DESIGN NOTES:

Reference: Blueline, Grading Plan, April 19, 2023

The following design assumptions were used:
Internal angle of friction for reinforced soil = 32 degrees (design only - see Material Note "F")
Unit weight of reinforced soil = 125 pcf
Maximum wall height = 12.00 feet (single tier), 22.67 feet (total height for two tiers)
Batter of wall = 1H : 10V
Surcharge = Footing Load and Backslope

TECHNICAL SPECIFICATIONS FOR MECHANICALLY STABILIZED LOCK + LOAD RETAINING WALLS
GENERAL:

A. The work involves the supply and installation of soil reinforced retaining walls. The Concrete Panels and Counterforts will consist of Lock + Load Stone. Counterfort and Geogrid are the types of soil reinforcement. The work will include, but is not limited to:
- excavation to the grades shown on the civil drawings
- supply and installation of geogrid reinforcement
- supply and installation of drainage fill and piping
- supply and installation of segmental Lock + Load Stones
- supply and installation of retained and reinforced soil fill

B. The walls shall be installed on undisturbed Native Soils or Structural Fill, as appropriate.

MATERIALS

A. Concrete Panels and Counterforts are locked together to form a "Stone". The retaining walls have been designed on the basis of Lock + Load Retaining Wall "Stones". Stones are to be purchased from a licensed Lock + Load manufacturer. The Lock + Load trademark on each pallet identifies Lock + Load products.

B. Information on the purchase of Lock + Load products can be obtained through:

Pacific LOCK + LOAD, Inc.
Telephone: (503) 682-2868
Website: www.pacificlocknload.com

C. Geogrid - See Geogrid Schedule.

D. Drainage Fill - Drainage Fill placed around and above the perforated drainage pipe shall consist of clean aggregate between 3/4 inch and 1 1/2 inch.

E. Face Gravel - 3/4 inch to 1 inch Clean Crushed Rock, no fines. Face Gravel shall be compacted thoroughly to ensure no settlement of panels.

F. Reinforced Backfill - Suitable granular material approved by the Geotechnical Engineer.

G. Leveling Pad - The Leveling Pad shall consist of angular, crushed aggregate of maximum size of 3/4 inch. The Leveling Pad Fill may be single size or may be well graded containing a maximum of 5% passing the #200 sieve.

EXECUTION

A. Contractor shall excavate to the lines and grades shown on the construction drawings. The Geotechnical Engineer should observe the excavation prior to the placement of the leveling material or fill soils.

B. Over-excavation of deleterious soils or rock shall be replaced with material meeting the specifications described in the section "Material G" above, and compacted to 95% of ASTM D-1557-91 (Modified Proctor) within 2% of the optimum moisture content of the soil.

C. The first course of concrete Lock + Load Stones shall be placed on the Leveling Pad and the alignment and level checked.

D. Stones shall be placed with the top of the panel level and parallel to the wall face. The Counterfort Base installs horizontal and perpendicular to the face of the retaining wall.

E. Geogrid shall be oriented with the highest strength axis perpendicular to the wall alignment.

F. Geogrid reinforcement shall be placed at the levels and to the lengths shown on the drawings beginning at the back of the Lock + Load Panels.

G. The geogrid shall be laid horizontally in the direction perpendicular to the face of the retaining wall. The geogrid shall be pulled taut, free of wrinkles and anchored prior to backfill placement on the geogrid.

H. The geogrid reinforcement shall be continuous throughout their embedment lengths. Spliced connection between shorter pieces of geogrid is not permitted.

I. The drainage pipe discharge points shall be connected to approved discharge.

J. Reinforced and Retained Backfill shall be placed, spread and compacted in such a manner that minimizes the development of slack in the geogrid.

K. Reinforced and Retained Backfill shall be placed and compacted in lifts not to exceed 8 inches where hand compaction equipment is used and not more than 12 inches where heavy compaction equipment is used. FIRST - compact over tail of Counterfort then away from the retaining wall structure. Hand operated compaction equipment (700 lb. to 1,000 lb.) Vibratory Plate shall be used to compact face gravel at wall face.

L. Reinforced and Retained Backfill shall be compacted to 95% of the maximum density as determined by ASTM D-1557-91 (Modified Proctor) or equivalent. The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer and shall be within 2 percentage points of the optimum moisture content.

M. Hand-operated equipment (700 lb. to 1,000 lb. Vibratory Plate) shall be used within 26 inches of the front face of the concrete facing.

N. Tracked construction equipment shall not be operated directly upon the geogrid reinforcement. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid.

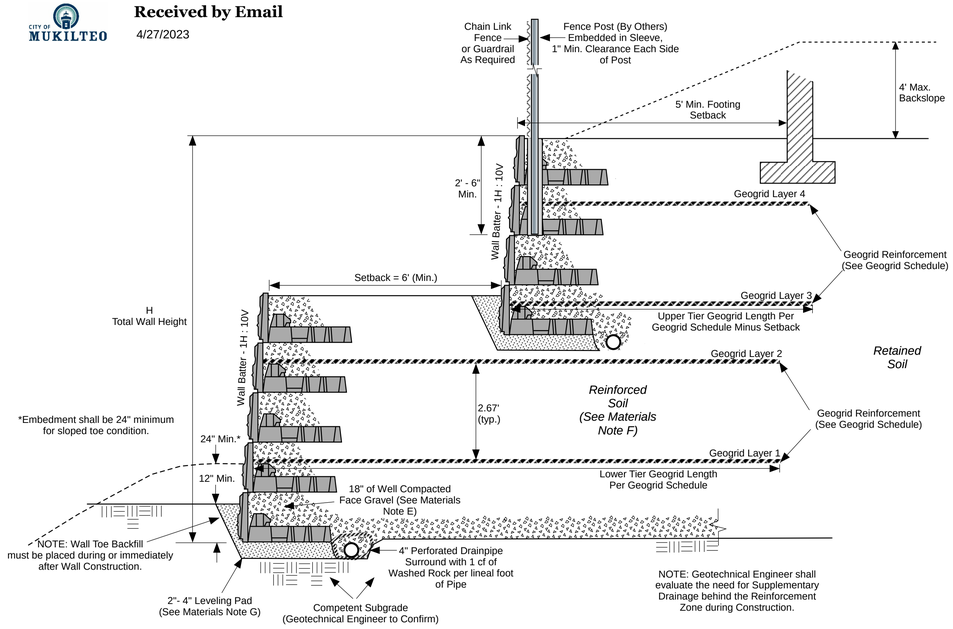
O. Rubber tired equipment may pass over the geogrid reinforcement at slow speeds less than 5 mph. Sudden braking and sharp turning shall be avoided.

P. At the end of each day of operation, the contractor shall slope the last lift of reinforced backfill away from the wall units to direct runoff away from the wall face. The contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

NOTE: Wall Alignment and Heights To Be Established By Contractor / Surveyor.

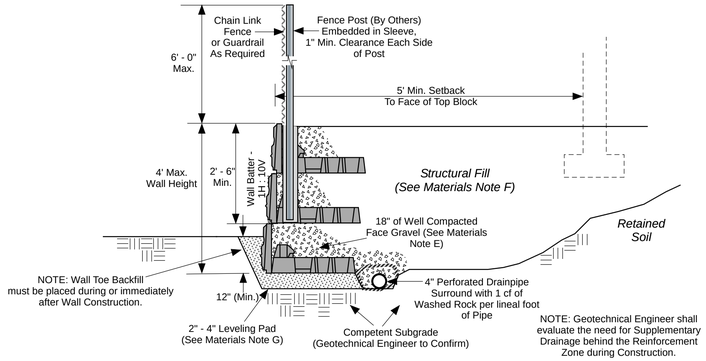
CITY OF MUKILTEO

Received by Email
4/27/2023



TIERED WALL SECTION (If upper tier is within 1H:1V of lower tier)

NOT - TO - SCALE



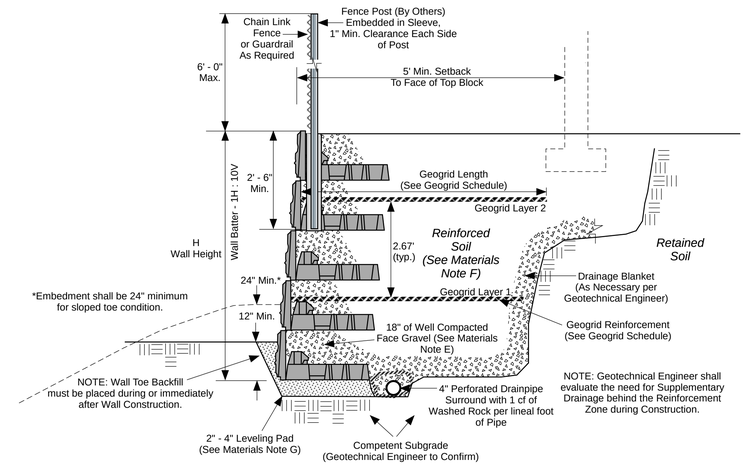
GRAVITY WALL CONDITION (4 Foot Max. Height)

NOT - TO - SCALE

GEOGRID SCHEDULE

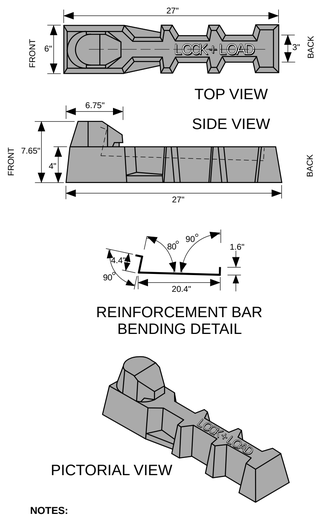
# of Panels	H, Wall Height (feet)	Geogrid Length (feet)	Layers							
			1	2	3	4	5	6	7	8
4	5.33	7.00	A	A	-	-	-	-	-	-
5	6.67	8.00	A	A	-	-	-	-	-	-
6	8.00	9.00	A	A	A	-	-	-	-	-
7	9.33	10.00	A	A	A	-	-	-	-	-
8	10.67	12.00	B	A	A	A	-	-	-	-
9	12.00	14.00	B	A	A	A	-	-	-	-
10	13.33	15.00	B	A	A	A	A	-	-	-
11	14.67	17.00	B	B	A	A	A	-	-	-
12	16.00	18.00	B	B	A	A	A	A	-	-
13	17.33	20.00	C	B	A	A	A	A	-	-
14	18.67	22.00	C	B	B	A	A	A	A	-
15	20.00	23.00	C	B	B	A	A	A	A	-
16	21.33	25.00	C	C	B	B	A	A	A	A
17	22.67	27.00	C	C	B	B	A	A	A	A

GEOGRID: A = Miragrid 5XT
B = Miragrid 8XT
C = Miragrid 10XT



TYPICAL WALL SECTION

NOT - TO - SCALE

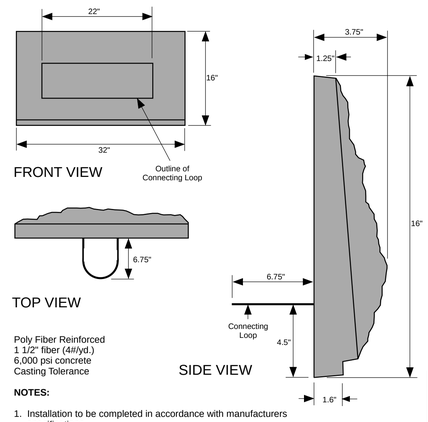


NOTES:

1. Installation to be completed in accordance with manufacturer's specifications.
2. Do not scale from drawings.

LOCK + LOAD COUNTERFORT

NOT - TO - SCALE



NOTES:

1. Installation to be completed in accordance with manufacturers specifications.
2. Do not scale from drawings.

LOCK + LOAD PANEL

NOT - TO - SCALE

HENRY T. WRIGHT
STATE OF WASHINGTON
53803
REGISTERED
PROFESSIONAL ENGINEER
04/24/2023

Lock + Load Wall Designs and Notes
HARBOR GROVE
Mukilteo, Washington

Earth Solutions NW, LLC
Geotechnical Engineering Construction Observation/Testing and Environmental Services

Revisions	Date

Proj. No.	7975.01
Date	04/24/2023
Drawn	MRS
Checked	HTW

Sheet No.
W1

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove
MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

22.67 Foot Tiered Lock + Load Wall with Footing Load

04/24/2023

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100
Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL ....Tier\22.67 Tier.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	c $_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3106 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

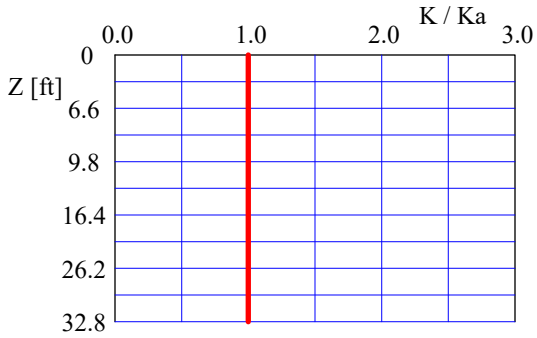
Kae (Kh > 0) = 0.8302 Kae (Kh = 0) = 0.3106 Δ Kae = 0.5196
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd 22.67 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 21.67 ft, where H1 = 11.00 and H2 = 10.67 }

Soil in front of wall is Horizontal.

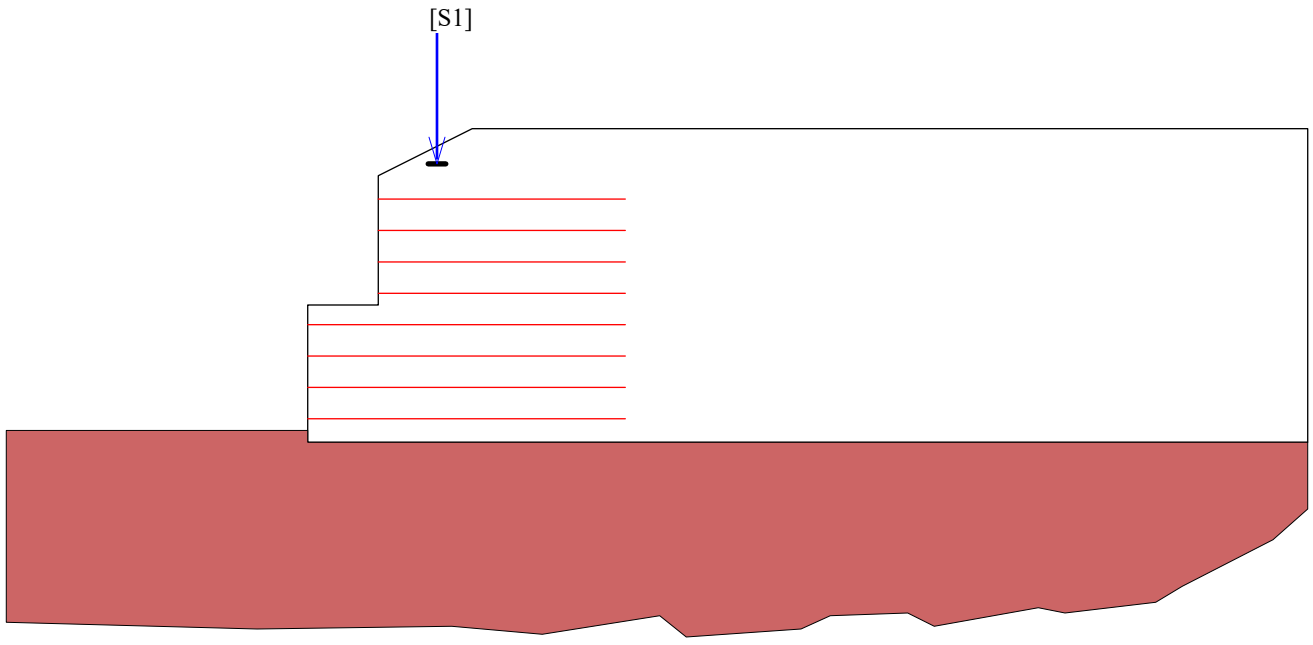
Batter, ω 0.0 [deg]
Backslope, β 26.6 [deg]
Backslope rise 4.0 [ft] Broken back equivalent angle, I = 5.04° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 6.0 ft, Blackslope2 = 0.0 deg. and Backslope rise, S2 = 0.0 ft.

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10[ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 16.68, Meyerhof stress = 3009 lb/ft².
Foundation Interface: Direct sliding, Fs = 3.611, Eccentricity, e/L = -0.0085, Fs-overturning = 9.92

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	27.00	3	N/A	1.55	1.57	1.571	19.415	2.963	-0.0211	Miragrid 1..
2	4.67	27.00	3	N/A	2.21	2.23	2.229	23.240	3.252	-0.0389	Miragrid 1..
3	7.33	27.00	2	N/A	1.95	1.97	1.966	21.854	3.599	-0.0588	Miragrid 8XT
4	10.00	27.00	2	N/A	2.00	2.02	2.024	18.295	4.024	-0.0828	Miragrid 8XT
5	12.67	21.00	1	N/A	1.92	1.94	1.943	18.139	4.640	0.0088	Miragrid 5XT
6	15.33	21.00	1	N/A	1.98	2.00	2.004	13.563	5.700	-0.0005	Miragrid 5XT
7	18.00	21.00	1	N/A	2.38	2.40	2.404	10.873	7.403	-0.0097	Miragrid 5XT
8	20.67	21.00	1	N/A	2.06	2.08	2.080	5.292	10.573	-0.0207	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 8.98, Meyerhof stress = 4125 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.321, Eccentricity, e/L = 0.1356, Fs-overturning = 2.82

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	27.00	3	N/A	1.19	1.20	1.204	13.112	1.145	0.0903	Miragrid 1..
2	4.67	27.00	3	N/A	1.57	1.58	1.584	14.143	1.383	0.0348	Miragrid 1..
3	7.33	27.00	2	N/A	1.36	1.37	1.372	12.974	1.756	-0.0153	Miragrid 8XT
4	10.00	27.00	2	N/A	1.41	1.43	1.428	11.028	2.439	-0.0620	Miragrid 8XT
5	12.67	21.00	1	N/A	1.21	1.22	1.224	9.410	1.629	0.0717	Miragrid 5XT
6	15.33	21.00	1	N/A	1.27	1.28	1.284	7.192	2.259	0.0311	Miragrid 5XT
7	18.00	21.00	1	N/A	1.47	1.48	1.485	5.498	3.598	0.0015	Miragrid 5XT
8	20.67	21.00	1	N/A	1.38	1.40	1.397	2.985	7.520	-0.0192	Miragrid 5XT

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

21.33 Foot Tiered Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL ....Tier\21.33 Tier.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3110 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

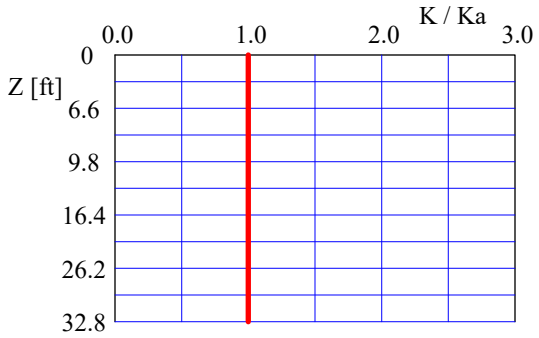
Kae (Kh > 0) = 0.8440 Kae (Kh = 0) = 0.3110 Δ Kae = 0.5330
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd 21.34 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 20.34 ft, where H1 = 9.67 and H2 = 10.67 }

Soil in front of wall is Horizontal.

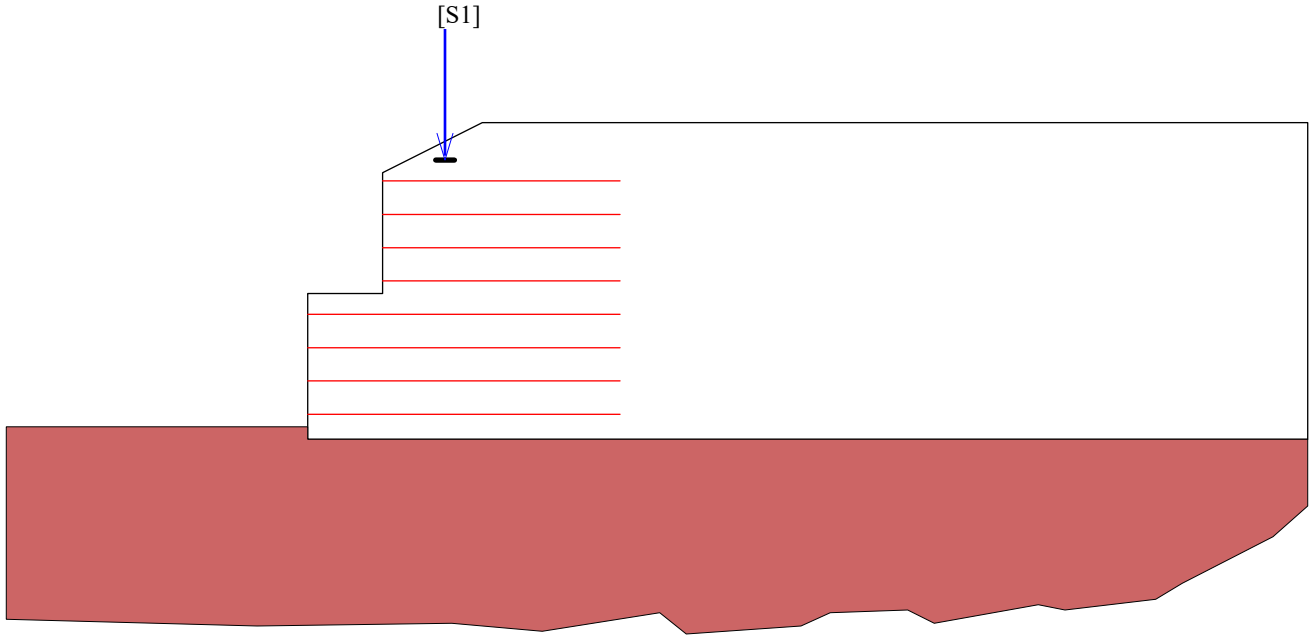
Batter, ω 0.0 [deg]
Backslope, β 26.6 [deg]
Backslope rise 4.0 [ft] Broken back equivalent angle, I = 5.35° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 6.0 ft, Blackslope2 = 0.0 deg. and Backslope rise, S2 = 0.0 ft.

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 16.39, Meyerhof stress = 2842 lb/ft².

Foundation Interface: Direct sliding, Fs = 3.500, Eccentricity, e/L = -0.0071, Fs-overturning = 9.41

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	25.00	3	N/A	1.65	1.66	1.662	17.835	2.880	-0.0210	Miragrid 1..
2	4.67	25.00	3	N/A	2.35	2.37	2.375	21.252	3.175	-0.0407	Miragrid 1..
3	7.33	25.00	2	N/A	2.09	2.11	2.111	19.864	3.531	-0.0629	Miragrid 8XT
4	10.00	25.00	2	N/A	2.17	2.19	2.194	16.509	3.969	-0.0902	Miragrid 8XT
5	12.67	19.00	1	N/A	2.11	2.13	2.129	15.248	4.623	0.0061	Miragrid 5XT
6	15.33	19.00	1	N/A	2.19	2.21	2.211	10.781	5.814	-0.0048	Miragrid 5XT
7	18.00	19.00	1	N/A	2.59	2.62	2.617	7.687	7.851	-0.0163	Miragrid 5XT
8	20.67	19.00	1	N/A	3.55	3.59	3.586	4.757	12.108	-0.0328	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 8.59, Meyerhof stress = 3951 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.303, Eccentricity, e/L = 0.1383, Fs-overturning = 2.77

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	25.00	3	N/A	1.27	1.28	1.284	12.172	1.138	0.0890	Miragrid 1..
2	4.67	25.00	3	N/A	1.69	1.70	1.703	13.089	1.396	0.0291	Miragrid 1..
3	7.33	25.00	2	N/A	1.47	1.49	1.486	11.931	1.816	-0.0248	Miragrid 8XT
4	10.00	25.00	2	N/A	1.54	1.56	1.560	10.053	3.867	-0.0901	Miragrid 8XT
5	12.67	19.00	1	N/A	1.34	1.35	1.353	7.999	1.705	0.0625	Miragrid 5XT
6	15.33	19.00	1	N/A	1.41	1.43	1.429	5.784	2.503	0.0198	Miragrid 5XT
7	18.00	19.00	1	N/A	1.63	1.65	1.647	3.980	4.455	-0.0100	Miragrid 5XT
8	20.67	19.00	1	N/A	2.05	2.08	2.075	2.212	11.253	-0.0326	Miragrid 5XT

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

20 Foot Tiered Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL .... w Tier\20 Tier.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3116 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

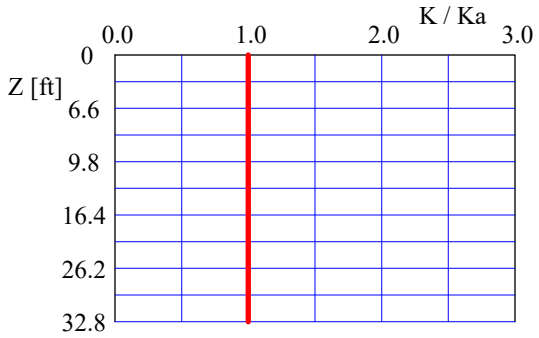
Kae (Kh > 0) = 0.8612 Kae (Kh = 0) = 0.3116 Δ Kae = 0.5496
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd 20.00 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 19.00 ft, where H1 = 9.67 and H2 = 9.33 }

Soil in front of wall is Horizontal.

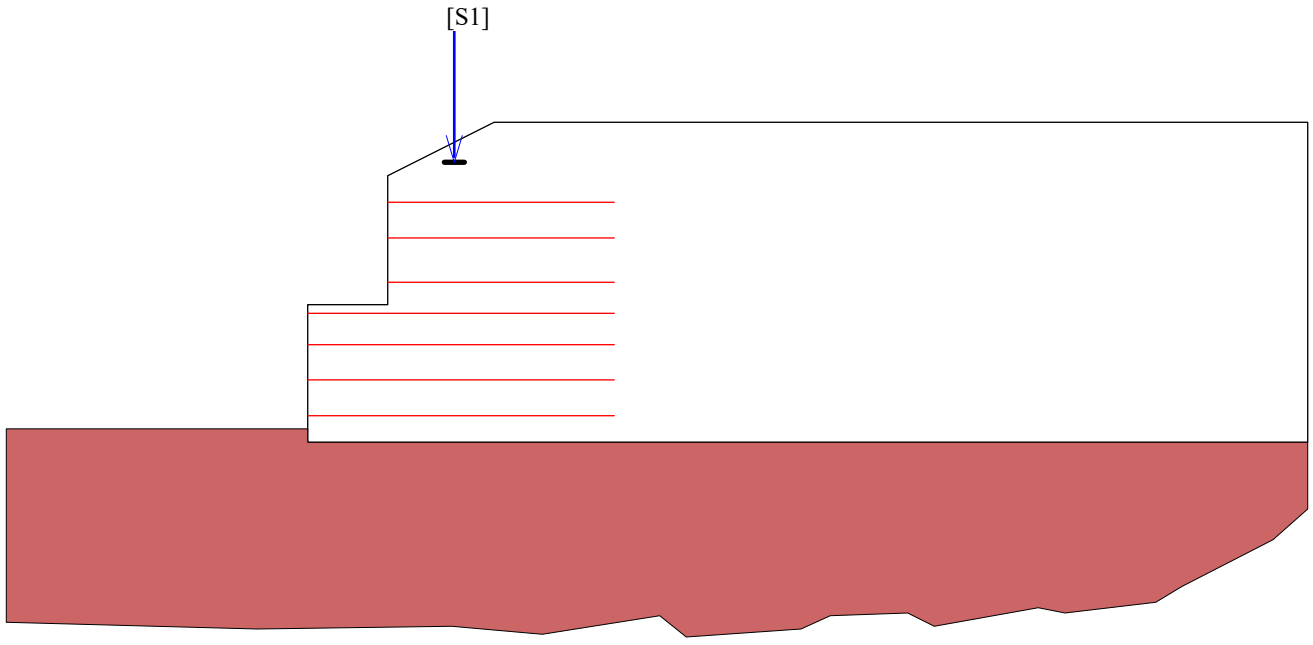
Batter, ω 0.0 [deg]
Backslope, β 26.6 [deg]
Backslope rise 4.0 [ft] Broken back equivalent angle, I = 5.71° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 6.0 ft, Blackslope2 = 0.0 deg. and Backslope rise, S2 = 0.0 ft.

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 15.95, Meyerhof stress = 2662 lb/ft².
Foundation Interface: Direct sliding, Fs = 3.324, Eccentricity, e/L = -0.0114, Fs-overturning = 8.82

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	23.00	3	N/A	1.82	1.84	1.839	16.937	2.739	-0.0277	Miragrid 1..
2	4.67	23.00	2	N/A	2.05	2.08	2.076	20.181	3.024	-0.0513	Miragrid 8XT
3	7.33	23.00	2	N/A	2.53	2.55	2.553	19.998	3.367	-0.0788	Miragrid 8XT
4	9.67	23.00	1	N/A	2.43	2.46	2.457	24.526	3.726	-0.1094	Miragrid 5XT
5	12.00	17.00	1	N/A	1.53	1.54	1.545	8.833	4.355	0.0055	Miragrid 5XT
6	15.33	17.00	1	N/A	2.12	2.14	2.140	6.825	5.964	-0.0112	Miragrid 5XT
7	18.00	17.00	1	N/A	2.09	2.11	2.111	3.215	8.491	-0.0268	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 8.59, Meyerhof stress = 3654 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.279, Eccentricity, e/L = 0.1350, Fs-overturning = 2.73

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	23.00	3	N/A	1.46	1.48	1.476	12.191	1.130	0.0798	Miragrid 1..
2	4.67	23.00	2	N/A	1.54	1.56	1.557	13.226	1.418	0.0129	Miragrid 8XT
3	7.33	23.00	2	N/A	1.83	1.85	1.850	12.498	1.921	-0.0475	Miragrid 8XT
4	9.67	23.00	1	N/A	1.58	1.60	1.600	13.279	3.708	-0.1094	Miragrid 5XT
5	12.00	17.00	1	N/A	1.17	1.18	1.182	5.947	1.649	0.0649	Miragrid 5XT
6	15.33	17.00	1	N/A	1.54	1.55	1.555	4.279	2.871	0.0062	Miragrid 5XT
7	18.00	17.00	1	N/A	1.57	1.58	1.584	2.107	6.004	-0.0244	Miragrid 5XT

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title:	Harbor Grove
Project Number:	ES-7975.01
Client:	Sea Pac Homes
Designer:	HTW
Station Number:	

Description:

18.67 Foot Tiered Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL ....Tier\18.67 Tier.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3122 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

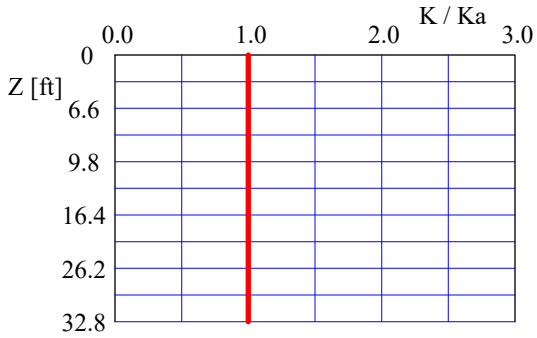
Kae (Kh > 0) = 0.8830 Kae (Kh = 0) = 0.3122 Δ Kae = 0.5708
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd 18.66 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 17.66 ft, where H1 = 8.33 and H2 = 9.33 }

Soil in front of wall is Horizontal.

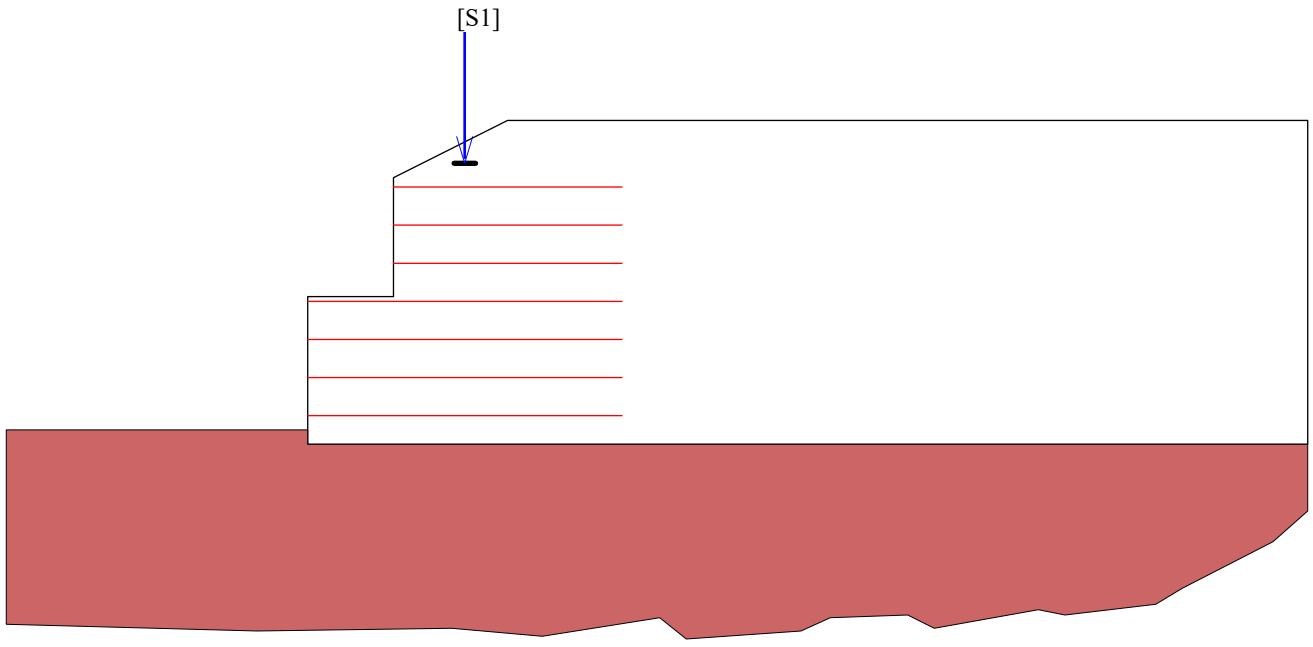
Batter, ω 0.0 [deg]
Backslope, β 26.6 [deg]
Backslope rise 4.0 [ft] Broken back equivalent angle, I = 6.12° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 6.0 ft, Blackslope2 = 0.0 deg. and Backslope rise, S2 = 0.0 ft.

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 16.03, Meyerhof stress = 2525 lb/ft².
Foundation Interface: Direct sliding, Fs = 3.364, Eccentricity, e/L = -0.0128, Fs-overturning = 9.04

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	22.00	3	N/A	2.02	2.04	2.043	16.763	2.783	-0.0297	Miragrid 1..
2	4.67	22.00	2	N/A	2.34	2.36	2.364	20.243	3.092	-0.0544	Miragrid 8XT
3	7.33	22.00	2	N/A	2.68	2.71	2.707	18.389	3.468	-0.0839	Miragrid 8XT
4	10.00	22.00	1	N/A	2.94	2.97	2.973	24.469	3.926	-0.1238	Miragrid 5XT
5	12.67	16.00	1	N/A	1.55	1.57	1.567	6.150	4.887	-0.0044	Miragrid 5XT
6	15.33	16.00	1	N/A	2.64	2.67	2.669	5.625	6.581	-0.0197	Miragrid 5XT
7	18.00	16.00	1	N/A	3.63	3.67	3.668	2.062	10.116	-0.0413	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 9.24, Meyerhof stress = 3352 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.320, Eccentricity, e/L = 0.1222, Fs-overturning = 2.91

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	22.00	3	N/A	1.63	1.65	1.649	12.169	1.180	0.0663	Miragrid 1..
2	4.67	22.00	2	N/A	1.76	1.78	1.778	13.305	1.515	-0.0010	Miragrid 8XT
3	7.33	22.00	2	N/A	1.99	2.01	2.007	11.851	3.188	-0.0828	Miragrid 8XT
4	10.00	22.00	1	N/A	1.89	1.91	1.913	13.049	3.920	-0.1238	Miragrid 5XT
5	12.67	16.00	1	N/A	1.23	1.24	1.243	4.355	2.080	0.0311	Miragrid 5XT
6	15.33	16.00	1	N/A	1.89	1.91	1.907	3.448	3.701	-0.0107	Miragrid 5XT
7	18.00	16.00	1	N/A	2.44	2.47	2.465	1.165	9.402	-0.0412	Miragrid 5XT

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

17.33 Foot Tiered Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL ....Tier\17.33 Tier.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3130 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

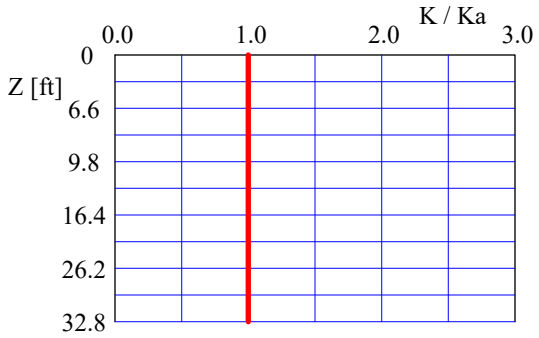
Kae (Kh > 0) = 0.9116 Kae (Kh = 0) = 0.3130 Δ Kae = 0.5986
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd 17.33 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 16.33 ft, where H1 = 8.33 and H2 = 8.00 }

Soil in front of wall is Horizontal.

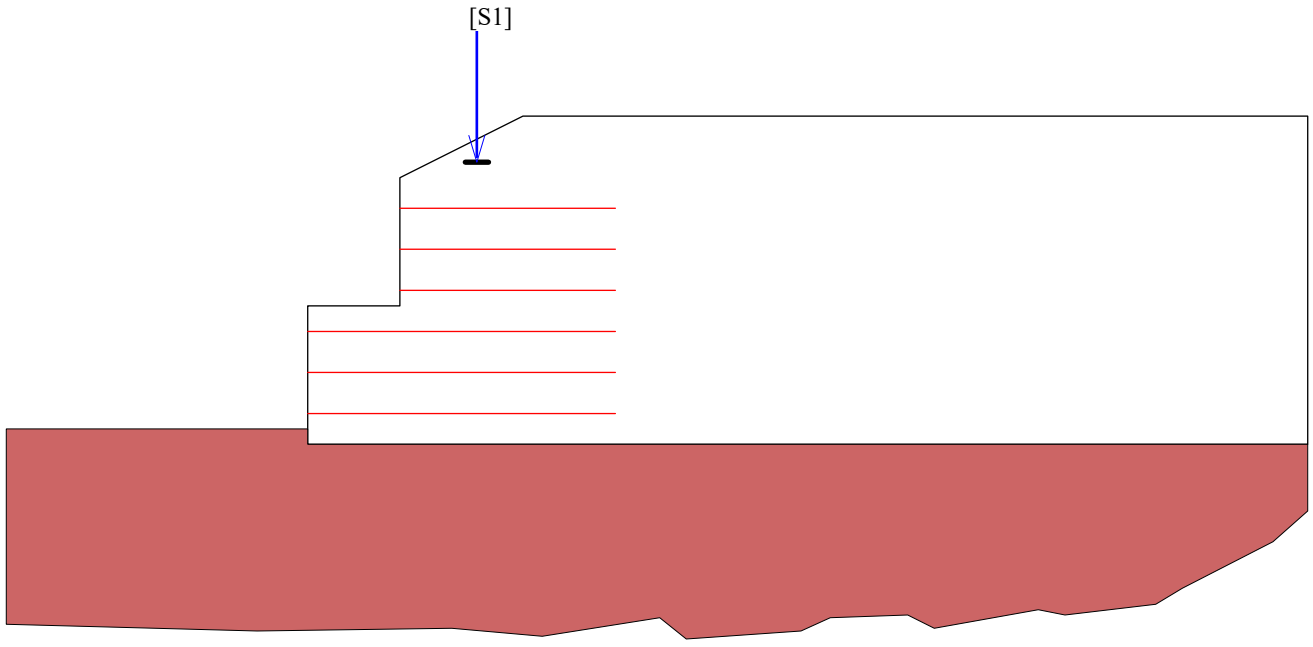
Batter, ω 0.0 [deg]
Backslope, β 26.6 [deg]
Backslope rise 4.0 [ft] Broken back equivalent angle, I = 6.58° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 6.0 ft, Blackslope2 = 0.0 deg. and Backslope rise, S2 = 0.0 ft.

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 15.53, Meyerhof stress = 2342 lb/ft².

Foundation Interface: Direct sliding, Fs = 3.152, Eccentricity, e/L = -0.0182, Fs-overturning = 8.35

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	20.00	3	N/A	2.48	2.50	2.502	17.190	2.609	-0.0387	Miragrid 1..
2	4.67	20.00	2	N/A	2.99	3.02	3.024	21.275	2.898	-0.0694	Miragrid 8XT
3	7.33	20.00	1	N/A	1.79	1.80	1.803	15.497	3.242	-0.1080	Miragrid 5XT
4	10.00	14.00	1	N/A	2.35	2.38	2.378	9.843	3.780	0.0064	Miragrid 5XT
5	12.67	14.00	1	N/A	2.46	2.49	2.487	5.828	4.889	-0.0127	Miragrid 5XT
6	15.33	14.00	1	N/A	2.13	2.16	2.156	1.927	6.927	-0.0342	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 9.27, Meyerhof stress = 3058 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.287, Eccentricity, e/L = 0.1178, Fs-overturning = 2.87

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	20.00	3	N/A	1.93	1.94	1.944	11.831	1.168	0.0540	Miragrid 1..
2	4.67	20.00	2	N/A	2.12	2.14	2.145	12.911	1.552	-0.0230	Miragrid 8XT
3	7.33	20.00	1	N/A	1.32	1.33	1.334	9.955	3.138	-0.1077	Miragrid 5XT
4	10.00	14.00	1	N/A	1.69	1.71	1.709	6.078	1.459	0.0805	Miragrid 5XT
5	12.67	14.00	1	N/A	1.80	1.82	1.822	3.697	2.320	0.0137	Miragrid 5XT
6	15.33	14.00	1	N/A	1.67	1.69	1.688	1.340	4.853	-0.0306	Miragrid 5XT

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

16 Foot Tiered Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL .... w Tier\16 Tier.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	125.0 lb/ft ³
Design value of internal angle of friction, ϕ	32.0 °

RETAINED SOIL

Unit weight, γ	125.0 lb/ft ³
Design value of internal angle of friction, ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{equiv.}$	32.0 °
Equivalent cohesion, $c_{equiv.}$	0.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3140 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ= 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

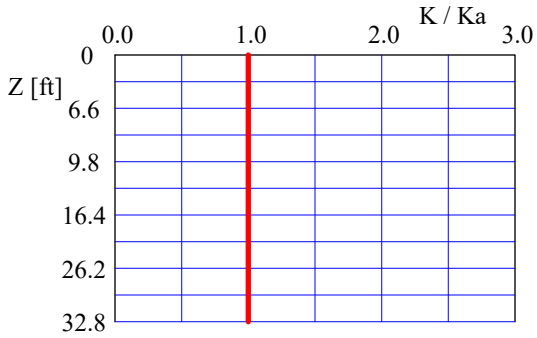
Kae (Kh > 0) = 0.9518 Kae (Kh = 0) = 0.3140 Δ Kae = 0.6377
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd 16.00 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 15.00 ft, where H1 = 7.00 and H2 = 8.00 }

Soil in front of wall is Horizontal.

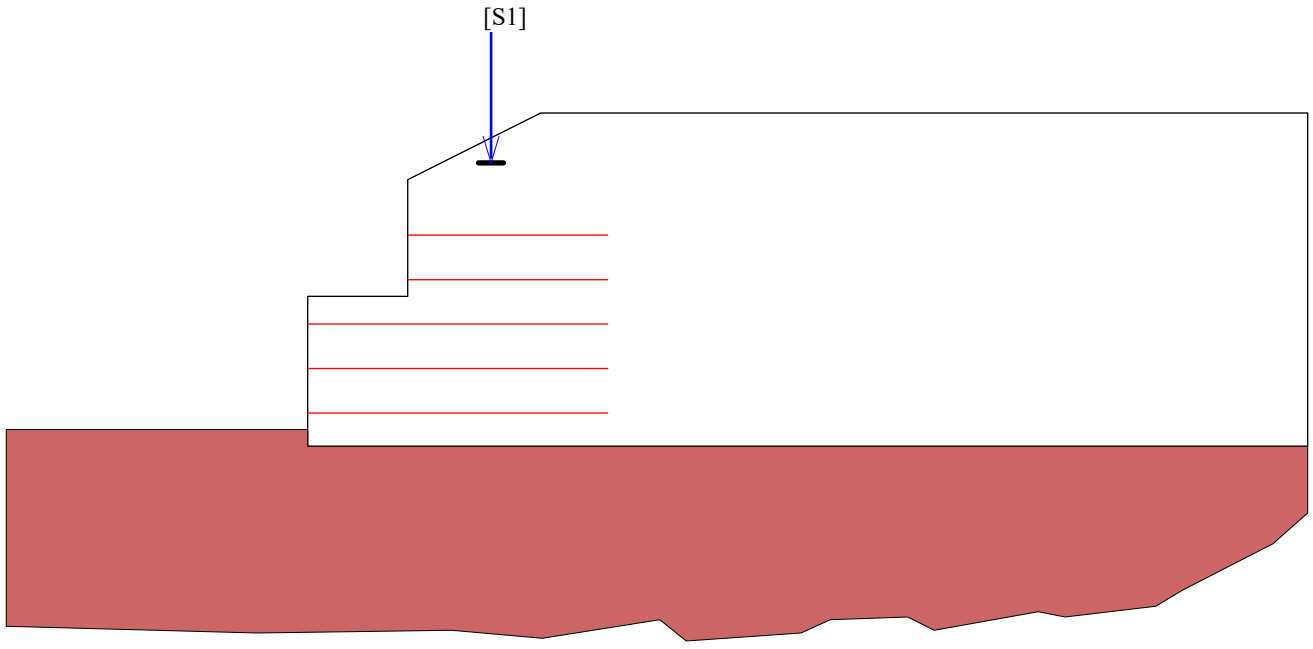
Batter, ω 0.0 [deg]
Backslope, β 26.6 [deg]
Backslope rise 4.0 [ft] Broken back equivalent angle, I = 7.13° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 6.0 ft, Blackslope2 = 0.0 deg. and Backslope rise, S2 = 0.0 ft.

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 15.18, Meyerhof stress = 2166 lb/ft².
Foundation Interface: Direct sliding, Fs = 2.986, Eccentricity, e/L = -0.0149, Fs-overturning = 7.64

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	18.00	2	N/A	2.07	2.09	2.093	15.110	2.479	-0.0383	Miragrid 8XT
2	4.67	18.00	2	N/A	3.27	3.31	3.306	18.653	2.764	-0.0737	Miragrid 8XT
3	7.33	18.00	1	N/A	2.15	2.17	2.169	14.524	3.098	-0.1199	Miragrid 5XT
4	10.00	12.00	1	N/A	3.23	3.26	3.261	9.107	3.639	-0.0008	Miragrid 5XT
5	12.67	12.00	1	N/A	1.68	1.69	1.694	2.286	4.882	-0.0266	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 8.53, Meyerhof stress = 2919 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.245, Eccentricity, e/L = 0.1247, Fs-overturning = 2.75

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	18.00	2	N/A	1.59	1.61	1.608	10.230	1.146	0.0525	Miragrid 8XT
2	4.67	18.00	2	N/A	2.28	2.30	2.304	11.053	2.323	-0.0689	Miragrid 8XT
3	7.33	18.00	1	N/A	1.53	1.54	1.542	8.845	2.975	-0.1194	Miragrid 5XT
4	10.00	12.00	1	N/A	2.15	2.17	2.171	5.079	1.515	0.0649	Miragrid 5XT
5	12.67	12.00	1	N/A	1.37	1.38	1.380	1.682	2.697	-0.0098	Miragrid 5XT

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

14.67 Foot Tiered Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL ....Tier\14.67 Tier.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	c $_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3153 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

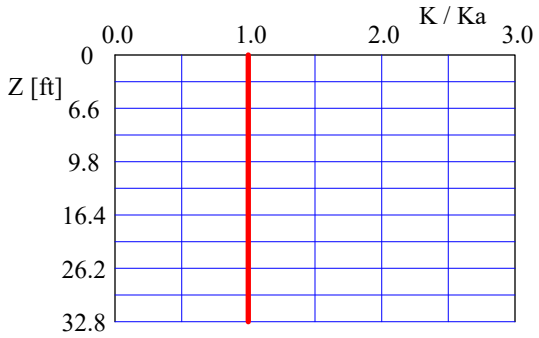
Kae (Kh > 0) = 1.0150 Kae (Kh = 0) = 0.3153 Δ Kae = 0.6996
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd 14.67 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 13.67 ft, where H1 = 7.00 and H2 = 6.67 }

Soil in front of wall is Horizontal.

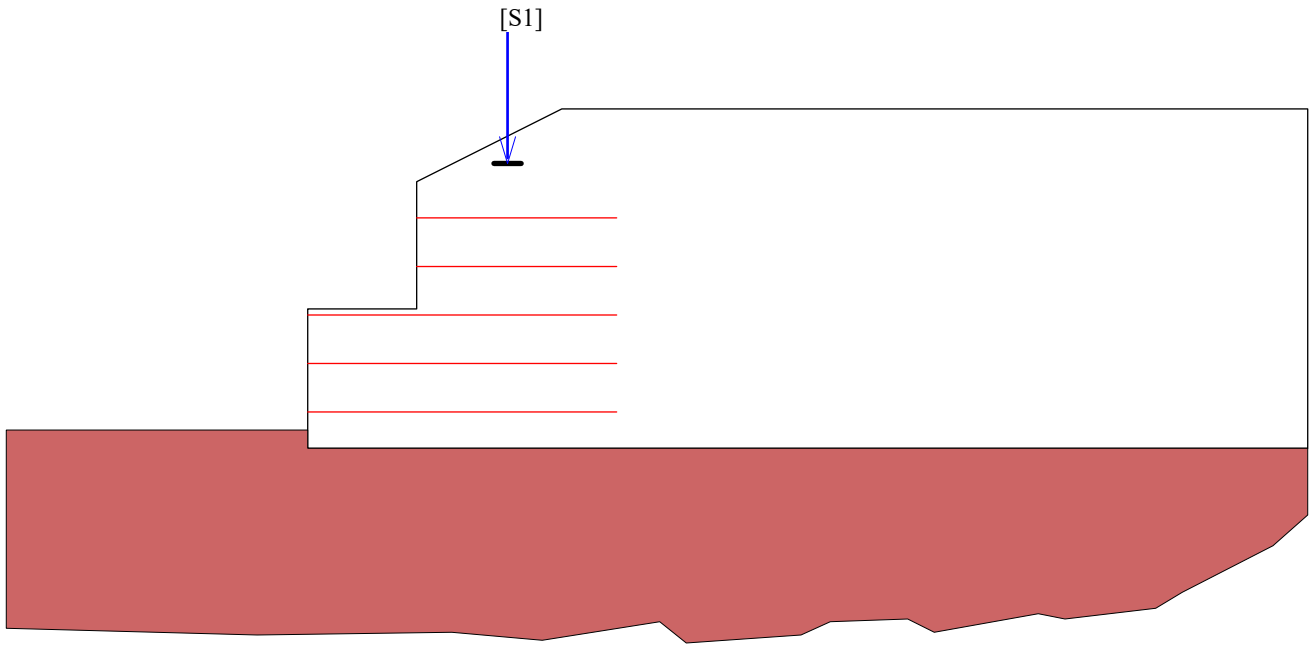
Batter, ω 0.0 [deg]
Backslope, β 26.6 [deg]
Backslope rise 4.0 [ft] Broken back equivalent angle, I = 7.76° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 6.0 ft, Blackslope2 = 0.0 deg. and Backslope rise, S2 = 0.0 ft.

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 15.01, Meyerhof stress = 2017 lb/ft².
Foundation Interface: Direct sliding, Fs = 2.924, Eccentricity, e/L = -0.0265, Fs-overturning = 7.73

	GEOGRID			CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	17.00	2	N/A	2.66	2.69	2.689	16.675	2.428	-0.0535	Miragrid 8XT
2	4.67	17.00	1	N/A	4.23	4.27	4.274	31.952	2.703	-0.0967	Miragrid 5XT
3	7.33	17.00	1	N/A	6.83	6.90	6.897	37.793	3.003	-0.1583	Miragrid 5XT
4	10.00	11.00	1	N/A	2.27	2.29	2.294	4.229	3.806	-0.0139	Miragrid 5XT
5	12.67	11.00	1	N/A	2.60	2.63	2.627	1.757	5.366	-0.0468	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 9.92, Meyerhof stress = 2509 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.273, Eccentricity, e/L = 0.1006, Fs-overturning = 2.98

	GEOGRID			CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	17.00	2	N/A	2.01	2.03	2.027	11.000	1.200	0.0234	Miragrid 8XT
2	4.67	17.00	1	N/A	2.43	2.45	2.455	14.718	2.428	-0.0943	Miragrid 5XT
3	7.33	17.00	1	N/A	3.29	3.33	3.326	14.017	2.997	-0.1582	Miragrid 5XT
4	10.00	11.00	1	N/A	1.79	1.81	1.809	2.971	1.749	0.0322	Miragrid 5XT
5	12.67	11.00	1	N/A	2.06	2.08	2.085	1.245	3.689	-0.0405	Miragrid 5XT

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

13.33 Foot Tiered Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL ....Tier\13.33 Tier.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3171 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

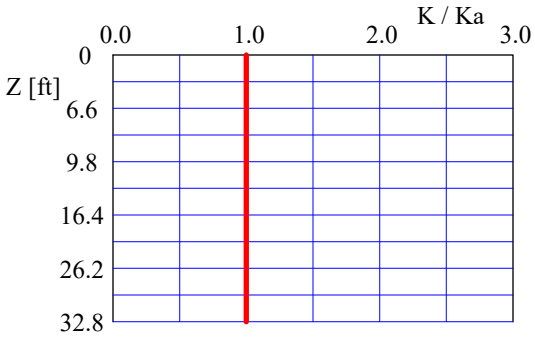
Kae (Kh > 0) = 1.1637 Kae (Kh = 0) = 0.3171 Δ Kae = 0.8466
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd 13.34 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 12.34 ft, where H1 = 5.67 and H2 = 6.67 }

Soil in front of wall is Horizontal.

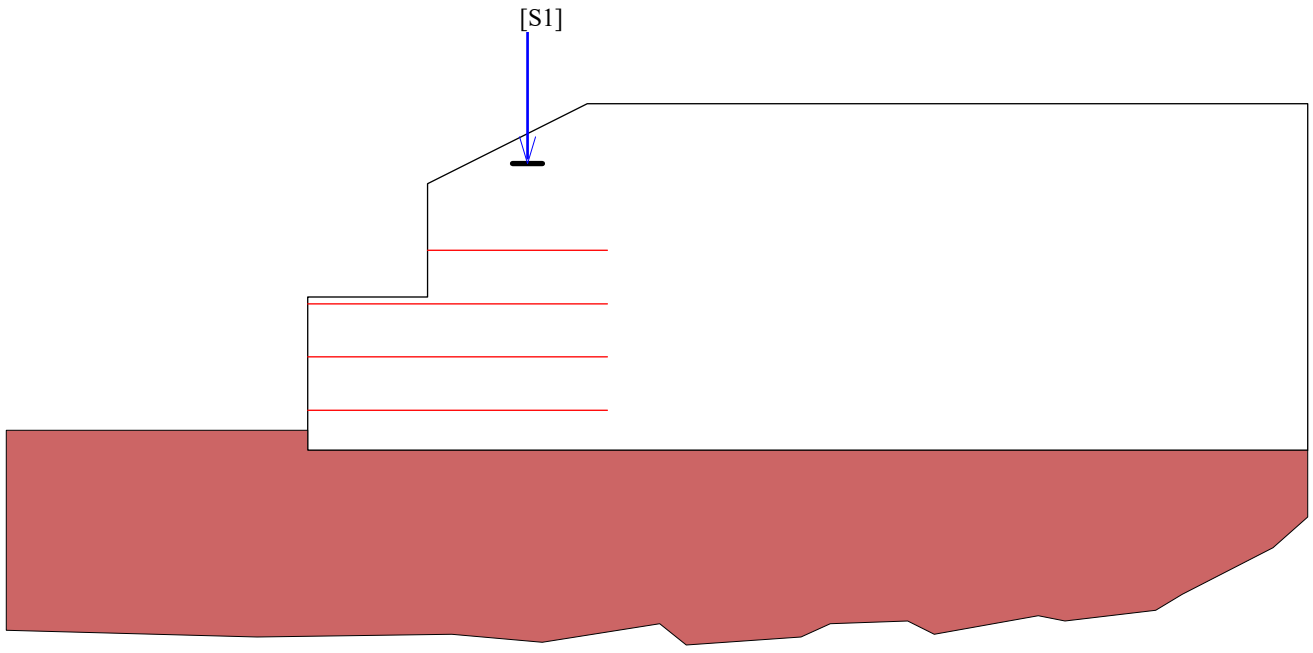
Batter, ω 0.0 [deg]
Backslope, β 26.6 [deg]
Backslope rise 4.0 [ft] Broken back equivalent angle, I = 8.53° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 6.0 ft, Blackslope2 = 0.0 deg. and Backslope rise, S2 = 0.0 ft.

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 14.65, Meyerhof stress = 1836 lb/ft².
Foundation Interface: Direct sliding, Fs = 2.720, Eccentricity, e/L = -0.0211, Fs-overturning = 6.89

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	15.00	2	N/A	2.87	2.90	2.902	14.011	2.262	-0.0527	Miragrid 8XT
2	4.67	15.00	1	N/A	4.57	4.61	4.612	25.845	2.517	-0.1044	Miragrid 5XT
3	7.33	15.00	1	N/A	7.88	7.96	7.961	31.468	2.769	-0.1840	Miragrid 5XT
4	10.00	9.00	1	N/A	2.24	2.26	2.260	2.366	3.605	-0.0358	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 8.36, Meyerhof stress = 2464 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.177, Eccentricity, e/L = 0.1198, Fs-overturning = 2.69

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	15.00	2	N/A	2.14	2.16	2.158	9.068	1.660	-0.0354	Miragrid 8XT
2	4.67	15.00	1	N/A	2.58	2.60	2.604	11.649	2.190	-0.1005	Miragrid 5XT
3	7.33	15.00	1	N/A	3.63	3.66	3.663	11.027	2.760	-0.1839	Miragrid 5XT
4	10.00	9.00	1	N/A	1.81	1.83	1.830	1.726	1.880	-0.0009	Miragrid 5XT

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

12 Foot Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL .... w Tier\12 Foot.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3102 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

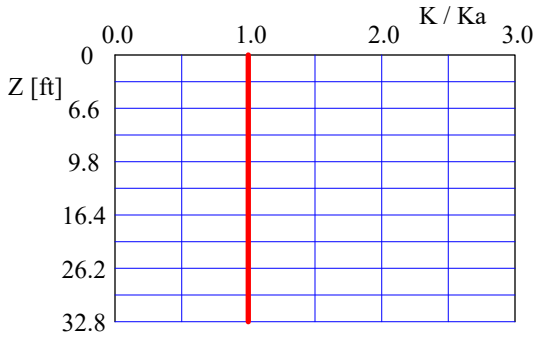
Kae (Kh > 0) = 0.7621 Kae (Kh = 0) = 0.2709 Δ Kae = 0.4912
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 12.00 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 11.00 ft }

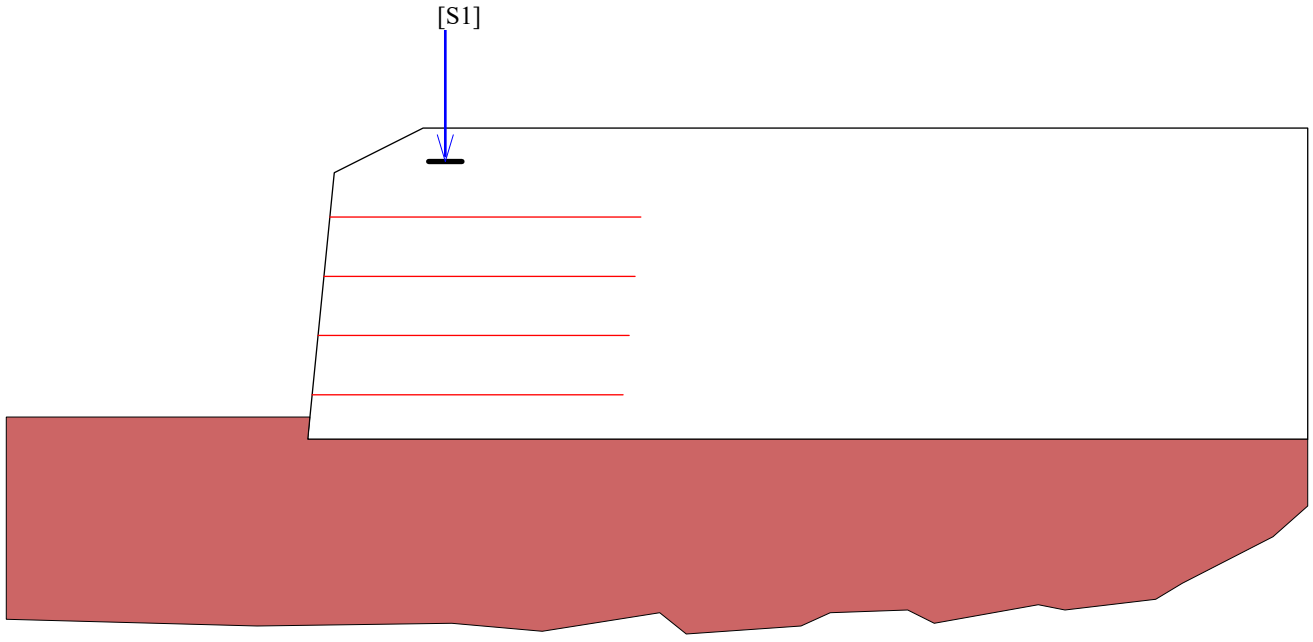
Soil in front of wall is Horizontal.

Batter, ω 5.7 [deg]
Backslope, β 26.6 [deg]
Backslope rise 2.0 [ft] Broken back equivalent angle, I = 4.76° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 13.59, Meyerhof stress = 1868 lb/ft².

Foundation Interface: Direct sliding, Fs = 4.062, Eccentricity, e/L = 0.0191, Fs-overturning = 10.38

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	14.00	2	N/A	2.26	2.29	2.287	9.681	3.689	0.0097	Miragrid 8XT
2	4.67	14.00	1	N/A	2.24	2.26	2.264	11.014	4.843	0.0009	Miragrid 5XT
3	7.33	14.00	1	N/A	2.74	2.76	2.763	9.050	6.984	-0.0035	Miragrid 5XT
4	10.00	14.00	1	N/A	2.19	2.21	2.208	4.107	12.361	-0.0028	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 6.14, Meyerhof stress = 2793 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.370, Eccentricity, e/L = 0.1780, Fs-overturning = 2.53

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	14.00	2	N/A	1.59	1.60	1.604	5.788	1.250	0.1243	Miragrid 8XT
2	4.67	14.00	1	N/A	1.40	1.41	1.413	5.645	1.672	0.0649	Miragrid 5XT
3	7.33	14.00	1	N/A	1.65	1.66	1.665	4.431	2.781	0.0197	Miragrid 5XT
4	10.00	14.00	1	N/A	1.49	1.50	1.505	2.363	6.969	0.0003	Miragrid 5XT

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

10.67 Foot Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL ....Tier\10.67 Foot.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3110 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

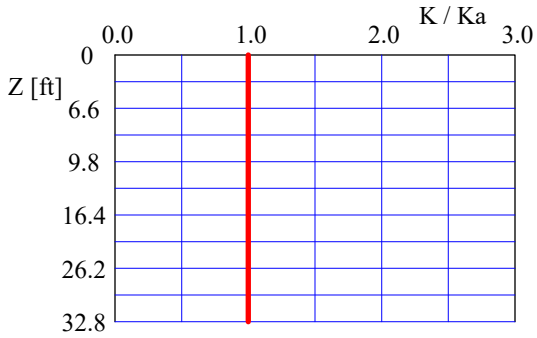
Kae (Kh > 0) = 0.7844 Kae (Kh = 0) = 0.2713 Δ Kae = 0.5131
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 10.67 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 9.67 ft }

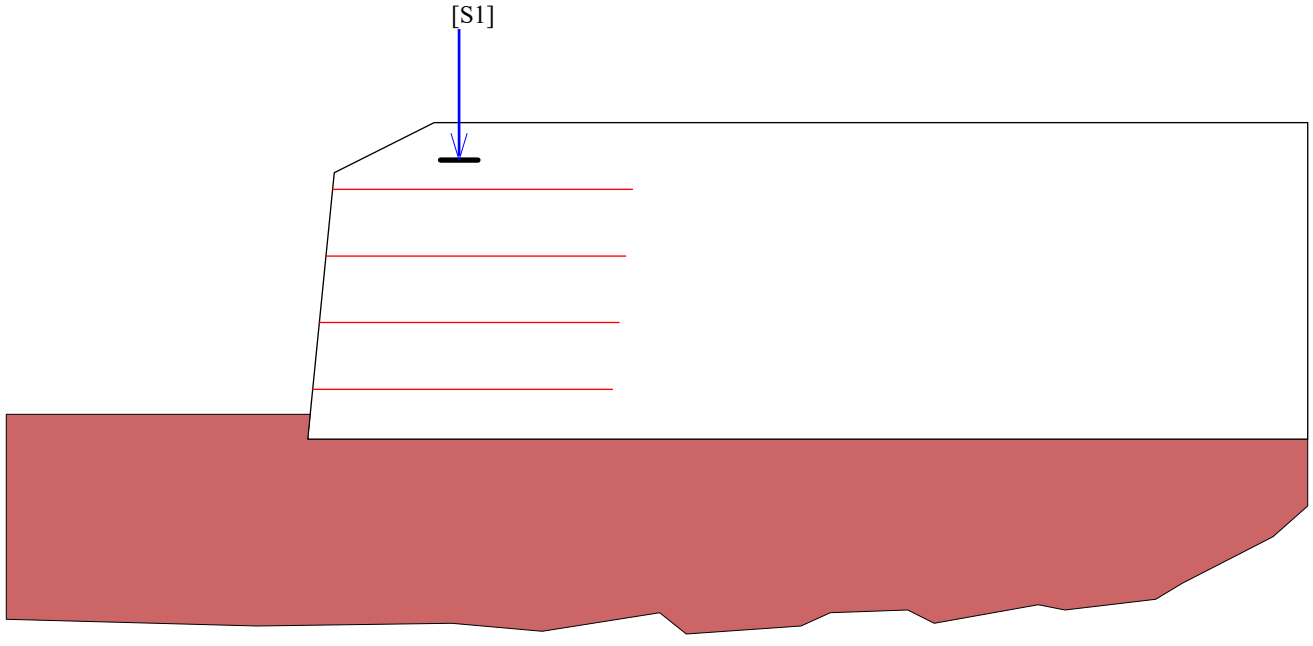
Soil in front of wall is Horizontal.

Batter, ω 5.7 [deg]
Backslope, β 26.6 [deg]
Backslope rise 2.0 [ft] Broken back equivalent angle, I = 5.35° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 12.82, Meyerhof stress = 1709 lb/ft².
Foundation Interface: Direct sliding, Fs = 3.886, Eccentricity, e/L = 0.0173, Fs-overturning = 9.53

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	12.00	2	N/A	2.50	2.52	2.525	8.213	3.605	0.0051	Miragrid 8XT
2	4.67	12.00	1	N/A	2.50	2.52	2.522	9.096	4.944	-0.0064	Miragrid 5XT
3	7.33	12.00	1	N/A	2.97	3.00	3.002	6.879	7.759	-0.0130	Miragrid 5XT
4	10.00	12.00	1	N/A	3.73	3.77	3.771	4.302	17.414	-0.0162	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 5.25, Meyerhof stress = 2685 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.305, Eccentricity, e/L = 0.1937, Fs-overturning = 2.32

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	12.00	2	N/A	1.80	1.82	1.816	5.079	1.219	0.1271	Miragrid 8XT
2	4.67	12.00	1	N/A	1.61	1.63	1.630	4.879	1.795	0.0496	Miragrid 5XT
3	7.33	12.00	1	N/A	1.89	1.91	1.911	3.615	3.484	0.0016	Miragrid 5XT
4	10.00	12.00	1	N/A	2.31	2.33	2.332	2.178	14.532	-0.0159	Miragrid 5XT

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

9.33 Foot Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL ....Tier\10.67 Foot.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3122 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

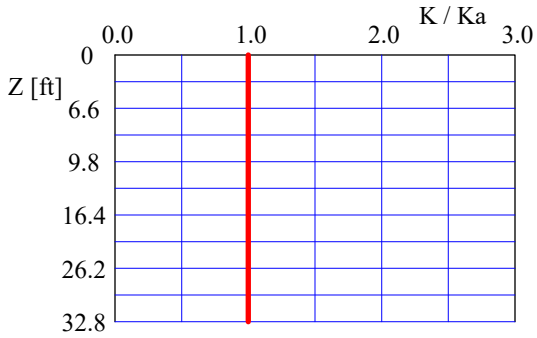
Kae (Kh > 0) = 0.8189 Kae (Kh = 0) = 0.2720 Δ Kae = 0.5469
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 9.33 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 8.33 ft }

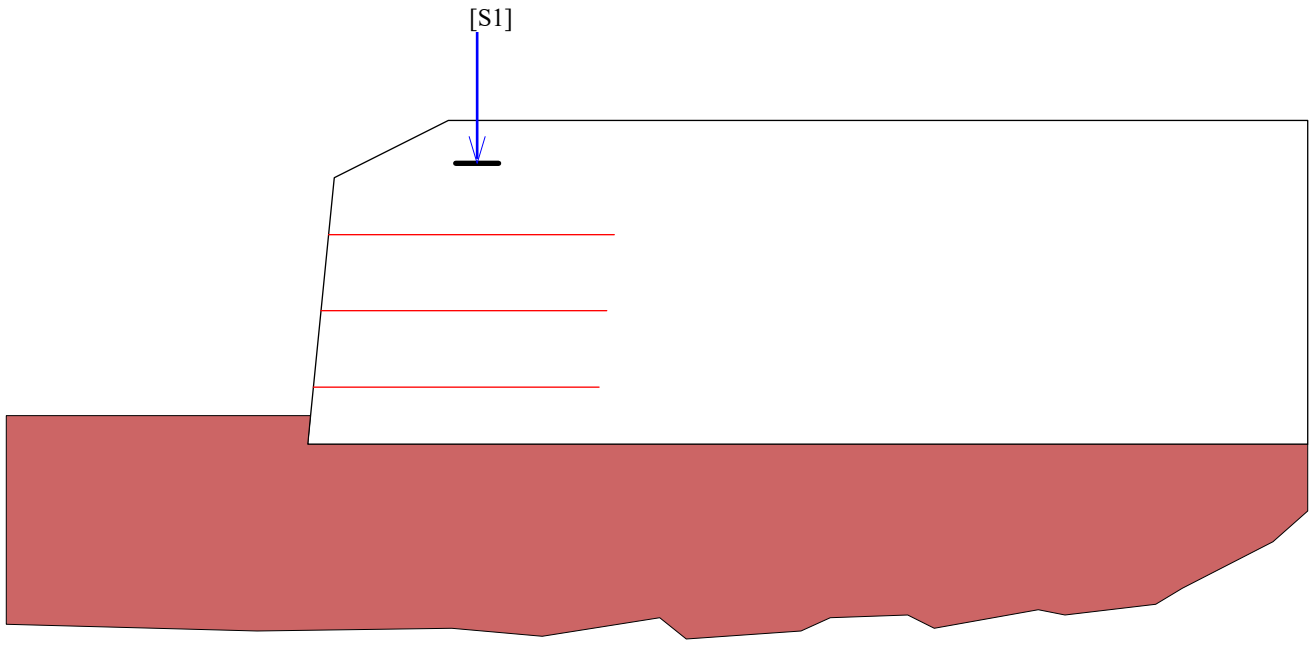
Soil in front of wall is Horizontal.

Batter, ω 5.7 [deg]
Backslope, β 26.6 [deg]
Backslope rise 2.0 [ft] Broken back equivalent angle, I = 6.12° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 12.06, Meyerhof stress = 1541 lb/ft².
Foundation Interface: Direct sliding, Fs = 3.677, Eccentricity, e/L = 0.0116, Fs-overturning = 8.61

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	10.00	1	N/A	2.10	2.12	2.121	7.988	3.508	-0.0053	Miragrid 5XT
2	4.67	10.00	1	N/A	3.15	3.18	3.180	8.129	5.119	-0.0225	Miragrid 5XT
3	7.33	10.00	1	N/A	2.22	2.25	2.247	3.469	9.226	-0.0361	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 4.31, Meyerhof stress = 2597 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.226, Eccentricity, e/L = 0.2137, Fs-overturning = 2.07

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	10.00	1	N/A	1.38	1.40	1.395	4.386	1.187	0.1222	Miragrid 5XT
2	4.67	10.00	1	N/A	1.88	1.90	1.898	3.932	1.997	0.0233	Miragrid 5XT
3	7.33	10.00	1	N/A	1.58	1.60	1.600	2.117	5.114	-0.0299	Miragrid 5XT

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

8 Foot Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL ....L w Tier\8 Foot.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

RETAINED SOIL

Unit weight,	γ	125.0 lb/ft ^{3}
Design value of internal angle of friction,	ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight,	$\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction,	$\phi_{equiv.}$	32.0 °
Equivalent cohesion,	$c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3140 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49 N γ = 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

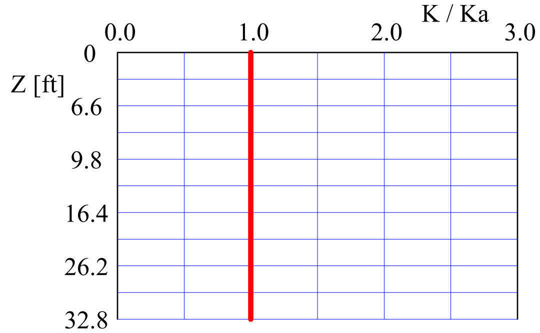
Kae (Kh > 0) = 0.8799 Kae (Kh = 0) = 0.2731 Δ Kae = 0.6068
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 8.00 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 7.00 ft }

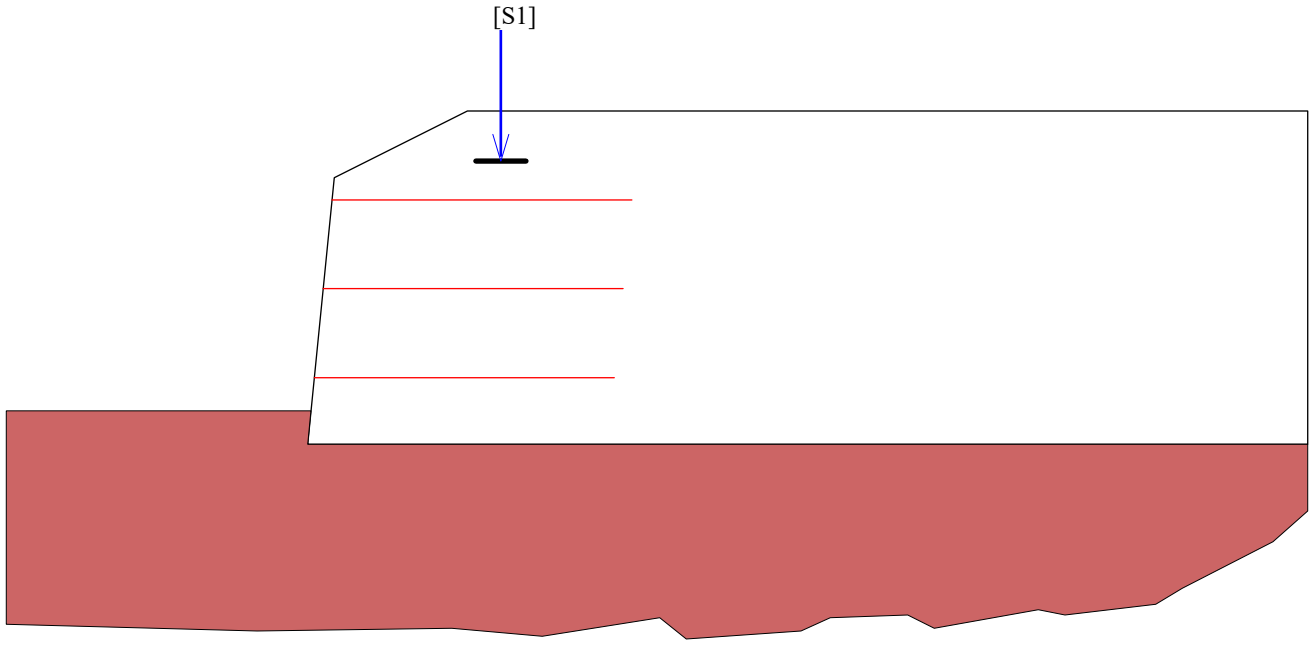
Soil in front of wall is Horizontal.

Batter, ω 5.7 [deg]
Backslope, β 26.6 [deg]
Backslope rise 2.0 [ft] Broken back equivalent angle, I = 7.13° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 11.95, Meyerhof stress = 1400 lb/ft².

Foundation Interface: Direct sliding, Fs = 3.817, Eccentricity, e/L = -0.0023, Fs-overturning = 9.28

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	9.00	1	N/A	2.49	2.52	2.519	7.415	3.772	-0.0216	Miragrid 5XT
2	4.67	9.00	1	N/A	5.15	5.20	5.200	10.008	6.006	-0.0427	Miragrid 5XT
3	7.33	9.00	1	N/A	14.63	14.77	14.775	15.926	13.855	-0.0678	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 4.94, Meyerhof stress = 2198 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.252, Eccentricity, e/L = 0.1942, Fs-overturning = 2.19

GEOGRID				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	9.00	1	N/A	1.69	1.71	1.709	4.238	1.321	0.0826	Miragrid 5XT
2	4.67	9.00	1	N/A	2.81	2.84	2.838	4.323	2.610	-0.0158	Miragrid 5XT
3	7.33	9.00	1	N/A	4.96	5.01	5.010	3.904	11.435	-0.0672	Miragrid 5XT

AASHTO 2002 ASD DESIGN METHOD
Harbor Grove

MSEW+: Update # 2020.2

PROJECT IDENTIFICATION

Title: Harbor Grove
Project Number: ES-7975.01
Client: Sea Pac Homes
Designer: HTW
Station Number:

Description:

6.67 Foot Lock + Load Wall with Footing Load

Company's information:

Name: ESNW
Street: 15365 NE 90th St, Ste 100

Redmond, WA 98052
Telephone #: 425-449-4704
Fax #:
E-Mail: henryw@esnw.com

File path and name: C:\Users\henry.wright\Documents\MSEW Files\7975.01 LnL .... Tier\6.67 Foot.BENp

Original date and time of creating this file: Mon Apr 24 07:42:51 2023

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	125.0 lb/ft ³
Design value of internal angle of friction, ϕ	32.0 °

RETAINED SOIL

Unit weight, γ	125.0 lb/ft ³
Design value of internal angle of friction, ϕ	32.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{equiv.}$	32.0 °
Equivalent cohesion, $c_{equiv.}$	0.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3073 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 61.00° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3171 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity is controlled by general shear.
Bearing capacity factors (calculated by MSEW): Nc = 35.49   N γ= 30.21

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.727
Design acceleration coefficient in Internal Stability: Kh = Am = 0.727
Design acceleration coefficient in External Stability: Kh_d = 0.419 => Kh = Am = 0.432
(Kh in External Stability is based on allowable displacement, d = 50 mm. using AASHTO 2002 equation)

Kae (Kh > 0) = 1.0693   Kae (Kh = 0) = 0.2751 Δ Kae = 0.7942
Seismic soil-geogrid friction coefficient, F* is 100.0% of its specified static value.

INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	4700.0	7400.0	9500.0		
Durability reduction factor, RFd	1.10	1.10	1.10		
Installation-damage reduction factor, RFid	1.10	1.10	1.10		
Creep reduction factor, RFc	1.58	1.58	1.58	N/A	N/A
Fs-overall for strength	N/A	N/A	N/A		
Coverage ratio, Rc	1.000	1.000	1.000		
Friction angle along geogrid-soil interface, ρ	25.67	25.67	25.67		
Pullout resistance factor, F*	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	$0.80 \cdot \tan\phi$	N/A	N/A
Scale-effect correction factor, α	0.8	0.8	0.8		

Variation of Lateral Earth Pressure Coefficient With Depth

Z	K / Ka
0 ft	1.00
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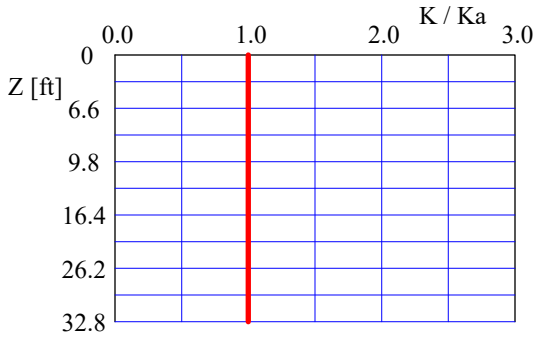


INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 6.67 [ft] { Embedded depth is E = 1.00 ft, and height above top of finished bottom grade is H = 5.67 ft }

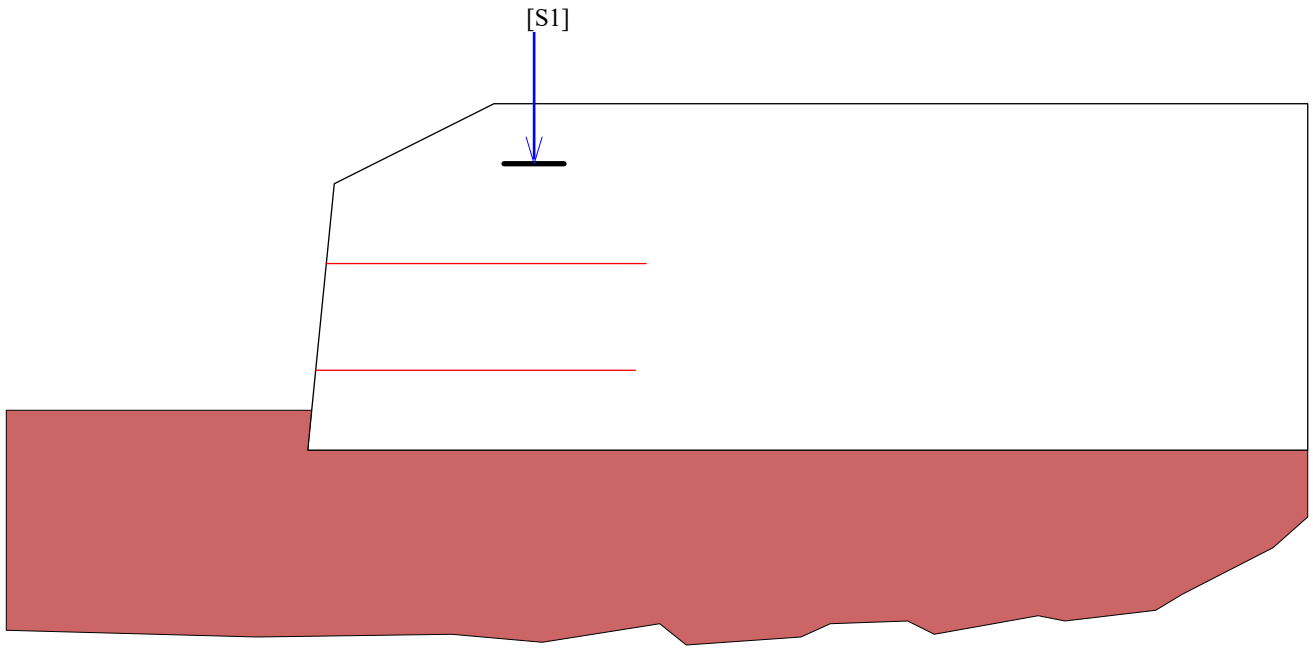
Soil in front of wall is Horizontal.

Batter, ω 5.7 [deg]
Backslope, β 26.6 [deg]
Backslope rise 2.0 [ft] Broken back equivalent angle, I = 8.53° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Pv-d = 1500.0 and Pv-l = 500.0 [lb/ft].
Footing width, b=1.5 [ft]. Distance of center of footing from wall face, d = 5.0 [ft] @ depth of 1.5 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 10.60, Meyerhof stress = 1331 lb/ft².
Foundation Interface: Direct sliding, Fs = 4.007, Eccentricity, e/L = -0.0236, Fs-overturning = 10.30

	GEOGRID			CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	8.00	1	N/A	3.09	3.12	3.122	6.933	4.161	-0.0471	Miragrid 5XT
2	4.67	8.00	1	N/A	7.08	7.15	7.153	9.958	7.622	-0.0778	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 5.82, Meyerhof stress = 1821 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.264, Eccentricity, e/L = 0.1653, Fs-overturning = 2.37

	GEOGRID			CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	8.00	1	N/A	1.95	1.97	1.971	3.606	1.474	0.0379	Miragrid 5XT
2	4.67	8.00	1	N/A	3.36	3.39	3.392	3.619	3.919	-0.0659	Miragrid 5XT