

*12/24/2021 Addendum*  
***STRUCTURAL CALCULATIONS***

Upper House  
4276 East Mercer Way  
Mercer Island, WA - 98040



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Project: 4273 East Mercer Way

By: JDA

Proj No: 165-2021

Date: 12/24/2021

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Summary

Include calculation for a site retaining wall at sloped soil condition (see page 2)

Update calculations for detail 1/S3.2 to reflect new top of footing elevations (see page 3)



**Subject:** Calculation Overview

**Project:** 4276 E Mercer Way

**Client:** CenterLine

Project No.: 165-2021

Date: 12/24/2021

# Site retaining wall (7/S3.2) retaining sloped soil (2H:1V)

## CANTILEVER RETAINING WALL EXTERNAL STABILITY

limitations: uses Rankine coefficients for noncohesive soils, external moment at top of wall does not contribute to restoring moment (overturning only), no deflection or service load checks, soil on low side of wall does not brace wall against overturning (sliding only)  
 reference: Nilson & Winter, Design of Concrete Structures, 11th Edition, page 680  
 file author: S. Frech last modified: 4/25/2002

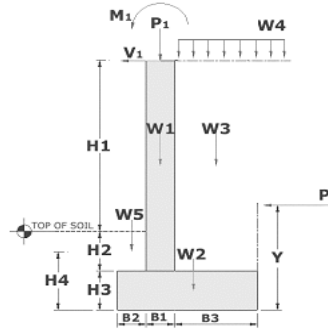
### SOIL DATA

w	125	(pcf)	soil unit weight
phi	35	(deg)	soil internal angle of friction
del	0	(deg)	surface angle incline
	0.35		coeff. friction w/Concrete
	0.819		cosine(phi)
	1.000		cosine(del)
Ca	0.400	50 psf	coeff. of active pressure
Cp	2.800	350 psf	coeff. of passive pressure

Unit Weight	Int Friction	Coeff. Friction		Soil
		w. Conc		
110-120	33-40	0.5-0.6		Sand or gravel, no fines
120-130	25-35	0.4-0.5		Sand or gravel, w/ fines
110-120	23-30	0.3-0.4		Silty sand, high clay
100-120	25-35	0.2-0.4		Medium or stiff clay
90-110	20-25	0.2-0.3		Soft clay, silt

### WALL GEOMETRY

H1	2.8333333	(ft)	soil retained
H2	1.1666667	(ft)	soil depth above toe
H3	0.8333333	(ft)	footing thickness
H4	1.5	(ft)	passive pressure soil depth
B1	0.6666667	(ft)	wall width
B2	0.8333333	(ft)	toe width
B3	1.5	(ft)	heel width
H	4.8333333	(ft)	total height
B	3	(ft)	total base
	150	(pcf)	concrete unit weight



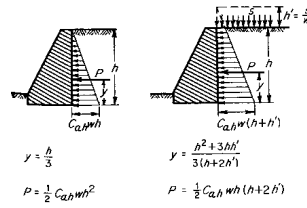
### EXTERNAL LOADS

P <sub>applied</sub>	0	(lb/ft)	
V <sub>applied</sub>	0	(lb/ft)	2
M <sub>applied</sub>	0	(lb-ft / ft)	
Surcharge	32	(psf)	

### LOAD CALCULATIONS

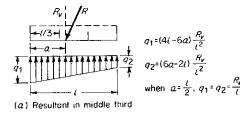
#### lateral soil force and overturning moment

H <sub>prime</sub>	0.26	(ft)	converted surcharge
Y	1.69	(ft)	distance to soil load resultant
P	647	(lbs)	soil load resultant
	1090	(lb-ft)	M <sub>o</sub> , soil + surcharge
	0	(lb-ft)	M <sub>o</sub> , external load
	1,090	(lb-ft)	total overturning Moment



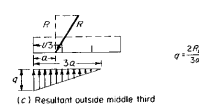
#### wall restoring forces

component	weight (#)	arm (ft)	moment (#-ft)
w1 (concrete)	400	1.17	467
w2 (concrete)	375	1.50	563
w3 (heel soil)	750	2.25	1688
w4 (surcharge)	48	2.25	108
w5 (toe soil)	122	0.42	51
P applied	0	0.33	0
vert. force	1,695	moment	2,875



#### lateral sliding resistance

394	(lb)	passive pressure sliding resistance
593	(lb)	soil friction force
987	(lb)	total sliding resistance



### STABILITY FACTOR OF SAFETY CHECKS

	1	F.S. overturning
	1	F.S. sliding
overturning	2.64	OK
sliding	1.53	OK
		(PP+F)/(Ph+V)

### SOIL BEARING

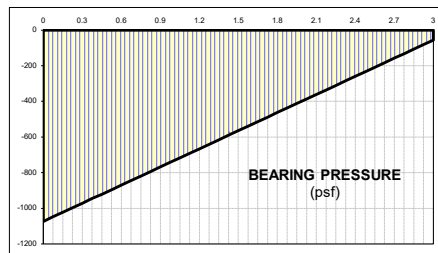
a	1.05	(ft)	distance to resultant
	1.00' to 2.00'		middle third of footing
q1	1074	(psf)	bearing pressure @ toe
q2	57	(psf)	bearing pressure @ heel

### FACTORED (1.7) STEM LOAD FORCES

4	(ft)	H1 + H2
1.41	(ft)	line of action (above base)
452	(lbs)	P (arm only)
452	(lbs)	Ph (arm only)
1.1	(kip-ft)	Mu (arm moment)

### FACTORED (1.7) FOOTING LOADS

0.6	(kip-ft)	Mu @ Toe (Bot Reinf)
0.4	(kip-ft)	Mu @ Heel (Bot Reinf)
1.32	(kip)	Vu @ Toe
0.79	(kip)	Vu @ Heel



### Footing

ØVc	7.969	10" thick
As	0.24	#4 @ 10"
a	0.0004	
ØMn	7.56	k-ft
	0.8	4-#4
	0.0022222	Reinf. Ratio
	0.002	Reinf. Ratio

### Wall

ØVc	5.692	8" thick
As	0.15	#4 @ 16" oc
a	0.0002	
ØMn	4.05	k-ft
	0.00125	Reinf. Ratio

LRFD soil 1345.55 psf @ Wall interface  
1825.8 'psf @ Toe

961.35 psf @ Wall interface  
96.9 'psf @ Heel

200.1041667 # in Toe @ 0.55555556 ft from Wall  
1121.291667 # in Toe @ 0.41666667 ft from Wall

648.3375 # in Toe @ 0.5 ft from Wall  
145.35 # in Toe @ 0.75 ft from Wall

ASD values taken from RISA model

0.35 friction factor multiplied by ASD Dead load

Height of Passive

Passive + Friction

Height (ft)	F <sub>top</sub> (plf)	F <sub>bot</sub> (plf)	Dead (plf)	Friction (plf)	Passive	Height of Passive	R <sub>bot</sub> (plf)	Sliding
6	341	581	1,663	582	394	1.5	976	OK
8	606	1,033	2,071	725	394	1.5	1,119	OK
10	947	1,613	2,480	868	886	2.25	1,754	OK
12	1,363	2,323	4,625	1,619	886	2.25	2,505	OK
14	1,855	3,162	5,292	1,852	1,323	2.75	3,176	OK
16	2,423	4,130	5,958	2,085	2,144	3.5	4,229	OK

Detail 4/S3.2

WALL													
	M <sub>max</sub> (K-in) LRFD	ØMn (K-in)	V <sub>max</sub> (K) LRFD	ØVn (K)	a (in)	As <sub>vert</sub> (in <sup>2</sup> )	ρ <sub>vert</sub>	As <sub>horiz</sub> (in <sup>2</sup> )	ρ <sub>horiz</sub>	Fy (ksi)	F'c (ksi)	b (in)	d (in)
6	13.2	47.2	0.9	5.4	0.352941176	0.15	0.0015625	0.2	0.002083333	60	2.5	12	6
8	31.2	62.3	1.6	5.4	0.470588235	0.2	0.002083333	0.2	0.002083333	60	2.5	12	6
10	61.0	74.1	2.5	5.4	0.564705882	0.24	0.0025	0.2	0.002083333	60	2.5	12	6
12	105.5	151.9	3.6	7.2	0.875294118	0.372	0.0031	0.31	0.002583333	60	2.5	12	8
14	167.5	187.1	5.0	7.2	1.094117647	0.465	0.003875	0.31	0.002583333	60	2.5	12	8
16	250.0	257.4	6.5	7.2	1.552941176	0.66	0.0055	0.31	0.002583333	60	2.5	12	8
KEY	18.2	47.2	1.5	5.4	0.352941176	0.15	0.0015625	0.2	0.002083333	60	2.5	12	6

Height (ft)	F <sub>top</sub> (plf)	F <sub>bot</sub> (plf)	Dead (plf)	Friction (plf)
6	461	821	1,599	560
8	819	1,459	2,007	702
10	1,280	2,280	3,666	1,283

Detail 1/S3.2

WALL													
	M <sub>max</sub> (K-in) LRFD	ØMn (K-in)	V <sub>max</sub> (K) LRFD	ØVn (K)	a (in)	As <sub>vert</sub> (in <sup>2</sup> )	ρ <sub>vert</sub>	As <sub>horiz</sub> (in <sup>2</sup> )	ρ <sub>horiz</sub>	Fy (ksi)	F'c (ksi)	b (in)	d (in)
6	18.5	47.2	0.9	5.4	0.352941176	0.15	0.0015625	0.2	0.002083333	60	2.5	12	6
8	43.8	62.3	1.6	5.4	0.470588235	0.2	0.002083333	0.2	0.002083333	60	2.5	12	6
10	85.6	94.3	2.5	5.4	0.729411765	0.31	0.003229167	0.2	0.002083333	60	2.5	12	6