KIA CO

P.O. Box 7255
Bellevue, WA 98008

Phone 425-351-5999
Kiaeng.ali@gmail.com

EDWARD & CATHERINE MORAN
RESIDENCE SITE SHORING

5000 WEST MERCER WAY
MERCER ISLAND, WASHINGTON 98040

STRUCTURAL CALCULATIONS

NOVEMBER 30, 2021
JOB NO: 171-2101

SOIL DATA:

Active Pressure = 40 pcf
Passive Pressure = 200 pcf
Passive Pressure to Neglect = 24"

Seismic Loading = 8H

Max HT. = 10.5 FT
Pile Spacing = 8'-0" o.c. Max
Pile Diameter = 30"

Steel Fy = 50 ksi

SEISMIC:

Zip Code: 98040

Ss = 1.439
S1 = 0.552

Fa = 1.00
Fv = 1.50

Sds = 0.959
Sd1 = 0.552

Above values per Soil's Report by: Nelson Geotech. Associates, Inc., File No. 1211520, November 20, 2020.

Conc. F'c = 1,000 psi
Rebar Fy = 60,000 psi

Soil Bearing = 1500 psf (Per Soil's Report)

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RetainPro (c) 1987-2019, Build 11.19.11.12
License : KW-06062136
License To : RB Engineers

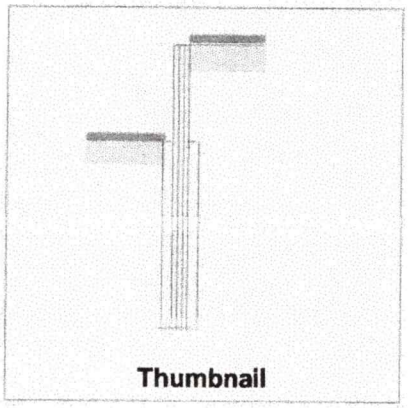
Soldier Pile Retaining Wall

Code: IBC 2018,AISC 360-16

Design Parameters

Wall height (retained height)	6.50	ft
Backfill slope	0.00	deg
Soil Density	125.00	pcf
Soil Phi angle		deg
Surcharge top of soil @ retained	52	psf
Allow. Passive	200	psf / ft
Apply S.F. to Passive	1.0	
Pile Spacing	8.0	ft
Diameter of encasement	5.50	in
Multiplier to Passive Wedge	2.0	
Required Embedment	12.15	ft
Total Pile Embedment	13.00	ft
Soldier Beam Selection	W16x26	
Lagging Depth	0.00	ft
Lagging Selection	PT4x8	
Steel Design Method	**ASD**	
Lateral Presure Method	EPF	
Passive Pressure to Neglect	24.00	in
	0	
Tieback Location	None	
Steel Fy	50	ksi

Consider pile unbraced for lateral torsional buckling



Thumbnail

Design Results

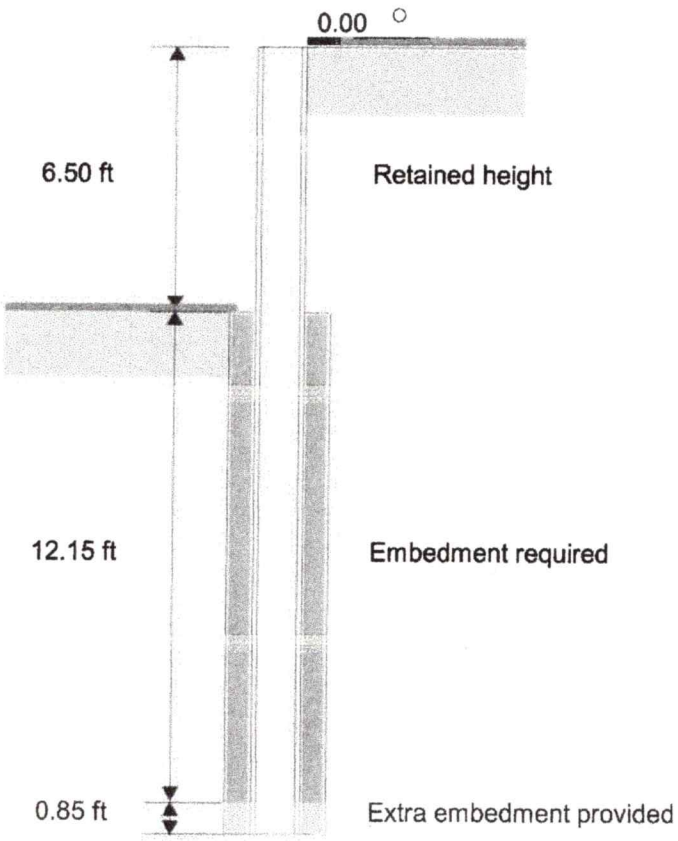
Required embedment	12.15	ft	12.15ft = 10.15 + 2 ft neglecte
Embedment Used		ft	
Deflection at top of pile	0.04	in	
Pile Pw	2,704	Flange W	
Pile Total Lateral	9,464	lb	
Depth to Max M	2.79	ft	
Mmax in Pile (Service)	40,969	ft-lbs	
Vmax in Pile (Service)	9,464	lb	

Status Checks

				Ratio	Status
Ma	40,969 ft-lbs	Mn/Omega	95,116 ft-lbs	0.43	OK
Va	9,464 lb	Vn/Omega	70,509 lb	0.13	OK
Embedment Required					OK

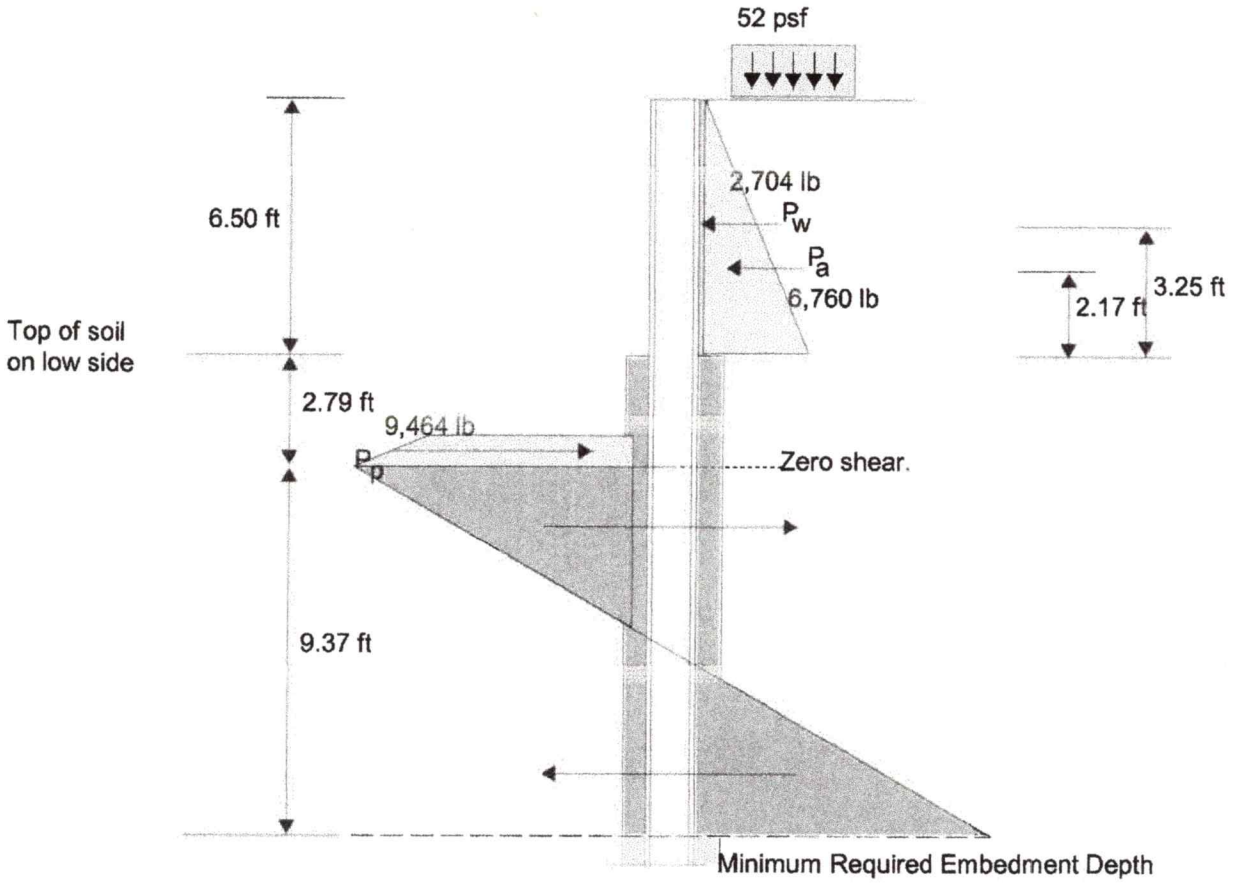
P-1/17

Construction Diagram



P-2/17

Wall Loading Diagram



P-3/17

Pile Section	W16x26
Pile Spacing	8.00 ft
Pile is encased in concrete	Yes
Diameter of encasement	30.00 in
Multiplier to Passive Wedge (Arching Factor)	2.00
Total Pile Embedment	13.00 ft
Pile Yield Stress, Fy	50 ksi

Unbraced Length for Soldier Pile

- (●) Consider pile unbraced for lateral torsional buckling
- ( ) Consider pile fully-braced for lateral torsional buckling

☑ Use Lagging (Used to calculate design pressure on lagging at specified depth.)

Lagging Depth	0.00	ft
Lagging Pressure @ Depth	16.6	psf
**Lagging Mom. @ Depth	106	ft-lbs
Lagging Shear @ Depth	67	lbs/vert. ft
Lagging Section:	PT4x8	

**Moment is 0.8 * WL^2/8 where the factor 0.8 accounts for arching action in the soil.

P-4/17

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License : KW-06062136
License To : RB Engineers

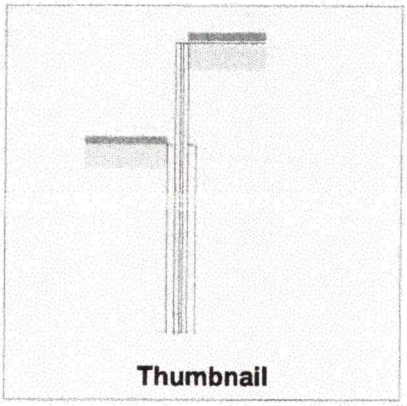
Soldier Pile Retaining Wall

Code: IBC 2018,AISC 360-16

Design Parameters

Wall height (retained height)	8.50	ft
Backfill slope	0.00	deg
Soil Density	125.00	pcf
Soil Phi angle		deg
Surcharge top of soil @ retained	68	psf
Allow. Passive	200	psf / ft
Apply S.F. to Passive	1.0	
Pile Spacing	8.0	ft
Diameter of encasement	5.53	in
Multiplier to Passive Wedge	2.0	
Required Embedment	15.94	ft
Total Pile Embedment	16.00	ft
Soldier Beam Selection	W16x31	
Lagging Depth	8.50	ft
Lagging Selection	PT 4x8	
Steel Design Method	**ASD**	
Lateral Presure Method	EPF	
Passive Pressure to Neglect	24.00	in
	0	
Tieback Location	None	
Steel Fy	50	ksi

Consider pile unbraced for lateral torsional buckling



Thumbnail

Design Results

Required embedment	15.94	ft 15.94ft = 13.94 + 2 ft neglecte
Embedment Used		ft
Deflection at top of pile	0.13	in

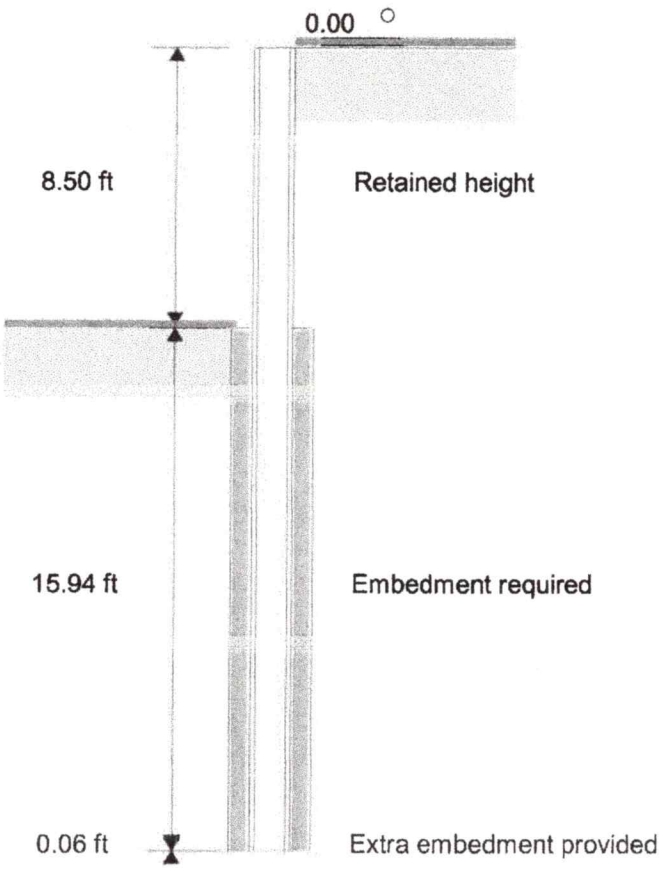
Pile Pw	4,624	Flange W
Pile Total Lateral	16,184	lb
Depth to Max M	4.03	ft
Mmax in Pile (Service)	95,783	ft-lbs
Vmax in Pile (Service)	16,184	lb

Status Checks

				Ratio	Status
Ma	95,783 ft-lbs	Mn/Omega	105,215 ft-lbs	0.91	OK
Va	16,184 lb	Vn/Omega	87,450 lb	0.19	OK
Embedment Required					OK

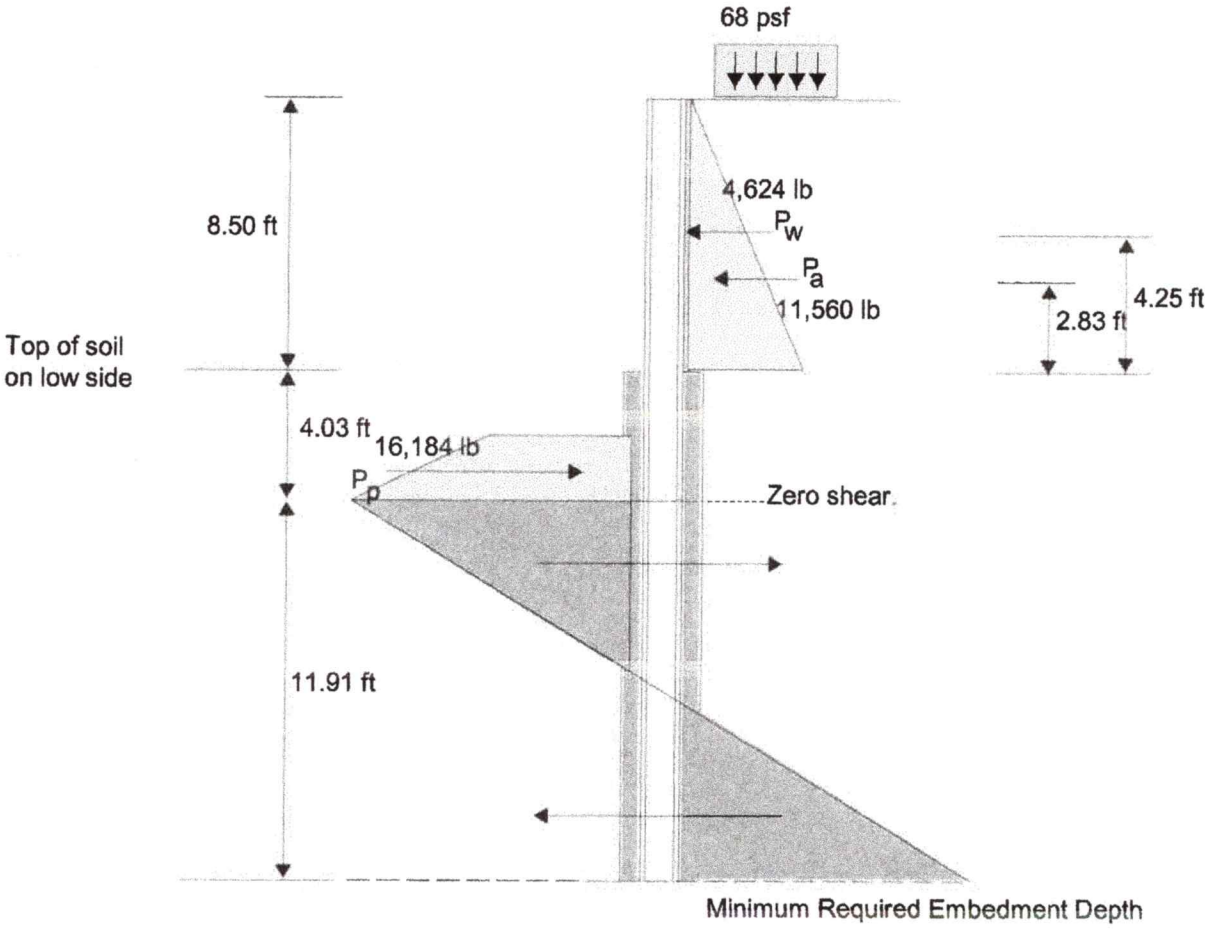
P-5/17

Construction Diagram



P-6/17

Wall Loading Diagram



P-7/17

Pile Section	W16x31	
Pile Spacing	8.00	ft
Pile is encased in concrete	Yes	
Diameter of encasement	30.00	in
Multiplier to Passive Wedge (Arching Factor)	2.00	
Total Pile Embedment	16.00	ft
Pile Yield Stress, Fy	50	ksi

Unbraced Length for Soldier Pile

◉ Consider pile unbraced for lateral torsional buckling

○ Consider pile fully-braced for lateral torsional buckling

☑ Use Lagging (Used to calculate design pressure on lagging at specified depth.)

Lagging Depth	8.50	ft
Lagging Pressure @ Depth	361.8	psf
**Lagging Mom. @ Depth	2,315	ft-lbs
Lagging Shear @ Depth	1,447	lbs/vert. ft
Lagging Section:	PT 4x8	

**Moment is 0.8 * WL^2/8 where the factor 0.8 accounts for arching action in the soil.

P-8/17

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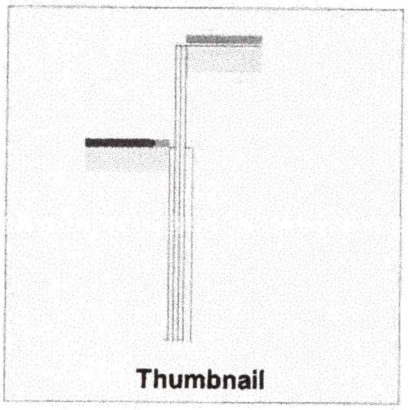
Soldier Pile Retaining Wall

Code: IBC 2018,AISC 360-16

Design Parameters

Wall height (retained height)	10.50	ft
Backfill slope	0.00	deg
Soil Density	125.00	pcf
Soil Phi angle		deg
Surcharge top of soil @ retained	84	psf
Allow. Passive	200	psf / ft
Apply S.F. to Passive	1.0	
Pile Spacing	8.0	ft
Diameter of encasement	7.07	in
Multiplier to Passive Wedge	2.0	
Required Embedment	19.77	ft
Total Pile Embedment	20.00	ft
Soldier Beam Selection	W16x50	
Lagging Depth	10.50	ft
Lagging Selection	PT 4x8	
Steel Design Method	**ASD**	
Lateral Presure Method	EPF	
Passive Pressure to Neglect	24.00	in
	0	
Tieback Location	None	
Steel Fy	50	ksi

Consider pile unbraced for lateral torsional buckling



Design Results

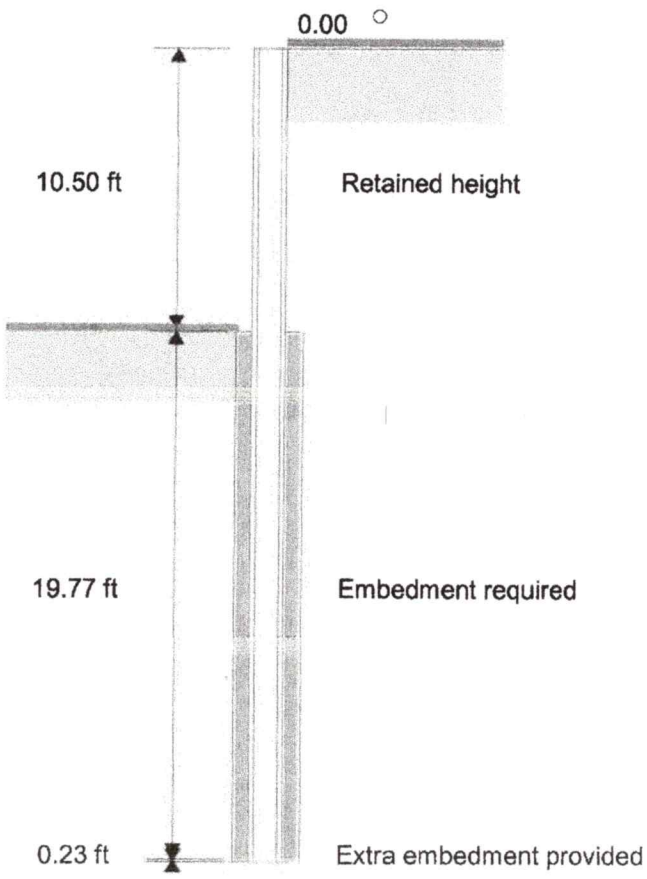
Required embedment	19.77	ft	19.77ft = 17.77 + 2 ft neglecte
Embedment Used		ft	
Deflection at top of pile	0.22	in	
Pile Pw	7,056	Flange W	
Pile Total Lateral	24,696	lb	
Depth to Max M	5.31	ft	
Mmax in Pile (Service)	185,978	ft-lbs	
Vmax in Pile (Service)	24,696	lb	

Status Checks

				Ratio	Status
Ma	185,978 ft-lbs	Mn/Omega	192,454 ft-lbs	0.97	OK
Va	24,696 lb	Vn/Omega	123,880 lb	0.20	OK
Embedment Required					OK

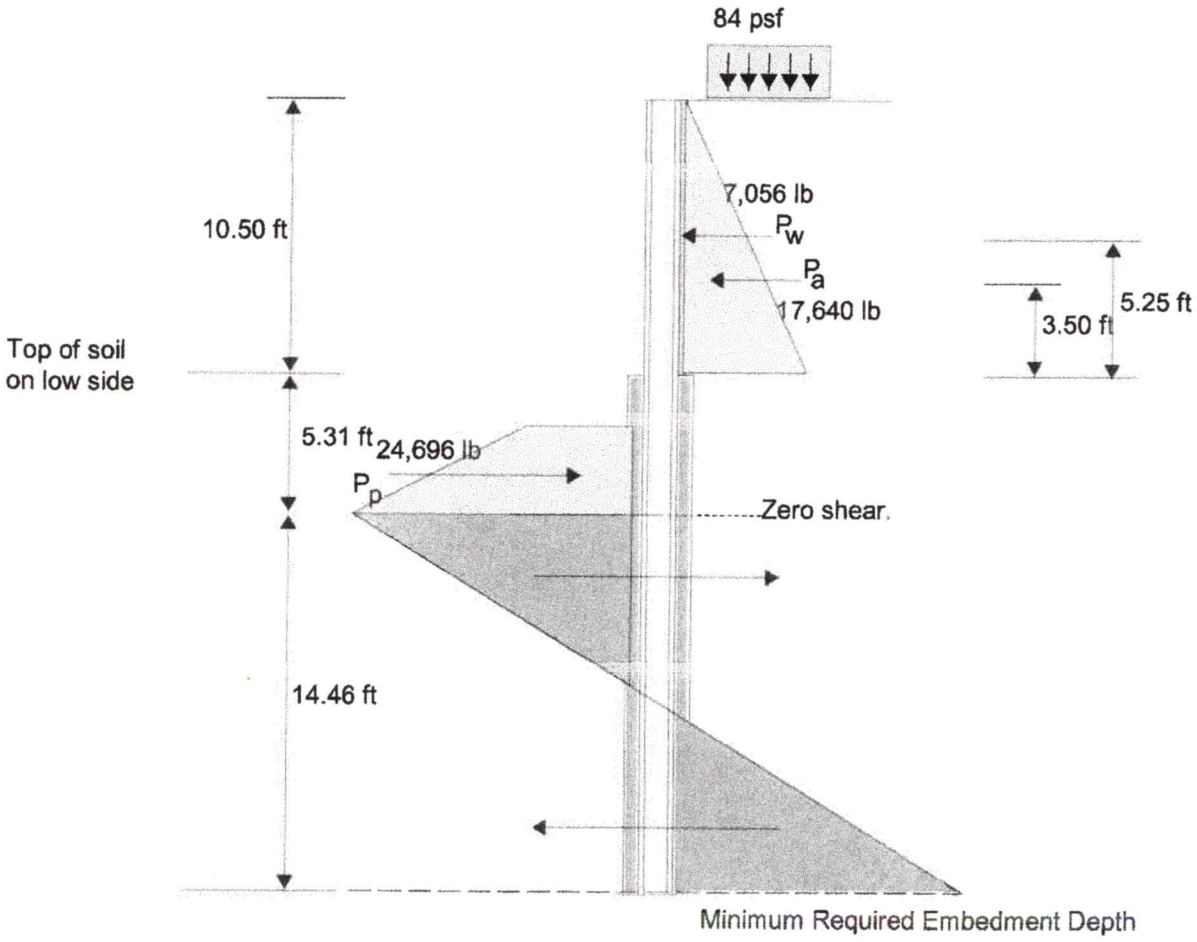
5-9/7

Construction Diagram



12-10/17

Wall Loading Diagram



P-11/17

Pile Section	W16x50
Pile Spacing	8.00 ft
Pile is encased in concrete	Yes
Diameter of encasement	30.00 in
Multiplier to Passive Wedge (Arching Factor)	2.00
Total Pile Embedment	20.00 ft
Pile Yield Stress, Fy	50 ksi

Unbraced Length for Soldier Pile

◉ Consider pile unbraced for lateral torsional buckling

○ Consider pile fully-braced for lateral torsional buckling

☑ Use Lagging (Used to calculate design pressure on lagging at specified depth.)

Lagging Depth	10.50	ft
Lagging Pressure @ Depth	446.9	psf
**Lagging Mom. @ Depth	2,860	ft-lbs
Lagging Shear @ Depth	1,788	lbs/vert. ft
Lagging Section:	PT 4x8	

**Moment is 0.8 * WL^2/8 where the factor 0.8 accounts for arching action in the soil.

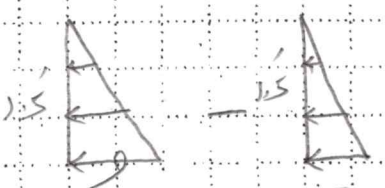
12-12-17

SURCHARGE @ P1 THRU P17:

WALL HT = 10.5' + 1.5' = 12.0'

ACTIVE PRESS. → 90 PCF @ TOP 1.5'
→ 40 PCF, TYP.

SURCHARGE = (135 − 60) / 40
= 1.875'
USE: 2' SURCHARGE



90 × 1.5 = 135 PSF 40 × 1.5 = 60 PSF

TOP 1.5'

KIA CO	Project/Subject: 5000 WEST MERCER WAY, MERCER ISLAND, WA	By: A.G.	Sheet No.: P-13/17
		Date: 10-21	Job No.: 171-2101

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Soldier Pile Retaining Wall

Code: IBC 2018,AISC 360-16

Design Parameters

Wall height (retained height)	12.00	ft
Backfill slope	0.00	deg
Soil Density	125.00	pcf
Soil Phi angle		deg
Surcharge top of soil @ retained	235	psf
Allow. Passive	200	psf / ft
Apply S.F. to Passive	1.0	
Pile Spacing	8.0	ft
Diameter of encasement	10.40	in
Multiplier to Passive Wedge	2.0	
Required Embedment	26.65	ft
Total Pile Embedment	27.00	ft
Soldier Beam Selection	W16x100	
Lagging Depth	12.00	ft
Lagging Selection	PT 6x8	
Steel Design Method	**ASD**	
Lateral Presure Method	EPF	
Passive Pressure to Neglect	24.00	in
	0	
Tieback Location	None	
Steel Fy	50	ksi

Consider pile unbraced for lateral torsional buckling

Design Results

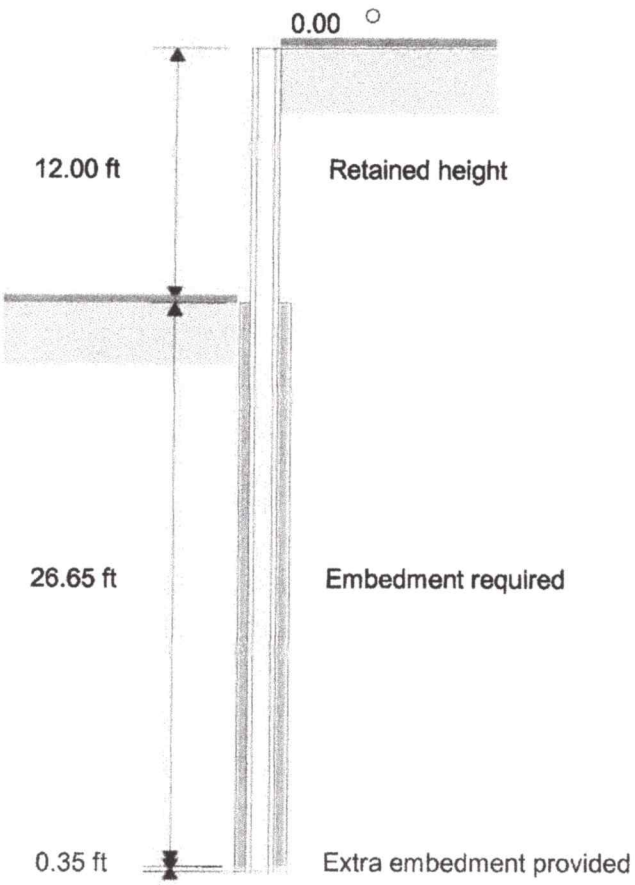
Required embedment	26.65	ft 26.65ft = 24.65 + 2 ft neglecte
Embedment Used		ft
Deflection at top of pile	0.30	in
Pile Pw	22,560	Flange W
Pile Total Lateral	45,600	lb
Depth to Max M	7.76	ft
Mmax in Pile (Service)	463,592	ft-lbs
Vmax in Pile (Service)	45,600	lb

Status Checks

				Ratio	Status
Ma	463,592 ft-lbs	Mn/Omega	469,236 ft-lbs	0.99	OK
Va	45,600 lb	Vn/Omega	198,900 lb	0.23	OK
Embedment Required					OK

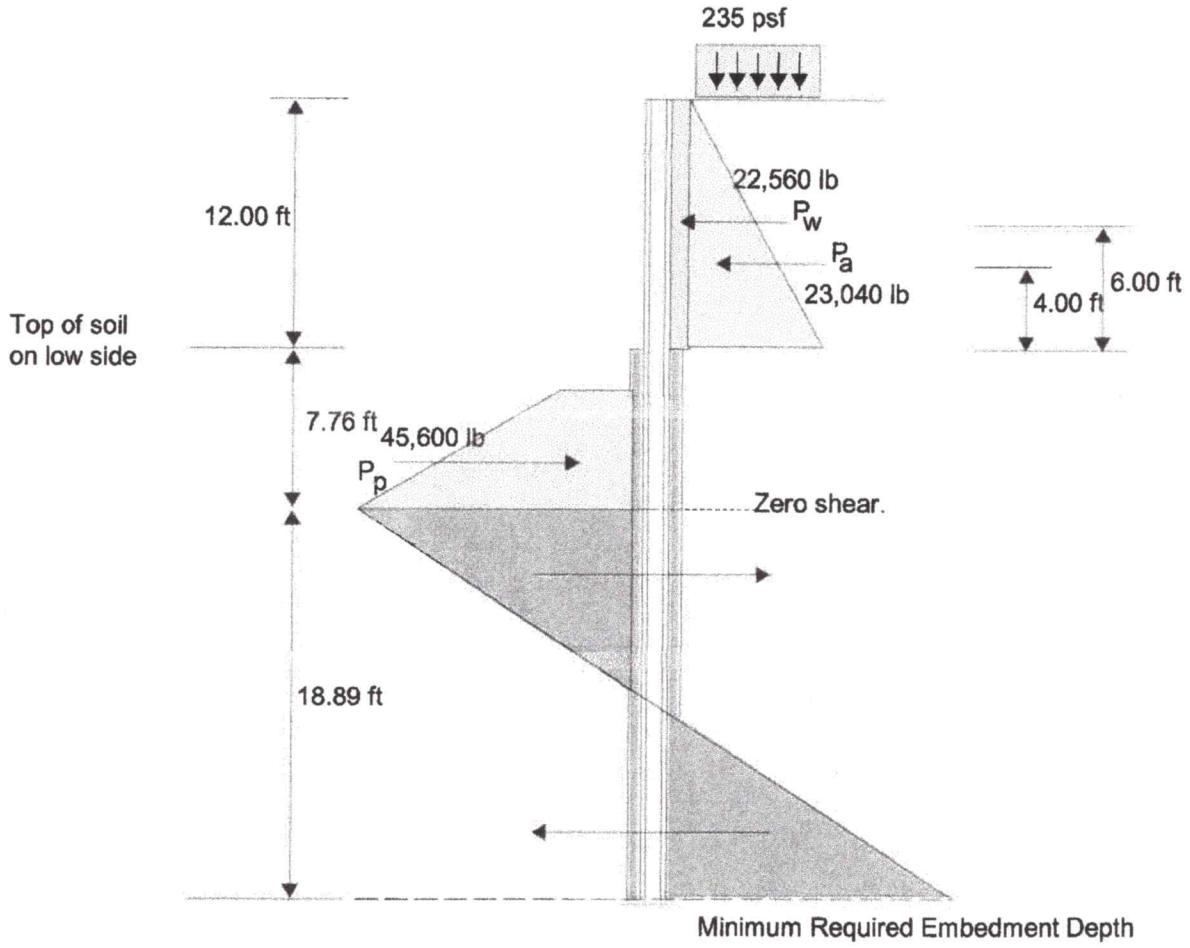
P-14/17

Construction Diagram



P-15/17

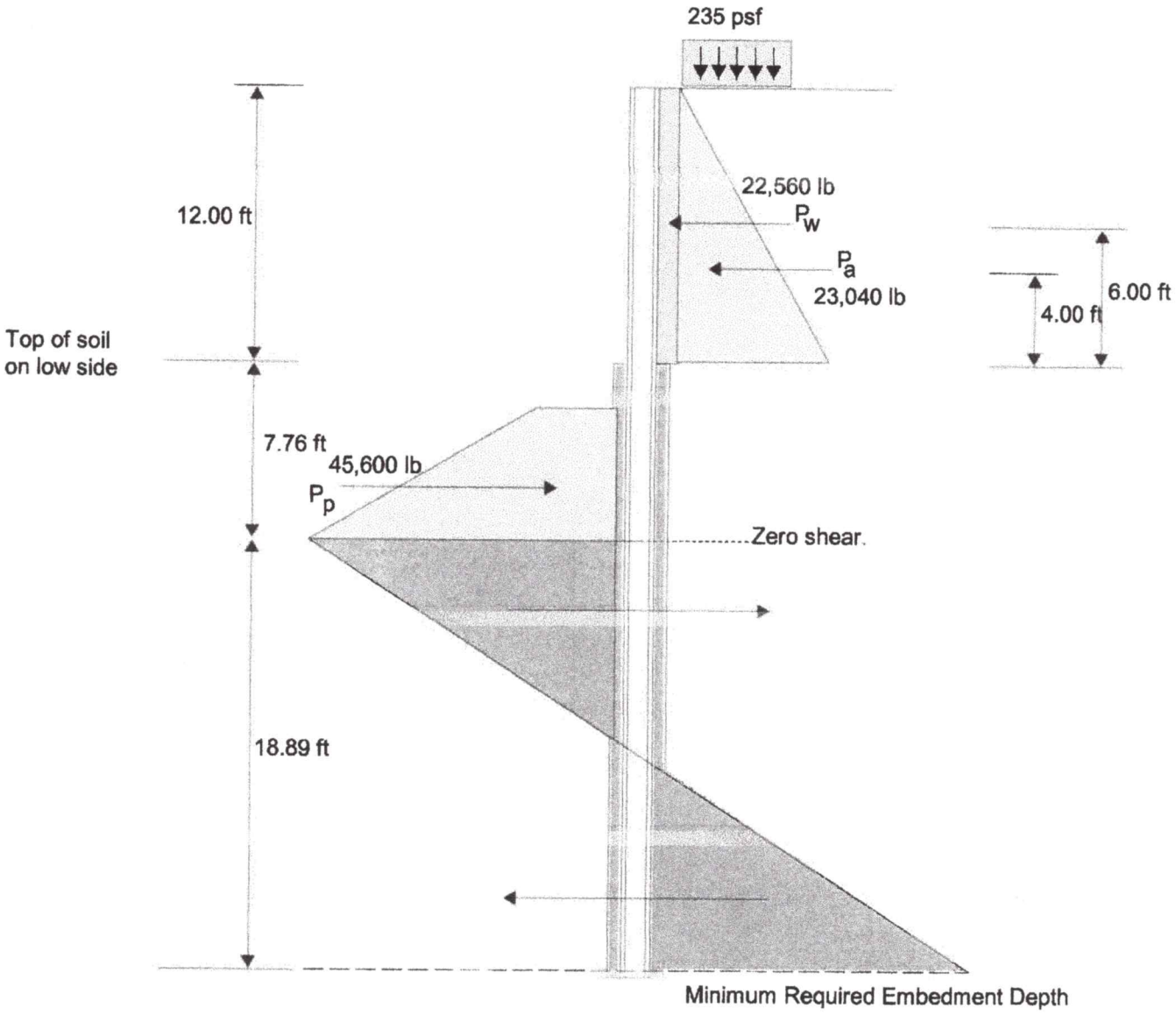
Wall Loading Diagram



P-16/17

Soldier Pile Retaining Wall

Code: IBC 2018,AISC 360-16



P-17/17

APPENDIX

NELSON GEOTECHNICAL
ASSOCIATES, INC.

17311-135th Ave. N.E. Suite A-500
Woodinville, WA 98072
(425) 486-1669
www.nelsongeotech.com

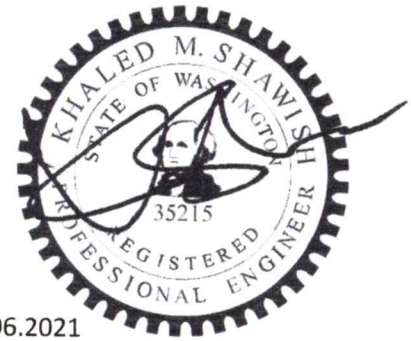
MEMORANDUM

DATE: August 6, 2021

TO: Bill Gottlieb
wmgottlieb@planone.biz
Edward Moran
Edmoran82@gmail.com
Catherine Moran
Catherine.b.moran@gmail.com

FROM: Khaled M. Shawish, PE
Katelyn S. Brower, GIT

RE: Plan Review Memorandum
5000 West Mercer Way
Mercer Island, Washington
NGA File No. 1211520



08.06.2021

This memorandum presents our supplemental geotechnical recommendations and opinions regarding the proposed Moran Residence development project located at 5000 West Mercer Way in Mercer Island, Washington.

INTRODUCTION

We previously prepared a geotechnical report titled ***"Geotechnical Engineering Evaluation – Moran Residence Development – 5000 West Mercer Way – Mercer Island," dated November 20, 2020.*** The site is located within a mapped ancient slide area, but the core of the site slopes are interpreted to consist of native, competent soils. The plans include the construction of a single family residence in close proximity of the base of the site slopes. Within the report, we provided recommendations for the incorporation of a residence debris retaining wall or separate catchment wall to safeguard the residence from possible upslope soil and debris. We have since reviewed preliminary grading plans, where the residence and driveway are planned to be located within 5 to 10-feet from the planned retaining wall. We discussed options for the wall with you, and determined the most feasible approach would be a soldier pile wall. Based on anticipated loads and the final height of the wall, tiebacks may be required for lateral support. In the following sections, we review the plans for the wall alignment and provide recommendations for a soldier pile wall design and construction.

A-2/7

We were provided with a site plan titled "Site & Grading Plan," prepared by Justin Jones, PE, and dated April 22, 2021.

PLAN REVIEW

The proposed residence will be located within the west-central portion of the site and is planned to cover approximately 2,300 square feet. Associated driveways and attached garage will be located on the northern portion of the site. The wall alignment is planned to span the base of the slope along the length of the planned residence, located approximately 5-10 feet from the structure and driveway, depending on specific locations. The wall will continue and wrap around to the north side of the driveway, and around to the southeast portion of the residence to protect the proposed structures from potential soil movement. In general, the plans appear to reflect our general recommendations, as long as foundation support and retaining wall recommendations within the previous report and this memorandum are followed during construction.

RECOMMENDATIONS

Soldier Pile Wall

General: A solider pile shoring wall could be utilized to support cut excavations around the proposed structures. A soldier pile wall typically consists of a series of steel H-beams placed vertically at a certain spacing from one another (typically six to ten feet). The beams are usually placed in drilled shafts that are filled with a structural concrete or a lean mix. The concrete shafts are typically embedded below the bottom of the planned excavation a distance equal to one to two times the exposed height of the wall. The steel beams are extended above finished ground surface to provide shoring capabilities for the area to be retained. The beams are typically spanned by pressure treated timber lagging or concrete panels. The H-beam size, shaft diameter, shaft embedment, and pile spacing are dependent on the nature of the soils anticipated to be retained by the wall and the soils at depth, wall height, drainage conditions, and the final geometry.

Wall Design: The wall should be designed by an experienced structural engineer licensed in the State of Washington. The lateral earth pressure acting on the shoring wall will be dependent on the nature and density of the soil behind the wall, structure and traffic loads on the wall, and the amount of lateral wall movement that may occur as material is excavated from the front of the wall. If the shoring wall is free to yield at least one-thousandth of the retained height, an "active" loading condition develops. If the wall is restrained from movement by stiffness or bracing, the wall is considered in an "at-rest" loading condition. Active and at-rest earth pressure can be calculated based on equivalent fluid densities.

A-3/7

The shoring wall should be designed to resist a lateral load resulting from a fluid with a unit weight of 40 and 60 pounds per cubic foot (pcf) for the active and at-rest loading conditions, respectively. An additional uniform surcharge of 8H should be applied to the wall design to account for seismic loading, if the shoring walls are intended to provide permanent support; H in this case is the exposed height of the wall. These loads should be applied across the pile spacing above the excavation line. These loads can be resisted by a passive pressure of 200 pcf on the below grade medium dense or better native glacial soils encountered at depth. The passive pressure should be applied on two-pile diameters under the excavation line. These values of the passive pressure incorporate a factor of safety of 2.0. The upper two feet of pile embedment should be neglected when calculating the passive resistance for the permanent condition. Also, for the permanent condition, the below-grade portion of the wall should be no less than 1.5 times the wall stick-up height (exposed height).

The above loads should be applied on the full center-to-center pile spacing above the base of the exposed portion of the wall. A 50 percent reduction of the active pressure could be applied for the purpose of designing the wall lagging.

The above pressures assume that the on-site soils retained by the shoring wall are not significantly disturbed and that hydrostatic forces are not allowed to build up behind the wall. These values do not include the effects of surcharges other than what is described above. The retained soils should be readily drained and collected water should be routed into a permanent storm system. Adequate gaps should be maintained between the lagging elements to allow for any potential water seepage buildup to flow through the wall.

The wall designer should calculate the predicted wall deflection, including deflection resulting from the below-grade movement of the piles. The predicted deflection values should be confirmed in the field through a survey monitoring program. Also, surrounding structures should be monitored for any adverse effects resulting from shoring wall installation.

Tieback Anchors

General: If tiebacks are needed to support lateral loads, we recommend that these systems consist of drilled, grouted tieback anchors. If tiebacks are utilized to support lateral loads for the shoring wall, we anticipate these systems may extend into neighboring properties and easements. Permission to extend these systems onto the neighboring properties and/or easements should be obtained prior to finalizing plans utilizing tieback anchors. All nearby existing utilities and structures should also be fully understood prior to finalizing the tieback design.

A-4/7

We recommend that at least two of the anchors be performance tested to a minimum of 200 percent of the design loads to confirm design values. We recommend that measurements be made by the contractor in the field at the time of tieback installation to ensure that tiebacks do not encounter any existing structures or underground utilities.

No-Load Zone: The anchor portion of all tiebacks must be located a sufficient distance behind the wall face to develop resistance within a stable soil mass. We recommend the anchorage be obtained behind an assumed no-load zone at an inclination of 15 degrees below horizontal. The no-load zone is defined by a line extending horizontally from the base of the shoring wall back towards the cut a distance of six feet. This line should then extend up from the base elevation at an angle from the horizontal of 60 degrees. We recommend that we monitor soil conditions during anchor installation in order to evaluate adequate penetration into competent soils.

Soil Design Values: The tiebacks must terminate in native, competent soil interpreted to exist below the fill. For use in design of the anchors, we estimate an allowable grout to soil adhesion of 2,000 pounds per square foot (psf) be utilized for sizing the bonded portion of anchors terminated within the competent native soils. This value should be verified through two performance tests prior to ordering the production anchors.

Tieback Installation and Testing: The contractor should be responsible for using equipment suited for the site conditions. We do not recommend the use of an open-hole method for the purpose of installing the tiebacks due to the potential for soil caving. Secondary grouting to increase soil adhesion may be used; however, if secondary grouting is used, the anchors should be tested using the methods outlined for the performance testing. All anchors should be installed at an approximate inclination of 15 to 20 degrees below horizontal.

Two anchors should be performance-tested to 200 percent of the anchor design capacity. The performance test should consist of cyclic loading in increments of 25 percent of the design load, as outlined in the Federal Highways Administration (FHA) report No. FHWA/RD-82/047. The test locations should be determined in the field by NGA, based on soil conditions observed during anchor installation. All other tiebacks should be proof-tested to at least 130 percent of design capacity.

All other recommendations outlined in our previous report should be followed. We trust this memorandum should satisfy your needs at this time. Please contact us if you have any questions or require additional services.

A-5/7

o-o-o

NELSON GEOTECHNICAL ASSOCIATES, INC.

Gmail

Alireza Ghassemikia <kiaeng.ali@gmail.com>

Moran Residence Development Clarifications

2 messages

Carston Curd <carstonc@nelsongeotech.com> Tue, Oct 5, 2021 at 6:26 PM
To: Catherine Moran <catherine.b.moran@gmail.com>, "edmoran82@gmail.com" <edmoran82@gmail.com>, "kiaeng.ali@gmail.com" <kiaeng.ali@gmail.com>
Cc: William Gottlieb <wmgottlieb@planone.biz>, Khaled Shawish <khals@nelsongeotech.com>

Hi Team,

I'm starting this email chain to facilitate communication and make sure everyone is on the same page.

Catherine and Ed,

We have had discussions separately with both Ali and Bill about our recommendations for debris protection for the residence, but wanted to outline our assumptions and understanding so that you can confirm you understand the limits of the design and verify it meets your expectations.

- The property is expected to experience occasional, small slope failures which may result in debris falling down the steeper portions of the slope. *This is normal for steeply sloping properties.*
- A stick-up portion of the uphill retaining wall should be able to trap debris from falling over the wall and blocking access or impacting the residence. The height of this stickup portion will determine the frequency of over-topping failures which could result in impacts to the areas underlying the wall. Increasing the stickup to completely stop any amount of failure would require significant structural improvements to the wall to ensure that it can absorb those failures without bending. Thus, there's a cost-benefit calculation going on right now that needs your input.
- Based on discussions with Bill, the current design for the stickup is about 18-inches, which will trap ***most*** of the expected failures and will likely not bump up the design in terms of cost too much (TBD, based on Ali's calculations). Additional measures will need to be followed to maintain this low-risk level:
    - Foundations on that side of the house will need to be buffed up a bit (already in the plans for the design).
    - You should keep in mind that there is potential for debris to fall over the wall in extreme circumstances. This possibility will be greatly reduced by regularly inspecting the slope for recent failures and clearing the debris to maintain the stick-up shield height in-tact.
    - Vegetation on the slope should be properly maintained. An arborist should check large trees if their health or risk level is in question. Vegetation should not be removed from the slope without a restoration plan. Water should not be allowed to concentrate onto the slope from uphill properties.

At a minimum, this stickup protection should be present along the wall wherever the house is located downhill. You should decide if additional areas along the wall should incorporate this debris protection, given the assumptions above – we don't anticipate there will be failures every winter storm that happens, but there remains an inherent risk for areas left unprotected. Let me know if you have questions or concerns! I'd be happy to go over any portion of the geotechnical report with you in greater detail – I know it's a very technical document and sometimes important stuff can seem hidden in jargon.

Ali,

Khal is okay with the existing earth pressures of 40 pcf for portions of the wall with overlying slopes up to 1.5H:1V, such that the height of those overlying slopes are limited to 4-feet. If this is not the case, please forward me the grading plan and I can go over it in greater detail.

Hope this helps bring clarity!

Many thanks,

A-6/7

Carston Curd, GIT | Project Geologist

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Hi Carston,

Thanks for outlining everything above. Based on our understanding and conversations with Bill and Ali, we are comfortable with the stickup of the wall remaining at 18 inches.

Ali - do you have what you need to move forward?

Thanks,

Ed Moran
[Quoted text hidden]

A-7/7