Ground Support PLLC

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Design Memorandum

PROJECT: Hu Residence (Project No. 20-50)

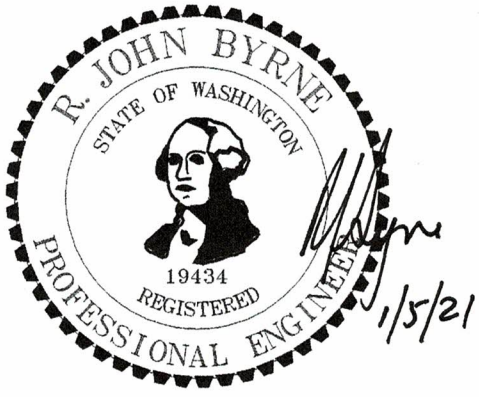
ADDRESS: 30xx – 69th Avenue SE
Mercer Island, WA

CLIENT: DHS Engineers
Attn: Dihong Shao
1601 5th Avenue, Suite 1100
Seattle, WA 98101

DATE: January 5, 2021

REFERENCES:

1. "Geotechnical Engineering Evaluation, Hu Residence Development, 30xx – 69th Avenue SE, Mercer Island, Washington", prepared by Nelson Geotechnical Associates, Inc., dated July 10, 2020
2. 2015 International Building Code.
3. "Geotechnical Engineering Circular No. 4, Ground Anchors and Anchored Systems", FHWA, dated June 1999.



BACKGROUND:

The planned residence is located at 30xx – 69th Avenue SE in the city of Mercer Island, Washington and consists of a three-level structure that includes two partially underground levels. The site is bounded to the north, east and south by private properties and to the west by 69th Avenue SE.

The site slopes steeply to the west. The planned residence will be located centrally within the site and cut into the east-facing slope. Excavation depths along the east side will be up to about 20 feet. Approximately 3,400 SF of shoring will be required to construct the residence and the majority of this shoring will also function as a permanent earth retaining wall to eliminate lateral earth pressures from the structure.

SUBSURFACE CONDITIONS:

The geotechnical report indicates that the site is underlain by surficial silt/sand fill which overlies native advance outwash silty sand soils and stiff to hard Lawton Clay deposits. Perched groundwater might also be encountered during construction.

RETAINING WALL SYSTEM:

The temporary shoring and permanent retaining wall system will consist of cantilevered and anchored soldier piles with temporary wood lagging. All soldier piles and ground anchors will be contained within the subject property. The subsurface building walls will be structurally attached to the soldier piles and serve as permanent facing for the earth retention system. In addition, the perimeter soldier piles will also serve as the deep foundations for the building wall loads. The construction sequence following pile installation will consist of sequential excavation and lagging, and installation and testing of anchors at the design elevations, until the bottom of the excavation is reached.

DESIGN PARAMETERS:

Design earth pressures corresponding to the soil self-weight are recommended in the geotechnical report. For the soldier pile and anchor design, a soil self-weight corresponding to 40 pcf was used in general. For the soldier piles along the east side of the excavation that directly support the upper slope, the design earth pressure was increased to 50 pcf.

Live load lateral surcharge pressures were taken as 50 psf. For the permanent retaining wall design, a seismic lateral earth pressure of 8H (psf) was used.

Footing loads to be supported by the perimeter retaining wall piles were specified by the structural engineer as 4 kips per linear foot.

The following design values were used to evaluate the depth of embedment of the soldier piles below the base of the excavation:

Passive Equivalent Fluid Density	200 pcf over 2 pile diameters
Allowable Pile End Bearing	20 ksf
Allowable Pile Skin Friction	1 ksf

DESIGN:

Anchors:

Individual anchor loads are developed from the design earth pressure diagrams presented on the Plans, using a tributary area method to assign loads to the individual anchors and to the toe shear in the piles. Anchor lengths are then determined from the no-load zone (see Plans) and the required bond zone. The length of the bond zone is determined from the anchor design load and the allowable pullout value. An allowable pullout resistance of 3 kips per linear foot (klf) has been used. Anchor designs are presented in Appendix A (Table A1 for the temporary shoring condition and Table A2 for the permanent retaining wall condition).

Soldier Piles:

Soldier pile loadings are determined from the design earth pressure diagrams and the locations and inclinations of the anchors. The spreadsheet output presented in Appendix B (Table B1 for temporary shoring condition and Table B2 for the permanent retaining wall condition) summarizes the following design aspects:

- Calculation of soldier pile loads and bending moments, consistent with the design apparent earth pressure diagrams provided on the Plans. For each soldier pile, the calculated shear force, axial load and bending moment are provided. Representative earth pressure diagrams, together with calculated shear force and bending moment diagrams, are shown for a number of piles, in Appendix B.
- Calculation of pile toe embedment requirements using the criteria indicated on the Plans.
- Pile structural steel sizing in accordance with the AISC 360-10 Specification for Structural Steel Buildings. Combined flexure and axial load, shear, and compact section steel design checks are performed for the critically loaded section of each pile along the length of the wall. The spreadsheet output summarizes the minimum steel section required for each pile.

Similar information is provided in Appendix C for the Stage 1 cantilevered condition prior to installation of the top row of anchors.

Anchor/Pile Connections:

The designs of the connections of the anchors to the soldier piles are summarized in Table 1. Required weld lengths and connection plate sizes were determined in accordance with AISC 360-10 and for Grade 36 steel plates and E70XX weld electrodes.

Lagging:

Timber lagging will be used to support the soil between adjacent soldier piles. The average design earth pressures for the lagging are indicated in Appendix A, and these design earth pressures are derived directly from the design earth pressure diagrams. Hem-Fir No. 2 lagging (4-inch) or equivalent will provide adequate support for the soil between the soldier piles, per the recommendations of the FHWA Engineering Circular No. 4.

Permanent Facing:

The building structure will comprise the permanent facing for the retaining wall system. The facing will be attached to the soldier piles by embedded headed studs. Facing design is presented in the structural plans.

TABLES

ANCHOR POCKET DESIGN SPREADSHEET **VERSION 2.0 (7/24/01)**

DESIGN ASSUMPTIONS

E70XX Electrodes For All Welding
Cover Plates Welded to Flange at Each End, Along Narrow End & Returned Down Edge Along Pile Web
Web Stiffener Plates Are Full Depth, Are Flush At Bearing End, & Welded Full Length & Along Bearing End On One Side Only

CONNECTION INPUT DATA

Case	Pile Section	Pile Grade (ksi)	Plate Steel Grade (ksi)	Design Anchor Load (k)	Actual Design Pile Moment (ft-k)	Max Design Pile Moment (ft-k)	Flange Width b_f (in)	Flange Thick t_f (in)	Beam Depth d (in)	Web Thick t_w (in)	Max Cutout Width (in)	Max Cutout Area (in^2)
1	W18x50	50.0	36.0	80.0	244.5	244.5	7.500	0.570	18.000	0.355	3.57	2.04
2	W18x55	50.0	36.0	80.0	270.3	270.3	7.530	0.630	18.100	0.390	3.57	2.25

DESIGN CALCULATIONS FOR COVER PLATE

Case	Max Cutout Force (k)	Design Cutout Force (k)	Cover Plate E70XX Weld Size (in)	Req'd Weld Length L (in)	Design Weld Length L (in)	Design Weld Width (in)	Req'd Weld Return Length (in)	Design Cover Plate Thick (in)	Req'd Cover Plate Width (in)	Design Cover Plate Width (in)	Req'd Cover Plate Length (in)	Design Cover Plate Length (in)
1	67.2	67.2	0.3125	14.5	14.5	2.5	12.0	0.750	3.77	4.00	30.0	30.0
2	74.2	74.2	0.3125	16.0	16.0	2.5	13.5	0.750	4.17	4.00	33.0	33.0

DESIGN CALCULATIONS FOR WEB STIFFENER

Case	Single Stiffener Force (k)	Total Stiffener E70XX Weld Size (in)	Stiffener Thickness (in)	Req'd Weld Length (in)	Design Weld & Stiffener Length (in)	Req'd Stiffener Compress Area (in^2)	Req'd Stiffener Width (in)	Design Stiffener Width (in)	Stiffener "b/t" Ratio	Allowable Stiffener "b/t" Ratio
1	40.0	0.2500	0.500	10.8	16.0	1.852	3.7	4.0	8.0	10.7
2	40.0	0.2500	0.500	10.8	16.0	1.852	3.7	4.0	8.0	10.7

TABLE 1
ANCHOR POCKET DESIGN

APPENDIX A

ANCHOR DESIGN

							Anchor 1						Design	Pile Top	Pile Toe	Pile Toe	Pile	Lagging
					$L=NH^2$	Unif. Press.	Elevation	Angle	Anchor Load	Bar	Total Length	Bond Length	Beam	Elevation	Embed	Elevation	Length	Pressure
Pile ID	Station (ft)	Height (ft)	Spacing (ft)	No. Anchors	N (psf/ft)	P (psf)	(feet)	(degrees)	(kips)	Size	(feet)	(feet)		(feet)	(feet)	(feet)	(feet)	(psf)
N1	7.5	9.4	8	0	20	50	0.00	0	0	0	0.0	0.0	W14x48	247.0	17.3	219.0	28.0	426
N2	15.5	9.4	8	0	20	50	0.00	0	0	0	0.0	0.0	W14x48	247.0	17.3	219.0	28.0	426
N3	19.5	9.4	5.25	0	20	50	0.00	0	0	0	0.0	0.0	W14x34	247.0	14.7	222.0	25.0	426
N4	26	9.4	6.5	0	20	50	0.00	0	0	0	0.0	0.0	W14x38	247.0	16.0	221.0	26.0	426
N5	32.5	9.4	6.05	0	20	50	0.00	0	0	0	0.0	0.0	W14x34	247.0	15.5	221.0	26.0	426
N6	38.1	9.4	6.8	0	20	50	0.00	0	0	0	0.0	0.0	W14x38	247.0	16.2	220.0	27.0	426
N7	46.1	9.4	5.95	0	20	50	0.00	0	0	0	0.0	0.0	W14x34	247.0	15.4	221.0	26.0	426
N8	50	9.4	5.75	0	20	50	0.00	0	0	0	0.0	0.0	W14x34	247.0	15.2	221.0	26.0	426
N9	57.6	9.4	5.75	0	20	50	0.00	0	0	0	0.0	0.0	W14x34	247.0	15.2	221.0	26.0	426
N10	61.5	12.4	5.2	0	20	50	0.00	0	0	0	0.0	0.0	W14x53	250.0	18.7	218.0	32.0	546
N11	68	12.4	5.65	0	20	50	0.00	0	0	0	0.0	0.0	W18x50	250.0	17.8	219.0	31.0	546
N12	72.8	21.0	6.7	1	20	50	251.00	45	66	No. 11	34.2	22.2	W14x53	258.0	10.3	226.0	32.0	890
E1	102.5	22.5	5.5	1	25	50	251.50	45	77	1-1/4-inch	38.2	25.6	W18x55	260.0	10.2	226.0	34.0	1175
E2	108.5	22.5	5	1	25	50	251.00	20	54	No. 10	30.1	18.0	W14x53	260.0	10.4	226.0	34.0	1175
E3	112.5	23.5	4.85	1	20	50	252.50	20	44	No. 9	27.9	14.8	W14x53	261.0	10.3	226.0	35.0	989
E4	118.2	20.5	6.1	1	25	50	251.00	45	69	No. 11	35.0	23.1	W18x50	258.0	9.8	227.0	31.0	1075
E5	124.7	20.5	6.5	1	25	50	251.00	45	74	1-inch	36.6	24.7	W18x55	258.0	10.0	226.0	32.0	1075
E6	131.2	20.5	6.5	1	25	50	251.00	45	74	1-inch	36.6	24.7	W18x55	258.0	10.0	226.0	32.0	1075
E7	137.7	20.5	6.5	1	25	50	251.00	35	64	No. 11	32.8	21.3	W18x50	258.0	10.0	226.0	32.0	1075
E8	144.2	20.5	6.15	1	25	50	251.00	20	53	No. 10	29.3	17.6	W18x50	258.0	9.9	227.0	31.0	1075
E9	150	20.1	6.9	1	20	50	250.00	40	59	No. 11	30.9	19.8	W14x48	258.0	9.8	227.0	31.0	854
E10	158	20.1	8	1	20	50	251.00	35	61	No. 11	31.9	20.5	W18x50	258.0	9.9	227.0	31.0	854
E11	166	20.1	8.25	1	20	50	250.00	40	71	1-inch	34.8	23.7	W18x50	258.0	9.7	227.0	31.0	854
E12	174.5	20.1	8.25	1	20	50	251.00	20	55	No. 10	30.1	18.5	W18x50	258.0	10.0	226.0	32.0	854
S1	202.5	16.9	5	0	20	50	0.00	0	0	0	0.0	0.0	W18x97	254.0	22.6	214.0	40.0	727
S2	208.5	15.6	6	0	20	50	0.00	0	0	0	0.0	0.0	W18x97	253.0	22.4	214.0	39.0	673
S3	214.5	9.5	6.5	0	20	50	0.00	0	0	0	0.0	0.0	W14x38	247.0	16.1	220.0	27.0	430
S4	221.5	10.0	6.75	0	20	50	0.00	0	0	0	0.0	0.0	W14x43	247.0	17.1	219.0	28.0	450
S5	228	10.0	5.75	0	20	50	0.00	0	0	0	0.0	0.0	W14x38	247.0	16.1	220.0	27.0	450
S6	233	13.6	6.5	0	20	50	0.00	0	0	0	0.0	0.0	W18x71	250.0	20.4	215.0	35.0	596
S7	241	12.8	8	0	20	50	0.00	0	0	0	0.0	0.0	W18x76	249.0	20.8	215.0	34.0	561
S8	249	9.7	8	0	20	50	0.00	0	0	0	0.0	0.0	W14x48	246.0	17.8	217.0	29.0	439
NA1	300.5	9.5	4	0	25	50	0.00	0	0	0	0.0	0.0	W14x34	258.0	14.4	233.0	25.0	525
NA2	306.5	9.5	5.4	0	25	50	0.00	0	0	0	0.0	0.0	W14x38	258.0	16.1	231.0	27.0	525
NA3	311.3	8.8	6.4	0	0	50	0.00	0	0	0	0.0	0.0	W14x34	257.0	9.3	238.0	19.0	50
NA4	319.3	9.4	8	0	0	50	0.00	0	0	0	0.0	0.0	W14x34	255.0	10.3	234.0	21.0	50
NA5	327.3	6.4	8	0	0	50	0.00	0	0	0	0.0	0.0	W14x34	252.0	8.3	236.0	16.0	50

TABLE A1
ANCHOR DESIGN - TEMPORARY SHORING

							Anchor 1						Design	Pile Top	Pile Toe	Pile Toe	Pile	Lagging
					$L=NH^2$	Unif. Press.	Elevation	Angle	Anchor Load	Bar	Total Length	Bond Length	Beam	Elevation	Embed	Elevation	Length	Pressure
Pile ID	Station (ft)	Height (ft)	Spacing (ft)	No. Anchors	N (psf/ft)	P (psf)	(feet)	(degrees)	(kips)	Size	(feet)	(feet)		(feet)	(feet)	(feet)	(feet)	(psf)
N3	19.5	8.4	5.25	0	20	73	0.00	0	0	0	0.0	0.0	W14x34	247.0	13.9	224.0	23.0	409
N4	26	8.4	6.5	0	20	73	0.00	0	0	0	0.0	0.0	W14x34	247.0	15.1	222.0	25.0	409
N5	32.5	8.4	6.05	0	20	73	0.00	0	0	0	0.0	0.0	W14x34	247.0	14.7	223.0	24.0	409
N6	38.1	8.4	6.8	0	20	73	0.00	0	0	0	0.0	0.0	W14x34	247.0	15.3	222.0	25.0	409
N7	46.1	8.4	5.95	0	20	73	0.00	0	0	0	0.0	0.0	W14x34	247.0	14.6	223.0	24.0	409
N8	50	8.4	5.75	0	20	73	0.00	0	0	0	0.0	0.0	W14x34	247.0	14.4	223.0	24.0	409
N9	57.6	8.4	5.75	0	20	73	0.00	0	0	0	0.0	0.0	W14x34	247.0	14.4	223.0	24.0	409
N10	61.5	11.4	5.2	0	20	85	0.00	0	0	0	0.0	0.0	W14x53	250.0	18.2	219.0	31.0	541
N11	68	11.4	5.65	0	20	85	0.00	0	0	0	0.0	0.0	W18x50	250.0	17.3	220.0	30.0	541
N12	72.8	20.0	6.7	1	20	122	251.00	45	73	1-inch	35.8	24.5	W14x53	258.0	9.9	228.0	30.0	922
E1	102.5	21.5	5.5	1	25	128	251.50	45	83	1-1/4-inch	39.6	27.7	W18x50	260.0	9.8	228.0	32.0	1203
E2	108.5	21.5	5	1	25	128	251.00	20	58	No. 11	30.8	19.4	W14x48	260.0	9.9	228.0	32.0	1203
E3	112.5	22.5	4.85	1	20	132	252.50	20	50	No. 10	29.0	16.6	W14x48	261.0	10.0	227.0	34.0	1031
E4	118.2	19.5	6.1	1	25	119	251.00	45	74	1-inch	35.8	24.7	W18x50	258.0	9.5	228.0	30.0	1094
E5	124.7	19.5	6.5	1	25	119	251.00	45	79	1-1/4-inch	37.5	26.4	W18x50	258.0	9.7	228.0	30.0	1094
E6	131.2	19.5	6.5	1	25	119	251.00	45	79	1-1/4-inch	37.5	26.4	W18x50	258.0	9.7	228.0	30.0	1094
E7	137.7	19.5	6.5	1	25	119	251.00	35	68	No. 11	33.6	22.8	W18x50	258.0	9.7	228.0	30.0	1094
E8	144.2	19.5	6.15	1	25	119	251.00	20	56	No. 10	29.8	18.9	W14x53	258.0	10.2	227.0	31.0	1094
E9	150	19.1	6.9	1	20	118	250.00	40	65	No. 11	32.1	21.8	W14x43	258.0	9.4	228.0	30.0	882
E10	158	19.1	8	1	20	118	251.00	35	67	No. 11	33.2	22.5	W18x50	258.0	9.6	228.0	30.0	882
E11	166	19.1	8.25	1	20	118	250.00	40	78	1-1/4-inch	36.4	26.1	W14x53	258.0	9.9	228.0	30.0	882
E12	174.5	19.1	8.25	1	20	118	251.00	20	61	No. 11	31.1	20.3	W18x50	258.0	9.7	228.0	30.0	882
S1	202.5	15.9	5	0	20	104	0.00	0	0	0	0.0	0.0	W18x97	254.0	22.5	215.0	39.0	742
S2	208.5	14.6	6	0	20	99	0.00	0	0	0	0.0	0.0	W18x97	253.0	22.2	215.0	38.0	681
S3	214.5	8.5	6.5	0	20	73	0.00	0	0	0	0.0	0.0	W14x34	247.0	15.2	222.0	25.0	413
S4	221.5	9.0	6.75	0	20	75	0.00	0	0	0	0.0	0.0	W14x43	247.0	16.3	221.0	26.0	435
S5	228	9.0	5.75	0	20	75	0.00	0	0	0	0.0	0.0	W14x34	247.0	15.3	222.0	25.0	435
S6	233	12.6	6.5	0	20	91	0.00	0	0	0	0.0	0.0	W18x71	250.0	20.1	217.0	33.0	596
S7	241	11.8	8	0	20	87	0.00	0	0	0	0.0	0.0	W18x76	249.0	20.3	216.0	33.0	558
S8	249	8.7	8	0	20	74	0.00	0	0	0	0.0	0.0	W14x43	246.0	16.9	219.0	27.0	423
NA1	300.5	8.5	4	0	25	73	0.00	0	0	0	0.0	0.0	W14x34	258.0	13.5	235.0	23.0	498
NA2	306.5	8.5	5.4	0	25	73	0.00	0	0	0	0.0	0.0	W14x34	258.0	15.1	233.0	25.0	498
NA3	311.3	7.8	6.4	0	0	70	0.00	0	0	0	0.0	0.0	W14x34	257.0	9.6	239.0	18.0	70
NA4	319.3	8.4	8	0	0	73	0.00	0	0	0	0.0	0.0	W14x34	255.0	10.9	235.0	20.0	73
NA5	327.3	5.4	8	0	0	60	0.00	0	0	0	0.0	0.0	W14x34	252.0	8.0	237.0	15.0	60

TABLE A2
ANCHOR DESIGN - PERMANENT WALL

APPENDIX B

SOLDIER PILE DESIGN

		Soldier Beam Loads-Below Anchor 1					Pile Vertical Load Analysis								Toe Dist. Depth (ft) 2
Pile ID	Design Beam	Axial Load (kips)	Moment (ft-kips)	Free Length (feet)	Steel Section	Flex/Ax Ratio	Pile Diameter (ft)	Pile End Area (ft^2)	Pile Skin Area (ft^2/ft)	Pile End Bear (ksf)	Pile Skin Frict (ksf)	End Bearing (kips)	Skin Friction (klf)	Axial Load (kips)	Embed Length (ft)
N1	W14x48	0	179	9.40	W14x48	0.91	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
N2	W14x48	0	179	9.40	W14x48	0.91	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
N3	W14x34	0	109	9.40	W14x34	0.80	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
N4	W14x38	0	140	9.40	W14x38	0.91	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
N5	W14x34	0	129	9.40	W14x34	0.94	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
N6	W14x38	0	148	9.40	W14x38	0.96	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
N7	W14x34	0	126	9.40	W14x34	0.93	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
N8	W14x34	0	121	9.40	W14x34	0.89	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
N9	W14x34	0	121	9.40	W14x34	0.89	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
N10	W14x53	0	224	12.40	W14x53	0.99	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
N11	W18x50	0	238	12.40	W18x50	0.94	2.50	4.91	7.85	20.00	1.00	98.2	7.9	0	0.0
N12	W14x53	47	202	14.00	W14x53	1.00	2.00	3.14	6.28	20.00	1.00	62.8	6.3	47	-0.5
E1	W18x55	54	233	14.50	W18x55	0.90	2.50	4.91	7.85	20.00	1.00	98.2	7.9	54	-3.6
E2	W14x53	18	199	14.00	W14x53	0.94	2.00	3.14	6.28	20.00	1.00	62.8	6.3	18	-5.1
E3	W14x53	15	195	15.50	W14x53	0.92	2.00	3.14	6.28	20.00	1.00	62.8	6.3	15	-5.6
E4	W18x50	49	220	14.00	W18x50	0.94	2.50	4.91	7.85	20.00	1.00	98.2	7.9	49	-4.3
E5	W18x55	52	236	14.00	W18x55	0.91	2.50	4.91	7.85	20.00	1.00	98.2	7.9	52	-3.8
E6	W18x55	52	236	14.00	W18x55	0.91	2.50	4.91	7.85	20.00	1.00	98.2	7.9	52	-3.8
E7	W18x50	37	236	14.00	W18x50	0.99	2.50	4.91	7.85	20.00	1.00	98.2	7.9	37	-5.8
E8	W18x50	18	222	14.00	W18x50	0.91	2.50	4.91	7.85	20.00	1.00	98.2	7.9	18	-8.2
E9	W14x48	38	174	13.00	W14x48	0.94	2.00	3.14	6.28	20.00	1.00	62.8	6.3	38	-1.9
E10	W18x50	35	230	14.00	W18x50	0.96	2.50	4.91	7.85	20.00	1.00	98.2	7.9	35	-6.0
E11	W18x50	46	207	13.00	W18x50	0.88	2.50	4.91	7.85	20.00	1.00	98.2	7.9	46	-4.7
E12	W18x50	19	237	14.00	W18x50	0.97	2.50	4.91	7.85	20.00	1.00	98.2	7.9	19	-8.1
S1	W18x97	0	482	16.93	W18x97	0.91	2.50	4.91	7.85	20.00	1.00	98.2	7.9	0	0.0
S2	W18x97	0	473	15.57	W18x97	0.90	2.50	4.91	7.85	20.00	1.00	98.2	7.9	0	0.0
S3	W14x38	0	144	9.50	W14x38	0.94	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
S4	W14x43	0	172	10.00	W14x43	0.99	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
S5	W14x38	0	143	10.00	W14x38	0.93	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
S6	W18x71	0	362	13.64	W18x71	0.99	2.50	4.91	7.85	20.00	1.00	98.2	7.9	0	0.0
S7	W18x76	0	387	12.77	W18x76	0.95	2.50	4.91	7.85	20.00	1.00	98.2	7.9	0	0.0
S8	W14x48	0	195	9.71	W14x48	1.00	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
NA1	W14x34	0	101	9.50	W14x34	0.74	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
NA2	W14x38	0	142	9.50	W14x38	0.93	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
NA3	W14x34	0	26	8.75	W14x34	0.19	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
NA4	W14x34	0	36	9.36	W14x34	0.27	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0
NA5	W14x34	0	19	6.40	W14x34	0.14	2.00	3.14	6.28	20.00	1.00	62.8	6.3	0	0.0

TABLE B1
SOLDIER PILE DESIGN - TEMPORARY SHORING

Wall Height (ft)	12.40
Depth of Embed (ft)	18.74
Depth to Top of Passive (ft)	14.40

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	A1	50.0		12.40	5.20	3224		6.20	24.94	80410
	A2		40.0	12.40	5.20		15991	8.27	22.87	365786
	A3	496.0		18.74	2.00	18591		21.77	9.37	174210
	A4		40.0	18.74	2.00		14049	24.89	6.25	87766
Resisting	P1	400.0		16.74	4.00	26786		22.77	8.37	224212
	P2		200.0	16.74	4.00		112106	25.56	5.58	625595
	P3	0.0		0.00	4.00	0		31.14	0.00	0
	P4		0.0	0.00	4.00		0	31.14	0.00	0

Moments about pile toe

Sum of resisting moments (ft-lbf)	849807
Sum of driving moments (ft-lbf)	708173
FS	1.20

Depth to Zero Shear (ft) at "M"	21.51

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	a1	50.0		12.40	5.20	3224		6.20	15.31	49345
	a2		40.0	12.40	5.20		15991	8.27	13.24	211703
	a3	496.0		9.11	2.00	9033		16.95	4.55	41124
	a4		40.0	9.11	2.00		3316	18.47	3.04	10066
Resisting	p1	400.0		7.11	4.00	11369		17.95	3.55	40391
	p2		200.0	7.11	4.00		20195	19.14	2.37	47833
	p3	0.0		0.00	4.00	0		0.00	21.51	0
	p4		0.0	0.00	4.00		0	0.00	21.51	0

Moments at Zero Shear Point

Sum of shear forces (lbf) at "M"	0
Sum of moments (ft-lbf) at "M"	224014

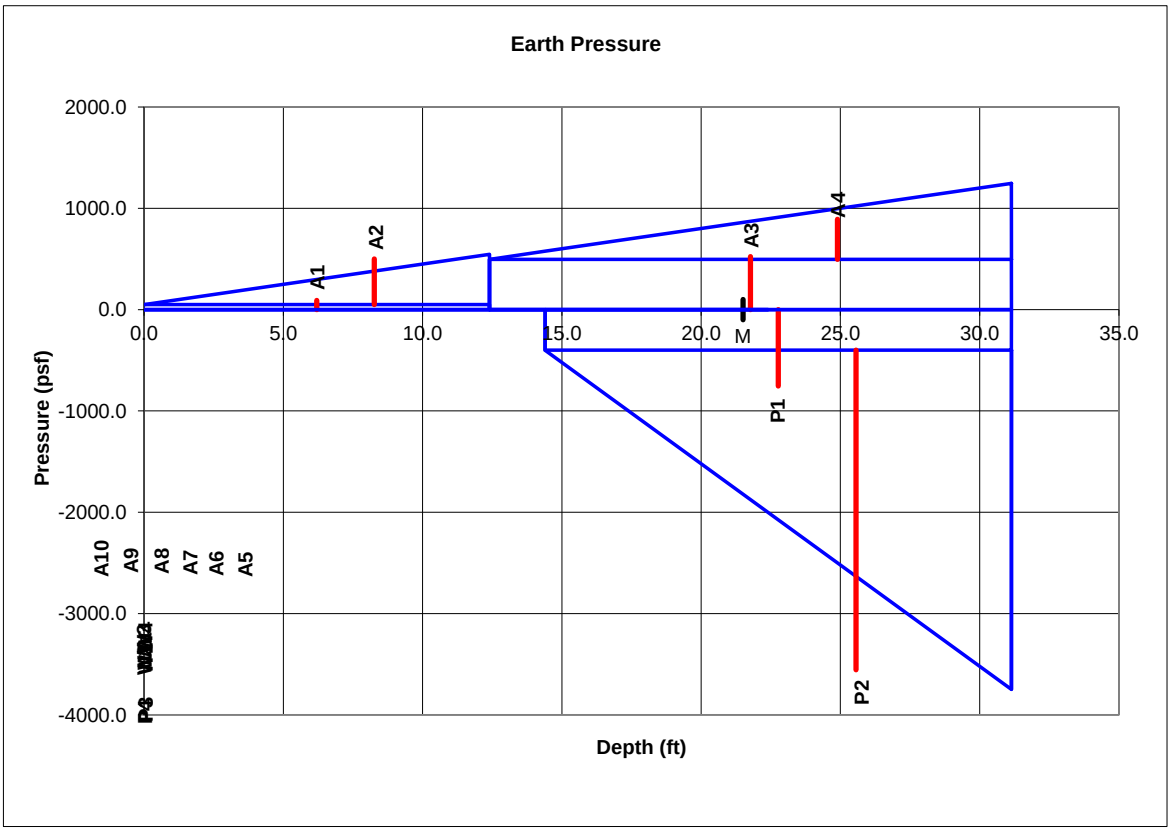
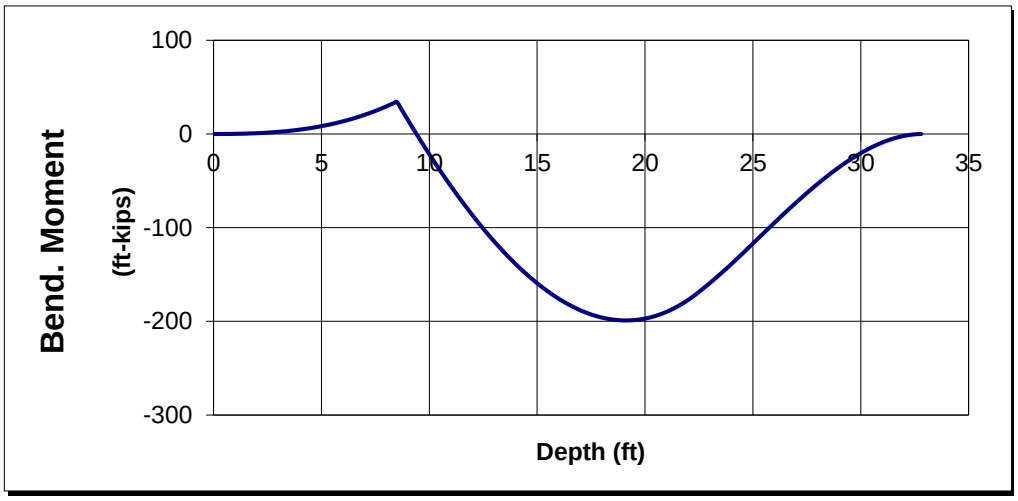
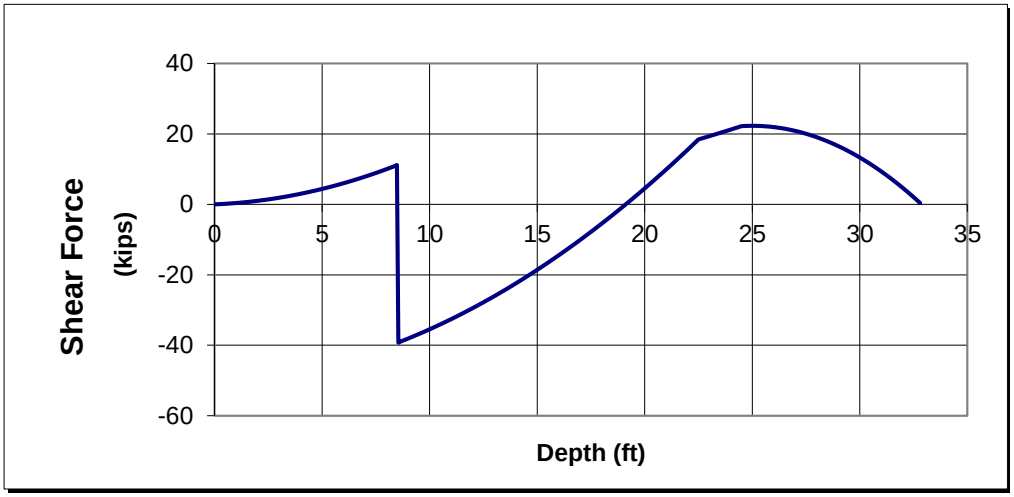
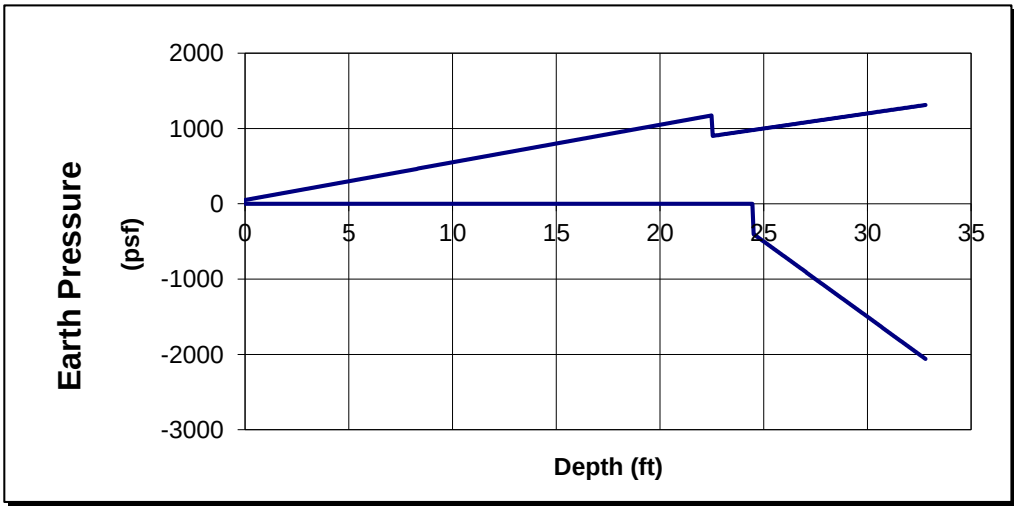


FIGURE B1 SOLDIER BEAM - N10







Wall Height (ft)	**22.5**
Pile Spacing (ft)	**5.00**

FIGURE B2 SOLDIER BEAM - E2

Point	Depth	Pressure	Width		Force	Depth(CG)	Moment
A	0.00	0.0	5.00	F_{AB}	63281	15.00	1130751
B	22.50	1125.0	5.00	F_{BC}	0	0.00	0
C	22.50	1125.0	5.00	F_{CD}	0	0.00	0
D	22.50	0.0	5.00	F_{AD}	63281	15.00	
	22.50	0.0					
E	22.50	900.0	2.00	F_{EF}	22964	28.01	111621
F	32.87	1314.7	2.00				
	32.87	0.0					
G	24.50	0.0	4.00	F_{GH}	0	0.00	0
H	24.50	-400.0	4.00	F_{HI}	-41404	29.63	-134173
I	32.87	-2073.7	4.00	F_{IJ}	0	0.00	0
J	32.87	-2073.7	4.00	F_{JK}	0	0.00	0
K	32.87	-2073.7	4.00	F_{GK}	-41404	29.63	
	32.87	0.0					
	0.00	0.0					
L	0.00	50.0	5.00	F_{LM}	5625	11.25	121605
M	22.50	50.0	5.00				
	22.50	0.0					
	0.00	0.0					
N	0.00	0.0	5.00	F_{NO}	0	0.00	0
O	0.00	0.0	5.00				
	0.00	0.0					
	0.00	0.0					
P	0.00	0.0	5.00	F_{PQ}	0	0.00	0
Q	0.00	0.0	5.00				
	0.00	0.0					
	0.00	0.0					
R	0.00	0.0	5.00	F_{RS}	0	0.00	0
S	0.00	0.0	5.00				
	0.00	0.0					
T	22.50	0.0	5.00	F_{TU}	0	0.00	0
U	22.50	0.0	5.00	F_{UV}	0	0.00	0
V	22.50	0.0	5.00	F_{VW}	0	0.00	0
W	32.50	0.0	5.00	F_{TW}	0	0.00	
	32.50	0					
				Anchor 1	50467	8.50	1229803
				Amchor 2	0	0.00	0
				Anchor 3	0	0.00	0
				Anchor 4	0	0.00	0
				Load 1	0	0.00	0
				Σ Forces	0	Σ Moments	0

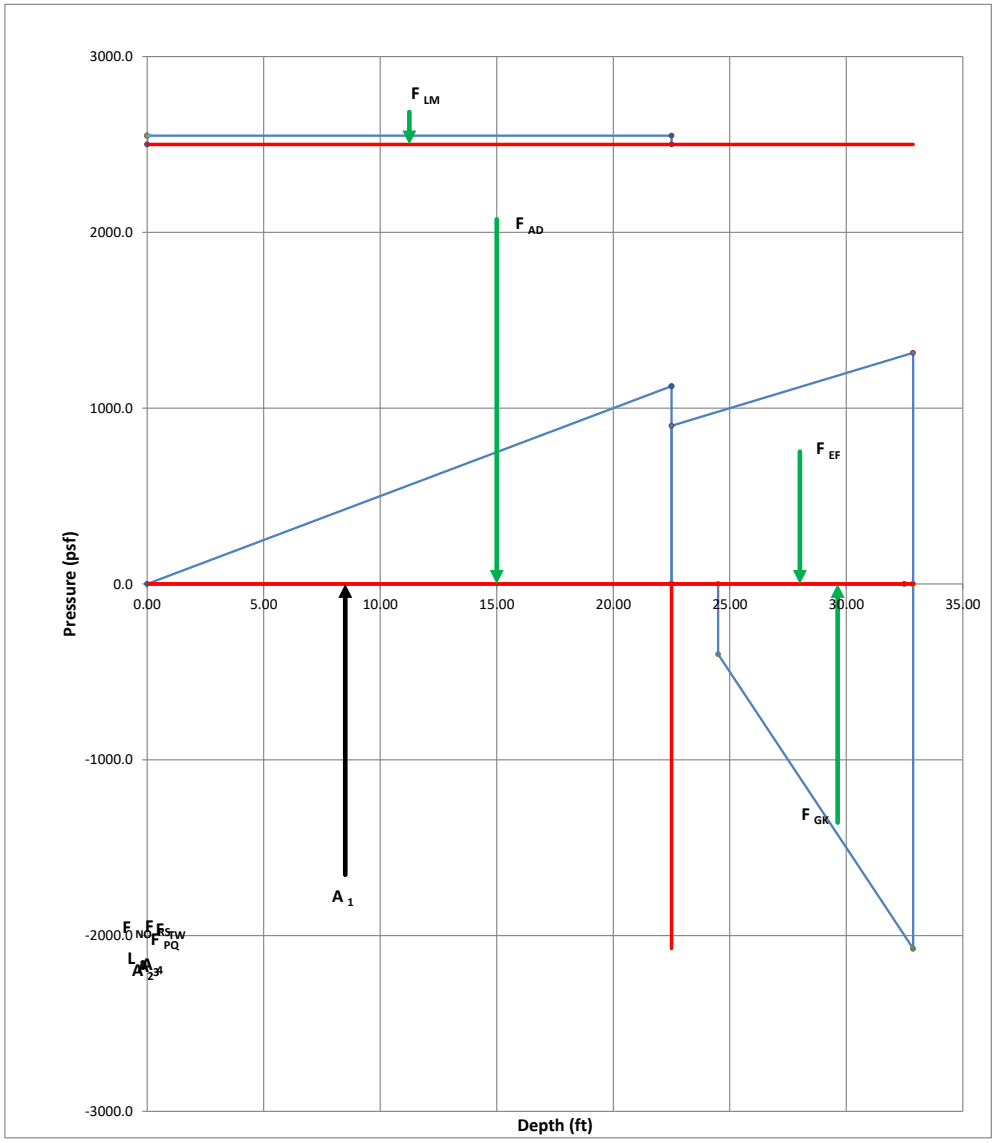
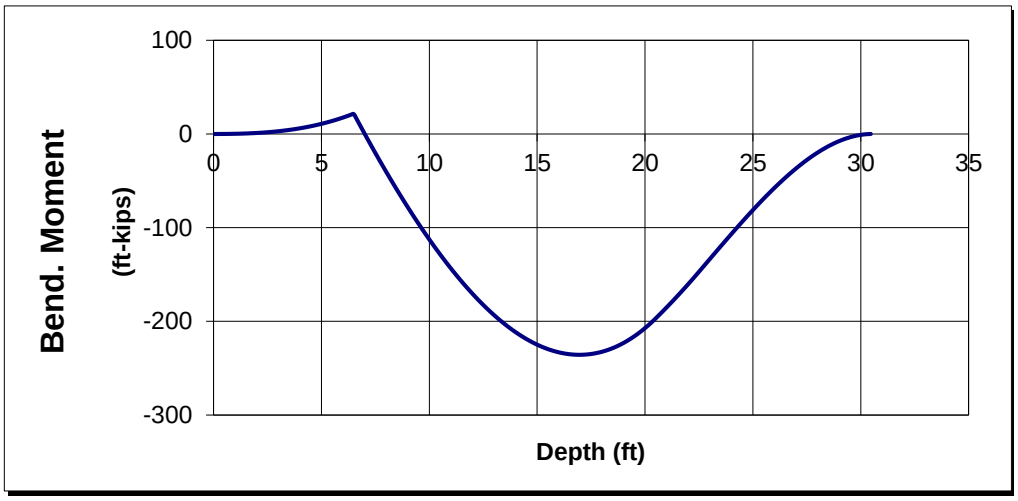
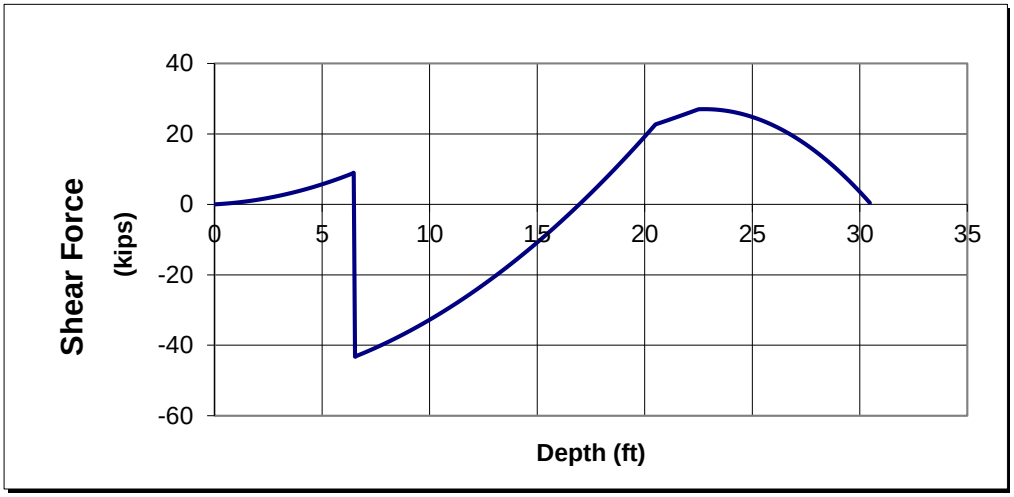
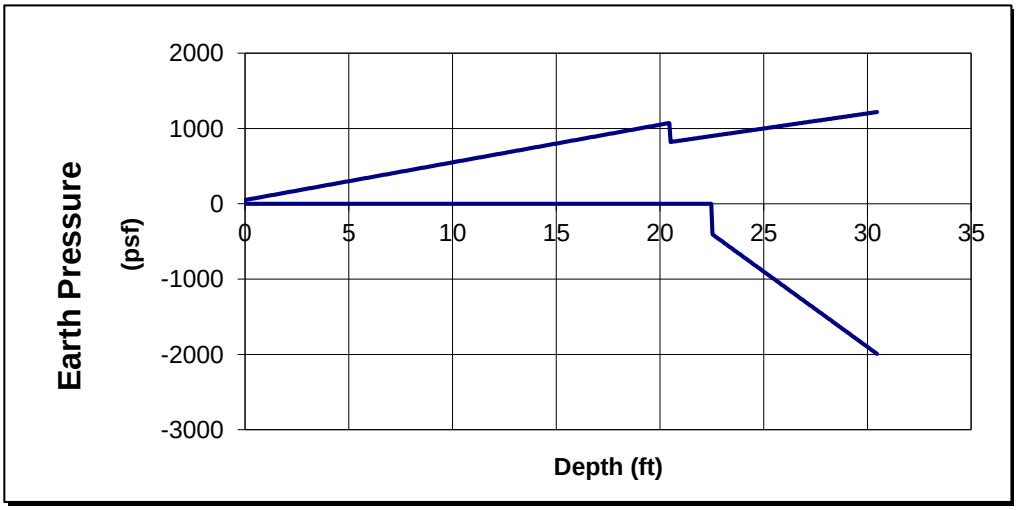


FIGURE B2 (cont'd) SOLDIER BEAM - E2

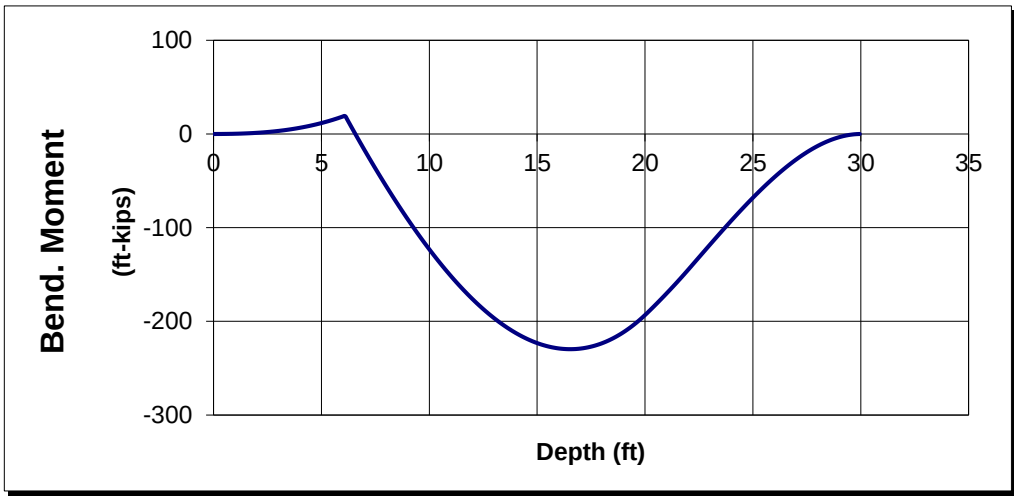


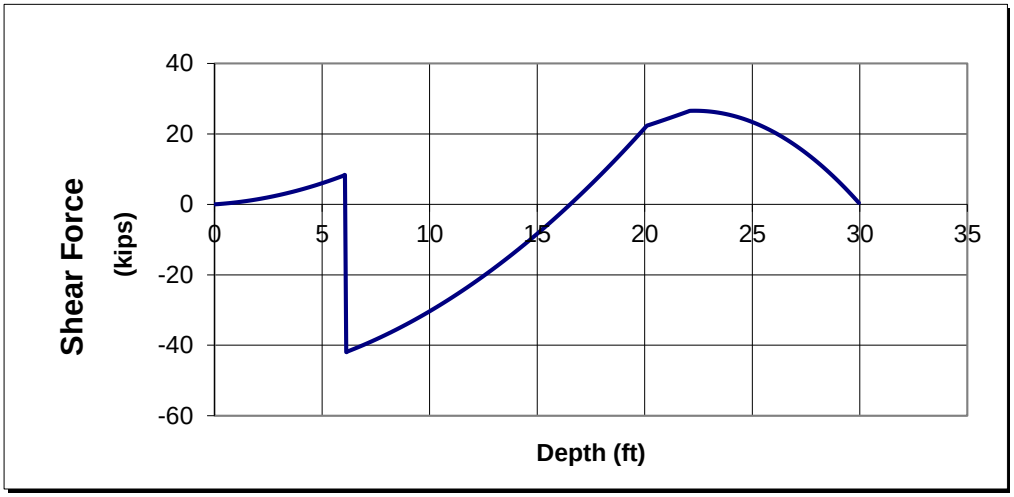


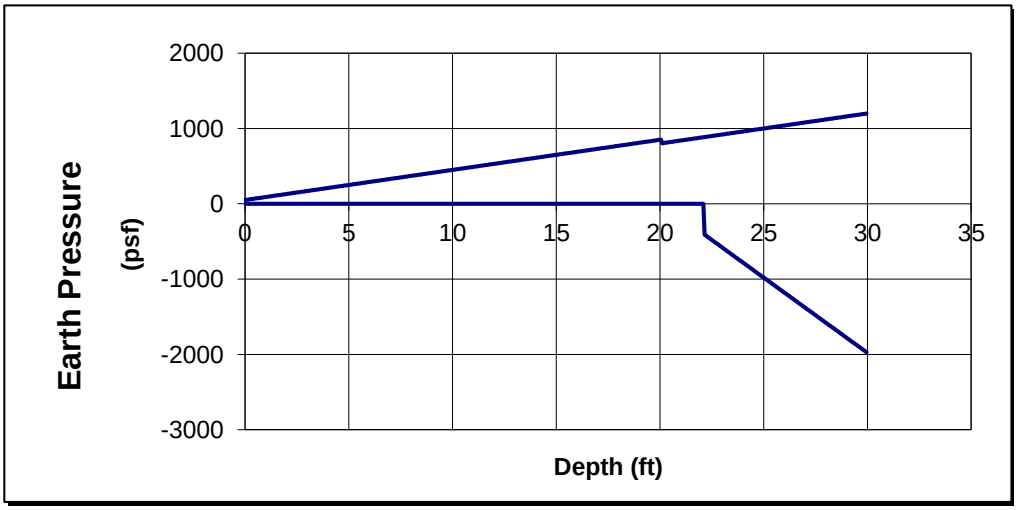


Wall Height (ft)	**20.5**
Pile Spacing (ft)	**6.50**

FIGURE B3 SOLDIER BEAM - E7







Wall Height (ft)	**20.1**
Pile Spacing (ft)	**8.00**

FIGURE B4 SOLDIER BEAM - E10

Wall Height (ft)	16.93
Depth of Embed (ft)	22.58
Depth to Top of Passive (ft)	18.93

	Force	p (psf)	Kγ (psf)	h (ft)	w (ft)	phw (lbf)	Kγ h²w/2 (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	A1	50.0		16.93	5.00	4233		8.47	31.05	131435
	A2		40.0	16.93	5.00		28669	11.29	28.23	809272
	A3	677.3		22.58	2.50	38240		28.22	11.29	431813
	A4		40.0	22.58	2.50		25503	31.99	7.53	191992
Resisting	P1	400.0		20.58	5.00	41169		29.22	10.29	423723
	P2		200.0	20.58	5.00		211862	32.65	6.86	1453692
	P3	0.0		0.00	5.00	0		39.52	0.00	0
	P4		0.0	0.00	5.00		0	39.52	0.00	0

Moments about pile toe

Sum of resisting moments (ft-lbf)	1877415
Sum of driving moments (ft-lbf)	1564513
FS	1.20

Depth to Zero Shear (ft) at "M"	27.82

	Force	p (psf)	Kγ (psf)	h (ft)	w (ft)	phw (lbf)	Kγ h²w/2 (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	a1	50.0		16.93	5.00	4233		8.47	19.35	81919
	a2		40.0	16.93	5.00		28669	11.29	16.53	473913
	a3	677.3		10.89	2.50	18433		22.38	5.44	100340
	a4		40.0	10.89	2.50		5926	24.19	3.63	21505
Resisting	p1	400.0		8.89	5.00	17774		23.38	4.44	78975
	p2		200.0	8.89	5.00		39487	24.86	2.96	116972
	p3	0.0		0.00	5.00	0		0.00	27.82	0
	p4		0.0	0.00	5.00		0	0.00	27.82	0

Moments at Zero Shear Point

Sum of shear forces (lbf) at "M"	0
Sum of moments (ft-lbf) at "M"	481731

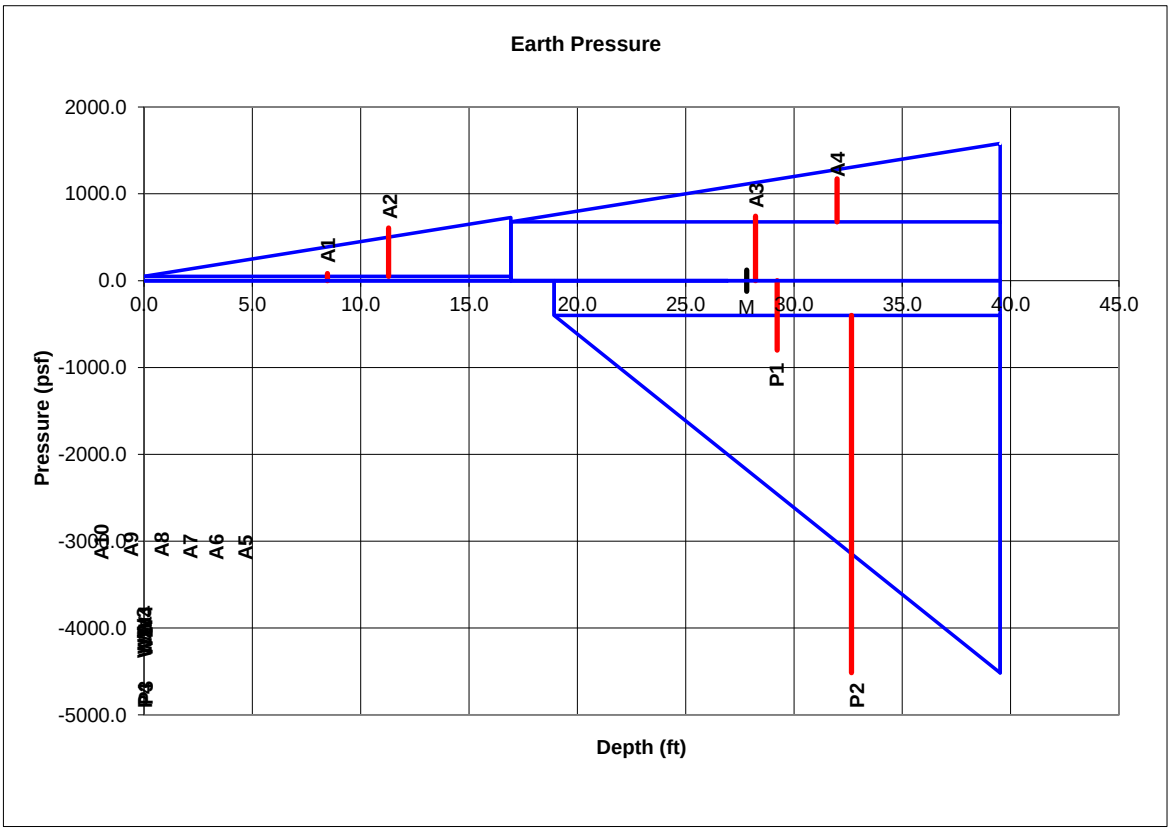


FIGURE B5 SOLDIER BEAM - S1

Wall Height (ft)	12.77
Depth of Embed (ft)	20.82
Depth to Top of Passive (ft)	14.77

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	A1	50.0		12.77	8.00	5109		6.39	27.20	138970
	A2		40.0	12.77	8.00		26098	8.51	25.07	654395
	A3	510.9		20.82	2.50	26587		23.18	10.41	276728
	A4		40.0	20.82	2.50		21667	26.65	6.94	150350
Resisting	P1	400.0		18.82	5.00	37634		24.18	9.41	354079
	P2		200.0	18.82	5.00		177040	27.32	6.27	1110452
	P3	0.0		0.00	5.00	0		33.59	0.00	0
	P4		0.0	0.00	5.00		0	33.59	0.00	0

Moments about pile toe

Sum of resisting moments (ft-lbf)	1464532
Sum of driving moments (ft-lbf)	1220443
FS	1.20

Depth to Zero Shear (ft) at "M"	22.90

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	a1	50.0		12.77	8.00	5109		6.39	16.51	84352
	a2		40.0	12.77	8.00		26098	8.51	14.38	375373
	a3	510.9		10.13	2.50	12932		17.83	5.06	65475
	a4		40.0	10.13	2.50		5127	19.52	3.38	17304
Resisting	p1	400.0		8.13	5.00	16252		18.83	4.06	66029
	p2		200.0	8.13	5.00		33014	20.19	2.71	89422
	p3	0.0		0.00	5.00	0		0.00	22.90	0
	p4		0.0	0.00	5.00		0	0.00	22.90	0

Moments at Zero Shear Point

Sum of shear forces (lbf) at "M"	0
Sum of moments (ft-lbf) at "M"	387052

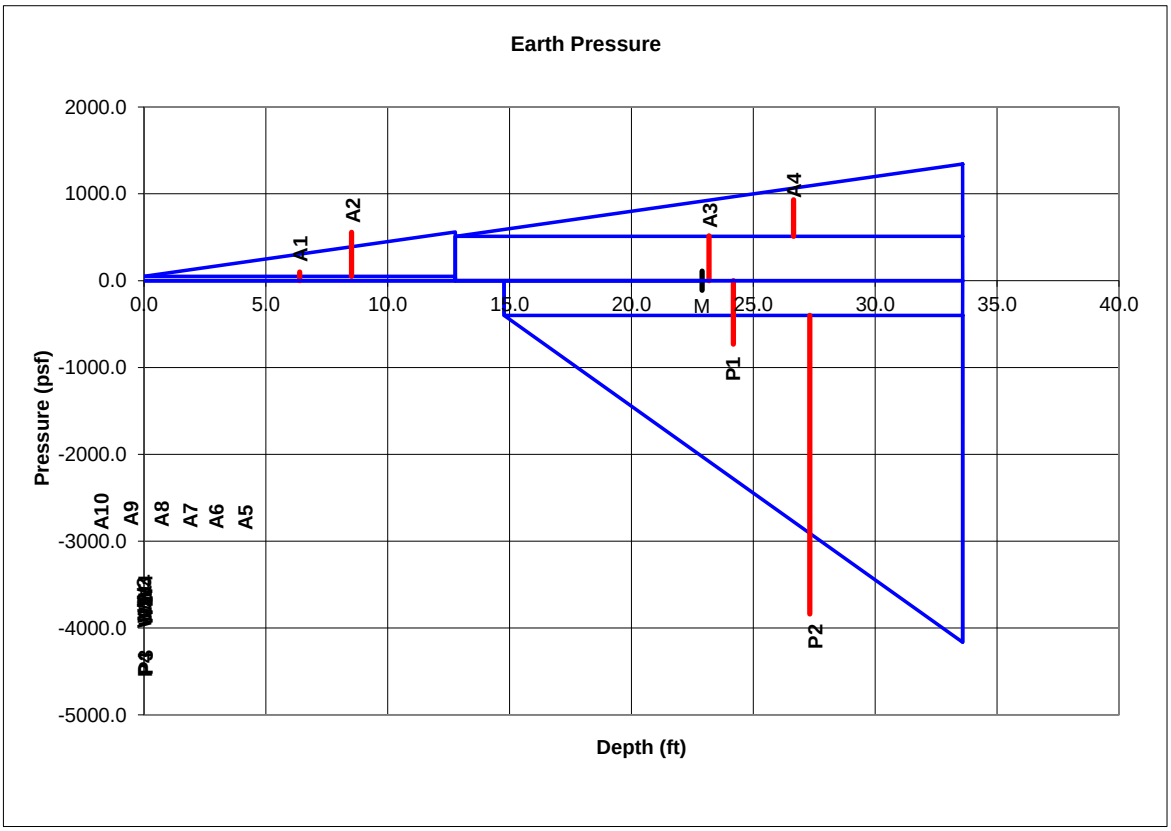


FIGURE B6 SOLDIER BEAM - S7

Wall Height (ft)	9.50
Depth of Embed (ft)	16.07
Depth to Top of Passive (ft)	11.50

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	A1	50.0		9.50	5.40	2565		4.75	20.82	53392
	A2		50.0	9.50	5.40		12184	6.33	19.23	234319
	A3	380.0		16.07	2.00	12210		17.53	8.03	98077
	A4		40.0	16.07	2.00		10324	20.21	5.36	55286
Resisting	P1	400.0		14.07	4.00	22505		18.53	7.03	158269
	P2		200.0	14.07	4.00		79134	20.88	4.69	371019
	P3	0.0		0.00	4.00	0		25.57	0.00	0
	P4		0.0	0.00	4.00		0	25.57	0.00	0

Moments about pile toe

Sum of resisting moments (ft-lbf)	529288
Sum of driving moments (ft-lbf)	441074
FS	1.20

Depth to Zero Shear (ft) at "M"	17.38

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	a1	50.0		9.50	5.40	2565		4.75	12.63	32387
	a2		50.0	9.50	5.40		12184	6.33	11.04	134549
	a3	380.0		7.88	2.00	5986		13.44	3.94	23576
	a4		40.0	7.88	2.00		2482	14.75	2.63	6516
Resisting	p1	400.0		5.88	4.00	9403		14.44	2.94	27628
	p2		200.0	5.88	4.00		13814	15.42	1.96	27060
	p3	0.0		0.00	4.00	0		0.00	17.38	0
	p4		0.0	0.00	4.00		0	0.00	17.38	0

Moments at Zero Shear Point

Sum of shear forces (lbf) at "M"	0
Sum of moments (ft-lbf) at "M"	142340

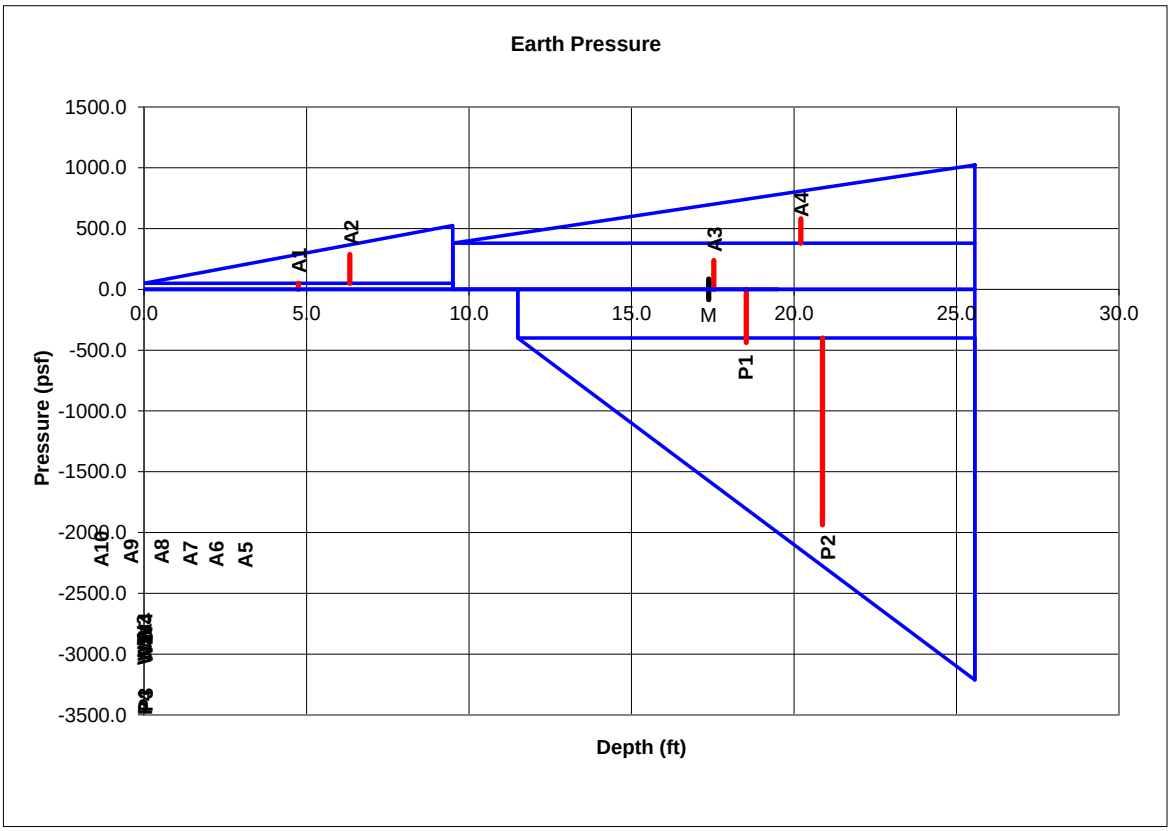


FIGURE B7 SOLDIER BEAM - NA2

			Soldier Beam Loads-Below Anchor 1					Pile Vertical Load Analysis								Toe Dist. Depth (ft) 2
Pile ID	Design Beam	Axial Load (kips)	Moment (ft-kips)	Free Length (feet)	Steel Section	Flex/Ax Ratio	Pile Diameter (ft)	Pile End Area (ft^2)	Pile Skin Area (ft^2/ft)	Pile End Bear (ksf)	Pile Skin Frict (ksf)	End Bearing (kips)	Skin Friction (klf)	Axial Load (kips)	Embed Length (ft)
N3	W14x34	21	93	8.40	W14x34	0.72	2.00	3.14	6.28	20.00	1.00	62.8	6.3	21	-4.7
N4	W14x34	26	119	8.40	W14x34	0.92	2.00	3.14	6.28	20.00	1.00	62.8	6.3	26	-3.9
N5	W14x34	24	110	8.40	W14x34	0.85	2.00	3.14	6.28	20.00	1.00	62.8	6.3	24	-4.1
N6	W14x34	27	126	8.40	W14x34	0.97	2.00	3.14	6.28	20.00	1.00	62.8	6.3	27	-3.7
N7	W14x34	24	107	8.40	W14x34	0.83	2.00	3.14	6.28	20.00	1.00	62.8	6.3	24	-4.2
N8	W14x34	23	103	8.40	W14x34	0.80	2.00	3.14	6.28	20.00	1.00	62.8	6.3	23	-4.3
N9	W14x34	23	103	8.40	W14x34	0.80	2.00	3.14	6.28	20.00	1.00	62.8	6.3	23	-4.3
N10	W14x53	21	209	11.40	W14x53	0.99	2.00	3.14	6.28	20.00	1.00	62.8	6.3	21	-4.7
N11	W18x50	23	222	11.40	W18x50	0.91	2.50	4.91	7.85	20.00	1.00	98.2	7.9	23	-7.6
N12	W14x53	79	182	13.00	W14x53	0.94	2.00	3.14	6.28	20.00	1.00	62.8	6.3	79	4.5
E1	W18x50	81	206	13.50	W18x50	0.94	2.50	4.91	7.85	20.00	1.00	98.2	7.9	81	-0.2
E2	W14x48	40	173	13.00	W14x48	0.94	2.00	3.14	6.28	20.00	1.00	62.8	6.3	40	-1.7
E3	W14x48	36	178	14.50	W14x48	0.97	2.00	3.14	6.28	20.00	1.00	62.8	6.3	36	-2.2
E4	W18x50	77	196	13.00	W18x50	0.88	2.50	4.91	7.85	20.00	1.00	98.2	7.9	77	-0.7
E5	W18x50	82	209	13.00	W18x50	0.95	2.50	4.91	7.85	20.00	1.00	98.2	7.9	82	-0.1
E6	W18x50	82	209	13.00	W18x50	0.95	2.50	4.91	7.85	20.00	1.00	98.2	7.9	82	-0.1
E7	W18x50	65	209	13.00	W18x50	0.92	2.50	4.91	7.85	20.00	1.00	98.2	7.9	65	-2.2
E8	W14x53	44	200	13.00	W14x53	0.98	2.00	3.14	6.28	20.00	1.00	62.8	6.3	44	-1.0
E9	W14x43	69	152	12.00	W14x43	0.99	2.00	3.14	6.28	20.00	1.00	62.8	6.3	69	3.1
E10	W18x50	71	208	13.00	W18x50	0.92	2.50	4.91	7.85	20.00	1.00	98.2	7.9	71	-1.5
E11	W14x53	83	184	12.00	W14x53	0.95	2.00	3.14	6.28	20.00	1.00	62.8	6.3	83	5.3
E12	W18x50	54	215	13.00	W18x50	0.93	2.50	4.91	7.85	20.00	1.00	98.2	7.9	54	-3.7
S1	W18x97	20	488	15.93	W18x97	0.94	2.50	4.91	7.85	20.00	1.00	98.2	7.9	20	-8.0
S2	W18x97	24	470	14.57	W18x97	0.91	2.50	4.91	7.85	20.00	1.00	98.2	7.9	24	-7.4
S3	W14x34	26	123	8.50	W14x34	0.95	2.00	3.14	6.28	20.00	1.00	62.8	6.3	26	-3.9
S4	W14x43	27	150	9.00	W14x43	0.90	2.00	3.14	6.28	20.00	1.00	62.8	6.3	27	-3.7
S5	W14x34	9	124	9.00	W14x34	0.93	2.00	3.14	6.28	20.00	1.00	62.8	6.3	9	-6.5
S6	W18x71	14	348	12.64	W18x71	0.97	2.50	4.91	7.85	20.00	1.00	98.2	7.9	14	-8.7
S7	W18x76	17	365	11.77	W18x76	0.91	2.50	4.91	7.85	20.00	1.00	98.2	7.9	17	-8.4
S8	W14x43	13	168	8.71	W14x43	0.99	2.00	3.14	6.28	20.00	1.00	62.8	6.3	13	-6.0
NA1	W14x34	6	84	8.50	W14x34	0.63	2.00	3.14	6.28	20.00	1.00	62.8	6.3	6	-7.0
NA2	W14x34	9	119	8.50	W14x34	0.89	2.00	3.14	6.28	20.00	1.00	62.8	6.3	9	-6.6
NA3	W14x34	9	30	7.75	W14x34	0.23	2.00	3.14	6.28	20.00	1.00	62.8	6.3	9	-6.5
NA4	W14x34	12	44	8.36	W14x34	0.34	2.00	3.14	6.28	20.00	1.00	62.8	6.3	12	-6.0
NA5	W14x34	9	17	5.40	W14x34	0.14	2.00	3.14	6.28	20.00	1.00	62.8	6.3	9	-6.6

TABLE B2
SOLDIER PILE DESIGN - PERMANENT WALL

Wall Height (ft)	11.40
Depth of Embed (ft)	18.24
Depth to Top of Passive (ft)	13.40

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	A1	85.4		11.40	5.20	5061		5.70	23.94	121164
	A2		40.0	11.40	5.20		13516	7.60	22.04	297879
	A3	456.0		18.24	2.00	16634		20.52	9.12	151698
	A4		40.0	18.24	2.00		13307	23.56	6.08	80902
Resisting	P1	400.0		16.24	4.00	25983		21.52	8.12	210971
	P2		200.0	16.24	4.00		105485	24.23	5.41	571001
	P3	0.0		0.00	4.00	0		29.64	0.00	0
	P4		0.0	0.00	4.00		0	29.64	0.00	0

Moments about pile toe

Sum of resisting moments (ft-lbf)	781972
Sum of driving moments (ft-lbf)	651643
FS	1.20

Depth to Zero Shear (ft) at "M"	20.26

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	a1	85.4		11.40	5.20	5061		5.70	14.56	73691
	a2		40.0	11.40	5.20		13516	7.60	12.66	171105
	a3	456.0		8.86	2.00	8080		15.83	4.43	35792
	a4		40.0	8.86	2.00		3140	17.31	2.95	9272
Resisting	p1	400.0		6.86	4.00	10975		16.83	3.43	37643
	p2		200.0	6.86	4.00		18821	17.97	2.29	43036
	p3	0.0		0.00	4.00	0		0.00	20.26	0
	p4		0.0	0.00	4.00		0	0.00	20.26	0

Moments at Zero Shear Point

Sum of shear forces (lbf) at "M"	0
Sum of moments (ft-lbf) at "M"	209181

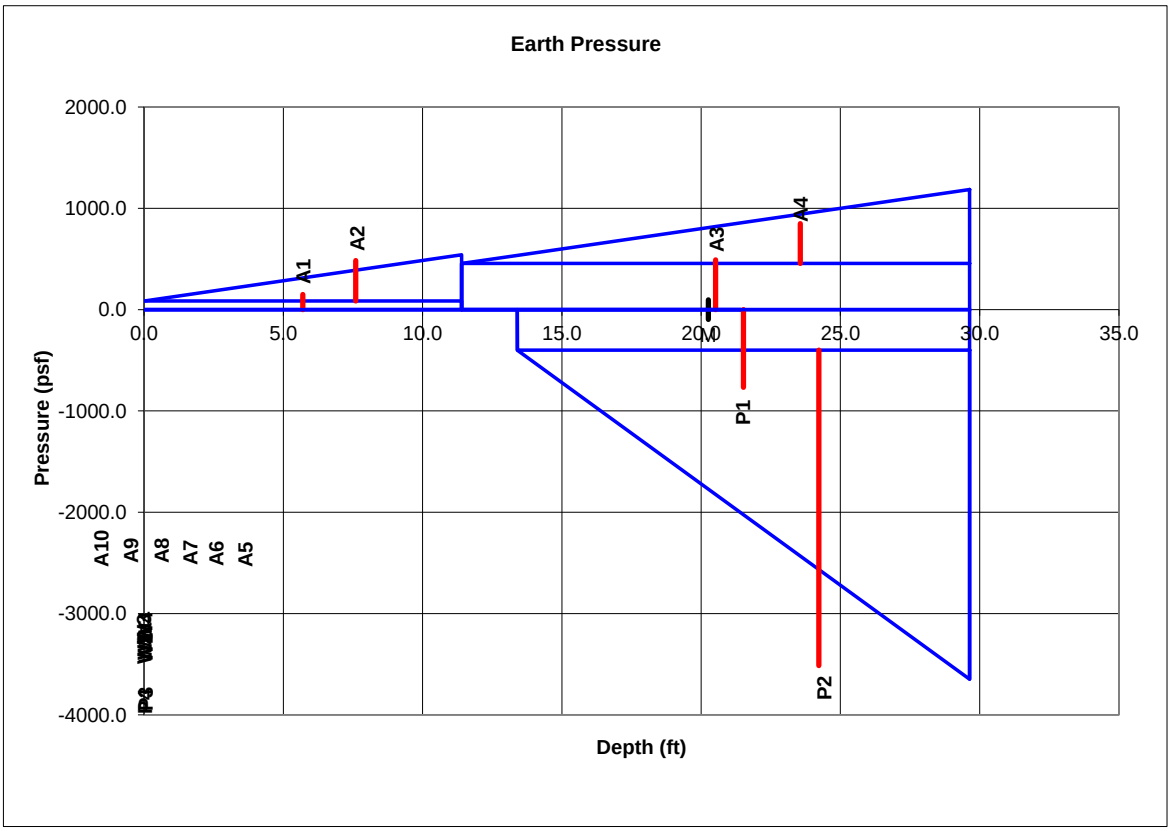
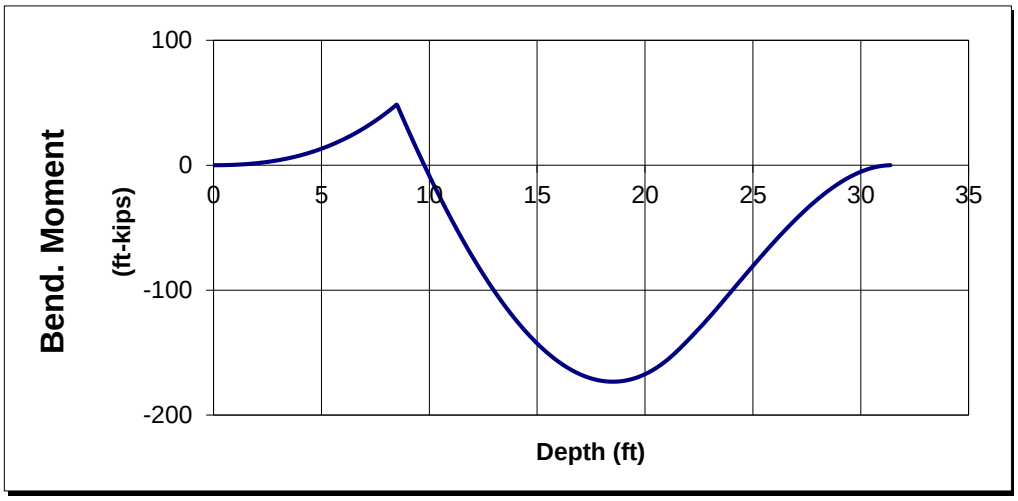
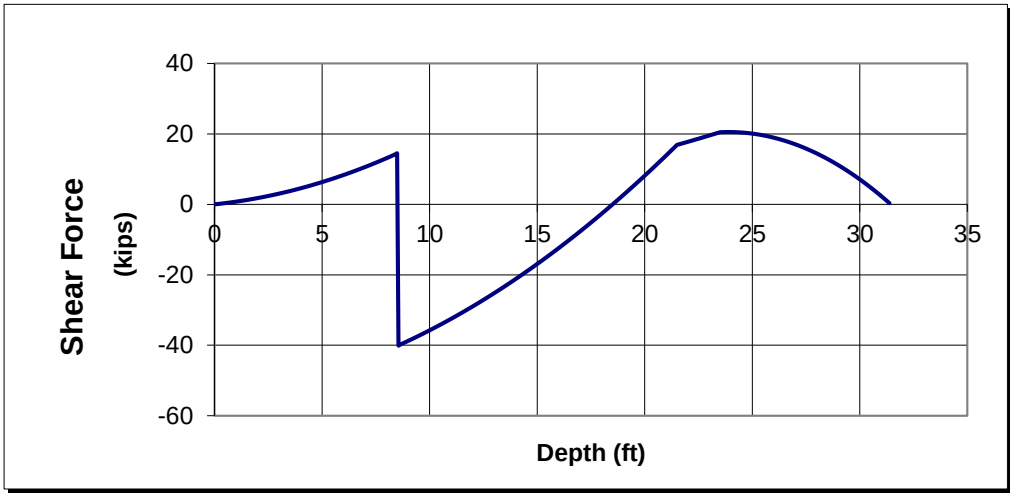
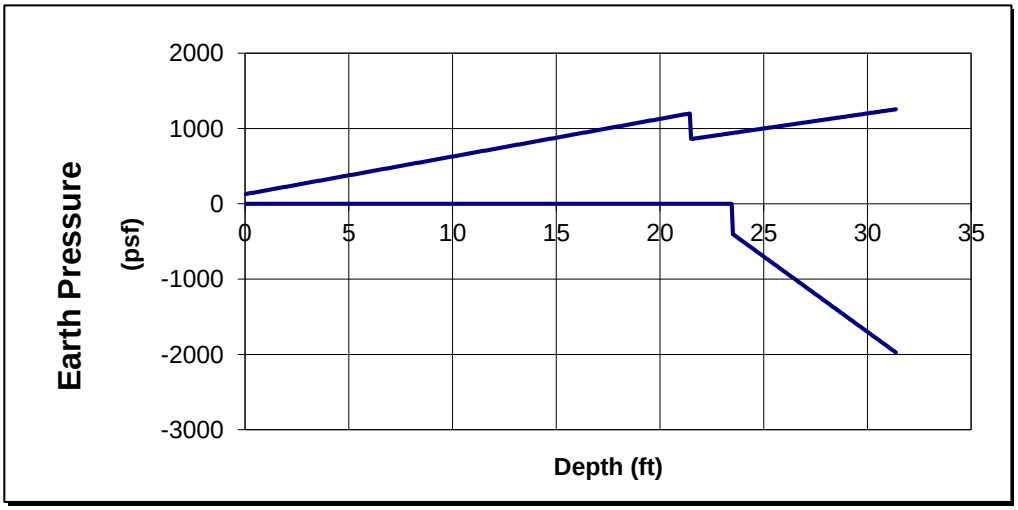


FIGURE B8 SOLDIER BEAM - N10

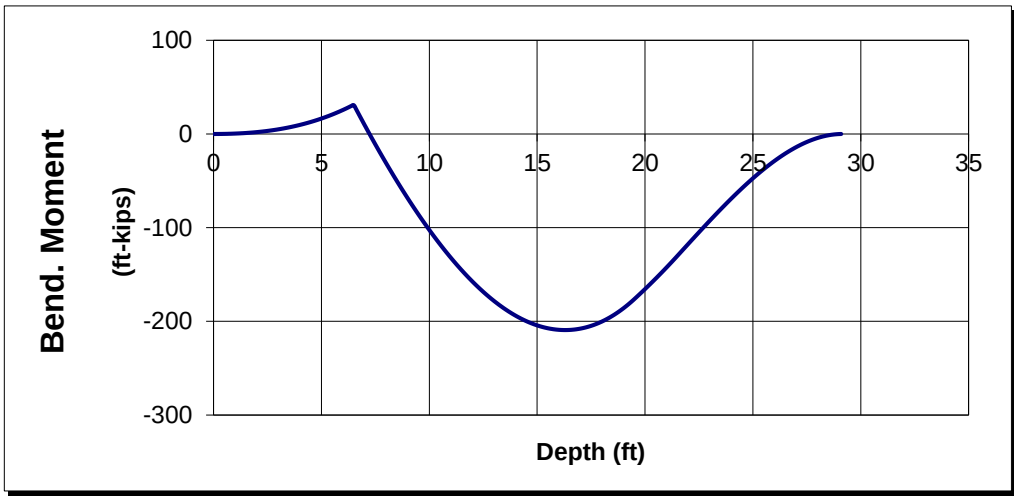


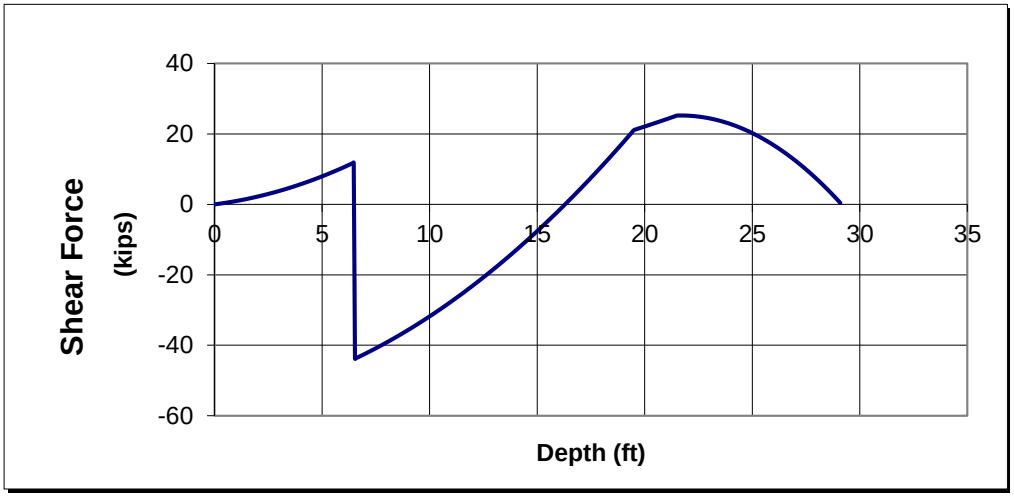


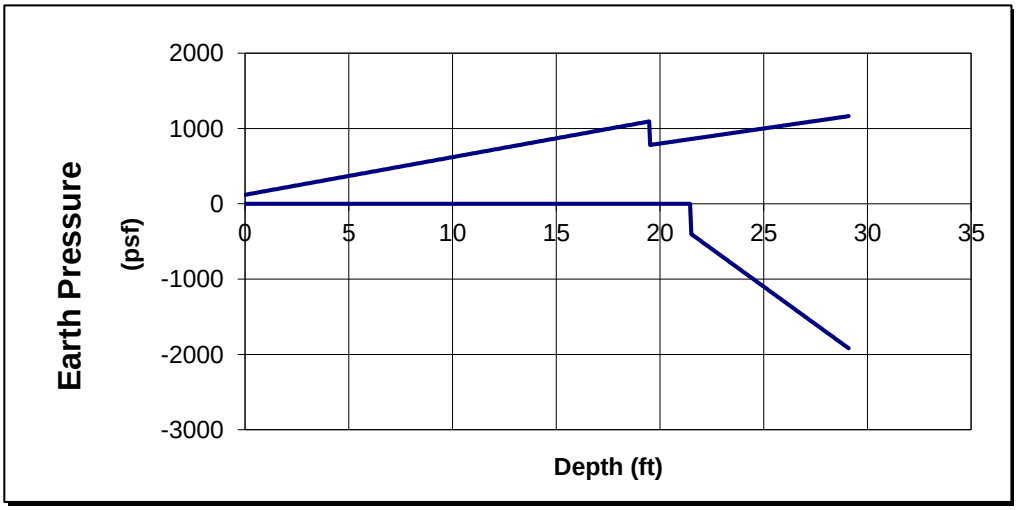


Wall Height (ft)	**21.5**
Pile Spacing (ft)	**5.00**

FIGURE B9 SOLDIER BEAM - E2

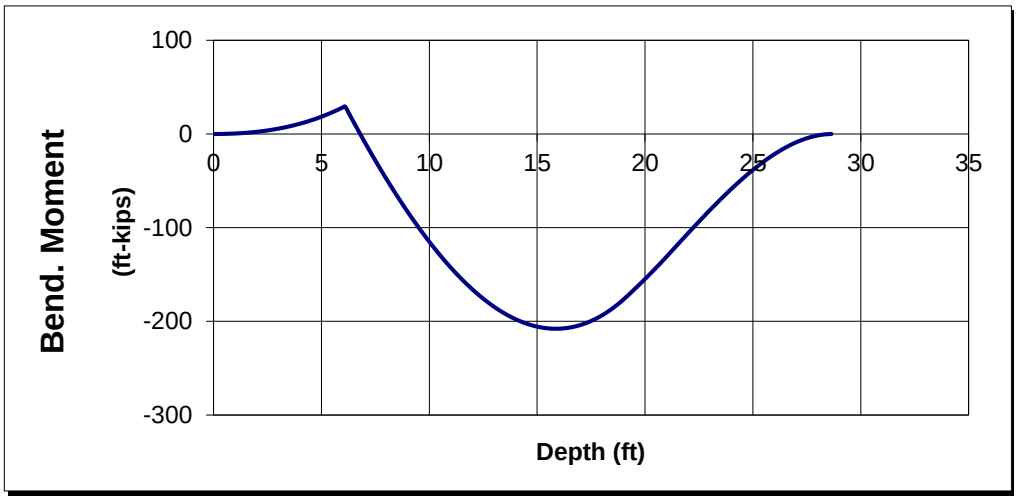


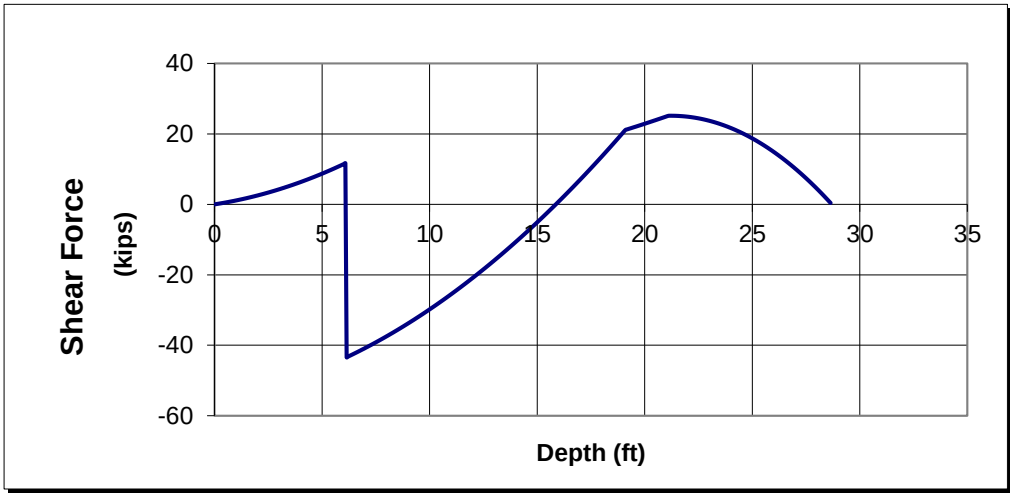


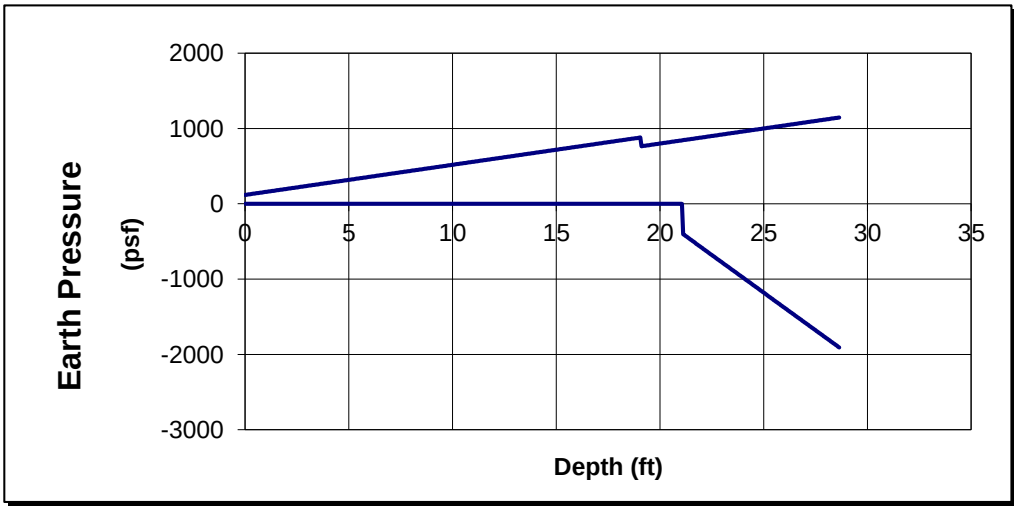


Wall Height (ft)	**19.5**
Pile Spacing (ft)	**6.50**

FIGURE B10 SOLDIER BEAM - E7







Wall Height (ft)	**19.1**
Pile Spacing (ft)	**8.00**

FIGURE B11 SOLDIER BEAM - E10

Wall Height (ft)	15.93
Depth of Embed (ft)	22.55
Depth to Top of Passive (ft)	17.93

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	A1	104.4		15.93	5.00	8317		7.97	30.52	253810
	A2		40.0	15.93	5.00		25382	10.62	27.86	707149
	A3	637.3		22.55	2.50	35925		27.21	11.27	405044
	A4		40.0	22.55	2.50		25424	30.96	7.52	191095
Resisting	P1	400.0		20.55	5.00	41099		28.21	10.27	422275
	P2		200.0	20.55	5.00		211137	31.63	6.85	1446243
	P3	0.0		0.00	5.00	0		38.48	0.00	0
	P4		0.0	0.00	5.00		0	38.48	0.00	0

Moments about pile toe

Sum of resisting moments (ft-lbf)	1868518
Sum of driving moments (ft-lbf)	1557098
FS	1.20

Depth to Zero Shear (ft) at "M"	26.78

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	a1	104.4		15.93	5.00	8317		7.97	18.82	156512
	a2		40.0	15.93	5.00		25382	10.62	16.16	410226
	a3	637.3		10.85	2.50	17288		21.36	5.43	93799
	a4		40.0	10.85	2.50		5888	23.17	3.62	21296
Resisting	p1	400.0		8.85	5.00	17703		22.36	4.43	78346
	p2		200.0	8.85	5.00		39173	23.83	2.95	115577
	p3	0.0		0.00	5.00	0		0.00	26.78	0
	p4		0.0	0.00	5.00		0	0.00	26.78	0

Moments at Zero Shear Point

Sum of shear forces (lbf) at "M"	0
Sum of moments (ft-lbf) at "M"	487911

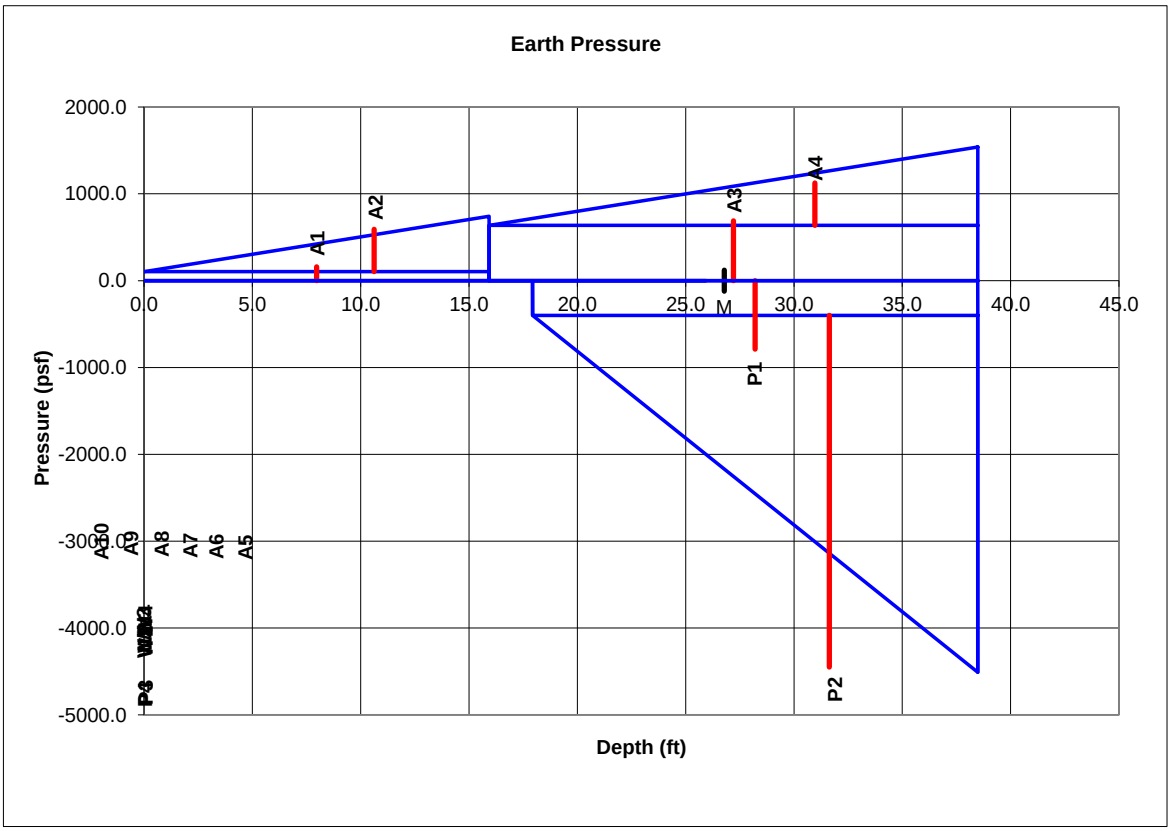


FIGURE B12 SOLDIER BEAM - S1

Wall Height (ft)	11.77
Depth of Embed (ft)	20.33
Depth to Top of Passive (ft)	13.77

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	A1	86.9		11.77	8.00	8187		5.89	26.22	214670
	A2		40.0	11.77	8.00		22171	7.85	24.26	537820
	A3	470.9		20.33	2.50	23936		21.94	10.17	243349
	A4		40.0	20.33	2.50		20672	25.33	6.78	140114
Resisting	P1	400.0		18.33	5.00	36667		22.94	9.17	336116
	P2		200.0	18.33	5.00		168058	25.99	6.11	1027028
	P3	0.0		0.00	5.00	0		32.11	0.00	0
	P4		0.0	0.00	5.00		0	32.11	0.00	0

Moments about pile toe

Sum of resisting moments (ft-lbf)	1363144
Sum of driving moments (ft-lbf)	1135953
FS	1.20

Depth to Zero Shear (ft) at "M"	21.66

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	a1	86.9		11.77	8.00	8187		5.89	15.77	129149
	a2		40.0	11.77	8.00		22171	7.85	13.81	306232
	a3	470.9		9.89	2.50	11640		16.72	4.94	57549
	a4		40.0	9.89	2.50		4889	18.36	3.30	16114
Resisting	p1	400.0		7.89	5.00	15776		17.72	3.94	62223
	p2		200.0	7.89	5.00		31111	19.03	2.63	81804
	p3	0.0		0.00	5.00	0		0.00	21.66	0
	p4		0.0	0.00	5.00		0	0.00	21.66	0

Moments at Zero Shear Point

Sum of shear forces (lbf) at "M"	0
Sum of moments (ft-lbf) at "M"	365017

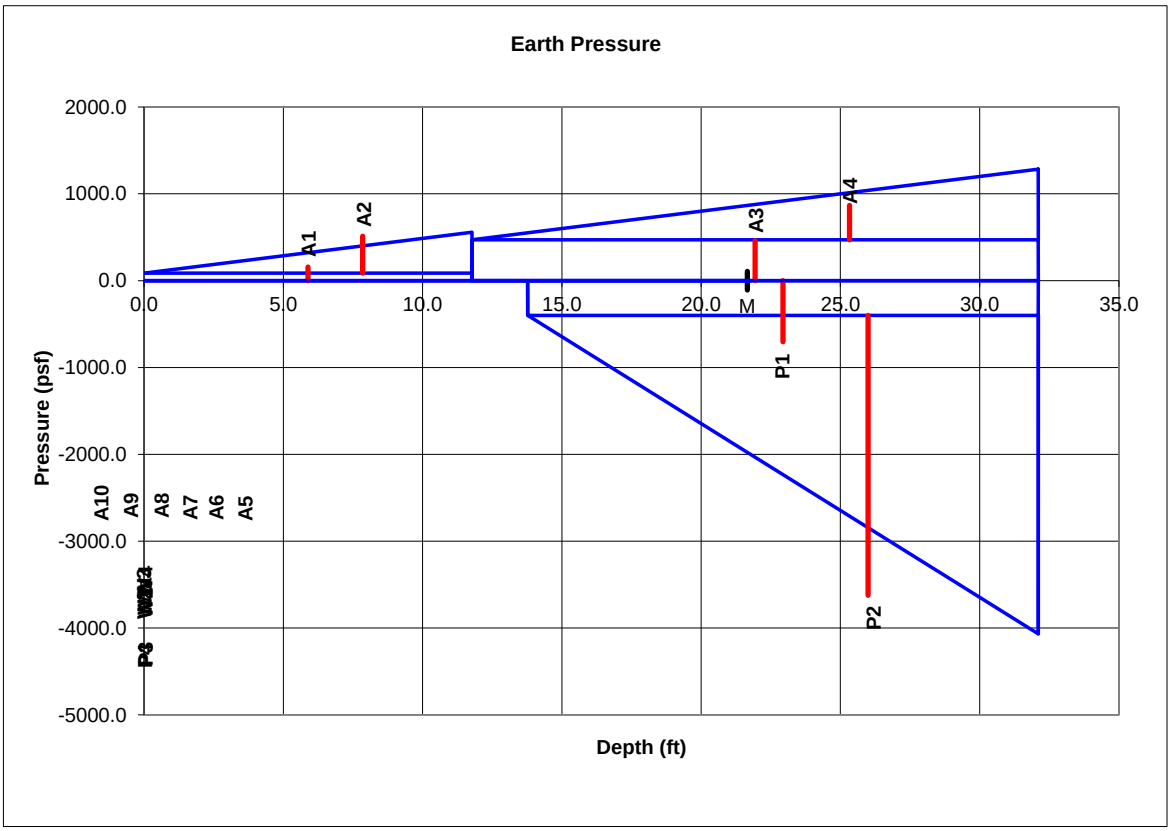


FIGURE B13 SOLDIER BEAM - S7

Wall Height (ft)	8.50
Depth of Embed (ft)	15.08
Depth to Top of Passive (ft)	10.50

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	A1	73.2		8.50	5.40	3360		4.25	19.33	64947
	A2		50.0	8.50	5.40		9754	5.67	17.91	174724
	A3	340.0		15.08	2.00	10255		16.04	7.54	77320
	A4		40.0	15.08	2.00		9096	18.55	5.03	45725
Resisting	P1	400.0		13.08	4.00	20928		17.04	6.54	136873
	P2		200.0	13.08	4.00		68436	19.22	4.36	298387
	P3	0.0		0.00	4.00	0		23.58	0.00	0
	P4		0.0	0.00	4.00		0	23.58	0.00	0

Moments about pile toe

Sum of resisting moments (ft-lbf)	435260
Sum of driving moments (ft-lbf)	362716
FS	1.20

Depth to Zero Shear (ft) at "M"	15.91

	Force	p (psf)	K_γ (psf)	h (ft)	w (ft)	phw (lbf)	$K_\gamma h^2 w/2$ (lbf)	depth (ft)	moment arm (ft)	moment (ft-lbf)
Driving	a1	73.2		8.50	5.40	3360		4.25	11.66	39166
	a2		50.0	8.50	5.40		9754	5.67	10.24	99881
	a3	340.0		7.41	2.00	5037		12.20	3.70	18653
	a4		40.0	7.41	2.00		2194	13.44	2.47	5418
Resisting	p1	400.0		5.41	4.00	8651		13.20	2.70	23388
	p2		200.0	5.41	4.00		11694	14.10	1.80	21076
	p3	0.0		0.00	4.00	0		0.00	15.91	0
	p4		0.0	0.00	4.00		0	0.00	15.91	0

Moments at Zero Shear Point

Sum of shear forces (lbf) at "M"	0
Sum of moments (ft-lbf) at "M"	118654

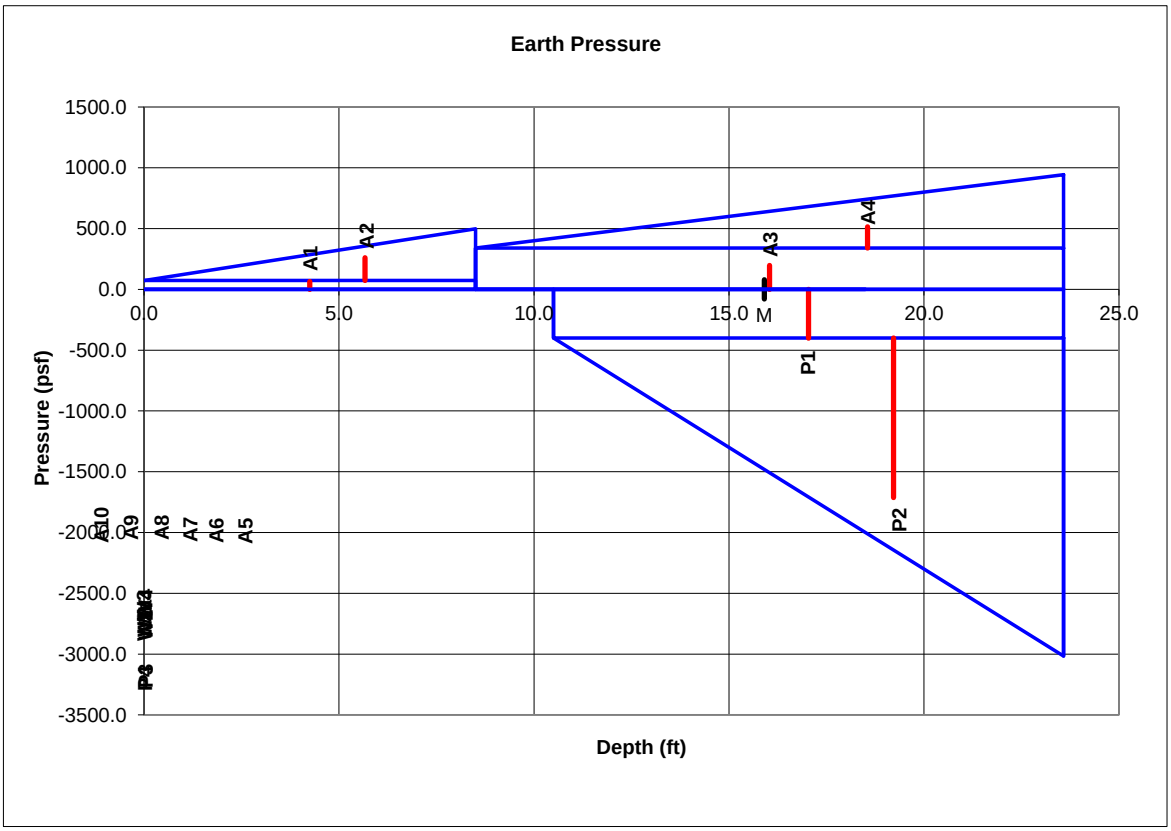


FIGURE B14 SOLDIER BEAM - NA2

APPENDIX C

SOLDIER PILE DESIGN – STAGE 1 CANTILEVER

Pile ID	Station (ft)	Height (ft)	Spacing (ft)	No. Anchors	$L=NH^2$ N (psf/ft)	Unif. Press. P (psf)	Design Beam	Pile Top Elevation (feet)	Pile Toe Embed (feet)	Pile Toe Elevation (feet)	Pile Length (feet)	Lagging Pressure (psf)
N12	72.8	9.0	6.7	0	20	50	W14x34	258.0	15.6	233.0	25.0	410
E1	102.5	10.0	5.5	0	25	50	W14x43	260.0	16.9	232.0	28.0	550
E2	108.5	10.5	5	0	25	50	W14x43	260.0	17.1	231.0	29.0	575
E3	112.5	10.0	4.85	0	20	50	W14x34	261.0	15.1	235.0	26.0	449
E4	118.2	8.5	6.1	0	25	50	W14x34	258.0	15.3	233.0	25.0	475
E5	124.7	8.5	6.5	0	25	50	W14x34	258.0	15.6	233.0	25.0	475
E6	131.2	8.5	6.5	0	25	50	W14x34	258.0	15.6	233.0	25.0	475
E7	137.7	8.5	6.5	0	25	50	W14x34	258.0	15.6	233.0	25.0	475
E8	144.2	8.5	6.15	0	25	50	W14x34	258.0	15.3	233.0	25.0	475
E9	150	9.1	6.9	0	20	50	W14x38	258.0	15.9	232.0	26.0	414
E10	158	8.1	8	0	20	50	W14x34	258.0	15.2	233.0	25.0	374
E11	166	9.1	8.25	0	20	50	W14x43	258.0	17.0	230.0	28.0	414
E12	174.5	8.1	8.25	0	20	50	W14x34	258.0	15.4	233.0	25.0	374

TABLE C1
SOLDIER PILE DESIGN - INITIAL CANTILEVER STAGE