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STRUCTURAL CALCULATIONS

FOR

MERCER ISLAND RESIDENCE DRIVEWAY SOLDIER PILE WALL
6838 96TH AVE SE
MERCER ISLAND, WA 98040

PREPARED BY
PCS STRUCTURAL *SOLUTIONS*

NOVEMBER 30, 2023
21-201

SOLDIER PILE WALL LOADING DIAGRAM

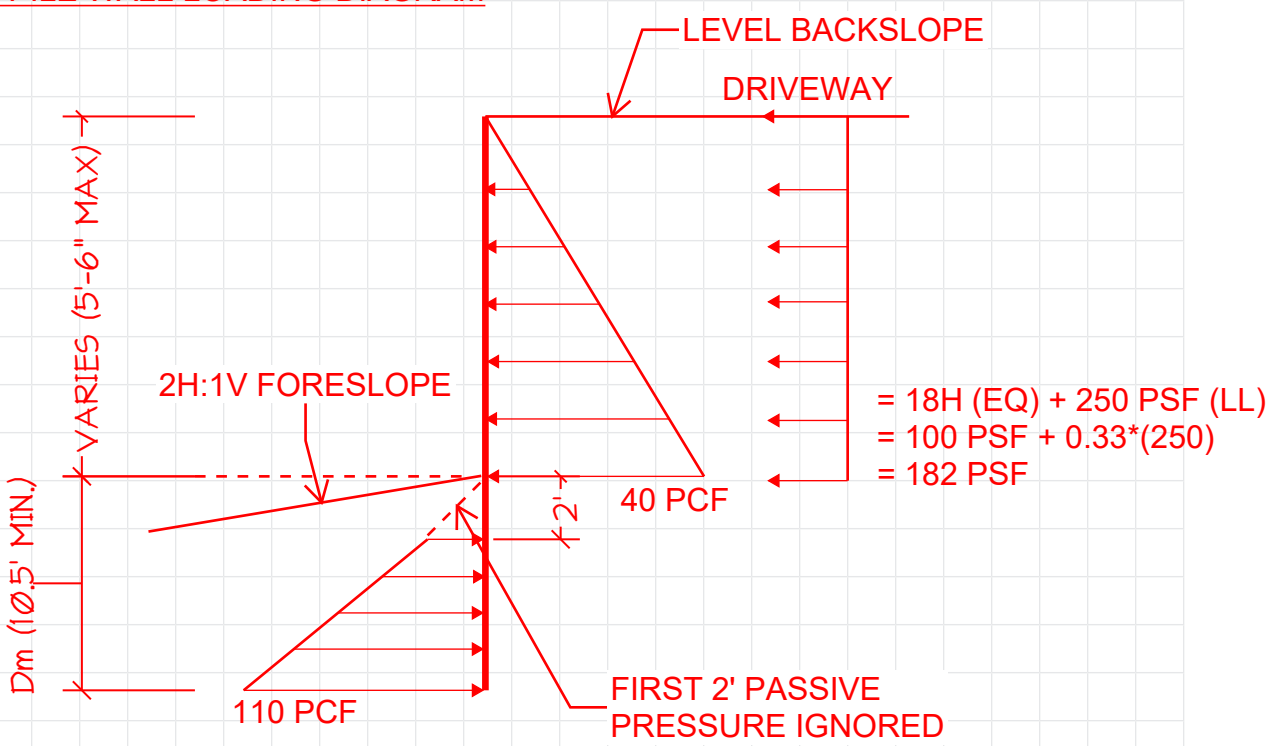


Table 1. Lateral Earth Pressure Parameters

Earth Pressure Condition	Foreslope Condition	Backslope Condition	Earth Pressure Coefficient	Equivalent Fluid Density[2] (pcf)[1]	Uniform Lateral Surcharge Pressure[3] (psf)[1]
Active	-	Level	0.33	40	0.33S

USE 18"Ø CONC. PILE W/ W8x40 STEEL PILE - SEE EXCEL

ALLOWABLE DEFLECTION = 2L/180 = 0.733"

CALCULATED DEFLECTION = 0.113" < 0.733" - DEFLECTION OK

CHECK PILE MINIMUM SHEAR CAPACITY:

25 KIP MIN. SHEAR CAPACITY OF PILE PER GEOTECH.

ØVn = 0.6*(50 KSI)*(8.25")*(0.36")
= 89 KIPS > 25 KIP MIN. - PILE SHEAR OK

CANTILEVERED SOLDIER PILE RETAINING WALL

General equation for moment balance to determine pile embedment:

0=PaLL*H*S*(H/2+Dm)+Pa*H^2*0.5*S*(H/3+Dm)+Pa*Dia*Wa*H*Dm^2/2+Pa*Dia*Wa*Dm^3/6-Pp*DIA*Wp*Dm^3/6

General equation for shear balance to determine maximum moment height:

0=PaLL*H*S+Pa*H^2/2*S+Pa*Dia*Wa*H*Ds+Pa*Dia*Wa*Ds^2/2-Pp*Dia*Wp*Ds^2/2

Active pressure on wall:	40	pcf	
Active pressure on pile:	0	pcf	(below wall)
L or E surcharge on wall:	182	psf	(live load or earthquake)
Passive pressure at pile:	110	pcf	
Spacing of Piles:	8.00	ft oc	
concrete pile diameter:	1.50	ft	
passive width on pile:	3.00	x pile diameter	
active width on pile:	1.00	x pile diameter	

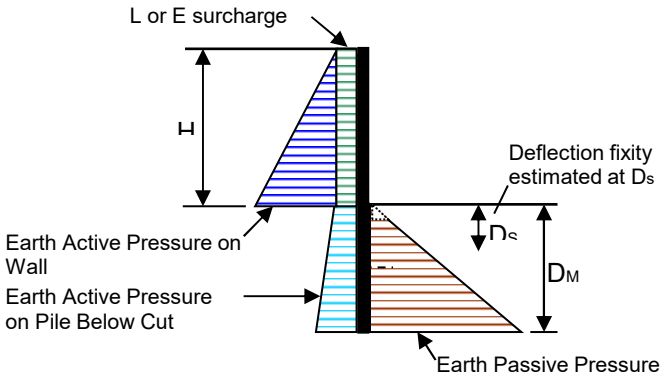
F_y = psi

F_b = psi $F_b = 0.6\ F_y$

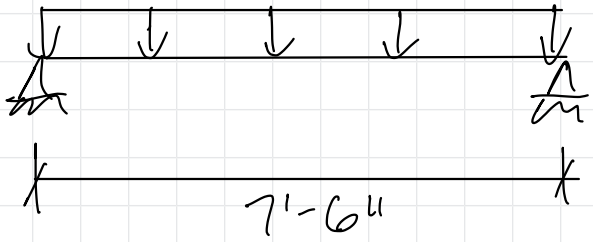
S pile = M/F_b

Total drilling depth = H+Dm

	Moment			Shear		Steel Pile Demand		Steel Pile Selection				
H	equation	**Dm**	H+Dm	equation	**Ds**	M	S	**Steel**	S	I		
ft	set to 0	feet	feet	set to 0	feet	ft-k	in^3	**Section**	in^3	in^4		
5.5	0	13.5	**19.0**	8888	4.0	77	31	**W8X40**	36	146	0.113	
2.5	0	8.0	**10.5**	680	4.0	19	7	**W8X40**	36	146	0.007	



Check Logging: Assume P.P.T. 6x6



$$H_{Active} = \left(\frac{5.5}{12}\right)(40\ pcf)(5.5') = 101\ plf$$

$$E = \left(\frac{5.5}{12}\right)(18 * 5.5') = 45.4\ plf$$

$$L = \left(\frac{5.5}{12}\right)(250\ psf)(0.33) = 37.8\ plf$$

6x6 OK - SEE ENERCALC

Project Title: MERCER ISLAND RESIDENCE
Engineer: AED
Project ID: 21-201
Project Descr:

Wood Beam

Project File: Lagging.ec6

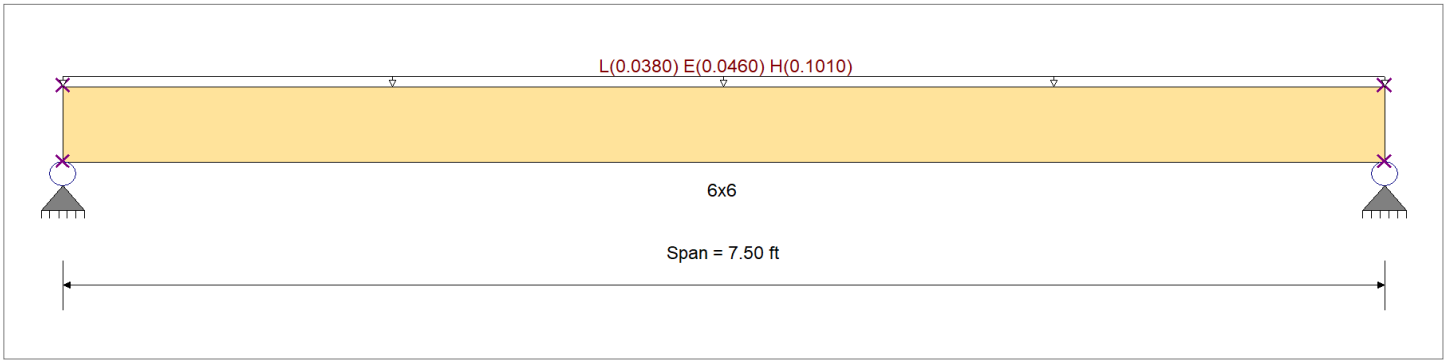
DESCRIPTION: Driveway Soldier Pile Wall - Lagging

CODE REFERENCES

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2018

Material Properties

Analysis Method :	Allowable Stress Design	Fb +	975.0 psi	*E : Modulus of Elasticity*	
Load Combination :	IBC 2018	Fb -	975.0 psi	Ebend- xx	1,300.0 ksi
		Fc - Prll	850.0 psi	Eminbend - xx	470.0 ksi
Wood Species :	Hem-Fir	Fc - Perp	405.0 psi		
Wood Grade :	No.1	Fv	140.0 psi		
		Ft	650.0 psi	Density	26.840 pcf
Beam Bracing :	Completely Unbraced				



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added
Loads on all spans...
Uniform Load on ALL spans : L = 0.0380, E = 0.0460, H = 0.1010 k/ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.542 : 1	Maximum Shear Stress Ratio	=	0.210 : 1
Section used for this span		6x6	Section used for this span		6x6
fb: Actual	=	422.95 psi	fv: Actual	=	22.83 psi
F'b	=	780.00 psi	F'v	=	108.64 psi
Load Combination		+L+H	Load Combination		+L+H
Location of maximum on span	=	3.750 ft	Location of maximum on span	=	7.062 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.039 in	Ratio =	2315 >=360	Span: 1 : E Only
Max Upward Transient Deflection	0 in	Ratio =	0 <360	n/a
Max Downward Total Deflection	0.130 in	Ratio =	693 >=180	Span: 1 : +0.750L+0.5250E+H
Max Upward Total Deflection	0 in	Ratio =	0 <180	n/a

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	CD	CM	C_t	CLx	C_F	Cfu	C_i	C_r	Moment Values M	fb	F'b	Shear Values V	fv	F'v
H Only														0.0	0.00	0.0	0.0
Length = 7.50 ft	1	0.438	0.170	0.90	1.00	1.00	1.00	1.000	1.00	0.80	1.00	0.71	307.3	702.0	0.33	16.6	97.8
+L+H					1.00	1.00	1.00	1.000	1.00	0.80	1.00			0.0	0.00	0.0	0.0
Length = 7.50 ft	1	0.542	0.210	1.00	1.00	1.00	1.00	1.000	1.00	0.80	1.00	0.98	423.0	780.0	0.46	22.8	108.6
+0.750L+H					1.00	1.00	1.00	1.000	1.00	0.80	1.00			0.0	0.00	0.0	0.0
Length = 7.50 ft	1	0.404	0.157	1.25	1.00	1.00	1.00	1.000	1.00	0.80	1.00	0.91	394.0	975.0	0.43	21.3	135.8
+0.70E+H					1.00	1.00	1.00	1.000	1.00	0.80	1.00			0.0	0.00	0.0	0.0
Length = 7.50 ft	1	0.325	0.126	1.60	1.00	1.00	1.00	1.000	1.00	0.80	1.00	0.94	405.3	1,248.0	0.44	21.9	173.8
+0.750L+0.5250E+H					1.00	1.00	1.00	1.000	1.00	0.80	1.00			0.0	0.00	0.0	0.0

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Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	CD	CM	C_t	CLx	C_F	Cfu	C_i	C_r	Moment Values M	fb	F'b	Shear Values V	fv	F'v
Length = 7.50 ft	**1**	0.375	0.145	1.60	1.00	1.00	1.00	1.000	1.00	0.80	1.00	1.08	467.5	1,248.0	0.51	25.2	173.8
+0.60H					1.00	1.00	1.00	1.000	1.00	0.80	1.00			0.0	0.00	0.0	0.0
Length = 7.50 ft	**1**	0.148	0.057	1.60	1.00	1.00	1.00	1.000	1.00	0.80	1.00	0.43	184.4	1,248.0	0.20	10.0	173.8
+0.70E+0.60H					1.00	1.00	1.00	1.000	1.00	0.80	1.00			0.0	0.00	0.0	0.0
Length = 7.50 ft	**1**	0.226	0.088	1.60	1.00	1.00	1.00	1.000	1.00	0.80	1.00	0.65	282.4	1,248.0	0.31	15.2	173.8

Overall Maximum Deflections

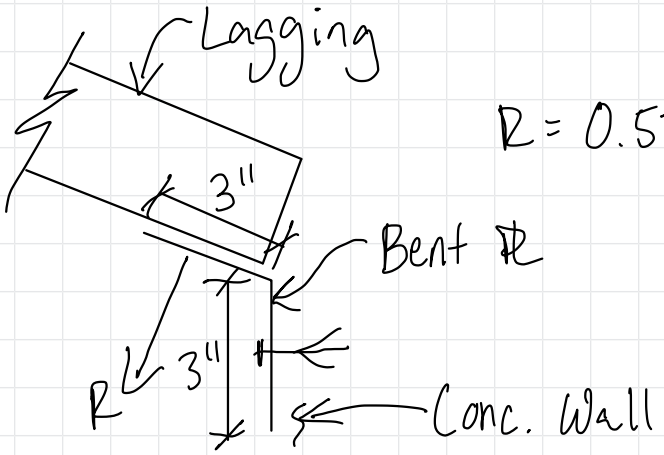
Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+0.750L+0.5250E+H	1	0.1298	3.777		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.576	0.576
Max Upward from Load Combinations	0.576	0.576
Max Upward from Load Cases	0.379	0.379
H Only	0.379	0.379
+L+H	0.521	0.521
+0.750L+H	0.486	0.486
+0.70E+H	0.500	0.500
+0.750L+0.5250E+H	0.576	0.576
+0.60H	0.227	0.227
+0.70E+0.60H	0.348	0.348
L Only	0.143	0.143
E Only	0.173	0.173

Check Bent ℄ to Conc. Wall:



SEE ENERCALC

$R = 0.576 \cdot \left(\frac{12"}{6"}\right) = 1.152\ K/FT$ (ASD)

$M = 1.152k \cdot 2" = 2.31\ k\text{-}in$

$f_b = \frac{2.31\ k\text{-}in}{\frac{(12)(5/16^2)}{6}} = 11.83\ KSI$

$f_{b\,allow} = \frac{36\ KSI}{1.67} = 21.6\ KSI > 11.83\ KSI$ ✓ OK

Check Prying Action:

Anchor Demand

$t_{np} = \sqrt{\frac{\Omega\, 4\, T_u\, b'}{p\, F_u}} = \sqrt{\frac{(1.67)(4)(2)(1.188)}{(5.25)(58)}}$

$t_{np} = 0.23" < 0.31"$ ✓ OK

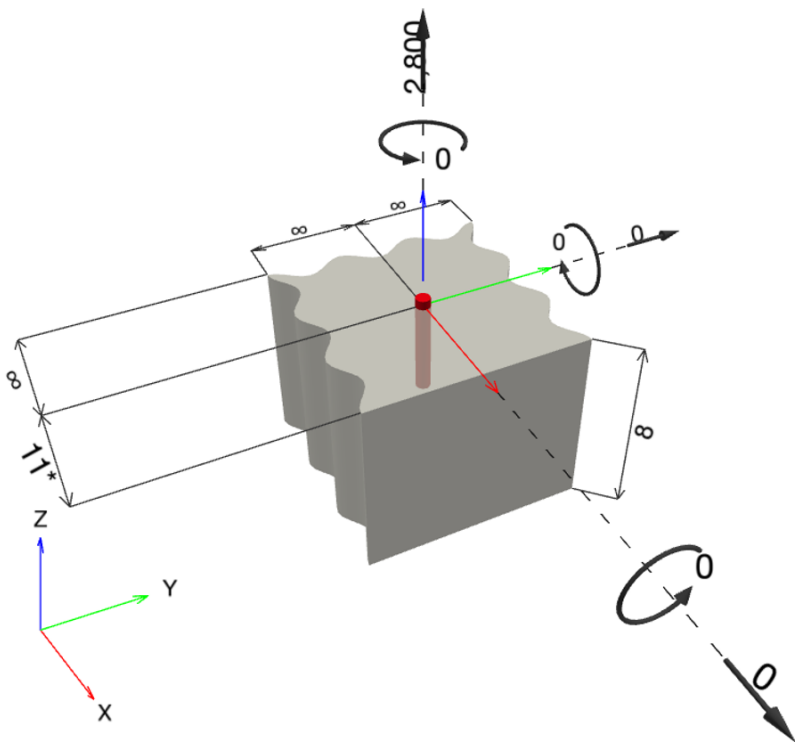
Company:	PCS STRUCTURAL SOLUTIONS	Page:	1
Address:		Specifier:	AED
Phone I Fax:	|	E-Mail:	
Design:	Bent PL Anchorage - Driveway Wall	Date:	11/27/2023
Fastening point:			

Specifier's comments:

1 Input data

Anchor type and diameter:	**Kwik Bolt TZ2 - CS 5/8 (4) hnom3**
Item number:	2210272 KB-TZ2 5/8x5 1/2
Effective embedment depth:	$h_{ef,act}$ = 4.000 in., h_{nom} = 4.500 in.
Material:	Carbon Steel
Evaluation Service Report:	ESR-4266
Issued I Valid:	12/17/2021 | 12/1/2023
Proof:	Design Method ACI 318-14 / Mech
Stand-off installation:	
Profile:	
Base material:	cracked concrete, 4000, f_c' = 4,000 psi; h = 8.000 in.
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar

Geometry [in.] & Loading [lb, in.lb]



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Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 2,800; V_x = 0; V_y = 0; M_x = 0; M_y = 0; M_z = 0;	no	51

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Fastening point:			

2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Concrete Breakout Failure	2,800	5,591	51 / -	OK
Shear	-	-	-	- / -	N/A

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	-	-	-	-	N/A

3 Warnings

- Please consider all details and hints/warnings given in the detailed report!

Fastening meets the design criteria!

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Address:		Specifier:	AED
Phone I Fax:	|	E-Mail:	
Design:	Bent PL Anchorage - Driveway Wall	Date:	11/27/2023
Fastening point:			

4 Remarks; Your Cooperation Duties

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