



## Analysis of reinforced slopes

### Input data

#### Project

Task : WESTGATE, CLECKHEATON  
 Part : SECTION 1-1  
 Customer : GILLCON  
 Author : WM  
 Date : 11/09/2024  
 Project number : 24-5558

#### 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	
		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 [-]	
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  $n = 7$   
 Block height  $h = 0.40$  m  
 Block width  $b = 0.10$  m  
 Block offset  $o_1 = 0.04$  m

**Material****Block material**

Unit weight  $\gamma = 24.00$  kN/m<sup>3</sup>  
 Cohesion  $c = 0.00$  kPa  
 Friction  $f = 0.580$   
 Shear bearing capacity of joint  $R_s = 6.60$  kN/m

Reinforced soil - Class 6I

**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	Secugrid 40/40 Q6	Secugrid 40/40 Q6	—————	40.00	18.12	0.60	0.70

**Reinforcement details****1. Secugrid 40/40 Q6**

Short-term char. strength  $T_{ult} = 40.00$  kN/m  
 Long-term design strength  $R_t = 18.12$  kN/m  
 Overall coeff. of model uncertainty  $FS_{UNC} = 1.50$

Calculate reduction factors

Life time : 120 years  
 Creep red. factor  $RF_{CR} = 1.35$   
 Chemistry : pH 4.0-9.0  
 Durability red. factor  $RF_D = 1.00$   
 Partical size :  $D_{90} \leq 35$  mm  
 Installation damage red. factor  $RF_{ID} = 1.09$

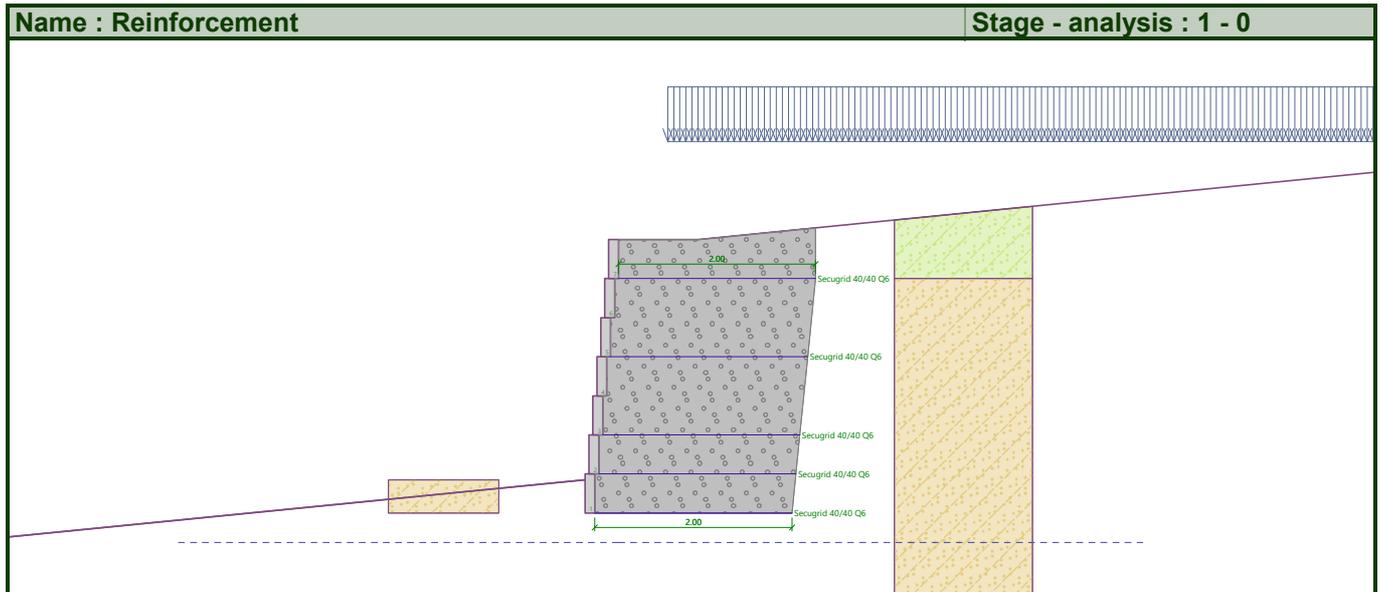
**Reinforcement**

Total number of input reinforcements : 5.



**Reinforcement details**

Block No.	Type of reinforcement	Origin $l_1$ [m]	End $l_2$ [m]	Height from bottom $y$ [m]	Length $l$ [m]
1	Secugrid 40/40 Q6	-0.24	1.76	0.00	2.00
2	Secugrid 40/40 Q6	-0.20	1.80	0.40	2.00
3	Secugrid 40/40 Q6	-0.16	1.84	0.80	2.00
5	Secugrid 40/40 Q6	-0.08	1.92	1.60	2.00
7	Secugrid 40/40 Q6	0.00	2.00	2.40	2.00



**Soil parameters**

**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 :  $\delta = 23.33^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 19.00 \text{ kN/m}^3$

**CLASS 1/2**

Unit weight :  $\gamma = 19.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])**

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Geological profile and assigned soils**

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	0.40	0.00 .. 0.40	CLASS 1/2	
2	-	0.40 .. ∞	Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])	

**Terrain profile**

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	0.81	0.00
3	10.81	-1.00
4	11.81	-1.00

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

**Water influence**

GWT behind the structure lies at a depth of 3.10 m  
GWT in front of the structure lies at a depth of 3.10 m  
Subgrade at the heel is not permeable.  
Uplift in foot. bottom due to different pressures is not considered.

**Input surface surcharges**

No.	Surcharge		Action	Mag.1 [kN/m <sup>2</sup> ]	Mag.2 [kN/m <sup>2</sup> ]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	5.00		0.50	20.00	on terrain

No.	Name
1	5kPa

**Resistance on front face of the structure**

Resistance on front face of the structure: not considered  
Soil on front face of the structure - Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])  
Soil thickness in front of structure h = 0.34 m

**Terrain shape in front of structure**

No.	Coordinate x[m]	Depth z[m]
1	0.00	0.00
2	0.00	-0.34
3	-0.01	-0.34
4	-10.01	0.66
5	-11.01	0.66

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

**Verification No. 1****Forces acting on construction - combination 1**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-1.42	102.94	1.24	1.000	1.000	1.350



Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Active pressure	21.78	-0.98	9.02	2.20	1.350	1.350	1.350
Water pressure	0.00	-2.92	0.00	4.10	1.000	1.000	1.350
5kPa	4.39	-1.44	1.89	2.24	1.500	1.500	1.500
Weight - wall	0.00	-1.40	6.72	0.17	1.000	1.000	1.350
5kPa	0.00	-2.84	7.50	1.59	0.000	0.000	1.500

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 161.66$  kNm/mOverturning moment  $M_{ovr} = 38.43$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 66.29$  kN/mActive horizontal force  $H_{act} = 35.99$  kN/m**Wall for slip is SATISFACTORY****Overall check - WALL is SATISFACTORY****Forces acting on construction - combination 2**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-1.42	102.94	1.24	1.000	1.000	1.000
Active pressure	27.93	-0.98	8.83	2.20	1.000	1.000	1.000
Water pressure	0.00	-2.92	0.00	4.10	1.000	1.000	1.000
5kPa	5.56	-1.44	1.84	2.25	1.300	1.300	1.300
Weight - wall	0.00	-1.40	6.72	0.17	1.000	1.000	1.000
5kPa	0.00	-2.84	7.50	1.59	0.000	0.000	1.300

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 153.30$  kNm/mOverturning moment  $M_{ovr} = 37.90$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 51.42$  kN/mActive horizontal force  $H_{act} = 35.16$  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	-3.07	174.30	35.99	0.000	83.00
2	7.68	124.67	35.99	0.029	63.07
3	11.52	120.88	35.16	0.045	63.31
4	6.26	130.63	35.16	0.023	65.18

**Service load acting at the center of footing bottom**



No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-2.28	128.07	26.17
2	1.77	120.57	26.17

**Verification of foundation soil**

Stress in the footing bottom : rectangle

**Eccentricity verification**Max. eccentricity of normal force  $e = 0.029$ Maximum allowable eccentricity  $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY****Verification of bearing capacity**Max. stress at footing bottom  $\sigma = 83.00$  kPaBearing capacity of foundation soil  $R_d = 85.00$  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	-1.40	6.72	0.07	1.000
Active pressure	27.94	-0.97	8.87	2.10	1.000
5kPa	5.63	-1.46	1.75	2.15	1.300
Weight - reinforced soil	0.00	-1.42	103.53	1.14	1.000
5kPa	0.00	-2.85	7.84	1.52	0.000

**Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 1)**

Inclination of slip surface = 84.00 °

Overall normal force acting on reinforcement = 114.68 kN/m

Coefficient of reduction of slip along

geo-textile

Resistance along geo-reinforcement = 36.59 kN/m

Wall resistance = 3.57 kN/m

Overall bearing capacity of reinforcements = 0.00 kN/m

Results for the most unfavorable combination - No. 2

**Check for slip:**Resisting horizontal force  $H_{res} = 40.16$  kN/mActive horiz. force  $H_{act} = 35.26$  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	Secugrid 40/40 Q6	-2.99	2.80	18.12	16.50	98.81	3.03
2	Secugrid 40/40 Q6	-5.41	2.40	18.12	29.87	76.75	7.05
3	Secugrid 40/40 Q6	-6.72	2.00	18.12	37.07	57.51	11.68
4	Secugrid 40/40 Q6	-6.34	1.20	18.12	35.01	26.97	23.52
5	Secugrid 40/40 Q6	-2.85	0.40	18.12	15.70	7.03	40.49

**Check for tensile strength (reinforcement No.3)**Tension strength  $R_t = 18.12$  kN/mForce in reinforcement  $F_x = 6.72$  kN/m**Reinforcement for tensile strength is SATISFACTORY****Check for pull out resistance (reinforcement No.5)**Pull out resistance  $T_p = 7.03$  kN/mForce in reinforcement  $F_x = 2.85$  kN/m**Reinforcement for pull out resistance is SATISFACTORY****Overall verification - reinforcement is SATISFACTORY****Slope stability analysis****Results (Stage of construction 1)****Analysis 1****Circular slip surface**

Slip surface parameters						
Center :	x =	-2.16	[m]	Angles :	$\alpha_1 =$	-31.99 [°]
	z =	2.79	[m]		$\alpha_2 =$	68.99 [°]
Radius :	R =	6.83	[m]			
The slip surface after optimization.						

**Slope stability verification (Bishop)****Combination 1**Sum of active forces :  $F_a = 158.62$  kN/mSum of passive forces :  $F_p = 176.98$  kN/mSliding moment :  $M_a = 1149.96$  kNm/mResisting moment :  $M_p = 1283.09$  kNm/m

Utilization : 89.6 %

**Slope stability ACCEPTABLE****Combination 2**Sum of active forces :  $F_a = 118.48$  kN/mSum of passive forces :  $F_p = 124.96$  kN/mSliding moment :  $M_a = 809.19$  kNm/mResisting moment :  $M_p = 853.50$  kNm/m

Utilization : 94.8 %

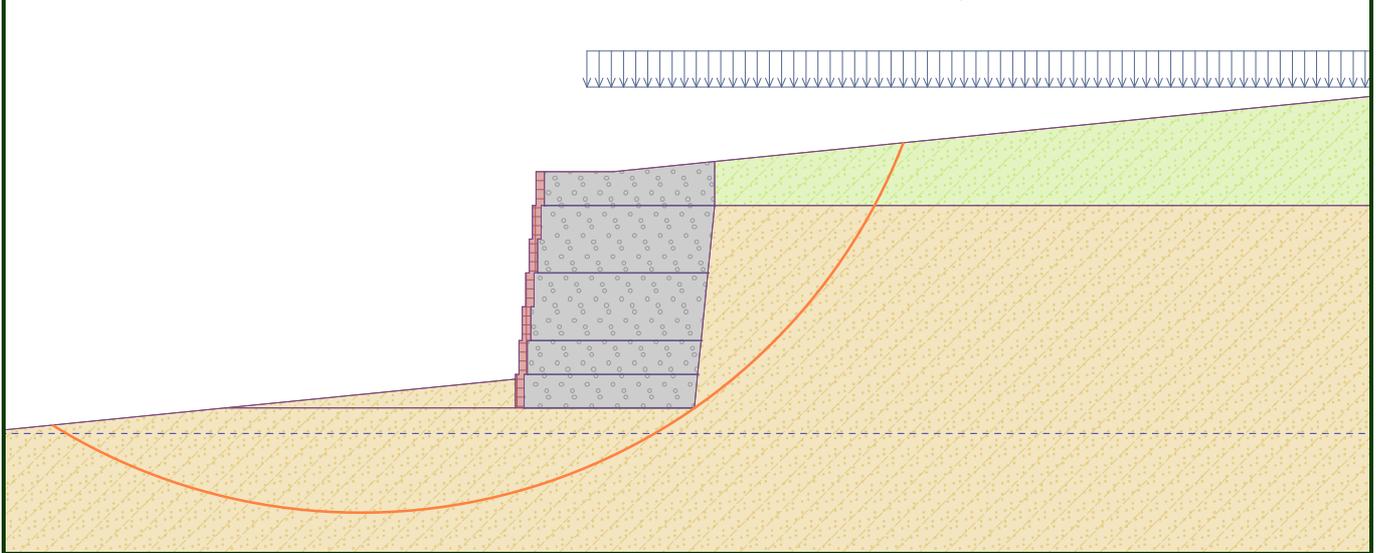
**Slope stability ACCEPTABLE**

Optimized slip surface for : Combination 2



Name : Analysis

Stage - analysis : 1 - 1





## Analysis of reinforced slopes

### Input data

#### Project

Task : WESTGATE, CLECKHEATON  
 Part : SECTION 2-2  
 Customer : GILLCON  
 Author : WM  
 Date : 11/09/2024  
 Project number : 24-5558

#### 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	
		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 [-]	
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  $n = 6$   
 Block height  $h = 0.40$  m  
 Block width  $b = 0.10$  m  
 Block offset  $o_1 = 0.04$  m

**Material****Block material**

Unit weight  $\gamma = 24.00$  kN/m<sup>3</sup>  
 Cohesion  $c = 0.00$  kPa  
 Friction  $f = 0.580$   
 Shear bearing capacity of joint  $R_s = 6.60$  kN/m

Reinforced soil - Class 6I

**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	Secugrid 40/40 Q6	Secugrid 40/40 Q6	—————	40.00	18.12	0.60	0.70

**Reinforcement details****1. Secugrid 40/40 Q6**

Short-term char. strength  $T_{ult} = 40.00$  kN/m  
 Long-term design strength  $R_t = 18.12$  kN/m  
 Overall coeff. of model uncertainty  $FS_{UNC} = 1.50$

Calculate reduction factors

Life time : 120 years  
 Creep red. factor  $RF_{CR} = 1.35$   
 Chemistry : pH 4.0-9.0  
 Durability red. factor  $RF_D = 1.00$   
 Partical size :  $D_{90} \leq 35$  mm  
 Installation damage red. factor  $RF_{ID} = 1.09$

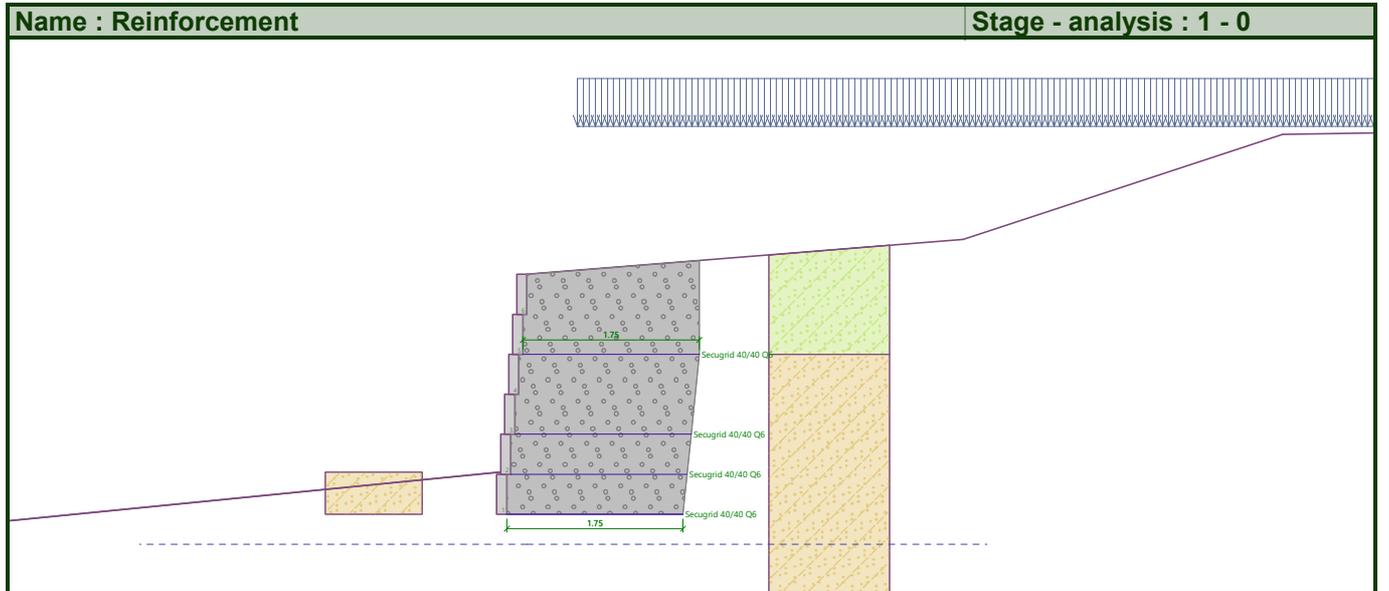
**Reinforcement**

Total number of input reinforcements : 4.



**Reinforcement details**

Block No.	Type of reinforcement	Origin $l_1$ [m]	End $l_2$ [m]	Height from bottom $y$ [m]	Length $l$ [m]
1	Secugrid 40/40 Q6	-0.20	1.55	0.00	1.75
2	Secugrid 40/40 Q6	-0.16	1.59	0.40	1.75
3	Secugrid 40/40 Q6	-0.12	1.63	0.80	1.75
5	Secugrid 40/40 Q6	-0.04	1.71	1.60	1.75



**Soil parameters**

**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 :  $\delta = 23.33^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 19.00 \text{ kN/m}^3$

**CLASS 1/2**

Unit weight :  $\gamma = 19.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])**

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Geological profile and assigned soils**

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	0.80	0.00 .. 0.80	CLASS 1/2	
2	-	0.80 .. ∞	Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])	

**Terrain profile**

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	4.33	-0.35
3	7.50	-1.40
4	12.54	-1.48
5	13.54	-1.48

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

Positive coordinate +z has downward direction.

**Water influence**

GWT behind the structure lies at a depth of 2.70 m

GWT in front of the structure lies at a depth of 2.70 m

Subgrade at the heel is not permeable.

Uplift in foot. bottom due to different pressures is not considered.

**Input surface surcharges**

No.	Surcharge		Action	Mag.1 [kN/m <sup>2</sup> ]	Mag.2 [kN/m <sup>2</sup> ]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	5.00		0.50	20.00	on terrain

No.	Name
1	5kPa

**Resistance on front face of the structure**

Resistance on front face of the structure: not considered

Soil on front face of the structure - Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])

Soil thickness in front of structure  $h = 0.42$  m

**Terrain shape in front of structure**

No.	Coordinate x[m]	Depth z[m]
1	0.00	0.00
2	0.00	-0.42
3	-0.01	-0.42
4	-10.01	0.58
5	-11.01	0.58

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

**Verification No. 1****Forces acting on construction - combination 1**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-1.23	78.02	1.09	1.000	1.000	1.350
Active pressure	16.62	-0.87	7.12	1.94	1.350	1.350	1.350
Water pressure	0.00	-2.54	0.00	3.56	1.000	1.000	1.350
5kPa	3.85	-1.25	1.74	1.96	1.500	1.500	1.500
Weight - wall	0.00	-1.20	5.76	0.15	1.000	1.000	1.350
5kPa	0.00	-2.49	6.05	1.41	0.000	0.000	1.500

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 109.45$  kNm/mOverturning moment  $M_{ovr} = 26.64$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 51.04$  kN/mActive horizontal force  $H_{act} = 28.21$  kN/m**Wall for slip is SATISFACTORY****Overall check - WALL is SATISFACTORY****Forces acting on construction - combination 2**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-1.23	78.02	1.09	1.000	1.000	1.000
Active pressure	21.41	-0.86	7.04	1.94	1.000	1.000	1.000
Water pressure	0.00	-2.54	0.00	3.56	1.000	1.000	1.000
5kPa	4.88	-1.25	1.72	1.96	1.300	1.300	1.300
Weight - wall	0.00	-1.20	5.76	0.15	1.000	1.000	1.000
5kPa	0.00	-2.49	6.05	1.41	0.000	0.000	1.300

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 103.73$  kNm/mOverturning moment  $M_{ovr} = 26.27$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 39.58$  kN/mActive horizontal force  $H_{act} = 27.75$  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	-1.25	134.40	28.21	0.000	72.65
2	5.99	96.00	28.21	0.034	55.64



No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [-]	Stress [kPa]
3	8.61	93.05	27.75	0.050	55.88
4	4.83	100.92	27.75	0.026	57.53

**Service load acting at the center of footing bottom**

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-0.93	98.69	20.47
2	1.97	92.64	20.47

**Verification of foundation soil**

Stress in the footing bottom : rectangle

**Eccentricity verification**Max. eccentricity of normal force  $e = 0.034$ Maximum allowable eccentricity  $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY****Verification of bearing capacity**Max. stress at footing bottom  $\sigma = 72.65$  kPaBearing capacity of foundation soil  $R_d = 85.00$  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	-1.20	5.76	0.05	1.000
Active pressure	21.48	-0.84	6.91	1.84	1.000
5kPa	4.99	-1.27	1.56	1.88	1.300
Weight - reinforced soil	0.00	-1.24	79.08	1.00	1.000
5kPa	0.00	-2.49	6.59	1.36	0.000

**Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 1)**Inclination of slip surface =  $84.00^\circ$ Overall normal force acting on reinforcement =  $88.01$  kN/mCoefficient of reduction of slip along  
geo-textile =  $0.60$ Resistance along geo-reinforcement =  $28.08$  kN/mWall resistance =  $3.06$  kN/mOverall bearing capacity of reinforcements =  $0.00$  kN/m

Results for the most unfavorable combination - No. 2

**Check for slip:**Resisting horizontal force  $H_{res} = 31.14$  kN/mActive horiz. force  $H_{act} = 27.96$  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	Secugrid 40/40 Q6	-2.63	2.40	18.12	14.51	75.79	3.47
2	Secugrid 40/40 Q6	-4.70	2.00	18.12	25.92	56.70	8.28
3	Secugrid 40/40 Q6	-5.65	1.60	18.12	31.15	40.28	14.02
4	Secugrid 40/40 Q6	-5.74	0.80	18.12	31.67	15.43	37.19

**Check for tensile strength (reinforcement No.4)**Tension strength  $R_t = 18.12$  kN/mForce in reinforcement  $F_x = 5.74$  kN/m**Reinforcement for tensile strength is SATISFACTORY****Check for pull out resistance (reinforcement No.4)**Pull out resistance  $T_p = 15.43$  kN/mForce in reinforcement  $F_x = 5.74$  kN/m**Reinforcement for pull out resistance is SATISFACTORY****Overall verification - reinforcement is SATISFACTORY****Slope stability analysis****Results (Stage of construction 1)****Analysis 1****Circular slip surface**

Slip surface parameters							
Center :	x =	-1.32	[m]	Angles :	$\alpha_1 =$	-32.62	[°]
	z =	2.18	[m]		$\alpha_2 =$	69.71	[°]
Radius :	R =	5.41	[m]				
The slip surface after optimization.							

**Slope stability verification (Bishop)****Combination 1**Sum of active forces :  $F_a = 110.65$  kN/mSum of passive forces :  $F_p = 135.81$  kN/mSliding moment :  $M_a = 620.72$  kNm/mResisting moment :  $M_p = 761.88$  kNm/m

Utilization : 81.5 %

**Slope stability ACCEPTABLE****Combination 2**Sum of active forces :  $F_a = 84.73$  kN/mSum of passive forces :  $F_p = 95.47$  kN/mSliding moment :  $M_a = 458.38$  kNm/mResisting moment :  $M_p = 516.48$  kNm/m

Utilization : 88.8 %

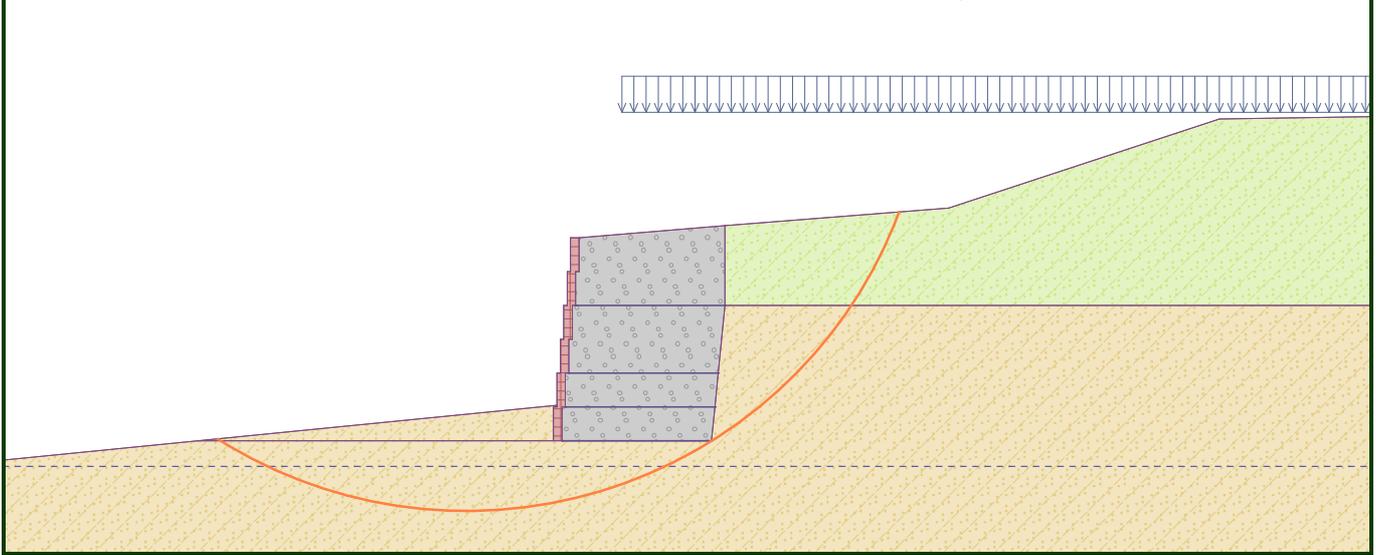
**Slope stability ACCEPTABLE**

Optimized slip surface for : Combination 2



Name : Analysis

Stage - analysis : 1 - 1





## Analysis of reinforced slopes

### Input data

#### Project

Task : WESTGATE, CLECKHEATON  
 Part : SECTION 3-3  
 Customer : GILLCON  
 Author : WM  
 Date : 11/09/2024  
 Project number : 24-5558

#### 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	
		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 [-]	
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  $n = 5$   
 Block height  $h = 0.40$  m  
 Block width  $b = 0.10$  m  
 Block offset  $o_1 = 0.04$  m

**Material****Block material**

Unit weight  $\gamma = 24.00$  kN/m<sup>3</sup>  
 Cohesion  $c = 0.00$  kPa  
 Friction  $f = 0.580$   
 Shear bearing capacity of joint  $R_s = 6.60$  kN/m

Reinforced soil - Class 6I

**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	Secugrid 40/40 Q6	Secugrid 40/40 Q6	—————	40.00	18.12	0.60	0.70

**Reinforcement details****1. Secugrid 40/40 Q6**

Short-term char. strength  $T_{ult} = 40.00$  kN/m  
 Long-term design strength  $R_t = 18.12$  kN/m  
 Overall coeff. of model uncertainty  $FS_{UNC} = 1.50$

Calculate reduction factors

Life time : 120 years  
 Creep red. factor  $RF_{CR} = 1.35$   
 Chemistry : pH 4.0-9.0  
 Durability red. factor  $RF_D = 1.00$   
 Partical size :  $D_{90} \leq 35$  mm  
 Installation damage red. factor  $RF_{ID} = 1.09$

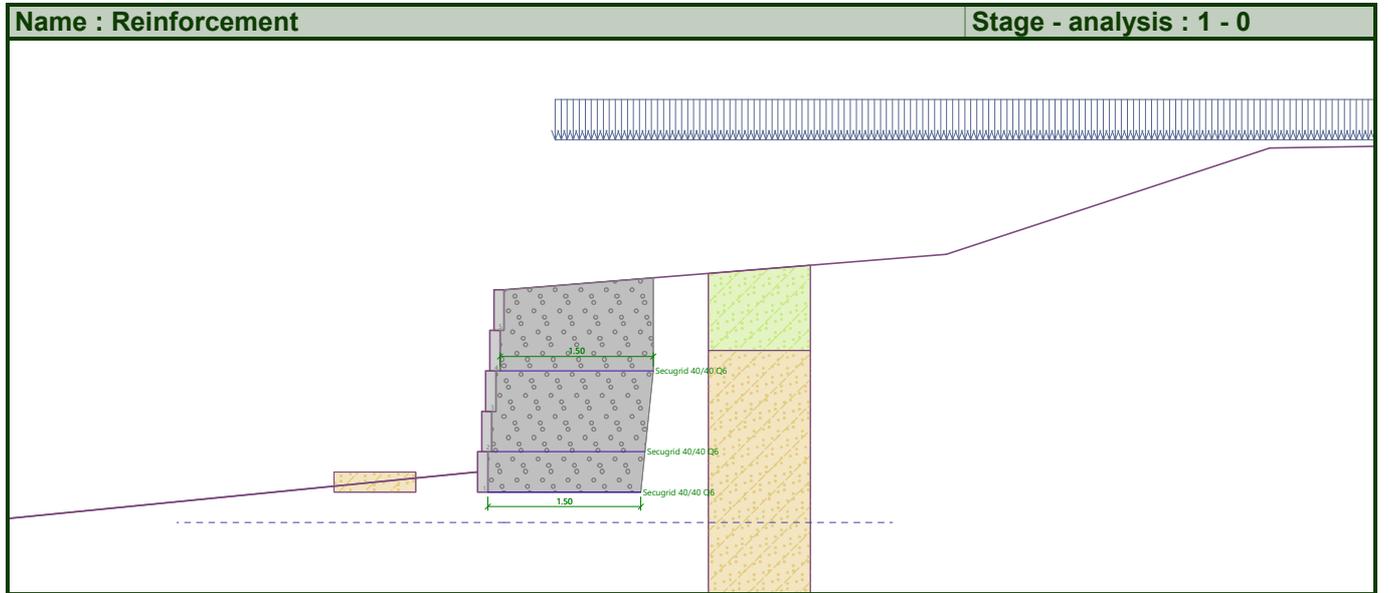
**Reinforcement**

Total number of input reinforcements : 3.



**Reinforcement details**

Block No.	Type of reinforcement	Origin $l_1$ [m]	End $l_2$ [m]	Height from bottom $y$ [m]	Length $l$ [m]
1	Secugrid 40/40 Q6	-0.16	1.34	0.00	1.50
2	Secugrid 40/40 Q6	-0.12	1.38	0.40	1.50
4	Secugrid 40/40 Q6	-0.04	1.46	1.20	1.50



**Soil parameters**

**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 :  $\delta = 23.33^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 19.00 \text{ kN/m}^3$

**CLASS 1/2**

Unit weight :  $\gamma = 19.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])**

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Geological profile and assigned soils**

No.	Thickness of layer $t$ [m]	Depth $z$ [m]	Assigned soil	Pattern
1	0.60	0.00 .. 0.60	CLASS 1/2	



No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
2	-	0.60 .. ∞	Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])	

**Terrain profile**

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	4.33	-0.35
3	7.50	-1.40
4	12.54	-1.48
5	13.54	-1.48

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

**Water influence**

GWT behind the structure lies at a depth of 2.30 m  
GWT in front of the structure lies at a depth of 2.30 m  
Subgrade at the heel is not permeable.  
Uplift in foot. bottom due to different pressures is not considered.

**Input surface surcharges**

No.	Surcharge		Action	Mag.1 [kN/m <sup>2</sup> ]	Mag.2 [kN/m <sup>2</sup> ]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	5.00		0.50	20.00	on terrain

No.	Name
1	5kPa

**Resistance on front face of the structure**

Resistance on front face of the structure: not considered  
Soil on front face of the structure - Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])  
Soil thickness in front of structure h = 0.20 m

**Terrain shape in front of structure**

No.	Coordinate x[m]	Depth z[m]
1	0.00	0.00
2	0.00	-0.20
3	-0.01	-0.20
4	-10.01	0.80
5	-11.01	0.80

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

**Verification No. 1****Forces acting on construction - combination 1**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-1.02	55.69	0.94	1.000	1.000	1.350
Active pressure	11.61	-0.73	5.05	1.67	1.350	1.350	1.350
Water pressure	0.00	-2.12	0.00	3.06	1.000	1.000	1.350



Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
5kPa	3.20	-1.04	1.47	1.69	1.500	1.500	1.500
Weight - wall	0.00	-1.00	4.80	0.13	1.000	1.000	1.350
5kPa	0.00	-2.08	4.80	1.24	0.000	0.000	1.500

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 68.08$  kNm/mOverturning moment  $M_{ovr} = 16.35$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 36.97$  kN/mActive horizontal force  $H_{act} = 20.47$  kN/m**Wall for slip is SATISFACTORY****Overall check - WALL is SATISFACTORY****Forces acting on construction - combination 2**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-1.02	55.69	0.94	1.000	1.000	1.000
Active pressure	14.80	-0.72	4.96	1.67	1.000	1.000	1.000
Water pressure	0.00	-2.12	0.00	3.06	1.000	1.000	1.000
5kPa	4.05	-1.04	1.46	1.69	1.300	1.300	1.300
Weight - wall	0.00	-1.00	4.80	0.13	1.000	1.000	1.000
5kPa	0.00	-2.08	4.80	1.24	0.000	0.000	1.300

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 64.45$  kNm/mOverturning moment  $M_{ovr} = 16.19$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 28.65$  kN/mActive horizontal force  $H_{act} = 20.07$  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	-0.88	97.90	20.47	0.000	61.18
2	3.89	69.52	20.47	0.035	46.72
3	5.61	67.35	20.07	0.052	46.99
4	2.87	73.59	20.07	0.024	48.35

**Service load acting at the center of footing bottom**



No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-0.64	71.82	14.80
2	1.47	67.02	14.80

**Verification of foundation soil**

Stress in the footing bottom : rectangle

**Eccentricity verification**Max. eccentricity of normal force  $e = 0.035$ Maximum allowable eccentricity  $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY****Verification of bearing capacity**Max. stress at footing bottom  $\sigma = 61.18$  kPaBearing capacity of foundation soil  $R_d = 85.00$  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	-1.00	4.80	0.03	1.000
Active pressure	14.69	-0.71	4.72	1.57	1.000
5kPa	4.16	-1.06	1.30	1.61	1.300
Weight - reinforced soil	0.00	-1.03	56.64	0.85	1.000
5kPa	0.00	-2.08	5.32	1.19	0.000

**Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 1)**Inclination of slip surface =  $84.00^\circ$ Overall normal force acting on reinforcement =  $63.05$  kN/mCoefficient of reduction of slip along  
geo-textile =  $0.60$ Resistance along geo-reinforcement =  $20.11$  kN/mWall resistance =  $2.55$  kN/mOverall bearing capacity of reinforcements =  $0.00$  kN/m

Results for the most unfavorable combination - No. 2

**Check for slip:**Resisting horizontal force  $H_{res} = 22.67$  kN/mActive horiz. force  $H_{act} = 20.10$  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	Secugrid 40/40 Q6	-2.24	2.00	18.12	12.34	54.20	4.13
2	Secugrid 40/40 Q6	-5.59	1.60	18.12	30.85	38.22	14.63
3	Secugrid 40/40 Q6	-5.63	0.80	18.12	31.05	14.26	39.47

**Check for tensile strength (reinforcement No.3)**Tension strength  $R_t = 18.12$  kN/m



Force in reinforcement  $F_x = 5.63$  kN/m

**Reinforcement for tensile strength is SATISFACTORY**

**Check for pull out resistance (reinforcement No.3)**

Pull out resistance  $T_p = 14.26$  kN/m

Force in reinforcement  $F_x = 5.63$  kN/m

**Reinforcement for pull out resistance is SATISFACTORY**

**Overall verification - reinforcement is SATISFACTORY**

## Slope stability analysis

### Results (Stage of construction 1)

#### Analysis 1

##### Circular slip surface

Slip surface parameters							
Center :	x =	-1.32	[m]	Angles :	$\alpha_1 =$	-31.35	[°]
	z =	1.84	[m]		$\alpha_2 =$	70.08	[°]
Radius :	R =	4.67	[m]				
The slip surface after optimization.							

#### Slope stability verification (Bishop)

##### Combination 1

Sum of active forces :  $F_a = 89.46$  kN/m

Sum of passive forces :  $F_p = 99.26$  kN/m

Sliding moment :  $M_a = 485.78$  kNm/m

Resisting moment :  $M_p = 539.00$  kNm/m

Utilization : 90.1 %

**Slope stability ACCEPTABLE**

##### Combination 2

Sum of active forces :  $F_a = 64.58$  kN/m

Sum of passive forces :  $F_p = 66.61$  kN/m

Sliding moment :  $M_a = 301.58$  kNm/m

Resisting moment :  $M_p = 311.06$  kNm/m

Utilization : 97.0 %

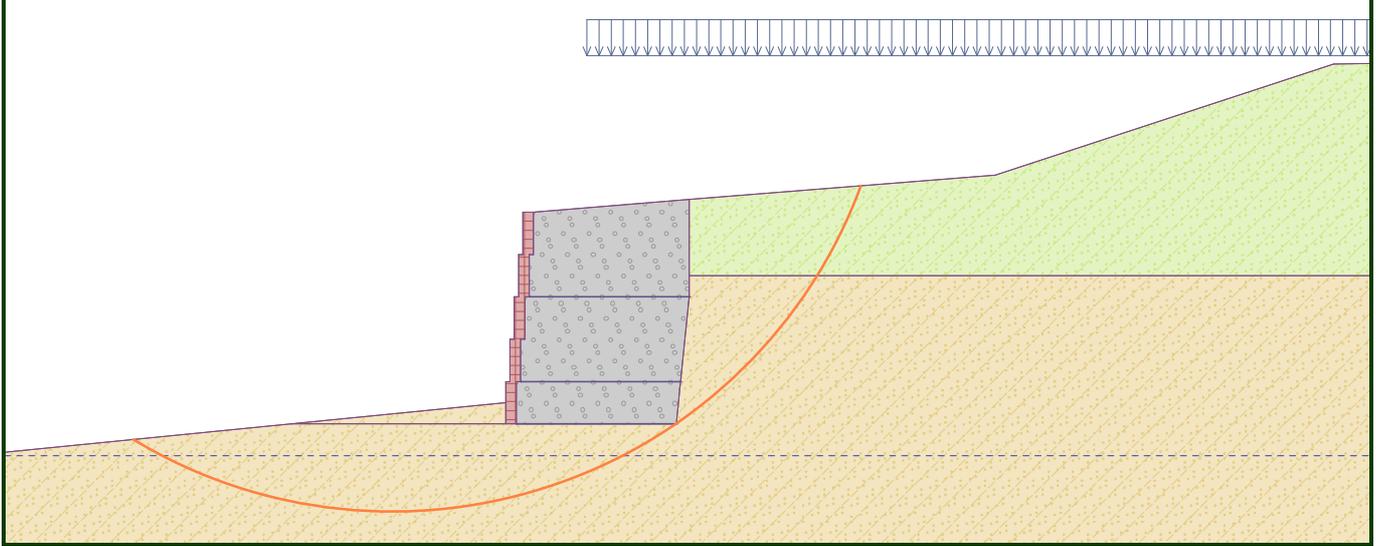
**Slope stability ACCEPTABLE**

Optimized slip surface for : Combination 2



Name : Analysis

Stage - analysis : 1 - 1





## Analysis of reinforced slopes

### Input data

#### Project

Task : WESTGATE, CLECKHEATON  
 Part : SECTION 4-4  
 Customer : GILLCON  
 Author : WM  
 Date : 11/09/2024  
 Project number : 24-5558

#### 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	
		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 [-]	
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  $n = 4$   
 Block height  $h = 0.40$  m  
 Block width  $b = 0.10$  m  
 Block offset  $o_1 = 0.04$  m

**Material****Block material**

Unit weight  $\gamma = 24.00$  kN/m<sup>3</sup>  
 Cohesion  $c = 0.00$  kPa  
 Friction  $f = 0.580$   
 Shear bearing capacity of joint  $R_s = 6.60$  kN/m

Reinforced soil - Class 6I

**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	Secugrid 40/40 Q6	Secugrid 40/40 Q6	—————	40.00	18.12	0.60	0.70

**Reinforcement details****1. Secugrid 40/40 Q6**

Short-term char. strength  $T_{ult} = 40.00$  kN/m  
 Long-term design strength  $R_t = 18.12$  kN/m  
 Overall coeff. of model uncertainty  $FS_{UNC} = 1.50$

Calculate reduction factors

Life time : 120 years  
 Creep red. factor  $RF_{CR} = 1.35$   
 Chemistry : pH 4.0-9.0  
 Durability red. factor  $RF_D = 1.00$   
 Partical size :  $D_{90} \leq 35$  mm  
 Installation damage red. factor  $RF_{ID} = 1.09$

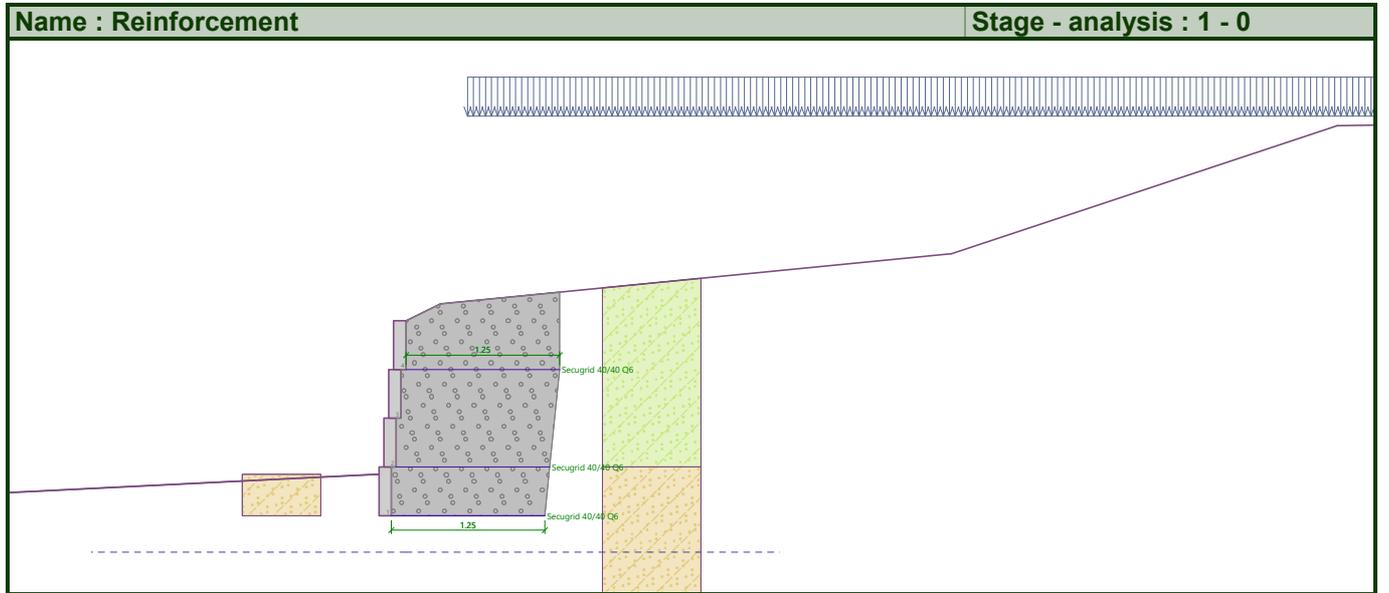
**Reinforcement**

Total number of input reinforcements : 3.



**Reinforcement details**

Block No.	Type of reinforcement	Origin $l_1$ [m]	End $l_2$ [m]	Height from bottom $y$ [m]	Length $l$ [m]
1	Secugrid 40/40 Q6	-0.12	1.13	0.00	1.25
2	Secugrid 40/40 Q6	-0.08	1.17	0.40	1.25
4	Secugrid 40/40 Q6	0.00	1.25	1.20	1.25



**Soil parameters**

**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 :  $\delta = 23.33^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 19.00 \text{ kN/m}^3$

**CLASS 1/2**

Unit weight :  $\gamma = 19.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])**

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Geological profile and assigned soils**

No.	Thickness of layer $t$ [m]	Depth $z$ [m]	Assigned soil	Pattern
1	1.20	0.00 .. 1.20	CLASS 1/2	



No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
2	-	1.20 .. ∞	Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])	

**Terrain profile**

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	0.28	-0.14
3	4.44	-0.55
4	7.58	-1.60
5	12.79	-1.68
6	13.79	-1.68

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

**Water influence**

GWT behind the structure lies at a depth of 1.90 m  
GWT in front of the structure lies at a depth of 1.90 m  
Subgrade at the heel is not permeable.  
Uplift in foot. bottom due to different pressures is not considered.

**Input surface surcharges**

No.	Surcharge		Action	Mag.1 [kN/m <sup>2</sup> ]	Mag.2 [kN/m <sup>2</sup> ]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	5.00		0.50	20.00	on terrain

No.	Name
1	5kPa

**Resistance on front face of the structure**

Resistance on front face of the structure: not considered  
Soil on front face of the structure - Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])  
Soil thickness in front of structure h = 0.34 m

**Terrain shape in front of structure**

No.	Coordinate x[m]	Depth z[m]
1	0.00	0.00
2	0.00	-0.34
3	-0.01	-0.34
4	-20.01	0.66
5	-21.01	0.66

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

**Verification No. 1****Forces acting on construction - combination 1**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-0.88	40.06	0.81	1.000	1.000	1.350
Active pressure	8.95	-0.62	3.81	1.41	1.350	1.350	1.350



Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Water pressure	0.00	-1.84	0.00	2.60	1.000	1.000	1.350
5kPa	2.79	-0.90	1.25	1.43	1.500	1.500	1.500
Weight - wall	0.00	-0.80	3.84	0.11	1.000	1.000	1.350
5kPa	0.00	-1.80	3.75	1.09	0.000	0.000	1.500

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 42.76$  kNm/mOverturning moment  $M_{ovr} = 11.27$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 27.08$  kN/mActive horizontal force  $H_{act} = 16.27$  kN/m**Wall for slip is SATISFACTORY****Overall check - WALL is SATISFACTORY****Forces acting on construction - combination 2**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-0.88	40.06	0.81	1.000	1.000	1.000
Active pressure	11.45	-0.62	3.74	1.41	1.000	1.000	1.000
Water pressure	0.00	-1.84	0.00	2.60	1.000	1.000	1.000
5kPa	3.54	-0.90	1.24	1.43	1.300	1.300	1.300
Weight - wall	0.00	-0.80	3.84	0.11	1.000	1.000	1.000
5kPa	0.00	-1.80	3.75	1.09	0.000	0.000	1.300

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 40.38$  kNm/mOverturning moment  $M_{ovr} = 11.24$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 20.95$  kN/mActive horizontal force  $H_{act} = 16.05$  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	-0.58	71.92	16.27	0.000	53.28
2	2.89	50.93	16.27	0.042	41.19
3	4.11	49.25	16.05	0.062	41.62
4	2.06	54.13	16.05	0.028	42.49

**Service load acting at the center of footing bottom**



No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-0.42	52.72	11.74
2	1.15	48.97	11.74

**Verification of foundation soil**

Stress in the footing bottom : rectangle

**Eccentricity verification**Max. eccentricity of normal force  $e = 0.042$ Maximum allowable eccentricity  $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY****Verification of bearing capacity**Max. stress at footing bottom  $\sigma = 53.28$  kPaBearing capacity of foundation soil  $R_d = 85.00$  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	3.84	0.01	1.000
Active pressure	11.58	-0.61	3.91	1.31	1.000
5kPa	3.60	-0.92	1.16	1.34	1.300
Weight - reinforced soil	0.00	-0.89	40.56	0.72	1.000
5kPa	0.00	-1.80	4.12	1.03	0.000

**Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 1)**Inclination of slip surface =  $84.00^\circ$ Overall normal force acting on reinforcement =  $45.97$  kN/mCoefficient of reduction of slip along  
geo-textile =  $0.60$ Resistance along geo-reinforcement =  $14.67$  kN/mWall resistance =  $2.04$  kN/mOverall bearing capacity of reinforcements =  $0.00$  kN/m

Results for the most unfavorable combination - No. 2

**Check for slip:**Resisting horizontal force  $H_{res} = 16.71$  kN/mActive horiz. force  $H_{act} = 16.26$  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	Secugrid 40/40 Q6	-1.99	1.60	18.12	10.95	38.87	5.11
2	Secugrid 40/40 Q6	-4.84	1.20	18.12	26.68	25.63	18.87
3	Secugrid 40/40 Q6	-3.32	0.40	18.12	18.33	7.10	46.81

**Check for tensile strength (reinforcement No.2)**Tension strength  $R_t = 18.12$  kN/m



Force in reinforcement  $F_x = 4.84$  kN/m

**Reinforcement for tensile strength is SATISFACTORY**

**Check for pull out resistance (reinforcement No.3)**

Pull out resistance  $T_p = 7.10$  kN/m

Force in reinforcement  $F_x = 3.32$  kN/m

**Reinforcement for pull out resistance is SATISFACTORY**

**Overall verification - reinforcement is SATISFACTORY**

## Slope stability analysis

### Results (Stage of construction 1)

#### Analysis 1

##### Circular slip surface

Slip surface parameters							
Center :	x =	-0.57	[m]	Angles :	$\alpha_1 =$	-35.33	[°]
	z =	1.54	[m]		$\alpha_2 =$	71.31	[°]
Radius :	R =	3.58	[m]				
The slip surface after optimization.							

#### Slope stability verification (Bishop)

##### Combination 1

Sum of active forces :  $F_a = 53.87$  kN/m

Sum of passive forces :  $F_p = 73.29$  kN/m

Sliding moment :  $M_a = 189.10$  kNm/m

Resisting moment :  $M_p = 257.26$  kNm/m

Utilization : 73.5 %

**Slope stability ACCEPTABLE**

##### Combination 2

Sum of active forces :  $F_a = 43.67$  kN/m

Sum of passive forces :  $F_p = 52.80$  kN/m

Sliding moment :  $M_a = 156.32$  kNm/m

Resisting moment :  $M_p = 189.02$  kNm/m

Utilization : 82.7 %

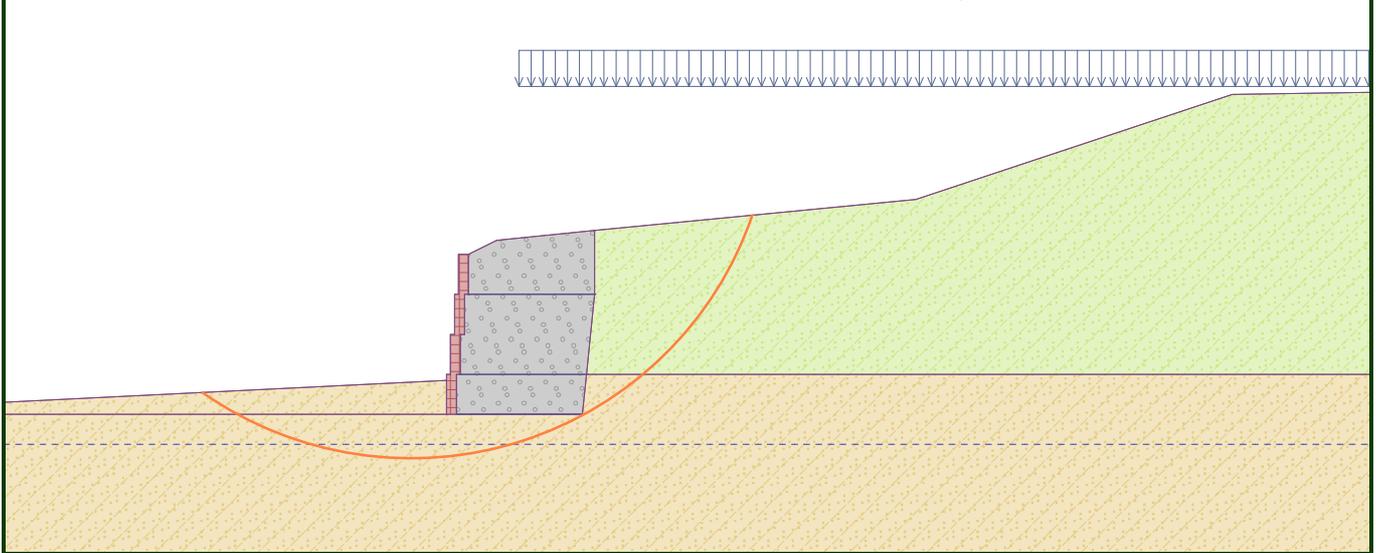
**Slope stability ACCEPTABLE**

Optimized slip surface for : Combination 2



Name : Analysis

Stage - analysis : 1 - 1





## Analysis of reinforced slopes

### Input data

#### Project

Task : WESTGATE, CLECKHEATON  
 Part : SECTION 7-7  
 Description : \*WALL 03 DESIGN IN ABEYANCE PENDING CONFIRMATION OF WALL FOUNDATION SOLUTION & RIG LOADS  
 Customer : GILLCON  
 Author : WM  
 Date : 11/09/2024  
 Project number : 24-5558

#### 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	
		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 [-]	
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  $n = 11$   
 Block height  $h = 0.40$  m  
 Block width  $b = 0.10$  m  
 Block offset  $o_1 = 0.04$  m

### Material

#### Block material

Unit weight  $\gamma = 24.00$  kN/m<sup>3</sup>  
 Cohesion  $c = 0.00$  kPa  
 Friction  $f = 0.580$   
 Shear bearing capacity of joint  $R_s = 6.60$  kN/m

Reinforced soil - Class 6I

### 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	Secugrid 40/40 Q6	Secugrid 40/40 Q6	—————	40.00	18.12	0.60	0.70

### Reinforcement details

#### 1. Secugrid 40/40 Q6

Short-term char. strength  $T_{ult} = 40.00$  kN/m  
 Long-term design strength  $R_t = 18.12$  kN/m  
 Overall coeff. of model uncertainty  $FS_{UNC} = 1.50$

Calculate reduction factors

Life time : 120 years  
 Creep red. factor  $RF_{CR} = 1.35$   
 Chemistry : pH 4.0-9.0  
 Durability red. factor  $RF_D = 1.00$   
 Partical size :  $D_{90} \leq 35$  mm  
 Installation damage red. factor  $RF_{ID} = 1.09$

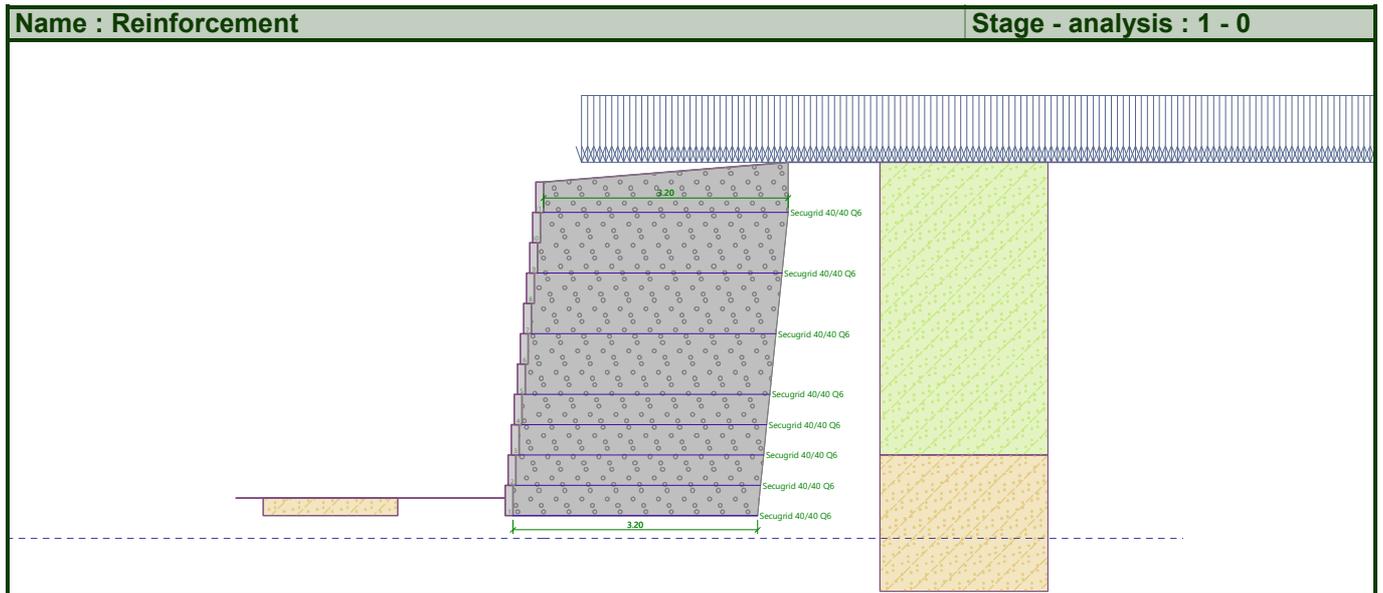
### Reinforcement

Total number of input reinforcements : 8.



**Reinforcement details**

Block No.	Type of reinforcement	Origin $l_1$ [m]	End $l_2$ [m]	Height from bottom $y$ [m]	Length $l$ [m]
1	Secugrid 40/40 Q6	-0.40	2.80	0.00	3.20
2	Secugrid 40/40 Q6	-0.36	2.84	0.40	3.20
3	Secugrid 40/40 Q6	-0.32	2.88	0.80	3.20
4	Secugrid 40/40 Q6	-0.28	2.92	1.20	3.20
5	Secugrid 40/40 Q6	-0.24	2.96	1.60	3.20
7	Secugrid 40/40 Q6	-0.16	3.04	2.40	3.20
9	Secugrid 40/40 Q6	-0.08	3.12	3.20	3.20
11	Secugrid 40/40 Q6	0.00	3.20	4.00	3.20



**Soil parameters**

**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 :  $\delta = 23.33^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 19.00 \text{ kN/m}^3$

**CLASS 1/2**

Unit weight :  $\gamma = 19.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])**

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Geological profile and assigned soils**

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	3.60	0.00 .. 3.60	CLASS 1/2	
2	-	3.60 .. ∞	Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])	

**Terrain profile**

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	0.01	0.00
3	3.22	-0.26
4	4.22	-0.26

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

Positive coordinate +z has downward direction.

**Water influence**

GWT behind the structure lies at a depth of 4.70 m

GWT in front of the structure lies at a depth of 4.70 m

Subgrade at the heel is not permeable.

Uplift in foot. bottom due to different pressures is not considered.

**Input surface surcharges**

No.	Surcharge		Action	Mag.1 [kN/m <sup>2</sup> ]	Mag.2 [kN/m <sup>2</sup> ]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	10.00		0.50	20.00	on terrain

No.	Name
1	10kPa

**Resistance on front face of the structure**

Resistance on front face of the structure: not considered

Soil on front face of the structure - Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])

Soil thickness in front of structure h = 0.23 m

Terrain in front of structure is flat.

**Settings of the stage of construction**

Design situation : permanent

**Verification No. 1****Forces acting on construction - combination 1**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-2.26	262.30	1.93	1.000	1.000	1.350
Active pressure	52.97	-1.56	21.85	3.46	1.350	1.350	1.350
Water pressure	0.00	-4.66	0.00	6.50	1.000	1.000	1.350
10kPa	13.56	-2.31	5.78	3.53	1.500	1.500	1.500
Weight - wall	0.00	-2.20	10.56	0.25	1.000	1.000	1.350
10kPa	0.00	-4.55	27.00	2.35	0.000	0.000	1.500

**Verification of complete wall****Check for overturning stability**

Resisting moment  $M_{res} = 641.37$  kNm/m

Overturning moment  $M_{ovr} = 158.48$  kNm/m

**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 165.37$  kN/mActive horizontal force  $H_{act} = 91.85$  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	-2.26	262.30	1.93	1.000	1.000	1.000
Active pressure	67.10	-1.56	21.11	3.46	1.000	1.000	1.000
Water pressure	0.00	-4.66	0.00	6.50	1.000	1.000	1.000
10kPa	17.16	-2.31	5.62	3.53	1.300	1.300	1.300
Weight - wall	0.00	-2.20	10.56	0.25	1.000	1.000	1.000
10kPa	0.00	-4.55	27.00	2.35	0.000	0.000	1.300

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 607.54$  kNm/mOverturning moment  $M_{ovr} = 156.16$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 128.15$  kN/mActive horizontal force  $H_{act} = 89.42$  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	-18.54	447.03	91.85	0.000	135.46
2	30.30	311.02	91.85	0.030	100.16
3	45.71	301.27	89.42	0.046	100.54
4	21.14	336.37	89.42	0.019	105.96

**Service load acting at the center of footing bottom**

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-13.90	327.49	66.53
2	5.00	300.49	66.53

**Verification of foundation soil**

Stress in the footing bottom : rectangle

**Eccentricity verification**Max. eccentricity of normal force  $e = 0.030$ Maximum allowable eccentricity  $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY**

**Verification of bearing capacity**Max. stress at footing bottom  $\sigma = 135.46$  kPaBearing capacity of foundation soil  $R_d = 140.00$  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	-2.20	10.56	0.15	1.000
Active pressure	67.21	-1.54	21.52	3.36	1.000
10kPa	17.25	-2.33	5.40	3.44	1.300
Weight - reinforced soil	0.00	-2.27	263.62	1.84	1.000
10kPa	0.00	-4.55	27.90	2.29	0.000

**Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 1)**

Inclination of slip surface = 84.00 °

Overall normal force acting on reinforcement = 292.16 kN/m

Coefficient of reduction of slip along

geo-textile

Resistance along geo-reinforcement = 93.21 kN/m

Wall resistance = 5.61 kN/m

Overall bearing capacity of reinforcements = 0.00 kN/m

Results for the most unfavorable combination - No. 2

**Check for slip:**Resisting horizontal force  $H_{res} = 98.82$  kN/mActive horiz. force  $H_{act} = 89.63$  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	Secugrid 40/40 Q6	-5.01	4.40	18.12	27.65	253.89	1.97
2	Secugrid 40/40 Q6	-9.46	4.00	18.12	52.22	217.85	4.34
3	Secugrid 40/40 Q6	-8.72	3.60	18.12	48.10	184.48	4.72
4	Secugrid 40/40 Q6	-7.97	3.20	18.12	43.98	153.77	5.18
5	Secugrid 40/40 Q6	-10.56	2.80	18.12	58.24	125.73	8.40
6	Secugrid 40/40 Q6	-11.46	2.00	18.12	63.24	77.65	14.76
7	Secugrid 40/40 Q6	-8.48	1.20	18.12	46.77	40.23	21.07
8	Secugrid 40/40 Q6	-4.43	0.40	18.12	24.43	13.48	32.85

**Check for tensile strength (reinforcement No.6)**Tension strength  $R_t = 18.12$  kN/mForce in reinforcement  $F_x = 11.46$  kN/m**Reinforcement for tensile strength is SATISFACTORY****Check for pull out resistance (reinforcement No.8)**Pull out resistance  $T_p = 13.48$  kN/mForce in reinforcement  $F_x = 4.43$  kN/m**Reinforcement for pull out resistance is SATISFACTORY**



**Overall verification - reinforcement is SATISFACTORY**



## Analysis of reinforced slopes

### Input data

#### Project

Task : WESTGATE, CLECKHEATON  
 Part : SECTION 8-8  
 Description : \*WALL 03 DESIGN IN ABEYANCE PENDING CONFIRMATION OF WALL FOUNDATION SOLUTION & RIG LOADS  
 Customer : GILLCON  
 Author : WM  
 Date : 11/09/2024  
 Project number : 24-5558

#### 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	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$Y_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$Y_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$Y_w =$	1.35 [-]		1.00 [-]	

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	$Y_\phi =$	1.00 [-]		1.25 [-]	
Partial factor on effective cohesion :	$Y_c =$	1.00 [-]		1.25 [-]	
Partial factor on undrained shear strength :	$Y_{cu} =$	1.00 [-]		1.40 [-]	
Partial factor on Poisson's ratio :	$Y_v =$	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  $h = 0.40$  m  
 Block width  $b = 0.10$  m  
 Block offset  $o_1 = 0.04$  m

**Material****Block material**

Unit weight  $\gamma = 24.00$  kN/m<sup>3</sup>  
 Cohesion  $c = 0.00$  kPa  
 Friction  $f = 0.580$   
 Shear bearing capacity of joint  $R_s = 6.60$  kN/m

Reinforced soil - Class 6I

**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	Secugrid 40/40 Q6	Secugrid 40/40 Q6	—————	40.00	18.12	0.60	0.70

**Reinforcement details****1. Secugrid 40/40 Q6**

Short-term char. strength  $T_{ult} = 40.00$  kN/m  
 Long-term design strength  $R_t = 18.12$  kN/m  
 Overall coeff. of model uncertainty  $FS_{UNC} = 1.50$

Calculate reduction factors

Life time : 120 years  
 Creep red. factor  $RF_{CR} = 1.35$   
 Chemistry : pH 4.0-9.0  
 Durability red. factor  $RF_D = 1.00$   
 Partical size :  $D_{90} \leq 35$  mm  
 Installation damage red. factor  $RF_{ID} = 1.09$

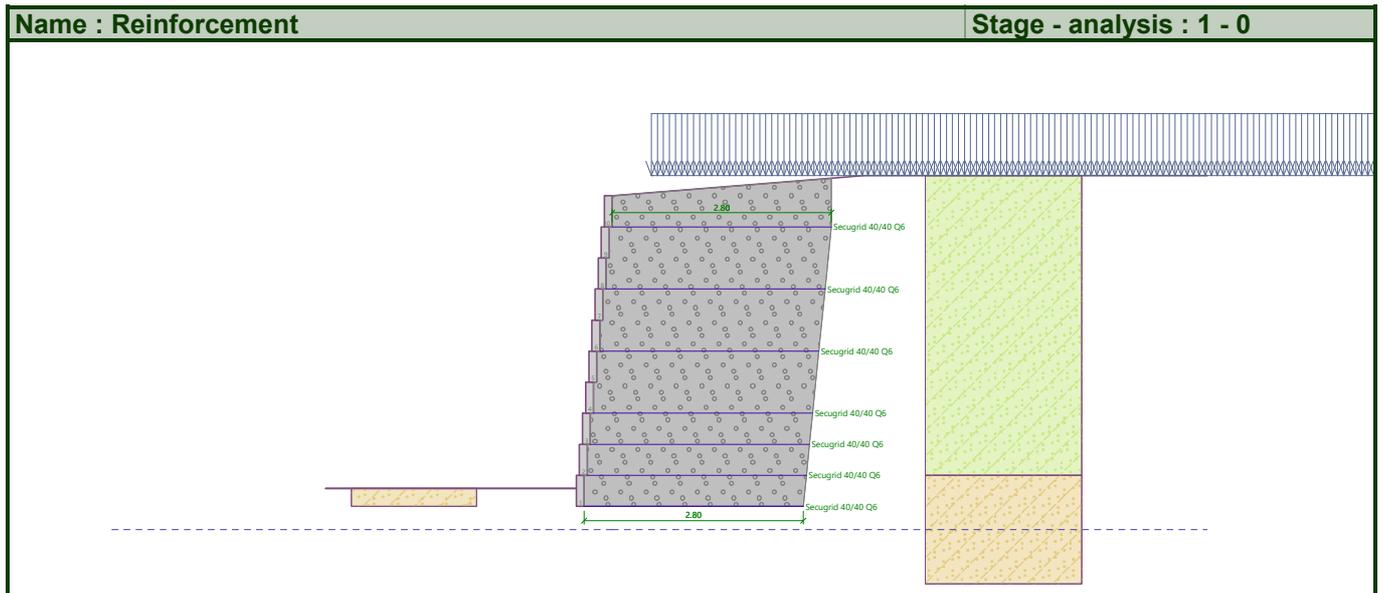
**Reinforcement**

Total number of input reinforcements : 7.



**Reinforcement details**

Block No.	Type of reinforcement	Origin $l_1$ [m]	End $l_2$ [m]	Height from bottom $y$ [m]	Length $l$ [m]
1	Secugrid 40/40 Q6	-0.36	2.44	0.00	2.80
2	Secugrid 40/40 Q6	-0.32	2.48	0.40	2.80
3	Secugrid 40/40 Q6	-0.28	2.52	0.80	2.80
4	Secugrid 40/40 Q6	-0.24	2.56	1.20	2.80
6	Secugrid 40/40 Q6	-0.16	2.64	2.00	2.80
8	Secugrid 40/40 Q6	-0.08	2.72	2.80	2.80
10	Secugrid 40/40 Q6	0.00	2.80	3.60	2.80



**Soil parameters**

**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 :  $\delta = 23.33^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 19.00 \text{ kN/m}^3$

**CLASS 1/2**

Unit weight :  $\gamma = 19.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])**

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Geological profile and assigned soils**

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	3.60	0.00 .. 3.60	CLASS 1/2	
2	-	3.60 .. ∞	Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])	

**Terrain profile**

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	0.01	0.00
3	3.22	-0.26
4	4.22	-0.26

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

Positive coordinate +z has downward direction.

**Water influence**

GWT behind the structure lies at a depth of 4.30 m

GWT in front of the structure lies at a depth of 4.30 m

Subgrade at the heel is not permeable.

Uplift in foot. bottom due to different pressures is not considered.

**Input surface surcharges**

No.	Surcharge		Action	Mag.1 [kN/m <sup>2</sup> ]	Mag.2 [kN/m <sup>2</sup> ]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	5.00		0.50	20.00	on terrain

No.	Name
1	5kPa

**Resistance on front face of the structure**

Resistance on front face of the structure: not considered

Soil on front face of the structure - Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])

Soil thickness in front of structure h = 0.23 m

Terrain in front of structure is flat.

**Settings of the stage of construction**

Design situation : permanent

**Verification No. 1****Forces acting on construction - combination 1**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-2.06	208.57	1.71	1.000	1.000	1.350
Active pressure	44.28	-1.42	18.29	3.04	1.350	1.350	1.350
Water pressure	0.00	-4.23	0.00	5.70	1.000	1.000	1.350
5kPa	6.16	-2.09	2.63	3.11	1.500	1.500	1.500
Weight - wall	0.00	-2.00	9.60	0.23	1.000	1.000	1.350
5kPa	0.00	-4.13	11.50	2.11	0.000	0.000	1.500

**Verification of complete wall****Check for overturning stability**

Resisting moment  $M_{res} = 445.50$  kNm/m

Overturning moment  $M_{ovr} = 104.39$  kNm/m

**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 131.23$  kN/mActive horizontal force  $H_{act} = 69.01$  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	-2.06	208.57	1.71	1.000	1.000	1.000
Active pressure	56.10	-1.42	17.67	3.04	1.000	1.000	1.000
Water pressure	0.00	-4.23	0.00	5.70	1.000	1.000	1.000
5kPa	7.79	-2.09	2.56	3.11	1.300	1.300	1.300
Weight - wall	0.00	-2.00	9.60	0.23	1.000	1.000	1.000
5kPa	0.00	-4.13	11.50	2.11	0.000	0.000	1.300

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 422.22$  kNm/mOverturning moment  $M_{ovr} = 101.03$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 101.73$  kN/mActive horizontal force  $H_{act} = 66.24$  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	-9.25	340.41	69.01	0.000	117.38
2	16.75	246.80	69.01	0.023	89.28
3	25.59	239.16	66.24	0.037	89.04
4	15.73	254.11	66.24	0.021	91.53

**Service load acting at the center of footing bottom**

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-6.95	250.58	50.44
2	0.64	239.08	50.44

**Verification of foundation soil**

Stress in the footing bottom : rectangle

**Eccentricity verification**Max. eccentricity of normal force  $e = 0.023$ Maximum allowable eccentricity  $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY**

**Verification of bearing capacity**Max. stress at footing bottom  $\sigma = 117.38$  kPaBearing capacity of foundation soil  $R_d = 120.00$  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	-2.00	9.60	0.13	1.000
Active pressure	44.40	-1.41	18.59	2.94	1.350
5kPa	6.20	-2.11	2.55	3.02	1.500
Weight - reinforced soil	0.00	-2.06	209.69	1.61	1.000
5kPa	0.00	-4.14	11.92	2.05	0.000

**Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 1)**

Inclination of slip surface = 84.00 °

Overall normal force acting on reinforcement = 238.61 kN/m

Coefficient of reduction of slip along

geo-textile

Resistance along geo-reinforcement = 76.12 kN/m

Wall resistance = 5.10 kN/m

Overall bearing capacity of reinforcements = 0.00 kN/m

Results for the most unfavorable combination - No. 1

**Check for slip:**Resisting horizontal force  $H_{res} = 81.23$  kN/mActive horiz. force  $H_{act} = 69.23$  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	Secugrid 40/40 Q6	-4.24	4.00	18.12	23.42	201.75	2.10
2	Secugrid 40/40 Q6	-7.91	3.60	18.12	43.67	169.87	4.66
3	Secugrid 40/40 Q6	-7.15	3.20	18.12	39.45	140.66	5.08
4	Secugrid 40/40 Q6	-9.29	2.80	18.12	51.27	114.11	8.14
5	Secugrid 40/40 Q6	-9.76	2.00	18.12	53.87	69.02	14.14
6	Secugrid 40/40 Q6	-6.77	1.20	18.12	37.38	34.59	19.58
7	Secugrid 40/40 Q6	-3.28	0.40	18.12	18.08	10.83	30.26

**Check for tensile strength (reinforcement No.5)**Tension strength  $R_t = 18.12$  kN/mForce in reinforcement  $F_x = 9.76$  kN/m**Reinforcement for tensile strength is SATISFACTORY****Check for pull out resistance (reinforcement No.7)**Pull out resistance  $T_p = 10.83$  kN/mForce in reinforcement  $F_x = 3.28$  kN/m**Reinforcement for pull out resistance is SATISFACTORY**



**Overall verification - reinforcement is SATISFACTORY**



## Analysis of reinforced slopes

### Input data

#### Project

Task : WESTGATE, CLECKHEATON  
 Part : SECTION 9-9  
 Description : \*WALL 03 DESIGN IN ABEYANCE PENDING CONFIRMATION OF WALL FOUNDATION SOLUTION & RIG LOADS  
 Customer : GILLCON  
 Author : WM  
 Date : 11/09/2024  
 Project number : 24-5558

#### 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	
		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 [-]	
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  $h = 0.40$  m  
 Block width  $b = 0.10$  m  
 Block offset  $o_1 = 0.04$  m

**Material****Block material**

Unit weight  $\gamma = 24.00$  kN/m<sup>3</sup>  
 Cohesion  $c = 0.00$  kPa  
 Friction  $f = 0.580$   
 Shear bearing capacity of joint  $R_s = 6.60$  kN/m

Reinforced soil - Class 6I

**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	Secugrid 40/40 Q6	Secugrid 40/40 Q6	—————	40.00	18.12	0.60	0.70

**Reinforcement details****1. Secugrid 40/40 Q6**

Short-term char. strength  $T_{ult} = 40.00$  kN/m  
 Long-term design strength  $R_t = 18.12$  kN/m  
 Overall coeff. of model uncertainty  $FS_{UNC} = 1.50$

Calculate reduction factors

Life time : 120 years  
 Creep red. factor  $RF_{CR} = 1.35$   
 Chemistry : pH 4.0-9.0  
 Durability red. factor  $RF_D = 1.00$   
 Partical size :  $D_{90} \leq 35$  mm  
 Installation damage red. factor  $RF_{ID} = 1.09$

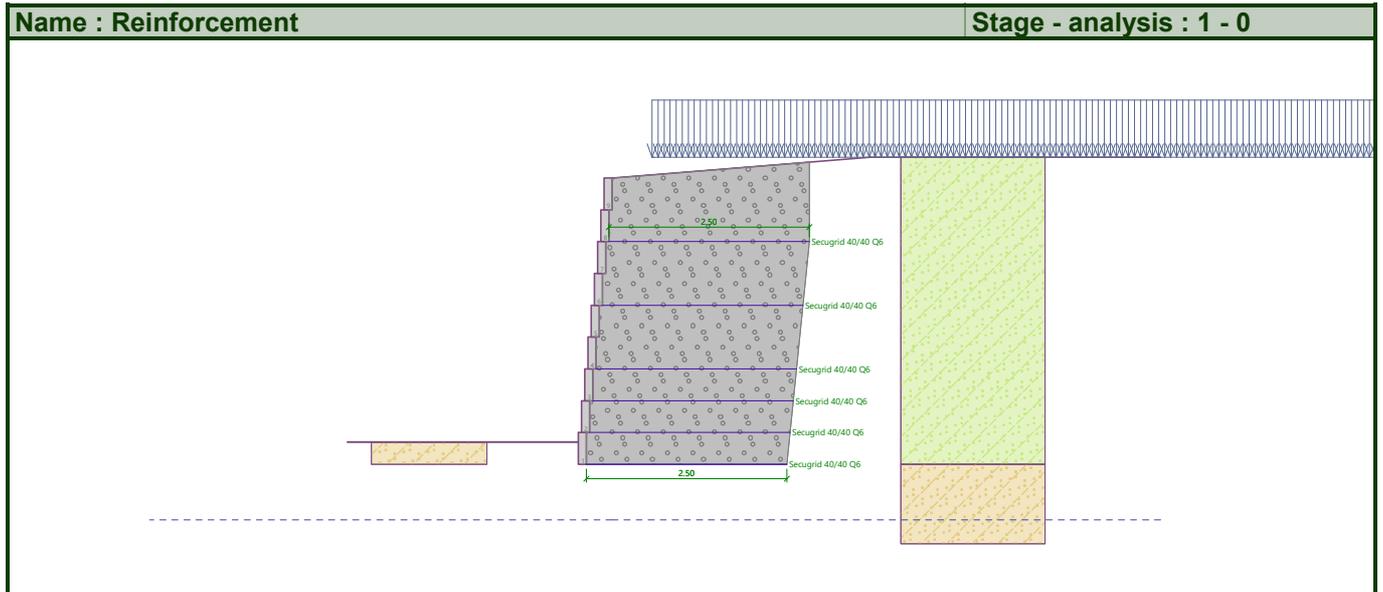
**Reinforcement**

Total number of input reinforcements : 6.



**Reinforcement details**

Block No.	Type of reinforcement	Origin $l_1$ [m]	End $l_2$ [m]	Height from bottom $y$ [m]	Length $l$ [m]
1	Secugrid 40/40 Q6	-0.32	2.18	0.00	2.50
2	Secugrid 40/40 Q6	-0.28	2.22	0.40	2.50
3	Secugrid 40/40 Q6	-0.24	2.26	0.80	2.50
4	Secugrid 40/40 Q6	-0.20	2.30	1.20	2.50
6	Secugrid 40/40 Q6	-0.12	2.38	2.00	2.50
8	Secugrid 40/40 Q6	-0.04	2.46	2.80	2.50



**Soil parameters**

**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 :  $\delta = 23.33^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 19.00 \text{ kN/m}^3$

**CLASS 1/2**

Unit weight :  $\gamma = 19.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])**

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 28.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Angle of friction struc.-soil :  $\delta = 18.67^\circ$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Geological profile and assigned soils**

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	3.60	0.00 .. 3.60	CLASS 1/2	
2	-	3.60 .. ∞	Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])	

**Terrain profile**

No.	Coordinates x [m]	Depth z [m]
1	0.00	0.00
2	0.01	0.00
3	3.22	-0.26
4	4.22	-0.26

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

Positive coordinate +z has downward direction.

**Water influence**

GWT behind the structure lies at a depth of 4.30 m

GWT in front of the structure lies at a depth of 4.30 m

Subgrade at the heel is not permeable.

Uplift in foot. bottom due to different pressures is not considered.

**Input surface surcharges**

No.	Surcharge		Action	Mag.1 [kN/m <sup>2</sup> ]	Mag.2 [kN/m <sup>2</sup> ]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		variable	5.00		0.50	20.00	on terrain

No.	Name
1	5kPa

**Resistance on front face of the structure**

Resistance on front face of the structure: not considered

Soil on front face of the structure - Granular MADE GROUND (ashy gravelly SAND [ASH & CLINKER])

Soil thickness in front of structure h = 0.28 m

Terrain in front of structure is flat.

**Settings of the stage of construction**

Design situation : permanent

**Verification No. 1****Forces acting on construction - combination 1**

Name	F <sub>hor</sub> [kN/m]	App.Pt. z [m]	F <sub>vert</sub> [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - reinforced soil	0.00	-1.84	167.10	1.53	1.000	1.000	1.350
Active pressure	36.43	-1.29	15.28	2.73	1.350	1.350	1.350
Water pressure	0.00	-3.80	0.00	5.06	1.000	1.000	1.350
5kPa	5.51	-1.87	2.43	2.78	1.500	1.500	1.500
Weight - wall	0.00	-1.80	8.64	0.21	1.000	1.000	1.350
5kPa	0.00	-3.72	9.80	1.90	0.000	0.000	1.500

**Verification of complete wall****Check for overturning stability**

Resisting moment  $M_{res} = 323.82$  kNm/m

Overturning moment  $M_{ovr} = 78.94$  kNm/m

**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 106.34$  kN/mActive horizontal force  $H_{act} = 57.45$  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	-1.84	167.10	1.53	1.000	1.000	1.000
Active pressure	46.13	-1.29	14.80	2.73	1.000	1.000	1.000
Water pressure	0.00	-3.80	0.00	5.06	1.000	1.000	1.000
5kPa	6.98	-1.88	2.38	2.78	1.300	1.300	1.300
Weight - wall	0.00	-1.80	8.64	0.21	1.000	1.000	1.000
5kPa	0.00	-3.72	9.80	1.90	0.000	0.000	1.300

**Verification of complete wall****Check for overturning stability**Resisting moment  $M_{res} = 306.40$  kNm/mOverturning moment  $M_{ovr} = 76.48$  kNm/m**Wall for overturning is SATISFACTORY****Check for slip**Resisting horizontal force  $H_{res} = 82.36$  kN/mActive horizontal force  $H_{act} = 55.20$  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	-3.82	276.21	57.45	0.000	106.23
2	15.12	200.00	57.45	0.029	81.67
3	21.79	193.63	55.20	0.043	81.53
4	14.15	206.37	55.20	0.026	83.79

**Service load acting at the center of footing bottom**

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	-2.93	203.24	41.94
2	2.95	193.44	41.94

**Verification of foundation soil**

Stress in the footing bottom : rectangle

**Eccentricity verification**Max. eccentricity of normal force  $e = 0.029$ Maximum allowable eccentricity  $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY**

**Verification of bearing capacity**Max. stress at footing bottom  $\sigma = 106.23$  kPaBearing capacity of foundation soil  $R_d = 120.00$  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	-1.80	8.64	0.11	1.000
Active pressure	36.40	-1.27	15.24	2.63	1.350
5kPa	5.58	-1.90	2.29	2.70	1.500
Weight - reinforced soil	0.00	-1.86	168.61	1.44	1.000
5kPa	0.00	-3.72	10.40	1.86	0.000

**Check for slip along geo-reinforcement with the maximal utilization (Reinforc. No.: 1)**

Inclination of slip surface = 84.00 °

Overall normal force acting on reinforcement = 192.62 kN/m

Coefficient of reduction of slip along

geo-textile

Resistance along geo-reinforcement = 61.45 kN/m

Wall resistance = 4.59 kN/m

Overall bearing capacity of reinforcements = 0.00 kN/m

Results for the most unfavorable combination - No. 1

**Check for slip:**Resisting horizontal force  $H_{res} = 66.04$  kN/mActive horiz. force  $H_{act} = 57.50$  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	Secugrid 40/40 Q6	-3.82	3.60	18.12	21.10	162.09	2.36
2	Secugrid 40/40 Q6	-7.08	3.20	18.12	39.05	133.68	5.29
3	Secugrid 40/40 Q6	-6.31	2.80	18.12	34.83	107.93	5.85
4	Secugrid 40/40 Q6	-8.05	2.40	18.12	44.43	84.84	9.49
5	Secugrid 40/40 Q6	-8.12	1.60	18.12	44.81	46.67	17.40
6	Secugrid 40/40 Q6	-6.07	0.80	18.12	33.48	19.16	31.67

**Check for tensile strength (reinforcement No.5)**Tension strength  $R_t = 18.12$  kN/mForce in reinforcement  $F_x = 8.12$  kN/m**Reinforcement for tensile strength is SATISFACTORY****Check for pull out resistance (reinforcement No.6)**Pull out resistance  $T_p = 19.16$  kN/mForce in reinforcement  $F_x = 6.07$  kN/m**Reinforcement for pull out resistance is SATISFACTORY****Overall verification - reinforcement is SATISFACTORY**