

GEO WALL



"BUILT FROM THE GROUND UP"

DESIGN REPORT FOR:

23SSL018

VILLAGE DR TOWNHOMES
STEAMBOAT SPRINGS, CO

August 31, 2023

REV 0



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1.0 Site Review

This project includes two site retaining walls. Both walls are located east of the proposed townhomes, adjacent to the east drive lane. Wall 1 is the lower terrace with Wall 2 placed directly on top. The beginning of the wall 1 has been extended and grading has been modified. Wall 1 has a maximum height of 4.50-feet and a horizontal length of 187.84-feet. Wall 2 has a maximum height of 6.00-feet and a horizontal length of 176.33-feet. The walls will need to be moved forward approximately 1.50-feet in order to allow room for construction within property limits. A vertical excavation or construction easement will be required due to proximity to property line.

2.0 Design Methodology

The proposed walls have been designed in accordance with the NCMA (National Concrete Masonry Association) design methodology. Refer to the NCMA Design Manual for Segmental Retaining Walls, 3rd edition for additional design and construction requirements.

3.0 Wall System

3.1 Modular Block Wall Units

The walls have been designed using Redi-Rock 28", 60" & 72" XL units using the standard 5.2° wall batter. Refer to the manufacturers information for additional details on the proposed retaining wall system and its material properties.

4.0 Soil Properties

Site soils information was obtained from the geotechnical report prepared by NorthWest Colorado Consultants, Inc dated 10 January 2019. The soil strengths shown were assumed and shall be verified by the project geotechnical engineer. GeoWall Designs, LLC should be contacted if the noted soil strengths are not met as a redesign may be required.

Zone	Description	ϕ	c'	γ
Retained Soil 1	Clayey Sand - SC/CL	26°	0 psf	125 pcf
Foundation Soil 1	Clayey Sand - SC/CL	26°	0 psf	125 pcf

Refer to the referenced soils report for additional information regarding the site soil conditions and geotechnical engineers' recommendations.

5.0 Maximum Surcharge Loadings & Slope Conditions

Below are the maximum surcharge and site slope conditions as evaluated within this design. The noted extremes may not be present for the entire length of any given wall. Dead load surcharge loadings are applied in addition to any equivalent geometric loadings applied within the design calculations. Refer to the contract civil plans for locations of all anticipated surcharge locations and grade geometry.

Wall No.	Live Load (psf)	Dead Load (psf)	Toe Slope	Back Slope
1	100	N/A	Flat	Flat
2	100	N/A	Flat	6H:1V

6.0 Hydraulic Conditions

6.1 Water Application

The proposed walls are not located within a wetland application and the ground water elevation is assumed to be located sufficiently below bottom of wall as to not influence overall stability. The project geotechnical engineer shall consider fluctuations in seasonal ground water elevations during the verification external failure mechanisms.

6.2 Erosion Control/Prevention

The contractor shall ensure positive drainage is maintained both during and after construction. Erosion prevention and protection shall be maintained above and below the retaining wall as designed by others. All downspouts, swales, and drainage features shall be diverted away from the wall location.

7.0 Seismic Conditions

The estimated 1-second peak ground acceleration (S_{D1}) is 0.164g. The retaining wall design has considered seismic conditions and applicable design requirements.

8.0 Wind Conditions

No additional surcharge due to wind is anticipated or included within this design of below grade structures. All freestanding, above grade structures, shall be designed or relocated to not influence the below grade retaining wall within a 1H:1V zone of influence. Refer to ASCE 7-16 for additional information on surcharge applications.

9.0 External Stability and Settlement

Global Stability has been evaluated by GeoWall Designs, LLC using soils noted in section 4.0 and shall be verified by the project geotechnical engineer. Local Bearing Capacities and Settlement are not covered under the scope of this design and shall be evaluated under the scope of the project geotechnical engineer. The foundation soils at each wall location shall be capable of supporting the applied bearing capacities shown within the shop drawings without failure or excessive settlement.

10.0 Limitations of Report

The design presented within this report is based on the information provided. GeoWall Designs, LLC accepts no liability for verifying site geometry, soil parameters, or ensuring all information provided is up to date. The contractor and/or owner's representative shall notify GeoWall Designs, LLC of any changes or conflicts with the actual site geometry prior to construction. Verification of site soil conditions, bearing capacities, anticipated settlement, and global stability shall be completed as directed within the construction plans and project specifications.

Appendix Item A: Design References

Landmark Consultants, Inc plan set for: Village Dr Townhomes Civil Construction Drawings, Project No.: 2136-017,
Last Dated: 07 September 2022

NorthWest Colorado Consultants, Inc report titled: Subsoil and Foundation Investigation, Proposed Partovi
Townhomes, Project No.: 19-11700, Last Dated: 10 January 2019

NCMA Design Manual for Segmental Retaining Walls, 3rd Edition

NCMA SRW Best Practices, 2nd Printing, 2017

ASCE 7-16 Minimum Design Loads and Associated Criteria

IBC-2018 International Building Code, 2018

Appendix Item B: Final Calculations

Calculations attached after this sheet

⚠ This is a beta release of the new ATC Hazards by Location website. Please [contact us](#) with feedback.

i The ATC Hazards by Location website will not be updated to support ASCE 7-22. [Find out why.](#)

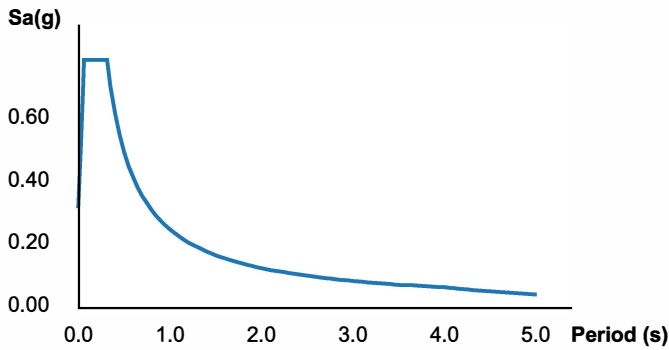
ATC Hazards by Location

Search Information

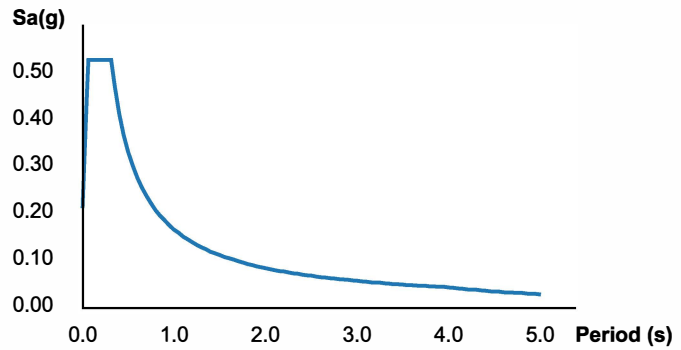
Address: Steamboat springs co
Coordinates: 40.4849769, -106.8317158
Elevation: 6723 ft
Timestamp: 2023-08-29T20:11:19.739Z
Hazard Type: Seismic
Reference Document: ASCE7-16
Risk Category: II
Site Class: D



MCE_R Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S _S	0.594	MCE _R ground motion (period=0.2s)
S ₁	0.103	MCE _R ground motion (period=1.0s)
S _{MS}	0.787	Site-modified spectral acceleration value
S _{M1}	0.247	Site-modified spectral acceleration value
S _{DS}	0.525	Numeric seismic design value at 0.2s SA
S _{D1}	0.164	Numeric seismic design value at 1.0s SA

Additional Information

Name	Value	Description
SDC	D	Seismic design category
F _a	1.324	Site amplification factor at 0.2s
F _v	2.394	Site amplification factor at 1.0s
CR _S	0.906	Coefficient of risk (0.2s)

CR ₁	0.946	Coefficient of risk (1.0s)
PGA	0.417	MCE _G peak ground acceleration
F _{PGA}	1.183	Site amplification factor at PGA
PGA _M	0.493	Site modified peak ground acceleration
T _L	4	Long-period transition period (s)
SsRT	0.594	Probabilistic risk-targeted ground motion (0.2s)
SsUH	0.656	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.103	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.109	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.5	Factored deterministic acceleration value (PGA)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Please note that the ATC Hazards by Location website will not be updated to support ASCE 7-22. [Find out why.](#)

Disclaimer

Hazard loads are provided by the U.S. Geological Survey [Seismic Design Web Services](#).

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REA Analysis

Project: 23SSL018 Village Dr Townhomes
 Location: Steamboat Springs, CO
 Designer: BTD
 Date: 8/31/2023
 Section: Section 1 - Static
 Design Method: NCMA_09_3rd_Ed, Ignore Vert. Force
 Design Unit: Redi-Rock XL-RR

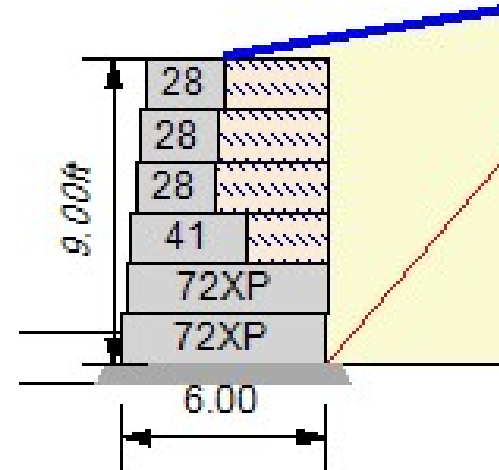
SOIL PARAMETERS	ϕ	coh	γ	
Retained Soil:	26 deg	0psf	125pcf	
Foundation Soil:	26 deg	0psf	125pcf	
Leveling Pad:	38 deg	0psf	110pcf	Crushed Stone

GEOMETRY

Design Height:	9.00ft	Live Load:	100psf
Wall Batter/Tilt:	5.20/ 0.00 deg	Live Load Offset:	0.00ft
Embedment:	1.00ft	Live Load Width:	100ft
Leveling Pad Depth:	0.50ft	Dead Load:	0psf
Slope Angle:	9.5 deg	Dead Load Offset:	0.0ft
Slope Length:	100.0ft	Dead Load Width:	0ft
Slope Toe Offset:	0.0ft	D.L. Embedment:	0ft
Leveling Pad Width:	7.00ft		
Vert δ on Single Dpth			

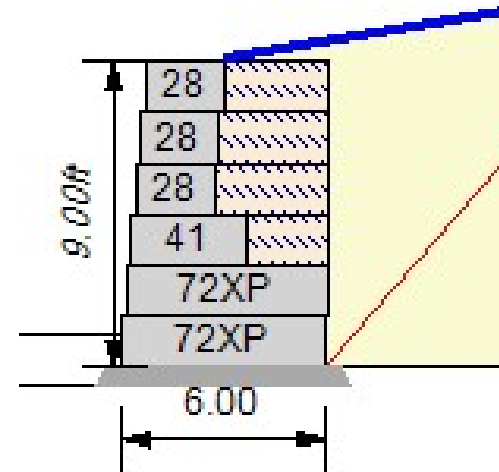
FACTORS OF SAFETY

Sliding:	1.50	Overturning:	1.50
Bearing:	2.00		



RESULTS

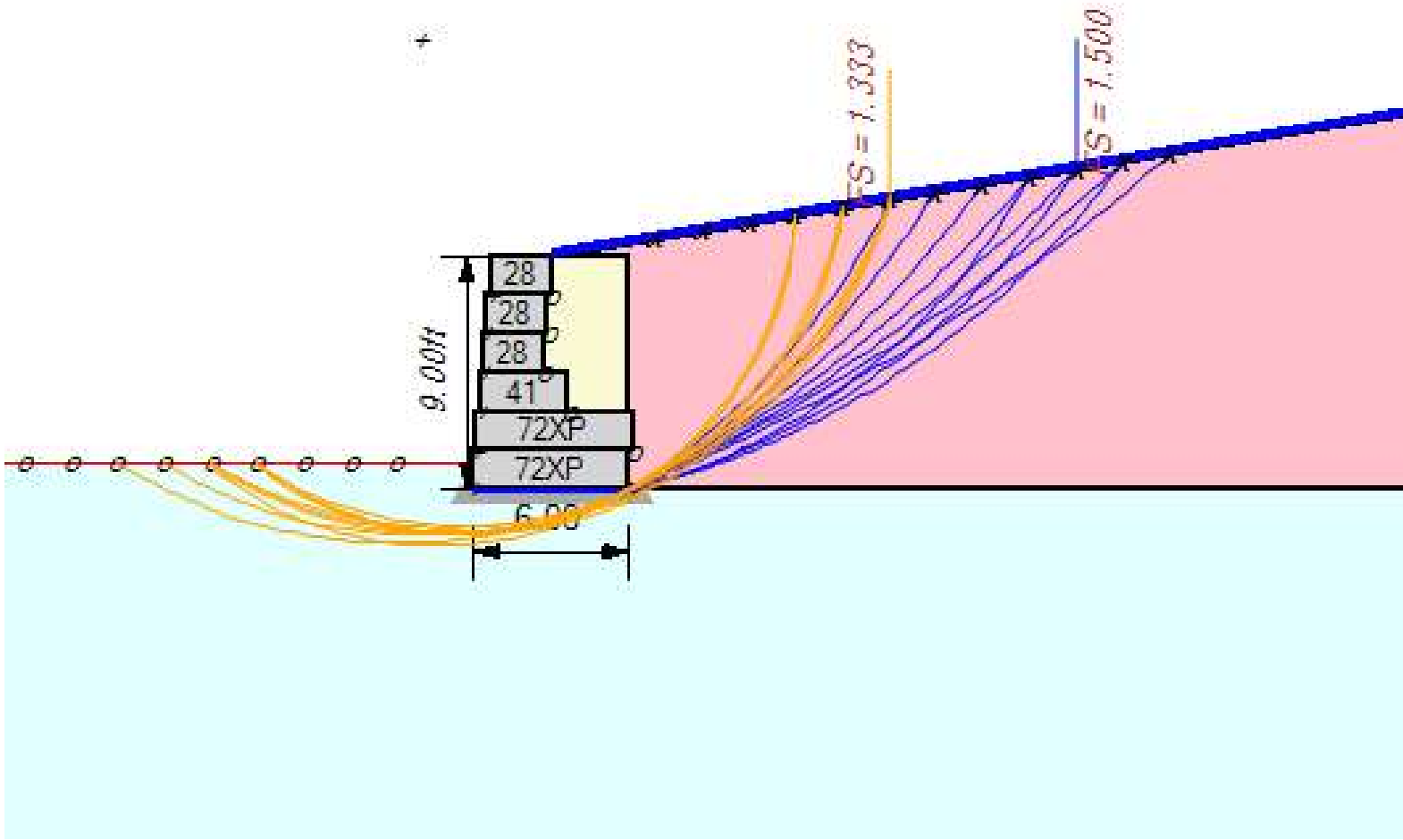
FoS Sliding: 1.73 (lvlpd) FoS Overturning: 1.86
 Bearing: 1439.78 FoS Bearing: 4.08



Name	Elev.[dpth]	ka	Pa	Paq	PaT	FSsl	FoS OT	%D/H
28	7.50[1.50]	0.399	56	60	116	90.59	8.08	156%
28	6.00[3.00]	0.357	201	107	308	34.67	3.38	78%
28	4.50[4.50]	0.357	451	160	612	18.07	1.86	52%
41	3.00[6.00]	0.399	933	219	1152	10.68	1.94	57%
72XP	1.50[7.50]	0.399	1605	231	1836	8.10	3.83	80%
72XP	0.00[9.00]	0.399	2250	290	2540	1.73	2.81	67%

Column Descriptions:

- ka: active earth pressure coefficient
- Pa: active earth pressure
- Paq: live surcharge earth pressure
- Paq2: live load 2 surcharge earth pressure
- Paqd: dead surcharge earth pressure
- (PaC): reduction in load due to cohesion
- PaT: sum of all earth pressures
- FSsl(lvl Pad): factor of safety for sliding at each layer. (FS sliding below the leveling pad)
- FSot: factor of safety of overturning about the toe.



COMPOUND RESULTS

Compound stability is a global analysis (Bishop) with the failure planes originating at the top of the slope / wall and exiting out through the face of the wall. For MSE walls, the resistance of the geogrid reinforcement is included in the analysis and the shear resistance of the face units is included.

ID	Enter Point X	Enter Point Y	Exit Point X	Exit Point Y	Center X	Center Y	Radius	FoS
2	23.20	12.36	6.00	0.00	-17.84	51.32	56.59	1.500
2	21.40	12.06	6.00	0.00	-15.49	43.30	48.34	1.500
2	25.00	12.66	6.00	0.00	-20.37	60.14	65.67	1.503
2	19.60	11.76	6.00	0.00	-13.31	36.07	40.92	1.506
2	26.80	12.96	6.00	0.00	-23.05	69.78	75.59	1.520
2	17.80	11.46	6.00	0.00	-11.33	29.64	34.33	1.530
3	23.20	12.36	6.00	0.00	-1.18	28.14	29.04	1.570
3	25.00	12.66	6.00	0.00	-2.02	32.61	33.58	1.575
3	21.40	12.06	6.00	0.00	-0.43	24.07	24.92	1.576
2	16.00	11.16	6.00	0.00	-9.54	23.98	28.58	1.584

GLOBAL RESULTS

Global stability is a global analysis (Bishop) with the failure planes originating at the top of the slope / wall and exiting out below the wall in the area in front of the structure. For MSE walls, the resistance of the geogrid reinforcement is included in the resisting forces. The curve may go through the base of the wall and the wall shear would be included. In most cases the failure plane will pass below the structure.

ID	Enter Point X	Enter Point Y	Exit Point X	Exit Point Y	Center X	Center Y	Radius	FoS
1	16.00	11.16	-11.91	1.00	-2.02	17.24	19.02	1.333
1	12.40	10.56	-10.11	1.00	-1.36	11.68	13.81	1.347
1	14.20	10.86	-10.11	1.00	-1.22	13.97	15.73	1.349
1	14.20	10.86	-8.31	1.00	-0.26	13.25	14.66	1.352
2	16.00	11.16	-10.11	1.00	-0.87	15.88	17.52	1.357
1	12.40	10.56	-8.31	1.00	-0.41	11.11	12.82	1.359
1	16.00	11.16	-10.11	1.00	-1.07	16.39	17.85	1.362
2	12.40	10.56	-8.31	1.00	-0.38	11.04	12.79	1.367
1	16.00	11.16	-13.71	1.00	-2.96	18.09	20.19	1.369
2	14.20	10.86	-8.31	1.00	0.02	12.60	14.28	1.378

REA Analysis

Project: 23SSL018 Village Dr Townhomes
 Location: Steamboat Springs, CO
 Designer: BTD
 Date: 8/31/2023
 Section: Section 1 - Seismic
 Design Method: NCMA_09_3rd_Ed, Ignore Vert. Force
 Design Unit: Redi-Rock XL-RR
 Seismic Acc: 0.164

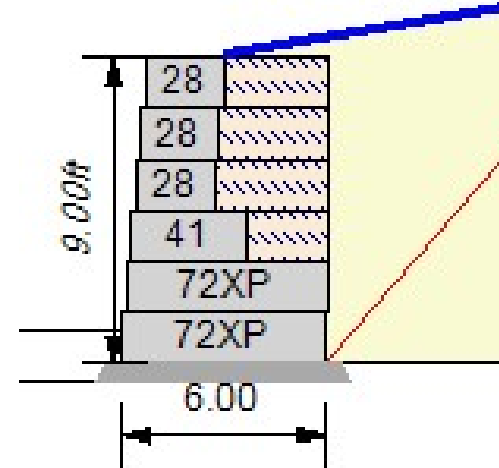
SOIL PARAMETERS	ϕ	coh	γ	
Retained Soil:	26 deg	0psf	125pcf	
Foundation Soil:	26 deg	0psf	125pcf	
Leveling Pad:	38 deg	0psf	110pcf	Crushed Stone

GEOMETRY

Design Height:	9.00ft	Live Load:	100psf
Wall Batter/Tilt:	5.20/ 0.00 deg	Live Load Offset:	0.00ft
Embedment:	1.00ft	Live Load Width:	100ft
Leveling Pad Depth:	0.50ft	Dead Load:	0psf
Slope Angle:	9.5 deg	Dead Load Offset:	0.0ft
Slope Length:	100.0ft	Dead Load Width:	0ft
Slope Toe Offset:	0.0ft	D.L. Embedment:	0ft
Leveling Pad Width:	7.00ft		
Vert δ on Single Dpth			

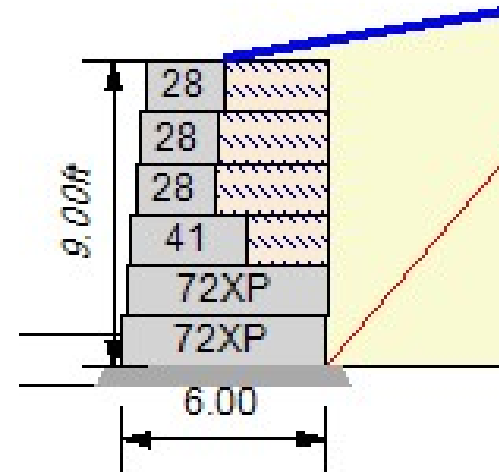
FACTORS OF SAFETY (Static / Seismic)

Sliding:	1.50 / 1.125	Overturning:	1.50 / 1.125
Bearing:	2.00 / 1.5		



RESULTS (Static / Seismic)

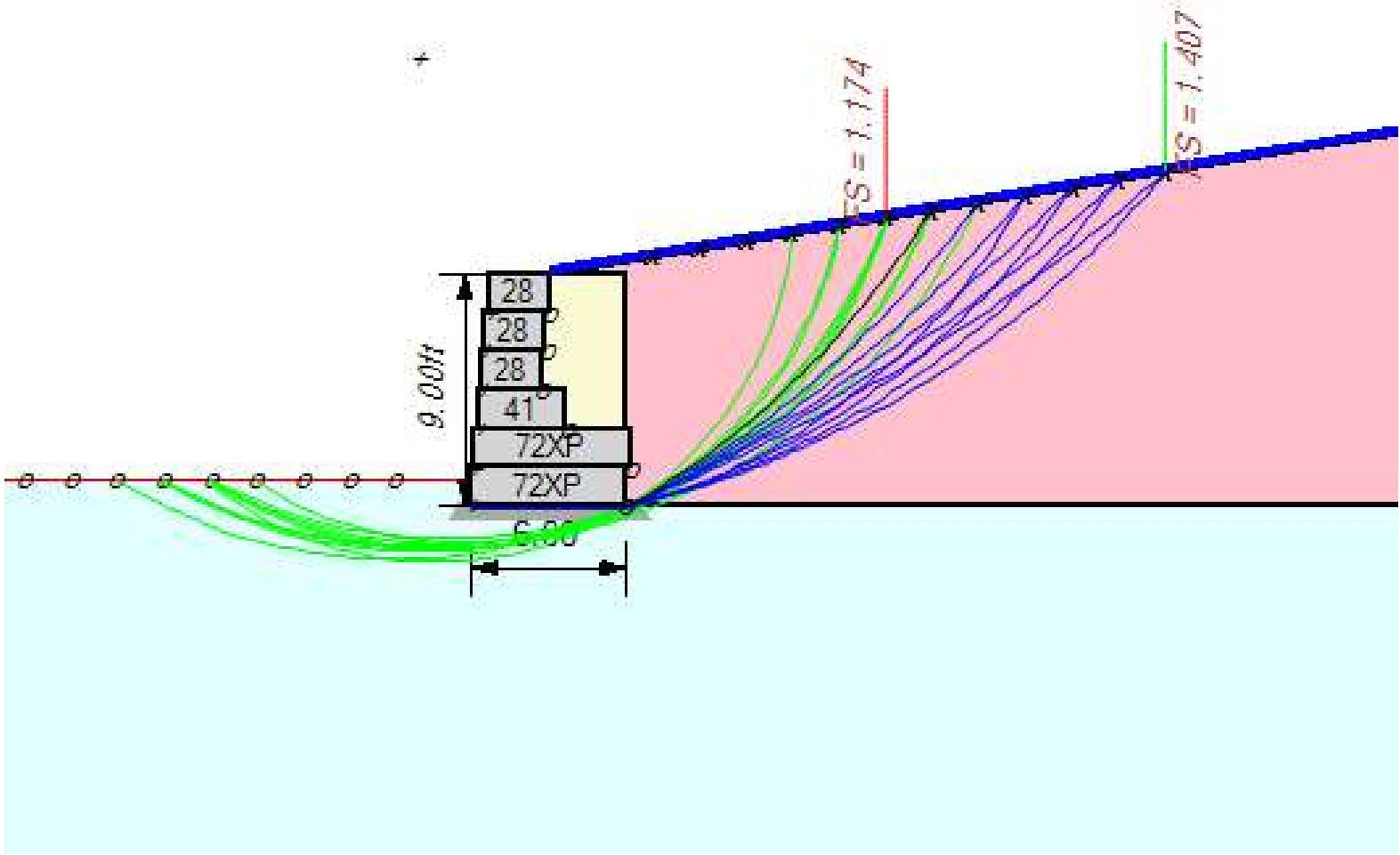
FoS Sliding: 1.73 (lvlpd) / 1.65 FoS Overturning: 1.86 / 2.56
 Bearing: 1439.78 / 1396.86 FoS Bearing: 4.08 / 4.77



Name	Elev.	ka	kae	Pa	Pae	Pir	Paq	PaT	FSsl	siesFSsl	FoS OT	FoS SeisOT
28	7.50	0.399	0.465	56	65	31	60	116	90.59	160.12	8.08	17.07
28	6.00	0.357	0.419	201	236	63	107	308	34.67	44.78	3.38	4.89
28	4.50	0.357	0.419	451	530	94	160	612	18.07	20.55	1.86	2.31
41	3.00	0.399	0.465	933	1079	137	219	1152	10.68	11.09	1.94	2.10
72XP	1.50	0.399	0.465	1605	1835	206	231	1836	8.10	7.64	3.83	3.62
72XP	0.00	0.399	0.465	2250	2581	273	290	2540	1.73	1.65	2.81	2.56

Column Descriptions:

- ka: active earth pressure coefficient
- kae: active seismic earth pressure coefficient
- Pa: active earth pressure
- Pae: dynamic earth pressure
- Pir: inertia force
- Paq: live surcharge earth pressure
- Paq2: live load 2 surcharge earth pressure
- Paqd: dead surcharge earth pressure
- (PaC): reduction in load due to cohesion
- PaT: sum of all earth pressures
- FSsl(lvl Pad): factor of safety for sliding at each layer. (FS sliding below the leveling pad)
- FSot: factor of safety of overturning about the toe.



COMPOUND RESULTS

Compound stability is a global analysis (Bishop) with the failure planes originating at the top of the slope / wall and exiting out through the face of the wall. For MSE walls, the resistance of the geogrid reinforcement is included in the analysis and the shear resistance of the face units is included.

ID	Enter Point X	Enter Point Y	Exit Point X	Exit Point Y	Center X	Center Y	Radius	FoS
2	26.80	12.96	6.00	0.00	-23.05	69.78	75.59	1.407
2	25.00	12.66	6.00	0.00	-20.37	60.14	65.67	1.410
2	23.20	12.36	6.00	0.00	-17.84	51.32	56.59	1.425
2	21.40	12.06	6.00	0.00	-15.49	43.30	48.34	1.444
3	26.80	12.96	6.00	0.00	-2.93	37.49	38.54	1.455
3	25.00	12.66	6.00	0.00	-2.02	32.61	33.58	1.460
2	19.60	11.76	6.00	0.00	-13.31	36.07	40.92	1.468
3	23.20	12.36	6.00	0.00	-1.18	28.14	29.04	1.471
3	21.40	12.06	6.00	0.00	-0.43	24.07	24.92	1.495
2	17.80	11.46	6.00	0.00	-11.33	29.64	34.33	1.513

GLOBAL RESULTS

Global stability is a global analysis (Bishop) with the failure planes originating at the top of the slope / wall and exiting out below the wall in the area in front of the structure. For MSE walls, the resistance of the geogrid reinforcement is included in the resisting forces. The curve may go through the base of the wall and the wall shear would be included. In most cases the failure plane will pass below the structure.

ID	Enter Point X	Enter Point Y	Exit Point X	Exit Point Y	Center X	Center Y	Radius	FoS
1	16.00	11.16	-11.91	1.00	-2.02	17.24	19.02	1.174
2	16.00	11.16	-10.11	1.00	-0.87	15.88	17.52	1.195
1	16.00	11.16	-10.11	1.00	-1.07	16.39	17.85	1.199
1	14.20	10.86	-10.11	1.00	-1.22	13.97	15.73	1.201
1	16.00	11.16	-13.71	1.00	-2.96	18.09	20.19	1.202
1	14.20	10.86	-8.31	1.00	-0.26	13.25	14.66	1.204
1	12.40	10.56	-10.11	1.00	-1.36	11.68	13.81	1.208
1	17.80	11.46	-10.11	1.00	-0.91	18.92	20.14	1.210
1	17.80	11.46	-11.91	1.00	-1.87	19.91	21.41	1.211
2	19.60	11.76	-11.91	1.00	-1.42	21.80	23.30	1.215