Analysis of Redi Rock wall

Input data

Project : 8243 West Mercer Way, Mercer Island, WA
Date : 5/17/2024

Settings

USA - Safety factor

Wall analysis

Verification methodology :	Safety factors (ASD)
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
Internal stability :	Standard - straight slip surface
Reduction coeff. of contact first block - base :	1.00

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	1.50	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Blocks

No.	Description	Block height h [in]	Block width w [in]	Unit weight γ [pcf]
1	Block 28 PC	18.00	28.00	120.00
2	Top block 28	18.00	28.00	120.00

No.	Description	Shear bearing capacity of joint F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Block friction f [°]
1	Block 28 PC	6061.00	11276.00	44.00
2	Top block 28	6061.00	11276.00	44.00

Setbacks

No.	Setback s [in]
1	0.000
2	0.033
3	0.135
6	0.269

Geometry

No. group	Description	Count	Setback s [in]
1	Block 28 PC	6	0.13
2	Top block 28	1	-

Base

Geometry

Upper setback a_1 = 0.00 ft
Lower setback a_2 = 1.00 ft
Height h = 1.00 ft
Width b = 4.00 ft

Material

Soil creating foundation - Clay with low or medium plasticity (CL, CI), stiff consistency, Sr > 0.8

Types of reinforcements

No.	Name	Type of reinforcement	Line type	Tensile strength		
				T_{ult} [lbf/ft]	R_t [lbf/ft]	R_{con} [lbf/ft]
2	Miragrid 8XT	Miragrid 8XT	- - - - - - - - - -	7400.00	3393.87	3423.30

2. Miragrid 8XT

Reinforcement details

Short-term char. strength	T_{ult}	= 7400.00	lbf/ft
Creep red. factor	RF_{CR}	= 1.58	
Durability red. factor	RF_D	= 1.15	
Installation damage red. factor	RF_{ID}	= 1.20	
Long-term design strength	R_t	= 3393.87	lbf/ft
Coefficient of direct slip along reinforcement	C_{ds}	= 0.67	
Coefficient of interaction of soil and geo-reinforcement	C_i	= 0.67	
Scale correction factor	α	= 0.8	
Long-term strength reduction factor	CR_{cr}	= 0.532	
Calculation of long-term connection strength	R_{con}	= 3423.30	lbf/ft

Reinforcements

Input mode : 1 reinforcement type
Reinf. installation : in every row of blocks (50%)
Type of reinforcement : Miragrid 8XT
Top reinforcement : straight (25%)
Reinforcement geometry : identical length of reinforcements
Length of reinforcement l = 2.50 ft

Reinforcements

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
1	Yes	Miragrid 8XT	2.50	
2	Yes	Miragrid 8XT	2.50	
3	Yes	Miragrid 8XT	2.50	
4	Yes	Miragrid 8XT	2.50	
5	Yes	Miragrid 8XT	2.50	
6	Yes	Miragrid 8XT	2.50	

No.	Consider	Name	Length of reinforcement l [ft]	End pt. coordinate l_k [ft]
7	Yes	Miragrid 8XT	2.50	

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	Clay with low or medium plasticity (CL, CI), stiff consistency, Sr > 0.8		19.00	320.0	133.00	70.50	0.00

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

Soil parameters

Clay with low or medium plasticity (CL, CI), stiff consistency, Sr > 0.8

Unit weight : γ = 133.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 19.00 °
Cohesion of soil : c_{ef} = 320.0 psf
Angle of friction struc.-soil : δ = 0.00 °
Saturated unit weight : γ_{sat} = 133.0 pcf

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Clay with low or medium plasticity (CL, CI), stiff consistency, Sr > 0.8	

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 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	50.00		12.00	12.00	on terrain
2	Yes		variable	300.00		12.00	12.00	on terrain

No.	Name
1	Driveway Dead Load
2	Driveway Live Load

Resistance on front face of the structure

Resistance on front face of the structure is not considered.

Settings of the stage of construction

Design situation : permanent
Reduction of soil/soil friction angle : do not reduce

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - reinforced soil	0.0	-5.38	3678.0	3.96	1.000
Active pressure	479.5	-1.38	165.1	5.64	1.000
Driveway Dead Load	72.6	-2.20	48.0	5.64	1.000
Driveway Live Load	562.6	-2.84	287.9	5.64	1.000
Weight - wall	0.0	-5.08	2844.2	1.55	1.000

Verification of complete wall

Place of verification : bottom of blocks

Check for overturning stability
Resisting moment M_{res} = 21804.0 lbfft/ft
Overturning moment M_{ovr} = 2419.9 lbfft/ft

Safety factor = 9.01 > 1.50
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 3637.83 lbf/ft
Active horizontal force H_{act} = 1114.73 lbf/ft

Safety factor = 3.26 > 1.50
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 [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	-2411.5	7023.16	1114.73	0.000	1453.1

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	-2411.5	7023.16	1114.73

Verification of foundation soil

Place of verification : bottom of blocks
Stress in the footing bottom : rectangle

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

Eccentricity of the normal force is SATISFACTORY

Verification of bearing capacity

Max. stress at footing bottom σ = 1453.1 psf
Allowable bearing capacity of foundation soil R_d = 3000.0 psf

Safety factor = 2.06 > 2.00
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 reinforcement No.: 1)

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.08	2887.1	-0.78	1.000
Active pressure	479.2	-1.38	165.0	2.50	1.000
Driveway Dead Load	71.9	-2.20	45.7	2.50	1.000
Driveway Live Load	555.5	-2.83	274.1	2.50	1.000
Weight - reinforced soil	0.0	-4.91	3033.6	1.43	1.000

Verification against slip along geotextile No.: 1

Inclination of slip surface = 90.00 °
Overall normal force acting on reinforcement = 3518.34 lbf/ft
Coefficient of reduction of slip along geo-textile = 0.92
Resistance along geo-reinforcement = 1111.52 lbf/ft
Wall resistance = 1740.78 lbf/ft
Overall bearing capacity of reinforcements = 0.00 lbf/ft

Check for slip:
Resisting horizontal force H_{res} = 2852.30 lbf/ft
Active horiz. force H_{act} = 1106.64 lbf/ft

Factor of safety = 2.58 > 1.50
Slip along geotextile is SATISFACTORY

Calculation of internal stability No. 1

Check for bearing capacity of reinforcement No.: 1

Check for tensile strength
Tension strength R_t = 848.47 lbf/ft
Force in reinforcement F_x = 214.32 lbf/ft

Safety factor = 3.96 > 1.50
Reinforcement for tensile strength is SATISFACTORY

Check for pull out resistance
Pull out resistance T_p = 322.17 lbf/ft
Force in reinforcement F_x = 214.32 lbf/ft

Safety factor = 1.50 > 1.50
Reinforcement for pull out resistance is SATISFACTORY

Verification of connection strength
Connection strength R_{con} = 855.83 lbf/ft
Force in reinforcement F_x = 214.32 lbf/ft

Safety factor = 3.99 > 1.50
Connection strength is SATISFACTORY

Overall verification - reinforcement is SATISFACTORY