EARTH SOLUTIONS NW
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Geotechnical Engineering
Environmental Services
Earthwork Observation & Testing
CESCL & Stormwater Services

AASHTO 2002 ASD DESIGN METHOD
Normandy Heights

MSEW+: Update # 2025.11

PROJECT IDENTIFICATION

Title: Normandy Heights
Project Number: ES-0593.07
Client: RM Homes, LLC
Designer: ESNW
Station Number:

Description:

4.00' Reinforced Fill Lock + Load (Footing Surcharge)

Company's information:

Name: ESNW, LLC
Street: 15365 NE 90th Street
Suite 100
Redmond, WA 98052
Telephone #: 4254494704
Fax #:
E-Mail: info@esnw.com

HENRY T. WRIGHT
STATE OF WASHINGTON
53803
REGISTERED
PROFESSIONAL ENGINEER
04/10/2026

File path and name: C:\Users\chase.halsen\OneDrive - Earth Solutions NW\Des.....
.....4.00' (Footing).BENp

Original date and time of creating this file: Fri Oct 17 07:00:05 2025

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

City of Puyallup
Building
REVIEWED
FOR
COMPLIANCE
SKinnear
04/17/2026
2:48:58 PM

PRRWF20260536

Calculations required to be provided by the Permittee on site for all Inspections

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) = 0.3073 (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 = 0.00 N γ= 7.40

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.550
Design acceleration coefficient in Internal Stability: Kh = Am = 0.550
Design acceleration coefficient in External Stability: Kh_d = 0.352 => Kh = Am = 0.386
(Kh in External Stability is based on allowable displacement, d = 25 mm. using AASHTO 2002 equation)

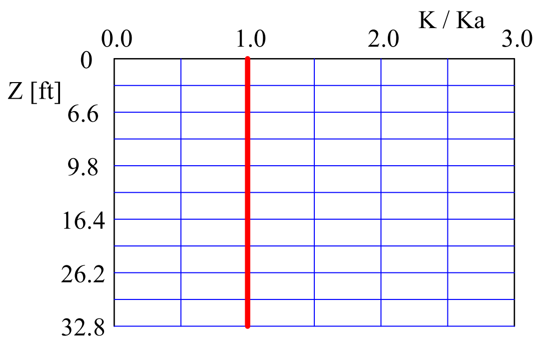
Kae (Kh > 0) = 0.5894 Kae (Kh = 0) = 0.2705 Δ Kae = 0.3189
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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				
Durability reduction factor, RFd	1.10				
Installation-damage reduction factor, RFid	1.05				
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	25.60				
Pullout resistance factor, F*	$0.60 \cdot \tan\phi$	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.0				

Variation of Lateral Earth Pressure Coefficient With Depth

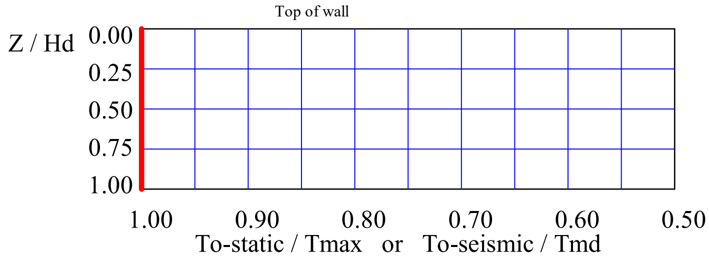
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Segmental precast concrete panels.
Depth of panel is 2.50 ft. Horizontal distance to Center of Gravity of panel is 1.25 ft.
Average unit weight of panel is γ_f = 135.00 lb/ft ³

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Miragrid ..	N/A	N/A	N/A	N/A
Durability reduction factor, RFd	1.15	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A
CRu = Tult-connection/Tult-geogrid	0.90	N/A	N/A	N/A	N/A

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

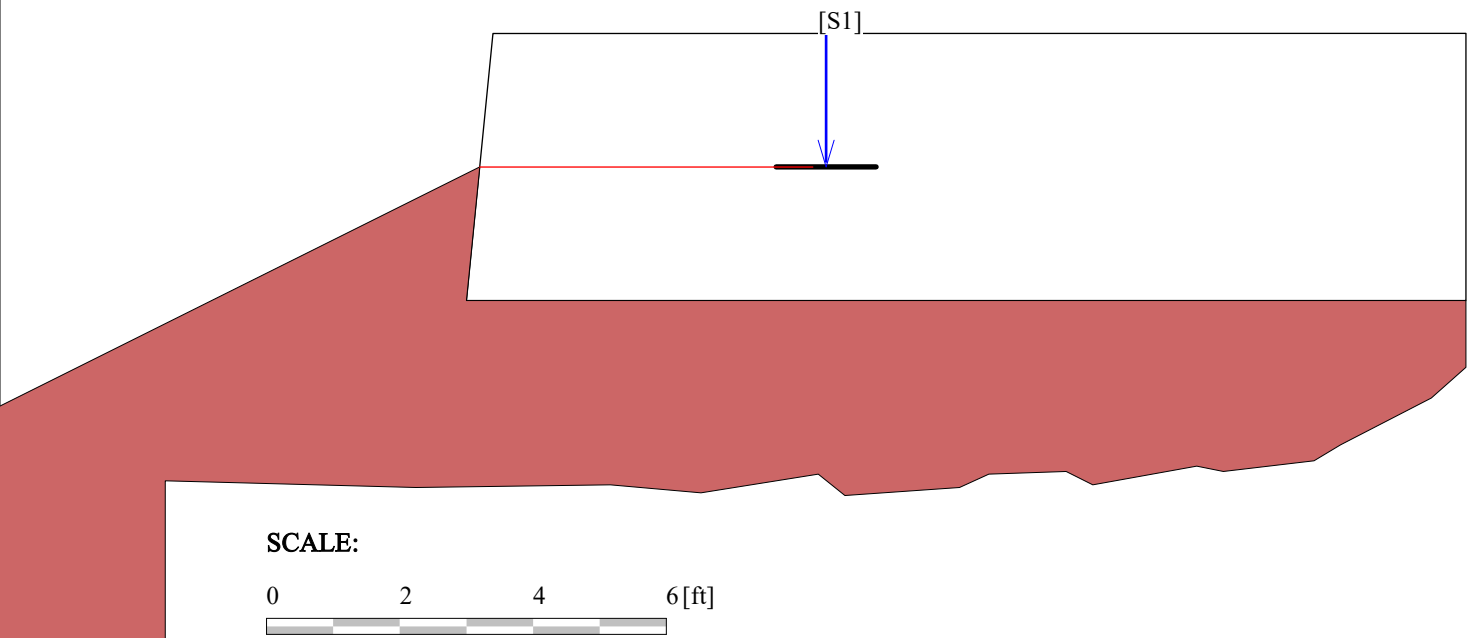
Design height, Hd 4.00 [ft] { Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 2.00 ft }
Soil in front of the wall is inclined at 2H:1V. Hs = 6.56 ft.

Batter, ω 5.7 [deg]
Backslope, β 0.0 [deg]
Backslope rise 12.0 [ft] Broken back equivalent angle, I = 0.00° (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 = 2000.0 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 2.0 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 3.61, Meyerhof stress = 619 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.676, Eccentricity, e/L = 0.0004, Fs-overturning = 6.39

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	5.00	1	N/A	8.31	9.20	9.197	4.225	12.215	-0.1676	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 3.10, Meyerhof stress = 667 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.137, Eccentricity, e/L = 0.0738, Fs-overturning = 3.57

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	5.00	1	N/A	5.31	5.88	5.878	1.864	4.609	-0.1542	Miragrid 5XT

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MSEW+: Update # 2025.11

PROJECT IDENTIFICATION

Title: Normandy Heights
Project Number: ES-0593.07
Client: RM Homes, LLC
Designer: ESNW
Station Number:

Description:

5.33' Reinforced Fill Lock + Load (Footing Surcharge)

Company's information:

Name: ESNW, LLC
Street: 15365 NE 90th Street
Suite 100
Redmond, WA 98052
Telephone #: 4254494704
Fax #:
E-Mail: info@esnw.com

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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) = 0.3073 (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 = 0.00 N γ= 7.40

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.550
Design acceleration coefficient in Internal Stability: Kh = Am = 0.550
Design acceleration coefficient in External Stability: Kh_d = 0.352 => Kh = Am = 0.386
(Kh in External Stability is based on allowable displacement, d = 25 mm. using AASHTO 2002 equation)

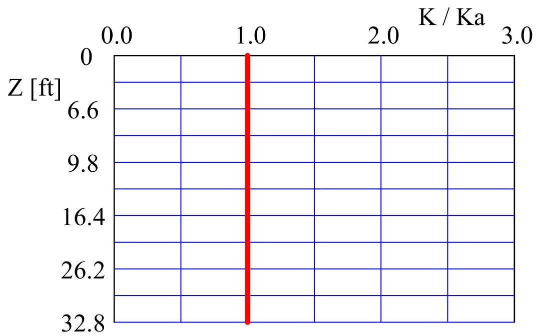
Kae (Kh > 0) = 0.5894 Kae (Kh = 0) = 0.2705 Δ Kae = 0.3189
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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				
Durability reduction factor, RFd	1.10				
Installation-damage reduction factor, RFid	1.05				
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	25.60				
Pullout resistance factor, F*	$0.60 \cdot \tan\phi$	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.0				

Variation of Lateral Earth Pressure Coefficient With Depth

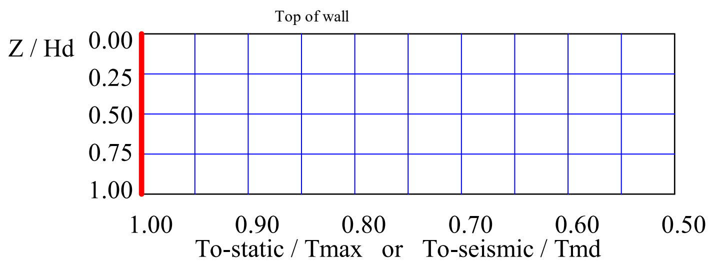
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Segmental precast concrete panels.
Depth of panel is 2.50 ft. Horizontal distance to Center of Gravity of panel is 1.25 ft.
Average unit weight of panel is γ_f = 135.00 lb/ft ³

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Miragrid ..	N/A	N/A	N/A	N/A
Durability reduction factor, RFd	1.15	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A
CRu = Tult-connection/Tult-geogrid	0.90	N/A	N/A	N/A	N/A

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

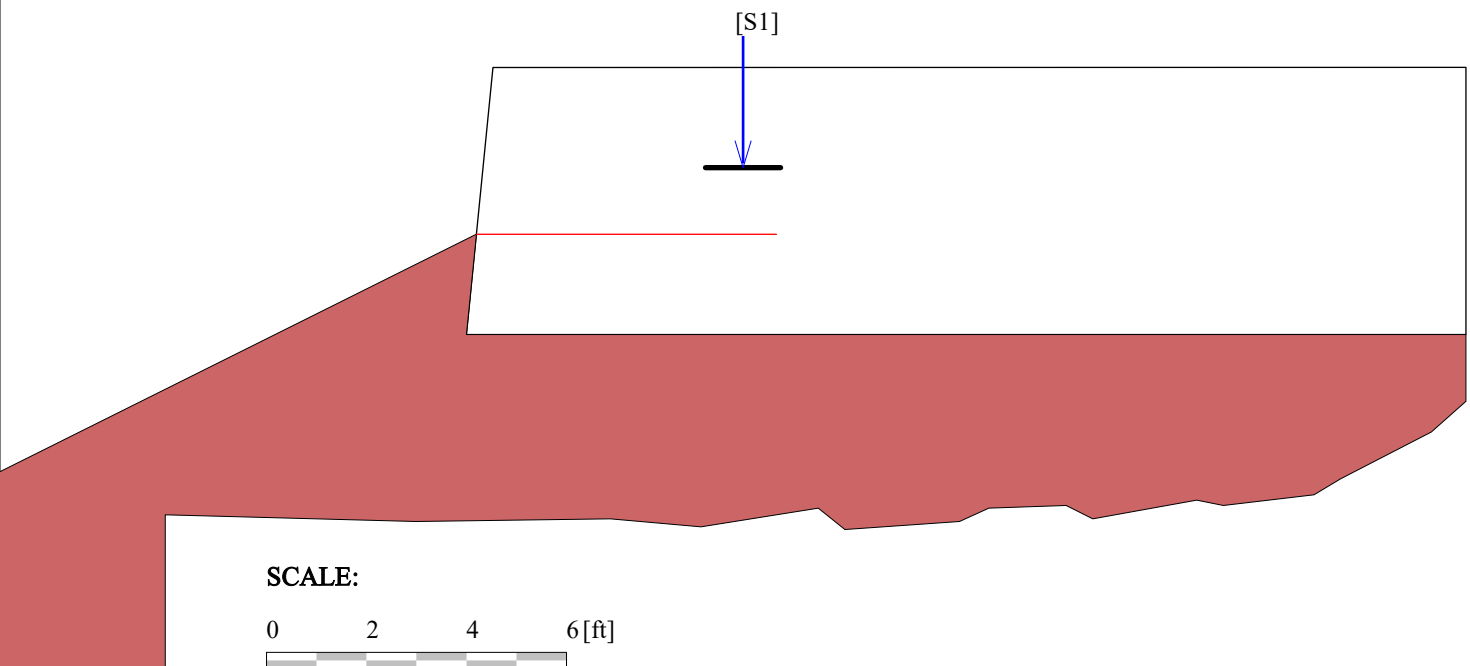
Design height, Hd 5.33 [ft] { Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 3.33 ft }
Soil in front of the wall is inclined at 2H:1V. Hs = 6.56 ft.

Batter, ω 5.7 [deg]
Backslope, β 0.0 [deg]
Backslope rise 12.0 [ft] Broken back equivalent angle, I = 0.00° (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 = 2000.0 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 2.0 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 2.00, Meyerhof stress = 1164 lb/ft².

Foundation Interface: Direct sliding, Fs = 2.869, Eccentricity, e/L = -0.0577, Fs-overturning = 8.29

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	6.00	1	N/A	4.68	5.18	5.180	4.905	4.763	-0.1573	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 2.73, Meyerhof stress = 995 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.631, Eccentricity, e/L = 0.0185, Fs-overturning = 4.15

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	6.00	1	N/A	2.99	3.31	3.310	2.164	2.633	-0.1339	Miragrid 5XT

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AASHTO 2002 ASD DESIGN METHOD
Normandy Heights

MSEW+: Update # 2025.11

PROJECT IDENTIFICATION

Title: Normandy Heights
Project Number: ES-0593.07
Client: RM Homes, LLC
Designer: ESNW
Station Number:

Description:

6.67' Reinforced Fill Lock + Load (Footing Surcharge)

Company's information:

Name: ESNW, LLC
Street: 15365 NE 90th Street
Suite 100
Redmond, WA 98052
Telephone #: 4254494704
Fax #:
E-Mail: info@esnw.com

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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) = 0.3073 (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 = 0.00 N γ= 7.40

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.550
Design acceleration coefficient in Internal Stability: Kh = Am = 0.550
Design acceleration coefficient in External Stability: Kh_d = 0.352 => Kh = Am = 0.386
(Kh in External Stability is based on allowable displacement, d = 25 mm. using AASHTO 2002 equation)

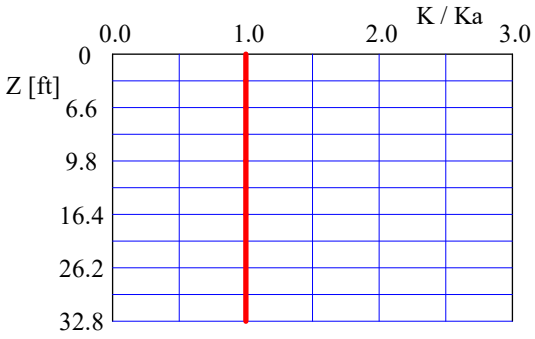
Kae (Kh > 0) = 0.5894 Kae (Kh = 0) = 0.2705 Δ Kae = 0.3189
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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				
Durability reduction factor, RFd	1.10				
Installation-damage reduction factor, RFid	1.05				
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	25.60				
Pullout resistance factor, F*	0.60·tanϕ	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.0				

Variation of Lateral Earth Pressure Coefficient With Depth

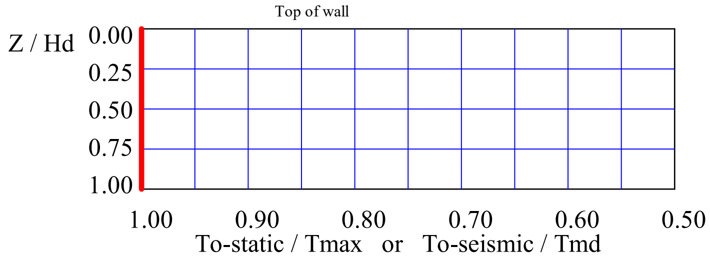
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection
(Analysis)

FACIA type: Segmental precast concrete panels.
Depth of panel is 2.50 ft. Horizontal distance to Center of Gravity of panel is 1.25 ft.
Average unit weight of panel is γ_f = 135.00 lb/ft ³

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Miragrid ..	N/A	N/A	N/A	N/A
Durability reduction factor, RFd	1.15	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A
CRu = Tult-connection/Tult-geogrid	0.90	N/A	N/A	N/A	N/A

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

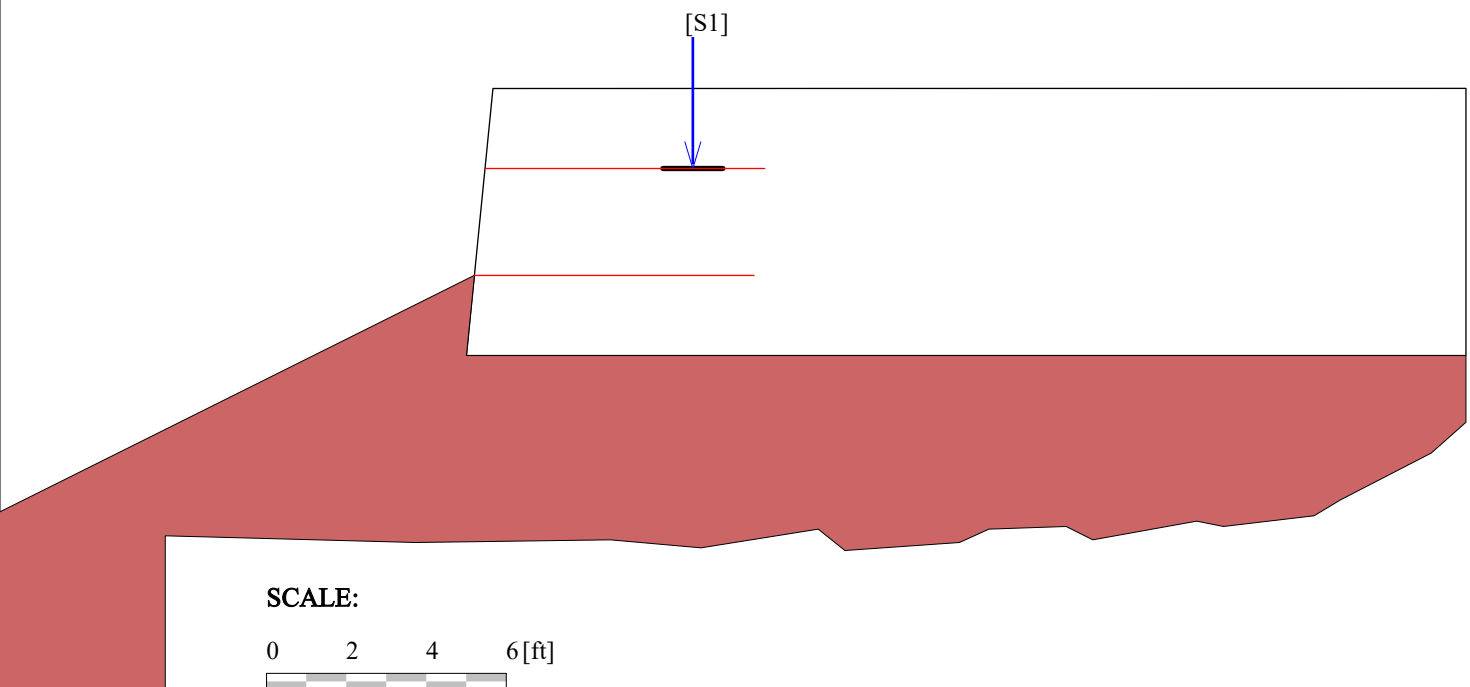
Design height, Hd 6.67 [ft] { Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 4.67 ft }
Soil in front of the wall is inclined at 2H:1V. Hs = 6.56 ft.

Batter, ω 5.7 [deg]
Backslope, β 0.0 [deg]
Backslope rise 12.0 [ft] Broken back equivalent angle, I = 0.00° (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 = 2000.0 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 2.0 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 2.00, Meyerhof stress = 1366 lb/ft².

Foundation Interface: Direct sliding, Fs = 5.528, Eccentricity, e/L = -0.0632, Fs-overturning = 16.69

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	7.00	1	N/A	3.99	4.41	4.410	6.156	6.807	-0.0897	Miragrid 5XT
2	4.67	7.00	1	N/A	11.96	13.23	13.231	4.281	23.234	-0.1317	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 2.72, Meyerhof stress = 1170 lb/ft².

Foundation Interface: Direct sliding, Fs = 2.086, Eccentricity, e/L = 0.0290, Fs-overturning = 4.68

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	7.00	1	N/A	2.81	3.11	3.110	3.074	2.568	-0.0495	Miragrid 5XT
2	4.67	7.00	1	N/A	5.97	6.60	6.600	1.400	8.767	-0.1267	Miragrid 5XT

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Designer: ESNW
Station Number:

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8.00' Reinforced Fill Lock + Load (Footing Surcharge)

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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) = 0.3073 (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 = 0.00 N γ= 7.40

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.550
Design acceleration coefficient in Internal Stability: Kh = Am = 0.550
Design acceleration coefficient in External Stability: Kh_d = 0.352 => Kh = Am = 0.386
(Kh in External Stability is based on allowable displacement, d = 25 mm. using AASHTO 2002 equation)

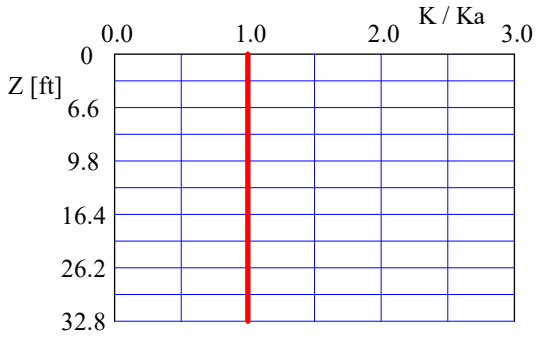
Kae (Kh > 0) = 0.5894 Kae (Kh = 0) = 0.2705 Δ Kae = 0.3189
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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				
Durability reduction factor, RFd	1.10				
Installation-damage reduction factor, RFid	1.05				
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	25.60				
Pullout resistance factor, F*	0.60·tanϕ	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.0				

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)

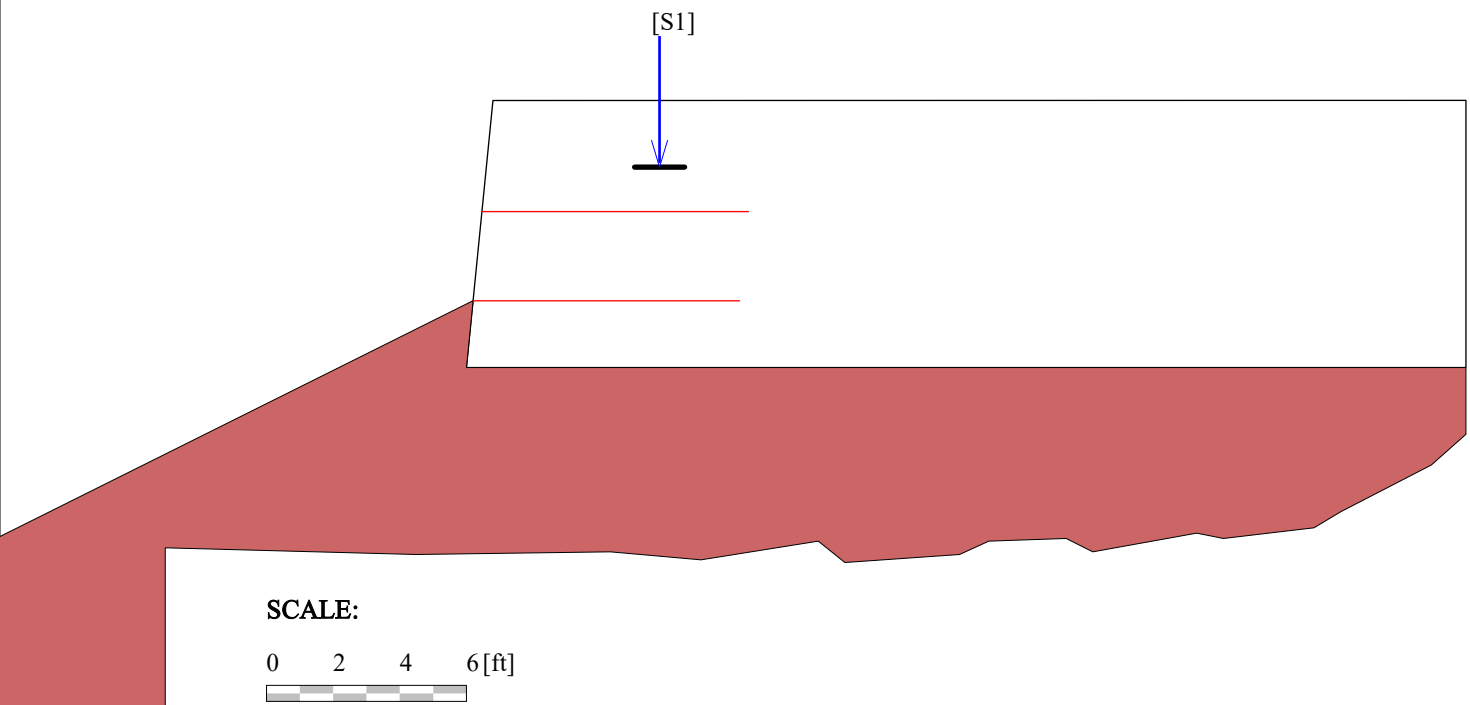
Design height, Hd 8.00 [ft] { Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 6.00 ft }
Soil in front of the wall is inclined at 2H:1V. Hs = 6.56 ft.

Batter, ω 5.7 [deg]
Backslope, β 0.0 [deg]
Backslope rise 12.0 [ft] Broken back equivalent angle, I = 0.00° (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 = 2000.0 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 2.0 [ft] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 2.55, Meyerhof stress = 1353 lb/ft².

Foundation Interface: Direct sliding, Fs = 4.881, Eccentricity, e/L = -0.0236, Fs-overturning = 13.27

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	3.15	3.48	3.484	6.627	5.388	-0.0430	Miragrid 5XT
2	4.67	8.00	1	N/A	6.11	6.76	6.762	7.839	11.836	-0.0641	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 2.16, Meyerhof stress = 1470 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.842, Eccentricity, e/L = 0.0860, Fs-overturning = 3.72

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	2.15	2.37	2.373	3.167	2.033	0.0141	Miragrid 5XT
2	4.67	8.00	1	N/A	3.49	3.86	3.858	3.009	4.466	-0.0497	Miragrid 5XT

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Environmental Services
Earthwork Observation & Testing
CESCL & Stormwater Services

AASHTO 2002 ASD DESIGN METHOD
Normandy Heights

MSEW+: Update # 2025.11

PROJECT IDENTIFICATION

Title: Normandy Heights
Project Number: ES-0593.07
Client: RM Homes, LLC
Designer: ESNW
Station Number:

Description:

4.00' Reinforced Fill Lock + Load

Company's information:

Name: ESNW, LLC
Street: 15365 NE 90th Street
Suite 100
Redmond, WA 98052
Telephone #: 4254494704
Fax #:
E-Mail: info@esnw.com

File path and name: C:\Users\chase.halsen\OneDrive - Earth Solutions NW\Des.....
.....d\4.00' (Slope).BENp

Original date and time of creating this file: Fri Oct 17 07:00:05 2025

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) = 0.4637 (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)

Note: specified A combined with I and δ produced a square root of -0.16 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.550
Design acceleration coefficient in Internal Stability: Kh = Am = 0.550
Design acceleration coefficient in External Stability: Kh_d = 0.352 => Kh = Am = 0.386
(Kh in External Stability is based on allowable displacement, d = 25 mm. using AASHTO 2002 equation)

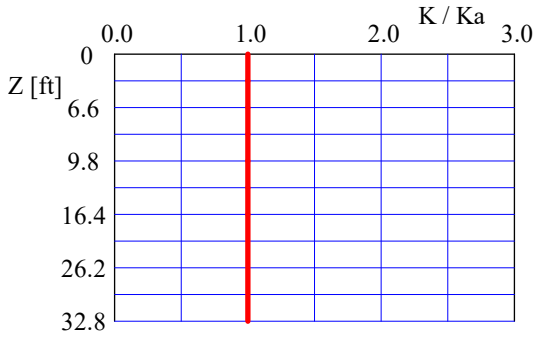
Kae (Kh > 0) = 1.3383 Kae (Kh = 0) = 0.3889 Δ Kae = 0.9493
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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				
Durability reduction factor, RFd	1.10				
Installation-damage reduction factor, RFid	1.05				
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	25.60				
Pullout resistance factor, F*	0.60·tanϕ	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.0				

Variation of Lateral Earth Pressure Coefficient With Depth

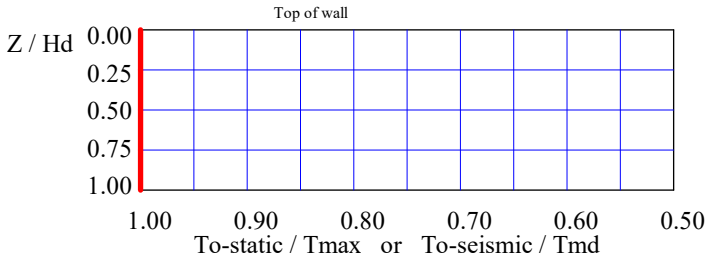
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Segmental precast concrete panels.
Depth of panel is 2.50 ft. Horizontal distance to Center of Gravity of panel is 1.25 ft.
Average unit weight of panel is γ_f = 135.00 lb/ft ^{3}

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Miragrid ..	N/A	N/A	N/A	N/A
Durability reduction factor, RFd	1.15	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A
CRu = Tult-connection/Tult-geogrid	0.90	N/A	N/A	N/A	N/A

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

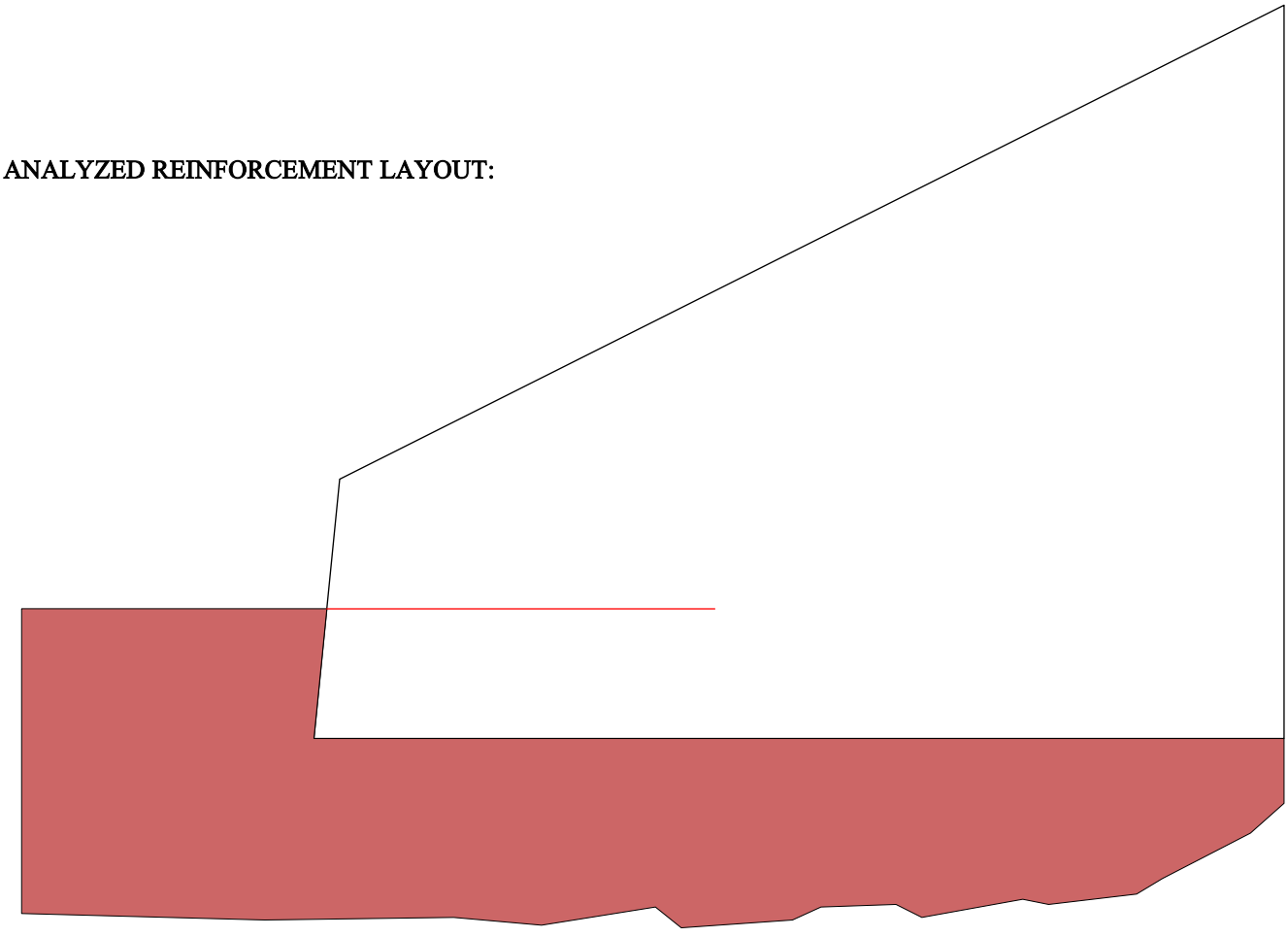
Design height, Hd 4.00 [ft] { Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 2.00 ft }

Soil in front of wall is Horizontal.

Batter, ω 5.7 [deg]
Backslope, β 26.6 [deg]
Backslope rise 12.0 [ft] Broken back equivalent angle, I = 26.60° (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]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 14.10, Meyerhof stress = 775 lb/ft².
Foundation Interface: Direct sliding, Fs = 2.334, Eccentricity, e/L = -0.0179, Fs-overturning = 6.12

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	6.00	1	N/A	6.16	6.81	6.810	4.174	2.183	-0.0654	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 8.43, Meyerhof stress = 1040 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.263, Eccentricity, e/L = 0.0991, Fs-overturning = 2.96

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	6.00	1	N/A	3.97	4.39	4.394	1.864	1.523	-0.0323	Miragrid 5XT

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CESCL & Stormwater Services

AASHTO 2002 ASD DESIGN METHOD
Normandy Heights

MSEW+: Update # 2025.11

PROJECT IDENTIFICATION

Title: Normandy Heights
Project Number: ES-0593.07
Client: RM Homes, LLC
Designer: ESNW
Station Number:

Description:

5.33' Reinforced Fill Lock + Load

Company's information:

Name: ESNW, LLC
Street: 15365 NE 90th Street
Suite 100
Redmond, WA 98052
Telephone #: 4254494704
Fax #:
E-Mail: info@esnw.com

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Original date and time of creating this file: Fri Oct 17 07:00:05 2025

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) = 0.4637 (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)

Note: specified A combined with I and δ produced a square root of -0.16 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.550
Design acceleration coefficient in Internal Stability: Kh = Am = 0.550
Design acceleration coefficient in External Stability: Kh_d = 0.352 => Kh = Am = 0.386
(Kh in External Stability is based on allowable displacement, d = 25 mm. using AASHTO 2002 equation)

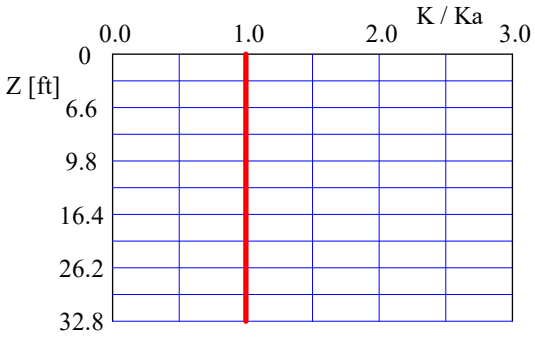
Kae (Kh > 0) = 1.3383 Kae (Kh = 0) = 0.3889 Δ Kae = 0.9493
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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				
Durability reduction factor, RFd	1.10				
Installation-damage reduction factor, RFid	1.05				
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	25.60				
Pullout resistance factor, F*	0.60·tanϕ	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.0				

Variation of Lateral Earth Pressure Coefficient With Depth

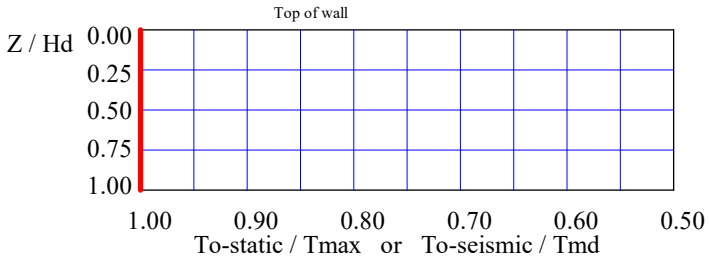
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Segmental precast concrete panels.
Depth of panel is 2.50 ft. Horizontal distance to Center of Gravity of panel is 1.25 ft.
Average unit weight of panel is γ_f = 135.00 lb/ft ^{3}

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Miragrid ..	N/A	N/A	N/A	N/A
Durability reduction factor, RFd	1.15	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A
CRu = Tult-connection/Tult-geogrid	0.90	N/A	N/A	N/A	N/A

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

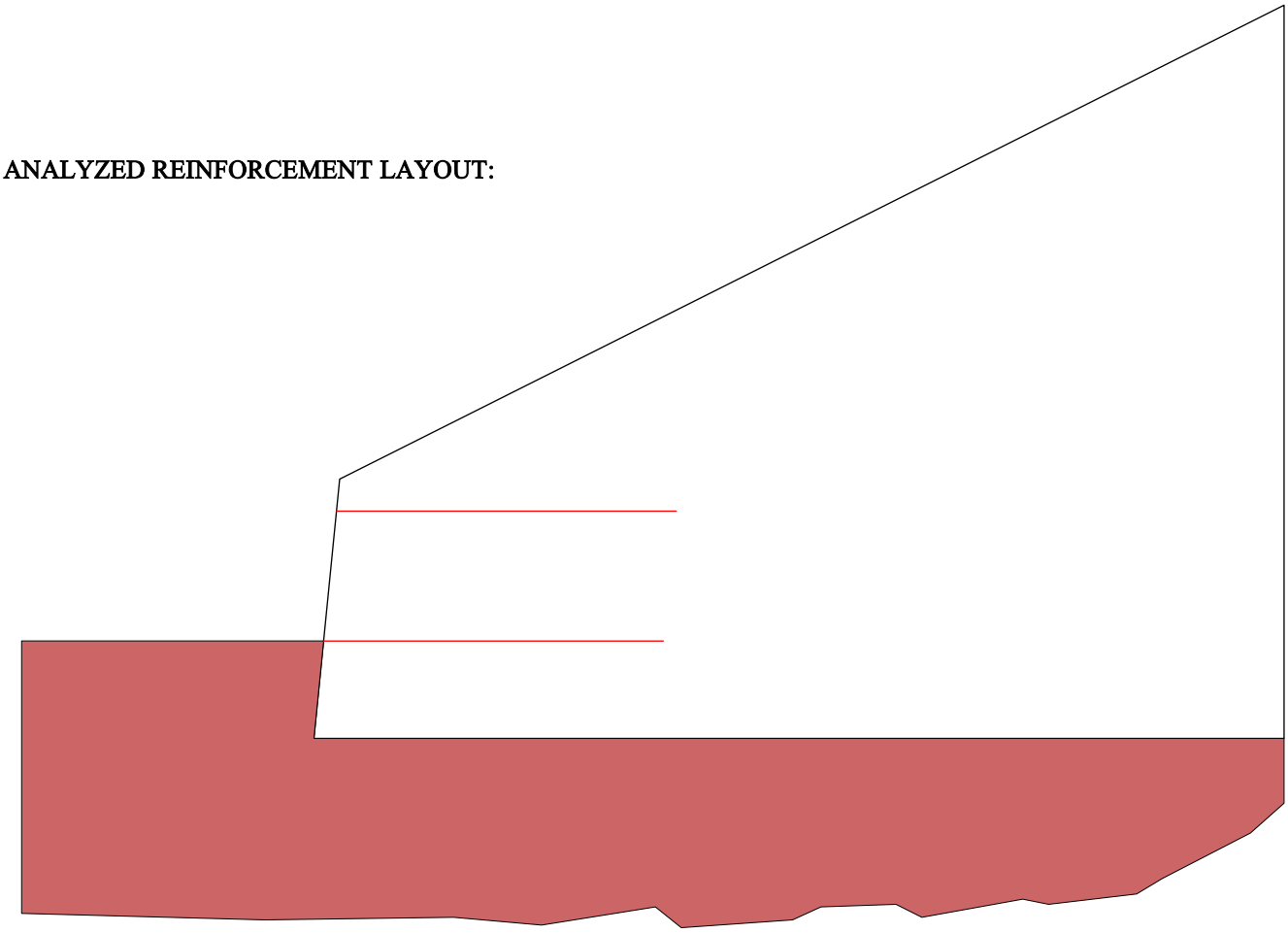
Design height, Hd 5.33 [ft] { Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 3.33 ft }

Soil in front of wall is Horizontal.

Batter, ω 5.7 [deg]
Backslope, β 26.6 [deg]
Backslope rise 12.0 [ft] Broken back equivalent angle, I = 26.60° (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]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 13.42, Meyerhof stress = 974 lb/ft².

Foundation Interface: Direct sliding, Fs = 2.216, Eccentricity, e/L = -0.0053, Fs-overturning = 5.39

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	7.00	1	N/A	4.34	4.80	4.800	4.987	2.001	-0.0436	Miragrid 5XT
2	4.67	7.00	1	N/A	17.26	19.09	19.093	8.989	2.491	-0.1219	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 5.89, Meyerhof stress = 1536 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.146, Eccentricity, e/L = 0.1431, Fs-overturning = 2.42

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	7.00	1	N/A	3.14	3.47	3.473	2.574	1.225	0.0198	Miragrid 5XT
2	4.67	7.00	1	N/A	7.78	8.61	8.611	2.612	2.331	-0.1188	Miragrid 5XT

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Environmental Services
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AASHTO 2002 ASD DESIGN METHOD
Normandy Heights

MSEW+: Update # 2025.11

PROJECT IDENTIFICATION

Title: Normandy Heights
Project Number: ES-0593.07
Client: RM Homes, LLC
Designer: ESNW
Station Number:

Description:

6.67' Reinforced Fill Lock + Load

Company's information:

Name: ESNW, LLC
Street: 15365 NE 90th Street
Suite 100
Redmond, WA 98052
Telephone #: 4254494704
Fax #:
E-Mail: info@esnw.com

File path and name: C:\Users\chase.halsen\OneDrive - Earth Solutions NW\Des.....
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Original date and time of creating this file: Fri Oct 17 07:00:05 2025

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) = 0.4637 (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)

Note: specified A combined with I and δ produced a square root of -0.16 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.550
Design acceleration coefficient in Internal Stability: Kh = Am = 0.550
Design acceleration coefficient in External Stability: Kh_d = 0.352 => Kh = Am = 0.386
(Kh in External Stability is based on allowable displacement, d = 25 mm. using AASHTO 2002 equation)

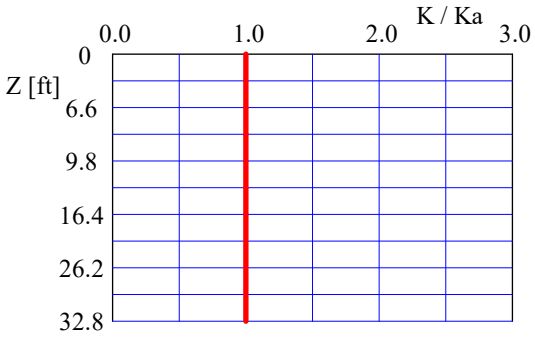
Kae (Kh > 0) = 1.3383 Kae (Kh = 0) = 0.3889 Δ Kae = 0.9493
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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				
Durability reduction factor, RFd	1.10				
Installation-damage reduction factor, RFid	1.05				
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	25.60				
Pullout resistance factor, F*	0.60·tanϕ	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.0				

Variation of Lateral Earth Pressure Coefficient With Depth

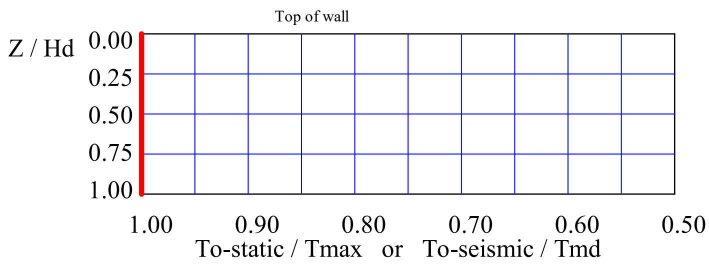
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection
(Analysis)

FACIA type: Segmental precast concrete panels.
Depth of panel is 2.50 ft. Horizontal distance to Center of Gravity of panel is 1.25 ft.
Average unit weight of panel is γ_f = 135.00 lb/ft³

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Miragrid ..	N/A	N/A	N/A	N/A
Durability reduction factor, RFd	1.15	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A
CRu = Tult-connection/Tult-geogrid	0.90	N/A	N/A	N/A	N/A

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

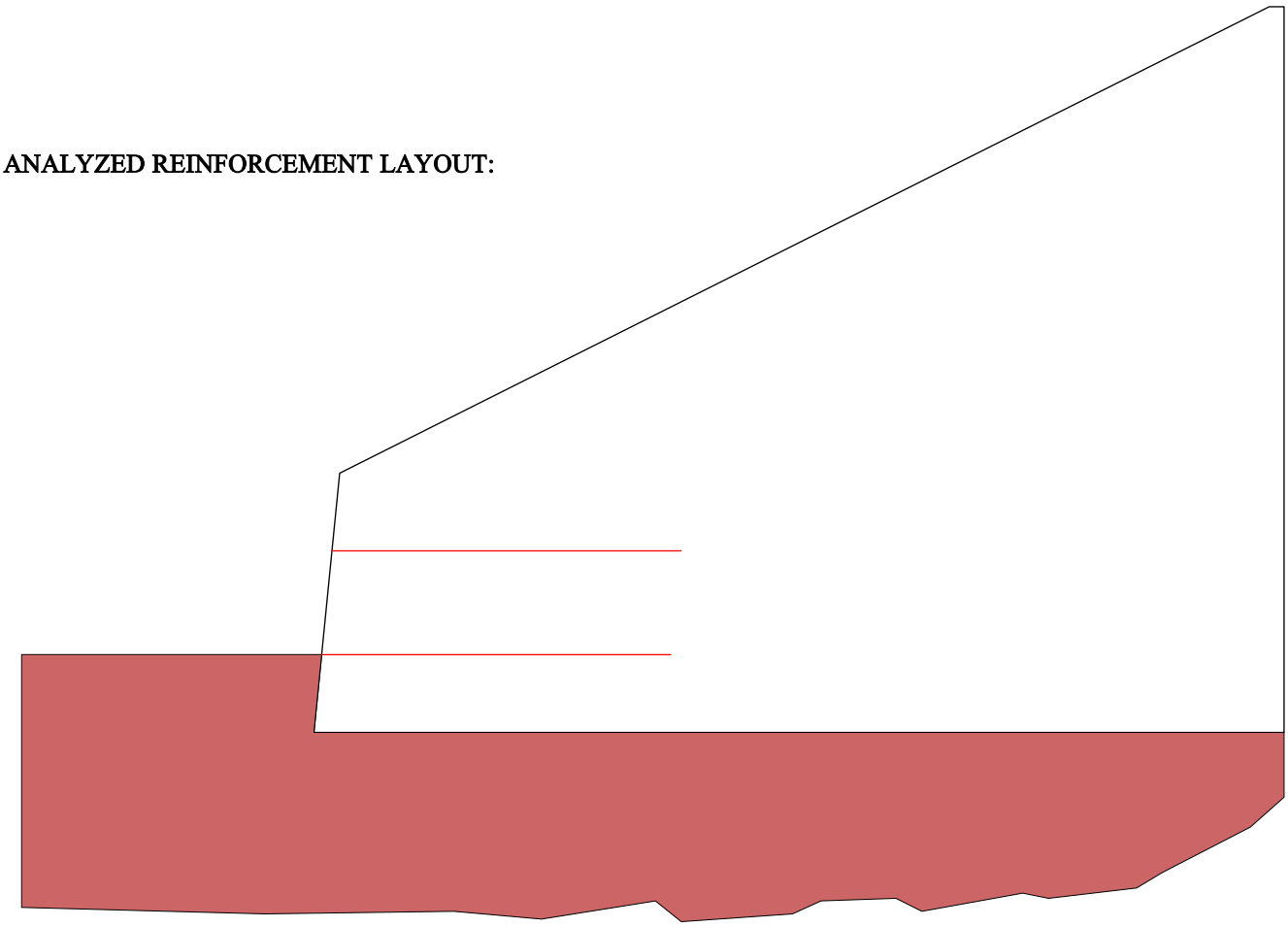
Design height, Hd 6.67 [ft] { Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 4.67 ft }

Soil in front of wall is Horizontal.

Batter, ω 5.7 [deg]
Backslope, β 26.6 [deg]
Backslope rise 12.0 [ft] Broken back equivalent angle, I = 26.60° (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]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 13.56, Meyerhof stress = 1234 lb/ft².

Foundation Interface: Direct sliding, Fs = 2.240, Eccentricity, e/L = -0.0080, Fs-overturning = 5.54

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	3.23	3.57	3.575	6.634	1.950	-0.0376	Miragrid 5XT
2	4.67	9.00	1	N/A	7.03	7.78	7.778	8.309	2.334	-0.0865	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 6.38, Meyerhof stress = 1875 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.169, Eccentricity, e/L = 0.1334, Fs-overturning = 2.52

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	2.25	2.49	2.493	3.267	1.155	0.0366	Miragrid 5XT
2	4.67	9.00	1	N/A	3.90	4.32	4.315	3.084	1.855	-0.0709	Miragrid 5XT

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Environmental Services
Earthwork Observation & Testing
CESCL & Stormwater Services

AASHTO 2002 ASD DESIGN METHOD
Normandy Heights

MSEW+: Update # 2025.11

PROJECT IDENTIFICATION

Title: Normandy Heights
Project Number: ES-0593.07
Client: RM Homes, LLC
Designer: ESNW
Station Number:

Description:

8.00' Reinforced Fill Lock + Load

Company's information:

Name: ESNW, LLC
Street: 15365 NE 90th Street
Suite 100
Redmond, WA 98052
Telephone #: 4254494704
Fax #:
E-Mail: info@esnw.com

File path and name: C:\Users\chase.halsen\OneDrive - Earth Solutions NW\Des.....
.....d\8.00' (Slope).BENp

Original date and time of creating this file: Fri Oct 17 07:00:05 2025

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) = 0.4637 (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)

Note: specified A combined with I and δ produced a square root of -0.16 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.550
Design acceleration coefficient in Internal Stability: Kh = Am = 0.550
Design acceleration coefficient in External Stability: Kh_d = 0.352 => Kh = Am = 0.386
(Kh in External Stability is based on allowable displacement, d = 25 mm. using AASHTO 2002 equation)

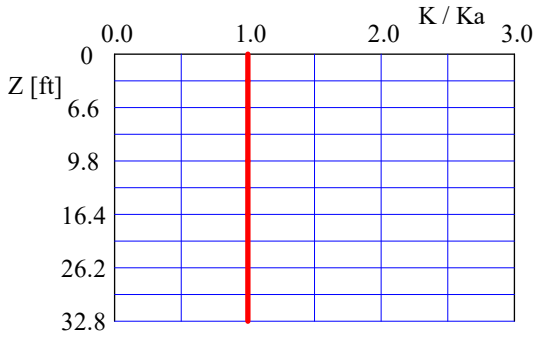
Kae (Kh > 0) = 1.3383 Kae (Kh = 0) = 0.3889 Δ Kae = 0.9493
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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				
Durability reduction factor, RFd	1.10				
Installation-damage reduction factor, RFid	1.05				
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Fs-overall for strength	N/A				
Coverage ratio, Rc	1.000				
Friction angle along geogrid-soil interface, ρ	25.60				
Pullout resistance factor, F*	0.60·tanϕ	N/A	N/A	N/A	N/A
Scale-effect correction factor, α	1.0				

Variation of Lateral Earth Pressure Coefficient With Depth

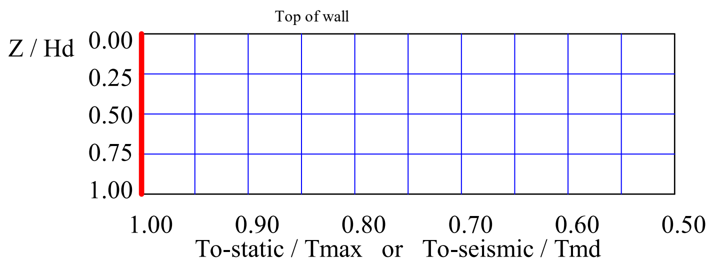
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection
(Analysis)

FACIA type: Segmental precast concrete panels.
Depth of panel is 2.50 ft. Horizontal distance to Center of Gravity of panel is 1.25 ft.
Average unit weight of panel is γ_f = 135.00 lb/ft ³

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Miragrid ..	N/A	N/A	N/A	N/A
Durability reduction factor, RFd	1.15	N/A	N/A	N/A	N/A
Creep reduction factor, RFc	1.44	N/A	N/A	N/A	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A
CRu = Tult-connection/Tult-geogrid	0.90	N/A	N/A	N/A	N/A

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

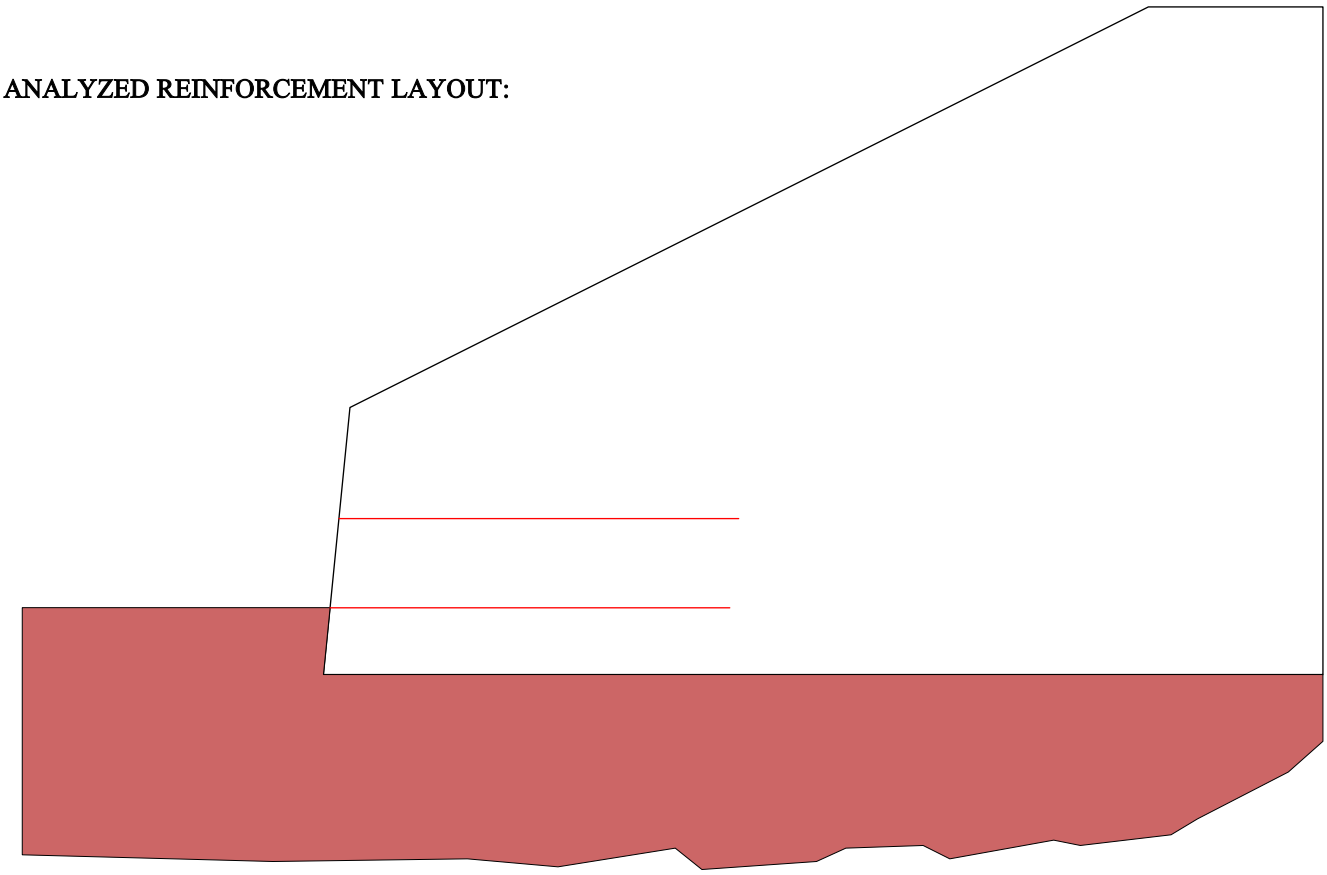
Design height, Hd 8.00 [ft] { Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 6.00 ft }

Soil in front of wall is Horizontal.

Batter, ω 5.7 [deg]
Backslope, β 26.6 [deg]
Backslope rise 12.0 [ft] Broken back equivalent angle, I = 26.60° (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]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 14.10, Meyerhof stress = 1549 lb/ft².

Foundation Interface: Direct sliding, Fs = 2.334, Eccentricity, e/L = -0.0179, Fs-overturning = 6.12

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	1	N/A	2.58	2.85	2.852	9.371	1.972	-0.0402	Miragrid 5XT
2	4.67	12.00	1	N/A	3.82	4.22	4.223	9.269	2.258	-0.0753	Miragrid 5XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 8.43, Meyerhof stress = 2079 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.263, Eccentricity, e/L = 0.0991, Fs-overturning = 2.96

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	1	N/A	1.73	1.92	1.918	4.406	1.185	0.0292	Miragrid 5XT
2	4.67	12.00	1	N/A	2.32	2.57	2.571	3.851	1.677	-0.0517	Miragrid 5XT

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Earthwork Observation & Testing
CESCL & Stormwater Services

AASHTO 2002 ASD DESIGN METHOD
Normandy Heights

MSEW+: Update # 2025.11

PROJECT IDENTIFICATION

Title: Normandy Heights
Project Number: ES-0593.07
Client: RM Homes, LLC
Designer: ESNW
Station Number:

Description:

15.7' Two-Tiered Lock+Load Wall

Company's information:

Name: ESNW, LLC
Street: 15365 NE 90th Street
Suite 100
Redmond, WA 98052
Telephone #: 4254494704
Fax #:
E-Mail: info@esnw.com

File path and name: C:\Users\chase.halsen\OneDrive - Earth Solutions NW\Des.....
.....\15.7' (Tiered).BENp

Original date and time of creating this file: Fri Oct 17 07:00:05 2025

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) = 0.3077 (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 = 0.00 N γ= 7.40

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.550
Design acceleration coefficient in Internal Stability: Kh = Am = 0.550
Design acceleration coefficient in External Stability: Kh_d = 0.352 => Kh = Am = 0.386
(Kh in External Stability is based on allowable displacement, d = 25 mm. using AASHTO 2002 equation)

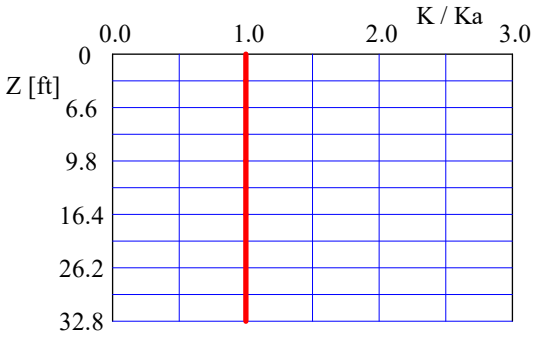
Kae (Kh > 0) = 0.6556 Kae (Kh = 0) = 0.3077 Δ Kae = 0.3479
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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	7600.0	10200.0	16000.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.05	1.05	1.05	1.05	
Creep reduction factor, RFc	1.44	1.44	1.44	1.44	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	25.60	25.60	25.60	25.60	
Pullout resistance factor, F*	0.60·tanϕ	0.60·tanϕ	0.60·tanϕ	0.60·tanϕ	N/A
Scale-effect correction factor, α	1.0	1.0	1.0	1.0	

Variation of Lateral Earth Pressure Coefficient With Depth

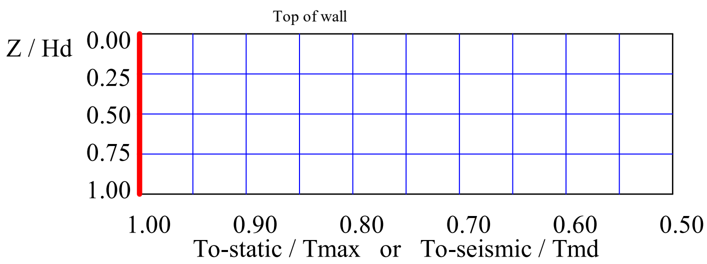
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection
(Analysis)

FACIA type: Segmental precast concrete panels.
Depth of panel is 2.50 ft. Horizontal distance to Center of Gravity of panel is 1.25 ft.
Average unit weight of panel is γ_f = 135.00 lb/ft ³

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Miragrid ..	Miragrid ..	Miragrd 1..	Miragrid ..	N/A
Durability reduction factor, RFd	1.15	1.15	1.15	1.15	N/A
Creep reduction factor, RFc	1.44	1.44	1.44	1.44	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A
CRu = Tult-connection/Tult-geogrid	0.90	0.90	0.90	0.90	N/A

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

Design height, Hd 15.67 [ft] { Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 13.67 ft, where H1 = 6.00 and H2 = 4.67 }

Soil in front of the wall is inclined at 2H:1V. Hs = 4.67 ft.

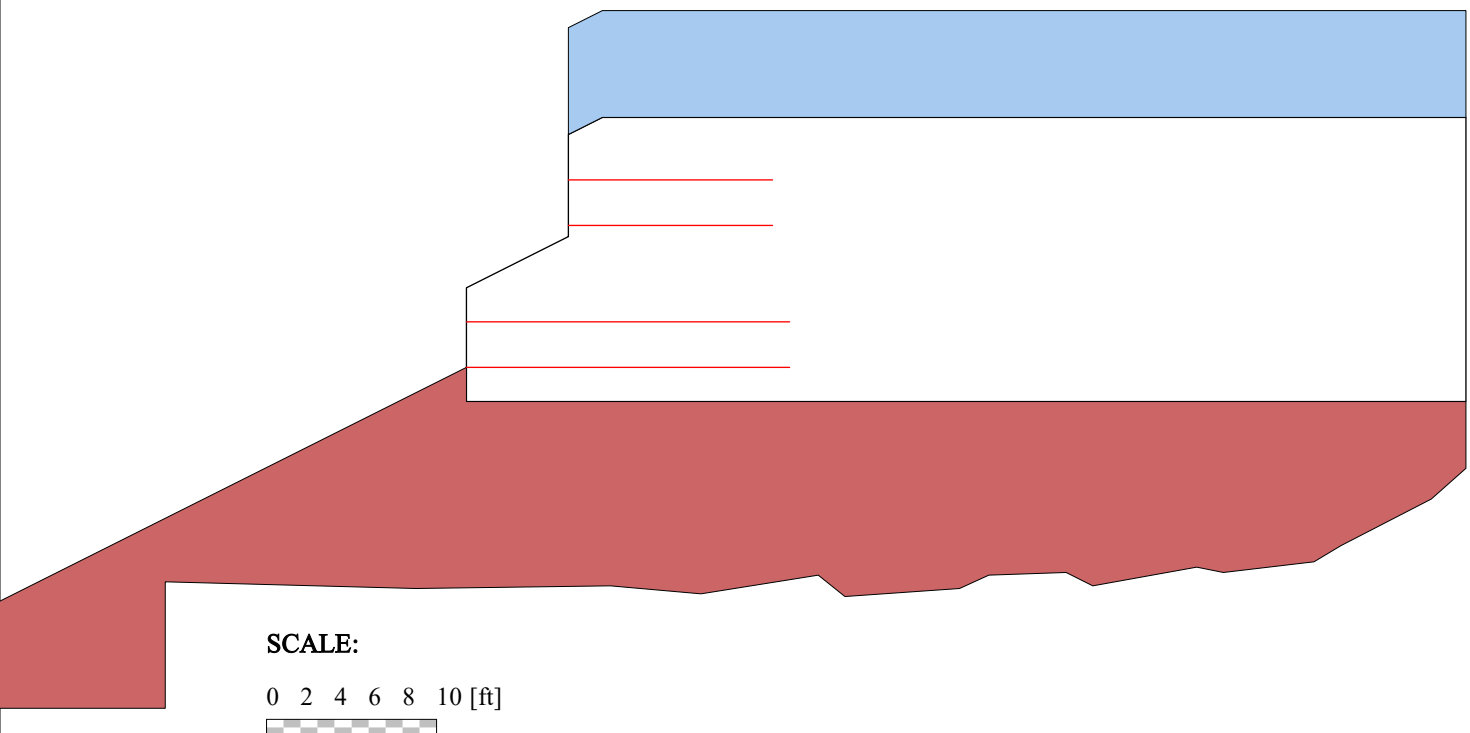
Batter, ω	0.0	[deg]	
Backslope, β	26.6	[deg]	
Backslope rise	1.0	[ft]	Broken back equivalent angle, I = 1.83° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 6.0 ft, Blackslope2 = 26.6 deg. and Backslope rise, S2 = 3.0 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], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 4.23, Meyerhof stress = 2000 lb/ft².

Foundation Interface: Direct sliding, Fs = 3.142, Eccentricity, e/L = -0.0054, Fs-overturning = 8.92

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	19.00	3	N/A	3.34	3.70	3.700	14.507	2.595	-0.0274	Miragrd 10XT
2	4.67	19.00	3	N/A	3.00	3.32	3.321	9.772	2.872	-0.0625	Miragrd 10XT
3	10.33	12.00	2	N/A	3.02	3.34	3.342	3.852	3.584	0.0201	Miragrid 8XT
4	13.00	12.00	2	N/A	5.47	6.05	6.048	2.996	4.780	0.0010	Miragrid 8XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 3.52, Meyerhof stress = 2195 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.507, Eccentricity, e/L = 0.0819, Fs-overturning = 3.77

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	19.00	3	N/A	2.40	2.65	2.650	7.388	1.369	0.0286	Miragrd 10XT
2	4.67	19.00	3	N/A	2.26	2.50	2.504	5.318	2.553	-0.0575	Miragrd 10XT
3	10.33	12.00	2	N/A	2.35	2.61	2.605	2.190	1.648	0.0661	Miragrid 8XT
4	13.00	12.00	2	N/A	3.80	4.20	4.201	1.468	2.734	0.0123	Miragrid 8XT

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Environmental Services
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CESCL & Stormwater Services

AASHTO 2002 ASD DESIGN METHOD
Normandy Heights

MSEW+: Update # 2025.11

PROJECT IDENTIFICATION

Title: Normandy Heights
Project Number: ES-0593.07
Client: RM Homes, LLC
Designer: ESNW
Station Number:

Description:

17.00' Two-Tiered Lock+Load Wall

Company's information:

Name: ESNW, LLC
Street: 15365 NE 90th Street
Suite 100
Redmond, WA 98052
Telephone #: 4254494704
Fax #:
E-Mail: info@esnw.com

File path and name: C:\Users\chase.halsen\OneDrive - Earth Solutions NW\Des.....
.....17.00' (Tiered).BENp

Original date and time of creating this file: Fri Oct 17 07:00:05 2025

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) = 0.3167 (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 = 0.00 N γ= 7.40

SEISMICITY (using AASHTO 2007)

Maximum ground acceleration coefficient, A = 0.550
Design acceleration coefficient in Internal Stability: Kh = Am = 0.550
Design acceleration coefficient in External Stability: Kh_d = 0.352 => Kh = Am = 0.386
(Kh in External Stability is based on allowable displacement, d = 25 mm. using AASHTO 2002 equation)

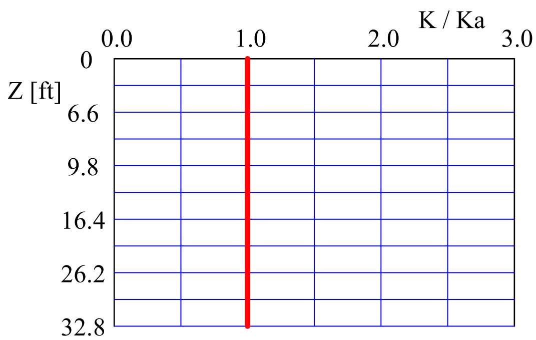
Kae (Kh > 0) = 0.8504 Kae (Kh = 0) = 0.3167 Δ Kae = 0.5337
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

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	7600.0	10200.0	16000.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.05	1.05	1.05	1.05	
Creep reduction factor, RFc	1.44	1.44	1.44	1.44	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	25.60	25.60	25.60	25.60	
Pullout resistance factor, F*	0.60·tan ϕ	0.60·tan ϕ	0.60·tan ϕ	0.60·tan ϕ	N/A
Scale-effect correction factor, α	1.0	1.0	1.0	1.0	

Variation of Lateral Earth Pressure Coefficient With Depth

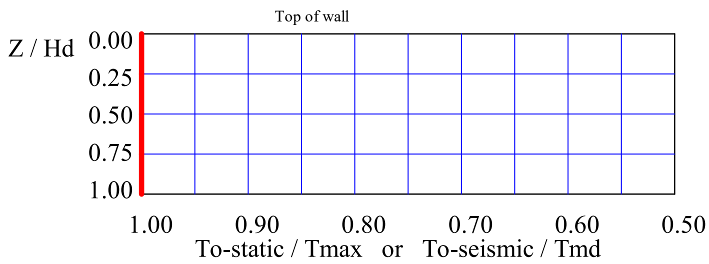
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Segmental precast concrete panels.
Depth of panel is 2.50 ft. Horizontal distance to Center of Gravity of panel is 1.25 ft.
Average unit weight of panel is γ_f = 135.00 lb/ft ³

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	1.00
0.25	1.00
0.50	1.00
0.75	1.00
1.00	1.00



D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	Miragrid ..	Miragrid ..	Miragrd 1..	Miragrid ..	N/A
Durability reduction factor, RFd	1.15	1.15	1.15	1.15	N/A
Creep reduction factor, RFc	1.44	1.44	1.44	1.44	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A
CRu = Tult-connection/Tult-geogrid	0.90	0.90	0.90	0.90	N/A

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

Design height, Hd 17.00 [ft] { Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 15.00 ft, where H1 = 6.00 and H2 = 6.00 }

Soil in front of the wall is inclined at 2H:1V. Hs = 6.00 ft.

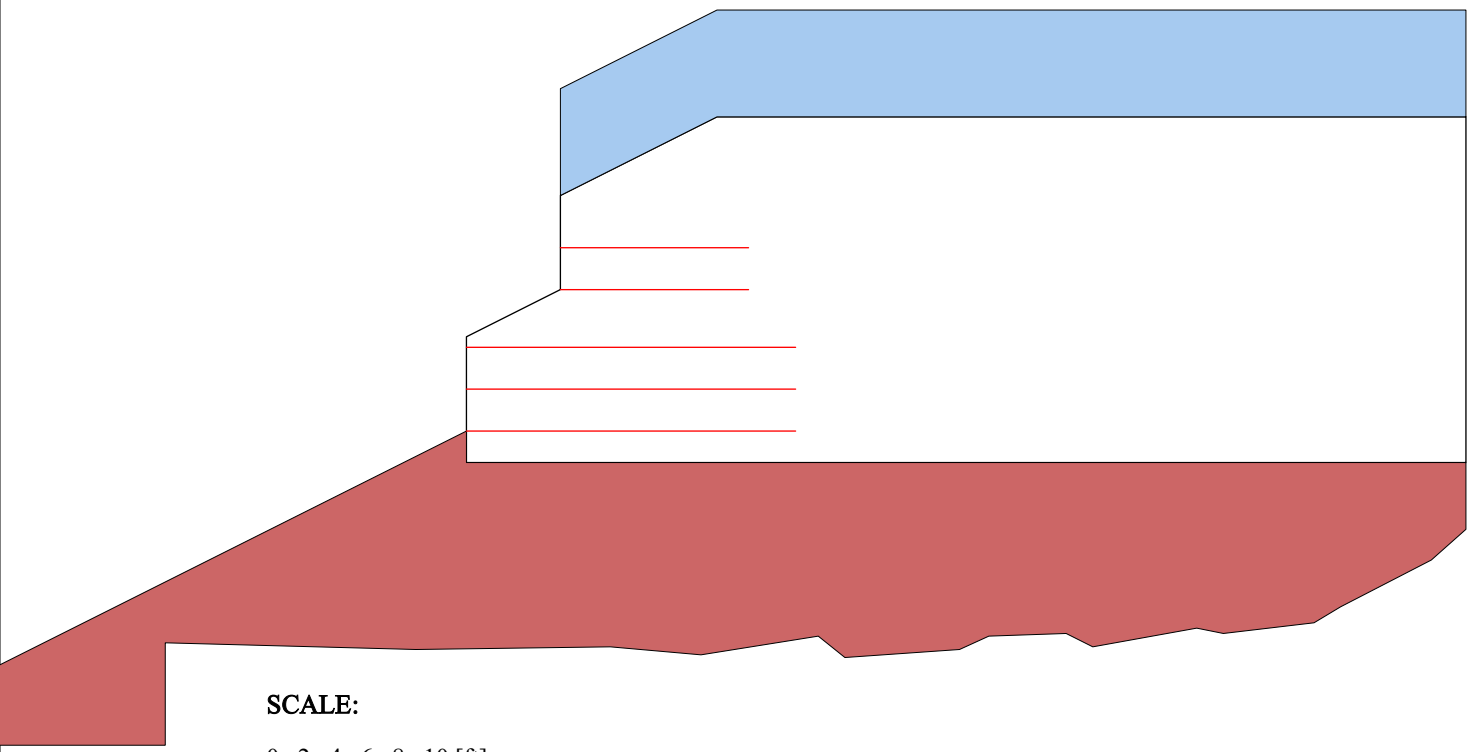
Batter, ω	0.0	[deg]	
Backslope, β	26.6	[deg]	
Backslope rise	5.0	[ft]	Broken back equivalent angle, I = 8.37° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 6.0 ft, Blackslope2 = 26.6 deg. and Backslope rise, S2 = 3.0 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], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 3.82, Meyerhof stress = 2477 lb/ft².

Foundation Interface: Direct sliding, Fs = 2.617, Eccentricity, e/L = -0.0028, Fs-overturning = 6.60

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	21.00	3	N/A	2.48	2.75	2.748	14.631	2.110	-0.0236	Miragrd 10XT
2	4.67	21.00	3	N/A	3.75	4.15	4.154	17.586	2.255	-0.0550	Miragrd 10XT
3	7.33	21.00	3	N/A	3.70	4.10	4.095	13.382	2.394	-0.0945	Miragrd 10XT
4	11.00	12.00	2	N/A	2.87	3.18	3.175	4.256	2.054	0.0135	Miragrid 8XT
5	13.67	12.00	2	N/A	3.19	3.53	3.525	2.265	2.304	-0.0312	Miragrid 8XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 2.62, Meyerhof stress = 3013 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.322, Eccentricity, e/L = 0.1015, Fs-overturning = 3.08

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	21.00	3	N/A	1.95	2.16	2.157	8.391	1.164	0.0476	Miragrd 10XT
2	4.67	21.00	3	N/A	2.71	3.00	3.002	9.062	1.457	-0.0186	Miragrd 10XT
3	7.33	21.00	3	N/A	2.75	3.04	3.038	7.132	2.285	-0.0911	Miragrd 10XT
4	11.00	12.00	2	N/A	2.33	2.58	2.576	2.550	1.190	0.0737	Miragrid 8XT
5	13.67	12.00	2	N/A	2.60	2.88	2.881	1.371	1.691	-0.0151	Miragrid 8XT