GEODESIGN INC
AN NV5 COMPANY

Memorandum

To:	Jerry Liu	From:	Kevin J. Lamb, P.E.
Company:	DKS Associates	Date:	February 11, 2021
Address:	720 SW Washington Street, Suite 500 Portland, OR 97205		

cc:	Corey Jurcak, SCJ Alliance (via email only)

GDI Project:	DKS-13-01
RE:	Cantilever Soldier Pile Wall Recommendations Federal Way 47th and Dash Point Road Roundabout Project 47th Avenue SW and SW Dash Point Road Federal Way, Washington

INTRODUCTION

We understand that it has been determined that site constraints and required wall heights will prevent the use of a concrete masonry unit block gravity wall from being used to support the slope cut on the southwest side of the intersection. Anticipated wall heights are up to approximately 10 feet and sufficient room for sloping the cut at up to a 0.75H:1V cut would require a temporary construction easement. A cantilever soldier pile wall has been determined to be a feasible alternative to a gravity wall. Geotechnical recommendations to support a cantilever soldier pile wall are provided below.

WALL DESIGN PARAMETERS

Soil parameters for estimating lateral earth pressures on the recommended shoring wall are provided on Figure 1 and are discussed below. We have assumed that the cantilever walls and any gravity wall sections will be free to rotate slightly around the base of the walls so that active soil conditions develop behind the walls. The walls should be designed as permanent shoring walls with appropriate corrosion protection for soldier piles.

We have assumed drained soil conditions for the walls based on subsurface conditions encountered in the borings.

Static lateral earth pressures acting on the wall should also be increased to account for seismic loading on each of the recommended wall types, as shown on Figure 1. The seismic pressure should be estimated as a uniform rectangular pressure of 6H pounds per square foot (psf), where H is the design retention height of the wall. The height of the wall used in the above equation should be measured from the finished ground surface in front of the wall to the top of the wall. The resultant should be applied at 0.6H of the exposed wall height. The value is based on one-half of the peak horizontal ground acceleration of 0.3 g.

Resistance to lateral loads may be developed through friction along the base of conventional walls and through passive resistance on the embedded portion of the wall. The recommended passive pressure is shown on Figure 1 and assumes the grade in front of the wall will result in a slope inclined at less than approximately 3H:1V. Base friction resistance for the gravity wall may be computed using a coefficient of friction of 0.4 applied to the dead load forces. A factor of safety of 1.5 has been applied to the passive pressure.

CANTILEVER SOLDIER PILE WALL

Soldier pile walls consist of H-shaped steel beams that are installed and backfilled with concrete into vertical drilled holes. We anticipate pile spacing will be between 6 to 8 feet on-center along the wall alignment. Cantilevered soldier pile walls are suitable for excavations up to approximately 15 feet in height. Timber lagging is set within the pile flanges that lock it into place so that it supports the exposed cut face.

Cantilever soldier pile walls should be designed to resist active lateral earth pressure based on the triangular pressure distribution shown on Figure 1. We have assumed that the permanent slope behind the wall will be inclined at less than 3H:1V.

Design of the cantilever soldier pile wall should include surcharge loads if loads are anticipated within a horizontal distance equal to or less than the height of the wall. We recommend a lateral surcharge pressure of 70 psf to account for up to 2 feet of soil load above the wall height behind the wall.

Passive pressure will depend on subsurface conditions and on the slope of the ground surface in front of the wall. The lateral earth pressures provided on Figure 1 account for sloping ground below the wall for inclinations up to approximately 3H:1V. The passive resistance in the upper 2 feet of soil should be neglected adjacent to the wall.

For both the cantilever and tieback soldier pile walls, we have assumed that the shoring will deflect into the excavation, resulting in settlement of the ground surface behind the wall. We anticipate that settlement will become negligible within a horizontal distance of one-half the height of the wall. The magnitude of settlement will depend on the quality of construction, but with good construction practices it should generally be less than 1 inch to 2 inches adjacent to the wall.

SOLDIER PILES

Soldier piles should be embedded to provide enough resistance against kick-out at the toe of the wall; we anticipate a minimum embedment depth of 1.2 to 1.5 times the depth of the excavation will be required for cantilever soldier pile walls. Soldier piles are expected to be embedded into the dense, glacially consolidated material encountered below surficial fill materials. We recommend using factors of safety of 1.5 and 2.0 for design against overturning and kick-out, respectively.

Soldier piles embedded a minimum of 4 feet into undisturbed, dense, recessional outwash material encountered below a depth of 7.5 feet below ground surface may be designed using an allowable

end bearing pressure of 25 kips per square foot (ksf), which includes a factor of safety of 3.0. Shaft resistance below the base of the excavation can be designed using a side friction value of 0.70 ksf, which includes a factor of safety of 3.0. Side friction above the excavation base should be neglected.

L-PILE PARAMETERS

SCJ Alliance has requested L-Pile parameters to support design of the cantilever soldier pile wall. Provided below are the recommended parameters based on the soil encountered in boring B-1 that was drilled near the southwest corner.

- Soil type: Sand (Reese)
- Effective density: 0.072 pounds per cubic inch (pci)
- Modulus of subgrade reaction k-value: 90 pci
- Friction angle: 36 degrees
- Undrained cohesion: 0
- Strain factor: 0

For soldier pile walls with a single linear alignment of piles, no pile reduction factors for group effects are required.

LAGGING

Lagging typically consists of untreated or pressure-treated timber planks or concrete panels. Untreated timber planks are typically used for temporary lagging that will be in service less than three years and will be covered with permanent, load-carrying fascia. Pressure-treated timber planks can be used for permanent lagging and are considered to have a design life limited to approximately 20 years. Timber lagging should consist of Douglas fir-larch grade no. 2 or better in accordance with Washington Standard Specifications for Road, Bridge, and Municipal Construction (2020) 0-09.1(1). Concrete lagging use should be limited to cantilever soldier pile walls.

Lagging should be installed and backfilled on newly excavated faces the same working day the face is excavated and should be designed to resist lateral earth and surcharge pressures. Lagging should be sized using the procedures outlined in the Federal Highway Administration Geotechnical Engineering Circular No. 4. Permanent fascia or lagging should be designed to resist 100 percent of the recommended lateral earth pressures.

Voids that develop during construction behind the lagging should be backfilled as soon as practical. Lean concrete or controlled density fill can be used to fill voids behind the lagging. It should be placed in lifts at the end of each lagging stage. Gaps or voids between the lifts are acceptable and will help prevent the buildup of hydrostatic pressure should perched water or seepage be encountered.

TEMPORARY CUT SLOPES

Excavations can be completed with conventional earthwork equipment. Trench cut excavations should stand vertical to a depth of at least 4 feet, provided perched groundwater seepage does not occur in the trench walls. Some sloughing and caving of the sidewalls should be expected in utility trench excavations.

Excavations to construct retaining walls can be sloped similar to the existing slope. The existing slope cut is inclined at approximately 1H:1V and is stable with occasional raveling.

We anticipate that temporary slope cuts that stand for less than two weeks can be sloped at 0.75H:1V and can include a temporary 4-foot vertical cut at the toe. The exposed cut should be covered with Visqueen sheeting or a geotextile material to manage occasional raveling of the slope face. The condition of the temporary cut will need to be observed each day for indications of instability by the Contractor's competent person or a licensed geotechnical engineer.

Where recommended slope inclination extends into adjacent private property, a cantilever soldier pile wall is recommended to accommodate the site constraints.

All excavations should be made in accordance with applicable OSHA and state regulations. While we have described certain approaches to excavation in the foregoing discussion, the contractor should be responsible for selecting the excavation methods, monitoring the trench excavations for safety, and providing shoring as required to protect personnel and adjacent areas.

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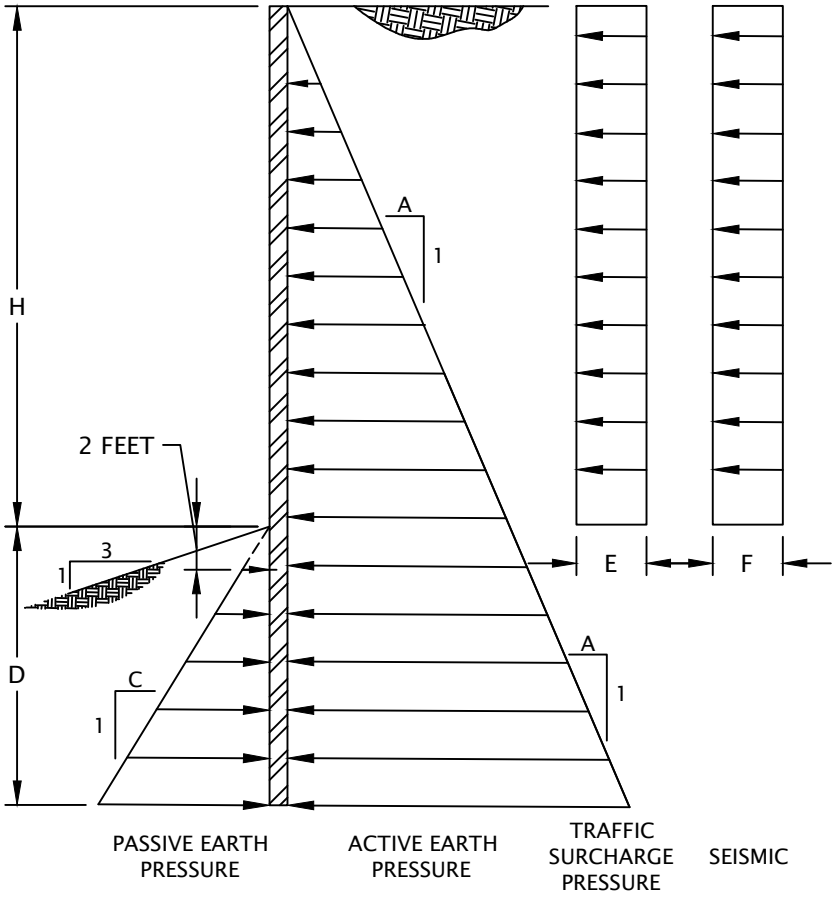
We appreciate the opportunity to be of continued service to you. Please call if you have questions concerning this memorandum or if we can provide additional services.

KJL:sn
Attachment
One copy submitted (via email only)
Document ID: DKS-13-01-021121-geom.docx

Signed 02/11/2021

FIGURES



CANTILEVER SOLDIER PILE

RECOMMENDED LATERAL EARTH PRESSURES

	A	B	C	D	E (TRAFFIC)	F (SEISMIC)
ACTIVE	35 PCF	-	-	-	70 PSF	6H PSF
PASSIVE	-	-	300 PCF	-	-	-

LEGEND:

H TOTAL HEIGHT OF EXCAVATION (FEET)

D EMBEDMENT DEPTH (FEET)

A, B, C, ... EARTH PRESSURE FACTORS (SEE TABLE)

1. MINIMUM RECOMMENDED EMBEDMENT (D) IS 8 FEET.
2. PASSIVE PRESSURES ARE ALLOWABLE VALUES AND INCLUDE A 1.5 FACTOR OF SAFETY.
3. PASSIVE PRESSURE ACTS OVER 2.5 TIMES THE CONCRETED DIAMETER OF THE SOLDIER PILE OR THE PILE SPACING, WHICHEVER IS LESS.
4. APPARENT EARTH PRESSURE AND SURCHARGE ACT OVER THE PILE SPACING ABOVE THE BASE OF THE EXCAVATION.
5. ADDITIONAL SURCHARGE FROM FOOTINGS, LARGE STOCKPILES, HEAVY EQUIPMENT, ETC. MUST BE ADDED TO THESE PRESSURES.
6. ALL DIMENSIONS ARE IN FEET.
7. DIAGRAM IS NOT TO SCALE.

GEODESIGN INC AN NV5 COMPANY	DKS-13-01	**LATERAL EARTH PRESSURES**	
	FEBRUARY 2021	47TH AND DASH POINT ROAD ROUNDABOUT FEDERAL WAY, WA	**FIGURE 1**