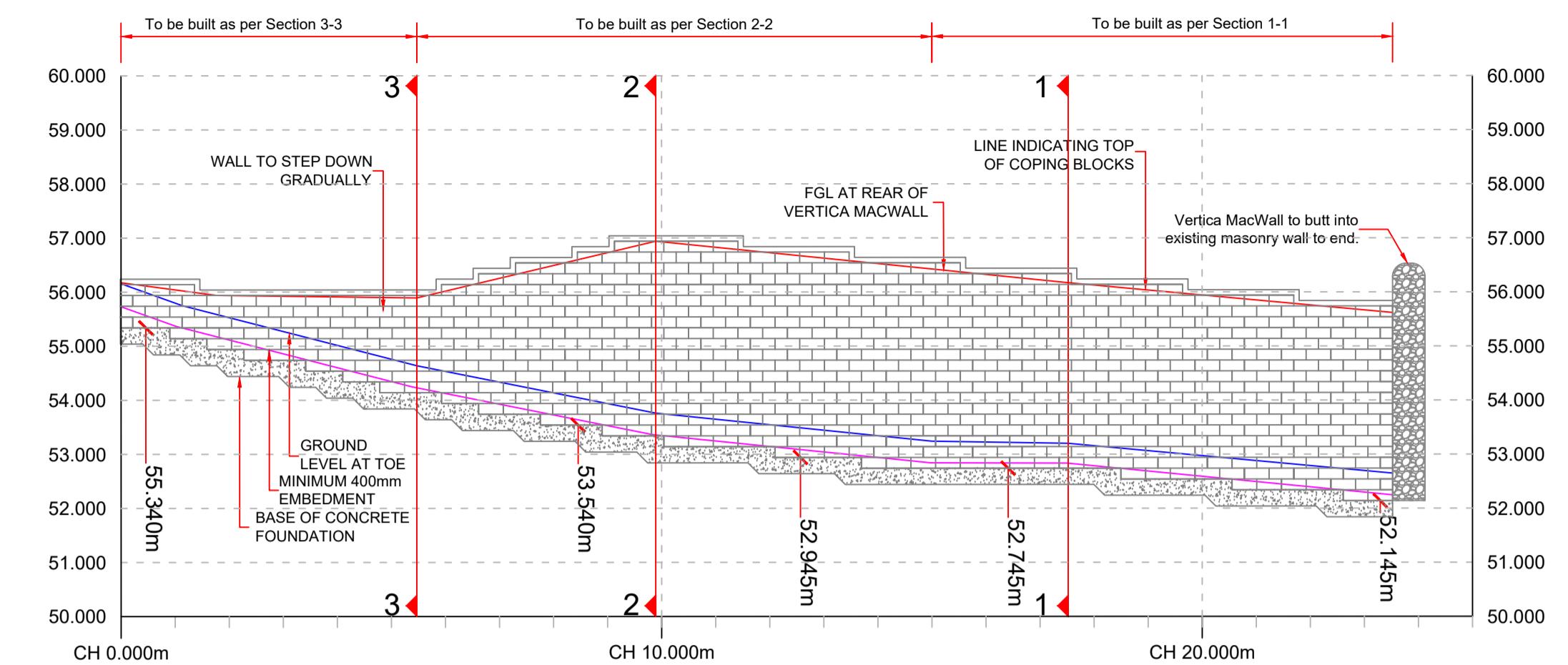
ELEVATION WALL - 01

1:100



ELEVATION WALL - 02

1:100



NOTES:

- 1) All dimensions in mm's unless otherwise specified.
- 2) BLOCKS: MacWall Vertica 4 degree blocks
- 3) INSTALLATION: Please refer to standard Manufacturer's installation guidelines.
- 4) BACKFILL: The backfill for the reinforced slope shall comprise a selected compacted granular fill material to comply with SFHW Class 6I. This material is assumed to have the following characteristics: $\phi' = 35$ degrees, $\gamma = 19 \text{ kN/m}^3$ and $c' = 0 \text{ kPa}$, compacted in accordance with SFHW Series 600. The Contractor is responsible for the selection of this material to ensure compliance with the geotechnical characteristics as shown on the relevant drawings and in the design documents/calculations.

No Fines Concrete (NFC) Sections: No fines concrete backfill is to be used behind the MacWall facing blocks. The concrete backfill must be tamped into the voids in and behind the Vertica MacWall facing blocks to create a monolithic structure. No fines concrete backfill with minimum density of 18 kN/m^3 . Typical Spec for no fines concrete:

- 6:1 to 7:1 Stone to Cement ratio (by weight)
- Clean crushed stone typically 14-20mm
- 1:2 Water to Cement ratio*

* Water/ cement ratio is only a guide value. The product needs to flow but if there is too much liquid, this can cause issues. It is better to mix on the dry side and then add water at the job site if needed.

4) DRAINAGE: Standard MacWall drainage detail is to be formed behind the facing blocks, as shown on the attached drawings. This is to comprise 300mm free draining aggregate (CLASS 6H) behind the blocks with block voids filled with same material. This should be roddable and connected to an approved outlet.

5) FOUNDATION FOR WALLS: Minimum 300mm deep C20/25 concrete leveling pad on fresh, intact BEDROCK (Granodiorite) with a minimum allowable bearing capacity of 200kPa (to be confirmed by the Project Consulting Engineer and/or a geologist prior to construction). Where any overburden, including soft, loose or unsuitable material (such as topsoil or Made Ground), is present at or below formation level of the wall, it must be removed down to fresh, intact BEDROCK and replaced with either C20/25 concrete (to a maximum depth of 0.5m).

06) SITE / IN-SITU SOILS: It is assumed the in-situ soils have the following properties as a minimum:

Overburden; (assumed to be firm to stiff slightly sandy gravelly CLAY - Made Ground/Glacial Till) assumed to have the following minimum properties:

$$\varphi = 32^\circ, \gamma = 18.5 \text{ kN/m}^3 \text{ and } c' = 0 \text{ kPa}$$

BEDROCK; (assumed to be fresh GRANODIORITE rock), assumed to have the following minimum properties:

$$\varphi = 45^\circ, \gamma = 22 \text{ kN/m}^3 \text{ and } c' = 0 \text{ kPa}$$

The Contractor/Project Consulting Engineer is responsible for ensuring the in-situ soils comply with the geotechnical characteristics as shown on the relevant drawings and in the design calculations.

7) TYPICAL FRONT FACE STEP: Face angle = 4°

08) GEOPIN TESTING: 10% of the installed GeoPins must be pull-out tested to confirm a minimum GeoPin capacity of 20kN. If a lower capacity is determined by testing, Geoman must be informed immediately to allow the spacing and length of the GeoPins to be reviewed. This must be undertaken prior to commencement of the retaining wall construction.

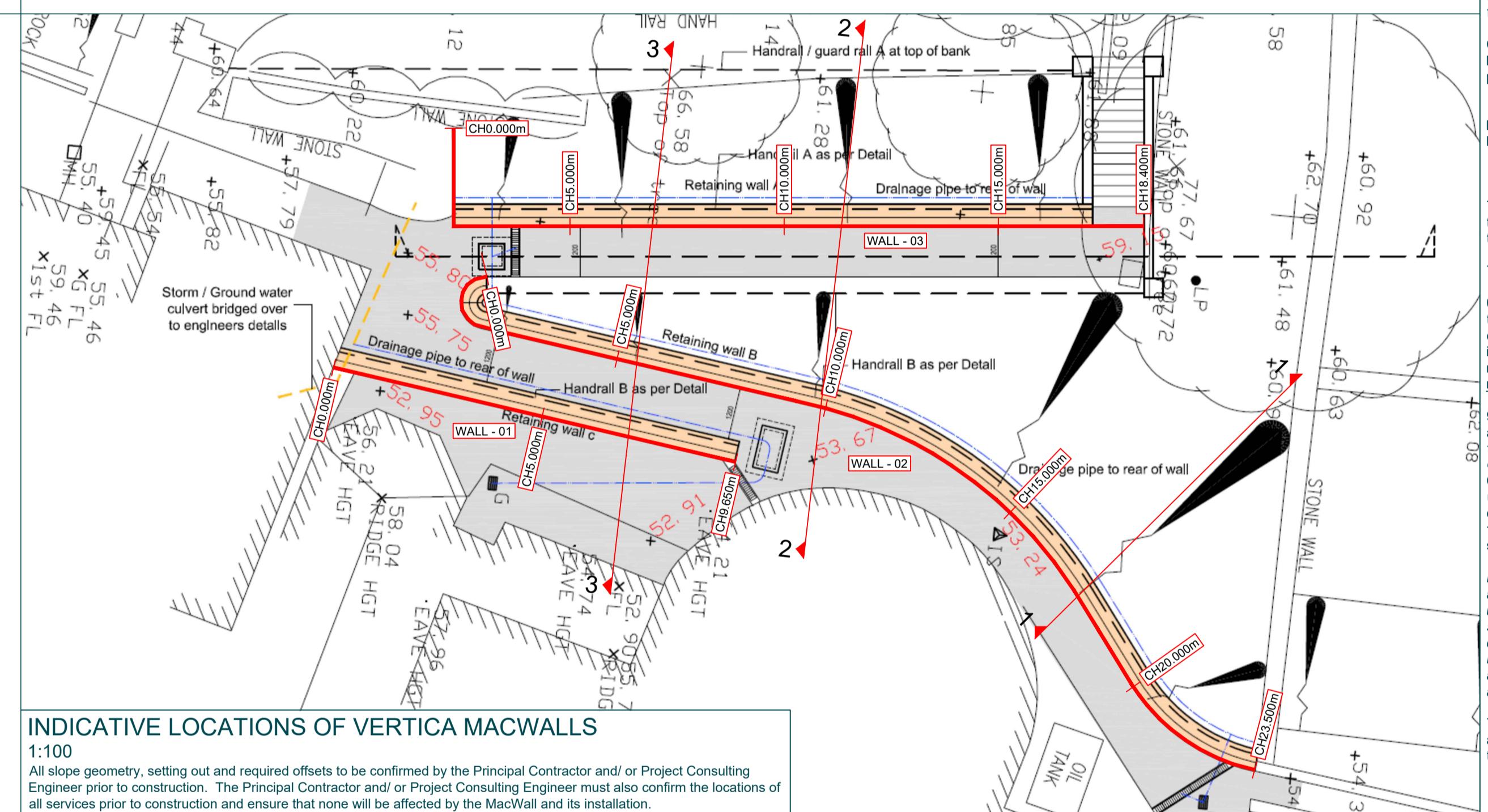
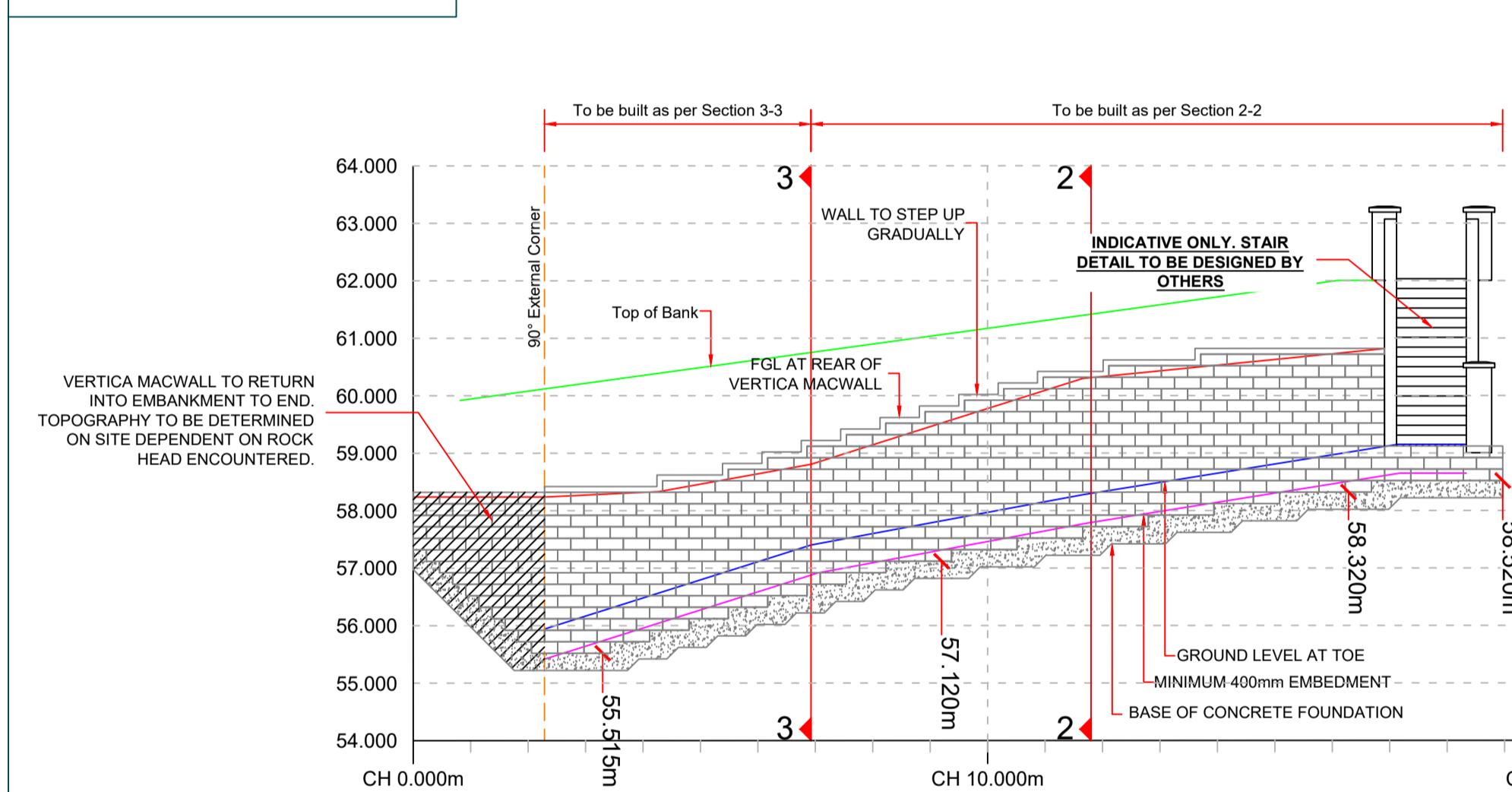
09) NOTES ON CALCULATIONS/DRAWINGS: These plans and the accompanying design documentation should be thoroughly checked by the Project Consulting Engineer/ Principal Contractor. Any apparent errors, omissions or variations should be reported immediately to Geoman Ltd. Construction of this walls shall not commence unless and until the Project Consulting Engineer/ Principal Contractor has considered the Geoman Design Submission Document (QD06 Ref: 17-5479) to ensure that there are no errors, omissions or conflict with the scheme design.

Maccaferri will not be liable for any loss or damage resulting from or arising out of the use of its products where those products have been used other than in accordance with Maccaferri's advice and product specifications. Unless advice is specifically requested in respect of parts of the slope not within the area where the works are undertaken Maccaferri shall not be liable for any loss or damage resulting from or arising out of any weakness or other problem in the slope outside the area where the works are undertaken.

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ELEVATION WALL - 03

1:100



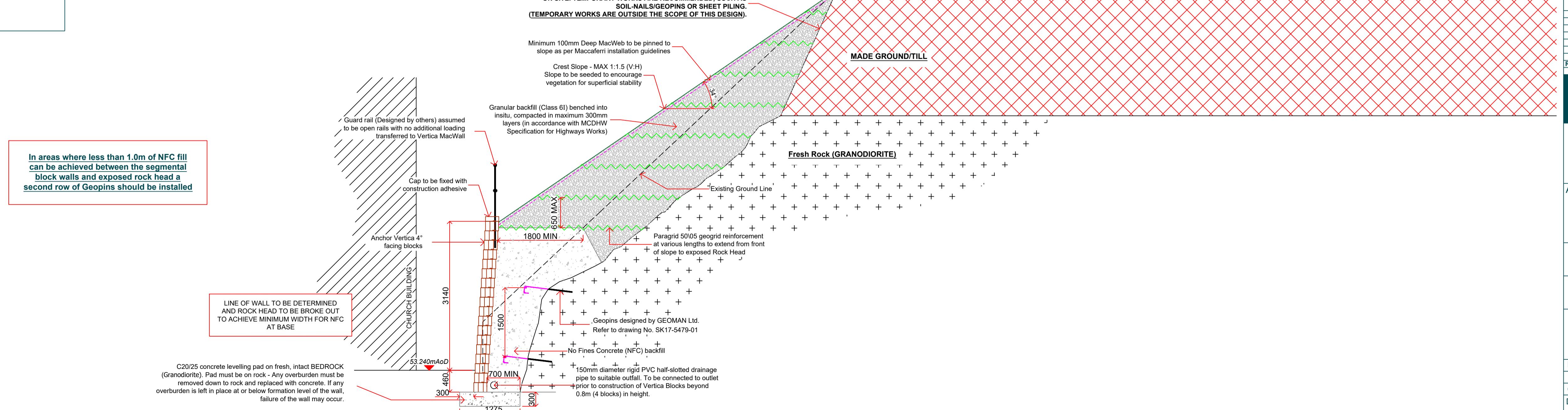
INDICATIVE LOCATIONS OF VERTICA MACWALLS

1:100

All slope geometry, setting out and required offsets to be confirmed by the Principal Contractor and/or Project Consulting Engineer prior to construction. The Principal Contractor and/or Project Consulting Engineer must also confirm the locations of all services prior to construction and ensure that none will be affected by the MacWall and its installation.

Section 1-1

1:50



FOR CONSTRUCTION

0	Issued for construction	L.K.D	10/11/2017
0	Rev: Issue / Revision:	L.K.D	08/08/2017

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Project Title: DOMINICAN CHAPEL, NEWRY

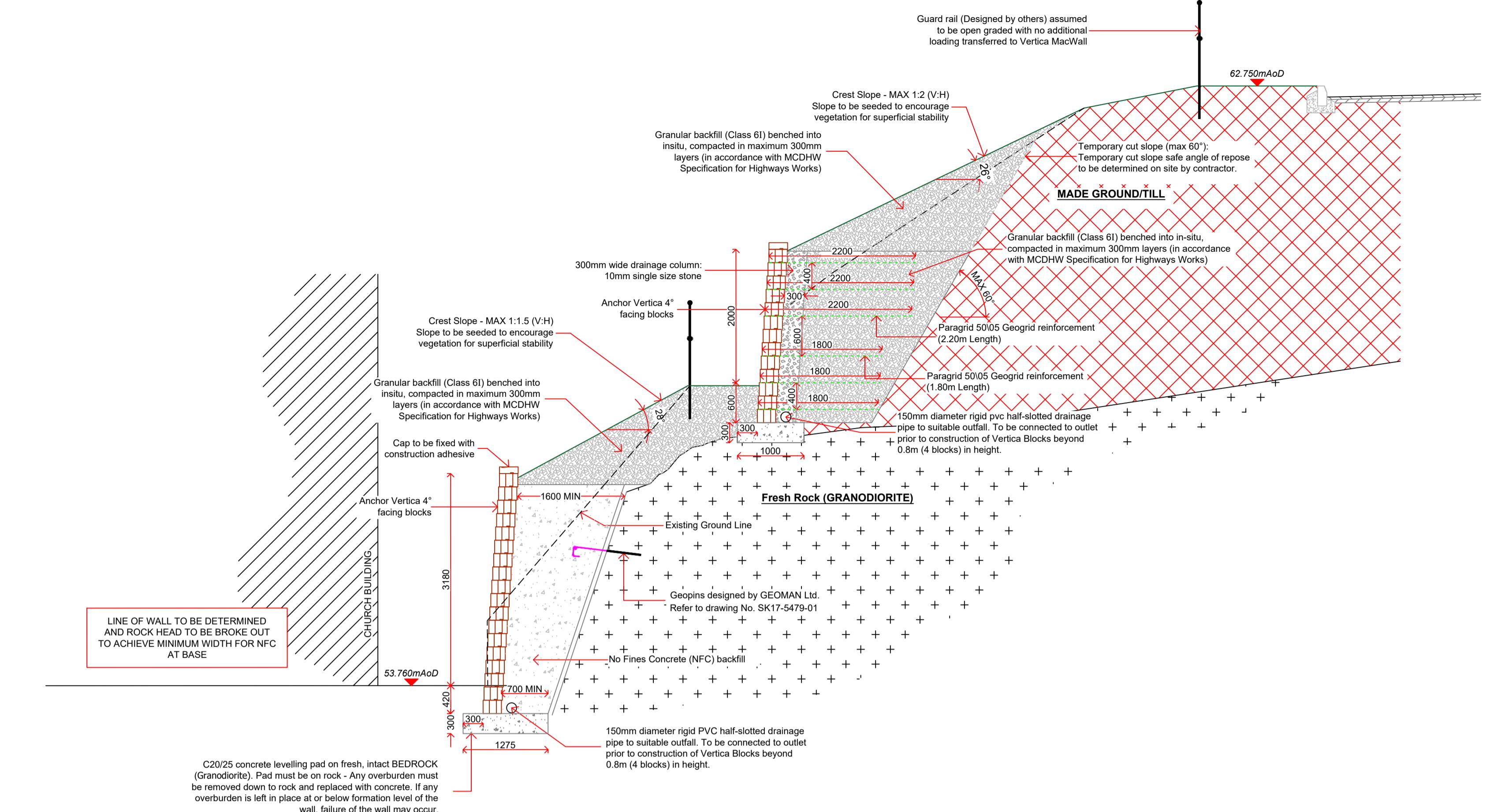
Client: SEAVIEW DEVELOPMENTS LTD.

Drawing Title: VERTICA MACWALL ELEVATIONS, PLAN & SECTIONS

Designed: L.K.D	Date: 08.08.17	Project No: 17-5479
Drawn: L.K.D	Date: 08.08.17	Scale: As Shown
Checked: S.P.	Date: 08.08.17	Revision: 0
Drawing No: SK17-5479-02		

Section 2-2

1:50



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Project Title: DOMINICAN CHAPEL, NEWRY		
Client: SEAVIEW DEVELOPMENTS LTD.		
Drawing Title: VERTICA MACWALL SECTIONS		
Designed: L.K.D	Date: 08.08.17	Project No: 17-5479
Drawn: L.K.D	Date: 08.08.17	Scale: As Shown
Checked: <i>[Signature]</i>	Date: 08.08.17	
Drawing No: SK17-5479-03	Revision: 0	

Section 3-3

1:50

