Verdura® 40/60 Retaining Wall Feasibility Design and Response to Plan Review Comments from City of Lake Forest

Project:
Portola Center Project (South Parcel), TTM 15353
Lake Forest, CA

Prepared for:

SunRanch Capital Partners, LLC
Attn: Mr. Scott Molloy
610 West Ash Street, Suite 1500
San Diego, CA 92101

SRD Project No: 0704-034A
August 10, 2012

SOIL RETENTION

DESIGNS INC.

Date: August 10, 2012 SRD Project No: 0704-034A

To: SunRanch Capital Partners, LLC.
Attn: Mr. Scott Molloy
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San Diego, CA 92101
Phone: 619-234-4050

Subject: ***Verdura***® 40/60 Retaining Wall Feasibility Design and Response to Plan Review Comments from the City of Lake Forest, Portola Center Project (South Parcel), TTM 15353, Lake Forest, CA

In accordance with your request, ***Soil Retention Designs, Inc. (SRD)*** has prepared this updated feasibility design report to address four representative wall geometries for the proposed ***Verdura***® retaining walls at the subject site. The enclosed structural design is an updated feasibility study and includes structural wall calculations enclosed within this report and accompanying cross-section design wall drawings (***Verdura***® Segmental Retaining Wall Drawings - Sheets 1 through 6). The subject structural design is based upon the Tentative Tract Map 15353, prepared by Hunsaker and Associates, dated May 8, 2012. Please note that this feasibility design is not intended to be a construction document; but is solely prepared to facilitate planning requirements for Tentative Tract Map processing.

In addition, review comments from the City of Lake Forest Planning Department, prepared by Interwest Consulting Group, have also been addressed. Our responses are provided on an item by item basis with the comment list attached for reference.

REFERENCED DOCUMENTS

The information provided for use in the enclosed structural analyses included the following:

1. "Geotechnical Investigation, Portola Center South, Tentative Map 15353, Lake Forest, California," prepared by Geocon, Incorporated, Project No. G1218-52-01A, dated July 6, 2012.
2. Tentative Tract Map 15353, prepared by Hunsaker and Associates, dated May 8, 2012.
3. "Mechanically Stabilized Earth Walls and Reinforced Soil Slopes," prepared by Federal Highway Administration, Publication No. FHWA-NHI-00-043.

SCOPE OF WORK

The scope of design services provided for this project included the following:

1. Review of the above referenced documents relative to obtaining necessary design parameters.
2. In-office analysis and design of the proposed ***Verdura®*** retaining walls to accommodate critical aspects of the proposed civil design.
3. Preparation of this report, which contains our calculations, associated specifications, and accompanying design drawings for the proposed ***Verdura®*** retaining walls.
4. Response to City of Lake Forest plan review comments, dated November 2011.

LIMITATIONS

The design and recommendations provided herein are applicable to the use of the ***Verdura®*** retaining wall products, which is of proprietary ownership by Soil Retention Products, Inc.

Note that the scope of services authorized and provided herein is limited to a structural design of the proposed ***Verdura®*** Retaining Wall system. ***SRD*** did not provide any on-site geotechnical services such as subsurface investigations or identification/testing of soil materials that may be used in or near the proposed ***Verdura®*** retaining walls. Information presented herein is based on data provided in the referenced documents. If the conditions differ from those presented in the referenced documents, the engineering design and analyses provided by ***SRD*** may no longer be valid and additional engineering and analysis may be required. Conditions noted above include, but are not limited to, slope configurations, wall system type, wall/slope heights, soil materials and structural and/or external loadings. In addition, it should be noted that ***SRD*** is the wall designer and not the geotechnical engineer-of-record.

<u>RESPONSE TO CITY PLAN REVIEW COMMENTS</u>

SRD Response #S1 – Please note the following with regards to UBC and CBC conformance of the ***Verdura®*** retaining wall:

The ER-5515 evaluation report was prepared to determine conformance with the 1997 Uniform Building Code – Standard 21-4, Hollow and Solid Load-Bearing Concrete Masonry Units (see attachment). The UBC Standard 21-4 solely addresses manufacturing specifications for the block units and is based on ASTM Standard C90. The 2010 California Building Code (CBC) also relies upon the **<u>same ASTM standard</u>** (see section 2103.1).

Additionally, the 2010 California Building Code (CBC) specifies that the system be designed per Allowable Stress Design (ASD) methodology (see section 2107). Site specific design calculations for the proposed walls at the subject site have been provided per nationally recognized methodologies (Federal Highway Administration [FHWA]), which utilizes ASD methodology.

Please note that the ***Verdura***® retaining wall system is a CALTRANS-Approved wall system and is listed on the "Pre-Approved Alternate Earth Retaining Systems" as of April 2012, which can be obtained through the following link:

http://www.dot.ca.gov/hq/esc/approved_products_list/pdf/earth_retaining_syst.pdf

Soil Retention is currently working on updating the ICC evaluation to include additional reinforcement types and reference to the 2010 CBC. The ER-5515 remains active and is available through the ICC website.

SRD Response #S2 – This item is under the purview of the geotechnical engineer of record.

SRD Response #S3 – The requested inspections are included under Section 3.10 and 3.11 of the General Notes sheet of the provided drawings. Please note that the subject cross-sectional drawings are not considered full construction documents, but are intended to provide feasibility information as part of the planning stage of the project. Full construction drawings will be much more detailed showing specific wall profiles with structural detailing.

SRD Response #S4 – Please see the attached Figure #1 (rear of document) which shows the representative wall locations that this feasibility design addresses.

SRD Response #S5 – This item is under the purview of the civil and/or geotechnical engineer of record.

SRD Response #S6 – *Verdura*® retaining wall segmental blocks are manufactured with a proprietary concrete mix which is resistant to severe (or very severe) sulfate exposure and will perform superior to any Type V cement mix.

SRD Response #S6 (Duplicate Question #) – The proposed ***Verdura***® retaining walls have a maximum exposed height of 30 feet; however the walls are designed in some cases in a superimposed (terraced) condition creating heights in excess of 60 feet due to the 2:1 separation slopes and required embedment depths. The structural design methodology for terraced wall and/or an overall single height wall design is controlled by the offset distance between the walls. The following relationship recommended by Federal Highway Administration (FHWA) determines the type of analysis performed:

$$D \leq [1/20 * (H1 + H_2)]$$

D = Offset Distance
H_1 *= Height of Upper Wall*
H_2 *= Height of Lower Wall*

Per the FHWA design manual, for small upper wall offsets (where D ≤ 1/20 * [maximum 36 + 38] ≈ 4 feet), it is "assumed that the failure surface does not fundamentally change…The walls should be designed as a single wall…" Please see the attached excerpt from the FHWA design manual at the rear of text that further details this information.

For the subject site, the minimum offset between walls is on the order of 20+ feet. The "D" equation is not satisfied with this geometry, so the walls are designed in a terraced condition and internal stresses within the wall are significantly reduced. Our feasibility design for the terraced condition incorporates the use of "high-strength" geogrid reinforcement for these lower stresses. Steel reinforcements are not necessary for the proposed wall geometries. Additional information regarding terraced wall or independent wall design is outlined within the body of this report.

SRD Response #S7 – The requested references have been added to the updated ***Verdura***® Segmental Wall Drawings and this report.

SRD Response #S8 – Surcharge loadings for permanent structures and/or transient loading from road traffic are relatively small in comparison to the overall static loading of fill of the larger wall complexes. For this feasibility design, surcharge loading has not been incorporated, but may be appropriate during the construction permitting phase of the project.

SRD Response #S9 – Table 3 within the ***Verdura***® Segmental Wall Drawings have been updated to correspond to the recommendations within the referenced geotechnical reports. Note that the previous Table 3 was in error and has been corrected.

SRD Response #S10 – The subject walls were designed for a site acceleration of 0.36g. The previous Table 3 located within the ***Verdura***® Segmental Wall Drawings was in error and has been corrected.

SRD Response #S11 – Post-construction horizontal movements of ***Verdura***® retaining walls are discussed in the "Structural Setbacks" portion of the report.

SRD Response #S12 – Analysis is provided within the later part of this report for the most current representative wall geometries (see the "Wall Design" section and the Appendix).

SRD Response #S13 – Wet-stamp and signature are provided for both the updated ***Verdura***® Segmental Wall Drawings and this report.

VERDURA® RETAINING WALL DESIGN

General Wall Configurations – The proposed site design consists of multiple ***Verdura***® retaining walls located within the southerly and easterly perimeter slopes of the project site. Proposed walls consist of both single and double-tier walls positioned within 2:1 slopes which reach overall heights of up to 120 feet. Individual wall heights reach a maximum of 30 feet. Terraced walls are designed with 2:1 separation slopes or level areas between the walls typically 20 to 30 feet in horizontal distance.

Geotechnical Design Parameters - The geotechnical parameters used in design of the ***Verdura***® retaining walls are based upon the recommendations from the geotechnical engineer of record within the Referenced Document #1 and are summarized as follows:

- Reinforced zone (cohesion [c]= 500 psf, friction angle [φ]=32°);
- Retained zone (c=500 psf, φ=28°); and,
- Foundation zone (c=500 psf, φ=28°).

In accordance with nationally recognized design methodology, **<u>cohesion within the reinforced and retained soils is conservatively disregarded.</u>** The materials used within the reinforced zone may consist of either select onsite and/or imported fill material, provided the following quality criteria are met:

- Friction angle ≥ 32 degrees;
- Percent passing #200 sieve ≤ 35 percent;
- Expansion index of ≤ 50; and,
- Plasticity index of ≤ 20.

Based upon review of Referenced Document #1, it appears that these materials may be generated from the Puente Formation – Soquel Member (Tps – sandstone portion) and potentially other onsite sources.

Seismic Design Parameters – The site acceleration of 0.36g was utilized for the subject wall design based on information provided within Referenced Document #1.

Wall Design – Feasibility designs for the proposed ***Verdura®*** retaining walls for the subject site have been designed for both static and pseudo-static conditions using computer program MSEW (Mechanically Stabilized Earth Wall) 3.0 design software, developed by ADAMA Engineering, Inc. The structural designs have been completed per the AASHTO 2002 (ASD) design methodology. Structural design calculations include internal, external and local stability analyses. In addition, compound stability analysis is also included. The design calculations are provided within the appendix of this report and are preceded by a summary page of the critical factors of safety for the structural design (rear of text).

Structural design of walls in a superimposed (terraced) condition is primarily controlled by the offset distance between the walls and the relationship to the height of the lower wall. The determination of whether a single tiered design for a two-wall system or two independent designs are necessary is governed by the following relationship:

$$D \geq H_2 * \tan(90-\varphi_r)$$

D = Offset Distance
H_2 = Height of Lower Wall
φ_r = Friction Angle of Reinforced Backfill Soils

When “D” satisfies the above relationship, walls are not considered superimposed and the lower wall is designed as an independent wall with the upper wall modeled as a surcharge load. The upper wall is then designed without any influence from the wall below. When “D” does not satisfy the above relationship, walls are considered superimposed and a tiered design for a single system governs. Additional details regarding the design of terraced walls are included in attached excerpts from the referenced FHWA design manual at the back of this report.

Our analyses consisted of four (4) structural wall designs for both single-wall and tiered-wall geometries at the subject site and are representative of the more critical geometries within the subject site. The attached Figure #1 (rear of document) provides specific locations within the subject site as to where these designs are generally applicable. The structural designs are as follows:

- **Design 1 – Tiered 30-ft Walls with 20-ft Wide 2:1 Slope Separation** - Design 1 accommodates 30-ft high exposed height lower and upper walls with an 8-ft high 2:1 separation slope and 20-ft offset between the tiered walls. Embedment depth for the lower wall is 6 feet and 8 feet for the upper wall. The crest of the upper wall has a 20-ft high 2:1 ascending slope. This design is the "most-critical" tiered geometry within the subject site and is representative of the wall layout along the majority of the southern border within Lots "E", "F" and "G" (see Figure #1).

- **Design 2 – Tiered 30-ft Walls with 20-ft Wide Level Bench Separation** - Design 2 accommodates 30-ft high exposed height lower and upper walls with a 20-ft level bench offset between the tiered walls for a future access road. Embedment depth for the lower wall is 6 feet and 2 feet for the upper wall. The crest of the upper wall has a 5-ft high 2:1 ascending slope. This design is representative of the wall layout southwest of the proposed "Sports Park" area within the northern portion of Lot "G" (see Figure #1).

- **Design 3 – Single 20-ft Wall with 2:1 Crest** - Design 4 accommodates a 20.3-ft high exposed height wall with a 30-ft high 2:1 ascending slope at the crest. Embedment depth is a minimum 3 feet. This design is representative of the wall layout within an east canyon fill within Lot "C" (see Figure #1).

- **Design 4 – Tiered 12-ft over 30-ft Walls with 30-ft Separation** - Design 3 accommodates a 30-ft high exposed height lower wall and 12-ft high upper wall with a 12-ft high 2:1 separation slope and 30-ft offset between the tiered walls. Embedment depth for the lower wall is 6 feet and 10 feet for the upper wall. The crest of the upper wall has a 30-ft high 2:1 ascending slope. This design is representative of the wall layout within the northeast canyon fill within Lot "B" (see Figure #1).

Minimum safety factors for external, internal, and local stability satisfy the following criteria:

External Stability Calculations		
	Static	***Pseudostatic***
Base Sliding	1.5	1.1
Bearing Capacity	2.0	1.5
Overturning	2.0	1.5
Compound Stability	1.5	1.1
Internal Stability Calculations		
	Static	***Pseudostatic***
Sliding	1.5	1.1
Geogrid Pullout	1.5	1.1
Geogrid Strength	1.5	1.1
Local Stability Calculations		
	Static	***Pseudostatic***
Geogrid – Block Connection	1.5	1.1

The accompanying design drawings (***Verdura***® Segmental Retaining Wall Drawings - Sheets 1 through 6) depict cross-sections showing the geogrid lengths, strengths, and placement based upon these designs.

Wall Components – The proposed ***Verdura***® retaining walls are designed using ***Verdura***® 40 and 60 blocks, Miragrid geogrids and other accessory products, and described in "Part 2 – Products" of the "Specifications" of the accompanying design drawings (Sheet 1).

Toe embedment - Toe embedment (embedment of the wall base into the foundation soils) is typically provided to minimize the potential for erosion undermining of the wall base, enhance bearing capacity and enhance sliding resistance of the basal reinforcement layers. Embedment of the wall is accounted for in the calculations as part of the "total wall height". The embedment has no impact on the wall calculations (i.e. design methodology conservatively ignores passive earth pressures from soils in front of the wall and hence has no effect on the internal or external stability of the wall system/components).

Minimum requirements for wall embedment are summarized as follows:

MINIMUM EMBEDMENT REQUIREMENTS	
Sloping Condition at Toe of Wall	***Embedment Requirement****
Level	H/20 (Minimum 1-foot)
2H:1V	H/7 (Minimum 3 feet)

**Note: H equals the total height of an MSE wall.*

The toe embedment of the wall designs for the subject project are a minimum of 3 feet for the 20-ft high single wall in Design 3 and 6 feet for the 30-ft high tiered walls in Designs 1, 2 and 4. The designed embedment depths exceed the minimum nationally recognized standards. It should be noted that deeper embedment of 8 to 10 feet for the upper walls within the Design 1 and 4 conditions are required per the analyses. These depths typical vary based upon the height of the slope between the walls. Within Design 2, the upper tiered wall has an embedment of 2 feet as a result of the level condition in front of the wall. Additionally, all walls with descending slopes at the toe shall have an embedment depth which provides a minimum 7-foot to daylight condition per the geotechnical engineer of record.

Typical Structural Setbacks – Structures located above the tops of ***Verdura***® retaining walls that are over 30 feet in height should be setback behind a 1:1 (horizontal to vertical) structural influence line unless special foundation recommendations are employed (i.e. mat-type slabs, caisson footings, etc.), as directed by the geotechnical engineer of record. The 1:1 should be measured from the face of the wall and project upward to the slope/pad daylight.

Post-construction horizontal movements of ***Verdura***® retaining walls over 30 feet in height are expected to be less than 1/2 inch for single-tier walls (approximately 0.1% of total wall height) and 1 inch for multi-tier walls (approximately 0.2% of total wall height). Walls lower than 30 feet in height should have negligible lateral deflections. Both vertical and horizontal slope deformations and/or fill settlement surrounding the subject walls are under the purview of the geotechnical engineer of record. Our estimated horizontal movements do not account for the surrounding slopes and/or any underlying materials, but are solely for the walls themselves. In addition, pseudo-static designs are modeled based upon a 75mm (3 inch) displacement for external stability.

Wall Backfill – Requirements for backfill materials surrounding the proposed wall are included in the specifications of the ***Verdura***® Segmental Retaining Wall Drawings for this project. In summary, the materials should consist of engineered fill comprised of select onsite and/or imported soils accepted by the geotechnical engineer of record and having a minimum friction angle of 32 degrees shear strength when remolded to 90% of modified proctor density (ASTM D-1557). Soils within 6 inches of a reinforcing geosynthetic layer shall not contain particles larger than 4 inches in diameter.

Backfill Drainage – Retaining wall sub-drainage should be applied as shown on the accompanying design drawings and/or as directed by the geotechnical engineer of record. If groundwater conditions exist within the foundation soils below the proposed ***Verdura***® retaining walls, adequate drainage measures as directed by the geotechnical engineer of record should be employed to remedy the condition.

Surface Water Drainage – Drainage and channeling of surface water from above walls and from surrounding improvements should be directed to collection devices away from the retaining wall structures. Where possible, surface water should be collected in v-ditches, swales, or other collection/channeling devices in order to contain and discharge water to either end of the wall or away from the structures. Berms, curbs, gutters, swales or other devices may be required to prevent an excessive amount of concentrated runoff from draining over the crest of the wall and creating erosion problems. In no case should large volumes of runoff or concentrated flows be allowed to cascade over the top of ***Verdura***® retaining walls, discharge into the backfill or infill soils from which the wall is constructed or otherwise be allowed to saturate the structural fill of the wall.

Improvements Above Walls – The uppermost geosynthetic reinforcements are designed to be at least 2 feet beneath the top of wall elevations. The 2-foot zone is typically considered a suitable depth in which landscaping can be installed.

In general, ***SRD*** recommends placement of proposed improvements in areas that avoid conflicts with the geogrid reinforcements. Where there are planned improvements above walls, ***SRD*** recommends the use of a “buffer” slope atop the wall so that future excavations will avoid contact and/or potential damage to reinforcements for the walls. Based upon the current plan, a minimum “buffer” slope of 5 feet high is planned atop all walls, which would provide a minimum 7 feet to the uppermost geogrid reinforcements. Tree well and any pool excavations atop the walls should be planned to avoid cutting of reinforcements.

Root growth from trees and/or vegetation is not inhibited by or damaging to the geogrid reinforcement layers of the ***Verdura***® Retaining Wall system. Trees should be properly sized by the landscape architect so that root masses do not impart additional pressures on the wall face and anticipated tree canopies do not extend over the wall face when located on top of the wall.

Fence post and/or cable railings located at the top of walls should be constructed with caisson-type excavations which do not remove more than 25% of the geogrid materials at the face of the wall (e.g. spacing and size limited to 1-foot diameter caissons located on 4-foot centers).

Screen walls, which require footings resistance to significant lateral loads (i.e. wind loads, seismic loads), should be constructed with caisson and grade beam type foundations when located directly atop ***Verdura***® retaining walls. The following recommendations should be considered:

- Foundations systems located directly above ***Verdura***® retaining walls should comply with the following:

- Continuous trench foundations (and/or grade beams) shall be limited to 18 inches from top of wall elevations allowing for a minimum soil cover of 6 inches over geogrid reinforcement materials.

- Caisson foundations may be drilled vertically, but should not remove more than 25 percent of the geogrid materials (e.g. spacing and size limited to 2-foot diameter caissons located on 8-foot centers). Maximum diameter of caisson footings should be less than or equal to 3 feet.

- Foundation systems located closer than 5 feet from the top of ***Verdura***® retaining walls shall not rely upon passive pressure (acting towards the face of the wall) within the upper 2 feet measured from the top of wall.

- Foundation systems located a minimum of 5 feet away from the tops of ***Verdura***® retaining walls and/or located atop slopes above ***Verdura***® retaining walls may use passive pressures as directed by the geotechnical engineer of record.

Maintenance and Access – Maintenance and access for the proposed ***Verdura***® retaining walls should be provided per the direction of project planners. Planned ***Verdura***® retaining walls should be included within typical slope maintenance program guidelines.

Design Details – Detailed specifications, relative to the design of the ***Verdura***® retaining wall system, are provided on the accompanying drawings (***Verdura***® Segmental Retaining Wall Drawings - Sheets 1 through 6). The length, strength and spacing of geosynthetic reinforcements are depicted on the wall cross sections. Geogrid spacing for all wall areas shall not be more than 3 block courses except for top of wall areas as noted on the accompanying design drawings.

GLOBAL STABILITY ANALYSES

Global stability of earthen slopes surcharged by retaining walls is independent of local structural design for retaining walls and hence has not been conducted as part of the design included herein. The global stability of the slope and retaining wall combination is the responsibility of the geotechnical engineer of record and should be provided under separate cover. Minimum safety factors for potential failure surfaces that may occur behind and beneath the ***Verdura***® retaining wall within the surrounding slopes should be documented and approved by all appropriate reviewing agencies.

Modifications to geogrid lengths per the global stability analysis in the Referenced Document #1 have been broadly incorporated into the ***Verdura***® retaining wall drawings. The global stability recommendations from the geotechnical engineer should be more detailed for specific walls during the preparation of construction documents within the next phase of the project.

GEOTECHNICAL ENGINEER OF RECORD

It is the project geotechnical engineer of record's responsibility to review the enclosed design calculations, plans, and specifications in order to ensure that the assumptions made herein are consistent with their intentions. The geotechnical engineer of record will be responsible for ensuring that the soil, materials, and methods used in construction of the proposed ***Verdura***® retaining wall system are conducted in accordance with the specifications outlined herein.

CONCLUSIONS

Design of the above referenced ***Verdura***® retaining walls is feasible provided that the recommendations included herein and within the accompanying drawings are followed.

If you have any questions or wish additional information, please contact the undersigned.

Respectfully Submitted,

REGISTERED PROFESSIONAL ENGINEER
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Attachments: Design Summary Tables – Rear of Text
Appendix – ***Verdura***® Retaining Wall Design Calculations
Figure #1 – Wall Design Location Exhibit – Rear of Document
City of Lake Forest Plan Review Comments – Rear of Document
Uniform Building Code Standard 21-4 – Rear of Document
Excerpt from FHWA Design Manual "Superimposed Walls" – Rear of Document

Design Summary Table
Design 1
30' Over 30' Tiered Walls with 20' 2:1 Slope Offset

Design for Both Walls in Tiered Condition

Structure Geometry				
Total Height	74' Total Height Upper Wall – (30' Exposed with 8' Embedment) Lower Wall - (30' Exposed with 6' Embedment)			
Tiered Condition	20' Offset – 8' 2:1 Separation Slope Between Walls			
Crest Condition	20' 2:1 Ascending Slope			
Minimum Length/Height Ratio	Tiered Wall - 65'/74' (0.88) Lower Wall – 65'/36' (1.81) Upper Wall – 45'/38' (1.18)			
Geotechnical Parameters	**Reinforced**	**Retained**	**Foundation**	
Friction angle, φ, degrees	32	28	28	
Dry Unit Weight, γ_d, pcf	120	120	120	
Cohesion, c, psf	500*	500*	500	
Seismic acceleration, g	0.36g			
Global Stability	**Per Geotechnical Engineer of Record**			

*** Note: Cohesion within the reinforced and retained soil zones is conservatively ignored within the analysis.**

Minimum Factor of Safety

	FS, Static		FS, Seismic	
External Stability	**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
Sliding	1.75	≥1.5	1.20	≥1.1
Overturning	3.69	≥2.0	2.32	≥1.5
Bearing Capacity/Settlement	6.76	≥2.0	4.20	≥1.5
Compound Stability	1.78	≥1.5	1.15	≥1.1
Internal Stability	**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
Sliding	1.69	≥1.5	1.16	≥1.1
Pullout	4.04	≥1.5	2.46	≥1.1
Geogrid Strength	1.51	≥1.5	1.29	≥1.1
Local Stability	**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
Geogrid to Block Connection	1.56	≥1.5	1.18	≥1.1

Design Summary Table
Design 2
30' Over 30' Tiered Walls with 20' Level Bench Offset

Design for Both Walls in Tiered Condition

Structure Geometry				
Total Height	66' Total Height Upper Wall – (30' Exposed with 2' Embedment) Lower Wall - (30' Exposed with 6' Embedment)			
Tiered Condition	20' Offset Level Bench Between Walls			
Crest Condition	5' 2:1 Ascending Slope			
Minimum Length/Height Ratio	Tiered Wall - 50'/66' (0.76) Lower Wall – 50'/36' (1.39) Upper Wall – 30'/32' (0.94)			
Geotechnical Parameters	**Reinforced**	**Retained**	**Foundation**	
Friction angle, φ, degrees	32	28	28	
Dry Unit Weight, γ_d, pcf	120	120	120	
Cohesion, c, psf	500*	500*	500	
Seismic acceleration, g	0.36g			
Global Stability	**Per Geotechnical Engineer of Record**			

*** Note: Cohesion within the reinforced and retained soil zones is conservatively ignored within the analysis.**

Minimum Factor of Safety

	FS, Static		FS, Seismic	
External Stability	**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
Sliding	1.90	≥1.5	1.24	≥1.1
Overturning	3.84	≥2.0	2.20	≥1.5
Bearing Capacity/Settlement	6.99	≥2.0	4.11	≥1.5
Compound Stability	1.87	≥1.5	1.22	≥1.1
Internal Stability	**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
Sliding	1.78	≥1.5	1.17	≥1.1
Pullout	4.76	≥1.5	2.40	≥1.1
Geogrid Strength	1.53	≥1.5	1.31	≥1.1
Local Stability	**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
Geogrid to Block Connection	1.64	≥1.5	1.26	≥1.1

Design Summary Table
Design 3
20' Single Wall with 2:1 Slope

Structure Geometry				
	Total Height	23.3' (20.3' Exposed with 3' Embedment)		
	Crest Condition	30' 2:1 Ascending Slope		
	Minimum Length/Height Ratio	Lower Wall – 24'/23.3' (1.03)		
Geotechnical Parameters		**Reinforced**	**Retained**	**Foundation**
	Friction angle, φ, degrees	32	28	28
	Dry Unit Weight, γ_d, pcf	120	120	120
	Cohesion, c, psf	500*	500*	500
	Seismic acceleration, g	0.36g		
Global Stability		**Per Geotechnical Engineer of Record**		

*** Note: Cohesion within the reinforced and retained soil zones is conservatively ignored within the analysis.**

Minimum Factor of Safety

		FS, Static		FS, Seismic	
External Stability		**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
	Sliding	2.13	≥1.5	1.41	≥1.1
	Overturning	4.92	≥2.0	2.89	≥1.5
	Bearing Capacity/Settlement	10.61	≥2.0	7.67	≥1.5
	Compound Stability	1.58	≥1.5	1.12	≥1.1
Internal Stability		**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
	Sliding	2.01	≥1.5	1.36	≥1.1
	Pullout	16.21	≥1.5	5.46	≥1.1
	Geogrid Strength	2.00	≥1.5	1.14	≥1.1
Local Stability		**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
	Geogrid to Block Connection	2.65	≥1.5	1.17	≥1.1

Design Summary Table Design 4 12' Over 30' Tiered Walls with 30'Offset				
****Design for Both Walls in Tiered Condition****				
Structure Geometry				
Total Height	60' Total Height Upper Wall – (12' Exposed with 10' Embedment) Lower Wall - (30' Exposed with 6' Embedment)			
Tiered Condition	30' Offset – 12' 2:1 Separation Slope Between Walls			
Crest Condition	30' 2:1 Ascending Slope			
Minimum Length/Height Ratio	Tiered Wall - 50'/60' (0.83) Lower Wall – 50'/36' (1.39) Upper Wall – 25'/22' (1.14)			
Geotechnical Parameters	**Reinforced**	**Retained**	**Foundation**	
Friction angle, φ, degrees	32	28	28	
Dry Unit Weight, γ_d, pcf	120	120	120	
Cohesion, c, psf	500*	500*	500	
Seismic acceleration, g	0.36g			
Global Stability	**Per Geotechnical Engineer of Record**			
*** Note: Cohesion within the reinforced and retained soil zones is conservatively ignored within the analysis.**				
Minimum Factor of Safety				
	FS, Static		**FS, Seismic**	
External Stability	**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
Sliding	1.81	≥1.5	1.24	≥1.1
Overturning	3.79	≥2.0	2.40	≥1.5
Bearing Capacity/Settlement	7.25	≥2.0	4.57	≥1.5
Compound Stability	1.54	≥1.5	**Min 1.1 thru Geogrid Zone	≥1.1
Internal Stability	**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
Sliding	1.69	≥1.5	1.36	≥1.1
Pullout	2.31	≥1.5	1.49	≥1.1
Geogrid Strength	2.28	≥1.5	1.82	≥1.1
Local Stability	**Actual FS**	**Target FS**	**Actual FS**	**Target FS**
Geogrid to Block Connection	1.69	≥1.5	1.31	≥1.1

**** Safety factor in output is shown for slope area above the wall. This condition is outside the purview of a wall designer; however, consider that compound stability analysis does not consider the use of cohesion in calculations.**

Appendix

Verdura® Retaining Wall Design Calculations

(56 Pages)

AASHTO 2002 ASD DESIGN METHOD
Portola Center - TTM 15353

MSEW(3.0): Update # 14.3

PROJECT IDENTIFICATION

Title:	Portola Center - TTM 15353
Project Number:	0704 034A
Client:	SunRanch Capital Partners, LLC
Designer:	DAO
Station Number:	DESIGN 1

Description:

Tiered 30 ft over 30 ft Wall Height - 8 ft 2:1 Separation Slope -
Offset of 20 ft - 20 ft Ascending Slope at Crest

Company's information:

Name: Soil Retention Designs, Inc.
Street: 2501 State Street

Carlsbad, CA 92008
Telephone #: 760-966-6090
Fax #: 760-966-6099
E-Mail: dosborne@soilretention.com

Original file path and name: C:\Users\dosborne\Desktop\Portola South Rev Design\Upda.....
.....d - 20 ft offset.BEN

Original date and time of creating this file: Mon Nov 29 16:13:17 2010

PROGRAM MODE: ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	32.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	28.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	120.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	28.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	500.0 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) = 0.3721 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 25.80 N γ= 16.72

SEISMICITY

Maximum ground acceleration coefficient, A = 0.360
Design acceleration coefficient in Internal Stability: Kh = Am = 0.392
Design acceleration coefficient in External Stability: Kh_d = 0.175 => Kh = Am = 0.175
(Kh in External Stability is based on allowable displacement, d = 75 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.5415 Kae (Kh = 0) = 0.3721 Δ Kae = 0.1694
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

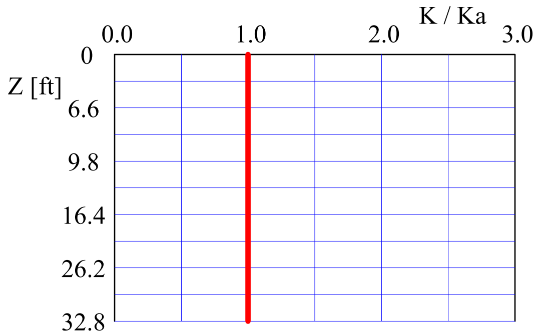
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	3590.0	6230.0	8300.0	12420.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.11	1.10	1.10	1.10	
Creep reduction factor, RFc	1.67	1.67	1.67	1.67	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	29.40	29.40	29.40	29.40	
Pullout resistance factor, F*	$0.90 \cdot \tan\rho$	$0.90 \cdot \tan\rho$	$0.90 \cdot \tan\rho$	$0.90 \cdot \tan\rho$	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

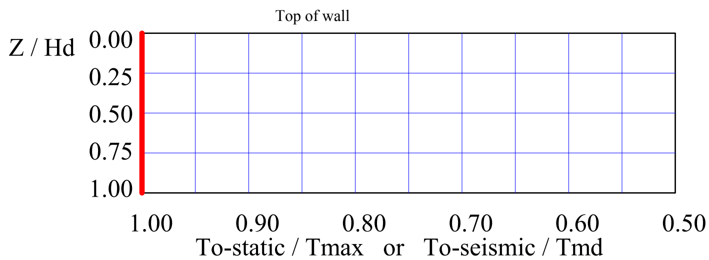
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (according to revised Demo 82) (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 1.00/0.67 ft. Horizontal distance to Center of Gravity of block is 0.42 ft.
Average unit weight of block is γ_f = 117.00 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



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRult [(2)]	σ	CRult	σ	CRult	σ	CRult	σ	CRult
0.0	0.98	0.0	0.50	0.0	0.25	0.0	0.34		
4000.0	0.98	1545.0	0.71	1831.0	0.72	1914.0	0.63	N/A	
		4000.0	0.71	4000.0	0.72	4000.0	0.63		

Geogrid Type #1[3)]		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRcr	σ	CRcr	σ	CRcr	σ	CRcr	σ	CRcr
0.0	0.98	0.0	0.50	0.0	0.25	0.0	0.34		
4000.0	0.98	1545.0	0.71	1831.0	0.72	1914.0	0.63	N/A	
		4000.0	0.71	4000.0	0.72	4000.0	0.63		

(1) σ = Confining stress in between stacked blocks [lb/ft ^{2}]
(2) CRult = Tc-ult / Tult
(3) CRcr = Tcre / Tult

In seismic analysis, long term strength is reduced to 100% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	V40 - 5XT	V40 - 8XT	V40 - 10XT	V40 - 20XT	N/A
Connection strength reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	N/A	N/A	N/A	N/A	N/A

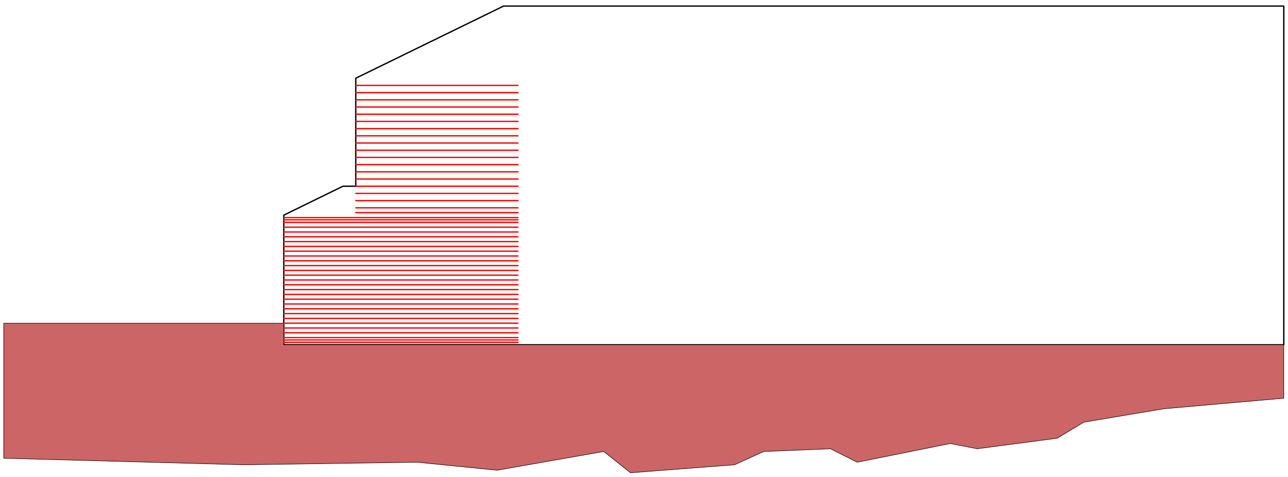
INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd	74.00	[ft]	{ Embedded depth is E = 6.00 ft, and height above top of finished bottom grade is H = 68.00 ft, where H1 = 30.00 and H2 = 30.00 }
Batter, ω	0.0	[deg]	
Backslope, β	26.0	[deg]	
Backslope rise	20.0	[ft]	Broken back equivalent angle, I = 7.70° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 20.0 ft, Blackslope2 = 26.0 deg. and Backslope rise, S2 = 8.0 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]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 5 10 15 20 25 30 [ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 6.76, Meyerhof stress = 10298 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.751, Eccentricity, e/L = 0.0648, Fs-overturning = 3.69

GEOGRID				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.67	65.00	4	2.26	1.95	1.952	179.236	1.687	0.0623	V40 - 20XT
2	1.33	65.00	4	3.43	2.96	2.964	268.559	1.695	0.0599	V40 - 20XT
3	2.00	65.00	4	2.30	1.99	1.991	177.929	1.703	0.0573	V40 - 20XT
4	3.33	65.00	4	1.75	1.51	1.512	131.517	1.719	0.0523	V40 - 20XT
5	4.67	65.00	4	1.78	1.54	1.537	130.011	1.735	0.0473	V40 - 20XT
6	6.00	65.00	4	1.82	1.57	1.568	129.001	1.751	0.0422	V40 - 20XT
7	7.33	65.00	4	1.84	1.59	1.589	127.085	1.768	0.0372	V40 - 20XT
8	8.67	65.00	4	1.87	1.62	1.617	125.535	1.785	0.0321	V40 - 20XT
9	10.00	65.00	4	1.91	1.65	1.651	124.579	1.802	0.0269	V40 - 20XT
10	11.33	65.00	4	1.94	1.67	1.674	122.638	1.819	0.0218	V40 - 20XT
11	12.67	65.00	4	1.97	1.70	1.705	121.159	1.837	0.0166	V40 - 20XT
12	14.00	65.00	4	2.02	1.74	1.743	120.146	1.855	0.0113	V40 - 20XT
13	15.33	65.00	4	2.05	1.77	1.769	118.239	1.873	0.0060	V40 - 20XT
14	16.67	65.00	4	2.09	1.80	1.803	116.778	1.891	0.0006	V40 - 20XT
15	18.00	65.00	4	2.14	1.85	1.846	115.768	1.909	-0.0048	V40 - 20XT
16	19.33	65.00	4	2.17	1.88	1.875	113.897	1.928	-0.0103	V40 - 20XT
17	20.67	65.00	4	2.15	1.91	1.914	112.457	1.947	-0.0159	V40 - 20XT
18	22.00	65.00	4	2.12	1.96	1.961	111.453	1.965	-0.0216	V40 - 20XT
19	23.33	65.00	4	2.07	2.00	1.995	109.622	1.984	-0.0274	V40 - 20XT
20	24.67	65.00	4	2.03	2.04	2.039	108.207	2.003	-0.0334	V40 - 20XT
21	26.00	65.00	4	1.99	2.09	2.092	107.214	2.022	-0.0395	V40 - 20XT
22	27.33	65.00	4	1.93	2.13	2.132	105.428	2.041	-0.0457	V40 - 20XT
23	28.67	65.00	4	1.88	2.18	2.181	104.044	2.060	-0.0521	V40 - 20XT
24	30.00	65.00	4	1.84	2.24	2.242	103.069	2.079	-0.0587	V40 - 20XT
25	31.33	65.00	4	1.78	2.29	2.288	101.333	2.098	-0.0655	V40 - 20XT
26	32.67	65.00	4	1.72	2.35	2.345	99.988	2.116	-0.0726	V40 - 20XT
27	34.00	65.00	4	2.21	3.20	3.201	131.303	2.134	-0.0800	V40 - 20XT
28	34.67	65.00	4	3.27	4.89	4.892	196.755	2.143	-0.0838	V40 - 20XT
29	35.33	65.00	4	2.13	3.30	3.301	130.191	2.152	-0.0876	V40 - 20XT
30	36.67	45.00	4	2.92	2.53	2.527	74.187	2.094	0.0604	V40 - 20XT
31	38.00	45.00	4	2.42	2.09	2.089	58.223	2.132	0.0550	V40 - 20XT
32	40.00	45.00	4	2.09	1.81	1.809	46.411	2.193	0.0469	V40 - 20XT
33	42.00	45.00	4	2.19	1.89	1.891	44.493	2.258	0.0390	V40 - 20XT
34	44.00	45.00	4	2.29	1.98	1.981	42.550	2.325	0.0311	V40 - 20XT
35	46.00	45.00	4	2.41	2.08	2.079	40.574	2.397	0.0232	V40 - 20XT
36	48.00	45.00	4	2.53	2.19	2.189	38.562	2.474	0.0152	V40 - 20XT
37	50.00	45.00	3	2.04	1.54	1.544	36.505	2.555	0.0073	V40 - 10XT
38	52.00	45.00	3	2.16	1.63	1.634	34.400	2.640	-0.0008	V40 - 10XT
39	54.00	45.00	3	2.30	1.74	1.736	32.233	2.731	-0.0091	V40 - 10XT
40	56.00	45.00	3	2.45	1.85	1.852	29.996	2.828	-0.0176	V40 - 10XT
41	58.00	45.00	3	2.62	1.98	1.983	27.670	2.929	-0.0265	V40 - 10XT
42	60.00	45.00	3	2.63	2.14	2.135	25.239	3.037	-0.0359	V40 - 10XT
43	62.00	45.00	3	2.59	2.31	2.313	22.671	3.150	-0.0459	V40 - 10XT
44	64.00	45.00	3	2.55	2.52	2.522	19.935	3.268	-0.0570	V40 - 10XT
45	66.00	45.00	3	2.50	2.77	2.773	16.975	3.389	-0.0693	V40 - 10XT
46	68.00	45.00	3	2.43	3.08	3.080	13.724	3.512	-0.0835	V40 - 10XT
47	70.00	45.00	3	2.35	3.46	3.463	10.064	3.631	-0.1005	V40 - 10XT
48	72.00	45.00	3	1.56	2.73	2.734	4.038	3.738	-0.1216	V40 - 10XT

GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

STATIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.783
(it corresponds to a critical circle at Xc = -32.00, Yc = 192.00 and R = 194.65 [ft]).

SEISMIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.150
(it corresponds to a critical circle at Xc = -8.00, Yc = 192.00 and R = 123.22 [ft]).

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 4.20, Meyerhof stress = 13485 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.204, Eccentricity, e/L = 0.1603, Fs-overturning = 2.32

GEOGRID				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.67	65.00	4	1.63	1.58	1.584	103.326	1.164	0.1555	V40 - 20XT
2	1.33	65.00	4	2.16	2.19	2.194	135.511	1.173	0.1508	V40 - 20XT
3	2.00	65.00	4	1.66	1.61	1.613	102.337	1.182	0.1461	V40 - 20XT
4	3.33	65.00	4	1.35	1.29	1.286	81.338	1.200	0.1368	V40 - 20XT
5	4.67	65.00	4	1.37	1.31	1.306	80.324	1.219	0.1275	V40 - 20XT
6	6.00	65.00	4	1.40	1.33	1.331	79.548	1.239	0.1183	V40 - 20XT
7	7.33	65.00	4	1.42	1.35	1.349	78.348	1.259	0.1093	V40 - 20XT
8	8.67	65.00	4	1.44	1.37	1.371	77.306	1.280	0.1002	V40 - 20XT
9	10.00	65.00	4	1.47	1.40	1.398	76.560	1.302	0.0913	V40 - 20XT
10	11.33	65.00	4	1.49	1.42	1.418	75.342	1.324	0.0825	V40 - 20XT
11	12.67	65.00	4	1.51	1.44	1.442	74.341	1.348	0.0736	V40 - 20XT
12	14.00	65.00	4	1.54	1.47	1.473	73.559	1.372	0.0649	V40 - 20XT
13	15.33	65.00	4	1.57	1.49	1.494	72.358	1.397	0.0562	V40 - 20XT
14	16.67	65.00	4	1.59	1.52	1.522	71.365	1.423	0.0476	V40 - 20XT
15	18.00	65.00	4	1.63	1.55	1.555	70.582	1.450	0.0390	V40 - 20XT
16	19.33	65.00	4	1.65	1.58	1.579	69.399	1.478	0.0305	V40 - 20XT
17	20.67	65.00	4	1.64	1.61	1.610	68.416	1.508	0.0219	V40 - 20XT
18	22.00	65.00	4	1.61	1.65	1.647	67.633	1.539	0.0135	V40 - 20XT
19	23.33	65.00	4	1.57	1.68	1.675	66.470	1.570	0.0050	V40 - 20XT
20	24.67	65.00	4	1.53	1.71	1.710	65.498	1.604	-0.0035	V40 - 20XT
21	26.00	65.00	4	1.50	1.75	1.751	64.718	1.638	-0.0120	V40 - 20XT
22	27.33	65.00	4	1.46	1.78	1.783	63.576	1.675	-0.0205	V40 - 20XT
23	28.67	65.00	4	1.42	1.82	1.822	62.617	1.713	-0.0292	V40 - 20XT
24	30.00	65.00	4	1.38	1.87	1.869	61.842	1.753	-0.0378	V40 - 20XT
25	31.33	65.00	4	1.33	1.91	1.906	60.725	1.794	-0.0465	V40 - 20XT
26	32.67	65.00	4	1.28	1.95	1.950	59.782	1.838	-0.0554	V40 - 20XT
27	34.00	65.00	4	1.52	2.52	2.517	72.237	1.884	-0.0644	V40 - 20XT
28	34.67	65.00	4	1.94	3.46	3.464	93.226	2.089	-0.0789	V40 - 20XT
29	35.33	65.00	4	1.46	2.59	2.587	71.296	2.097	-0.0827	V40 - 20XT
30	36.67	45.00	4	2.17	2.09	2.092	44.072	1.425	0.1295	V40 - 20XT
31	38.00	45.00	4	1.89	1.79	1.788	36.335	1.463	0.1190	V40 - 20XT
32	40.00	45.00	4	1.69	1.58	1.583	29.994	1.524	0.1035	V40 - 20XT
33	42.00	45.00	4	1.76	1.65	1.651	28.655	1.590	0.0886	V40 - 20XT
34	44.00	45.00	4	1.84	1.73	1.725	27.299	1.662	0.0742	V40 - 20XT
35	46.00	45.00	4	1.92	1.81	1.807	25.921	1.740	0.0602	V40 - 20XT
36	48.00	45.00	4	2.01	1.90	1.896	24.523	1.826	0.0467	V40 - 20XT
37	50.00	45.00	3	1.61	1.33	1.333	23.097	1.919	0.0336	V40 - 10XT
38	52.00	45.00	3	1.70	1.41	1.406	21.642	2.023	0.0209	V40 - 10XT
39	54.00	45.00	3	1.79	1.49	1.487	20.151	2.136	0.0085	V40 - 10XT
40	56.00	45.00	3	1.90	1.58	1.579	18.619	2.262	-0.0038	V40 - 10XT
41	58.00	45.00	3	2.02	1.68	1.682	17.037	2.401	-0.0159	V40 - 10XT
42	60.00	45.00	3	2.01	1.80	1.800	15.397	2.554	-0.0281	V40 - 10XT
43	62.00	45.00	3	1.96	1.94	1.936	13.684	2.723	-0.0405	V40 - 10XT
44	64.00	45.00	3	1.90	2.09	2.094	11.884	2.907	-0.0534	V40 - 10XT
45	66.00	45.00	3	1.83	2.28	2.279	9.972	3.106	-0.0672	V40 - 10XT
46	68.00	45.00	3	1.76	2.50	2.502	7.920	3.314	-0.0825	V40 - 10XT
47	70.00	45.00	3	1.66	2.77	2.772	5.683	3.521	-0.1001	V40 - 10XT
48	72.00	45.00	3	1.18	2.30	2.300	2.456	3.704	-0.1215	V40 - 10XT

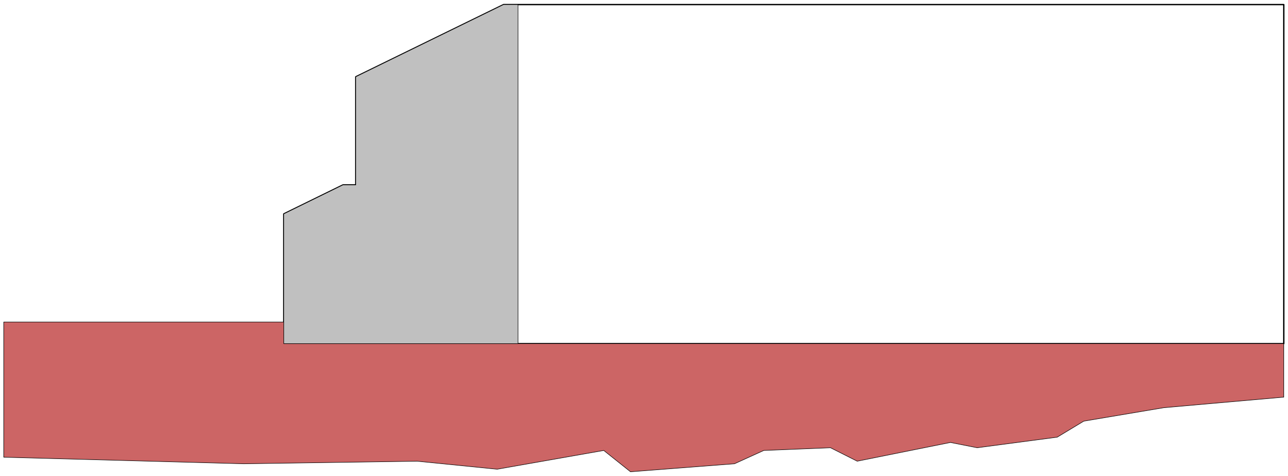
GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

STATIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.783
(it corresponds to a critical circle at Xc = -32.00, Yc = 192.00 and R = 194.65 [ft]).

SEISMIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.150
(it corresponds to a critical circle at Xc = -8.00, Yc = 192.00 and R = 123.22 [ft]).

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	69642	56596	[lb/ft ²]
Meyerhof stress, σ_V	10297.7	13485	[lb/ft ²]
Eccentricity, e	4.22	10.72	[ft]
Eccentricity, e/L	0.065	0.165	
Fs calculated	6.76	4.20	
Base length	65.00	65.00	[ft]



SCALE:

0 5 10 15 20 25 30 [ft]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.751 and Fs-seismic = 1.204

#	Geogrid Elevation [ft]	Geogrid Length [ft]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.67	65.00	1.687	1.164	4	V40 - 20XT
2	1.33	65.00	1.695	1.173	4	V40 - 20XT
3	2.00	65.00	1.703	1.182	4	V40 - 20XT
4	3.33	65.00	1.719	1.200	4	V40 - 20XT
5	4.67	65.00	1.735	1.219	4	V40 - 20XT
6	6.00	65.00	1.751	1.239	4	V40 - 20XT
7	7.33	65.00	1.768	1.259	4	V40 - 20XT
8	8.67	65.00	1.785	1.280	4	V40 - 20XT
9	10.00	65.00	1.802	1.302	4	V40 - 20XT
10	11.33	65.00	1.819	1.324	4	V40 - 20XT
11	12.67	65.00	1.837	1.348	4	V40 - 20XT
12	14.00	65.00	1.855	1.372	4	V40 - 20XT
13	15.33	65.00	1.873	1.397	4	V40 - 20XT
14	16.67	65.00	1.891	1.423	4	V40 - 20XT
15	18.00	65.00	1.909	1.450	4	V40 - 20XT
16	19.33	65.00	1.928	1.478	4	V40 - 20XT
17	20.67	65.00	1.947	1.508	4	V40 - 20XT
18	22.00	65.00	1.965	1.539	4	V40 - 20XT
19	23.33	65.00	1.984	1.570	4	V40 - 20XT
20	24.67	65.00	2.003	1.604	4	V40 - 20XT
21	26.00	65.00	2.022	1.638	4	V40 - 20XT
22	27.33	65.00	2.041	1.675	4	V40 - 20XT
23	28.67	65.00	2.060	1.713	4	V40 - 20XT
24	30.00	65.00	2.079	1.753	4	V40 - 20XT
25	31.33	65.00	2.098	1.794	4	V40 - 20XT
26	32.67	65.00	2.116	1.838	4	V40 - 20XT
27	34.00	65.00	2.134	1.884	4	V40 - 20XT
28	34.67	65.00	2.143	2.089	4	V40 - 20XT
29	35.33	65.00	2.152	2.097	4	V40 - 20XT
30	36.67	45.00	2.094	1.425	4	V40 - 20XT
31	38.00	45.00	2.132	1.463	4	V40 - 20XT
32	40.00	45.00	2.193	1.524	4	V40 - 20XT
33	42.00	45.00	2.258	1.590	4	V40 - 20XT
34	44.00	45.00	2.325	1.662	4	V40 - 20XT
35	46.00	45.00	2.397	1.740	4	V40 - 20XT
36	48.00	45.00	2.474	1.826	4	V40 - 20XT
37	50.00	45.00	2.555	1.919	3	V40 - 10XT
38	52.00	45.00	2.640	2.023	3	V40 - 10XT
39	54.00	45.00	2.731	2.136	3	V40 - 10XT
40	56.00	45.00	2.828	2.262	3	V40 - 10XT
41	58.00	45.00	2.929	2.401	3	V40 - 10XT
42	60.00	45.00	3.037	2.554	3	V40 - 10XT
43	62.00	45.00	3.150	2.723	3	V40 - 10XT
44	64.00	45.00	3.268	2.907	3	V40 - 10XT
45	66.00	45.00	3.389	3.106	3	V40 - 10XT
46	68.00	45.00	3.512	3.314	3	V40 - 10XT
47	70.00	45.00	3.631	3.521	3	V40 - 10XT
48	72.00	45.00	3.738	3.704	3	V40 - 10XT

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.0648, e/L seismic = 0.1603; Overturning: Fs-static = 3.69, Fs-seismic = 2.32

#	Geogrid Elevation [ft]	Geogrid Length [ft]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.67	65.00	0.0623	0.1555	4	V40 - 20XT
2	1.33	65.00	0.0599	0.1508	4	V40 - 20XT
3	2.00	65.00	0.0573	0.1461	4	V40 - 20XT
4	3.33	65.00	0.0523	0.1368	4	V40 - 20XT
5	4.67	65.00	0.0473	0.1275	4	V40 - 20XT
6	6.00	65.00	0.0422	0.1183	4	V40 - 20XT
7	7.33	65.00	0.0372	0.1093	4	V40 - 20XT
8	8.67	65.00	0.0321	0.1002	4	V40 - 20XT
9	10.00	65.00	0.0269	0.0913	4	V40 - 20XT
10	11.33	65.00	0.0218	0.0825	4	V40 - 20XT
11	12.67	65.00	0.0166	0.0736	4	V40 - 20XT
12	14.00	65.00	0.0113	0.0649	4	V40 - 20XT
13	15.33	65.00	0.0060	0.0562	4	V40 - 20XT
14	16.67	65.00	0.0006	0.0476	4	V40 - 20XT
15	18.00	65.00	-0.0048	0.0390	4	V40 - 20XT
16	19.33	65.00	-0.0103	0.0305	4	V40 - 20XT
17	20.67	65.00	-0.0159	0.0219	4	V40 - 20XT
18	22.00	65.00	-0.0216	0.0135	4	V40 - 20XT
19	23.33	65.00	-0.0274	0.0050	4	V40 - 20XT
20	24.67	65.00	-0.0334	-0.0035	4	V40 - 20XT
21	26.00	65.00	-0.0395	-0.0120	4	V40 - 20XT
22	27.33	65.00	-0.0457	-0.0205	4	V40 - 20XT
23	28.67	65.00	-0.0521	-0.0292	4	V40 - 20XT
24	30.00	65.00	-0.0587	-0.0378	4	V40 - 20XT
25	31.33	65.00	-0.0655	-0.0465	4	V40 - 20XT
26	32.67	65.00	-0.0726	-0.0554	4	V40 - 20XT
27	34.00	65.00	-0.0800	-0.0644	4	V40 - 20XT
28	34.67	65.00	-0.0838	-0.0789	4	V40 - 20XT
29	35.33	65.00	-0.0876	-0.0827	4	V40 - 20XT
30	36.67	45.00	0.0604	0.1295	4	V40 - 20XT
31	38.00	45.00	0.0550	0.1190	4	V40 - 20XT
32	40.00	45.00	0.0469	0.1035	4	V40 - 20XT
33	42.00	45.00	0.0390	0.0886	4	V40 - 20XT
34	44.00	45.00	0.0311	0.0742	4	V40 - 20XT
35	46.00	45.00	0.0232	0.0602	4	V40 - 20XT
36	48.00	45.00	0.0152	0.0467	4	V40 - 20XT
37	50.00	45.00	0.0073	0.0336	3	V40 - 10XT
38	52.00	45.00	-0.0008	0.0209	3	V40 - 10XT
39	54.00	45.00	-0.0091	0.0085	3	V40 - 10XT
40	56.00	45.00	-0.0176	-0.0038	3	V40 - 10XT
41	58.00	45.00	-0.0265	-0.0159	3	V40 - 10XT
42	60.00	45.00	-0.0359	-0.0281	3	V40 - 10XT
43	62.00	45.00	-0.0459	-0.0405	3	V40 - 10XT
44	64.00	45.00	-0.0570	-0.0534	3	V40 - 10XT
45	66.00	45.00	-0.0693	-0.0672	3	V40 - 10XT
46	68.00	45.00	-0.0835	-0.0825	3	V40 - 10XT
47	70.00	45.00	-0.1005	-0.1001	3	V40 - 10XT
48	72.00	45.00	-0.1216	-0.1215	3	V40 - 10XT

RESULTS for STRENGTH

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Tavailable [lb/ft]	Tmax [lb/ft]	Tmd [lb/ft]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.67	6146	3149.22	1221.03	N/A	1.952	N/A	1.584	V40 - 20XT
2	1.33	6146	2073.82	1214.12	N/A	2.964	N/A	2.194	V40 - 20XT
3	2.00	6146	3087.83	1207.10	N/A	1.991	N/A	1.613	V40 - 20XT
4	3.33	6146	4064.78	1193.18	N/A	1.512	N/A	1.286	V40 - 20XT
5	4.67	6146	3999.07	1179.14	N/A	1.537	N/A	1.306	V40 - 20XT
6	6.00	6146	3918.75	1165.21	N/A	1.568	N/A	1.331	V40 - 20XT
7	7.33	6146	3867.89	1151.29	N/A	1.589	N/A	1.349	V40 - 20XT
8	8.67	6146	3802.18	1137.25	N/A	1.617	N/A	1.371	V40 - 20XT
9	10.00	6146	3722.59	1123.32	N/A	1.651	N/A	1.398	V40 - 20XT
10	11.33	6146	3671.00	1109.39	N/A	1.674	N/A	1.418	V40 - 20XT
11	12.67	6146	3605.29	1095.36	N/A	1.705	N/A	1.442	V40 - 20XT
12	14.00	6146	3526.44	1081.43	N/A	1.743	N/A	1.473	V40 - 20XT
13	15.33	6146	3474.11	1067.50	N/A	1.769	N/A	1.494	V40 - 20XT
14	16.67	6146	3408.40	1053.47	N/A	1.803	N/A	1.522	V40 - 20XT
15	18.00	6146	3330.29	1039.54	N/A	1.846	N/A	1.555	V40 - 20XT
16	19.33	6146	3277.22	1025.61	N/A	1.875	N/A	1.579	V40 - 20XT
17	20.67	6146	3211.50	1011.58	N/A	1.914	N/A	1.610	V40 - 20XT
18	22.00	6146	3134.13	997.65	N/A	1.961	N/A	1.647	V40 - 20XT
19	23.33	6146	3080.33	983.72	N/A	1.995	N/A	1.675	V40 - 20XT
20	24.67	6146	3014.61	969.69	N/A	2.039	N/A	1.710	V40 - 20XT
21	26.00	6146	2937.98	955.76	N/A	2.092	N/A	1.751	V40 - 20XT
22	27.33	6146	2883.43	941.83	N/A	2.132	N/A	1.783	V40 - 20XT
23	28.67	6146	2817.72	927.80	N/A	2.181	N/A	1.822	V40 - 20XT
24	30.00	6146	2741.83	913.87	N/A	2.242	N/A	1.869	V40 - 20XT
25	31.33	6146	2686.54	899.94	N/A	2.288	N/A	1.906	V40 - 20XT
26	32.67	6146	2620.83	885.91	N/A	2.345	N/A	1.950	V40 - 20XT
27	34.00	6146	1920.12	871.98	N/A	3.201	N/A	2.517	V40 - 20XT
28	34.67	6146	1256.47	864.96	N/A	4.892	N/A	3.464	V40 - 20XT
29	35.33	6146	1861.84	858.05	N/A	3.301	N/A	2.587	V40 - 20XT
30	36.67	6146	2432.47	843.17	N/A	2.527	N/A	2.092	V40 - 20XT
31	38.00	6146	2941.59	829.24	N/A	2.089	N/A	1.788	V40 - 20XT
32	40.00	6146	3398.31	808.30	N/A	1.809	N/A	1.583	V40 - 20XT
33	42.00	6146	3250.83	787.35	N/A	1.891	N/A	1.651	V40 - 20XT
34	44.00	6146	3103.34	766.41	N/A	1.981	N/A	1.725	V40 - 20XT
35	46.00	6146	2955.86	745.46	N/A	2.079	N/A	1.807	V40 - 20XT
36	48.00	6146	2808.37	724.52	N/A	2.189	N/A	1.896	V40 - 20XT
37	50.00	4107	2660.89	703.57	N/A	1.544	N/A	1.333	V40 - 10XT
38	52.00	4107	2513.41	682.63	N/A	1.634	N/A	1.406	V40 - 10XT
39	54.00	4107	2365.92	661.68	N/A	1.736	N/A	1.487	V40 - 10XT
40	56.00	4107	2218.44	640.74	N/A	1.852	N/A	1.579	V40 - 10XT
41	58.00	4107	2070.95	619.79	N/A	1.983	N/A	1.682	V40 - 10XT
42	60.00	4107	1923.47	598.85	N/A	2.135	N/A	1.800	V40 - 10XT
43	62.00	4107	1775.99	577.90	N/A	2.313	N/A	1.936	V40 - 10XT
44	64.00	4107	1628.50	556.95	N/A	2.522	N/A	2.094	V40 - 10XT
45	66.00	4107	1481.02	536.01	N/A	2.773	N/A	2.279	V40 - 10XT
46	68.00	4107	1333.53	515.06	N/A	3.080	N/A	2.502	V40 - 10XT
47	70.00	4107	1186.05	494.12	N/A	3.463	N/A	2.772	V40 - 10XT
48	72.00	4107	1502.54	473.17	N/A	2.734	N/A	2.300	V40 - 10XT

RESULTS for PULLOUT

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Coverage Ratio	Tmax [lb/ft]	Tmd [lb/ft]	Le [ft]	La [ft]	Avail.Static Pullout, Pr [lb/ft]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [lb/ft]	Specified Seismic Fs	Actual Seismic Fs
1	0.67	1.000	3149.2	1221.0	64.63	0.37	564452.3	N/A	179.236	451561.8	N/A	103.326
2	1.33	1.000	2073.8	1214.1	64.26	0.74	556941.5	N/A	268.559	445553.2	N/A	135.511
3	2.00	1.000	3087.8	1207.1	63.89	1.11	549414.5	N/A	177.929	439531.6	N/A	102.337
4	3.33	1.000	4064.8	1193.2	63.15	1.85	534589.3	N/A	131.517	427671.4	N/A	81.338
5	4.67	1.000	3999.1	1179.1	62.41	2.59	519921.1	N/A	130.011	415936.9	N/A	80.324
6	6.00	1.000	3918.7	1165.2	61.67	3.33	505521.7	N/A	129.001	404417.4	N/A	79.548
7	7.33	1.000	3867.9	1151.3	60.94	4.06	491551.3	N/A	127.085	393241.0	N/A	78.348
8	8.67	1.000	3802.2	1137.3	60.19	4.81	477307.5	N/A	125.535	381846.0	N/A	77.306
9	10.00	1.000	3722.6	1123.3	59.46	5.54	463756.3	N/A	124.579	371005.1	N/A	76.560
10	11.33	1.000	3671.0	1109.4	58.72	6.28	450204.6	N/A	122.638	360163.7	N/A	75.342
11	12.67	1.000	3605.3	1095.4	57.98	7.02	436814.8	N/A	121.159	349451.8	N/A	74.341
12	14.00	1.000	3526.4	1081.4	57.24	7.76	423688.9	N/A	120.146	338951.1	N/A	73.559
13	15.33	1.000	3474.1	1067.5	56.50	8.50	410775.6	N/A	118.239	328620.5	N/A	72.358
14	16.67	1.000	3408.4	1053.5	55.76	9.24	398026.6	N/A	116.778	318421.3	N/A	71.365
15	18.00	1.000	3330.3	1039.5	55.02	9.98	385539.2	N/A	115.768	308431.4	N/A	70.582
16	19.33	1.000	3277.2	1025.6	54.29	10.71	373264.3	N/A	113.897	298611.5	N/A	69.399
17	20.67	1.000	3211.5	1011.6	53.54	11.46	361156.1	N/A	112.457	288924.9	N/A	68.416
18	22.00	1.000	3134.1	997.7	52.81	12.19	349307.1	N/A	111.453	279445.7	N/A	67.633
19	23.33	1.000	3080.3	983.7	52.07	12.93	337670.7	N/A	109.622	270136.6	N/A	66.470
20	24.67	1.000	3014.6	969.7	51.33	13.67	326203.3	N/A	108.207	260962.6	N/A	65.498
21	26.00	1.000	2938.0	955.8	50.59	14.41	314992.7	N/A	107.214	251994.2	N/A	64.718
22	27.33	1.000	2883.4	941.8	49.85	15.15	303994.7	N/A	105.428	243195.8	N/A	63.576
23	28.67	1.000	2817.7	927.8	49.11	15.89	293168.2	N/A	104.044	234534.5	N/A	62.617
24	30.00	1.000	2741.8	913.9	48.37	16.63	282596.0	N/A	103.069	226076.8	N/A	61.842
25	31.33	1.000	2686.5	899.9	47.63	17.37	272236.5	N/A	101.333	217789.2	N/A	60.725
26	32.67	1.000	2620.8	885.9	46.89	18.11	262050.7	N/A	99.988	209640.6	N/A	59.782
27	34.00	1.000	1920.1	872.0	46.15	18.85	252117.0	N/A	131.303	201693.6	N/A	72.237
28	34.67	1.000	1256.5	865.0	45.78	19.22	247217.1	N/A	196.755	197773.7	N/A	93.226
29	35.33	1.000	1861.8	858.1	45.42	19.58	242395.9	N/A	130.191	193916.7	N/A	71.296
30	36.67	1.000	2432.5	843.2	44.63	0.37	180456.3	N/A	74.187	144365.0	N/A	44.072
31	38.00	1.000	2941.6	829.2	43.89	1.11	171268.9	N/A	58.223	137015.1	N/A	36.335
32	40.00	1.000	3398.3	808.3	42.78	2.22	157717.7	N/A	46.411	126174.2	N/A	29.994
33	42.00	1.000	3250.8	787.4	41.67	3.33	144640.4	N/A	44.493	115712.3	N/A	28.655
34	44.00	1.000	3103.3	766.4	40.57	4.43	132048.0	N/A	42.550	105638.4	N/A	27.299
35	46.00	1.000	2955.9	745.5	39.46	5.54	119929.7	N/A	40.574	95943.7	N/A	25.921
36	48.00	1.000	2808.4	724.5	38.35	6.65	108296.1	N/A	38.562	86636.9	N/A	24.523
37	50.00	1.000	2660.9	703.6	37.24	7.76	97136.6	N/A	36.505	77709.3	N/A	23.097
38	52.00	1.000	2513.4	682.6	36.13	8.87	86461.8	N/A	34.400	69169.4	N/A	21.642
39	54.00	1.000	2365.9	661.7	35.02	9.98	76261.2	N/A	32.233	61008.9	N/A	20.151
40	56.00	1.000	2218.4	640.7	33.91	11.09	66545.1	N/A	29.996	53236.1	N/A	18.619
41	58.00	1.000	2071.0	619.8	32.81	12.19	57303.4	N/A	27.670	45842.7	N/A	17.037
42	60.00	1.000	1923.5	598.8	31.70	13.30	48546.2	N/A	25.239	38837.0	N/A	15.397
43	62.00	1.000	1776.0	577.9	30.59	14.41	40263.4	N/A	22.671	32210.7	N/A	13.684
44	64.00	1.000	1628.5	557.0	29.48	15.52	32464.9	N/A	19.935	25972.0	N/A	11.884
45	66.00	1.000	1481.0	536.0	28.37	16.63	25141.0	N/A	16.975	20112.8	N/A	9.972
46	68.00	1.000	1333.5	515.1	27.26	17.74	18301.4	N/A	13.724	14641.1	N/A	7.920
47	70.00	1.000	1186.0	494.1	26.15	18.85	11936.3	N/A	10.064	9549.1	N/A	5.683
48	72.00	1.000	1502.5	473.2	25.04	19.96	6066.5	N/A	4.038	4853.2	N/A	2.456

RESULTS for CONNECTION (static conditions)
Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Connection force, To [lb/ft]	Reduction factor for connection (short-term strength) CRult	Reduction factor for connection (long-term strength) CRcr	Available connection strength [lb/ft]	Available Geogrid strength, Tavailable [lb/ft]	Fs-overall connection strength Specified	Fs-overall connection strength Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.67	3149	0.63	0.63	7113	6146	N/A	2.26	N/A	1.95	V40 - 20XT
2	1.33	2074	0.63	0.63	7113	6146	N/A	3.43	N/A	2.96	V40 - 20XT
3	2.00	3088	0.63	0.63	7113	6146	N/A	2.30	N/A	1.99	V40 - 20XT
4	3.33	4065	0.63	0.63	7113	6146	N/A	1.75	N/A	1.51	V40 - 20XT
5	4.67	3999	0.63	0.63	7113	6146	N/A	1.78	N/A	1.54	V40 - 20XT
6	6.00	3919	0.63	0.63	7113	6146	N/A	1.82	N/A	1.57	V40 - 20XT
7	7.33	3868	0.63	0.63	7113	6146	N/A	1.84	N/A	1.59	V40 - 20XT
8	8.67	3802	0.63	0.63	7113	6146	N/A	1.87	N/A	1.62	V40 - 20XT
9	10.00	3723	0.63	0.63	7113	6146	N/A	1.91	N/A	1.65	V40 - 20XT
10	11.33	3671	0.63	0.63	7113	6146	N/A	1.94	N/A	1.67	V40 - 20XT
11	12.67	3605	0.63	0.63	7113	6146	N/A	1.97	N/A	1.70	V40 - 20XT
12	14.00	3526	0.63	0.63	7113	6146	N/A	2.02	N/A	1.74	V40 - 20XT
13	15.33	3474	0.63	0.63	7113	6146	N/A	2.05	N/A	1.77	V40 - 20XT
14	16.67	3408	0.63	0.63	7113	6146	N/A	2.09	N/A	1.80	V40 - 20XT
15	18.00	3330	0.63	0.63	7113	6146	N/A	2.14	N/A	1.85	V40 - 20XT
16	19.33	3277	0.63	0.63	7113	6146	N/A	2.17	N/A	1.88	V40 - 20XT
17	20.67	3212	0.61	0.61	6907	6146	N/A	2.15	N/A	1.91	V40 - 20XT
18	22.00	3134	0.59	0.59	6641	6146	N/A	2.12	N/A	1.96	V40 - 20XT
19	23.33	3080	0.56	0.56	6375	6146	N/A	2.07	N/A	2.00	V40 - 20XT
20	24.67	3015	0.54	0.54	6107	6146	N/A	2.03	N/A	2.04	V40 - 20XT
21	26.00	2938	0.52	0.52	5840	6146	N/A	1.99	N/A	2.09	V40 - 20XT
22	27.33	2883	0.49	0.49	5574	6146	N/A	1.93	N/A	2.13	V40 - 20XT
23	28.67	2818	0.47	0.47	5306	6146	N/A	1.88	N/A	2.18	V40 - 20XT
24	30.00	2742	0.45	0.45	5040	6146	N/A	1.84	N/A	2.24	V40 - 20XT
25	31.33	2687	0.42	0.42	4774	6146	N/A	1.78	N/A	2.29	V40 - 20XT
26	32.67	2621	0.40	0.40	4505	6146	N/A	1.72	N/A	2.35	V40 - 20XT
27	34.00	1920	0.38	0.38	4239	6146	N/A	2.21	N/A	3.20	V40 - 20XT
28	34.67	1256	0.36	0.36	4105	6146	N/A	3.27	N/A	4.89	V40 - 20XT
29	35.33	1862	0.35	0.35	3973	6146	N/A	2.13	N/A	3.30	V40 - 20XT
30	36.67	2432	0.63	0.63	7113	6146	N/A	2.92	N/A	2.53	V40 - 20XT
31	38.00	2942	0.63	0.63	7113	6146	N/A	2.42	N/A	2.09	V40 - 20XT
32	40.00	3398	0.63	0.63	7113	6146	N/A	2.09	N/A	1.81	V40 - 20XT
33	42.00	3251	0.63	0.63	7113	6146	N/A	2.19	N/A	1.89	V40 - 20XT
34	44.00	3103	0.63	0.63	7113	6146	N/A	2.29	N/A	1.98	V40 - 20XT
35	46.00	2956	0.63	0.63	7113	6146	N/A	2.41	N/A	2.08	V40 - 20XT
36	48.00	2808	0.63	0.63	7113	6146	N/A	2.53	N/A	2.19	V40 - 20XT
37	50.00	2661	0.72	0.72	5433	4107	N/A	2.04	N/A	1.54	V40 - 10XT
38	52.00	2513	0.72	0.72	5433	4107	N/A	2.16	N/A	1.63	V40 - 10XT
39	54.00	2366	0.72	0.72	5433	4107	N/A	2.30	N/A	1.74	V40 - 10XT
40	56.00	2218	0.72	0.72	5433	4107	N/A	2.45	N/A	1.85	V40 - 10XT
41	58.00	2071	0.72	0.72	5433	4107	N/A	2.62	N/A	1.98	V40 - 10XT
42	60.00	1923	0.67	0.67	5059	4107	N/A	2.63	N/A	2.14	V40 - 10XT
43	62.00	1776	0.61	0.61	4606	4107	N/A	2.59	N/A	2.31	V40 - 10XT
44	64.00	1629	0.55	0.55	4152	4107	N/A	2.55	N/A	2.52	V40 - 10XT
45	66.00	1481	0.49	0.49	3699	4107	N/A	2.50	N/A	2.77	V40 - 10XT
46	68.00	1334	0.43	0.43	3246	4107	N/A	2.43	N/A	3.08	V40 - 10XT
47	70.00	1186	0.37	0.37	2793	4107	N/A	2.35	N/A	3.46	V40 - 10XT
48	72.00	1503	0.31	0.31	2340	4107	N/A	1.56	N/A	2.73	V40 - 10XT

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Connection force, To [lb/ft]	Reduction factor for connection (short-term strength) CRult	Reduction factor for connection (long-term strength) CRcr	Available connection strength [lb/ft]	Available Geogrid strength, Tavailable [lb/ft]	Fs-overall connection strength Specified	Fs-overall connection strength Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.67	4370	0.63	0.63	7113	6146	N/A	1.63	N/A	1.58	V40 - 20XT
2	1.33	3288	0.63	0.63	7113	6146	N/A	2.16	N/A	2.19	V40 - 20XT
3	2.00	4295	0.63	0.63	7113	6146	N/A	1.66	N/A	1.61	V40 - 20XT
4	3.33	5258	0.63	0.63	7113	6146	N/A	1.35	N/A	1.29	V40 - 20XT
5	4.67	5178	0.63	0.63	7113	6146	N/A	1.37	N/A	1.31	V40 - 20XT
6	6.00	5084	0.63	0.63	7113	6146	N/A	1.40	N/A	1.33	V40 - 20XT
7	7.33	5019	0.63	0.63	7113	6146	N/A	1.42	N/A	1.35	V40 - 20XT
8	8.67	4939	0.63	0.63	7113	6146	N/A	1.44	N/A	1.37	V40 - 20XT
9	10.00	4846	0.63	0.63	7113	6146	N/A	1.47	N/A	1.40	V40 - 20XT
10	11.33	4780	0.63	0.63	7113	6146	N/A	1.49	N/A	1.42	V40 - 20XT
11	12.67	4701	0.63	0.63	7113	6146	N/A	1.51	N/A	1.44	V40 - 20XT
12	14.00	4608	0.63	0.63	7113	6146	N/A	1.54	N/A	1.47	V40 - 20XT
13	15.33	4542	0.63	0.63	7113	6146	N/A	1.57	N/A	1.49	V40 - 20XT
14	16.67	4462	0.63	0.63	7113	6146	N/A	1.59	N/A	1.52	V40 - 20XT
15	18.00	4370	0.63	0.63	7113	6146	N/A	1.63	N/A	1.55	V40 - 20XT
16	19.33	4303	0.63	0.63	7113	6146	N/A	1.65	N/A	1.58	V40 - 20XT
17	20.67	4223	0.61	0.61	6907	6146	N/A	1.64	N/A	1.61	V40 - 20XT
18	22.00	4132	0.59	0.59	6641	6146	N/A	1.61	N/A	1.65	V40 - 20XT
19	23.33	4064	0.56	0.56	6375	6146	N/A	1.57	N/A	1.68	V40 - 20XT
20	24.67	3984	0.54	0.54	6107	6146	N/A	1.53	N/A	1.71	V40 - 20XT
21	26.00	3894	0.52	0.52	5840	6146	N/A	1.50	N/A	1.75	V40 - 20XT
22	27.33	3825	0.49	0.49	5574	6146	N/A	1.46	N/A	1.78	V40 - 20XT
23	28.67	3746	0.47	0.47	5306	6146	N/A	1.42	N/A	1.82	V40 - 20XT
24	30.00	3656	0.45	0.45	5040	6146	N/A	1.38	N/A	1.87	V40 - 20XT
25	31.33	3586	0.42	0.42	4774	6146	N/A	1.33	N/A	1.91	V40 - 20XT
26	32.67	3507	0.40	0.40	4505	6146	N/A	1.28	N/A	1.95	V40 - 20XT
27	34.00	2792	0.38	0.38	4239	6146	N/A	1.52	N/A	2.52	V40 - 20XT
28	34.67	2121	0.36	0.36	4105	6146	N/A	1.94	N/A	3.46	V40 - 20XT
29	35.33	2720	0.35	0.35	3973	6146	N/A	1.46	N/A	2.59	V40 - 20XT
30	36.67	3276	0.63	0.63	7113	6146	N/A	2.17	N/A	2.09	V40 - 20XT
31	38.00	3771	0.63	0.63	7113	6146	N/A	1.89	N/A	1.79	V40 - 20XT
32	40.00	4207	0.63	0.63	7113	6146	N/A	1.69	N/A	1.58	V40 - 20XT
33	42.00	4038	0.63	0.63	7113	6146	N/A	1.76	N/A	1.65	V40 - 20XT
34	44.00	3870	0.63	0.63	7113	6146	N/A	1.84	N/A	1.73	V40 - 20XT
35	46.00	3701	0.63	0.63	7113	6146	N/A	1.92	N/A	1.81	V40 - 20XT
36	48.00	3533	0.63	0.63	7113	6146	N/A	2.01	N/A	1.90	V40 - 20XT
37	50.00	3364	0.72	0.72	5433	4107	N/A	1.61	N/A	1.33	V40 - 10XT
38	52.00	3196	0.72	0.72	5433	4107	N/A	1.70	N/A	1.41	V40 - 10XT
39	54.00	3028	0.72	0.72	5433	4107	N/A	1.79	N/A	1.49	V40 - 10XT
40	56.00	2859	0.72	0.72	5433	4107	N/A	1.90	N/A	1.58	V40 - 10XT
41	58.00	2691	0.72	0.72	5433	4107	N/A	2.02	N/A	1.68	V40 - 10XT
42	60.00	2522	0.67	0.67	5059	4107	N/A	2.01	N/A	1.80	V40 - 10XT
43	62.00	2354	0.61	0.61	4606	4107	N/A	1.96	N/A	1.94	V40 - 10XT
44	64.00	2185	0.55	0.55	4152	4107	N/A	1.90	N/A	2.09	V40 - 10XT
45	66.00	2017	0.49	0.49	3699	4107	N/A	1.83	N/A	2.28	V40 - 10XT
46	68.00	1849	0.43	0.43	3246	4107	N/A	1.76	N/A	2.50	V40 - 10XT
47	70.00	1680	0.37	0.37	2793	4107	N/A	1.66	N/A	2.77	V40 - 10XT
48	72.00	1976	0.31	0.31	2340	4107	N/A	1.18	N/A	2.30	V40 - 10XT

GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

A horizontal seismic coefficient, Kh=half of 'A', equal to 0.180 has been applied.
The seismic force is applied at the center of the sliding mass.

STATIC CONDITIONS:
For the specified search grid, the calculated minimum Fs is 1.783
(it corresponds to a critical circle at Xc = -32.00, Yc = 192.00 and R = 194.65 [ft] where (x=0, y=0) is taken at the TOE or Xc = 68.00, Yc = 1192.00 and R = 194.65 [ft] when the terrain coordinate system is used as shown in the table below.)

SEISMIC CONDITIONS:
For the specified search grid, the calculated minimum Fs is 1.150
(it corresponds to a critical circle at Xc = -8.00, Yc = 192.00 and R = 123.22 [ft] where (x=0, y=0) is taken at the TOE or Xc = 92.00, Yc = 1192.00 and R = 123.22 [ft] when the terrain coordinate system is used as shown in the table below.)

TERRAIN/WATER PROFILE

Point	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
Soil layer #1:	γ = 120.00 [lb/ft ³]			ϕ = 28.0°		c = 500.00 [lb/ft ²]					
x [ft]	0.0	15.0	20.0	50.0	185.0	205.0	250.0	300.0	350.0	400.0	500.0
y [ft]	1006.0	1006.0	1006.0	1006.0	1000.0	1090.0	1090.0	1090.0	1090.0	1090.0	1095.0

AASHTO 2002 ASD DESIGN METHOD
Portola Center - TTM 15353

MSEW(3.0): Update # 14.3

PROJECT IDENTIFICATION

Title:	Portola Center - TTM 15353
Project Number:	0704 034A
Client:	SunRanch Capital Partners, LLC
Designer:	DAO
Station Number:	DESIGN 2

Description:

Tiered 30 ft over 30 ft Wall Height - Level - Offset of 20 ft - 5 ft
Ascending Slope at Crest

Company's information:

Name: Soil Retention Designs, Inc.
Street: 2501 State Street

Carlsbad, CA 92008
Telephone #: 760-966-6090
Fax #: 760-966-6099
E-Mail: dosborne@soilretention.com

Original file path and name: C:\Users\dosborne\Desktop\Portola South Rev Design\Upda.....
.....t Tiered - Level.BEN
Original date and time of creating this file: Mon Nov 29 16:13:17 2010

PROGRAM MODE: ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	32.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	28.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	120.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{equiv.}$	28.0 °
Equivalent cohesion, $c_{equiv.}$	500.0 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) = 0.3619 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 25.80 N γ= 16.72

SEISMICITY

Maximum ground acceleration coefficient, A = 0.360
Design acceleration coefficient in Internal Stability: Kh = Am = 0.392
Design acceleration coefficient in External Stability: Kh_d = 0.175 => Kh = Am = 0.175
(Kh in External Stability is based on allowable displacement, d = 75 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.4962 Kae (Kh = 0) = 0.3619 Δ Kae = 0.1343
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

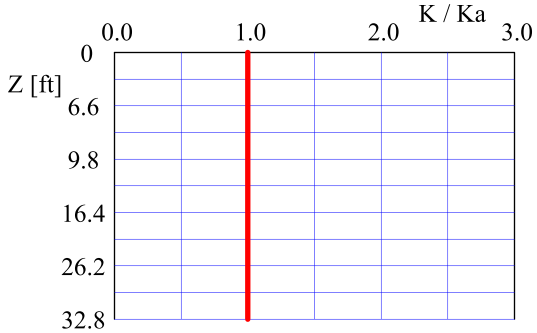
INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	3590.0	6230.0	8300.0	12420.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.11	1.10	1.10	1.10	
Creep reduction factor, RFc	1.67	1.67	1.67	1.67	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	29.40	29.40	29.40	29.40	
Pullout resistance factor, F*	0.90·tanϕ	0.90·tanϕ	0.90·tanϕ	0.90·tanϕ	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

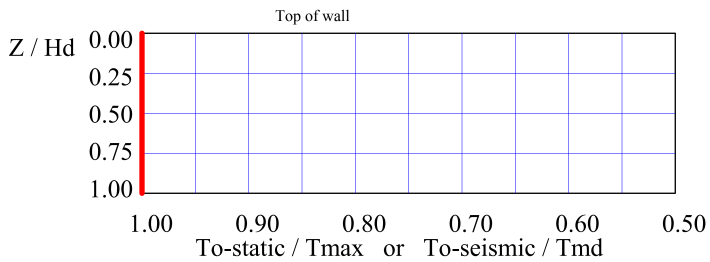
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (according to revised Demo 82) (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 1.00/0.67 ft. Horizontal distance to Center of Gravity of block is 0.42 ft.
Average unit weight of block is $\gamma_f = 117.00$ 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



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ (1)	CRult (2)	σ	CRult	σ	CRult	σ	CRult	σ	CRult
0.0	0.98	0.0	0.50	0.0	0.25	0.0	0.34		
4000.0	0.98	1545.0	0.71	1831.0	0.72	1914.0	0.63	N/A	
		4000.0	0.71	4000.0	0.72	4000.0	0.63		

Geogrid Type #1 (3)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRcr	σ	CRcr	σ	CRcr	σ	CRcr	σ	CRcr
0.0	0.98	0.0	0.50	0.0	0.25	0.0	0.34		
4000.0	0.98	1545.0	0.71	1831.0	0.72	1914.0	0.63	N/A	
		4000.0	0.71	4000.0	0.72	4000.0	0.63		

(1) σ = Confining stress in between stacked blocks [lb/ft ²]
(2) CRult = Tc-ult / Tult
(3) CRcr = Tcre / Tult

In seismic analysis, long term strength is reduced to 100% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	V40 - 5XT	V40 - 8XT	V40 - 10XT	V40 - 20XT	N/A
Connection strength reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	N/A	N/A	N/A	N/A	N/A

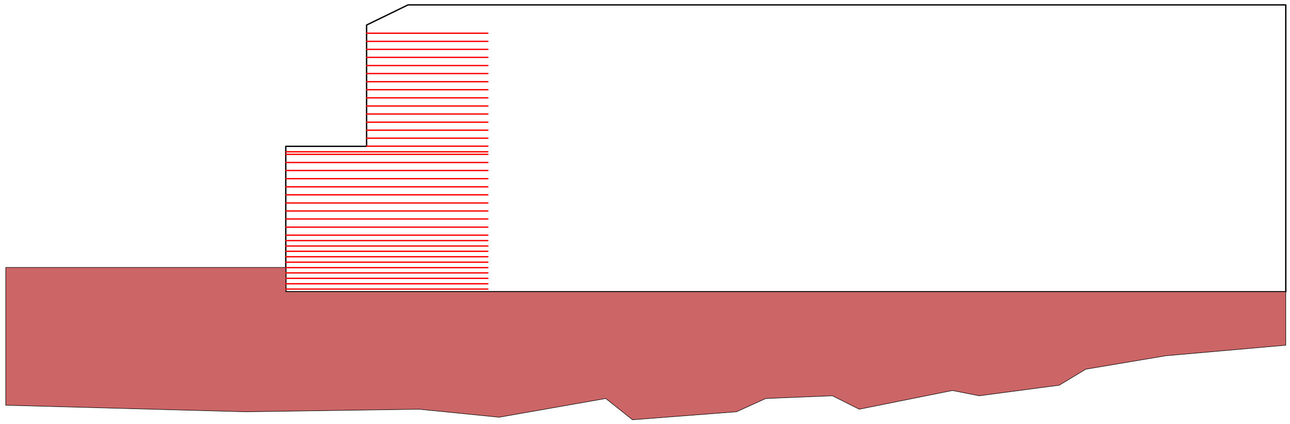
INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd	66.00	[ft]	{ Embedded depth is E = 6.00 ft, and height above top of finished bottom grade is H = 60.00 ft, where H1 = 30.00 and H2 = 30.00 }
Batter, ω	0.0	[deg]	
Backslope, β	26.0	[deg]	
Backslope rise	5.0	[ft]	Broken back equivalent angle, I = 2.17° (see Fig. 25 in DEMO 82)

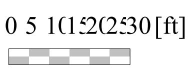
Offset of upper segment from lower one, Offset = 20.0 ft, Blackslope2 = 0.0 deg. and Backslope rise, S2 = 0.0 ft.

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]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:



ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 6.99, Meyerhof stress = 7999 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.896, Eccentricity, e/L = 0.0711, Fs-overturning = 3.84

GEOGRID				CONNECTION						
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.67	50.00	4	2.07	1.79	1.793	106.007	1.780	0.0678	V40 - 20XT
2	2.00	50.00	4	2.12	1.83	1.834	104.821	1.805	0.0613	V40 - 20XT
3	3.33	50.00	4	2.16	1.86	1.864	102.852	1.830	0.0547	V40 - 20XT
4	4.67	50.00	4	2.20	1.90	1.902	101.267	1.857	0.0480	V40 - 20XT
5	6.00	50.00	4	2.25	1.95	1.948	100.070	1.883	0.0414	V40 - 20XT
6	7.33	50.00	4	2.29	1.98	1.982	98.172	1.911	0.0348	V40 - 20XT
7	8.67	50.00	4	2.34	2.03	2.025	96.594	1.939	0.0280	V40 - 20XT
8	10.00	50.00	4	2.40	2.08	2.078	95.386	1.968	0.0213	V40 - 20XT
9	11.33	50.00	4	2.45	2.12	2.117	93.466	1.998	0.0145	V40 - 20XT
10	12.67	50.00	4	2.51	2.17	2.166	91.895	2.028	0.0076	V40 - 20XT
11	14.00	50.00	4	2.06	1.78	1.783	72.650	2.059	0.0006	V40 - 20XT
12	16.00	50.00	4	1.78	1.53	1.534	58.775	2.107	-0.0101	V40 - 20XT
13	18.00	50.00	4	1.84	1.59	1.593	57.223	2.156	-0.0211	V40 - 20XT
14	20.00	50.00	4	1.90	1.66	1.656	55.676	2.207	-0.0325	V40 - 20XT
15	22.00	50.00	4	1.86	1.72	1.725	54.139	2.259	-0.0444	V40 - 20XT
16	24.00	50.00	4	1.83	1.80	1.799	52.639	2.313	-0.0569	V40 - 20XT
17	26.00	50.00	4	1.79	1.88	1.880	51.116	2.367	-0.0701	V40 - 20XT
18	28.00	50.00	4	1.74	1.97	1.969	49.606	2.422	-0.0844	V40 - 20XT
19	30.00	50.00	4	1.69	2.07	2.067	48.107	2.477	-0.0999	V40 - 20XT
20	32.00	50.00	4	1.64	2.17	2.175	46.651	2.530	-0.1170	V40 - 20XT
21	34.00	50.00	4	2.35	3.41	3.406	67.074	2.581	-0.1362	V40 - 20XT
22	34.67	50.00	4	1.90	2.84	2.843	54.359	2.597	-0.1432	V40 - 20XT
23	36.01	30.00	3	4.32	3.27	3.266	77.207	2.628	0.0697	V40 - 10XT
24	38.00	30.00	3	2.28	1.72	1.721	36.582	2.781	0.0603	V40 - 10XT
25	40.00	30.00	3	2.42	1.83	1.830	34.740	2.954	0.0512	V40 - 10XT
26	42.00	30.00	3	2.59	1.96	1.958	32.947	3.150	0.0426	V40 - 10XT
27	44.00	30.00	2	2.06	1.58	1.581	31.128	3.374	0.0344	V40 - 8XT
28	46.00	30.00	2	2.23	1.71	1.710	29.280	3.633	0.0266	V40 - 8XT
29	48.00	30.00	2	2.43	1.86	1.863	27.416	3.935	0.0191	V40 - 8XT
30	50.00	30.00	2	2.67	2.04	2.045	25.478	4.292	0.0119	V40 - 8XT
31	52.00	30.00	2	2.96	2.27	2.267	23.472	4.721	0.0048	V40 - 8XT
32	54.00	30.00	2	3.23	2.54	2.542	21.376	5.244	-0.0021	V40 - 8XT
33	56.00	30.00	2	3.50	2.89	2.894	19.171	5.899	-0.0091	V40 - 8XT
34	58.00	30.00	2	3.87	3.36	3.359	16.754	6.740	-0.0166	V40 - 8XT
35	60.00	30.00	2	4.38	4.00	4.003	14.034	7.860	-0.0250	V40 - 8XT
36	62.00	30.00	2	5.13	4.95	4.951	10.800	9.423	-0.0356	V40 - 8XT
37	64.00	30.00	2	4.58	4.69	4.688	4.755	11.747	-0.0507	V40 - 8XT

GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

STATIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.872
(it corresponds to a critical circle at Xc = -8.00, Yc = 112.00 and R = 112.29 [ft]).

SEISMIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.216
(it corresponds to a critical circle at Xc = -56.00, Yc = 192.00 and R = 200.00 [ft]).

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 4.11, Meyerhof stress = 10858 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.239, Eccentricity, e/L = 0.1833, Fs-overturning = 2.20

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.67	50.00	4	1.50	1.46	1.456	61.157	1.166	0.1774	V40 - 20XT
2	2.00	50.00	4	1.53	1.49	1.487	60.336	1.186	0.1657	V40 - 20XT
3	3.33	50.00	4	1.55	1.51	1.511	59.190	1.208	0.1541	V40 - 20XT
4	4.67	50.00	4	1.58	1.54	1.540	58.203	1.231	0.1424	V40 - 20XT
5	6.00	50.00	4	1.62	1.58	1.576	57.376	1.254	0.1310	V40 - 20XT
6	7.33	50.00	4	1.64	1.60	1.602	56.267	1.279	0.1195	V40 - 20XT
7	8.67	50.00	4	1.68	1.64	1.636	55.282	1.304	0.1081	V40 - 20XT
8	10.00	50.00	4	1.72	1.67	1.675	54.449	1.331	0.0968	V40 - 20XT
9	11.33	50.00	4	1.75	1.71	1.706	53.324	1.363	0.0847	V40 - 20XT
10	12.67	50.00	4	1.78	1.74	1.743	52.341	1.398	0.0722	V40 - 20XT
11	14.00	50.00	4	1.55	1.49	1.491	43.787	1.435	0.0598	V40 - 20XT
12	16.00	50.00	4	1.39	1.32	1.318	36.899	1.496	0.0414	V40 - 20XT
13	18.00	50.00	4	1.44	1.37	1.366	35.845	1.562	0.0231	V40 - 20XT
14	20.00	50.00	4	1.48	1.42	1.418	34.794	1.634	0.0048	V40 - 20XT
15	22.00	50.00	4	1.45	1.47	1.474	33.747	1.715	-0.0135	V40 - 20XT
16	24.00	50.00	4	1.42	1.54	1.535	32.721	1.806	-0.0321	V40 - 20XT
17	26.00	50.00	4	1.38	1.60	1.601	31.679	1.908	-0.0509	V40 - 20XT
18	28.00	50.00	4	1.35	1.67	1.673	30.642	2.367	-0.0839	V40 - 20XT
19	30.00	50.00	4	1.30	1.75	1.752	29.609	2.442	-0.0997	V40 - 20XT
20	32.00	50.00	4	1.26	1.84	1.839	28.599	2.512	-0.1170	V40 - 20XT
21	34.00	50.00	4	1.61	2.67	2.669	36.722	2.576	-0.1362	V40 - 20XT
22	34.67	50.00	4	1.38	2.32	2.315	31.504	2.595	-0.1432	V40 - 20XT
23	36.01	30.00	3	2.64	2.36	2.364	37.729	1.544	0.1656	V40 - 10XT
24	38.00	30.00	3	1.72	1.44	1.442	22.113	1.632	0.1461	V40 - 10XT
25	40.00	30.00	3	1.82	1.53	1.527	20.887	1.731	0.1276	V40 - 10XT
26	42.00	30.00	3	1.93	1.63	1.627	19.673	1.843	0.1100	V40 - 10XT
27	44.00	30.00	2	1.53	1.31	1.307	18.443	1.970	0.0934	V40 - 8XT
28	46.00	30.00	2	1.64	1.41	1.405	17.192	2.117	0.0777	V40 - 8XT
29	48.00	30.00	2	1.76	1.52	1.520	15.930	2.287	0.0629	V40 - 8XT
30	50.00	30.00	2	1.91	1.65	1.654	14.620	2.487	0.0489	V40 - 8XT
31	52.00	30.00	2	2.09	1.82	1.815	13.270	2.990	0.0259	V40 - 8XT
32	54.00	30.00	2	2.24	2.01	2.011	11.866	3.425	0.0129	V40 - 8XT
33	56.00	30.00	2	2.38	2.25	2.254	10.403	4.002	0.0008	V40 - 8XT
34	58.00	30.00	2	2.55	2.56	2.564	8.827	4.800	-0.0106	V40 - 8XT
35	60.00	30.00	2	2.77	2.97	2.972	7.110	5.966	-0.0220	V40 - 8XT
36	62.00	30.00	2	3.07	3.54	3.535	5.177	7.782	-0.0344	V40 - 8XT
37	64.00	30.00	2	2.88	3.47	3.467	2.395	10.805	-0.0505	V40 - 8XT

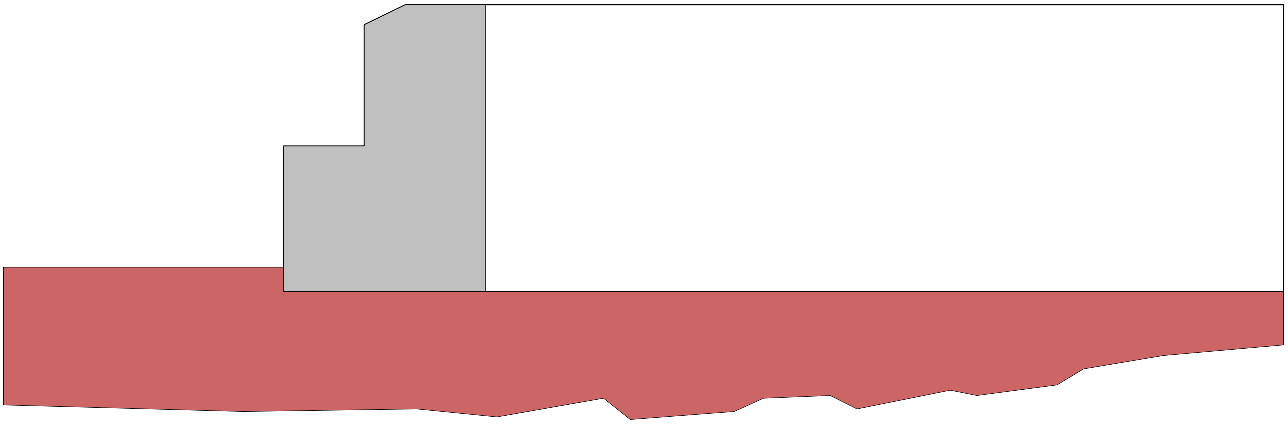
GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

STATIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.872
(it corresponds to a critical circle at Xc = -8.00, Yc = 112.00 and R = 112.29 [ft]).

SEISMIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.216
(it corresponds to a critical circle at Xc = -56.00, Yc = 192.00 and R = 200.00 [ft]).

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	55918	44665	[lb/ft ²]
Meyerhof stress, σ_V	7999.3	10858	[lb/ft ²]
Eccentricity, e	3.56	9.17	[ft]
Eccentricity, e/L	0.071	0.183	
Fs calculated	6.99	4.11	
Base length	50.00	50.00	[ft]



SCALE:

0 5 1(1:2(2:30 [ft]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.896 and Fs-seismic = 1.239

#	Geogrid Elevation [ft]	Geogrid Length [ft]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.67	50.00	1.780	1.166	4	V40 - 20XT
2	2.00	50.00	1.805	1.186	4	V40 - 20XT
3	3.33	50.00	1.830	1.208	4	V40 - 20XT
4	4.67	50.00	1.857	1.231	4	V40 - 20XT
5	6.00	50.00	1.883	1.254	4	V40 - 20XT
6	7.33	50.00	1.911	1.279	4	V40 - 20XT
7	8.67	50.00	1.939	1.304	4	V40 - 20XT
8	10.00	50.00	1.968	1.331	4	V40 - 20XT
9	11.33	50.00	1.998	1.363	4	V40 - 20XT
10	12.67	50.00	2.028	1.398	4	V40 - 20XT
11	14.00	50.00	2.059	1.435	4	V40 - 20XT
12	16.00	50.00	2.107	1.496	4	V40 - 20XT
13	18.00	50.00	2.156	1.562	4	V40 - 20XT
14	20.00	50.00	2.207	1.634	4	V40 - 20XT
15	22.00	50.00	2.259	1.715	4	V40 - 20XT
16	24.00	50.00	2.313	1.806	4	V40 - 20XT
17	26.00	50.00	2.367	1.908	4	V40 - 20XT
18	28.00	50.00	2.422	2.367	4	V40 - 20XT
19	30.00	50.00	2.477	2.442	4	V40 - 20XT
20	32.00	50.00	2.530	2.512	4	V40 - 20XT
21	34.00	50.00	2.581	2.576	4	V40 - 20XT
22	34.67	50.00	2.597	2.595	4	V40 - 20XT
23	36.01	30.00	2.628	1.544	3	V40 - 10XT
24	38.00	30.00	2.781	1.632	3	V40 - 10XT
25	40.00	30.00	2.954	1.731	3	V40 - 10XT
26	42.00	30.00	3.150	1.843	3	V40 - 10XT
27	44.00	30.00	3.374	1.970	2	V40 - 8XT
28	46.00	30.00	3.633	2.117	2	V40 - 8XT
29	48.00	30.00	3.935	2.287	2	V40 - 8XT
30	50.00	30.00	4.292	2.487	2	V40 - 8XT
31	52.00	30.00	4.721	2.990	2	V40 - 8XT
32	54.00	30.00	5.244	3.425	2	V40 - 8XT
33	56.00	30.00	5.899	4.002	2	V40 - 8XT
34	58.00	30.00	6.740	4.800	2	V40 - 8XT
35	60.00	30.00	7.860	5.966	2	V40 - 8XT
36	62.00	30.00	9.423	7.782	2	V40 - 8XT
37	64.00	30.00	11.747	10.805	2	V40 - 8XT

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.0711, e/L seismic = 0.1833; Overturning: Fs-static = 3.84, Fs-seismic = 2.20

#	Geogrid Elevation [ft]	Geogrid Length [ft]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.67	50.00	0.0678	0.1774	4	V40 - 20XT
2	2.00	50.00	0.0613	0.1657	4	V40 - 20XT
3	3.33	50.00	0.0547	0.1541	4	V40 - 20XT
4	4.67	50.00	0.0480	0.1424	4	V40 - 20XT
5	6.00	50.00	0.0414	0.1310	4	V40 - 20XT
6	7.33	50.00	0.0348	0.1195	4	V40 - 20XT
7	8.67	50.00	0.0280	0.1081	4	V40 - 20XT
8	10.00	50.00	0.0213	0.0968	4	V40 - 20XT
9	11.33	50.00	0.0145	0.0847	4	V40 - 20XT
10	12.67	50.00	0.0076	0.0722	4	V40 - 20XT
11	14.00	50.00	0.0006	0.0598	4	V40 - 20XT
12	16.00	50.00	-0.0101	0.0414	4	V40 - 20XT
13	18.00	50.00	-0.0211	0.0231	4	V40 - 20XT
14	20.00	50.00	-0.0325	0.0048	4	V40 - 20XT
15	22.00	50.00	-0.0444	-0.0135	4	V40 - 20XT
16	24.00	50.00	-0.0569	-0.0321	4	V40 - 20XT
17	26.00	50.00	-0.0701	-0.0509	4	V40 - 20XT
18	28.00	50.00	-0.0844	-0.0839	4	V40 - 20XT
19	30.00	50.00	-0.0999	-0.0997	4	V40 - 20XT
20	32.00	50.00	-0.1170	-0.1170	4	V40 - 20XT
21	34.00	50.00	-0.1362	-0.1362	4	V40 - 20XT
22	34.67	50.00	-0.1432	-0.1432	4	V40 - 20XT
23	36.01	30.00	0.0697	0.1656	3	V40 - 10XT
24	38.00	30.00	0.0603	0.1461	3	V40 - 10XT
25	40.00	30.00	0.0512	0.1276	3	V40 - 10XT
26	42.00	30.00	0.0426	0.1100	3	V40 - 10XT
27	44.00	30.00	0.0344	0.0934	2	V40 - 8XT
28	46.00	30.00	0.0266	0.0777	2	V40 - 8XT
29	48.00	30.00	0.0191	0.0629	2	V40 - 8XT
30	50.00	30.00	0.0119	0.0489	2	V40 - 8XT
31	52.00	30.00	0.0048	0.0259	2	V40 - 8XT
32	54.00	30.00	-0.0021	0.0129	2	V40 - 8XT
33	56.00	30.00	-0.0091	0.0008	2	V40 - 8XT
34	58.00	30.00	-0.0166	-0.0106	2	V40 - 8XT
35	60.00	30.00	-0.0250	-0.0220	2	V40 - 8XT
36	62.00	30.00	-0.0356	-0.0344	2	V40 - 8XT
37	64.00	30.00	-0.0507	-0.0505	2	V40 - 8XT

RESULTS for STRENGTH

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Tavailable [lb/ft]	Tmax [lb/ft]	Tmd [lb/ft]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.67	6146	3428.83	1325.90	N/A	1.793	N/A	1.456	V40 - 20XT
2	2.00	6146	3350.65	1306.21	N/A	1.834	N/A	1.487	V40 - 20XT
3	3.33	6146	3297.65	1286.51	N/A	1.864	N/A	1.511	V40 - 20XT
4	4.67	6146	3231.94	1266.66	N/A	1.902	N/A	1.540	V40 - 20XT
5	6.00	6146	3154.49	1246.97	N/A	1.948	N/A	1.576	V40 - 20XT
6	7.33	6146	3100.76	1227.27	N/A	1.982	N/A	1.602	V40 - 20XT
7	8.67	6146	3035.05	1207.43	N/A	2.025	N/A	1.636	V40 - 20XT
8	10.00	6146	2958.34	1187.73	N/A	2.078	N/A	1.675	V40 - 20XT
9	11.33	6146	2903.87	1168.04	N/A	2.117	N/A	1.706	V40 - 20XT
10	12.67	6146	2838.16	1148.19	N/A	2.166	N/A	1.743	V40 - 20XT
11	14.00	6146	3447.64	1128.49	N/A	1.783	N/A	1.491	V40 - 20XT
12	16.00	6146	4006.18	1098.88	N/A	1.534	N/A	1.318	V40 - 20XT
13	18.00	6146	3858.70	1069.26	N/A	1.593	N/A	1.366	V40 - 20XT
14	20.00	6146	3711.21	1039.64	N/A	1.656	N/A	1.418	V40 - 20XT
15	22.00	6146	3563.73	1010.02	N/A	1.725	N/A	1.474	V40 - 20XT
16	24.00	6146	3416.24	980.40	N/A	1.799	N/A	1.535	V40 - 20XT
17	26.00	6146	3268.76	950.78	N/A	1.880	N/A	1.601	V40 - 20XT
18	28.00	6146	3121.28	921.17	N/A	1.969	N/A	1.673	V40 - 20XT
19	30.00	6146	2973.79	891.55	N/A	2.067	N/A	1.752	V40 - 20XT
20	32.00	6146	2826.31	861.93	N/A	2.175	N/A	1.839	V40 - 20XT
21	34.00	6146	1804.48	832.31	N/A	3.406	N/A	2.669	V40 - 20XT
22	34.67	6146	2162.04	822.39	N/A	2.843	N/A	2.315	V40 - 20XT
23	36.01	4107	1257.80	801.35	N/A	3.266	N/A	2.364	V40 - 10XT
24	38.00	4107	2386.41	771.88	N/A	1.721	N/A	1.442	V40 - 10XT
25	40.00	4107	2245.10	742.26	N/A	1.830	N/A	1.527	V40 - 10XT
26	42.00	4107	2097.61	712.64	N/A	1.958	N/A	1.627	V40 - 10XT
27	44.00	3083	1950.13	683.02	N/A	1.581	N/A	1.307	V40 - 8XT
28	46.00	3083	1802.64	653.40	N/A	1.710	N/A	1.405	V40 - 8XT
29	48.00	3083	1655.16	623.78	N/A	1.863	N/A	1.520	V40 - 8XT
30	50.00	3083	1507.68	594.17	N/A	2.045	N/A	1.654	V40 - 8XT
31	52.00	3083	1360.19	564.55	N/A	2.267	N/A	1.815	V40 - 8XT
32	54.00	3083	1212.71	534.93	N/A	2.542	N/A	2.011	V40 - 8XT
33	56.00	3083	1065.22	505.31	N/A	2.894	N/A	2.254	V40 - 8XT
34	58.00	3083	917.74	475.69	N/A	3.359	N/A	2.564	V40 - 8XT
35	60.00	3083	770.25	446.07	N/A	4.003	N/A	2.972	V40 - 8XT
36	62.00	3083	622.77	416.45	N/A	4.951	N/A	3.535	V40 - 8XT
37	64.00	3083	657.62	386.84	N/A	4.688	N/A	3.467	V40 - 8XT

RESULTS for PULLOUT

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Coverage Ratio	Tmax [lb/ft]	Tmd [lb/ft]	Le [ft]	La [ft]	Avail.Static Pullout, Pr [lb/ft]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [lb/ft]	Specified Seismic Fs	Actual Seismic Fs
1	0.67	1.000	3428.8	1325.9	49.63	0.37	363480.7	N/A	106.007	290784.5	N/A	61.157
2	2.00	1.000	3350.6	1306.2	48.89	1.11	351218.9	N/A	104.821	280975.1	N/A	60.336
3	3.33	1.000	3297.7	1286.5	48.15	1.85	339170.3	N/A	102.852	271336.2	N/A	59.190
4	4.67	1.000	3231.9	1266.7	47.41	2.59	327289.4	N/A	101.267	261831.6	N/A	58.203
5	6.00	1.000	3154.5	1247.0	46.67	3.33	315670.9	N/A	100.070	252536.7	N/A	57.376
6	7.33	1.000	3100.8	1227.3	45.94	4.06	304407.4	N/A	98.172	243525.9	N/A	56.267
7	8.67	1.000	3035.1	1207.4	45.19	4.81	293166.7	N/A	96.594	234533.4	N/A	55.282
8	10.00	1.000	2958.3	1187.7	44.46	5.54	282184.3	N/A	95.386	225747.5	N/A	54.449
9	11.33	1.000	2903.9	1168.0	43.72	6.28	271414.0	N/A	93.466	217131.2	N/A	53.324
10	12.67	1.000	2838.2	1148.2	42.98	7.02	260813.4	N/A	91.895	208650.7	N/A	52.341
11	14.00	1.000	3447.6	1128.5	42.24	7.76	250470.3	N/A	72.650	200376.3	N/A	43.787
12	16.00	1.000	4006.2	1098.9	41.13	8.87	235463.5	N/A	58.775	188370.8	N/A	36.899
13	18.00	1.000	3858.7	1069.3	40.02	9.98	220805.8	N/A	57.223	176644.6	N/A	35.845
14	20.00	1.000	3711.2	1039.6	38.91	11.09	206626.9	N/A	55.676	165301.5	N/A	34.794
15	22.00	1.000	3563.7	1010.0	37.81	12.19	192936.2	N/A	54.139	154349.0	N/A	33.747
16	24.00	1.000	3416.2	980.4	36.70	13.30	179827.1	N/A	52.639	143861.7	N/A	32.721
17	26.00	1.000	3268.8	950.8	35.59	14.41	167086.8	N/A	51.116	133669.4	N/A	31.679
18	28.00	1.000	3121.3	921.2	34.48	15.52	154834.0	N/A	49.606	123867.2	N/A	30.642
19	30.00	1.000	2973.8	891.5	33.37	16.63	143059.8	N/A	48.107	114447.9	N/A	29.609
20	32.00	1.000	2826.3	861.9	32.26	17.74	131849.4	N/A	46.651	105479.5	N/A	28.599
21	34.00	1.000	1804.5	832.3	31.15	18.85	121034.4	N/A	67.074	96827.5	N/A	36.722
22	34.67	1.000	2162.0	822.4	30.78	19.22	117525.9	N/A	54.359	94020.7	N/A	31.504
23	36.01	1.000	1257.8	801.3	29.99	0.01	97110.8	N/A	77.207	77688.7	N/A	37.729
24	38.00	1.000	2386.4	771.9	28.89	1.11	87299.7	N/A	36.582	69839.8	N/A	22.113
25	40.00	1.000	2245.1	742.3	27.78	2.22	77995.2	N/A	34.740	62396.1	N/A	20.887
26	42.00	1.000	2097.6	712.6	26.67	3.33	69109.3	N/A	32.947	55287.4	N/A	19.673
27	44.00	1.000	1950.1	683.0	25.57	4.43	60704.5	N/A	31.128	48563.6	N/A	18.443
28	46.00	1.000	1802.6	653.4	24.46	5.54	52780.7	N/A	29.280	42224.6	N/A	17.192
29	48.00	1.000	1655.2	623.8	23.35	6.65	45378.0	N/A	27.416	36302.4	N/A	15.930
30	50.00	1.000	1507.7	594.2	22.24	7.76	38411.9	N/A	25.478	30729.5	N/A	14.620
31	52.00	1.000	1360.2	564.5	21.13	8.87	31926.7	N/A	23.472	25541.4	N/A	13.270
32	54.00	1.000	1212.7	534.9	20.02	9.98	25922.7	N/A	21.376	20738.1	N/A	11.866
33	56.00	1.000	1065.2	505.3	18.91	11.09	20421.9	N/A	19.171	16337.5	N/A	10.403
34	58.00	1.000	917.7	475.7	17.81	12.19	15375.4	N/A	16.754	12300.4	N/A	8.827
35	60.00	1.000	770.3	446.1	16.70	13.30	10810.0	N/A	14.034	8648.0	N/A	7.110
36	62.00	1.000	622.8	416.5	15.59	14.41	6725.6	N/A	10.800	5380.5	N/A	5.177
37	64.00	1.000	657.6	386.8	14.48	15.52	3126.8	N/A	4.755	2501.4	N/A	2.395

RESULTS for CONNECTION (static conditions)
Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Connection force, To [lb/ft]	Reduction factor for connection (short-term strength) CRult	Reduction factor for connection (long-term strength) CRcr	Available connection strength [lb/ft]	Available Geogrid strength, Tavailable [lb/ft]	Fs-overall connection strength Specified	Fs-overall connection strength Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.67	3429	0.63	0.63	7113	6146	N/A	2.07	N/A	1.79	V40 - 20XT
2	2.00	3351	0.63	0.63	7113	6146	N/A	2.12	N/A	1.83	V40 - 20XT
3	3.33	3298	0.63	0.63	7113	6146	N/A	2.16	N/A	1.86	V40 - 20XT
4	4.67	3232	0.63	0.63	7113	6146	N/A	2.20	N/A	1.90	V40 - 20XT
5	6.00	3154	0.63	0.63	7113	6146	N/A	2.25	N/A	1.95	V40 - 20XT
6	7.33	3101	0.63	0.63	7113	6146	N/A	2.29	N/A	1.98	V40 - 20XT
7	8.67	3035	0.63	0.63	7113	6146	N/A	2.34	N/A	2.03	V40 - 20XT
8	10.00	2958	0.63	0.63	7113	6146	N/A	2.40	N/A	2.08	V40 - 20XT
9	11.33	2904	0.63	0.63	7113	6146	N/A	2.45	N/A	2.12	V40 - 20XT
10	12.67	2838	0.63	0.63	7113	6146	N/A	2.51	N/A	2.17	V40 - 20XT
11	14.00	3448	0.63	0.63	7113	6146	N/A	2.06	N/A	1.78	V40 - 20XT
12	16.00	4006	0.63	0.63	7113	6146	N/A	1.78	N/A	1.53	V40 - 20XT
13	18.00	3859	0.63	0.63	7113	6146	N/A	1.84	N/A	1.59	V40 - 20XT
14	20.00	3711	0.62	0.62	7041	6146	N/A	1.90	N/A	1.66	V40 - 20XT
15	22.00	3564	0.59	0.59	6641	6146	N/A	1.86	N/A	1.72	V40 - 20XT
16	24.00	3416	0.55	0.55	6241	6146	N/A	1.83	N/A	1.80	V40 - 20XT
17	26.00	3269	0.52	0.52	5840	6146	N/A	1.79	N/A	1.88	V40 - 20XT
18	28.00	3121	0.48	0.48	5440	6146	N/A	1.74	N/A	1.97	V40 - 20XT
19	30.00	2974	0.45	0.45	5040	6146	N/A	1.69	N/A	2.07	V40 - 20XT
20	32.00	2826	0.41	0.41	4640	6146	N/A	1.64	N/A	2.17	V40 - 20XT
21	34.00	1804	0.38	0.38	4239	6146	N/A	2.35	N/A	3.41	V40 - 20XT
22	34.67	2162	0.36	0.36	4105	6146	N/A	1.90	N/A	2.84	V40 - 20XT
23	36.01	1258	0.72	0.72	5433	4107	N/A	4.32	N/A	3.27	V40 - 10XT
24	38.00	2386	0.72	0.72	5433	4107	N/A	2.28	N/A	1.72	V40 - 10XT
25	40.00	2245	0.72	0.72	5433	4107	N/A	2.42	N/A	1.83	V40 - 10XT
26	42.00	2098	0.72	0.72	5433	4107	N/A	2.59	N/A	1.96	V40 - 10XT
27	44.00	1950	0.71	0.71	4021	3083	N/A	2.06	N/A	1.58	V40 - 8XT
28	46.00	1803	0.71	0.71	4021	3083	N/A	2.23	N/A	1.71	V40 - 8XT
29	48.00	1655	0.71	0.71	4021	3083	N/A	2.43	N/A	1.86	V40 - 8XT
30	50.00	1508	0.71	0.71	4021	3083	N/A	2.67	N/A	2.04	V40 - 8XT
31	52.00	1360	0.71	0.71	4021	3083	N/A	2.96	N/A	2.27	V40 - 8XT
32	54.00	1213	0.69	0.69	3913	3083	N/A	3.23	N/A	2.54	V40 - 8XT
33	56.00	1065	0.66	0.66	3733	3083	N/A	3.50	N/A	2.89	V40 - 8XT
34	58.00	918	0.63	0.63	3552	3083	N/A	3.87	N/A	3.36	V40 - 8XT
35	60.00	770	0.60	0.60	3372	3083	N/A	4.38	N/A	4.00	V40 - 8XT
36	62.00	623	0.56	0.56	3192	3083	N/A	5.13	N/A	4.95	V40 - 8XT
37	64.00	658	0.53	0.53	3012	3083	N/A	4.58	N/A	4.69	V40 - 8XT

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Connection force, To [lb/ft]	Reduction factor for connection (short-term strength) CRult	Reduction factor for connection (long-term strength) CRcr	Available connection strength [lb/ft]	Available Geogrid strength, Tavailable [lb/ft]	Fs-overall connection strength Specified	Fs-overall connection strength Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.67	4755	0.63	0.63	7113	6146	N/A	1.50	N/A	1.46	V40 - 20XT
2	2.00	4657	0.63	0.63	7113	6146	N/A	1.53	N/A	1.49	V40 - 20XT
3	3.33	4584	0.63	0.63	7113	6146	N/A	1.55	N/A	1.51	V40 - 20XT
4	4.67	4499	0.63	0.63	7113	6146	N/A	1.58	N/A	1.54	V40 - 20XT
5	6.00	4401	0.63	0.63	7113	6146	N/A	1.62	N/A	1.58	V40 - 20XT
6	7.33	4328	0.63	0.63	7113	6146	N/A	1.64	N/A	1.60	V40 - 20XT
7	8.67	4242	0.63	0.63	7113	6146	N/A	1.68	N/A	1.64	V40 - 20XT
8	10.00	4146	0.63	0.63	7113	6146	N/A	1.72	N/A	1.67	V40 - 20XT
9	11.33	4072	0.63	0.63	7113	6146	N/A	1.75	N/A	1.71	V40 - 20XT
10	12.67	3986	0.63	0.63	7113	6146	N/A	1.78	N/A	1.74	V40 - 20XT
11	14.00	4576	0.63	0.63	7113	6146	N/A	1.55	N/A	1.49	V40 - 20XT
12	16.00	5105	0.63	0.63	7113	6146	N/A	1.39	N/A	1.32	V40 - 20XT
13	18.00	4928	0.63	0.63	7113	6146	N/A	1.44	N/A	1.37	V40 - 20XT
14	20.00	4751	0.62	0.62	7041	6146	N/A	1.48	N/A	1.42	V40 - 20XT
15	22.00	4574	0.59	0.59	6641	6146	N/A	1.45	N/A	1.47	V40 - 20XT
16	24.00	4397	0.55	0.55	6241	6146	N/A	1.42	N/A	1.54	V40 - 20XT
17	26.00	4220	0.52	0.52	5840	6146	N/A	1.38	N/A	1.60	V40 - 20XT
18	28.00	4042	0.48	0.48	5440	6146	N/A	1.35	N/A	1.67	V40 - 20XT
19	30.00	3865	0.45	0.45	5040	6146	N/A	1.30	N/A	1.75	V40 - 20XT
20	32.00	3688	0.41	0.41	4640	6146	N/A	1.26	N/A	1.84	V40 - 20XT
21	34.00	2637	0.38	0.38	4239	6146	N/A	1.61	N/A	2.67	V40 - 20XT
22	34.67	2984	0.36	0.36	4105	6146	N/A	1.38	N/A	2.32	V40 - 20XT
23	36.01	2059	0.72	0.72	5433	4107	N/A	2.64	N/A	2.36	V40 - 10XT
24	38.00	3158	0.72	0.72	5433	4107	N/A	1.72	N/A	1.44	V40 - 10XT
25	40.00	2987	0.72	0.72	5433	4107	N/A	1.82	N/A	1.53	V40 - 10XT
26	42.00	2810	0.72	0.72	5433	4107	N/A	1.93	N/A	1.63	V40 - 10XT
27	44.00	2633	0.71	0.71	4021	3083	N/A	1.53	N/A	1.31	V40 - 8XT
28	46.00	2456	0.71	0.71	4021	3083	N/A	1.64	N/A	1.41	V40 - 8XT
29	48.00	2279	0.71	0.71	4021	3083	N/A	1.76	N/A	1.52	V40 - 8XT
30	50.00	2102	0.71	0.71	4021	3083	N/A	1.91	N/A	1.65	V40 - 8XT
31	52.00	1925	0.71	0.71	4021	3083	N/A	2.09	N/A	1.82	V40 - 8XT
32	54.00	1748	0.69	0.69	3913	3083	N/A	2.24	N/A	2.01	V40 - 8XT
33	56.00	1571	0.66	0.66	3733	3083	N/A	2.38	N/A	2.25	V40 - 8XT
34	58.00	1393	0.63	0.63	3552	3083	N/A	2.55	N/A	2.56	V40 - 8XT
35	60.00	1216	0.60	0.60	3372	3083	N/A	2.77	N/A	2.97	V40 - 8XT
36	62.00	1039	0.56	0.56	3192	3083	N/A	3.07	N/A	3.54	V40 - 8XT
37	64.00	1044	0.53	0.53	3012	3083	N/A	2.88	N/A	3.47	V40 - 8XT

GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

A horizontal seismic coefficient, Kh=half of 'A', equal to 0.180 has been applied.
The seismic force is applied at the center of the sliding mass.

STATIC CONDITIONS:
For the specified search grid, the calculated minimum Fs is 1.872

(it corresponds to a critical circle at Xc = -8.00, Yc = 112.00 and R = 112.29 [ft] where (x=0, y=0) is taken at the TOE or Xc = 92.00, Yc = 1112.00 and R = 112.29 [ft] when the terrain coordinate system is used as shown in the table below.)

SEISMIC CONDITIONS:
For the specified search grid, the calculated minimum Fs is 1.216

(it corresponds to a critical circle at Xc = -56.00, Yc = 192.00 and R = 200.00 [ft] where (x=0, y=0) is taken at the TOE or Xc = 44.00, Yc = 1192.00 and R = 200.00 [ft] when the terrain coordinate system is used as shown in the table below.)

TERRAIN/WATER PROFILE

Point	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
Soil layer #1:	γ = 120.00 [lb/ft ³]			ϕ = 28.0°		c = 500.00 [lb/ft ²]					
x [ft]	0.0	15.0	20.0	50.0	170.0	205.0	250.0	300.0	350.0	400.0	500.0
y [ft]	1006.0	1006.0	1006.0	1006.0	1000.0	1070.0	1070.0	1070.0	1075.0	1075.0	1075.0

AASHTO 2002 ASD DESIGN METHOD
Portola Center - TTM 15353

MSEW(3.0): Update # 14.3

PROJECT IDENTIFICATION

Title:	Portola Center - TTM 15353
Project Number:	0704 034A
Client:	Sunranch Capital Partners, LLC
Designer:	DAO
Station Number:	DESIGN 3

Description:

20 ft Total Height - Single Wall - 30 ft 2:1 Ascending Slope at Crest

Company's information:

Name: Soil Retention Designs, Inc.
Street: 2501 State Street

Carlsbad, CA 92008
Telephone #: 760-966-6090
Fax #: 760-966-6099
E-Mail: dosborne@soilretention.com

Original file path and name: C:\Users\dosborne\Desktop\Portola South Rev Design\Upda..... .....pe - Single Wall.BEN

Original date and time of creating this file: Mon Nov 29 16:13:17 2010

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	32.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	28.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	120.0 lb/ft ^{3}
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	28.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	500.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2210 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 44.10° (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.4206 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 25.80 N_γ = 16.72

SEISMICITY

Maximum ground acceleration coefficient, A = 0.360
Design acceleration coefficient in Internal Stability: Kh = Am = 0.392
Design acceleration coefficient in External Stability: Kh_d = 0.175 => Kh = Am = 0.175
(Kh in External Stability is based on allowable displacement, d = 75 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.8349 Kae (Kh = 0) = 0.4206 Δ Kae = 0.4143
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

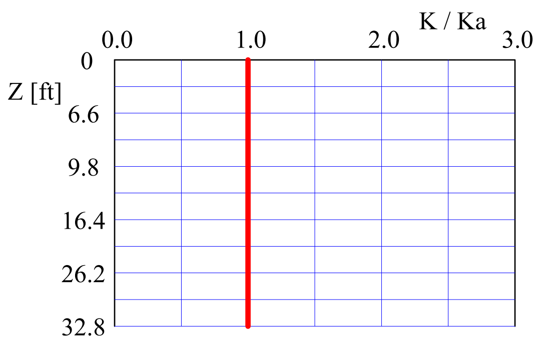
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	3590.0	6230.0	8300.0	12420.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.11	1.10	1.10	1.10	
Creep reduction factor, RFc	1.67	1.67	1.67	1.67	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	29.40	29.40	29.40	29.40	
Pullout resistance factor, F*	0.90·tarϕ	0.90·tanϕ	0.90·tanϕ	0.90·tanϕ	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

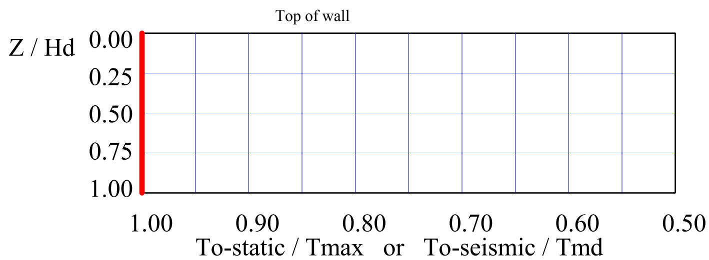
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (according to revised Demo 82)
(Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 1.00/0.67 ft. Horizontal distance to Center of Gravity of block is 0.42 ft.
Average unit weight of block is $\gamma_f = 117.00$ 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



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRult [(2)]	σ	CRult	σ	CRult	σ	CRult	σ	CRult
0.0	0.98	0.0	0.50	0.0	0.25	0.0	0.34		
4000.0	0.98	1545.0	0.71	1831.0	0.72	1914.0	0.63	N/A	
		4000.0	0.71	4000.0	0.72	4000.0	0.63		

Geogrid Type #1 [3)]		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRcr	σ	CRcr	σ	CRcr	σ	CRcr	σ	CRcr
0.0	0.98	0.0	0.50	0.0	0.25	0.0	0.34		
4000.0	0.98	1545.0	0.71	1831.0	0.72	1914.0	0.63	N/A	
		4000.0	0.71	4000.0	0.72	4000.0	0.63		

(1) σ = Confining stress in between stacked blocks [lb/ft ²]
(2) CRult = Tc-ult / Tult
(3) CRcr = Tcre / Tult

In seismic analysis, long term strength is reduced to 100% of its static value.

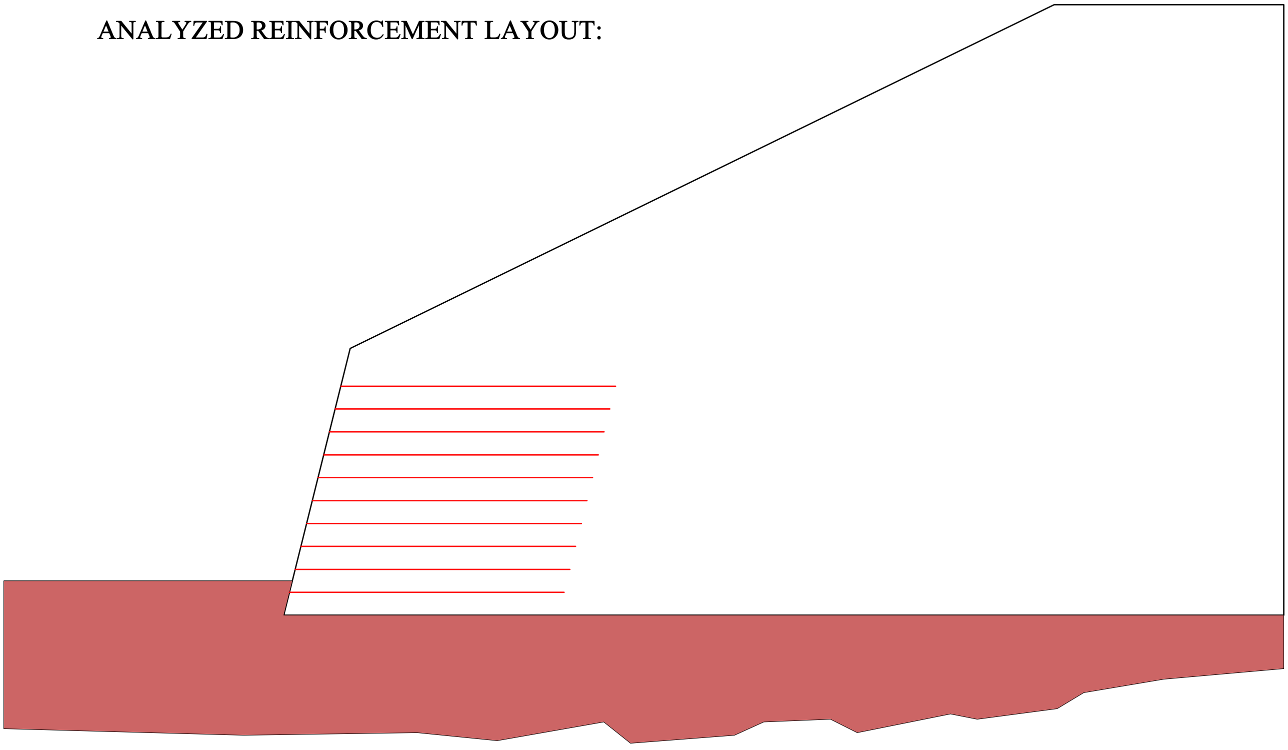
D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	V40 - 5XT	V40 - 8XT	V40 - 10XT	V40 - 20XT	N/A
Connection strength reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	N/A	N/A	N/A	N/A	N/A

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

Design height, Hd	23.30	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 20.30 ft }
Batter, ω	14.0	[deg]	
Backslope, β	26.0	[deg]	
Backslope rise	30.0	[ft]	Broken back equivalent angle, I = 26.00° (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]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10[ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 10.61, Meyerhof stress = 3427 lb/ft².

Foundation Interface: Direct sliding, Fs = 2.133, Eccentricity, e/L = -0.0129, Fs-overturning = 4.92

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	24.00	3	2.65	2.00	2.003	28.165	2.014	-0.0214	V40 - 10XT
2	4.00	24.00	3	4.40	3.33	3.327	42.585	2.114	-0.0294	V40 - 10XT
3	6.00	24.00	2	3.56	2.73	2.732	40.993	2.221	-0.0373	V40 - 8XT
4	8.00	24.00	2	3.93	3.02	3.016	39.001	2.337	-0.0449	V40 - 8XT
5	10.00	24.00	2	4.39	3.36	3.365	37.054	2.463	-0.0527	V40 - 8XT
6	12.00	24.00	2	4.75	3.81	3.805	35.171	2.598	-0.0609	V40 - 8XT
7	14.00	24.00	2	5.21	4.38	4.379	33.381	2.743	-0.0700	V40 - 8XT
8	16.00	24.00	2	5.83	5.16	5.155	31.734	2.895	-0.0806	V40 - 8XT
9	18.00	24.00	2	6.73	6.27	6.266	30.322	3.049	-0.0940	V40 - 8XT
10	20.00	24.00	2	4.48	4.41	4.413	16.207	3.194	-0.1122	V40 - 8XT

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 7.67, Meyerhof stress = 4262 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.414, Eccentricity, e/L = 0.0815, Fs-overturning = 2.89

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	2.00	24.00	3	1.17	1.14	1.143	9.982	1.361	0.0583	V40 - 10XT
2	4.00	24.00	3	1.50	1.54	1.538	11.577	1.460	0.0367	V40 - 10XT
3	6.00	24.00	2	1.20	1.25	1.255	11.057	1.573	0.0165	V40 - 8XT
4	8.00	24.00	2	1.31	1.37	1.374	10.421	1.703	-0.0023	V40 - 8XT
5	10.00	24.00	2	1.45	1.52	1.519	9.788	1.855	-0.0200	V40 - 8XT
6	12.00	24.00	2	1.55	1.70	1.698	9.159	2.032	-0.0369	V40 - 8XT
7	14.00	24.00	2	1.67	1.92	1.925	8.535	2.238	-0.0533	V40 - 8XT
8	16.00	24.00	2	1.82	2.22	2.221	7.919	2.477	-0.0700	V40 - 8XT
9	18.00	24.00	2	2.03	2.63	2.626	7.316	2.748	-0.0882	V40 - 8XT
10	20.00	24.00	2	1.89	2.42	2.422	5.463	3.031	-0.1098	V40 - 8XT

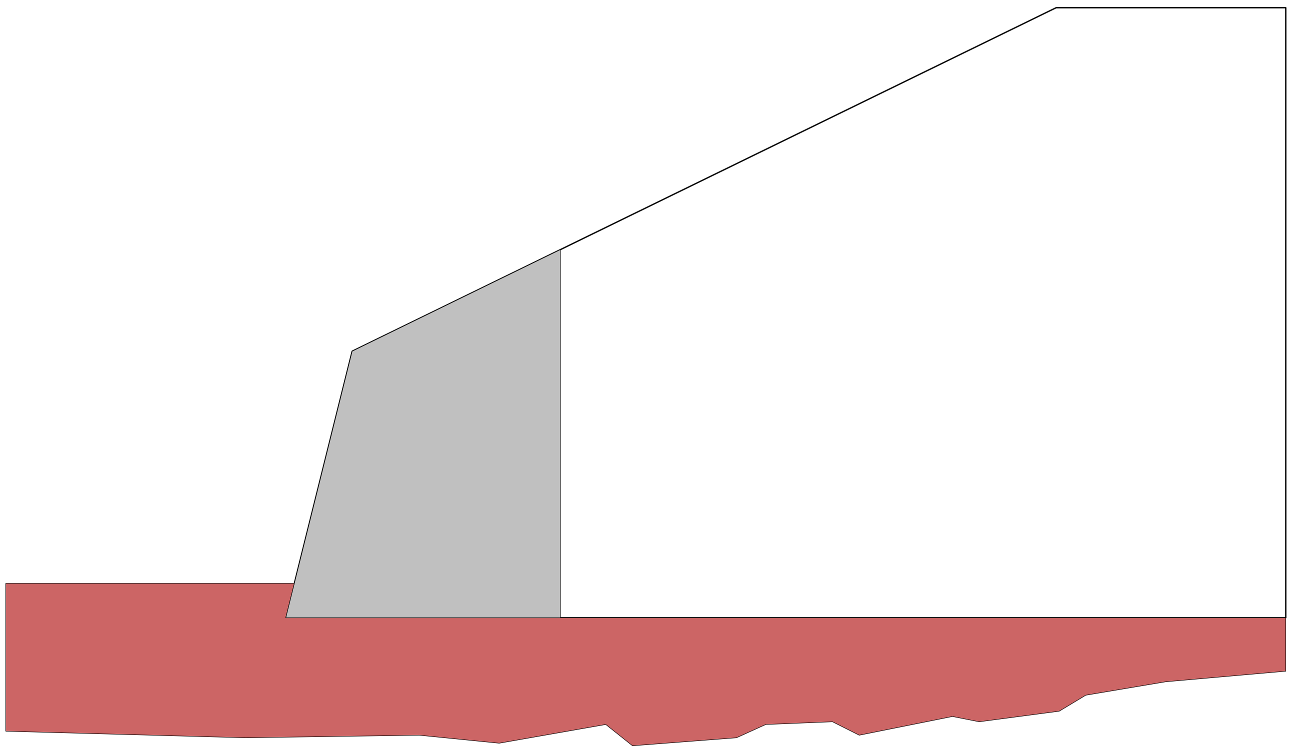
GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

STATIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.582
(it corresponds to a critical circle at Xc = -20.00, Yc = 112.00 and R = 113.77 [ft]).

SEISMIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.119
(it corresponds to a critical circle at Xc = -20.00, Yc = 112.00 and R = 113.77 [ft]).

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	36351	32694	[lb/ft ²]
Meyerhof stress, σ_V	3426.8	4262	[lb/ft ²]
Eccentricity, e	-0.31	2.13	[ft]
Eccentricity, e/L	-0.013	0.089	
Fs calculated	10.61	7.67	
Base length	24.00	24.00	[ft]



SCALE:

0 2 4 6 8 10[ft]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 2.133 and Fs-seismic = 1.414

#	Geogrid Elevation [ft]	Geogrid Length [ft]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	2.00	24.00	2.014	1.361	3	V40 - 10XT
2	4.00	24.00	2.114	1.460	3	V40 - 10XT
3	6.00	24.00	2.221	1.573	2	V40 - 8XT
4	8.00	24.00	2.337	1.703	2	V40 - 8XT
5	10.00	24.00	2.463	1.855	2	V40 - 8XT
6	12.00	24.00	2.598	2.032	2	V40 - 8XT
7	14.00	24.00	2.743	2.238	2	V40 - 8XT
8	16.00	24.00	2.895	2.477	2	V40 - 8XT
9	18.00	24.00	3.049	2.748	2	V40 - 8XT
10	20.00	24.00	3.194	3.031	2	V40 - 8XT

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = -0.0129, e/L seismic = 0.0815; Overturning: Fs-static = 4.92, Fs-seismic = 2.89

#	Geogrid Elevation [ft]	Geogrid Length [ft]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	2.00	24.00	-0.0214	0.0583	3	V40 - 10XT
2	4.00	24.00	-0.0294	0.0367	3	V40 - 10XT
3	6.00	24.00	-0.0373	0.0165	2	V40 - 8XT
4	8.00	24.00	-0.0449	-0.0023	2	V40 - 8XT
5	10.00	24.00	-0.0527	-0.0200	2	V40 - 8XT
6	12.00	24.00	-0.0609	-0.0369	2	V40 - 8XT
7	14.00	24.00	-0.0700	-0.0533	2	V40 - 8XT
8	16.00	24.00	-0.0806	-0.0700	2	V40 - 8XT
9	18.00	24.00	-0.0940	-0.0882	2	V40 - 8XT
10	20.00	24.00	-0.1122	-0.1098	2	V40 - 8XT

RESULTS for STRENGTH

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Tavailable [lb/ft]	Tmax [lb/ft]	Tmd [lb/ft]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	2.00	4107	2050.57	2578.22	N/A	2.003	N/A	1.143	V40 - 10XT
2	4.00	4107	1234.46	2398.36	N/A	3.327	N/A	1.538	V40 - 10XT
3	6.00	3083	1128.40	2218.49	N/A	2.732	N/A	1.255	V40 - 8XT
4	8.00	3083	1022.33	2038.63	N/A	3.016	N/A	1.374	V40 - 8XT
5	10.00	3083	916.27	1858.77	N/A	3.365	N/A	1.519	V40 - 8XT
6	12.00	3083	810.20	1678.91	N/A	3.805	N/A	1.698	V40 - 8XT
7	14.00	3083	704.14	1499.04	N/A	4.379	N/A	1.925	V40 - 8XT
8	16.00	3083	598.07	1319.18	N/A	5.155	N/A	2.221	V40 - 8XT
9	18.00	3083	492.01	1139.32	N/A	6.266	N/A	2.626	V40 - 8XT
10	20.00	3083	698.65	959.45	N/A	4.413	N/A	2.422	V40 - 8XT

RESULTS for PULLOUT

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Coverage Ratio	Tmax [lb/ft]	Tmd [lb/ft]	Le [ft]	La [ft]	Avail.Static Pullout, Pr [lb/ft]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [lb/ft]	Specified Seismic Fs	Actual Seismic Fs
1	2.00	1.000	2050.6	2578.2	22.43	1.57	57753.7	N/A	28.165	46202.9	N/A	9.982
2	4.00	1.000	1234.5	2398.4	20.87	3.13	52569.5	N/A	42.585	42055.6	N/A	11.577
3	6.00	1.000	1128.4	2218.5	19.30	4.70	46256.8	N/A	40.993	37005.4	N/A	11.057
4	8.00	1.000	1022.3	2038.6	17.74	6.26	39871.5	N/A	39.001	31897.2	N/A	10.421
5	10.00	1.000	916.3	1858.8	16.17	7.83	33951.1	N/A	37.054	27160.9	N/A	9.788
6	12.00	1.000	810.2	1678.9	14.61	9.39	28495.7	N/A	35.171	22796.5	N/A	9.159
7	14.00	1.000	704.1	1499.0	13.04	10.96	23505.1	N/A	33.381	18804.1	N/A	8.535
8	16.00	1.000	598.1	1319.2	11.48	12.52	18979.5	N/A	31.734	15183.6	N/A	7.919
9	18.00	1.000	492.0	1139.3	9.91	14.09	14918.8	N/A	30.322	11935.0	N/A	7.316
10	20.00	1.000	698.7	959.5	8.35	15.65	11323.0	N/A	16.207	9058.4	N/A	5.463

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Connection force, To [lb/ft]	Reduction factor for connection (short-term strength) CRult	Reduction factor for connection (long-term strength) CRcr	Available connection strength [lb/ft]	Available Geogrid strength, Tavailable [lb/ft]	Fs-overall connection strength Specified	Fs-overall connection strength Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	2.00	2051	0.72	0.72	5433	4107	N/A	2.65	N/A	2.00	V40 - 10XT
2	4.00	1234	0.72	0.72	5433	4107	N/A	4.40	N/A	3.33	V40 - 10XT
3	6.00	1128	0.71	0.71	4021	3083	N/A	3.56	N/A	2.73	V40 - 8XT
4	8.00	1022	0.71	0.71	4021	3083	N/A	3.93	N/A	3.02	V40 - 8XT
5	10.00	916	0.71	0.71	4021	3083	N/A	4.39	N/A	3.36	V40 - 8XT
6	12.00	810	0.68	0.68	3850	3083	N/A	4.75	N/A	3.81	V40 - 8XT
7	14.00	704	0.65	0.65	3669	3083	N/A	5.21	N/A	4.38	V40 - 8XT
8	16.00	598	0.62	0.62	3489	3083	N/A	5.83	N/A	5.16	V40 - 8XT
9	18.00	492	0.58	0.58	3309	3083	N/A	6.73	N/A	6.27	V40 - 8XT
10	20.00	699	0.55	0.55	3129	3083	N/A	4.48	N/A	4.41	V40 - 8XT

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Connection force, To [lb/ft]	Reduction factor for connection (short-term strength) CRult	Reduction factor for connection (long-term strength) CRcr	Available connection strength [lb/ft]	Available Geogrid strength, Tavailable [lb/ft]	Fs-overall connection strength Specified	Fs-overall connection strength Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	2.00	4629	0.72	0.72	5433	4107	N/A	1.17	N/A	1.14	V40 - 10XT
2	4.00	3633	0.72	0.72	5433	4107	N/A	1.50	N/A	1.54	V40 - 10XT
3	6.00	3347	0.71	0.71	4021	3083	N/A	1.20	N/A	1.25	V40 - 8XT
4	8.00	3061	0.71	0.71	4021	3083	N/A	1.31	N/A	1.37	V40 - 8XT
5	10.00	2775	0.71	0.71	4021	3083	N/A	1.45	N/A	1.52	V40 - 8XT
6	12.00	2489	0.68	0.68	3850	3083	N/A	1.55	N/A	1.70	V40 - 8XT
7	14.00	2203	0.65	0.65	3669	3083	N/A	1.67	N/A	1.92	V40 - 8XT
8	16.00	1917	0.62	0.62	3489	3083	N/A	1.82	N/A	2.22	V40 - 8XT
9	18.00	1631	0.58	0.58	3309	3083	N/A	2.03	N/A	2.63	V40 - 8XT
10	20.00	1658	0.55	0.55	3129	3083	N/A	1.89	N/A	2.42	V40 - 8XT

GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

A horizontal seismic coefficient, Kh=half of 'A', equal to 0.180 has been applied.
The seismic force is applied at the center of the sliding mass.

STATIC CONDITIONS:
For the specified search grid, the calculated minimum Fs is 1.582
(it corresponds to a critical circle at Xc = -20.00, Yc = 112.00 and R = 113.77 [ft] where (x=0, y=0) is taken at the TOE or Xc = 55.00, Yc = 1112.00 and R = 113.77 [ft] when the terrain coordinate system is used as shown in the table below.)

SEISMIC CONDITIONS:
For the specified search grid, the calculated minimum Fs is 1.119
(it corresponds to a critical circle at Xc = -20.00, Yc = 112.00 and R = 113.77 [ft] where (x=0, y=0) is taken at the TOE or Xc = 55.00, Yc = 1112.00 and R = 113.77 [ft] when the terrain coordinate system is used as shown in the table below.)

TERRAIN/WATER PROFILE

Point	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
Soil layer #1: γ = 120.00 [lb/ft ³] ϕ = 28.0° c = 500.00 [lb/ft ²]											
x [ft]	0.0	10.0	15.0	20.0	50.0	100.0	125.0	140.0	200.0	275.0	300.0
y [ft]	1003.0	1003.0	1003.0	1003.0	1003.0	1000.0	1044.0	1050.0	1055.0	1055.0	1055.0

AASHTO 2002 ASD DESIGN METHOD
Portola Center - TTM 15353

MSEW(3.0): Update # 14.3

PROJECT IDENTIFICATION

Title:	Portola Center - TTM 15353
Project Number:	0704 034A
Client:	SunRanch Capital Partners, LLC
Designer:	DAO
Station Number:	DESIGN 4

Description:

Tiered 30 ft over 12 ft Wall Height - 12 ft 2:1 Separation Slope -
Offset of 30 ft - 30 ft Ascending Slope at Crest

Company's information:

Name: Soil Retention Designs, Inc.
Street: 2501 State Street

Carlsbad, CA 92008
Telephone #: 760-966-6090
Fax #: 760-966-6099
E-Mail: dosborne@soilretention.com

Original file path and name: C:\Users\dosborne\Desktop\Design 4 - 30 ft over 12 ft T.....
.....d - 30 ft offset.BEN

Original date and time of creating this file: Mon Nov 29 16:13:17 2010

PROGRAM MODE: ANALYSIS
of SUPERIMPOSED WALL
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	32.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	28.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	120.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	28.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	500.0 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) = 0.4017 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 25.80 N γ= 16.72

SEISMICITY

Maximum ground acceleration coefficient, A = 0.360
Design acceleration coefficient in Internal Stability: Kh = Am = 0.392
Design acceleration coefficient in External Stability: Kh_d = 0.175 => Kh = Am = 0.175
(Kh in External Stability is based on allowable displacement, d = 75 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.6634 Kae (Kh = 0) = 0.4017 Δ Kae = 0.2617
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

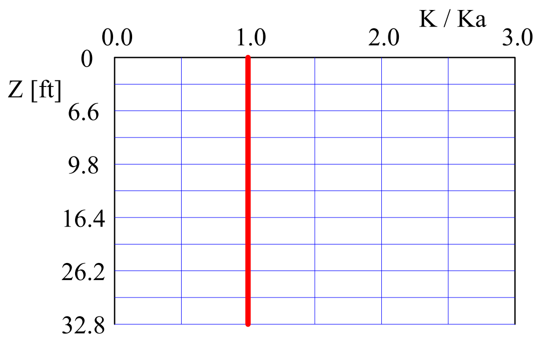
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [lb/ft]	3590.0	6230.0	8300.0	12420.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.11	1.10	1.10	1.10	
Creep reduction factor, RFc	1.67	1.67	1.67	1.67	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	29.40	29.40	29.40	29.40	
Pullout resistance factor, F*	0.90·tanϕ	0.90·tanϕ	0.90·tanϕ	0.90·tanϕ	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

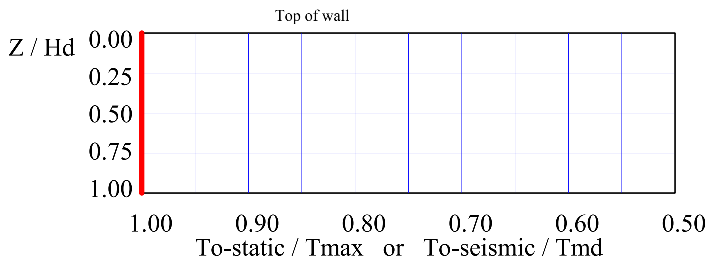
Z	K / Ka
0 ft	1.00
3.3 ft	1.00
6.6 ft	1.00
9.8 ft	1.00
13.1 ft	1.00
16.4 ft	1.00
19.7 ft	1.00



INPUT DATA: Facia and Connection (according to revised Demo 82)
(Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 1.00/0.67 ft. Horizontal distance to Center of Gravity of block is 0.42 ft.
Average unit weight of block is γ_f = 117.00 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



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ (1)	CRult (2)	σ	CRult	σ	CRult	σ	CRult	σ	CRult
0.0	0.98	0.0	0.50	0.0	0.25	0.0	0.34		
4000.0	0.98	1545.0	0.71	1831.0	0.72	1914.0	0.63	N/A	
		4000.0	0.71	4000.0	0.72	4000.0	0.63		

Geogrid Type #1(3)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRcr	σ	CRcr	σ	CRcr	σ	CRcr	σ	CRcr
0.0	0.98	0.0	0.50	0.0	0.25	0.0	0.34		
4000.0	0.98	1545.0	0.71	1831.0	0.72	1914.0	0.63	N/A	
		4000.0	0.71	4000.0	0.72	4000.0	0.63		

(1) σ = Confining stress in between stacked blocks [lb/ft ²]
(2) CRult = Tc-ult / Tult
(3) CRcr = Tcre / Tult

In seismic analysis, long term strength is reduced to 100% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	V40 - 5XT	V40 - 8XT	V40 - 10XT	V40 - 20XT	N/A
Connection strength reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	N/A	N/A	N/A	N/A	N/A

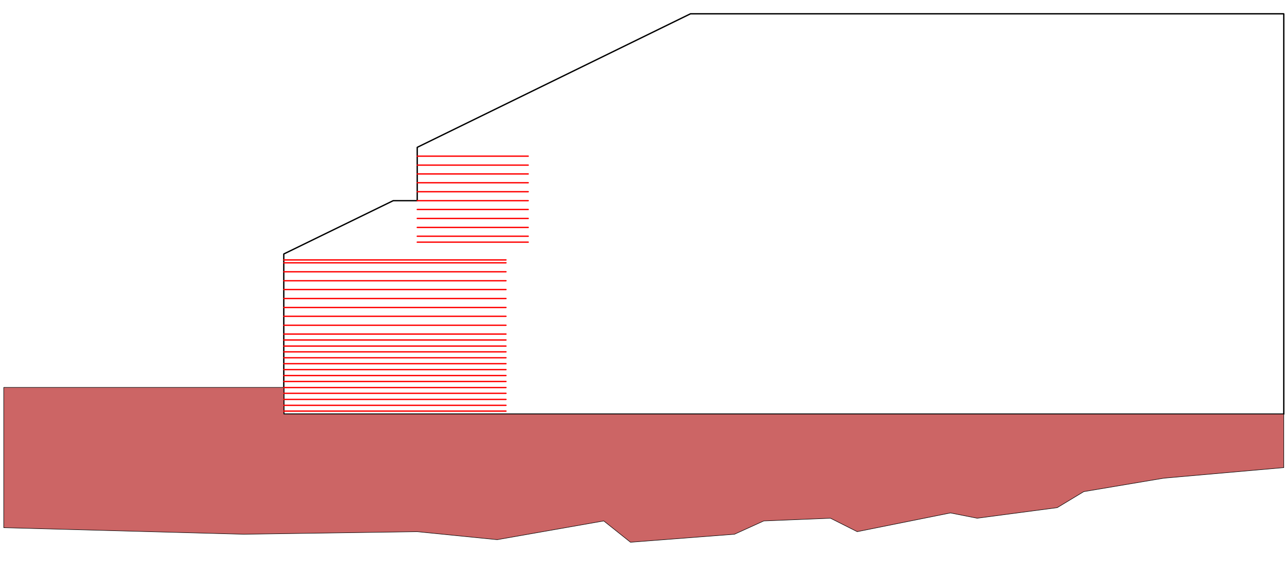
INPUT DATA: Geometry and Surcharge loads (of SUPERIMPOSED wall)

Design height, Hd	60.00	[ft]	{ Embedded depth is E = 6.00 ft, and height above top of finished bottom grade is H = 54.00 ft, where H1 = 12.00 and H2 = 30.00 }
Batter, ω	0.0	[deg]	
Backslope, β	26.0	[deg]	
Backslope rise	30.0	[ft]	Broken back equivalent angle, I = 14.04° (see Fig. 25 in DEMO 82)

Offset of upper segment from lower one, Offset = 30.0 ft, Blackslope2 = 26.0 deg. and Backslope rise, S2 = 12.0 ft.

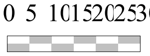
U N I F O R M   S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 5 1015202530 [ft]



ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 7.25, Meyerhof stress = 7798 lb/ft².
Foundation Interface: Direct sliding, Fs = 1.805, Eccentricity, e/L = 0.0650, Fs-overturning = 3.79

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.67	50.00	4	2.63	2.28	2.275	121.547	1.690	0.0622	V40 - 20XT
2	2.00	50.00	4	2.71	2.34	2.341	120.585	1.709	0.0566	V40 - 20XT
3	3.33	50.00	4	2.77	2.39	2.391	118.730	1.729	0.0510	V40 - 20XT
4	4.67	50.00	4	2.84	2.45	2.454	117.271	1.749	0.0454	V40 - 20XT
5	6.00	50.00	4	2.93	2.53	2.530	116.323	1.770	0.0398	V40 - 20XT
6	7.33	50.00	4	3.00	2.59	2.590	114.464	1.791	0.0341	V40 - 20XT
7	8.67	50.00	4	3.08	2.66	2.664	113.093	1.812	0.0284	V40 - 20XT
8	10.00	50.00	4	3.18	2.75	2.752	112.169	1.833	0.0227	V40 - 20XT
9	11.33	50.00	4	3.27	2.82	2.824	110.365	1.855	0.0170	V40 - 20XT
10	12.67	50.00	4	3.37	2.91	2.912	109.041	1.877	0.0111	V40 - 20XT
11	14.00	50.00	4	3.49	3.02	3.017	108.098	1.899	0.0053	V40 - 20XT
12	15.33	50.00	4	3.59	3.10	3.105	106.419	1.921	-0.0007	V40 - 20XT
13	16.67	50.00	4	3.72	3.21	3.212	105.098	1.943	-0.0069	V40 - 20XT
14	18.00	50.00	4	3.10	2.68	2.678	83.657	1.965	-0.0131	V40 - 20XT
15	20.00	50.00	4	2.69	2.34	2.345	68.116	1.998	-0.0228	V40 - 20XT
16	22.00	50.00	4	2.68	2.48	2.484	66.948	2.030	-0.0330	V40 - 20XT
17	24.00	50.00	4	2.68	2.64	2.642	65.836	2.061	-0.0437	V40 - 20XT
18	26.00	50.00	4	2.68	2.82	2.821	64.793	2.089	-0.0553	V40 - 20XT
19	28.00	50.00	4	2.68	3.03	3.026	63.792	2.114	-0.0679	V40 - 20XT
20	30.00	50.00	4	4.07	4.97	4.969	95.854	2.135	-0.0819	V40 - 20XT
21	32.00	50.00	4	10.49	13.89	13.892	244.145	2.149	-0.0977	V40 - 20XT
22	34.00	50.00	4	19.88	28.82	28.822	459.327	2.154	-0.1160	V40 - 20XT
23	34.67	50.00	4	1.69	2.53	2.533	39.023	2.153	-0.1229	V40 - 20XT
24	38.67	25.00	4	4.58	3.95	3.955	36.481	1.905	0.0609	V40 - 20XT
25	40.00	25.00	4	3.85	3.33	3.329	27.940	1.961	0.0513	V40 - 20XT
26	42.00	25.00	4	3.42	2.95	2.951	21.260	2.052	0.0370	V40 - 20XT
27	44.00	25.00	4	3.64	3.18	3.176	19.334	2.150	0.0228	V40 - 20XT
28	46.00	25.00	4	3.71	3.44	3.438	17.377	2.258	0.0085	V40 - 20XT
29	48.00	25.00	3	2.81	2.50	2.504	15.360	2.376	-0.0060	V40 - 10XT
30	50.00	25.00	3	2.78	2.75	2.752	13.265	2.503	-0.0211	V40 - 10XT
31	52.00	25.00	3	2.75	3.05	3.053	11.065	2.640	-0.0374	V40 - 10XT
32	54.00	25.00	3	2.71	3.43	3.429	8.722	2.783	-0.0559	V40 - 10XT
33	56.00	25.00	3	2.66	3.91	3.911	6.176	2.924	-0.0783	V40 - 10XT
34	58.00	25.00	3	1.80	3.16	3.162	2.313	3.046	-0.1078	V40 - 10XT

GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

STATIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.538
(it corresponds to a critical circle at Xc = -8.00, Yc = 224.00 and R = 170.29 [ft]).

SEISMIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 0.991
(it corresponds to a critical circle at Xc = -8.00, Yc = 224.00 and R = 170.29 [ft]).

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

Bearing capacity, Fs = 4.57, Meyerhof stress = 10241 lb/ft².

Foundation Interface: Direct sliding, Fs = 1.241, Eccentricity, e/L = 0.1547, Fs-overturning = 2.40

GEOGRID #	Elevation [ft]	Length [ft]	Type #	CONNECTION Fs-overall [connection strength]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.67	50.00	4	1.85	1.82	1.816	68.374	1.357	0.1012	V40 - 20XT
2	2.00	50.00	4	1.90	1.86	1.863	67.563	1.379	0.0937	V40 - 20XT
3	3.33	50.00	4	1.93	1.90	1.901	66.399	1.402	0.0864	V40 - 20XT
4	4.67	50.00	4	1.98	1.95	1.947	65.378	1.426	0.0791	V40 - 20XT
5	6.00	50.00	4	2.03	2.00	2.001	64.562	1.450	0.0719	V40 - 20XT
6	7.33	50.00	4	2.07	2.05	2.045	63.382	1.474	0.0648	V40 - 20XT
7	8.67	50.00	4	2.13	2.10	2.098	62.395	1.500	0.0577	V40 - 20XT
8	10.00	50.00	4	2.19	2.16	2.160	61.575	1.525	0.0508	V40 - 20XT
9	11.33	50.00	4	2.24	2.21	2.213	60.409	1.552	0.0439	V40 - 20XT
10	12.67	50.00	4	2.30	2.27	2.275	59.429	1.579	0.0370	V40 - 20XT
11	14.00	50.00	4	2.36	2.35	2.347	58.575	1.606	0.0302	V40 - 20XT
12	15.33	50.00	4	2.43	2.41	2.410	57.456	1.634	0.0234	V40 - 20XT
13	16.67	50.00	4	2.50	2.48	2.484	56.452	1.662	0.0166	V40 - 20XT
14	18.00	50.00	4	2.21	2.16	2.160	47.779	1.690	0.0098	V40 - 20XT
15	20.00	50.00	4	2.00	1.95	1.947	40.633	1.732	-0.0005	V40 - 20XT
16	22.00	50.00	4	1.99	2.05	2.053	39.639	1.774	-0.0109	V40 - 20XT
17	24.00	50.00	4	1.97	2.17	2.171	38.657	1.815	-0.0216	V40 - 20XT
18	26.00	50.00	4	1.95	2.30	2.303	37.690	1.852	-0.0327	V40 - 20XT
19	28.00	50.00	4	1.93	2.45	2.453	36.715	1.885	-0.0445	V40 - 20XT
20	30.00	50.00	4	2.52	3.62	3.624	47.338	1.911	-0.0571	V40 - 20XT
21	32.00	50.00	4	3.92	6.93	6.934	73.002	1.927	-0.0709	V40 - 20XT
22	34.00	50.00	4	4.56	9.58	9.575	84.343	1.929	-0.0866	V40 - 20XT
23	34.67	50.00	4	1.31	2.16	2.157	24.171	1.925	-0.0924	V40 - 20XT
24	38.67	25.00	4	3.36	3.25	3.247	21.395	1.283	0.1448	V40 - 20XT
25	40.00	25.00	4	2.97	2.83	2.826	17.229	1.340	0.1247	V40 - 20XT
26	42.00	25.00	4	2.73	2.57	2.565	13.592	1.437	0.0961	V40 - 20XT
27	44.00	25.00	4	2.89	2.75	2.752	12.301	1.548	0.0691	V40 - 20XT
28	46.00	25.00	4	2.94	2.97	2.968	10.995	1.677	0.0436	V40 - 20XT
29	48.00	25.00	3	2.21	2.15	2.153	9.656	1.829	0.0194	V40 - 10XT
30	50.00	25.00	3	2.17	2.35	2.354	8.275	2.006	-0.0039	V40 - 10XT
31	52.00	25.00	3	2.12	2.60	2.596	6.838	2.215	-0.0268	V40 - 10XT
32	54.00	25.00	3	2.07	2.89	2.893	5.329	2.455	-0.0502	V40 - 10XT
33	56.00	25.00	3	2.00	3.27	3.268	3.719	2.720	-0.0759	V40 - 10XT
34	58.00	25.00	3	1.45	2.76	2.756	1.485	2.974	-0.1073	V40 - 10XT

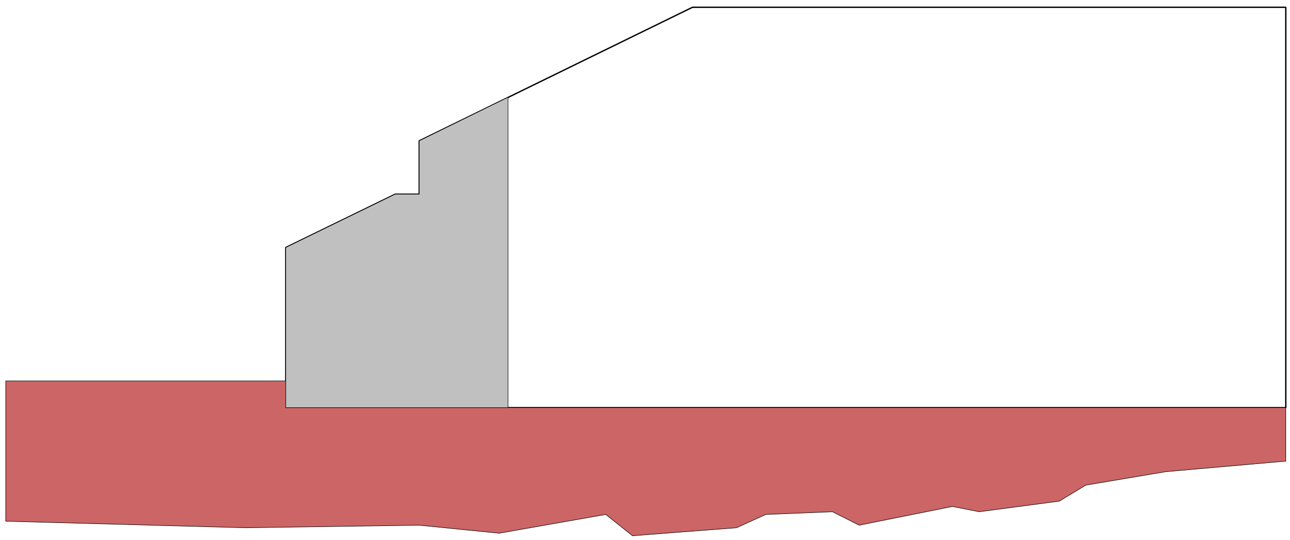
GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

STATIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 1.538
(it corresponds to a critical circle at Xc = -8.00, Yc = 224.00 and R = 170.29 [ft]).

SEISMIC CONDITIONS: For the specified search grid, the calculated minimum Fs is 0.991
(it corresponds to a critical circle at Xc = -8.00, Yc = 224.00 and R = 170.29 [ft]).

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	56534	46798	[lb/ft ²]
Meyerhof stress, σ_V	7798.2	10241	[lb/ft ²]
Eccentricity, e	3.25	8.10	[ft]
Eccentricity, e/L	0.065	0.162	
Fs calculated	7.25	4.57	
Base length	50.00	50.00	[ft]



SCALE:

0 5 10 15 20 25 30 [ft]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.805 and Fs-seismic = 1.241

#	Geogrid Elevation [ft]	Geogrid Length [ft]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.67	50.00	1.690	1.357	4	V40 - 20XT
2	2.00	50.00	1.709	1.379	4	V40 - 20XT
3	3.33	50.00	1.729	1.402	4	V40 - 20XT
4	4.67	50.00	1.749	1.426	4	V40 - 20XT
5	6.00	50.00	1.770	1.450	4	V40 - 20XT
6	7.33	50.00	1.791	1.474	4	V40 - 20XT
7	8.67	50.00	1.812	1.500	4	V40 - 20XT
8	10.00	50.00	1.833	1.525	4	V40 - 20XT
9	11.33	50.00	1.855	1.552	4	V40 - 20XT
10	12.67	50.00	1.877	1.579	4	V40 - 20XT
11	14.00	50.00	1.899	1.606	4	V40 - 20XT
12	15.33	50.00	1.921	1.634	4	V40 - 20XT
13	16.67	50.00	1.943	1.662	4	V40 - 20XT
14	18.00	50.00	1.965	1.690	4	V40 - 20XT
15	20.00	50.00	1.998	1.732	4	V40 - 20XT
16	22.00	50.00	2.030	1.774	4	V40 - 20XT
17	24.00	50.00	2.061	1.815	4	V40 - 20XT
18	26.00	50.00	2.089	1.852	4	V40 - 20XT
19	28.00	50.00	2.114	1.885	4	V40 - 20XT
20	30.00	50.00	2.135	1.911	4	V40 - 20XT
21	32.00	50.00	2.149	1.927	4	V40 - 20XT
22	34.00	50.00	2.154	1.929	4	V40 - 20XT
23	34.67	50.00	2.153	1.925	4	V40 - 20XT
24	38.67	25.00	1.905	1.283	4	V40 - 20XT
25	40.00	25.00	1.961	1.340	4	V40 - 20XT
26	42.00	25.00	2.052	1.437	4	V40 - 20XT
27	44.00	25.00	2.150	1.548	4	V40 - 20XT
28	46.00	25.00	2.258	1.677	4	V40 - 20XT
29	48.00	25.00	2.376	1.829	3	V40 - 10XT
30	50.00	25.00	2.503	2.006	3	V40 - 10XT
31	52.00	25.00	2.640	2.215	3	V40 - 10XT
32	54.00	25.00	2.783	2.455	3	V40 - 10XT
33	56.00	25.00	2.924	2.720	3	V40 - 10XT
34	58.00	25.00	3.046	2.974	3	V40 - 10XT

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.0650, e/L seismic = 0.1547; Overturning: Fs-static = 3.79, Fs-seismic = 2.40

#	Geogrid Elevation [ft]	Geogrid Length [ft]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.67	50.00	0.0622	0.1012	4	V40 - 20XT
2	2.00	50.00	0.0566	0.0937	4	V40 - 20XT
3	3.33	50.00	0.0510	0.0864	4	V40 - 20XT
4	4.67	50.00	0.0454	0.0791	4	V40 - 20XT
5	6.00	50.00	0.0398	0.0719	4	V40 - 20XT
6	7.33	50.00	0.0341	0.0648	4	V40 - 20XT
7	8.67	50.00	0.0284	0.0577	4	V40 - 20XT
8	10.00	50.00	0.0227	0.0508	4	V40 - 20XT
9	11.33	50.00	0.0170	0.0439	4	V40 - 20XT
10	12.67	50.00	0.0111	0.0370	4	V40 - 20XT
11	14.00	50.00	0.0053	0.0302	4	V40 - 20XT
12	15.33	50.00	-0.0007	0.0234	4	V40 - 20XT
13	16.67	50.00	-0.0069	0.0166	4	V40 - 20XT
14	18.00	50.00	-0.0131	0.0098	4	V40 - 20XT
15	20.00	50.00	-0.0228	-0.0005	4	V40 - 20XT
16	22.00	50.00	-0.0330	-0.0109	4	V40 - 20XT
17	24.00	50.00	-0.0437	-0.0216	4	V40 - 20XT
18	26.00	50.00	-0.0553	-0.0327	4	V40 - 20XT
19	28.00	50.00	-0.0679	-0.0445	4	V40 - 20XT
20	30.00	50.00	-0.0819	-0.0571	4	V40 - 20XT
21	32.00	50.00	-0.0977	-0.0709	4	V40 - 20XT
22	34.00	50.00	-0.1160	-0.0866	4	V40 - 20XT
23	34.67	50.00	-0.1229	-0.0924	4	V40 - 20XT
24	38.67	25.00	0.0609	0.1448	4	V40 - 20XT
25	40.00	25.00	0.0513	0.1247	4	V40 - 20XT
26	42.00	25.00	0.0370	0.0961	4	V40 - 20XT
27	44.00	25.00	0.0228	0.0691	4	V40 - 20XT
28	46.00	25.00	0.0085	0.0436	4	V40 - 20XT
29	48.00	25.00	-0.0060	0.0194	3	V40 - 10XT
30	50.00	25.00	-0.0211	-0.0039	3	V40 - 10XT
31	52.00	25.00	-0.0374	-0.0268	3	V40 - 10XT
32	54.00	25.00	-0.0559	-0.0502	3	V40 - 10XT
33	56.00	25.00	-0.0783	-0.0759	3	V40 - 10XT
34	58.00	25.00	-0.1078	-0.1073	3	V40 - 10XT

RESULTS for STRENGTH

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Tavailable [lb/ft]	Tmax [lb/ft]	Tmd [lb/ft]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.67	6146	2701.40	1140.37	N/A	2.275	N/A	1.816	V40 - 20XT
2	2.00	6146	2625.94	1123.43	N/A	2.341	N/A	1.863	V40 - 20XT
3	3.33	6146	2570.23	1106.49	N/A	2.391	N/A	1.901	V40 - 20XT
4	4.67	6146	2504.51	1089.43	N/A	2.454	N/A	1.947	V40 - 20XT
5	6.00	6146	2429.79	1072.49	N/A	2.530	N/A	2.001	V40 - 20XT
6	7.33	6146	2373.33	1055.55	N/A	2.590	N/A	2.045	V40 - 20XT
7	8.67	6146	2307.62	1038.48	N/A	2.664	N/A	2.098	V40 - 20XT
8	10.00	6146	2233.64	1021.54	N/A	2.752	N/A	2.160	V40 - 20XT
9	11.33	6146	2176.44	1004.60	N/A	2.824	N/A	2.213	V40 - 20XT
10	12.67	6146	2110.73	987.53	N/A	2.912	N/A	2.275	V40 - 20XT
11	14.00	6146	2037.48	970.59	N/A	3.017	N/A	2.347	V40 - 20XT
12	15.33	6146	1979.55	953.65	N/A	3.105	N/A	2.410	V40 - 20XT
13	16.67	6146	1913.84	936.58	N/A	3.212	N/A	2.484	V40 - 20XT
14	18.00	6146	2294.84	919.64	N/A	2.678	N/A	2.160	V40 - 20XT
15	20.00	6146	2621.43	894.17	N/A	2.345	N/A	1.947	V40 - 20XT
16	22.00	6146	2473.95	868.69	N/A	2.484	N/A	2.053	V40 - 20XT
17	24.00	6146	2326.46	843.22	N/A	2.642	N/A	2.171	V40 - 20XT
18	26.00	6146	2178.98	817.75	N/A	2.821	N/A	2.303	V40 - 20XT
19	28.00	6146	2031.49	792.27	N/A	3.026	N/A	2.453	V40 - 20XT
20	30.00	6146	1236.97	766.80	N/A	4.969	N/A	3.624	V40 - 20XT
21	32.00	6146	442.45	741.32	N/A	13.892	N/A	6.934	V40 - 20XT
22	34.00	6146	213.26	715.85	N/A	28.822	N/A	9.575	V40 - 20XT
23	34.67	6146	2426.10	707.32	N/A	2.533	N/A	2.157	V40 - 20XT
24	38.67	6146	1554.24	565.92	N/A	3.955	N/A	3.247	V40 - 20XT
25	40.00	6146	1846.31	548.98	N/A	3.329	N/A	2.826	V40 - 20XT
26	42.00	6146	2082.65	523.51	N/A	2.951	N/A	2.565	V40 - 20XT
27	44.00	6146	1935.17	498.03	N/A	3.176	N/A	2.752	V40 - 20XT
28	46.00	6146	1787.68	472.56	N/A	3.438	N/A	2.968	V40 - 20XT
29	48.00	4107	1640.20	447.08	N/A	2.504	N/A	2.153	V40 - 10XT
30	50.00	4107	1492.71	421.61	N/A	2.752	N/A	2.354	V40 - 10XT
31	52.00	4107	1345.23	396.14	N/A	3.053	N/A	2.596	V40 - 10XT
32	54.00	4107	1197.75	370.66	N/A	3.429	N/A	2.893	V40 - 10XT
33	56.00	4107	1050.26	345.19	N/A	3.911	N/A	3.268	V40 - 10XT
34	58.00	4107	1298.86	319.71	N/A	3.162	N/A	2.756	V40 - 10XT

RESULTS for PULLOUT

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Coverage Ratio	Tmax [lb/ft]	Tmd [lb/ft]	Le [ft]	La [ft]	Avail.Static Pullout, Pr [lb/ft]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [lb/ft]	Specified Seismic Fs	Actual Seismic Fs
1	0.67	1.000	2701.4	1140.4	49.63	0.37	328346.9	N/A	121.547	262677.5	N/A	68.374
2	2.00	1.000	2625.9	1123.4	48.89	1.11	316649.9	N/A	120.585	253319.9	N/A	67.563
3	3.33	1.000	2570.2	1106.5	48.15	1.85	305162.0	N/A	118.730	244129.6	N/A	66.399
4	4.67	1.000	2504.5	1089.4	47.41	2.59	293705.9	N/A	117.271	234964.7	N/A	65.378
5	6.00	1.000	2429.8	1072.5	46.67	3.33	282640.3	N/A	116.323	226112.2	N/A	64.562
6	7.33	1.000	2373.3	1055.5	45.94	4.06	271660.9	N/A	114.464	217328.7	N/A	63.382
7	8.67	1.000	2307.6	1038.5	45.19	4.81	260976.6	N/A	113.093	208781.3	N/A	62.395
8	10.00	1.000	2233.6	1021.5	44.46	5.54	250545.0	N/A	112.169	200436.0	N/A	61.575
9	11.33	1.000	2176.4	1004.6	43.72	6.28	240204.3	N/A	110.365	192163.4	N/A	60.409
10	12.67	1.000	2110.7	987.5	42.98	7.02	230156.7	N/A	109.041	184125.3	N/A	59.429
11	14.00	1.000	2037.5	970.6	42.24	7.76	220247.2	N/A	108.098	176197.7	N/A	58.575
12	15.33	1.000	1979.6	953.7	41.50	8.50	210662.3	N/A	106.419	168529.8	N/A	57.456
13	16.67	1.000	1913.8	936.6	40.76	9.24	201140.7	N/A	105.098	160912.5	N/A	56.452
14	18.00	1.000	2294.8	919.6	40.02	9.98	191979.7	N/A	83.657	153583.8	N/A	47.779
15	20.00	1.000	2621.4	894.2	38.91	11.09	178562.5	N/A	68.116	142850.0	N/A	40.633
16	22.00	1.000	2473.9	868.7	37.81	12.19	165625.0	N/A	66.948	132500.0	N/A	39.639
17	24.00	1.000	2326.5	843.2	36.70	13.30	153165.0	N/A	65.836	122532.0	N/A	38.657
18	26.00	1.000	2179.0	817.7	35.59	14.41	141182.2	N/A	64.793	112945.8	N/A	37.690
19	28.00	1.000	2031.5	792.3	34.48	15.52	129592.4	N/A	63.792	103673.9	N/A	36.715
20	30.00	1.000	1237.0	766.8	33.37	16.63	118568.4	N/A	95.854	94854.7	N/A	47.338
21	32.00	1.000	442.4	741.3	32.26	17.74	108021.8	N/A	244.145	86417.5	N/A	73.002
22	34.00	1.000	213.3	715.9	31.15	18.85	97954.3	N/A	459.327	78363.4	N/A	84.343
23	34.67	1.000	2426.1	707.3	30.78	19.22	94673.3	N/A	39.023	75738.7	N/A	24.171
24	38.67	1.000	1554.2	565.9	24.63	0.37	56700.9	N/A	36.481	45360.7	N/A	21.395
25	40.00	1.000	1846.3	549.0	23.89	1.11	51586.2	N/A	27.940	41269.0	N/A	17.229
26	42.00	1.000	2082.7	523.5	22.78	2.22	44277.5	N/A	21.260	35422.0	N/A	13.592
27	44.00	1.000	1935.2	498.0	21.67	3.33	37414.2	N/A	19.334	29931.3	N/A	12.301
28	46.00	1.000	1787.7	472.6	20.57	4.43	31065.1	N/A	17.377	24852.1	N/A	10.995
29	48.00	1.000	1640.2	447.1	19.46	5.54	25193.8	N/A	15.360	20155.1	N/A	9.656
30	50.00	1.000	1492.7	421.6	18.35	6.65	19800.4	N/A	13.265	15840.3	N/A	8.275
31	52.00	1.000	1345.2	396.1	17.24	7.76	14884.7	N/A	11.065	11907.7	N/A	6.838
32	54.00	1.000	1197.7	370.7	16.13	8.87	10446.8	N/A	8.722	8357.4	N/A	5.329
33	56.00	1.000	1050.3	345.2	15.02	9.98	6486.7	N/A	6.176	5189.4	N/A	3.719
34	58.00	1.000	1298.9	319.7	13.91	11.09	3004.5	N/A	2.313	2403.6	N/A	1.485

RESULTS for CONNECTION (static conditions)
Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Connection force, To [lb/ft]	Reduction factor for connection (short-term strength) CRult	Reduction factor for connection (long-term strength) CRcr	Available connection strength [lb/ft]	Available Geogrid strength, Tavailable [lb/ft]	Fs-overall connection strength Specified	Fs-overall connection strength Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.67	2701	0.63	0.63	7113	6146	N/A	2.63	N/A	2.28	V40 - 20XT
2	2.00	2626	0.63	0.63	7113	6146	N/A	2.71	N/A	2.34	V40 - 20XT
3	3.33	2570	0.63	0.63	7113	6146	N/A	2.77	N/A	2.39	V40 - 20XT
4	4.67	2505	0.63	0.63	7113	6146	N/A	2.84	N/A	2.45	V40 - 20XT
5	6.00	2430	0.63	0.63	7113	6146	N/A	2.93	N/A	2.53	V40 - 20XT
6	7.33	2373	0.63	0.63	7113	6146	N/A	3.00	N/A	2.59	V40 - 20XT
7	8.67	2308	0.63	0.63	7113	6146	N/A	3.08	N/A	2.66	V40 - 20XT
8	10.00	2234	0.63	0.63	7113	6146	N/A	3.18	N/A	2.75	V40 - 20XT
9	11.33	2176	0.63	0.63	7113	6146	N/A	3.27	N/A	2.82	V40 - 20XT
10	12.67	2111	0.63	0.63	7113	6146	N/A	3.37	N/A	2.91	V40 - 20XT
11	14.00	2037	0.63	0.63	7113	6146	N/A	3.49	N/A	3.02	V40 - 20XT
12	15.33	1980	0.63	0.63	7113	6146	N/A	3.59	N/A	3.10	V40 - 20XT
13	16.67	1914	0.63	0.63	7113	6146	N/A	3.72	N/A	3.21	V40 - 20XT
14	18.00	2295	0.63	0.63	7113	6146	N/A	3.10	N/A	2.68	V40 - 20XT
15	20.00	2621	0.62	0.62	7041	6146	N/A	2.69	N/A	2.34	V40 - 20XT
16	22.00	2474	0.59	0.59	6641	6146	N/A	2.68	N/A	2.48	V40 - 20XT
17	24.00	2326	0.55	0.55	6241	6146	N/A	2.68	N/A	2.64	V40 - 20XT
18	26.00	2179	0.52	0.52	5840	6146	N/A	2.68	N/A	2.82	V40 - 20XT
19	28.00	2031	0.48	0.48	5440	6146	N/A	2.68	N/A	3.03	V40 - 20XT
20	30.00	1237	0.45	0.45	5040	6146	N/A	4.07	N/A	4.97	V40 - 20XT
21	32.00	442	0.41	0.41	4640	6146	N/A	10.49	N/A	13.89	V40 - 20XT
22	34.00	213	0.38	0.38	4239	6146	N/A	19.88	N/A	28.82	V40 - 20XT
23	34.67	2426	0.36	0.36	4105	6146	N/A	1.69	N/A	2.53	V40 - 20XT
24	38.67	1554	0.63	0.63	7113	6146	N/A	4.58	N/A	3.95	V40 - 20XT
25	40.00	1846	0.63	0.63	7113	6146	N/A	3.85	N/A	3.33	V40 - 20XT
26	42.00	2083	0.63	0.63	7113	6146	N/A	3.42	N/A	2.95	V40 - 20XT
27	44.00	1935	0.62	0.62	7041	6146	N/A	3.64	N/A	3.18	V40 - 20XT
28	46.00	1788	0.59	0.59	6641	6146	N/A	3.71	N/A	3.44	V40 - 20XT
29	48.00	1640	0.61	0.61	4606	4107	N/A	2.81	N/A	2.50	V40 - 10XT
30	50.00	1493	0.55	0.55	4152	4107	N/A	2.78	N/A	2.75	V40 - 10XT
31	52.00	1345	0.49	0.49	3699	4107	N/A	2.75	N/A	3.05	V40 - 10XT
32	54.00	1198	0.43	0.43	3246	4107	N/A	2.71	N/A	3.43	V40 - 10XT
33	56.00	1050	0.37	0.37	2793	4107	N/A	2.66	N/A	3.91	V40 - 10XT
34	58.00	1299	0.31	0.31	2340	4107	N/A	1.80	N/A	3.16	V40 - 10XT

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [ft]	Connection force, To [lb/ft]	Reduction factor for connection (short-term strength) CRult	Reduction factor for connection (long-term strength) CRcr	Available connection strength [lb/ft]	Available Geogrid strength, Tavailable [lb/ft]	Fs-overall connection strength Specified	Fs-overall connection strength Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.67	3842	0.63	0.63	7113	6146	N/A	1.85	N/A	1.82	V40 - 20XT
2	2.00	3749	0.63	0.63	7113	6146	N/A	1.90	N/A	1.86	V40 - 20XT
3	3.33	3677	0.63	0.63	7113	6146	N/A	1.93	N/A	1.90	V40 - 20XT
4	4.67	3594	0.63	0.63	7113	6146	N/A	1.98	N/A	1.95	V40 - 20XT
5	6.00	3502	0.63	0.63	7113	6146	N/A	2.03	N/A	2.00	V40 - 20XT
6	7.33	3429	0.63	0.63	7113	6146	N/A	2.07	N/A	2.05	V40 - 20XT
7	8.67	3346	0.63	0.63	7113	6146	N/A	2.13	N/A	2.10	V40 - 20XT
8	10.00	3255	0.63	0.63	7113	6146	N/A	2.19	N/A	2.16	V40 - 20XT
9	11.33	3181	0.63	0.63	7113	6146	N/A	2.24	N/A	2.21	V40 - 20XT
10	12.67	3098	0.63	0.63	7113	6146	N/A	2.30	N/A	2.27	V40 - 20XT
11	14.00	3008	0.63	0.63	7113	6146	N/A	2.36	N/A	2.35	V40 - 20XT
12	15.33	2933	0.63	0.63	7113	6146	N/A	2.43	N/A	2.41	V40 - 20XT
13	16.67	2850	0.63	0.63	7113	6146	N/A	2.50	N/A	2.48	V40 - 20XT
14	18.00	3214	0.63	0.63	7113	6146	N/A	2.21	N/A	2.16	V40 - 20XT
15	20.00	3516	0.62	0.62	7041	6146	N/A	2.00	N/A	1.95	V40 - 20XT
16	22.00	3343	0.59	0.59	6641	6146	N/A	1.99	N/A	2.05	V40 - 20XT
17	24.00	3170	0.55	0.55	6241	6146	N/A	1.97	N/A	2.17	V40 - 20XT
18	26.00	2997	0.52	0.52	5840	6146	N/A	1.95	N/A	2.30	V40 - 20XT
19	28.00	2824	0.48	0.48	5440	6146	N/A	1.93	N/A	2.45	V40 - 20XT
20	30.00	2004	0.45	0.45	5040	6146	N/A	2.52	N/A	3.62	V40 - 20XT
21	32.00	1184	0.41	0.41	4640	6146	N/A	3.92	N/A	6.93	V40 - 20XT
22	34.00	929	0.38	0.38	4239	6146	N/A	4.56	N/A	9.58	V40 - 20XT
23	34.67	3133	0.36	0.36	4105	6146	N/A	1.31	N/A	2.16	V40 - 20XT
24	38.67	2120	0.63	0.63	7113	6146	N/A	3.36	N/A	3.25	V40 - 20XT
25	40.00	2395	0.63	0.63	7113	6146	N/A	2.97	N/A	2.83	V40 - 20XT
26	42.00	2606	0.63	0.63	7113	6146	N/A	2.73	N/A	2.57	V40 - 20XT
27	44.00	2433	0.62	0.62	7041	6146	N/A	2.89	N/A	2.75	V40 - 20XT
28	46.00	2260	0.59	0.59	6641	6146	N/A	2.94	N/A	2.97	V40 - 20XT
29	48.00	2087	0.61	0.61	4606	4107	N/A	2.21	N/A	2.15	V40 - 10XT
30	50.00	1914	0.55	0.55	4152	4107	N/A	2.17	N/A	2.35	V40 - 10XT
31	52.00	1741	0.49	0.49	3699	4107	N/A	2.12	N/A	2.60	V40 - 10XT
32	54.00	1568	0.43	0.43	3246	4107	N/A	2.07	N/A	2.89	V40 - 10XT
33	56.00	1395	0.37	0.37	2793	4107	N/A	2.00	N/A	3.27	V40 - 10XT
34	58.00	1619	0.31	0.31	2340	4107	N/A	1.45	N/A	2.76	V40 - 10XT

GLOBAL/COMPOUND STABILITY ANALYSIS (Using Bishop method and ROR = 0.0)

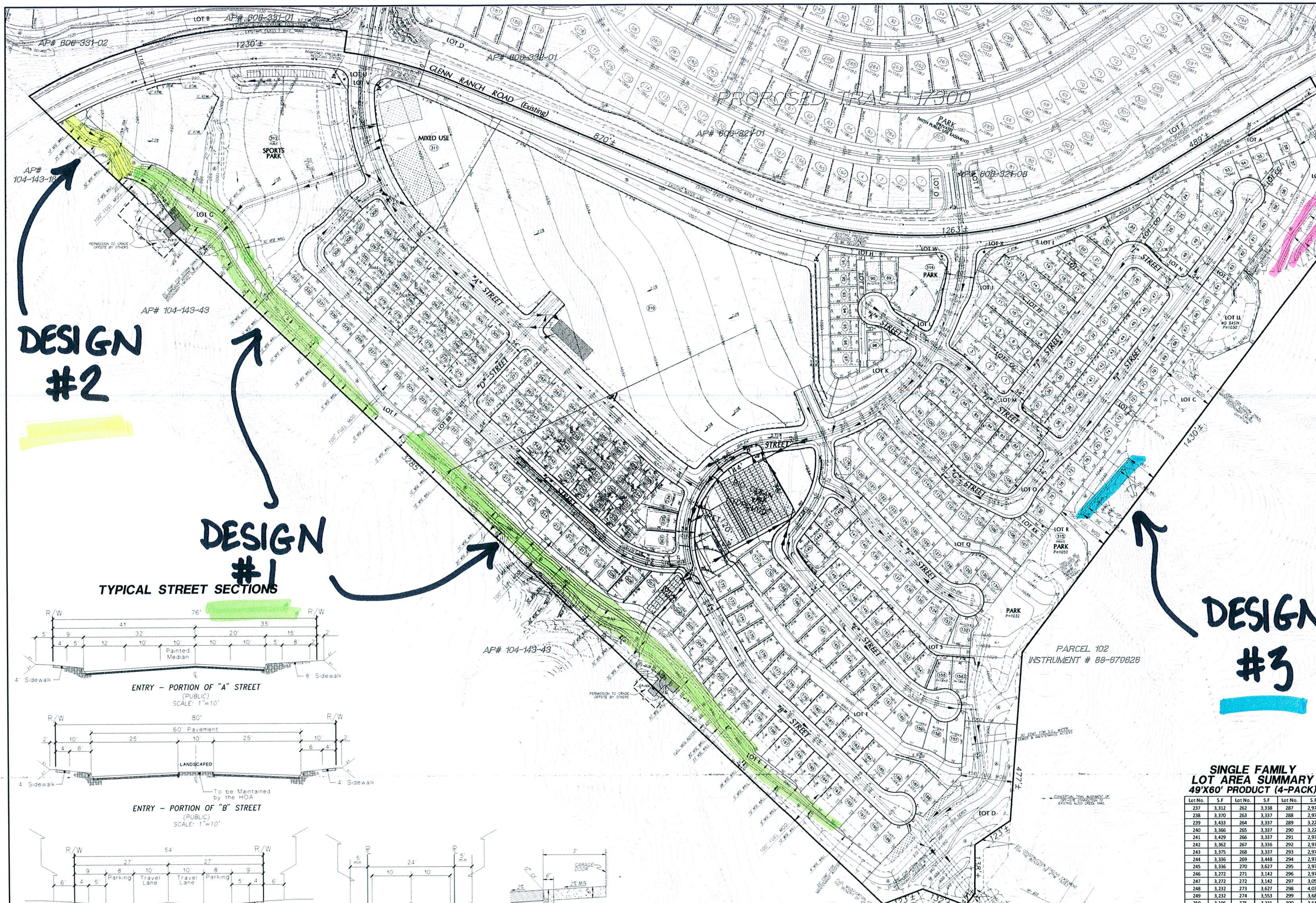
A horizontal seismic coefficient, Kh=half of 'A', equal to 0.180 has been applied.
The seismic force is applied at the center of the sliding mass.

STATIC CONDITIONS:
For the specified search grid, the calculated minimum Fs is 1.538
(it corresponds to a critical circle at Xc = -8.00, Yc = 224.00 and R = 170.29 [ft] where (x=0, y=0) is taken at the TOE or Xc = 92.00, Yc = 1224.00 and R = 170.29 [ft] when the terrain coordinate system is used as shown in the table below.)

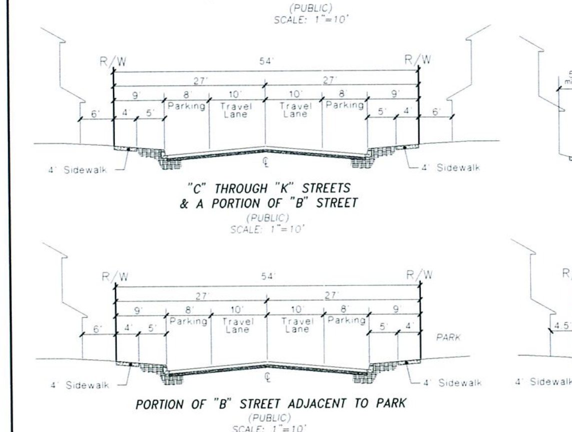
SEISMIC CONDITIONS:
For the specified search grid, the calculated minimum Fs is 0.991
(it corresponds to a critical circle at Xc = -8.00, Yc = 224.00 and R = 170.29 [ft] where (x=0, y=0) is taken at the TOE or Xc = 92.00, Yc = 1224.00 and R = 170.29 [ft] when the terrain coordinate system is used as shown in the table below.)

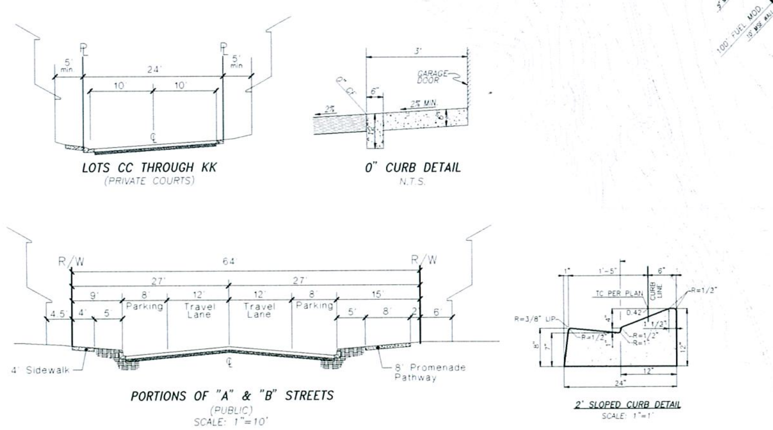
TERRAIN/WATER PROFILE

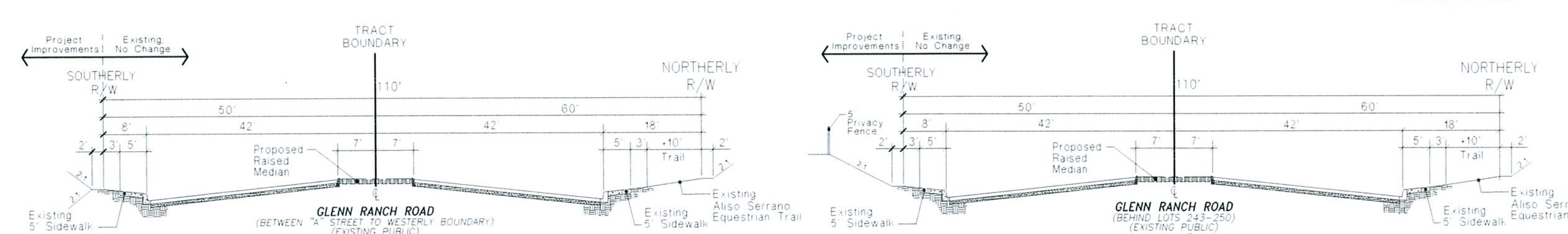
Point	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
Soil layer #1:	γ = 120.00 [lb/ft ³]			ϕ = 28.0°		c = 500.00 [lb/ft ²]					
x [ft]	0.0	15.0	20.0	50.0	180.0	205.0	250.0	300.0	350.0	400.0	500.0
y [ft]	1006.0	1006.0	1006.0	1006.0	1000.0	1090.0	1090.0	1090.0	1090.0	1090.0	1095.0

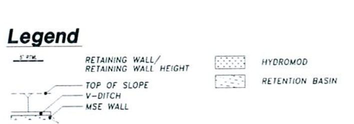


TYPICAL STREET SECTIONS









SLOPE DESIGNATIONS

(A) MAINTAINED BY PUBLIC AGENCY OR HOME OWNERS ASSOCIATION
(B) MAINTAINED BY HOME OWNERS ASSOCIATION
(C) MAINTAINED BY PRIVATE OWNERS

SINGLE FAMILY LOT AREA SUMMARY 50'X68' PRODUCT

Lot No.	S.F	Lot No.	S.F	Lot No.	S.F
1	3,640	27	3,533	53	5,290
2	4,571	28	3,822	54	3,936
3	5,020	29	3,403	55	4,304
4	4,600	30	3,400	56	5,456
5	3,400	31	3,400	57	5,896
6	3,400	32	3,400	58	4,173
7	3,400	33	3,400	59	4,308
8	3,600	34	3,400	60	3,720
9	3,600	35	3,400	61	3,438
10	3,600	36	3,400	62	3,400
11	3,600	37	3,400	63	3,400
12	4,221	38	4,855	64	3,400
13	3,400	39	4,113	65	3,400
14	3,400	40	4,064	66	3,400
15	3,400	41	4,366	67	3,400
16	3,400	42	3,612	68	3,400
17	3,600	43	3,914	69	3,400
18	3,600	44	3,864	70	3,400
19	6,580	45	3,814	71	3,400
20	4,757	46	3,764	72	3,400
21	3,787	47	4,226	73	3,400
22	4,718	48	4,000	74	3,400
23	6,719	49	4,000	75	3,405
24	6,555	50	3,992	76	3,578
25	3,538	51	5,033	77	4,021
26	3,543	52	5,884		

TOTAL GROSS 304,835 S.F.
6.99 Acres
AVERAGE GROSS 3,959 S.F.

SINGLE FAMILY LOT AREA SUMMARY 45'X80' PRODUCT

Lot No.	S.F	Lot No.	S.F	Lot No.	S.F
78	4,055	105	4,716	132	5,055
79	4,136	106	4,132	133	5,543
80	4,096	107	4,695	134	4,898
81	3,622	108	4,210	135	4,120
82	3,630	109	4,922	136	4,039
83	3,645	110	4,814	137	3,915
84	3,959	111	4,334	138	3,867
85	3,809	112	4,227	139	3,889
86	3,634	113	3,642	140	3,922
87	3,770	114	3,678	141	4,168
88	3,830	115	3,714	142	4,462
89	5,541	116	3,749	143	3,860
90	4,639	117	3,737	144	4,499
91	4,472	118	4,868	145	4,321
92	3,600	119	6,829	146	3,769
93	3,671	120	4,129	147	3,769
94	3,695	121	3,948	148	3,770
95	3,640	122	3,956	149	4,274
96	3,600	123	4,012	150	4,287
97	5,555	124	3,976	151	4,301
98	4,036	125	3,882	152	4,315
99	4,839	126	3,788	153	4,329
100	4,684	127	3,699	154	5,609
101	4,576	128	4,134	155	5,808
102	4,787	129	5,391	156	5,139
103	4,799	130	3,835		
104	4,914	131	4,310		

TOTAL GROSS 338,491 S.F.
7.77 Acres
AVERAGE GROSS 4,285 S.F.

SINGLE FAMILY LOT AREA SUMMARY 49'X60' PRODUCT (4-PACK)

Lot No.	S.F	Lot No.	S.F	Lot No.	S.F
237	3,312	262	3,338	287	2,975
238	3,370	263	3,337	288	2,975
239	3,433	264	3,337	289	3,222
240	3,366	265	3,337	290	3,222
241	3,429	266	3,337	291	2,975
242	3,362	267	3,336	292	2,975
243	3,375	268	3,337	293	2,975
244	3,336	269	3,448	294	2,975
245	3,336	270	3,627	295	2,975
246	3,272	271	3,142	296	2,975
247	3,272	272	3,142	297	3,059
248	3,232	273	3,627	298	4,039
249	3,232	274	3,553	299	3,682
250	3,106	275	3,331	300	3,641
251	3,106	276	3,331	301	3,641
252	2,975	277	3,331	302	3,641
253	2,975	278	3,331	303	3,640
254	2,975	279	3,331	304	3,640
255	2,975	280	3,331	305	3,888
256	2,975	281	3,527	306	4,302
257	2,975	282	3,110	307	3,347
258	2,975	283	2,975	308	3,347
259	2,975	284	2,975	309	3,992
260	2,975	285	2,975		
261	2,975	286	2,975		

TOTAL GROSS 239,815 S.F.
5.50 Acres
AVERAGE GROSS 3,285 S.F.

PARK SUMMARY

Lot No.	Gross	Net
312	6.3	5.0
313	1.8	1.6
314	0.5	0.5
315	2.1	1.6

SINGLE FAMILY LOT AREA SUMMARY 50'X85' PRODUCT

Lot No.	S.F	Lot No.	S.F	Lot No.	S.F
157	6,523	184	4,299	211	4,563
158	5,567	185	4,511	212	4,736
159	6,091	186	5,471	213	4,879
160	5,629	187	4,618	214	4,927
161	5,291	188	5,598	215	4,921
162	5,135	189	6,706	216	4,616
163	5,317	190	5,603	217	4,617
164	5,500	191	5,709	218	4,673
165	5,719	192	5,765	219	4,732
166	6,016	193	5,850	220	4,790
167	6,019	194	5,733	221	4,848
168	5,449	195	5,368	222	5,080
169	4,994	196	5,441	223	5,235
170	5,031	197	5,677	224	5,424
171	5,160	198	6,135	225	5,328
172	5,212	199	5,714	226	4,955
173	4,792	200	5,459	227	4,593
174	4,836	201	5,020	228	4,432
175	5,104	202	5,336	229	4,444
176	6,111	203	5,326	230	4,480
177	4,929	204	5,306	231	4,522
178	4,831	205	5,417	232	4,636
179	4,704	206	5,361	233	5,133
180	4,343	207	6,473	234	6,881
181	4,344	208	6,445	235	7,127
182	4,345	209	5,901	236	7,365
183	4,346	210	4,710		

TOTAL GROSS 422,223 S.F.
9.69 Acres
AVERAGE GROSS 5,278 S.F.

NOTES

1. EXISTING LAND USE: VACANT.
2. PROPOSED LAND USE: RESIDENTIAL, MIXED USE AND PARK.
3. EXISTING ZONING: CITY OF LAKE FOREST – PORTOLA HILLS PLANNED COMMUNITY SINGLE FAMILY, MULTIFAMILY, MIXED USE, PARK, & OPEN SPACE.
4. PROPOSED ZONING: CITY OF LAKE FOREST – PORTOLA HILLS PLANNED COMMUNITY SINGLE FAMILY, MULTIFAMILY, MIXED USE, PARK, & OPEN SPACE.
5. WATER SERVICE PROVIDED BY: IRVINE RANCH WATER DISTRICT.
6. SANITARY SEWER SERVICE PROVIDED BY: IRVINE RANCH WATER DISTRICT.
7. ELECTRIC SERVICE PROVIDED BY: SOUTHERN CALIFORNIA EDISON COMPANY.
8. GAS SERVICE PROVIDED BY: SOUTHERN CALIFORNIA GAS COMPANY.
9. TELEPHONE SERVICE PROVIDED BY: PACIFIC BELL.
10. CABLE SERVICE PROVIDED BY: COX TELECOMMUNICATION.
11. SOLID WASTE MANAGEMENT IS UNDER THE JURISDICTION OF: COUNTY ENVIRONMENTAL MANAGEMENT AGENCY WASTE MANAGEMENT DEPARTMENT.
12. PROJECT IS LOCATED WITHIN THE JURISDICTION OF THE SADDLEBACK VALLEY UNIFIED SCHOOL DISTRICT.
13. NO BUILDINGS EXIST ON THIS SITE.
14. ALL PROPOSED UTILITIES TO BE UNDERGROUND.
15. DRAINAGE FACILITIES TO BE DESIGNED IN ACCORDANCE WITH THE MASTER PLAN OF DRAINAGE, AND COUNTY OF ORANGE GRADING AND EXCAVATION CODE.
16. ALL GRADING, SLOPE TERRACE DRAINS AND DOWN DRAINS SHALL CONFORM TO THE COUNTY OF ORANGE GRADING AND EXCAVATION CODE.
17. ALL SLOPES SHALL BE [illegible] UNLESS OTHERWISE NOTED.
18. THE LOCAL PARK CODE REQUIREMENT FOR THIS PROJECT IS 5.0 AC. (626 UNITS x .008) AND SHALL BE SATISFIED BY A COMBINATION OF PARK LAND AND IMPROVEMENTS ON SITE. THE ADJOINING TRACT (17300) WILL BE ALLOWED TO JOINTLY UTILIZE THE SURPLUS PARK CREDIT TO MEET ITS OWN PARK REQUIREMENT.
19. WE RESERVE THE RIGHT TO FILE MULTIPLE FINAL MAPS ON SUBJECT TENTATIVE [illegible]
20. ALL SLOPES WITHIN LETTERED LOTS TO BE MAINTAINED BY THE HOME OWNERS ASSOCIATION.
21. AP# 606-351-01, & 606-341-(01,03,04,05,07)
22. THE PROJECT C.C & R.'S SHALL INCLUDE PROVISIONS FOR PARKING RESTRICTION OF COMMERCIAL VEHICLES AND PERMITTING ENCROACHMENT FOR LANDSCAPE MAINTENANCE VEHICLES PER MUNICIPAL CODE, SECTION 12.12.020-PERMIT.
23. PER FIRM MAPS 06059C0317H AND 06059C0336H, THE PROJECT GRADING DOES NOT RESIDE WITHIN FLOOD HAZARD ZONE LIMITS.
24. MAINTENANCE OF THE UNDERGROUND DETENTION BASIN SHALL BE BY THE HOME OWNERS ASSOCIATION.
25. EARTHWORK – CUT = 2,267,000 CYS, FILL = 2,267,000 CYS

LOT SUMMARY

Lot No.	Land Use	Number of Units	Maintenance Responsibility	Acres
1-309	SINGLE FAMILY RESIDENTIAL	309	HOMEOWNER	29.9
310	MULTI-FAMILY (TOWNHOMES)	260	M.F. HOA	14.1
311	COMMERCIAL/MIXED USE	57	M.F. HOA	2.0
312	PARK SITE (PUBLIC)		CITY	6.3
313	PARK SITE (PUBLIC)		CITY	1.8
314	PARK SITE (PUBLIC)		CITY	0.5
315	PARK SITE (PUBLIC)		CITY	2.1
A-X	OPEN SPACE		HOA	17.5
Y-BB	PUBLIC UTILITY EASEMENTS/FIRE ACCESS & COMMON ACCESS		HOA	0.3
CC-KK	PRIVATE COURTS		HOA	0.6
	PUBLIC INTERIOR STREETS		CITY	14.1
LL	DETENTION BASIN		HOA	0.6
	EXISTING GLENN RANCH ROAD		CITY	5.7
	TOTALS	626		95.5

LEGAL DESCRIPTION

IN THE CITY OF LAKE FOREST, COUNTY OF ORANGE, STATE OF CALIFORNIA, BEING A PORTION OF GLENN RANCH ROAD OF TRACT NO. 13524 AS SHOWN ON A MAP FILED IN BOOK 639, PAGES 11 THROUGH 15, INCLUSIVE, AND A PORTION OF LOT 9 OF TRACT NO. 13849, AS SHOWN ON A MAP FILED IN BOOK 639, PAGES 16 THROUGH 22, INCLUSIVE, BOTH OF MISCELLANEOUS MAPS, IN THE OFFICE OF THE COUNTY RECORDER OF SAID COUNTY. TOGETHER WITH A PORTION OF PARCEL 1 OF LOT LINE ADJUSTMENT NO. LLA 2010-01, RECORDED SEPTEMBER 16, 2010, AS INSTRUMENT NO. 2010000460178, AND ALL OF PARCEL 2 OF LOT LINE ADJUSTMENT NO. LLA 2008-01, RECORDED JULY 28, 2008, AS INSTRUMENT NO. 2008000358439, BOTH OF OFFICIAL RECORDS, IN THE OFFICE OF THE COUNTY RECORDER OF SAID COUNTY.

STATEMENT OF OWNERSHIP

WE, SUNRANCH CAPITAL PARTNERS LLC, DO HEREBY STATE THAT WE ARE OWNERS OF THE PROPERTY COMPRISING THIS TENTATIVE TRACT MAP, AND WE HAVE CONSENTED TO THE SUBMISSION OF SAID MAP.

DATE

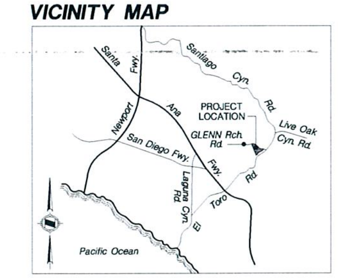
I HEREBY STATE THAT THIS MAP WAS PREPARED UNDER MY SUPERVISION AND THAT THE OWNER OF RECORD HAS KNOWLEDGE OF AND CONSENTS TO THE FILING OF THIS MAP.

DATE

EDWARD A. MANDICH

REGISTERED PROFESSIONAL ENGINEER EDWARD A MANDICH No. 59089 CIVIL STATE OF CALIFORNIA

VICINITY MAP



DATE	REVISION	BY
-	-	-

MAP DATE IDENTIFIER
DATE OF LATEST CHANGE TO THIS MAP: 5/11/12 BY: JAM
DATE OF THIS PLOT: 05/29/12

DATE 5/11/2012
W.O. 3751-1
GROSS AREA 95.5 AC.±
CONTOUR INTERVAL 2'
TOTAL LOTS 315 NUMBERED
38 LETTERED

FEET 0 50 100 200
INCHES 0 1/2 1 2

PREPARED FOR:

SUNRANCH CAPITAL PARTNERS LLC
280 NEWPORT CENTER DRIVE
SUITE 240
NEWPORT BEACH, CA 92660

PREPARED BY:

H&A
HUNSAKER & ASSOCIATES IRVINE, INC.
PLANNING • ENGINEERING • SURVEYING
Three Hughes • Irvine, CA 92618
FX: (949) 583-0759 • PH: (949) 583-1010

TENTATIVE TRACT MAP NO. 15353

SHEET 1 OF 2

WO: 3751-1 TTM 15353 PORTOLA CENTER BIN: 152B RM: 269 DOC.: 67468

F:\0334\Planning\0A_Project\TTM\334P-TT15353.dwg

RECEIVED

JAN 1 0 2012

City of Lake Forest
Planning

Memorandum

To: Ron Santos, Senior Planner

Cc: Dennis Jue, Deputy City Engineer

Prepared Under Direction of: Tim D'Zmura, Interwest Consulting Group

From: Steven Palmer, Interwest Consulting Group
Roger Peterson, Interwest Consulting Group

Date: December 16, 2011

Subject: **Portola Center Segmental Retaining Walls for the North and South Parcels – Preliminary Structural Plan Review**

Interwest Consulting Group has performed a preliminary review of the above referenced Portola Center Segmental Retaining Walls at the north and south parcels and our comments are noted below:

S1. Please provide a current ICC ES report that is in conformance with the 2009 IBC. Please note that ER-5515 is in compliance with the 1997 Uniform Building Code.

S2. Please submit a letter from the geotechnical engineer confirming that the design and detailing of the segmental retaining walls have been reviewed and that it has been determined that the recommendations in the Geotechnical Report have been properly incorporated into the calculations and drawings.

S3. Specify on plans that the geotechnical engineer shall be retained to provide observation and testing services during the grading and construction phase of retaining walls per the recommendations of the geotechnical report and that inspection and testing reports shall be submitted to the Building Department.

S4. Please provide a plan to clarify the locations of the various segmental retaining walls shown on the drawings prepared by Soil Retention Designs Inc.

S5. Section 9.13.13 of the Geotechnical Report recommends that a soldier pile wall should be used at the location adjacent to Glenn Ranch Road on the northeast side of the site, from Saddleback Road to Alley B-B', rather than the proposed segmental retaining wall. Please provide calculations and details for this soldier pile wall if used.

S6. Section 9.2.3 and Appendix B of the Geotechnical Report show that the on site materials possess a severe sulfate exposure to concrete structures. Please verify that the Verdura segmental concrete blocks will be acceptable for use in soil with severe sulfate exposure. Please note per ACI Section 4.3 that concrete used in severe sulfate exposure is to be made with type V cement, have a maximum water / cement ratio of 0.45 and have a minimum compressive strength of 4500 psi.

S6. Section 9.13.12 of the Geotechnical Report specifies that MSE walls in excess of 60' high should be constructed using metallic reinforcement in the reinforced zone to prevent significant deformations that would be expected in similar height walls reinforced with geosynthetic reinforcement. Please verify if metallic reinforcement should be used at walls over 60' in height.

S7. On sheet 1, (at both sets of drawings), please reference the Geotechnical Report prepared by Geocon Inc.

S8. Please verify if a surcharge at the top of the retaining walls due to future structures or roads should be included in the design of the retaining walls.

S9. At sheet 1, (at both sets of drawings), please amend Table 3 to correspond with the Geotechnical Report and the values used in the design of the walls.

S10. Please clarify how the seismic coefficient was determined. Please justify using 0.5 x 0.63g for the seismic coefficient.

S11. Please provide calculations for the vertical and horizontal deformations of the MSE walls as required per section 9.13.10 of the Geotechnical Report.

S12. Please provide calculations for the 76' tall wall, the 116' tall wall and the 90' tall wall shown on sheets 2/5, 3/5 and 4/5 respectively for the North Parcel.

S13. Please provide drawings and calculation that bear the wet stamp and signature of the engineer of record.

UNIFORM BUILDING CODE STANDARD 21-4
HOLLOW AND SOLID LOAD-BEARING CONCRETE MASONRY UNITS

Based on Standard Specification C 90-95 of the American Society for Testing and Materials. Extracted, with permission, from the *Annual Book of ASTM Standards*, copyright American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428

SECTION 21.401 — SCOPE

This standard covers solid (units with 75 percent or more net area) and hollow load-bearing concrete masonry units made from portland cement, water and mineral aggregates with or without the inclusion of other materials.

SECTION 21.402 — CLASSIFICATION

21.402.1 Types. Two types of concrete masonry units in each of two grades are covered as follows:

21.402.1.1 Type I, moisture-controlled units. Units designated as Type I shall conform to all requirements of this standard including the moisture content requirements of Table 21-4-A.

21.402.1.2 Type II, nonmoisture-controlled units. Units designated as Type II shall conform to all requirements of this standard except the moisture content requirements of Table 21-4-A.

21.402.2 Grades. Concrete masonry units manufactured in accordance with this standard shall conform to two grades as follows:

21.402.2.1 Grade N. Units having a weight classification of 85 pcf (1360 kg/m^3) or greater, for general use such as in exterior walls below and above grade that may or may not be exposed to moisture penetration or the weather and for interior walls and backup.

21.402.2.2 Grade S. Units having a weight classification of less than 85 pcf (1360 kg/m^3), for uses limited to above-grade installation in exterior walls with weather-protective coatings and in walls not exposed to the weather.

SECTION 21.403 — MATERIALS

21.403.1 Cementitious Materials. Materials shall conform to the following applicable standards:

1. Portland Cement—ASTM C 150 modified as follows:

   Limitation on insoluble residue—1.5 percent maximum.
   Limitation on air content of mortar,
   Volume percent—22 percent maximum.
   Limitation on loss on ignition—7 percent maximum.
   Limestone with a minimum 85 percent calcium carbonate ($CaCO_3$) content may be added to the cement, provided the requirements of ASTM C 150 as modified above are met.

2. Blended Cements—ASTM C 595.

3. Hydrated Lime, Type S—UBC Standard 21-13.

21.403.2 Other Constituents and Aggregates. Air-entraining agents, coloring pigments, integral water repellents, finely ground silica, aggregates, and other constituents, shall be previously established as suitable for use in concrete or shall be shown by test or experience to not be detrimental to the durability of the concrete.

SECTION 21.404 — PHYSICAL REQUIREMENTS

At the time of delivery to the work site, the units shall conform to the physical requirements prescribed in Table 21-4-B. The moisture content of Type I concrete masonry units at time of delivery shall conform to the requirements prescribed in Table 21-4-A.

At the time of delivery to the purchaser, the linear shrinkage of Type II units shall not exceed 0.065 percent.

SECTION 21.405 — MINIMUM FACE-SHELL AND WEB THICKNESSES

Face-shell (FST) and web (WT) thicknesses shall conform to the requirements listed in Table 21-4-C.

SECTION 21.406 — PERMISSIBLE VARIATIONS IN DIMENSIONS

21.406.1 Precision Units. For precision units, no overall dimension (width, height and length) shall differ by more than $^1/_8$ inch (3.2 mm) from the specified standard dimensions.

21.406.2 Particular Feature Units. For particular feature units, dimensions shall be in accordance with the following:

1. For molded face units, no overall dimension (width, height and length) shall differ by more than $^1/_8$ inch (3.2 mm) from the specified standard dimension. Dimensions of molded features (ribs, scores, hex-shapes, patterns, etc.) shall be within $^1/_{16}$ inch (1.6 mm) of the specified standard dimensions and shall be within $^1/_{16}$ inch (1.6 mm) of the specified placement of the unit.

2. For split-faced units, all non-split overall dimensions (width, height and length) shall differ by no more than $^1/_8$ inch (3.2 mm) from the specified standard dimensions. On faces that are split, overall dimensions will vary. Local suppliers should be consulted to determine dimensional tolerances achievable.

3. For slumped units, no overall height dimension shall differ by more than $^1/_8$ inch (3.2 mm) from the specified standard dimension. On faces that are slumped, overall dimensions will vary. Local suppliers should be consulted to determine dimension tolerances achievable.

NOTE: Standard dimensions of units are the manufacturer's designated dimensions. Nominal dimensions of modular size units, except slumped units, are equal to the standard dimensions plus $^3/_8$ inch (9.5 mm), the thickness of one standard mortar joint. Slumped units are equal to the standard dimensions plus $^1/_2$ inch (13 mm), the thickness of one standard mortar joint. Nominal dimensions of nonmodular size units usually exceed the standard dimensions by $^1/_8$ inch to $^1/_4$ inch (3.2 mm to 6.4 mm).

SECTION 21.407 — VISUAL INSPECTION

All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or impair the strength or perm-anence of the construction. Units may have minor cracks incidental to the usual method of manufacture, or minor chipping resulting from customary methods of handling in shipment and delivery.

Units that are intended to serve as a base for plaster or stucco shall have a sufficiently rough surface to afford a good bond.

Where units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks or other imperfections when viewed from 20 feet (6100 mm), except that not more than 5 percent of a shipment may have slight cracks or small chips not larger than 1 inch (25.4 mm).

SECTION 21.408 — METHODS OF SAMPLING AND TESTING

The purchaser or authorized representative shall be accorded proper facilities to inspect and sample the units at the place of manufacture from the lots ready for delivery.

Sample and test units in accordance with ASTM C 140.

Total linear drying shrinkage shall be based on tests of concrete masonry units made with the same materials, concrete mix design, manufacturing process and curing method, conducted in accordance with ASTM C 426 and not more than 24 months prior to delivery.

SECTION 21.409 — REJECTION

If the samples tested from a shipment fail to conform to the specified requirements, the manufacturer may sort it, and new specimens shall be selected by the purchaser from the retained lot and tested at the expense of the manufacturer. If the second set of specimens fails to conform to the specified requirements, the entire lot shall be rejected.

TABLE 21-4-A—MOISTURE CONTENT REQUIREMENTS FOR TYPE I UNITS

	MOISTURE CONTENT, MAX. PERCENT OF TOTAL ABSORPTION (Average of 3 Units)		
	Humidity Conditions at Jobsite or Point of Use		
LINEAR SHRINKAGE, PERCENT	Humid[1]	Intermediate[2]	Arid[3]
0.03 or less	45	40	35
From 0.03 to 0.045	40	35	30
0.045 to 0.065, max.	35	30	25

[1] Average annual relative humidity above 75 percent.

[2] Average annual relative humidity 50 to 75 percent.

[3] Average annual relative humidity less than 50 percent.

TABLE 21-4-B—STRENGTH AND ABSORPTION REQUIREMENTS

COMPRESSIVE STRENGTH, MIN, psi (MPa)		WATER ABSORPTION, MAX, lb./ft. (kg/m) (Average of 3 Units)		
Average Net Area		Weight Classification—Oven-dry Weight of Concrete, lb./ft. (kg/m)		
Average of 3 Units	Individual Unit	Lightweight, Less than 105 (1680)	Medium Weight, 105 to less than 125 (1680-2000)	Normal Weight, 125 (2000) or more
1900 (13.1)	1700 (11.7)	18 (288)	15 (240)	13 (208)

TABLE 21-4-C—MINIMUM THICKNESS OF FACE-SHELLS AND WEBS

NOMINAL WIDTH (W) OF UNIT (inches)	FACE-SHELL THICKNESS (FST) MIN., (inches)[1, 4]	WEB THICKNESS (WT) Webs[1] Min., (inches)	WEB THICKNESS (WT) Equivalent Web Thickness, Min., In./Lin. Ft.[2]
	× 25.4 for mm		× 83 for mm/lin. m
3 and 4	3/4	3/4	1 5/8
6	1	1	2 1/4
8	1 1/4	1	2 1/4
10	1 3/8 1 1/4[3]	1 1/8	2 1/2
12	1 1/2 1 1/4[3]	1 1/8	2 1/2

[1] Average of measurements on three units taken at the thinnest point.

[2] Sum of the measured thickness of all webs in the unit, multiplied by 12 (305 when using metric), and divided by the length of the unit. In the case of open-ended units where the open-ended portion is solid grouted, the length of that open-ended portion shall be deducted from the overall length of the unit.

[3] This face-shell thickness (FST) is applicable where allowable design load is reduced in proportion to the reduction in thicknesses shown, except that allowable design load on solid-grouted units shall not be reduced.

[4] For split-faced units, a maximum of 10 percent of a shipment may have face-shell thicknesses less than those shown, but in no case less than 3/4 inch (19 mm).

5.2 SUPERIMPOSED WALLS

The design of superimposed MSE walls is made in two steps:

(1) A design using simplified design rules for calculating external stability and locating the internal failure plane for internal stability as shown in figure 48.

(2) A stability analysis, including both compound and global stability using a reinforced soil global stability computer program outlined in chapter 6. This is an essential computation.

For **preliminary design**, the following minimum values for reinforcement length, of L_1 and L_2, should be used for offsets (D) greater than [$1/20\ (H_1 + H_2)$]:

Upper wall: $L'_1 \geq 0.7\ H_1$

Lower wall: $L'_2 \geq 0.6\ H$

where H = total height

Where the offset distance (D) is greater than $H_2 \tan(90-\varphi_r)$, walls are not considered superimposed and are independently designed.

For a small upper wall offset; $D \leq [\ 1/20\ (H_1 + H_2)\ ]$, it is assumed that the failure surface does not fundamentally change and it is simply adjusted laterally by the offset distance D. The walls should be designed as a single wall with a height H.

External stability calculations for the upper wall are conventionally performed as outlined in chapter 4. For the lower wall, consider the upper wall as a surcharge in computing bearing pressures. In lieu of a conventional external sliding stability computation, perform a slope stability analysis with failure circles exiting at the base. A minimum factor of safety of 1.5 is generally warranted.

For calculating the internal stability, the maximum tensile force lines are as indicated in figure 48a. These relationships are somewhat empirical and geometrically derived.

For intermediate offset distances, see figure 48a for the location of the failure surface and consider the vertical pressures in figure 48b for internal stress calculations.

For large setback distances, [$D \geq H_2 \tan(90-\varphi_r)$], the maximum tensile force lines are considered independently, without regard to the geometry of the two superimposed walls. For internal stability computations, the upper wall is neglected.

The balance of the computations remain identical as in chapter 4.

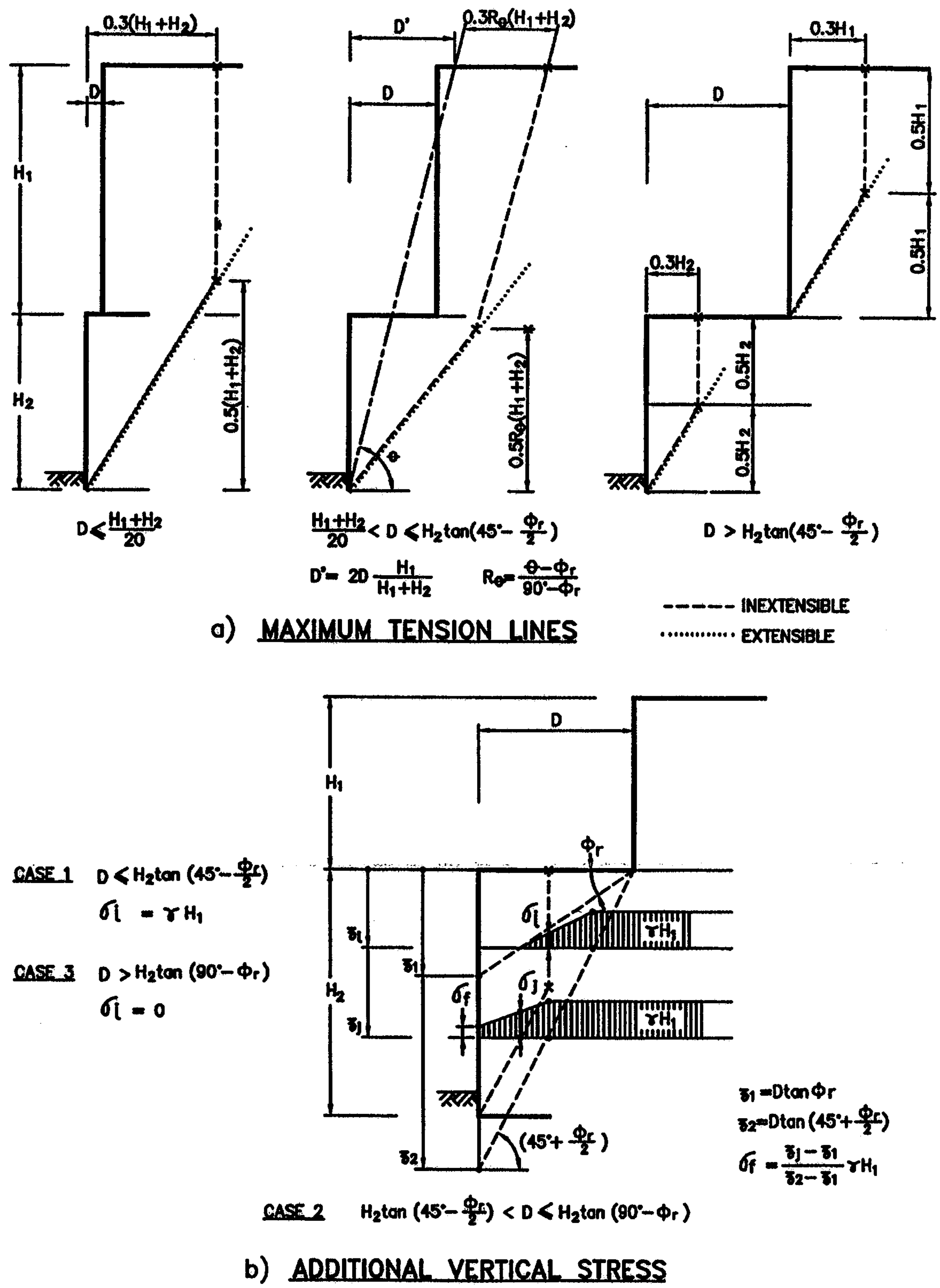


Figure 48. Design rules for superimposed walls.