PATERSON GROUP

memorandum

re: **Grande Retaining Wall – Global Stability Analysis**
Proposed Residential Development
1386 & 1394 Greely Lane, Ottawa, Ontario

to: Cassidy - **Mr. Chris Poirier** - chris@cassidyewconstruction.com
date: June 23, 2025
file: PG7615-MEMO.01

Further to your request and authorization, Paterson Group (Paterson) prepared the following memorandum to provide a geotechnical review of the global stability analysis of the proposed Grande retaining wall's structure.

1.0 Background Information

As requested, Paterson Group Inc. (Paterson) completed a two Grande retaining wall design to be located at the subject site. The Grande retaining wall system has been designed for the subject site to consider site constraints and grading requirements. The walls have also been designed in accordance with the Canadian Highway and Bridge Design Code (CHBDC) 2019. Details of the retaining walls are presented below and are depicted in Drawing PG7563-FIG.01 attached.

The following grading plan prepared by D.B. GRAY ENGINEERING INC. was reviewed as part of our retaining wall designs:

❑ Project Proposed 1-storey building 1386 – 13947 Greely Lane, Grading plan, Revision.05 dated March 24, 2025.

Based on our review, the exposed portions of the subject Grande retaining wall vary in height between 1.0 to 1.6 m.

This memorandum should be read in conjunction with Paterson Group report PG6052-1 Revision.06, dated October 7, 2024.

Retaining Wall Guard Rail

The proposed guard rail is recommended to be extended through the top two Grande block and designed by others. It is understood that the guard rail is to consist of a non-wind bearing properties. It should be noted that the guard rail should be installed using galvanized steel to protect the railing/fencing system from long-term corrosion. Refer to City of Ottawa fencing standard - Figure 7.9.

2.0 Global and Internal Stability Analysis

The global stability analysis was modeled using Fine by Geo 5, a computer program which permits a two-dimensional slope stability analysis calculating several methods including the Bishop's method, which is a widely accepted slope analysis method. The software further allows for the internal review of the design as per various codes including the CHBDC 2019. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to forces favoring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is stable. However, due to intrinsic limitations of the calculation methods and the variability of the subsurface soil and groundwater conditions, a factor of safety greater than 1.0 is generally required for the failure risk to be considered acceptable.

A minimum factor of safety of 1.5 is generally recommended for conditions where the slope failure would comprise permanent structures. An analysis considering seismic loading was also completed. A horizontal acceleration of 0.192 g was considered for the sections for the seismic loading condition. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading.

The retaining wall section was reviewed using the design loading according to CHBDC 2019.

The highest retaining wall cross-section was studied as the worst-case scenario. The following parameters were used for the slope stability analysis under static and seismic conditions:

Table 1 - Effective Soil Parameters for Stability Analysis

Soil Layer	Unit Weight (kN/m^3)	Friction Angle (degrees)	Cohesion (kPa)
Granular B Type II	22	40	0
Engineered Fill	22	40	0
Native Soil: Silty Sand	19	30	5

The total strength parameters for seismic analysis were chosen based on our general knowledge of the geology in the area.

The strength parameters used for seismic analysis at the slope cross-section are presented in Table 2 below.

Table 2 - Total Strength Soil Parameters for Seismic Analysis			
Soil Layer	**Unit Weight (kN/m^3)**	**Friction Angle (degrees)**	**Cohesion (kPa)**
Granular B Type II	22	40	0
Engineered Fill	22	40	0
Native Soil: Silty Sand	19	30	5

Analysis Results

The factor of safety for the retaining wall section was greater than 1.5 for static conditions. Similarly, the results under seismic loading yielded a factor of safety for this section greater than 1.1.

The internal and structural design reviewed the bearing capacity, overturning resistance, and sliding resistance of the retaining wall units as per various loading conditions described in the CHBDC 2019. All analysis were found to be acceptable; the worst-case scenario is presented in attached calculation sheets.

Based on these results, the retaining wall design is considered suitable from a geotechnical perspective.

Table 3 below provides preliminary structural review of the proposed retaining walls based on Canadian Bridge and Highway design code (CHBDC) using the Grande retaining wall product specifications.

Table 3 - Preliminary Structural Check of All Failure Modes (CDR/FS)				
Section	**Overturning** (Service/Ultimate/ Seismic)	**Sliding** (Service/Ultimate/ Seismic)	**Bearing** (Service/Ultimate/ Seismic)	**Global Stability** (Static/Seismic)
Section 1	2.70/1.18/2.06	3.10/2.11/1.26	1.68/2.64/1.12	1.87/1.59

3.0 Geotechnical Recommendations

Backfill Material

The retaining wall should be backfilled with free-draining granular backfill materials and incorporate longitudinal drains and weeper holes to provide positive drainage for the backfill. For the purpose of this report, it is recommended that the wall is backfilled with either OPSS Granular B Type II or Granular A materials.

The backfill should be placed within a wedge-shaped zone defined by a line drawn up and back from the back edge of the base block of the wall at an inclination of 1H:1V or a minimum of 1 m behind the back of the blocks. All material should be compacted to a minimum of 98% of the material's SPMDD.

Drainage

A 100 mm diameter perforated drainage pipe wrapped in geotextile such as Terrafix 270R or equivalent approved other, surrounded on all sides by 150 mm of clear crushed stone, and should be installed at the heel of the bottom block. The drainage system should have a positive outlet to a nearby catch basin or an existing ditch. It is recommended that the outlets be spaced evenly along the retaining wall with a minimum spacing of 30 m center to center passing through the wall or connected to a nearby catch basin.

Testing and Inspections Criteria

It is recommended that the following be completed once the retaining wall design and construction program are determined:

- Observation of all bearing surfaces prior to backfill.
- Observation of all subgrades prior to placing backfilling materials.
- Observation of the drainage system prior to backfilling.
- Field density tests to ensure the specified level of compaction was achieved.
- Periodic observation of the retaining wall installation, especially at the first course.

A report confirming that these works have been conducted in general accordance with Paterson's recommendations could be issued upon request, following the completion of a satisfactory material testing and observation program by the geotechnical consultant.

We trust that the current submission meets your immediate requirements.

Best Regards,

Paterson Group Inc.

Fabrice Venadiambu, P.eng., Ing

Joey R. Villeneuve, M.A.Sc., P.eng., Ing.

Prefab wall analysis

Input data (Stage of construction 1)

Project : 1386 & 1394 Greely Lane, Ottawa, ON
Customer : Permacon
Date : 6/23/2025
Project number : PG7615

Settings

(input for current task)

Materials and standards

Concrete structures : CSA A23.3-14

Wall analysis

Verification methodology : according to LRFD
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333

Load factors					
Design situation - Strength I					
		Minimum		Maximum	
Dead load of structural components :	DC =	0.95	[–]	1.10	[–]
Dead load of wearing surfaces :	DW =	0.65	[–]	1.50	[–]
Earth pressure - active :	EH_A =	0.80	[–]	1.25	[–]
Earth pressure - at rest :	EH_R =	0.80	[–]	1.25	[–]
Earth surcharge load (permanent) :	ES =	0.80	[–]	1.25	[–]
Vertical pressure of earth fill :	EV =	1.00	[–]	1.35	[–]
Live load surcharge :	LL =	1.70	[–]	1.70	[–]
Water load :	WA =	0.90	[–]	1.10	[–]

Resistance factors			
Design situation - Strength I			
Resistance factor on overturning :	ϕ_o =	0.55	[–]
Resistance factor on sliding :	ϕ_t =	0.90	[–]
Resistance factor on bearing capacity :	ϕ_b =	1.00	[–]
Resistance factor on passive pressure :	ϕ_{VE} =	0.50	[–]

Load factors					
Design situation - Service I					
		Minimum		Maximum	
Dead load of structural components :	DC =	1.00	[–]	1.00	[–]
Dead load of wearing surfaces :	DW =	1.00	[–]	1.00	[–]
Earth pressure - active :	EH_A =	1.00	[–]	1.00	[–]
Earth pressure - at rest :	EH_R =	1.00	[–]	1.00	[–]

Load factors					
Design situation - Service I					
Earth surcharge load (permanent) :	ES =	1.00	[–]	1.00	[–]
Vertical pressure of earth fill :	EV =	1.00	[–]	1.00	[–]
Live load surcharge :	LL =	0.90	[–]	0.90	[–]
Water load :	WA =	1.00	[–]	1.00	[–]

Resistance factors			
Design situation - Service I			
Resistance factor on overturning :	ϕ_o =	1.00	[–]
Resistance factor on sliding :	ϕ_t =	1.00	[–]
Resistance factor on bearing capacity :	ϕ_b =	1.00	[–]
Resistance factor on passive pressure :	ϕ_{VE} =	1.00	[–]

Load factors					
Design situation - Extreme I					
		Minimum		Maximum	
Dead load of structural components :	DC =	0.80	[–]	1.25	[–]
Dead load of wearing surfaces :	DW =	0.80	[–]	1.25	[–]
Earth pressure - active :	EH_A =	0.90	[–]	1.50	[–]
Earth pressure - at rest :	EH_R =	0.90	[–]	1.35	[–]
Earth surcharge load (permanent) :	ES =	0.80	[–]	1.25	[–]
Vertical pressure of earth fill :	EV =	1.00	[–]	1.35	[–]
Live load surcharge :	LL =	0.00	[–]	0.00	[–]
Water load :	WA =	1.00	[–]	1.00	[–]

Resistance factors			
Design situation - Extreme I			
Resistance factor on overturning :	ϕ_o =	1.00	[–]
Resistance factor on sliding :	ϕ_t =	1.00	[–]
Resistance factor on bearing capacity :	ϕ_b =	1.00	[–]
Resistance factor on passive pressure :	ϕ_{VE} =	1.00	[–]

Geometry of structure

Slope of wall = 0.00 °

No.	Block width w [m]	Block height h [m]	Offset k [m]	Offs.(L) o_1 [m]	Offs.(R) o_2 [m]	Merge	Unit weight [kN/m³]	Block friction [–]	Cohesion [kPa]	Shear bear.cap. [kN/m] F_{min}	F_{max}
10	0.44	0.20	-0.063	0.000	0.000	No	22.00	0.533	0.00	0.00	-
9	0.38	0.20	0.063	0.000	0.000	No	22.00	0.533	0.00	0.00	-
8	0.75	0.20	0.000	0.000	0.000	No	22.00	0.533	0.00	0.00	-
7	0.38	0.20	0.063	0.000	0.000	No	22.00	0.533	0.00	0.00	-
6	0.38	0.20	0.000	0.000	0.000	No	22.00	0.533	0.00	0.00	-
5	0.38	0.20	0.063	0.000	0.000	No	22.00	0.533	0.00	0.00	-
4	0.75	0.20	0.000	0.000	0.000	No	22.00	0.533	0.00	0.00	-
3	0.75	0.20	0.063	0.000	0.000	No	22.00	0.533	0.00	0.00	-
2	0.75	0.20	0.000	0.000	0.000	No	22.00	0.533	0.00	0.00	-

No.	Block width w [m]	Block height h [m]	Offset k [m]	Offs.(L) o_1 [m]	Offs.(R) o_2 [m]	Merge	Unit weight [kN/m³]	Block friction [–]	Cohesion [kPa]	Shear bear.cap. [kN/m] F_{min}	F_{max}
1	0.75	0.20	-	0.000	0.000	-	22.00	-	-	-	-

Note: Blocks are ordered from bottom to the top

Basic soil parameters

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]	γ_{su} [kN/m³]	δ [°]
1	Granular B		40.00	0.00	22.00	12.00	26.00
2	Engineered Fill		40.00	0.00	22.00	12.00	26.00
3	native soil		30.00	5.00	19.00	9.00	20.00

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

Soil parameters

Granular B

Unit weight : γ = 22.00 kN/m³
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Angle of friction struc.-soil : δ = 26.00 °
Soil : cohesionless
Saturated unit weight : γ_{sat} = 22.00 kN/m³

Engineered Fill

Unit weight : γ = 22.00 kN/m³
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Angle of friction struc.-soil : δ = 26.00 °
Soil : cohesionless
Saturated unit weight : γ_{sat} = 22.00 kN/m³

native soil

Unit weight : γ = 19.00 kN/m³
Stress-state : effective
Angle of internal friction : ϕ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 5.00 kPa
Angle of friction struc.-soil : δ = 20.00 °
Soil : cohesionless
Saturated unit weight : γ_{sat} = 19.00 kN/m³

Backfill

Assigned soil : Granular B
Slope = 45.00 °

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	1.00	0.00 .. 1.00	Engineered Fill	
2	-	1.00 .. ∞	native soil	

Foundation

Type of foundation : strip foundation
Soil of foundation - Granular B

Geometry

Foundation thickness $h = 0.20$ m
Offset left $b_l = 0.20$ m
Offset right $b_p = 0.20$ m

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		variable	12.00		0.50	10.00	on terrain

No.	Name
1	Live Load

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - Engineered Fill
Soil thickness in front of structure $h = 0.25$ m

Terrain in front of structure is flat.

Global settings

Settings of the stage of construction

Design situation : Strength I
The wall is free to move. Active earth pressure is therefore assumed.
Reduction of soil/soil friction angle : do not reduce

Verification No. 1 (Stage of construction 1)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-0.89	25.04	0.42	0.950	0.950	1.100
FF resistance	-0.25	-0.08	0.00	0.00	0.800	0.800	1.250
Weight - earth wedge	0.00	-0.98	2.02	0.62	1.000	1.000	1.350
Weight - earth wedge	0.00	-1.77	1.92	0.74	1.000	1.000	1.350
Active pressure	8.38	-0.69	8.67	0.74	1.250	1.250	1.250

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Live Load	2.97	-0.77	2.52	0.75	1.700	1.700	1.700

Verification of complete wall

Check for overturning stability

Resisting moment M_{res} = 13.11 kNm/m
Overturning moment M_{ovr} = 11.14 kNm/m

Capacity demand ratio CDR = 1.18

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 32.35 kN/m
Active horizontal force H_{act} = 15.32 kN/m

Capacity demand ratio CDR = 2.11

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 75.71 kPa

Bearing capacity of foundation soil (Stage of construction 1)

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	2.79	47.97	15.21	0.078	75.71
2	3.37	42.83	15.32	0.105	72.28

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	1.73	40.16	11.10

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force e = 0.105
Maximum allowable eccentricity e_{alw} = 0.333

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 75.71 kPa
Allowable bearing capacity of foundation soil R_d = 200.00 kPa
Capacity demand ratio CDR = 2.64

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Dimensioning No. 1 (Stage of construction 1)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-0.21	3.59	0.17	0.950	0.950	1.100
Active pressure	0.32	-0.13	0.15	0.38	1.250	1.250	1.250
Live Load	0.00	-0.40	0.00	0.38	1.700	1.700	1.700

Verification of construction joint above the block No.: 8

Check for overturning stability

Resisting moment M_{res} = 0.36 kNm/m
Overturning moment M_{ovr} = 0.05 kNm/m

Capacity demand ratio CDR = 6.84

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 1.73 kN/m
Active horizontal force H_{act} = 0.39 kN/m

Capacity demand ratio CDR = 4.37

Joint for slip is SATISFACTORY

Slope stability analysis

Input data (Construction stage 1)

Project

Settings

(input for current task)

Stability analysis

Verification methodology : according to LRFD
Earthquake analysis : Standard

Load factors					
Design situation - Service I					
		Minimum		Maximum	
Earth surcharge load (permanent) :	ES =	1.00	[–]	1.00	[–]
Live load surcharge :	LL =	0.00	[–]	1.00	[–]

Resistance factors			
Design situation - Service I			
Resistance factor on stability :	ϕ_{SS} =	0.65	[–]

Load factors			
Design situation - Extreme I			
		Minimum	Maximum

Load factors					
Design situation - Extreme I					
Earth surcharge load (permanent) :	ES =	1.00	[–]	1.00	[–]
Live load surcharge :	LL =	0.00	[–]	0.00	[–]

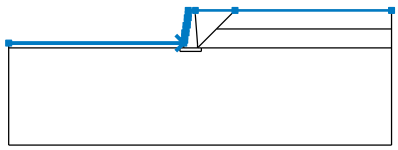
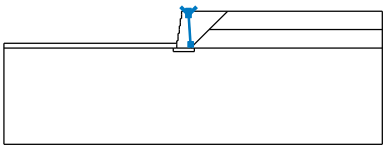
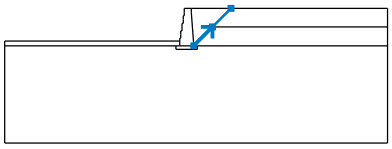
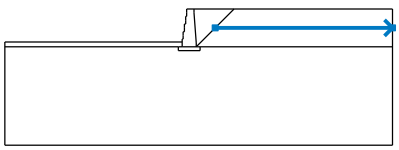
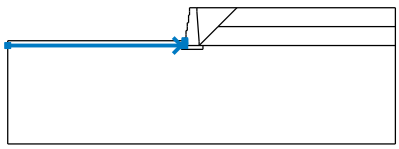
Resistance factors			
Design situation - Extreme I			
Resistance factor on stability :	ϕ_{SS} =	0.90	[–]

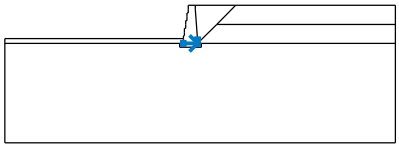
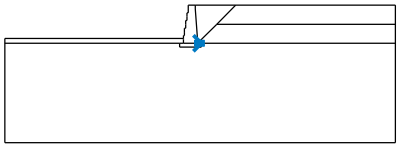
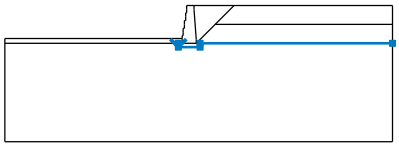
Anchors

Verification methodology : Safety factors (ASD)

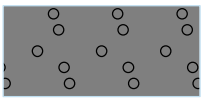
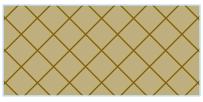
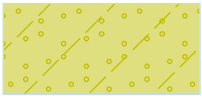
Safety factors			
Safety factor for steel strength :	SF_t =	1.50	[–]
Safety factor for pull out resistance (soil) :	SF_e =	1.50	[–]
Safety factor for pull out resistance (grouting) :	SF_c =	1.50	[–]

Interface

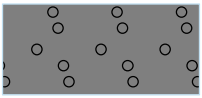
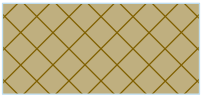
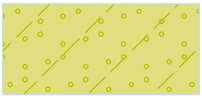
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-10.00	-1.75	-0.63	-1.75	-0.63	-1.60
		-0.57	-1.60	-0.57	-1.40	-0.57	-1.20
		-0.50	-1.20	-0.50	-1.00	-0.50	-0.80
		-0.44	-0.80	-0.44	-0.60	-0.44	-0.40
		-0.38	-0.40	-0.38	-0.20	-0.38	0.00
		0.00	0.00	2.12	0.00	10.50	0.00
2		0.00	0.00	0.00	-0.20	0.12	-1.80
3		0.12	-2.00	1.12	-1.00	2.12	0.00
4		1.12	-1.00	10.50	-1.00		
5		-10.00	-2.00	-0.83	-2.00	-0.63	-2.00
		-0.63	-1.80	-0.63	-1.75		

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
6		-0.63	-2.00	0.12	-2.00	0.12	-1.80
7		0.12	-2.00	0.32	-2.00		
8		-0.83	-2.00	-0.83	-2.20	0.32	-2.20
		0.32	-2.00	10.50	-2.00		

Soil parameters - effective stress state

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
1	Granular B		40.00	0.00	22.00
2	Engineered Fill		40.00	0.00	22.00
3	native soil		30.00	5.00	19.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [–]
1	Granular B		22.00		
2	Engineered Fill		22.00		
3	native soil		19.00		

Soil parameters

Granular B

Unit weight : γ = 22.00 kN/m³

Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : ϕ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

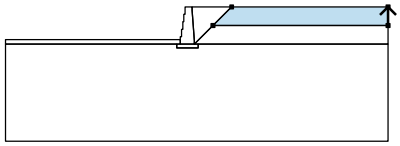
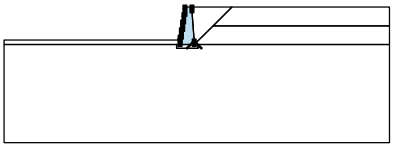
Engineered Fill
Unit weight : γ = 22.00 kN/m^3
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : ϕ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

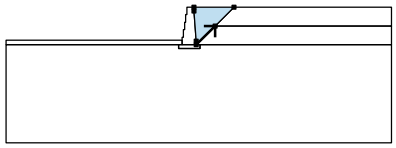
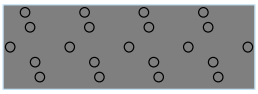
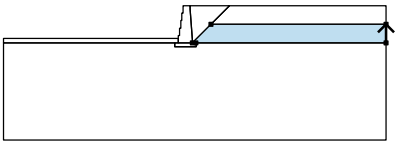
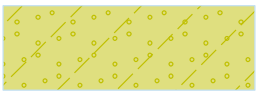
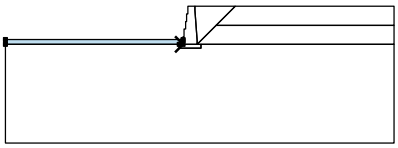
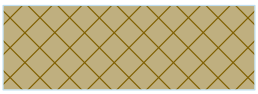
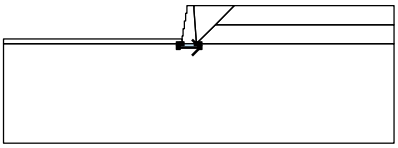
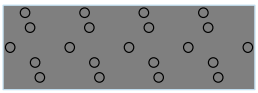
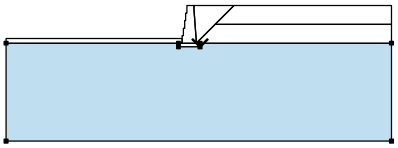
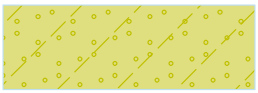
native soil
Unit weight : γ = 19.00 kN/m^3
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : ϕ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 5.00 kPa
Saturated unit weight : γ_{sat} = 19.00 kN/m^3

Rigid Bodies

No.	Name	Sample	γ [kN/m³]
1	Material of structure		22.00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		10.50	-1.00	10.50	0.00	Engineered Fill
		2.12	0.00	1.12	-1.00	
2		0.12	-2.00	0.12	-1.80	Material of structure
		0.00	-0.20	0.00	0.00	
		-0.38	0.00	-0.38	-0.20	
		-0.38	-0.40	-0.44	-0.40	
		-0.44	-0.60	-0.44	-0.80	
		-0.50	-0.80	-0.50	-1.00	
		-0.50	-1.20	-0.57	-1.20	
		-0.57	-1.40	-0.57	-1.60	
		-0.63	-1.60	-0.63	-1.75	
		-0.63	-1.80	-0.63	-2.00	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
3		0.12	-2.00	1.12	-1.00	Granular B
		2.12	0.00	0.00	0.00	
		0.00	-0.20	0.12	-1.80	
4		10.50	-2.00	10.50	-1.00	native soil
		1.12	-1.00	0.12	-2.00	
		0.32	-2.00			
5		-0.83	-2.00	-0.63	-2.00	Engineered Fill
		-0.63	-1.80	-0.63	-1.75	
		-10.00	-1.75	-10.00	-2.00	
6		-0.83	-2.20	0.32	-2.20	Granular B
		0.32	-2.00	0.12	-2.00	
		-0.63	-2.00	-0.83	-2.00	
7		0.32	-2.00	0.32	-2.20	native soil
		-0.83	-2.20	-0.83	-2.00	
		-10.00	-2.00	-10.00	-7.20	
		10.50	-7.20	10.50	-2.00	

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	variable	on terrain	x = 0.50	l = 10.00		0.00	12.00		kN/m^2

Surcharges

No.	Name
1	Live Load

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : Service I

Results (Construction stage 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters							
Center :	x =	-0.71	[m]	Angles :	α_1 =	-31.54	[°]
	z =	0.50	[m]		α_2 =	79.08	[°]
Radius :	R =	2.64	[m]				
The slip surface after optimization.							

Total weight of soil above the slip surface: 89.09 kN/m

Slope stability verification (Bishop)

Sum of active forces : F_a = 45.86 kN/m

Sum of passive forces : F_p = 84.36 kN/m

Sliding moment : M_a = 121.06 kNm/m

Resisting moment : M_p = 144.77 kNm/m

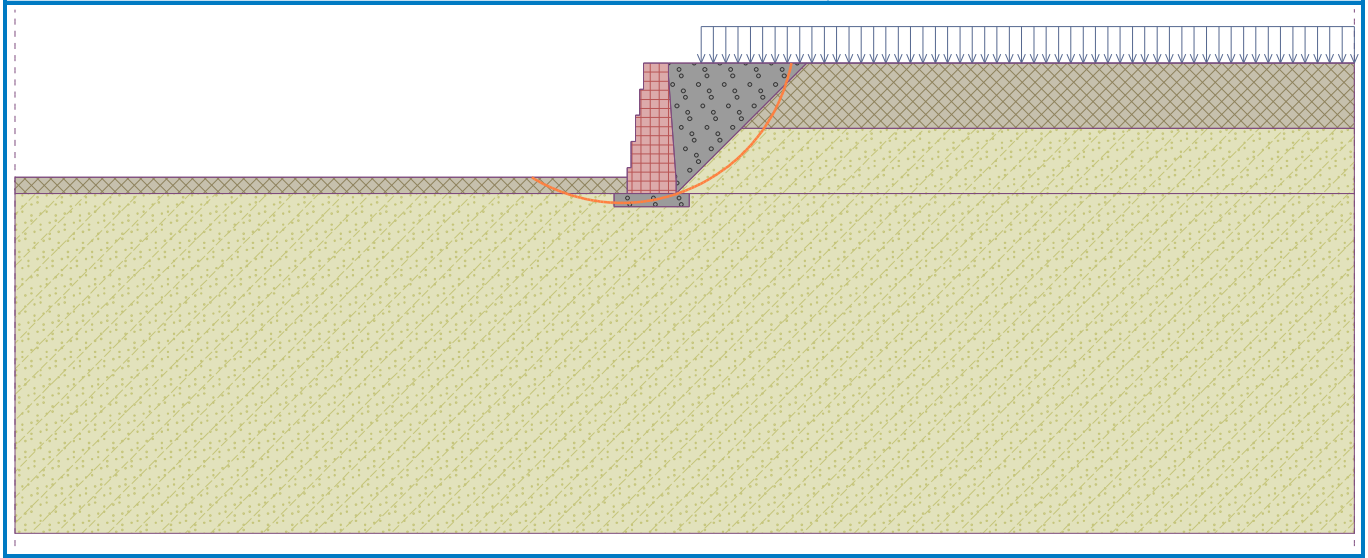
Utilization : 83.6 %

Capacity demand ratio CDR: 1.196

Factor of Safety: 1.872

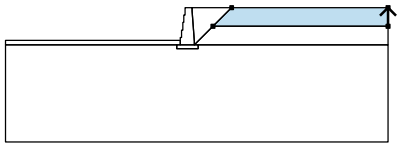
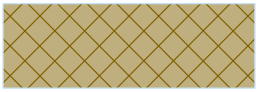
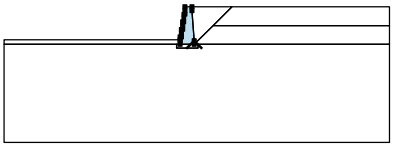
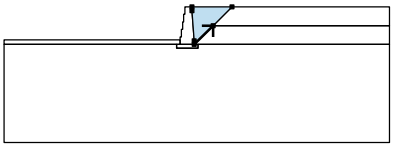
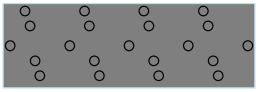
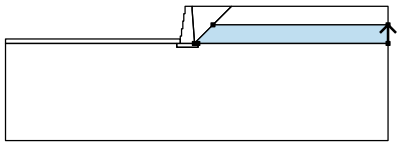
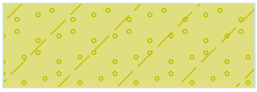
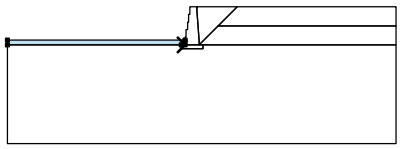
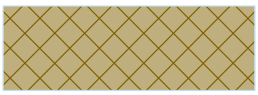
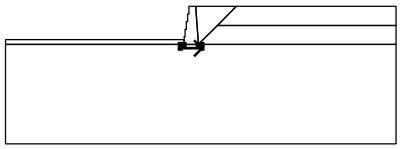
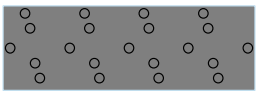
Slope stability ACCEPTABLE

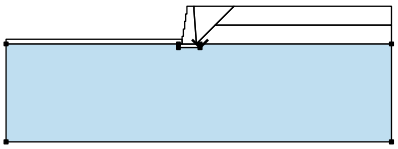
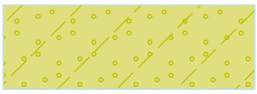
Name : Static - global stability analysis	Stage - analysis : 1 - 1



Input data (Construction stage 2)

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		10.50	-1.00	10.50	0.00	Engineered Fill
		2.12	0.00	1.12	-1.00	
2		0.12	-2.00	0.12	-1.80	Material of structure
		0.00	-0.20	0.00	0.00	
		-0.38	0.00	-0.38	-0.20	
		-0.38	-0.40	-0.44	-0.40	
		-0.44	-0.60	-0.44	-0.80	
		-0.50	-0.80	-0.50	-1.00	
		-0.50	-1.20	-0.57	-1.20	
		-0.57	-1.40	-0.57	-1.60	
		-0.63	-1.60	-0.63	-1.75	
		-0.63	-1.80	-0.63	-2.00	
3		0.12	-2.00	1.12	-1.00	Granular B
		2.12	0.00	0.00	0.00	
		0.00	-0.20	0.12	-1.80	
4		10.50	-2.00	10.50	-1.00	native soil
		1.12	-1.00	0.12	-2.00	
		0.32	-2.00			
5		-0.83	-2.00	-0.63	-2.00	Engineered Fill
		-0.63	-1.80	-0.63	-1.75	
		-10.00	-1.75	-10.00	-2.00	
6		-0.83	-2.20	0.32	-2.20	Granular B
		0.32	-2.00	0.12	-2.00	
		-0.63	-2.00	-0.83	-2.00	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
7		0.32	-2.00	0.32	-2.20	native soil
		-0.83	-2.20	-0.83	-2.00	
		-10.00	-2.00	-10.00	-7.20	
		10.50	-7.20	10.50	-2.00	

Surcharge

No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F, x	q_2, z	unit
1	No	No	strip	variable	on terrain	x = 0.50	l = 10.00		0.00	12.00		kN/m²

Surcharges

No.	Name
1	Live Load

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Horizontal seismic coefficient : K_h = 0.1980
Vertical seismic coefficient : K_v = 0.0000

Settings of the stage of construction

Design situation : Extreme I

Results (Construction stage 2)

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters							
Center :	x =	-0.79	[m]	Angles :	α_1 =	-27.43	[°]
	z =	1.25	[m]		α_2 =	68.30	[°]
Radius :	R =	3.38	[m]				
The slip surface after optimization.							

Total weight of soil above the slip surface: 101.57 kN/m

Slope stability verification (Bishop)

Sum of active forces : F_a = 49.66 kN/m
Sum of passive forces : F_p = 79.39 kN/m

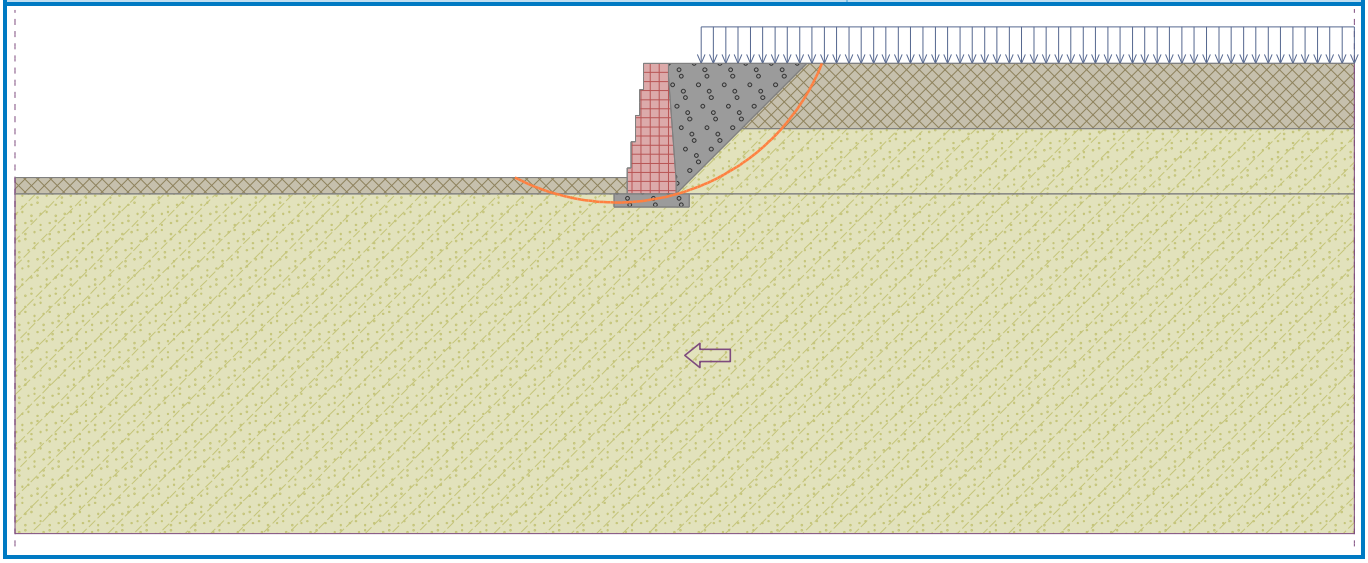
Sliding moment : M_a = 167.85 kNm/m
Resisting moment : M_p = 241.50 kNm/m
Utilization : 69.5 %

Capacity demand ratio CDR: 1.439

Factor of Safety: 1.598

Slope stability ACCEPTABLE

Name : Seismic - Global Stability Analysis	Stage - analysis : 2 - 1



Input data (Stage of construction 2)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	1.00	0.00 .. 1.00	Engineered Fill	
2	-	1.00 .. ∞	native soil	

Foundation

Type of foundation : strip foundation
Soil of foundation - Granular B

Geometry

Foundation thickness h = 0.20 m
Offset left b_l = 0.20 m
Offset right b_p = 0.20 m

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge		Action	Mag.1	Mag.2	Ord.x	Length	Depth
	new	change		[kN/m²]	[kN/m²]	x [m]	l [m]	z [m]
1	No	No	variable	12.00		0.50	10.00	on terrain

No.	Name
1	Live Load

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - Engineered Fill
Soil thickness in front of structure h = 0.25 m
Terrain in front of structure is flat.

Earthquake

Factor of horizontal acceleration K_h = 0.0000
Factor of vertical acceleration K_v = 0.0000

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : Service I
The wall is free to move. Active earth pressure is therefore assumed.
Reduction of soil/soil friction angle : do not reduce

Verification No. 1 (Stage of construction 2)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-0.89	25.04	0.42	1.000	1.000	1.000
Earthq.- constr.	0.00	-0.89	0.00	0.42	1.000	1.000	1.000
FF resistance	-0.25	-0.08	0.00	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-0.98	2.02	0.62	1.000	1.000	1.000
Earthquake - soil wedge	0.00	-0.98	0.00	0.62	1.000	1.000	1.000
Weight - earth wedge	0.00	-1.77	1.92	0.74	1.000	1.000	1.000
Earthquake - soil wedge	0.00	-1.77	0.00	0.74	1.000	1.000	1.000
Active pressure	8.38	-0.69	8.67	0.74	1.000	1.000	1.000
Earthq.- act.pressure	0.00	-2.00	0.00	0.75	1.000	1.000	1.000
Live Load	2.97	-0.77	2.52	0.75	0.900	0.900	0.900

Verification of complete wall

Check for overturning stability

Resisting moment M_{res} = 21.22 kNm/m
Overturning moment M_{ovr} = 7.85 kNm/m

Capacity demand ratio CDR = 2.70

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 33.48 kN/m
Active horizontal force H_{act} = 10.80 kN/m

Capacity demand ratio CDR = 3.10

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 59.56 kPa

Bearing capacity of foundation soil (Stage of construction 2)

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	1.60	39.91	10.80	0.053	59.56

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	1.73	40.16	11.10

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.053$
Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom $\sigma = 59.56$ kPa
Allowable bearing capacity of foundation soil $R_d = 100.00$ kPa
Capacity demand ratio CDR = 1.68

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Dimensioning No. 1 (Stage of construction 2)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-0.21	3.59	0.17	1.000	1.000	1.000
Earthq.- constr.	0.00	-0.21	0.00	0.17	1.000	1.000	1.000
Active pressure	0.32	-0.13	0.15	0.38	1.000	1.000	1.000
Earthq.- act.pressure	0.00	-0.40	0.00	0.38	1.000	1.000	1.000
Live Load	0.00	-0.40	0.00	0.38	0.900	0.900	0.900

Verification of construction joint above the block No.: 8

Check for overturning stability

Resisting moment $M_{res} = 0.67$ kNm/m
Overturning moment $M_{ovr} = 0.04$ kNm/m

Capacity demand ratio CDR = 15.94

Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 1.99 kN/m
Active horizontal force H_{act} = 0.32 kN/m

Capacity demand ratio CDR = 6.31

Joint for slip is SATISFACTORY

Input data (Stage of construction 3)

Geological profile and assigned soils

No.	Thickness of layer t [m]	Depth z [m]	Assigned soil	Pattern
1	1.00	0.00 .. 1.00	Engineered Fill	
2	-	1.00 .. ∞	native soil	

Foundation

Type of foundation : strip foundation
Soil of foundation - Granular B

Geometry

Foundation thickness h = 0.20 m
Offset left b_l = 0.20 m
Offset right b_p = 0.20 m

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	No	Yes	variable	17.00		0.50	10.00	on terrain

No.	Name
1	Live Load

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - Engineered Fill
Soil thickness in front of structure h = 0.25 m

Terrain in front of structure is flat.

Earthquake

Factor of horizontal acceleration K_h = 0.1980
Factor of vertical acceleration K_v = 0.0000

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : Extreme I

The wall is free to move. Active earth pressure is therefore assumed.

Reduction of soil/soil friction angle : do not reduce

Verification No. 1 (Stage of construction 3)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-0.89	25.04	0.42	0.800	0.800	1.250
Earthq.- constr.	4.96	-0.89	0.00	0.42	1.000	1.000	1.000
FF resistance	-0.25	-0.08	0.00	0.00	0.900	0.900	1.350
Weight - earth wedge	0.00	-0.98	2.02	0.62	1.000	1.000	1.350
Earthquake - soil wedge	0.40	-0.98	0.00	0.62	1.000	1.000	1.000
Weight - earth wedge	0.00	-1.77	1.92	0.74	1.000	1.000	1.350
Earthquake - soil wedge	0.38	-1.77	0.00	0.74	1.000	1.000	1.000
Active pressure	8.38	-0.69	8.67	0.74	1.500	1.500	1.500
Earthq.- act.pressure	5.65	-1.35	9.24	0.78	1.000	1.000	1.000
Live Load	4.20	-0.77	3.57	0.75	0.000	0.000	0.000

Verification of complete wall

Check for overturning stability

Resisting moment M_{res} = 27.81 kNm/m

Overturning moment M_{ovr} = 21.81 kNm/m

Capacity demand ratio CDR = 1.28

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 38.78 kN/m

Active horizontal force H_{act} = 23.74 kN/m

Capacity demand ratio CDR = 1.63

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 177.85 kPa

Bearing capacity of foundation soil (Stage of construction 3)

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	10.44	58.85	23.62	0.237	148.96
2	11.33	46.21	23.74	0.327	177.85

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	11.69	50.45	23.72

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verification

Max. eccentricity of normal force $e = 0.327$
Maximum allowable eccentricity $e_{alw} = 0.333$

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom $\sigma = 177.85$ kPa
Allowable bearing capacity of foundation soil $R_d = 200.00$ kPa
Capacity demand ratio CDR = 1.12

Bearing capacity of foundation soil is SATISFACTORY

Overall verification - bearing capacity of found. soil is SATISFACTORY

Dimensioning No. 1 (Stage of construction 3)

Forces acting on construction

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-0.67	15.14	0.37	0.800	0.800	1.250
Earthq.- constr.	3.00	-0.67	0.00	0.37	1.000	1.000	1.000
Weight - earth wedge	0.00	-0.38	2.02	0.55	1.000	1.000	1.350
Earthquake - soil wedge	0.40	-0.38	0.00	0.55	1.000	1.000	1.000
Weight - earth wedge	0.00	-1.17	1.92	0.68	1.000	1.000	1.350
Earthquake - soil wedge	0.38	-1.17	0.00	0.68	1.000	1.000	1.000
Active pressure	4.35	-0.47	6.71	0.67	1.500	1.500	1.500
Earthq.- act.pressure	2.83	-0.94	5.05	0.72	1.000	1.000	1.000
Live Load	2.35	-0.54	2.67	0.69	0.000	0.000	0.000

Verification of construction joint above the block No.: 3

Check for overturning stability

Resisting moment $M_{res} = 17.25$ kNm/m
Overturning moment $M_{ovr} = 8.35$ kNm/m

Capacity demand ratio CDR = 2.06

Joint for overturning stability is SATISFACTORY

Check for slip

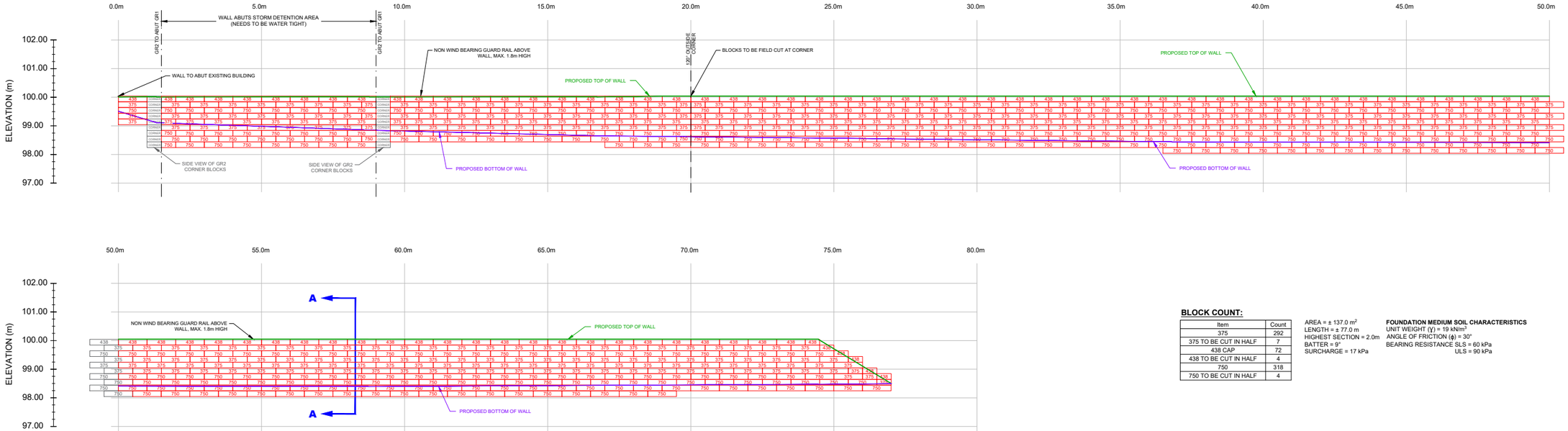
Resisting horizontal force $H_{res} = 16.60$ kN/m
Active horizontal force $H_{act} = 13.13$ kN/m

Capacity demand ratio CDR = 1.26

Joint for slip is SATISFACTORY

PROFILE VIEW (GR1 - PERIMETER WALL):

SCALE 1:150



BLOCK COUNT:

Item	Count
375	292
375 TO BE CUT IN HALF	7
438 CAP	72
438 TO BE CUT IN HALF	4
750	318
750 TO BE CUT IN HALF	4

AREA = ± 137.0 m^2
LENGTH = ± 77.0 m
HIGHEST SECTION = 2.0m
BATTER = 9°
SURCHARGE = 17 kPa

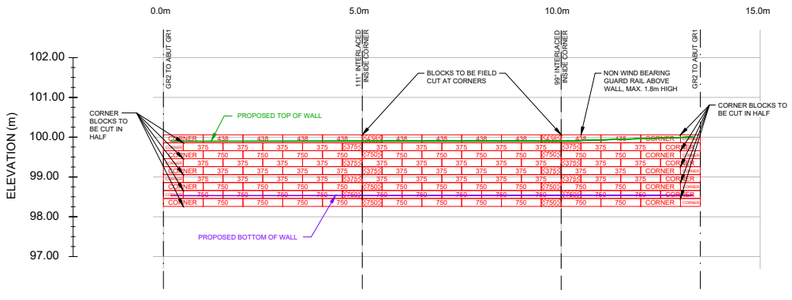
FOUNDATION MEDIUM SOIL CHARACTERISTICS
UNIT WEIGHT (γ) = 19 kN/m^3
ANGLE OF FRICTION (ϕ) = 30°
BEARING RESISTANCE SLS = 60 kPa
ULS = 90 kPa

PROFILE VIEW (GR2 - AROUND STORMWATER DETENTION AREA):

SCALE 1:150

LEGEND:

PORTION OF FULL BLOCK HIDDEN



BLOCK COUNT:

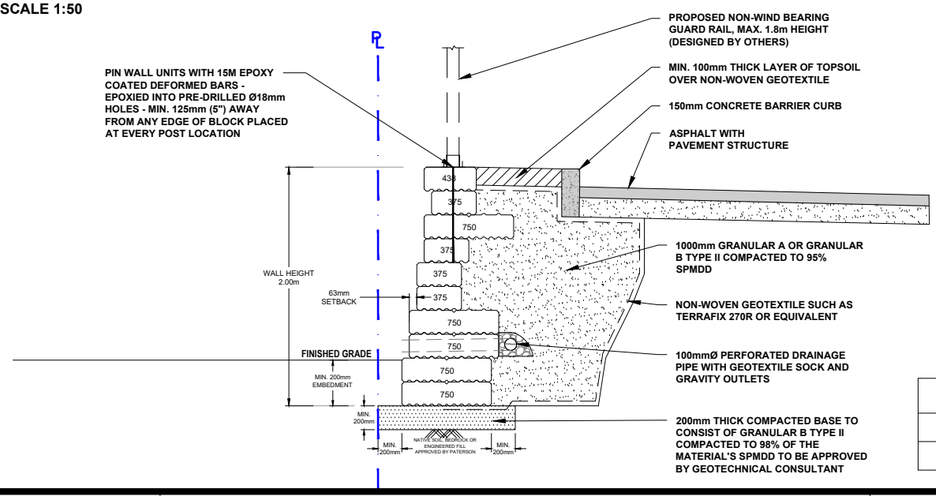
Item	Count
375	51
438 CAP	10
750	49
CORNER UNIT	14
CORNER UNIT TO BE CUT IN HALF	9

AREA = ± 24.3 m^2
LENGTH = ± 13.5 m
HIGHEST SECTION = 1.8m
VERTICAL WALL, BATTER = 0°
SURCHARGE =17 kPa

FOUNDATION MEDIUM SOIL CHARACTERISTICS
UNIT WEIGHT (γ) = 19 kN/m^3
ANGLE OF FRICTION (ϕ) = 30°
BEARING RESISTANCE SLS = 60 kPa
ULS = 90 kPa

CROSS SECTION A-A (HIGHEST SECTION):

SCALE 1:50



GR1 & GR2 TOTALS	
AREA	163.61 m^2
LENGTH	90.13 m

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

PERMACON

NO.	REVISIONS	DATE	INITIAL

PERMACON

PROPOSED GRANDE RETAINING WALL
1386 & 1394 GREELY LANE
OTTAWA, ONTARIO

Title:

GRANDE PRELIMINARY PROFILE (GR1 & GR2)

Scale:	AS SHOWN
Drawn by:	MLB
Checked by:	CT
Approved by:	AB
ON #:	ON-13025
Date:	05/2025
Report No.:	PG7563
Dwg. No.:	**FIGURE 1**
Revision No.:	

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