

NOTICE OF MEETING
HILLSIDE REVIEW BOARD
CITY OF ST. GEORGE
WASHINGTON COUNTY, UTAH

Public Notice

Notice is hereby given that the Hillside Review Board of the City of St. George, Washington County, Utah, will hold meetings at the referenced site on **Wednesday, February 8, 2023**, commencing on-site at approximately 9:00 a.m.

The estimated site times are in bold. The agenda for the meeting is as follows:

1. Consider a request for a hillside development permit for a residential retaining wall. The applicant is requesting that the Hillside Review Board consider the structural stability and mitigate the appearance and location of this retaining wall. The property is currently zoned R-1-8 (Single Family Residential, minimum lot size 8,000sf). The site is located at 150 N. Donlee Drive. The applicant is Ryan and Martina Davis. Case No. 2022-HS-018.
Meeting time is approx. 9:00 am

Carol Davidson, AICP, CFM, CPM
Senior Planner
Development Services

Reasonable Accommodation: The City of St. George will make efforts to provide reasonable accommodations to disabled members of the public in accessing City programs. Please contact the City Human Resources Office at (435) 627-4674 at least 24 hours in advance if you have special needs.

Meeting Location

Item #1 – Kneaders parking lot – 199 N. Bluff Street



HILLSIDE REVIEW BOARD AGENDA REPORT: 11/30/2022
HILLSIDE REVIEW BOARD AGENDA REPORT: 02/08/2023

150 N. Donlee Drive Hillside Development Permit (Case No. 2022-HS-018)		
Request:	A Hillside Development Permit to mitigate the placement of a block wall in the hillside development overlay zone.	
Applicant:	Ryan and Martina Davis	
Representative:	same	
Location:	150 N. Donlee Drive	
General Plan:	Low Density Residential (LDR), Open Space (OS)	
Existing Zoning:	R-1-8 (Single Family Residential, minimum lot size 8,000 sf)	
Surrounding Zoning:	North	R-1-8
	South	R-1-8
	East	OS (Open Space
	West	R-1-8
Land Area:	Approximately 0.26 acres	



UPDATE

This item was continued on 11/30/2022 to give the applicant time to address the issues brought up. The Concrete Block Wall Letter has been updated to address the concerns brought up in the Hillside Meeting in November (Please see Exhibit "D"). Below are the comments provided by Kent Nelson, P.E. on the updated letter:

1. The factors of safety I state in the report are what the readouts attached to the report give for the entire wall. Item 1 from the email points out a factor safety shown on the printout that's not for the entire wall.
2. I provided analyses for 3 different compaction levels. Very poor compaction/The compaction measured in our site visit/and the "ideal" compaction of 96% compaction. I felt that using a dry density of 132 pcf was unreasonable.
3. The walls still look fine after the weeks of light rain we've had. Drainage issues are fairly clearly discussed in the report and the owner has plans for drainage for the walls.

BACKGROUND

This is a request to obtain a hillside permit for the property located at 150 N. Donlee Drive, Lot 201, Valley View Heights Phase 2 (see Exhibit A, Final Plat). The applicant has put in a retaining wall along their rear property line, which is along the ridgeline above Bluff Street, to build up the property to make the yard more usable. The retaining wall was built without a hillside or building permit. After the retaining wall was built, the applicant hired a third-party engineer to evaluate the stability of the retaining wall. Please refer to Exhibit B to view the entire report

This hillside item has two purposes. The first is to determine if the retaining wall that was installed is structural sound, and if this Board agrees with the submitted engineering report found in Exhibit A. The second purpose is to mitigate the ridgeline setback issue. This property was subdivided before the hillside ordinance went into effect. According to the Ridgeline Map, this property is not located within the Cuesta (100' setback) or Plateau Ridge Line (50' setback); therefore, the ridgeline setback for this location is 30'. The location of the ridgeline has not been determined for this location. Please refer to the photos provided in Exhibit C.

APPLICABLE ORDINANCE(S) (Selected portions)

10-13A-6: Building Setbacks and Additional Design Standards:

- A. *Setbacks:* All setbacks shall conform to the underlying zone criteria except as provided herein. No structure or accessory structure shall be constructed within the setback area as defined below. However, a see-through wrought

iron fence with at least fifty percent (50%) of the fence open, landscaping, and a nonvertical swimming pool are permitted in the setback area.

1. *Ridgelines*: All ridgelines as shown on the ridgeline map shall be subject to the setback provisions contained herein. Setbacks from ridgelines not identified on the ridgeline map shall be a minimum of thirty feet (30'), or greater if recommended in the geotechnical reports.
 2. *Plateaus*: On plateaus, the setback from the ridgeline shall be a minimum of fifty feet (50') unless a greater setback is recommended in the geotechnical reports.
- C. *Cuesta*: Where a ridgeline occurs on a cuesta, the minimum setback shall be one hundred feet (100') measured normal (perpendicular) to the closest point of the ridge, unless a greater setback is recommended in the geotechnical report.
- D. *Additional Design Standards*:
1. Retaining walls shall be colored to blend into the surrounding natural geology.
 2. Retaining wall height is limited to the heights set forth in chapter 18 of this title and the standards for rock wall construction.
 3. Building exterior colors shall be earth tone and blend with the surrounding natural landscape.
 4. In residential zones, "no disturbance" areas shall be held as the "common area" of a project. Common areas shall be owned and maintained by the homeowners' association or may be deeded to the city when accepted by the city.
 5. In nonresidential zones, any "no disturbance" area shall be identified on the final site plan or final plat.
 6. Any required no disturbance area shall be identified on the ground with temporary fencing or other approved means to prevent accidental disturbance of the area during construction and such fencing shall be installed prior to issuance of a grading permit.
 7. The building site shall be located on the flattest portion of the parcel.
 8. No structure shall extend over any natural ridgeline. The structure shall be in contact with the ground at all edges. (Ord. 2019-10-002, 10-10-2019)

EXHIBITS PROVIDED

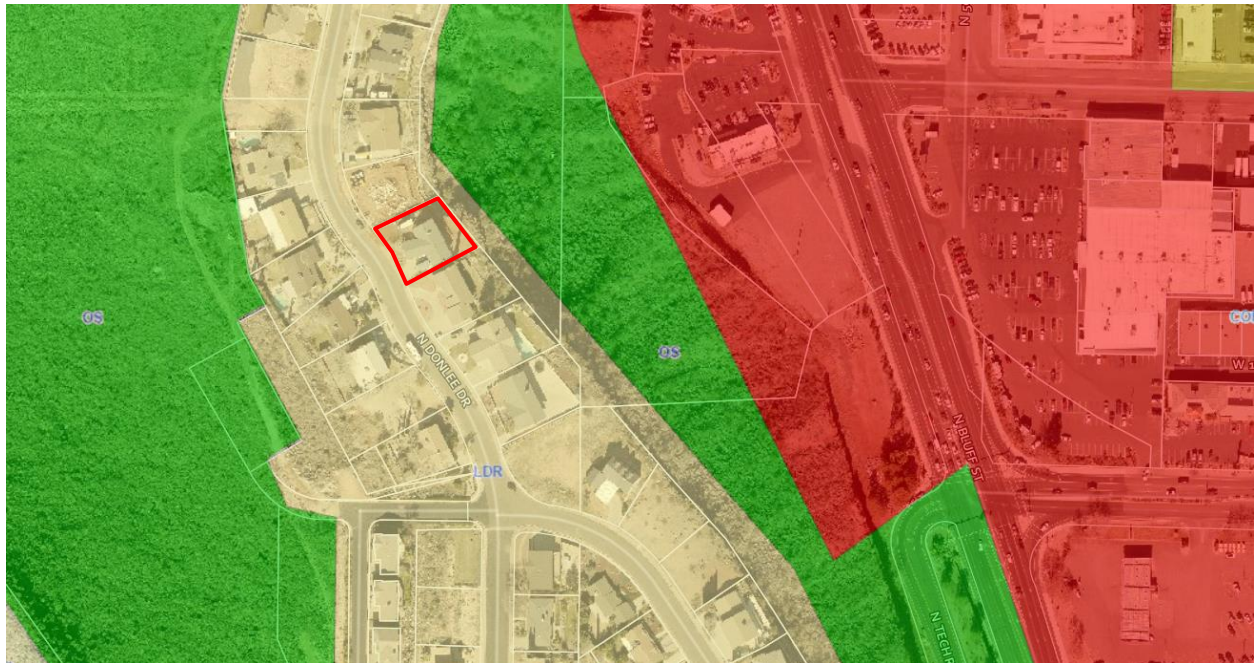
1. Exhibit A – Valley View Heights Phase 2 Final Plat
“Exhibit A” shows lot 201 of the final plat of Valley View Heights Phase 2
2. Exhibit B – Engineering Report
“Exhibit B” is a report made by Landmark engineers of the structural stability of the existing retaining wall
3. Exhibit C – Photos of the property before and after
“Exhibit C” are a collection of photos showing the location before and after the building of the retaining wall
4. Exhibit D – UPDATED Engineering Report
“Exhibit D” is an updated report (updated on 1/24/2023) by Landmark engineers to address the concerns that came up during the last hillside meeting

RECOMMENDATION

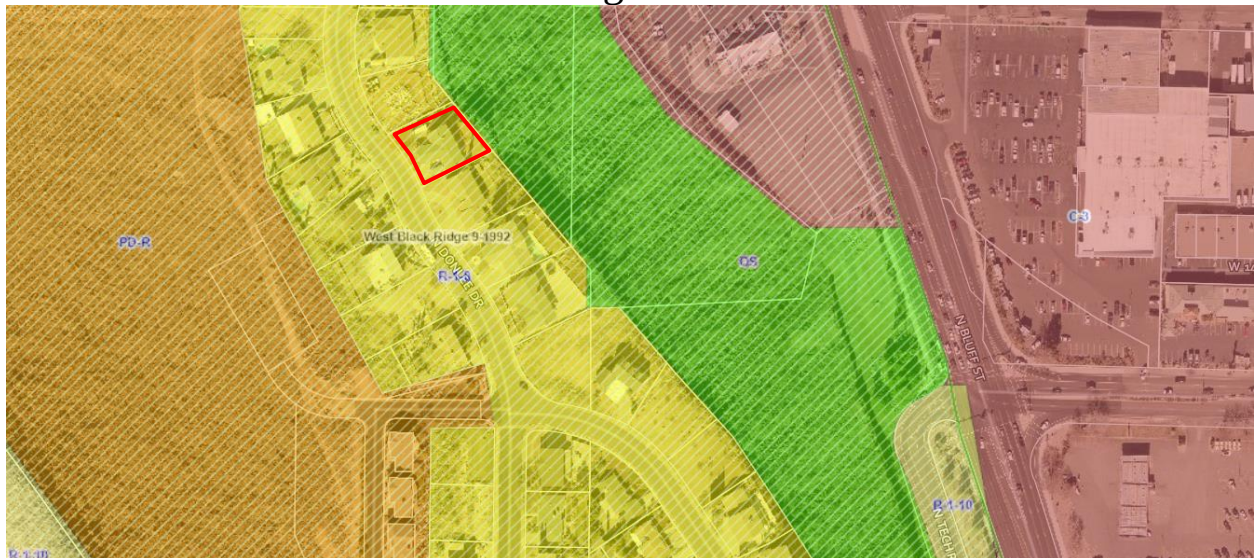
Staff recommends that the hillside review board evaluate the information provided to determine if the retaining wall built along the rear property line of 150 N, Donlee Drive is stable and whether any additional mitigation is necessary on look and location of this retaining wall.

This Board may recommend a Notice of Noncompliance letter be recorded against the property so that future owners will know that this retaining wall was erected without recommendation of this Board and without a building permit.

General Plan - COM



Zoning - R-1-8



CITY ENGINEER'S CERTIFICATE

I HEREBY CERTIFY THAT THIS OFFICE HAS REVIEWED THIS PLAT AND IT IS IN CONFORMITY WITH THE REQUIREMENTS OF PLAT IN THIS OFFICE.

DATE: 8-1-78

BY: Robert P. Gurdell
CITY ENGINEER

REMOVED BY: BUSH & GURGELL, INC.
100 WEST 100 EAST ST.
ST. GEORGE, UTAH 84770

APPROVAL OF PLANNING COMMISSION

ON THIS 22ND DAY OF JULY 1978, THE PLANNING COMMISSION OF THE CITY OF ST. GEORGE, UTAH, HAS REVIEWED THE ABOVE TITLED TRACT HEREIN SHOWN AND HAS APPROVED THE PLAT AND THE SUBDIVISION THEREOF.

DATE: 7-27-78

BY: Robert P. Gurdell
CITY ENGINEER

APPROVAL OF PLANNING AND ZONING ADMINISTRATION

I, ROBERT P. GURGELL, CITY ENGINEER, HAVE THIS DAY REVIEWED THE ABOVE TITLED TRACT HEREIN SHOWN AND HAS APPROVED THE PLAT AND THE SUBDIVISION THEREOF.

DATE: 7-27-78

BY: Robert P. Gurdell
CITY ENGINEER

VALLEY VIEW HEIGHTS-NO 2 SUBDIVISION

A SUBDIVISION OF A PORTION OF SECTIONS 24 AND 25, TOWNSHIP 41 SOUTH, RANGE 10 EAST AND MERIDIAN, ST. GEORGE, WASHINGTON COUNTY, UTAH

APPROVAL AND ACCEPTANCE BY CITY

WE, THE MAYOR AND CITY COUNCIL OF THE CITY OF ST. GEORGE, UTAH, HAVE REVIEWED THE ABOVE TITLED TRACT HEREIN SHOWN AND HAS APPROVED THE PLAT AND THE SUBDIVISION THEREOF.

DATE: 7-27-78

BY: Robert P. Gurdell
CITY ENGINEER

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DATE: 7-27-78

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CITY ENGINEER

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DATE: 7-27-78

BY: Robert P. Gurdell
CITY ENGINEER

Exhibit B

Retaining Wall Engineering Report

Exhibit C

Before and After Photos of the Project



Rear of House – Before



Rear of House - Before



Rear of House – Before



Rear of House – Google Earth



Rear of House – 11/21/2022



Rear of House – 11/21/2022



Rear of House – 11/21/2022



Rear of House – 11/21/2022

Exhibit D
UPDATED Retaining Wall Engineering Report



January 24, 2023

Ryan Davis
150 North Donlee Drive
St. George, Utah 84770

Subject: Concrete Block Wall Letter
150 North Donlee Drive
St. George, Utah
Landmark Project #220603

Ryan:

A Redi-Rock concrete block wall is under construction in the backyard of the residence at 150 North Donlee Drive in St. George, Utah. The wall is located near the top of a 160-foot-tall slope leading down to a parking lot on Bluff Street. A site visit by one of our engineers was completed to assess site conditions and to aid in a block wall analysis to assess the stability of the block wall.

ON-SITE VISIT

As part of the on-site visit, an engineer from Landmark and a field technician visited the site of the block wall on August 2, 2022, and completed soils density tests, dynamic cone penetrometer (DCP) tests, and measured the slope below the wall with a Smart Level.

We understand that the soil used as backfill for the wall consists of reject sand from the Bryce Christiansen Excavation pit. Lab testing on one sample from January 2022, Lab No.: 22SG0315, showed that a sample of reject sand had a maximum dry density of 131.2 pcf at an optimum moisture content of 8.7 percent.

Soil density tests were performed on samples of the imported backfill at or near the existing ground surface on both the upper and lower tiers of the wall. The tests showed that the soil had dry densities ranging from 103.0 to 123.2 pcf with an average dry density of 112.6 pcf. This indicates an average compaction of approximately 85.8 percent. The moisture content of the soil ranged from 3.3 to 13.7 percent with an average of 8.9 percent. The average in-place density of the soils, taking the moisture into account, was 122.6 pcf. A soil density sheet is attached to this letter.

Two dynamic cone penetrometer tests were performed on the soils adjacent to the soil density tests. One DCP test was performed on the backfill for each tier. When performing a DCP test, a 17.6-pound weight is dropped from a specified height multiple times to drive a cone tipped, metal rod into the ground. The penetration of the cone rod per blow is correlated to California Bearing Ratio (CBR) values.

The cone was driven deeper into the ground than the soil density testing was able to measure. The DCP testing was completed to show the density of the soil at depth compared to the surficial soils.

The testing shows that the CBR values stayed relatively consistent with depth in the lower tier and decreased with depth in the upper tier. This indicates that the soils down to the maximum depth of the DCP testing (approximately 34 inches) in the lower tier were compacted in a similar manner to the surficial soils. The CBR values in the upper tier tended to decrease with depth from 24 down to 7. This indicates that the surficial soils may have been compacted more than soils at depth. Therefore, it is assumed that the soils throughout the backfill were not compacted to the average moist unit weight of 122.6 pcf. DCP test sheets are attached to this letter.

The slope below the bottom tier of the block wall was measured with a smart level to be 40 degrees down to the east.

It was observed that the blocks used for the block walls were Redi Rock blocks that were 41 inches deep. The lower tier was observed to be 10.5 feet in height at its highest point. The bench between walls was measured to be 8 feet. The upper tier was observed to be 9 feet in height.

Basalt bedrock was observed to be located immediately below the bottom tier of the wall. The basalt appears to slope up to the level of the house at the top of the upper tier of the block wall.

INTERNAL STABILITY ANALYSIS

Using the Redi Rock Wall+ program, block wall analyses were performed based on the density tests, DCP tests, soil used as backfill and the wall configuration. It is our understanding that the walls were not constructed with geogrid reinforcement, and therefore, were analyzed as gravity retaining walls. The Redi Rock Wall+ program does not allow for designing two tiered walls. Therefore, the lower tier was designed with a surcharge of 1,080 psf, representing the upper tier.

Based on our on-site testing, we anticipate that the soils on-site have an average in place moist density of 122.6 pcf. Our laboratory testing shows that reject sand from the BCX pit has a maximum dry density of approximately 130 pcf. We anticipate that the internal friction angle of the reject sand to be approximately 32 degrees.

Three wall analyses were performed. One analysis was conservative with using soils with a dry density of 100 pcf (76.9% compaction) with an internal friction angle of 28 degrees. A second analysis was performed using soil conditions encountered on-site with a dry density of 112.6 pcf and an internal friction angle of 31 degrees. A third analysis was performed using ideal conditions for the soils used behind the wall with a dry density of 126 pcf (96% compaction) and an internal friction angle of 32 degrees. The factors of safety in both static and seismic conditions for each wall analysis are shown in the following table:

Unit Weight, pcf Friction Angle, deg.	Factors of Safety for Entire Wall (Static/Seismic)					
	Overturning Stability		Slip		Bearing Capacity	
	Static	Seismic	Static	Seismic	Static	Seismic
100/28 (Conservative)	1.52	1.25	4.06	2.48	3.74	2.11
112.6/31 (Actual)	1.66	1.34	4.87	3.02	4.36	2.70
126/32 (Ideal)	1.69	1.35	4.95	3.03	4.43	2.72

Printouts of the analyses are shown in Appendix A.

SECOND SITE VISIT

The St. George, Utah area has received light rain over the course of several weeks starting in the end of 2022 and ending in the beginning of 2023. On January 13, 2023, an engineer from Landmark visited the project site to observe the block wall conditions after several weeks of rain. It was observed that the surficial soil was very moist to wet. The block walls were observed to be at approximately the same slope as they were during the first site visit. The slope of the wall was not measured with a smart level during either visit.

It is the opinion of Landmark that the wall has not experienced movement with the increased hydrostatic pressure from the recent rain. Landmark makes no statement as to the stability of the wall under increased hydrostatic pressure from excessive rain. We recommend that surficial water be graded away from the retaining walls. We understand that the owner has plans to install a drainpipe on the lower tier that will drain water down to the north of the wall. Additionally, the upper tier will have a channel which will catch surface water and direct it to the north of the wall. A picture of the block with a channel is attached to this letter.

SUMMARY and RECOMMENDATIONS

Given the soil conditions recorded during our site visits and the factors of safety shown in our wall analyses, it is the opinion of Landmark Testing and Engineering that the block walls as constructed meet minimum factors of safety and will function as intended, provided water is directed away from the wall backfill and hydrostatic pressures in the backfill are minimalized.

Typical moisture control recommendations include, but are not limited to, grading the ground surface to drain surficial water away from the walls and limiting vegetation on or adjacent to the walls.

We understand that a pool is to be built behind the upper tier of the wall. We recommend that the pool be located as far from the residence and wall as possible, and a minimum of 10 feet from the rear face of the block in the upper wall. A leak in the pool poses a significant risk to the stability of the walls. It should be understood that Landmark does not recommend the construction of pools. However, if the pool is to be built behind the wall despite our recommendation, strict moisture control recommendations should be followed. These recommendations include but are not limited to the following:

- The pool should be located a minimum of 10 feet from the retaining wall and existing structure.
- Plumbing is a significant source of leaks. All plumbing should be fully leak tested and approved prior to filling of the pool.
- The water level in the pool should be strictly monitored and consideration should be given for installing a leak monitoring system. Any leaks should be repaired immediately.
- Consideration should be given to installing an impermeable membrane beneath and extending up the sides of the pool.

- We recommend concrete flatwork with drains surrounding the pool to drain surface water away from the pool, wall, and other structures.

Our services for this letter did not include a soils investigation beneath the pool. Construction of the pool is to be completed by the contractor according to best industry practices. Construction, maintenance, ownership, and all consequences associated with the pool are to be accepted by the pool owner.

Landmark did not design the concrete block retaining walls, nor complete construction testing during their construction. Our services consist only of the information found in this letter, and this letter should not be considered a Letter of Compliance nor an acceptance of liability.

If you have any questions or would like to discuss this project, please contact the undersigned at (435) 986-0566.

Sincerely,

LANDMARK TESTING & ENGINEERING

Kent Nelson, P.E.
Project Engineer



Reviewed by:



A handwritten signature in black ink, likely belonging to Steven Wells.

Steven Wells, P.E.
Geotechnical Manager



Client: Ryan Davis Address: 150 North Donlee Drive St George, UT 84770					Project : 150 North Donlee Drive Project No.: 220603 Date Tested: 8/2/2022							
Nuc. Gauge Make:		Troxler	Standard Ct.	1884/647	Model:	3440	Serial #:	36296	Calibration Date:		11/12/2021	
Test No.	Station / Location: House Pad			Elevation	Material Type	Moisture Content %	Dry Density PCF	Max. Density PCF	Optimum Moisture %	Relative Comp. %	Spec. Comp. %	Remarks P/F
1	Upper Tier: 5 ft North of South End			3 FT BFG	ISF	4.5	123.2	131.2	8.7	93.9%		
2	Upper Tier: 10 ft North of South End			3 FT BFG	ISF	3.3	116.7	131.2	8.7	88.9%		
3	Upper Tier: 15 ft North of South End			3 FT BFG	ISF	11.8	103.0	131.2	8.7	78.5%		
4	Lower Tier: 10 ft North of South End			FG	ISF	11.1	109.0	131.2	8.7	83.1%		
5	Lower Tier: 5 ft North of South End			FG	ISF	13.7	111.0	131.2	8.7	84.6%		



Dynamic Cone Penetrometer

Project: 150 North Donlee Drive
 Project #: 220603
 Sample Location: DCP-2

Date: 9/2/2022
 Tested By: K. Nelson
 Hammer Wt: 17.6 lb

Soil Classification: SILTY SAND (SM)

Water Table Depth: Not Encountered

Number of Blows	Cumulative Penetration, mm	Penetration Between Readings, mm	Penetration per Blow, mm	Hammer Factor	DCP Index, mm/blow	CBR %
Initial	300					
5	430	130	26	1	26	10
5	530	100	20	1	20	13
5	570	40	8	1	8	34
5	635	65	13	1	13	20
5	690	55	11	1	11	24
5	735	45	9	1	9	30
5	790	55	11	1	11	24
5	890	100	20	1	20	13
5	990	100	20	1	20	13
5	1025	35	7	1	7	39
5	1050	25	5	2	5	55
5	1100	50	10	3	10	26
5	1170	70	14	1	14	19

Tabulated Corelation of CBR vs. DCP Index

DCP Index mm/blow	CBR %	DCP Index mm/blow	CBR %	DCP Index mm/blow	CBR %
<3	100	39	4.8	69-71	2.5
3	80	40	4.7	72-74	2.4
4	60	41	4.6	75-77	2.3
5	50	42	4.4	78-80	2.2
6	40	43	4.3	81-83	2.1
7	35	44	4.2	84-87	2.0
8	30	45	4.1	88-91	1.9
9	25	46	4.0	92-96	1.8
10-11	20	47	3.9	97-101	1.7
12	18	48	3.8	102-107	1.6
13	16	49-50	3.7	108-114	1.5
14	15	51	3.6	115-121	1.4
15	14	52	3.5	112-130	1.3
16	13	53-54	3.4	131-140	1.2
17	12	55	3.3	141-152	1.1
18-19	11	56-57	3.2	153-166	1.0
20-21	10	58	3.1	167-183	0.9
22-23	9	59-60	3.0	184-205	0.8
24-26	8	61-62	2.9	206-233	0.7
27-29	7	63-64	2.8	234-271	0.6
30-34	6	65-66	2.7	272-234	0.5
35-38	5	67-68	2.6	>324	<0.5

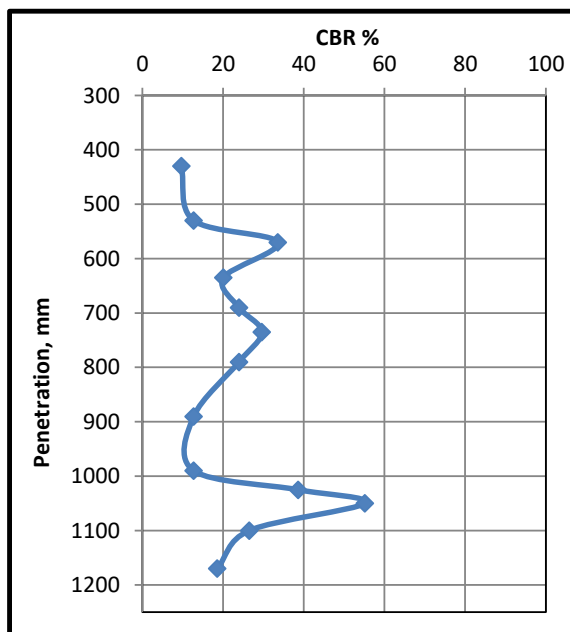


FIGURE 4



Dynamic Cone Penetrometer

Project: 150 North Donlee Drive
 Project #: 220603
 Sample Location: Upper Tier
 Soil Classification: SILTY SAND (SM)

Date: 9/2/2022
 Tested By: K. Nelson
 Hammer Wt: 17.6 lb
 Water Table Depth: Not Encountered

Number of Blows	Cumulative Penetration, mm	Penetration Between Readings, mm	Penetration per Blow, mm	Hammer Factor	DCP Index, mm/blow	CBR %
Initial	270					
5	325	55	11	1	11	24
5	395	70	14	1	14	19
5	470	75	15	1	15	17
5	560	90	18	1	18	14
5	740	180	36	1	36	7
5	790	50	10	1	10	26
5	805	15	3	1	3	95
	Refusal					

Tabulated Correlation of CBR vs. DCP Index

DCP Index mm/blow	CBR %	DCP Index mm/blow	CBR %	DCP Index mm/blow	CBR %
<3	100	39	4.8	69-71	2.5
3	80	40	4.7	72-74	2.4
4	60	41	4.6	75-77	2.3
5	50	42	4.4	78-80	2.2
6	40	43	4.3	81-83	2.1
7	35	44	4.2	84-87	2.0
8	30	45	4.1	88-91	1.9
9	25	46	4.0	92-96	1.8
10-11	20	47	3.9	97-101	1.7
12	18	48	3.8	102-107	1.6
13	16	49-50	3.7	108-114	1.5
14	15	51	3.6	115-121	1.4
15	14	52	3.5	112-130	1.3
16	13	53-54	3.4	131-140	1.2
17	12	55	3.3	141-152	1.1
18-19	11	56-57	3.2	153-166	1.0
20-21	10	58	3.1	167-183	0.9
22-23	9	59-60	3.0	184-205	0.8
24-26	8	61-62	2.9	206-233	0.7
27-29	7	63-64	2.8	234-271	0.6
30-34	6	65-66	2.7	272-234	0.5
35-38	5	67-68	2.6	>324	<0.5

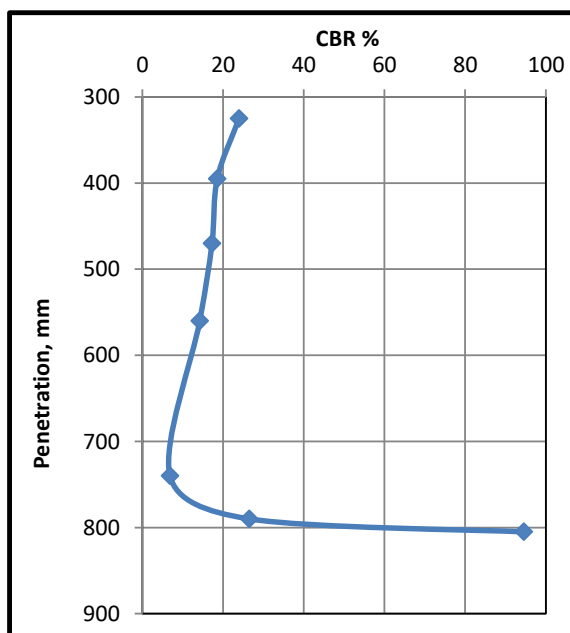




Photo 1: Blocks to be used on top of upper tier

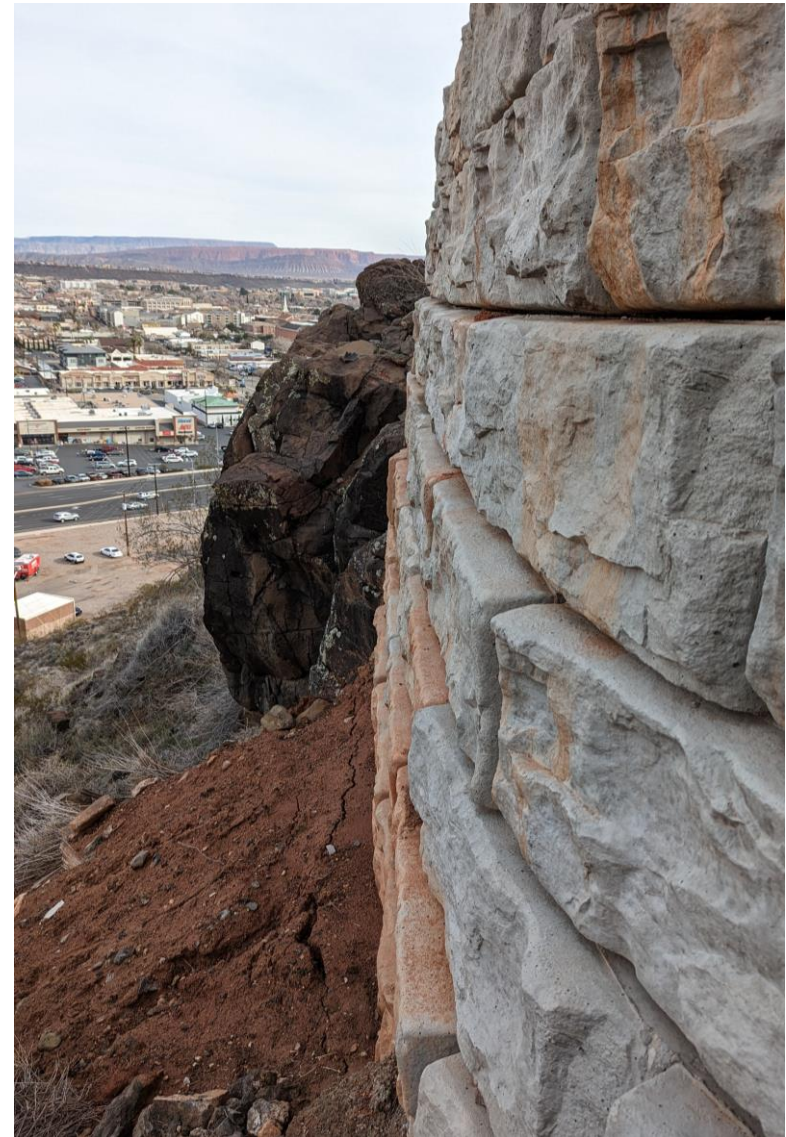


Photo 2: Lower tier after weeks of light rain

APPENDIX A

Analysis of Redi Rock wall

Input data

Task : 220603 - 150 North Donlee Drive Block Walls
 Part : Two 8-foot Block Walls
 Customer : Ryan Davis
 Author : Kent Nelson
 Date : 9/12/2022
 Project ID : 150 North Donlee Drive
 Project number : 220603

Settings

(input for current task)

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 :	$SF_o =$	1.00	[-]
Safety factor for sliding resistance :	$SF_s =$	1.00	[-]
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	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength $F_{\min}$ [lbf/ft]	Max. shear strength $F_{\max}$ [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	5	1.62
2	Block 41	1	1.62
3	Top block 28	1	-

Base

Geometry

Upper setback $a_1 = 0.00$ ftLower setback $a_2 = 1.00$ ftHeight $h = 1.00$ ftWidth $b = 5.00$ ft

Material

Soil creating foundation - Basalt

Basic soil parameters

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	Sand		28.00	0.0	100.00	46.50	28.00

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	Basalt		35.00	5000.0	140.00	77.50	35.00

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

Soil parameters

Sand

Unit weight : $\gamma = 100.0$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 28.00^\circ$
 Cohesion of soil : $c_{ef} = 0.0$ psf
 Angle of friction struc.-soil : $\delta = 28.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 109.0$ pcf

Basalt

Unit weight : $\gamma = 140.0$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 5000.0$ psf
 Angle of friction struc.-soil : $\delta = 35.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 140.0$ pcf

Backfill

Assigned soil : Sand

Slope = 40.00°

Geological profile and assigned soils

Position information

GPS : N 37.1111400; W 113.5966200
 N 37°6'40.10"; W 113°35'47.83"

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Basalt	

Terrain profile

Terrain behind construction has the slope 1: 8.00 (slope angle is 7.13°).

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	change	Action	Mag.1 [lb/ft ²]	Mag.2 [lb/ft ²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	1000.0				on terrain

Resistance on front face of the structure

Resistance on front face of the structure: at rest

Soil on front face of the structure - Sand

Soil thickness in front of structure $h = 1.00$ ft

Soil slope in front of structure $\beta = -35.00^\circ$

Applied forces acting on the structure

No.	Force new edit	Name	Action	F _x [lb/ft]	F _z [lb/ft]	M [lbfft/ft]	x [ft]	z [ft]
1	Yes	Force No. 1	permanent	0.00	1000.00	0.0	8.00	0.00

EarthquakeFactor of horizontal acceleration $K_h = 0.1100$ Factor of vertical acceleration $K_v = 0.0000$

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : permanent

Reduction of soil/soil friction angle : reduce to $2/3 \varphi$ (AASHTO)**Verification No. 1****Earthquake effects (active earth pressure) - partial results**

Layer No.	Thickness [ft]	Φ_d [°]	β [°]	ψ [°]	K_a	K_{ae}	$K_{ae}-K_a$	Comment
1	0.24	28.00	7.13	6.28	0.678	0.833	0.155	
2	0.42	28.00	7.13	6.28	0.678	0.833	0.155	
3	1.08	28.00	7.13	6.28	0.678	0.833	0.155	
4	7.93	28.00	7.13	6.28	0.317	0.421	0.105	
5	1.07	28.00	7.13	6.28	0.678	0.833	0.155	
6	1.00	35.00	7.13	6.28	0.272	0.364	0.092	

Earthquake effects (active earth pressure)

Layer No.	Start [ft] End [ft]	σ_z [psf]	σ_D [psf]	Pressure [psf]	Hor. comp. [psf]	Vertical comp. [psf]
1	-0.24	0.0	1214.3	188.0	131.6	134.3
	0.00	24.3	1190.0	184.3	129.0	131.6
2	0.00	24.3	1190.0	184.3	129.0	131.6
	0.42	65.9	1148.3	177.8	124.5	127.0
3	0.42	65.9	1148.3	177.8	124.5	127.0
	1.50	174.3	1040.0	161.0	112.7	115.0
4	1.50	174.3	1040.0	108.7	99.6	43.7
	9.43	967.0	247.3	25.9	23.7	10.4
5	9.43	967.0	247.3	38.3	26.8	27.3
	10.50	1074.3	140.0	21.7	15.2	15.5
6	10.50	1074.3	140.0	12.9	10.6	7.4
	11.50	1214.3	0.0	0.0	0.0	0.0

Forces acting on construction

Name	F _{hor} [lb/ft]	App.Pt. z [ft]	F _{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.12	4673.1	2.94	1.000
Earthq.- constr.	513.4	-5.18	0.0	2.95	1.000
FF resistance	-15.7	-0.33	0.0	0.00	1.000
Weight - earth wedge	0.0	-1.36	33.5	4.61	1.000
Earthquake - soil wedge	3.7	-1.36	0.0	4.61	1.000

Kent Nelson

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - earth wedge	0.0	-11.02	183.7	3.78	1.000
Earthquake - soil wedge	20.2	-11.02	0.0	3.78	1.000
Active pressure	1904.3	-4.34	1179.7	4.71	1.000
Earthq.- act.pressure	729.2	-7.82	458.2	4.71	1.000
Surch.1 - surface	3636.5	-6.51	2524.7	4.72	1.000
Surch.1 - surface	0.0	-11.62	1939.0	3.20	1.000
Force No. 1	0.0	-11.50	1000.0	10.23	1.000

Verification of complete wall

Check for overturning stability

Resisting moment $M_{res} = 50658.3 \text{ lbfft/ft}$

Overturning moment $M_{ovr} = 40521.7 \text{ lbfft/ft}$

Safety factor = 1.25 > 1.00

Wall for overturning is SATISFACTORY

Check for slip

Resisting horizontal force $H_{res} = 16849.64 \text{ lb/ft}$

Active horizontal force $H_{act} = 6791.50 \text{ lb/ft}$

Safety factor = 2.48 > 1.00

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.93	3973.1	2.02	1.000
Earthq.- constr.	446.0	-4.89	0.0	2.02	1.000
Weight - earth wedge	0.0	-10.02	183.7	2.78	1.000
Earthquake - soil wedge	20.2	-10.02	0.0	2.78	1.000
Active pressure	1701.5	-3.68	788.7	3.64	1.000
Earthq.- act.pressure	574.3	-7.27	360.4	3.71	1.000
Surch.1 - surface	3437.8	-5.79	1989.8	3.67	1.000
Surch.1 - surface	0.0	-10.62	1939.0	2.20	1.000
Force No. 1	0.0	-10.50	1000.0	9.23	1.000

Verification of block No. 1

Check for overturning stability

Resisting moment $M_{res} = 33549.2 \text{ lbfft/ft}$

Overturning moment $M_{ovr} = 32736.1 \text{ lbfft/ft}$

Safety factor = 1.02 > 1.00

Joint for overturning stability is SATISFACTORY

Check for slipResisting horizontal force $H_{res} = 7960.85$ lbf/ftActive horizontal force $H_{act} = 6179.79$ lbf/ft

Safety factor = 1.29 > 1.00

Joint for verification 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	19843.6	11992.04	6791.50	0.331	7093.6

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	19843.6	11992.04	6791.50

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verificationMax. eccentricity of normal force $e = 0.331$ Maximum allowable eccentricity $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY****Verification of bearing capacity**Max. stress at footing bottom $\sigma = 7093.6$ psfBearing capacity of foundation soil $R_d = 15000.0$ psf

Safety factor = 2.11 > 2.00

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

Analysis of Redi Rock wall

Input data

Task : 220603 - 150 North Donlee Drive Block Walls
 Part : Two 8-foot Block Walls
 Customer : Ryan Davis
 Author : Kent Nelson
 Date : 9/12/2022
 Project ID : 150 North Donlee Drive
 Project number : 220603

Settings

(input for current task)

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 :	$SF_o =$	1.00	[-]
Safety factor for sliding resistance :	$SF_s =$	1.00	[-]
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	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength $F_{\min}$ [lbf/ft]	Max. shear strength $F_{\max}$ [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	5	1.62
2	Block 41	1	1.62
3	Top block 28	1	-

Base

Geometry

Upper setback $a_1 = 0.00$ ftLower setback $a_2 = 1.00$ ftHeight $h = 1.00$ ftWidth $b = 5.00$ ft

Material

Soil creating foundation - Basalt

Basic soil parameters

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	Sand		28.00	0.0	100.00	46.50	28.00

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	Basalt		35.00	5000.0	140.00	77.50	35.00

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

Soil parameters

Sand

Unit weight : $\gamma = 100.0$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 28.00^\circ$
 Cohesion of soil : $c_{ef} = 0.0$ psf
 Angle of friction struc.-soil : $\delta = 28.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 109.0$ pcf

Basalt

Unit weight : $\gamma = 140.0$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 5000.0$ psf
 Angle of friction struc.-soil : $\delta = 35.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 140.0$ pcf

Backfill

Assigned soil : Sand

Slope = 40.00°

Geological profile and assigned soils

Position information

GPS : N 37.1111400; W 113.5966200
 N 37°6'40.10"; W 113°35'47.83"

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Basalt	

Terrain profile

Terrain behind construction has the slope 1: 8.00 (slope angle is 7.13°).

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	change	Action	Mag.1 [lb/ft ²]	Mag.2 [lb/ft ²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	1000.0				on terrain

Resistance on front face of the structure

Resistance on front face of the structure: at rest

Soil on front face of the structure - Sand

Soil thickness in front of structure $h = 1.00$ ft

Soil slope in front of structure $\beta = -35.00^\circ$

Applied forces acting on the structure

No.	Force new edit	Name	Action	F _x [lb/ft]	F _z [lb/ft]	M [lbfft/ft]	x [ft]	z [ft]
1	Yes	Force No. 1	permanent	0.00	1000.00	0.0	8.00	0.00

EarthquakeFactor 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 : permanent

Reduction of soil/soil friction angle : reduce to $2/3 \varphi$ (AASHTO)**Verification No. 1****Earthquake effects (active earth pressure) - partial results**

Layer No.	Thickness [ft]	φ_d [°]	β [°]	ψ [°]	K_a	K_{ae}	$K_{ae}-K_a$	Comment
1	0.24	28.00	7.13	0.00	0.678	0.678	0.000	
2	0.42	28.00	7.13	0.00	0.678	0.678	0.000	
3	1.08	28.00	7.13	0.00	0.678	0.678	0.000	
4	7.93	28.00	7.13	0.00	0.317	0.317	0.000	
5	1.07	28.00	7.13	0.00	0.678	0.678	0.000	
6	1.00	35.00	7.13	0.00	0.272	0.272	0.000	

Earthquake effects (active earth pressure)

Layer No.	Start [ft] End [ft]	σ_z [psf]	σ_D [psf]	Pressure [psf]	Hor. comp. [psf]	Vertical comp. [psf]
1	-0.24	0.0	1214.3	0.0	0.0	0.0
	0.00	24.3	1190.0	0.0	0.0	0.0
2	0.00	24.3	1190.0	0.0	0.0	0.0
	0.42	65.9	1148.3	0.0	0.0	0.0
3	0.42	65.9	1148.3	0.0	0.0	0.0
	1.50	174.3	1040.0	0.0	0.0	0.0
4	1.50	174.3	1040.0	0.0	0.0	0.0
	9.43	967.0	247.3	0.0	0.0	0.0
5	9.43	967.0	247.3	0.0	0.0	0.0
	10.50	1074.3	140.0	0.0	0.0	0.0
6	10.50	1074.3	140.0	0.0	0.0	0.0
	11.50	1214.3	0.0	0.0	0.0	0.0

Forces acting on construction

Name	F _{hor} [lb/ft]	App.Pt. z [ft]	F _{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.12	4673.1	2.94	1.000
Earthq.- constr.	0.0	-5.18	0.0	2.95	1.000
FF resistance	-15.7	-0.33	0.0	0.00	1.000
Weight - earth wedge	0.0	-1.36	33.5	4.61	1.000
Earthquake - soil wedge	0.0	-1.36	0.0	4.61	1.000

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - earth wedge	0.0	-11.02	183.7	3.78	1.000
Earthquake - soil wedge	0.0	-11.02	0.0	3.78	1.000
Active pressure	1904.3	-4.34	1179.7	4.71	1.000
Earthq.- act.pressure	0.0	-11.50	0.0	4.17	1.000
Surch.1 - surface	3636.5	-6.51	2524.7	4.72	1.000
Surch.1 - surface	0.0	-11.62	1939.0	3.20	1.000
Force No. 1	0.0	-11.50	1000.0	10.23	1.000

Verification of complete wall**Check for overturning stability**Resisting moment $M_{res} = 48500.7$ lbfft/ftOverturning moment $M_{ovr} = 31927.6$ lbfft/ft

Safety factor = 1.52 > 1.00

Wall for overturning is SATISFACTORY**Check for slip**Resisting horizontal force $H_{res} = 22445.23$ lb/ftActive horizontal force $H_{act} = 5525.03$ lb/ft

Safety factor = 4.06 > 1.00

Wall for slip is SATISFACTORY**Overall check - WALL is SATISFACTORY****Dimensioning No. 1****Forces acting on construction**

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.93	3973.1	2.02	1.000
Earthq.- constr.	0.0	-4.89	0.0	2.02	1.000
Weight - earth wedge	0.0	-10.02	183.7	2.78	1.000
Earthquake - soil wedge	0.0	-10.02	0.0	2.78	1.000
Active pressure	1701.5	-3.68	788.7	3.64	1.000
Earthq.- act.pressure	0.0	-10.50	0.0	3.17	1.000
Surch.1 - surface	3437.8	-5.79	1989.8	3.67	1.000
Surch.1 - surface	0.0	-10.62	1939.0	2.20	1.000
Force No. 1	0.0	-10.50	1000.0	9.23	1.000

Verification of block No. 1**Check for overturning stability**Resisting moment $M_{res} = 32213.7$ lbfft/ftOverturning moment $M_{ovr} = 26179.3$ lbfft/ft

Safety factor = 1.23 > 1.00

Joint for overturning stability is SATISFACTORY

Check for slipResisting horizontal force $H_{res} = 13025.33 \text{ lbf/ft}$ Active horizontal force $H_{act} = 5139.33 \text{ lbf/ft}$

Safety factor = 2.53 > 1.00

Joint for verification 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	12261.4	11533.82	5525.03	0.213	4013.4

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	12261.4	11533.82	5525.03

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verificationMax. eccentricity of normal force $e = 0.213$ Maximum allowable eccentricity $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY****Verification of bearing capacity**Max. stress at footing bottom $\sigma = 4013.4 \text{ psf}$ Bearing capacity of foundation soil $R_d = 15000.0 \text{ psf}$

Safety factor = 3.74 > 2.00

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

Analysis of Redi Rock wall

Input data

Task : 220603 - 150 North Donlee Drive Block Walls
 Part : Two 8-foot Block Walls
 Customer : Ryan Davis
 Author : Kent Nelson
 Date : 9/12/2022
 Project ID : 150 North Donlee Drive
 Project number : 220603

Settings

(input for current task)

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 :	$SF_o =$	1.00	[-]
Safety factor for sliding resistance :	$SF_s =$	1.00	[-]
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	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength $F_{\min}$ [lbf/ft]	Max. shear strength $F_{\max}$ [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	5	1.62
2	Block 41	1	1.62
3	Top block 28	1	-

Base

Geometry

Upper setback $a_1 = 0.00$ ftLower setback $a_2 = 1.00$ ftHeight $h = 1.00$ ftWidth $b = 5.00$ ft

Material

Soil creating foundation - Basalt

Basic soil parameters

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	Sand		31.00	0.0	112.60	50.10	29.00

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	Basalt		35.00	5000.0	140.00	77.50	35.00

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

Soil parameters

Sand

Unit weight : $\gamma = 112.6$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 31.00^\circ$
 Cohesion of soil : $c_{ef} = 0.0$ psf
 Angle of friction struc.-soil : $\delta = 29.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 112.6$ pcf

Basalt

Unit weight : $\gamma = 140.0$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 5000.0$ psf
 Angle of friction struc.-soil : $\delta = 35.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 140.0$ pcf

Backfill

Assigned soil : Sand

Slope = 40.00°

Geological profile and assigned soils

Position information

GPS : N 37.1111400; W 113.5966200
 N 37°6'40.10"; W 113°35'47.83"

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Basalt	

Terrain profile

Terrain behind construction has the slope 1: 8.00 (slope angle is 7.13°).

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	change	Action	Mag.1 [lb/ft ²]	Mag.2 [lb/ft ²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	1000.0				on terrain

Resistance on front face of the structure

Resistance on front face of the structure: at rest

Soil on front face of the structure - Sand

Soil thickness in front of structure $h = 1.00$ ft

Soil slope in front of structure $\beta = -35.00^\circ$

Applied forces acting on the structure

No.	Force new edit	Name	Action	F _x [lb/ft]	F _z [lb/ft]	M [lbfft/ft]	x [ft]	z [ft]
1	Yes	Force No. 1	permanent	0.00	1000.00	0.0	8.00	0.00

EarthquakeFactor of horizontal acceleration $K_h = 0.1100$ Factor of vertical acceleration $K_v = 0.0000$

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : permanent

Reduction of soil/soil friction angle : reduce to $2/3 \varphi$ (AASHTO)**Verification No. 1****Earthquake effects (active earth pressure) - partial results**

Layer No.	Thickness [ft]	Φ_d [°]	β [°]	ψ [°]	K_a	K_{ae}	$K_{ae}-K_a$	Comment
1	0.25	31.00	7.13	6.28	0.622	0.765	0.144	
2	0.42	31.00	7.13	6.28	0.622	0.765	0.144	
3	1.08	31.00	7.13	6.28	0.622	0.765	0.144	
4	7.89	31.00	7.13	6.28	0.278	0.372	0.093	
5	1.11	31.00	7.13	6.28	0.622	0.765	0.144	
6	1.00	35.00	7.13	6.28	0.272	0.364	0.092	

Earthquake effects (active earth pressure)

Layer No.	Start [ft] End [ft]	σ_z [psf]	σ_D [psf]	Pressure [psf]	Hor. comp. [psf]	Vertical comp. [psf]
1	-0.25	0.0	1350.0	194.1	133.0	141.4
	0.00	27.7	1322.3	190.1	130.3	138.5
2	0.00	27.7	1322.3	190.1	130.3	138.5
	0.42	74.6	1275.4	183.4	125.6	133.6
3	0.42	74.6	1275.4	183.4	125.6	133.6
	1.50	196.6	1153.4	165.9	113.6	120.8
4	1.50	196.6	1153.4	107.5	97.7	44.9
	9.39	1085.4	264.6	24.7	22.4	10.3
5	9.39	1085.4	264.6	38.0	26.1	27.7
	10.50	1210.0	140.0	20.1	13.8	14.7
6	10.50	1210.0	140.0	12.9	10.6	7.4
	11.50	1350.0	0.0	0.0	0.0	0.0

Forces acting on construction

Name	F _{hor} [lb/ft]	App.Pt. z [ft]	F _{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.12	4673.1	2.94	1.000
Earthq.- constr.	513.4	-5.18	0.0	2.95	1.000
FF resistance	-18.0	-0.33	0.0	0.00	1.000
Weight - earth wedge	0.0	-1.37	38.9	4.61	1.000
Earthquake - soil wedge	4.3	-1.37	0.0	4.61	1.000

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - earth wedge	0.0	-11.02	209.9	3.79	1.000
Earthquake - soil wedge	23.1	-11.02	0.0	3.79	1.000
Active pressure	1893.7	-4.32	1241.3	4.71	1.000
Earthq.- act.pressure	716.8	-7.88	474.1	4.71	1.000
Surch.1 - surface	3211.4	-6.51	2363.2	4.72	1.000
Surch.1 - surface	0.0	-11.62	1967.9	3.21	1.000
Force No. 1	0.0	-11.50	1000.0	10.23	1.000

Verification of complete wall**Check for overturning stability**Resisting moment $M_{res} = 50530.5$ lbfft/ftOverturning moment $M_{ovr} = 37653.0$ lbfft/ft

Safety factor = 1.34 > 1.00

Wall for overturning is SATISFACTORY**Check for slip**Resisting horizontal force $H_{res} = 19139.86$ lb/ftActive horizontal force $H_{act} = 6344.64$ lb/ft

Safety factor = 3.02 > 1.00

Wall for slip is SATISFACTORY**Overall check - WALL is SATISFACTORY****Dimensioning No. 1****Forces acting on construction**

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.93	3973.1	2.02	1.000
Earthq.- constr.	446.0	-4.89	0.0	2.02	1.000
Weight - earth wedge	0.0	-10.02	209.9	2.79	1.000
Earthquake - soil wedge	23.1	-10.02	0.0	2.79	1.000
Active pressure	1673.5	-3.69	813.8	3.65	1.000
Earthq.- act.pressure	577.6	-7.29	381.0	3.71	1.000
Surch.1 - surface	3019.5	-5.82	1837.6	3.68	1.000
Surch.1 - surface	0.0	-10.62	1967.9	2.21	1.000
Force No. 1	0.0	-10.50	1000.0	9.23	1.000

Verification of block No. 1**Check for overturning stability**Resisting moment $M_{res} = 33339.2$ lbfft/ftOverturning moment $M_{ovr} = 30385.4$ lbfft/ft

Safety factor = 1.10 > 1.00

Joint for overturning stability is SATISFACTORY

Check for slipResisting horizontal force $H_{res} = 10031.06$ lbf/ftActive horizontal force $H_{act} = 5739.71$ lbf/ft

Safety factor = 1.75 > 1.00

Joint for verification 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	17043.9	11968.55	6344.64	0.285	5561.9

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	17043.9	11968.55	6344.64

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verificationMax. eccentricity of normal force $e = 0.285$ Maximum allowable eccentricity $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY****Verification of bearing capacity**Max. stress at footing bottom $\sigma = 5561.9$ psfBearing capacity of foundation soil $R_d = 15000.0$ psf

Safety factor = 2.70 > 2.00

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

Analysis of Redi Rock wall

Input data

Task : 220603 - 150 North Donlee Drive Block Walls
 Part : Two 8-foot Block Walls
 Customer : Ryan Davis
 Author : Kent Nelson
 Date : 9/12/2022
 Project ID : 150 North Donlee Drive
 Project number : 220603

Settings

(input for current task)

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 :	$SF_o =$	1.00	[-]
Safety factor for sliding resistance :	$SF_s =$	1.00	[-]
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	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength $F_{\min}$ [lbf/ft]	Max. shear strength $F_{\max}$ [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	5	1.62
2	Block 41	1	1.62
3	Top block 28	1	-

Base

Geometry

Upper setback $a_1 = 0.00$ ftLower setback $a_2 = 1.00$ ftHeight $h = 1.00$ ftWidth $b = 5.00$ ft

Material

Soil creating foundation - Basalt

Basic soil parameters

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	Sand		31.00	0.0	112.60	50.10	29.00

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	Basalt		35.00	5000.0	140.00	77.50	35.00

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

Soil parameters

Sand

Unit weight : $\gamma = 112.6$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 31.00^\circ$
 Cohesion of soil : $c_{ef} = 0.0$ psf
 Angle of friction struc.-soil : $\delta = 29.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 112.6$ pcf

Basalt

Unit weight : $\gamma = 140.0$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 5000.0$ psf
 Angle of friction struc.-soil : $\delta = 35.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 140.0$ pcf

Backfill

Assigned soil : Sand

Slope = 40.00°

Geological profile and assigned soils

Position information

GPS : N 37.1111400; W 113.5966200
 N 37°6'40.10"; W 113°35'47.83"

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Basalt	

Terrain profile

Terrain behind construction has the slope 1: 8.00 (slope angle is 7.13°).

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	change	Action	Mag.1 [lb/ft ²]	Mag.2 [lb/ft ²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	1000.0				on terrain

Resistance on front face of the structure

Resistance on front face of the structure: at rest

Soil on front face of the structure - Sand

Soil thickness in front of structure $h = 1.00$ ft

Soil slope in front of structure $\beta = -35.00^\circ$

Applied forces acting on the structure

No.	Force new edit	Name	Action	F _x [lb/ft]	F _z [lb/ft]	M [lbfft/ft]	x [ft]	z [ft]
1	Yes	Force No. 1	permanent	0.00	1000.00	0.0	8.00	0.00

EarthquakeFactor 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 : permanent

Reduction of soil/soil friction angle : reduce to $2/3 \varphi$ (AASHTO)**Verification No. 1****Earthquake effects (active earth pressure) - partial results**

Layer No.	Thickness [ft]	φ_d [°]	β [°]	ψ [°]	K_a	K_{ae}	$K_{ae}-K_a$	Comment
1	0.25	31.00	7.13	0.00	0.622	0.622	0.000	
2	0.42	31.00	7.13	0.00	0.622	0.622	0.000	
3	1.08	31.00	7.13	0.00	0.622	0.622	0.000	
4	7.89	31.00	7.13	0.00	0.278	0.278	0.000	
5	1.11	31.00	7.13	0.00	0.622	0.622	0.000	
6	1.00	35.00	7.13	0.00	0.272	0.272	0.000	

Earthquake effects (active earth pressure)

Layer No.	Start [ft] End [ft]	σ_z [psf]	σ_D [psf]	Pressure [psf]	Hor. comp. [psf]	Vertical comp. [psf]
1	-0.25	0.0	1350.0	0.0	0.0	0.0
	0.00	27.7	1322.3	0.0	0.0	0.0
2	0.00	27.7	1322.3	0.0	0.0	0.0
	0.42	74.6	1275.4	0.0	0.0	0.0
3	0.42	74.6	1275.4	0.0	0.0	0.0
	1.50	196.6	1153.4	0.0	0.0	0.0
4	1.50	196.6	1153.4	0.0	0.0	0.0
	9.39	1085.4	264.6	0.0	0.0	0.0
5	9.39	1085.4	264.6	0.0	0.0	0.0
	10.50	1210.0	140.0	0.0	0.0	0.0
6	10.50	1210.0	140.0	0.0	0.0	0.0
	11.50	1350.0	0.0	0.0	0.0	0.0

Forces acting on construction

Name	F _{hor} [lb/ft]	App.Pt. z [ft]	F _{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.12	4673.1	2.94	1.000
Earthq.- constr.	0.0	-5.18	0.0	2.95	1.000
FF resistance	-18.0	-0.33	0.0	0.00	1.000
Weight - earth wedge	0.0	-1.37	38.9	4.61	1.000
Earthquake - soil wedge	0.0	-1.37	0.0	4.61	1.000

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - earth wedge	0.0	-11.02	209.9	3.79	1.000
Earthquake - soil wedge	0.0	-11.02	0.0	3.79	1.000
Active pressure	1893.7	-4.32	1241.3	4.71	1.000
Earthq.- act.pressure	0.0	-11.50	0.0	4.20	1.000
Surch.1 - surface	3211.4	-6.51	2363.2	4.72	1.000
Surch.1 - surface	0.0	-11.62	1967.9	3.21	1.000
Force No. 1	0.0	-11.50	1000.0	10.23	1.000

Verification of complete wall**Check for overturning stability**Resisting moment $M_{res} = 48295.2$ lbfft/ftOverturning moment $M_{ovr} = 29085.1$ lbfft/ft

Safety factor = 1.66 > 1.00

Wall for overturning is SATISFACTORY**Check for slip**Resisting horizontal force $H_{res} = 24761.01$ lb/ftActive horizontal force $H_{act} = 5087.13$ lb/ft

Safety factor = 4.87 > 1.00

Wall for slip is SATISFACTORY**Overall check - WALL is SATISFACTORY****Dimensioning No. 1****Forces acting on construction**

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.93	3973.1	2.02	1.000
Earthq.- constr.	0.0	-4.89	0.0	2.02	1.000
Weight - earth wedge	0.0	-10.02	209.9	2.79	1.000
Earthquake - soil wedge	0.0	-10.02	0.0	2.79	1.000
Active pressure	1673.5	-3.69	813.8	3.65	1.000
Earthq.- act.pressure	0.0	-10.50	0.0	3.20	1.000
Surch.1 - surface	3019.5	-5.82	1837.6	3.68	1.000
Surch.1 - surface	0.0	-10.62	1967.9	2.21	1.000
Force No. 1	0.0	-10.50	1000.0	9.23	1.000

Verification of block No. 1**Check for overturning stability**Resisting moment $M_{res} = 31924.8$ lbfft/ftOverturning moment $M_{ovr} = 23760.8$ lbfft/ft

Safety factor = 1.34 > 1.00

Joint for overturning stability is SATISFACTORY

Check for slipResisting horizontal force $H_{res} = 15192.32$ lbf/ftActive horizontal force $H_{act} = 4693.04$ lbf/ft

Safety factor = 3.24 > 1.00

Joint for verification 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	9526.0	11494.42	5087.13	0.166	3438.9

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	9526.0	11494.42	5087.13

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verificationMax. eccentricity of normal force $e = 0.166$ Maximum allowable eccentricity $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY****Verification of bearing capacity**Max. stress at footing bottom $\sigma = 3438.9$ psfBearing capacity of foundation soil $R_d = 15000.0$ psf

Safety factor = 4.36 > 2.00

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

Analysis of Redi Rock wall

Input data

Task : 220603 - 150 North Donlee Drive Block Walls
 Part : Two 8-foot Block Walls
 Customer : Ryan Davis
 Author : Kent Nelson
 Date : 9/12/2022
 Project ID : 150 North Donlee Drive
 Project number : 220603

Settings

(input for current task)

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 :	$SF_o =$	1.00	[-]
Safety factor for sliding resistance :	$SF_s =$	1.00	[-]
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	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength $F_{\min}$ [lbf/ft]	Max. shear strength $F_{\max}$ [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	5	1.62
2	Block 41	1	1.62
3	Top block 28	1	-

Base

Geometry

Upper setback $a_1 = 0.00$ ftLower setback $a_2 = 1.00$ ftHeight $h = 1.00$ ftWidth $b = 5.00$ ft

Material

Soil creating foundation - Basalt

Basic soil parameters

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	Sand		32.00	0.0	126.00	63.50	29.00

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	Basalt		35.00	5000.0	140.00	77.50	35.00

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

Soil parameters

Sand

Unit weight : $\gamma = 126.0$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 32.00^\circ$
 Cohesion of soil : $c_{ef} = 0.0$ psf
 Angle of friction struc.-soil : $\delta = 29.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 126.0$ pcf

Basalt

Unit weight : $\gamma = 140.0$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 5000.0$ psf
 Angle of friction struc.-soil : $\delta = 35.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 140.0$ pcf

Backfill

Assigned soil : Sand

Slope = 40.00°

Geological profile and assigned soils

Position information

GPS : N 37.1111400; W 113.5966200
 N 37°6'40.10"; W 113°35'47.83"

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Basalt	

Terrain profile

Terrain behind construction has the slope 1: 8.00 (slope angle is 7.13°).

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	change	Action	Mag.1 [lb/ft ²]	Mag.2 [lb/ft ²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	1000.0				on terrain

Resistance on front face of the structure

Resistance on front face of the structure: at rest

Soil on front face of the structure - Sand

Soil thickness in front of structure $h = 1.00$ ft

Soil slope in front of structure $\beta = -35.00^\circ$

Applied forces acting on the structure

No.	Force new edit	Name	Action	F_x [lb/ft]	F_z [lb/ft]	M [lbfft/ft]	x [ft]	z [ft]
1	Yes	Force No. 1	permanent	0.00	1000.00	0.0	8.00	0.00

Earthquake

Factor of horizontal acceleration $K_h = 0.1100$ Factor of vertical acceleration $K_v = 0.0000$

Water below the GWT is restricted.

Settings of the stage of construction

Design situation : permanent

Reduction of soil/soil friction angle : reduce to $2/3 \varphi$ (AASHTO)

Verification No. 1

Earthquake effects (active earth pressure) - partial results

Layer No.	Thickness [ft]	Φ_d [°]	β [°]	ψ [°]	K_a	K_{ae}	$K_{ae}-K_a$	Comment
1	0.25	32.00	7.13	6.28	0.603	0.744	0.141	
2	0.42	32.00	7.13	6.28	0.603	0.744	0.141	
3	1.08	32.00	7.13	6.28	0.603	0.744	0.141	
4	7.88	32.00	7.13	6.28	0.266	0.356	0.090	
5	1.12	32.00	7.13	6.28	0.603	0.744	0.141	
6	1.00	35.00	7.13	6.28	0.272	0.364	0.092	

Earthquake effects (active earth pressure)

Layer No.	Start [ft] End [ft]	σ_z [psf]	σ_D [psf]	Pressure [psf]	Hor. comp. [psf]	Vertical comp. [psf]
1	-0.25	0.0	1494.2	210.0	142.9	153.9
	0.00	31.2	1463.0	205.6	139.9	150.7
2	0.00	31.2	1463.0	205.6	139.9	150.7
	0.42	83.7	1410.5	198.2	134.9	145.3
3	0.42	83.7	1410.5	198.2	134.9	145.3
	1.50	220.2	1274.0	179.0	121.8	131.2
4	1.50	220.2	1274.0	114.3	103.8	47.7
	9.38	1213.2	281.0	25.2	22.9	10.5
5	9.38	1213.2	281.0	39.5	26.9	28.9
	10.50	1354.2	140.0	19.7	13.4	14.4
6	10.50	1354.2	140.0	12.9	10.6	7.4
	11.50	1494.2	0.0	0.0	0.0	0.0

Forces acting on construction

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.12	4673.1	2.94	1.000
Earthq.- constr.	513.4	-5.18	0.0	2.95	1.000
FF resistance	-20.2	-0.33	0.0	0.00	1.000
Weight - earth wedge	0.0	-1.37	44.1	4.61	1.000
Earthquake - soil wedge	4.8	-1.37	0.0	4.61	1.000

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - earth wedge	0.0	-11.02	236.1	3.80	1.000
Earthquake - soil wedge	26.0	-11.02	0.0	3.80	1.000
Active pressure	2035.7	-4.32	1348.9	4.71	1.000
Earthq.- act.pressure	758.4	-7.92	506.7	4.72	1.000
Surch.1 - surface	3084.2	-6.51	2299.3	4.72	1.000
Surch.1 - surface	0.0	-11.62	1978.4	3.22	1.000
Force No. 1	0.0	-11.50	1000.0	10.23	1.000

Verification of complete wall**Check for overturning stability**Resisting moment $M_{res} = 51065.0$ lbfft/ftOverturning moment $M_{ovr} = 37816.2$ lbfft/ft

Safety factor = 1.35 > 1.00

Wall for overturning is SATISFACTORY**Check for slip**Resisting horizontal force $H_{res} = 19424.64$ lb/ftActive horizontal force $H_{act} = 6402.26$ lb/ft

Safety factor = 3.03 > 1.00

Wall for slip is SATISFACTORY**Overall check - WALL is SATISFACTORY****Dimensioning No. 1****Forces acting on construction**

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.93	3973.1	2.02	1.000
Earthq.- constr.	446.0	-4.89	0.0	2.02	1.000
Weight - earth wedge	0.0	-10.02	236.1	2.80	1.000
Earthquake - soil wedge	26.0	-10.02	0.0	2.80	1.000
Active pressure	1793.1	-3.69	873.4	3.65	1.000
Earthq.- act.pressure	623.7	-7.30	415.1	3.71	1.000
Surch.1 - surface	2895.2	-5.83	1774.5	3.68	1.000
Surch.1 - surface	0.0	-10.62	1978.4	2.22	1.000
Force No. 1	0.0	-10.50	1000.0	9.23	1.000

Verification of block No. 1**Check for overturning stability**Resisting moment $M_{res} = 33563.5$ lbfft/ftOverturning moment $M_{ovr} = 30500.9$ lbfft/ft

Safety factor = 1.10 > 1.00

Joint for overturning stability is SATISFACTORY

Check for slipResisting horizontal force $H_{res} = 10165.29$ lbf/ftActive horizontal force $H_{act} = 5784.02$ lbf/ft

Safety factor = 1.76 > 1.00

Joint for verification 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	16967.8	12086.60	6402.26	0.281	5513.2

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	16967.8	12086.60	6402.26

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verificationMax. eccentricity of normal force $e = 0.281$ Maximum allowable eccentricity $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY****Verification of bearing capacity**Max. stress at footing bottom $\sigma = 5513.2$ psfBearing capacity of foundation soil $R_d = 15000.0$ psf

Safety factor = 2.72 > 2.00

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

Analysis of Redi Rock wall

Input data

Task : 220603 - 150 North Donlee Drive Block Walls
 Part : Two 8-foot Block Walls
 Customer : Ryan Davis
 Author : Kent Nelson
 Date : 9/12/2022
 Project ID : 150 North Donlee Drive
 Project number : 220603

Settings

(input for current task)

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 :	$SF_o =$	1.00	[-]
Safety factor for sliding resistance :	$SF_s =$	1.00	[-]
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	Height h [in]	Width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Block 60	18.00	60.00	130.00
4	Top block 24 straight	18.00	24.00	108.00
5	Planter 41	18.00	40.50	120.00
6	Planter 60	18.00	60.00	112.00
7	Top block 28	18.00	28.00	120.00
8	Top block 41	18.00	40.50	120.00
9	Top block 24 straight garden	18.00	24.00	80.00
10	Block R-5236 HC	36.00	52.00	110.00
11	Block R-7236 HC	36.00	72.00	110.00
12	Block R-9636 HC	36.00	96.00	110.00
13	Block R-41 HC	18.00	40.50	110.00

No.	Description	Min. shear strength $F_{\min}$ [lbf/ft]	Max. shear strength $F_{\max}$ [lbf/ft]	Friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Block 60	6061.00	11276.00	44.00
4	Top block 24 straight	6061.00	11276.00	44.00
5	Planter 41	6061.00	11276.00	44.00
6	Planter 60	6061.00	11276.00	44.00
7	Top block 28	6061.00	11276.00	44.00
8	Top block 41	6061.00	11276.00	44.00
9	Top block 24 straight garden	6061.00	11276.00	44.00
10	Block R-5236 HC	4550.00	12000.00	44.00
11	Block R-7236 HC	4550.00	12000.00	44.00
12	Block R-9636 HC	4550.00	12000.00	44.00
13	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.010
2	0.375
3	1.625
4	9.375
5	16.625

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	5	1.62
2	Block 41	1	1.62
3	Top block 28	1	-

Base**Geometry**Upper setback $a_1 = 0.00$ ftLower setback $a_2 = 1.00$ ftHeight $h = 1.00$ ftWidth $b = 5.00$ ft**Material**

Soil creating foundation - Basalt

Basic soil parameters

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	Sand		32.00	0.0	126.00	63.50	29.00

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
2	Basalt		35.00	5000.0	140.00	77.50	35.00

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

Soil parameters

Sand

Unit weight : $\gamma = 126.0$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 32.00^\circ$
 Cohesion of soil : $c_{ef} = 0.0$ psf
 Angle of friction struc.-soil : $\delta = 29.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 126.0$ pcf

Basalt

Unit weight : $\gamma = 140.0$ pcf
 Stress-state : effective
 Angle of internal friction : $\Phi_{ef} = 35.00^\circ$
 Cohesion of soil : $c_{ef} = 5000.0$ psf
 Angle of friction struc.-soil : $\delta = 35.00^\circ$
 Saturated unit weight : $\gamma_{sat} = 140.0$ pcf

Backfill

Assigned soil : Sand

Slope = 40.00°

Geological profile and assigned soils

Position information

GPS : N 37.1111400; W 113.5966200
 N 37°6'40.10"; W 113°35'47.83"

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Assigned soil	Pattern
1	-	0.00 .. ∞	Basalt	

Terrain profile

Terrain behind construction has the slope 1: 8.00 (slope angle is 7.13°).

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	change	Action	Mag.1 [lb/ft ²]	Mag.2 [lb/ft ²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		permanent	1000.0				on terrain

Resistance on front face of the structure

Resistance on front face of the structure: at rest

Soil on front face of the structure - Sand

Soil thickness in front of structure $h = 1.00$ ft

Soil slope in front of structure $\beta = -35.00^\circ$

Applied forces acting on the structure

No.	Force new edit	Name	Action	F _x [lb/ft]	F _z [lb/ft]	M [lbfft/ft]	x [ft]	z [ft]
1	Yes	Force No. 1	permanent	0.00	1000.00	0.0	8.00	0.00

EarthquakeFactor 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 : permanent

Reduction of soil/soil friction angle : reduce to $2/3 \phi$ (AASHTO)**Verification No. 1****Earthquake effects (active earth pressure) - partial results**

Layer No.	Thickness [ft]	Φ_d [°]	β [°]	ψ [°]	K_a	K_{ae}	$K_{ae}-K_a$	Comment
1	0.25	32.00	7.13	0.00	0.603	0.603	0.000	
2	0.42	32.00	7.13	0.00	0.603	0.603	0.000	
3	1.08	32.00	7.13	0.00	0.603	0.603	0.000	
4	7.88	32.00	7.13	0.00	0.266	0.266	0.000	
5	1.12	32.00	7.13	0.00	0.603	0.603	0.000	
6	1.00	35.00	7.13	0.00	0.272	0.272	0.000	

Earthquake effects (active earth pressure)

Layer No.	Start [ft] End [ft]	σ_z [psf]	σ_D [psf]	Pressure [psf]	Hor. comp. [psf]	Vertical comp. [psf]
1	-0.25	0.0	1494.2	0.0	0.0	0.0
	0.00	31.2	1463.0	0.0	0.0	0.0
2	0.00	31.2	1463.0	0.0	0.0	0.0
	0.42	83.7	1410.5	0.0	0.0	0.0
3	0.42	83.7	1410.5	0.0	0.0	0.0
	1.50	220.2	1274.0	0.0	0.0	0.0
4	1.50	220.2	1274.0	0.0	0.0	0.0
	9.38	1213.2	281.0	0.0	0.0	0.0
5	9.38	1213.2	281.0	0.0	0.0	0.0
	10.50	1354.2	140.0	0.0	0.0	0.0
6	10.50	1354.2	140.0	0.0	0.0	0.0
	11.50	1494.2	0.0	0.0	0.0	0.0

Forces acting on construction

Name	F _{hor} [lb/ft]	App.Pt. z [ft]	F _{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-5.12	4673.1	2.94	1.000
Earthq.- constr.	0.0	-5.18	0.0	2.95	1.000
FF resistance	-20.2	-0.33	0.0	0.00	1.000
Weight - earth wedge	0.0	-1.37	44.1	4.61	1.000
Earthquake - soil wedge	0.0	-1.37	0.0	4.61	1.000

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - earth wedge	0.0	-11.02	236.1	3.80	1.000
Earthquake - soil wedge	0.0	-11.02	0.0	3.80	1.000
Active pressure	2035.7	-4.32	1348.9	4.71	1.000
Earthq.- act.pressure	0.0	-11.50	0.0	4.21	1.000
Surch.1 - surface	3084.2	-6.51	2299.3	4.72	1.000
Surch.1 - surface	0.0	-11.62	1978.4	3.22	1.000
Force No. 1	0.0	-11.50	1000.0	10.23	1.000

Verification of complete wall**Check for overturning stability**Resisting moment $M_{res} = 48675.5$ lbfft/ftOverturning moment $M_{ovr} = 28857.2$ lbfft/ft

Safety factor = 1.69 > 1.00

Wall for overturning is SATISFACTORY**Check for slip**Resisting horizontal force $H_{res} = 25222.67$ lb/ftActive horizontal force $H_{act} = 5099.68$ lb/ft

Safety factor = 4.95 > 1.00

Wall for slip is SATISFACTORY**Overall check - WALL is SATISFACTORY****Dimensioning No. 1****Forces acting on construction**

Name	F_{hor} [lb/ft]	App.Pt. z [ft]	F_{vert} [lb/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.93	3973.1	2.02	1.000
Earthq.- constr.	0.0	-4.89	0.0	2.02	1.000
Weight - earth wedge	0.0	-10.02	236.1	2.80	1.000
Earthquake - soil wedge	0.0	-10.02	0.0	2.80	1.000
Active pressure	1793.1	-3.69	873.4	3.65	1.000
Earthq.- act.pressure	0.0	-10.50	0.0	3.21	1.000
Surch.1 - surface	2895.2	-5.83	1774.5	3.68	1.000
Surch.1 - surface	0.0	-10.62	1978.4	2.22	1.000
Force No. 1	0.0	-10.50	1000.0	9.23	1.000

Verification of block No. 1**Check for overturning stability**Resisting moment $M_{res} = 32021.7$ lbfft/ftOverturning moment $M_{ovr} = 23505.7$ lbfft/ft

Safety factor = 1.36 > 1.00

Joint for overturning stability is SATISFACTORY

Check for slipResisting horizontal force $H_{res} = 15545.35$ lbf/ftActive horizontal force $H_{act} = 4688.35$ lbf/ft

Safety factor = 3.32 > 1.00

Joint for verification 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	9131.5	11579.92	5099.68	0.158	3383.1

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	9131.5	11579.92	5099.68

Verification of foundation soil

Stress in the footing bottom : rectangle

Eccentricity verificationMax. eccentricity of normal force $e = 0.158$ Maximum allowable eccentricity $e_{alw} = 0.333$ **Eccentricity of the normal force is SATISFACTORY****Verification of bearing capacity**Max. stress at footing bottom $\sigma = 3383.1$ psfBearing capacity of foundation soil $R_d = 15000.0$ psf

Safety factor = 4.43 > 2.00

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