Revised
Structural Calculations:

Huber Residence

9611 SE 72nd St

Mercer Island, WA 98040

Prepared for:	Brandt Design Group
Job #:	01519-2021-06
Date:	September 10, 2021
Revised:	November 16, 2022

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Criteria Sheet

Codes

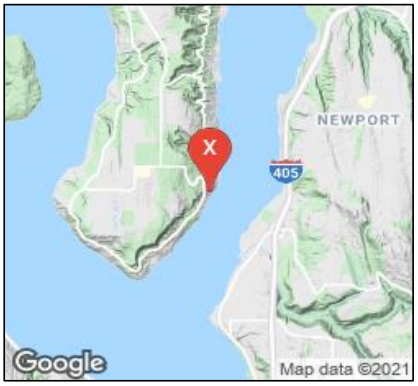
Structural	IBC 2018
Loading	ASCE 7-16
Wood:	NDS 2018
Steel:	AISC 360-16
Concrete:	ACI 318-14
Masonry:	TMS 402/602-16

Project Location

Street & Number	9611 SE 72nd St
City:	Mercer Island
State:	WA
ZIP:	98040
Latitude:	47.5380 N
Longitude:	-122.2114 W
Ground Elevation	48 ft

Occupancy Category

Risk Category: II ASCE 7 Table 1.5-1



Seismic Load Summary:

Analysis Procedure: Equivalent Lateral Force Procedure

Lateral System: Light-frame (wood) Walls Sheathed with Wood Structural Panels Rated for Shear Resistance

R:	6.50	C_d=	4
Base Shear V =	27 kips	Ω_o=	2.5
S_S=	1.451	S_1=	0.501
S_{DS}=	1.16	S_{D1}=	0.57
C_s=	0.179	I_E=	1.0

Story Information

Stories Above Grade (Including Mezzanine Levels): 2

Horizontal and Vertical Irregularities:

Is the building a "Regular Structure"? (No horizontal or vertical irregularities): Yes

Wind Load Summary:

V= 98 K_{ZT}= 1.00

Exposure = C

Dead Loads:

Roof		Floor	
Roofing	2.5 psf	Finish Floor	1 psf
1/2" Sheathing	1.8 psf	1.5" Gypcrete	18.75 psf
Trusses @ 24" oc	2.5 psf	3/4" Sheathing	2.7 psf
Misc./Mech.	1 psf	Joists @ 16" oc	2.2 psf
Ceiling Finish	2.8 psf	Misc./Mech.	2 psf
Solar Panels	5	Ceiling Finish	2.8
	15 psf		29.45 psf
Use	15 psf	Use	30 psf

Live Loads:

Snow	25	psf
Floor	40	psf

Soils:

Soils Report Provided? No To be approved by the authority having jurisdiction, per 11.8.2 exception.

Allowable Bearing	3000	psf	Active	55/35	pcf (Restrained/Unrestrained)
Sliding, μ	0.5		Seismic Surcharge	6H	

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Huber Residence

Criteria

DATE 9/10/2021

PROJ. # 01519-2021-06

DESIGN DMR

SHEET 1

Seismic Design

ASCE 7-16 Seismic Analysis Equivalent Lateral Force Procedure

Seismic Force Resisting System Per Table 12.2-1		
	System	Bearing Wall Systems
	Type:	Light-frame (wood) Walls Sheathed with Wood Structural Panels Rated for Shear Resistance

Seismic Design Cat.	D	
Risk Category	II	I, II, or III, or IV per Table 1.5-1
Site Class	D (Default)	Assumed default soil properties, per 11.4.3.
Diaphragm Flexibility	Flexible	

Section 12.8.1.3 Exceptions

Regular Structure	Yes
≤ 5 Stories above grade	Yes
T ≤ 0.5s	Yes
ρ = 1.0	No
Not Site Class E or F	Yes
Risk Category I or II	Yes

If all exceptions are met, S_{DS} may be taken as 1, but not less than 0.7*(Calculated S_{DS})

S_S	1.451 g	2% in 50 yr, Latitude & Longitude lookup
S_1	0.501 g	2% in 50 yr, Latitude & Longitude lookup
R	6.50	
C_d	4.0	
Ω_o	2.5	
I_e	1.00	Table 1.5-2
h_n	33.0 ft	
Ct	0.02	Table 12.8-2
x	0.75	Table 12.8-2
T_a	0.28 sec	
T	0.28 sec	Eq. 12.8-7
T_0	0.10 sec	
T_S	0.49 sec	
T_L	6.00 sec	
F_a	1.20	Table 11.4-1
F_v	1.70	Table 11.4-2
S_{MS}	1.74 g	Eq. 11.4-1
S_{M1}	0.85 g	Eq. 11.4-2
S_{DS}	1.161 g	Eq. 11.4-3
S_{D1}	0.568 g	Eq. 11.4-4
C_s	***0.179 Controls***	Eq. 12.8-2
	0.317	Eq. 12.8-3 need not exceed, T < T_L
	0.010	Eq. 12.8-5 or 12.8-6 minimum
C_s, design	0.179	Section 11.4.8 Exception 2 Applied
Bldg. Weight	151.8 k	
V = C_SW	27.1 k	Eq. 12.8-1, Strength Level Base Shear
V = C_{Sasd}W	19.0 k	Eq. 12.8-1 ASD Base Shear

Building Period Per Alternate Analysis

T (sec)	

Per Geotech Report

F_a	
F_v	

$$T_a = C_t h_n^x \quad \text{Eq. 12.8.7}$$

$$S_{MS} = F_a S_S \quad \text{Eq. 11.4-1}$$
$$S_{M1} = F_v S_1 \quad \text{Eq. 11.4-2}$$
$$S_{DS} = {}^2/_3\, S_{MS} \quad \text{Eq. 11.4-3}$$
$$S_{D1} = {}^2/_3\, S_{M1} \quad \text{Eq. 11.4-4}$$

$$C_S = \frac{S_{DS}}{(R/I_e)} \quad \text{Eq. 12.8-2}$$
$$C_S = \frac{S_{D1}}{T(R/I_e)} \quad \text{Eq. 12.8-3}$$
$$C_S = \frac{S_{D1} T_L}{T^2 (R/I_e)} \quad \text{Eq. 12.8-4}$$
$$C_S \geq 0.044 S_{DS} I_e \quad \text{Eq. 12.8-5}$$
$$C_S \geq 0.01 \quad \text{Eq. 12.8-5}$$
$$C_S \geq 0.5 \frac{S_1}{(R/I_e)} \quad \text{Eq. 12.8-6}$$

$$C_{VX} = w_x h_x^k / \sum_{i=1}^{n} w_x h_i^k \quad \text{Eq. 12.8-12}$$

$$F_{px} = {}^{\sum_{i=x}^{n} F_i}/_{\sum_{i=x}^{n} w_i}\, w_{px} \quad \text{Eq. 12.10-1}$$
$$F_{px} \geq 0.2 S_{DS} I_e w_{px} \quad \text{Eq. 12.10-2}$$
$$F_{px} \leq 0.4 S_{DS} I_e w_{px} \quad \text{Eq. 12.10-3}$$

Vertical Distribution ASD ρ= 1.3 k= 1.000

Level	h_x (ft)	W_x (k)	h_x^k (ft)	$W_x h_x^k$	Story Shear ASD			Diaphragm Force (ρ not included)				
					C_{vx} (%)	F_x (k)	SV (k)	$F_{px,calc}$	$F_{px,min}$	$F_{px,max}$	$F_{px,design}$	γ=F_{px}/F_x
Roof	33.0	26.40	33.0	871	0.281	6.9	**6.9**	5.3	4.3	8.6	**5.3**	0.77
Upper	24.0	60.43	24.0	1450	0.468	11.5	**18.5**	9.9	9.8	19.6	**9.9**	0.86
Main	12.0	64.95	12.0	779	0.251	6.2	**24.7**	8.1	10.6	21.1	**10.6**	1.70
Σ		151.8		3101		**24.7**						

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Wind Design - MWFRS

ASCE 7 Chapter 27 - Directional Procedure

Design Method	ASD

Wind Coefficients

Exposure	C	
V=	98	mph
K_d=	0.85	Table 26.6-1
K_h=	1.02	Table 26.10-1
K_e=	1.00	Table 26.9-1
G=	0.85	26.9.4

Location and Building Dimensions

Calculate Kzt?	No	
Kzt	1.00	
Roof Type	Gable	
Roof Angle - Transverse Dir	0	degrees
Roof Angle - Long Dir	26.6	degrees
Ground to top of roof	40	ft
Bot of roof to top of roof	7	ft
Mean Roof Height, h	36.5	ft
Short Plan Dimension	50	ft
Long Plan Dimension	50	ft
Parapet ?	No	
Ground to top of parapet		ft
Average Parapet Height		ft
Ht of 2nd Level Above Grade	15	ft

Velocity Pressure at Mean Roof Height, q_h =	21.4	psf

Transverse Wind Pressures

L/B = 1.00 h/L = 0.73

Pressure Coefficients from Figure 27.3-1:

Bldg Face	C_p
Windward Wall	0.8
Leeward Wall	-0.50
Windward Roof	-1.08 / -0.18
Leeward Roof	-0.59

Wall Pressures (Unfactored): ASD

Ht	K_z	q_z	$P_{ww\ walls}$	P_{lwalls}	**P_{walls} (psf)**
0-15	0.85	17.73	12.06	9.08	**12.7**
15-20	0.9	18.78	12.77	9.08	**13.1**
20-25	0.94	19.61	13.33	9.08	**13.4**
25-30	0.98	20.44	13.90	9.08	**13.8**
30-40	1.04	21.70	14.75	9.08	**14.3**
41-50	1.09	22.74	15.46	9.08	**14.7**
51-60	1.13	23.57	16.03	9.08	**15.1**
61-70	1.17	24.41	16.60	9.08	**15.4**
71-80	1.21	25.24	17.16	9.08	**15.7**
81-90	1.24	25.87	17.59	9.08	**16.0**
91-100	1.26	26.29	17.87	9.08	**16.2**

Roof Pressures (Unfactored) ASD

Windward		Leeward	**Horiz Proj (psf)**
Max	Min		
-3.3	-19.7	-10.7	**4.80**

Longitudinal Wind Pressures

L/B = 1.00 h/L = 0.73

Pressure Coefficients from Figure 27.4-1:

Bldg Face	C_p
Windward Wall	0.8
Leeward Wall	-0.50
Windward Roof	-0.35 / 0.14
Leeward Roof	-0.60

Wall Pressures (Unfactored): ASD

Ht	K_z	q_z	$P_{ww\ walls}$	P_{lwalls}	**P_{walls} (psf)**
0-15	0.85	17.73	12.06	9.08	**12.68**
15-20	0.9	18.78	12.77	9.08	**13.11**
20-25	0.94	19.61	13.33	9.08	**13.45**
25-30	0.98	20.44	13.90	9.08	**13.79**
30-40	1.04	21.70	14.75	9.08	**14.30**
41-50	1.09	22.74	15.46	9.08	**14.72**
51-60	1.13	23.57	16.03	9.08	**15.06**
61-70	1.17	24.41	16.60	9.08	**15.40**
71-80	1.21	25.24	17.16	9.08	**15.74**
81-90	1.24	25.87	17.59	9.08	**16.00**
91-100	1.26	26.29	17.87	9.08	**16.17**

Roof Pressures (Unfactored) ASD

Windward		Leeward	**Horiz Proj (psf)**
Max	Min		
2.5	-6.3	-10.9	**4.80**

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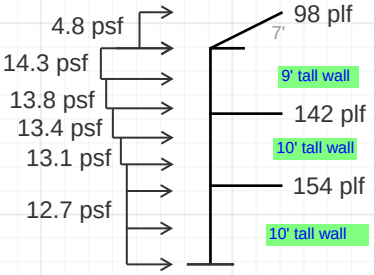
Lateral Design

Wind Pressure Distribution



Base Shear = 18.9 k

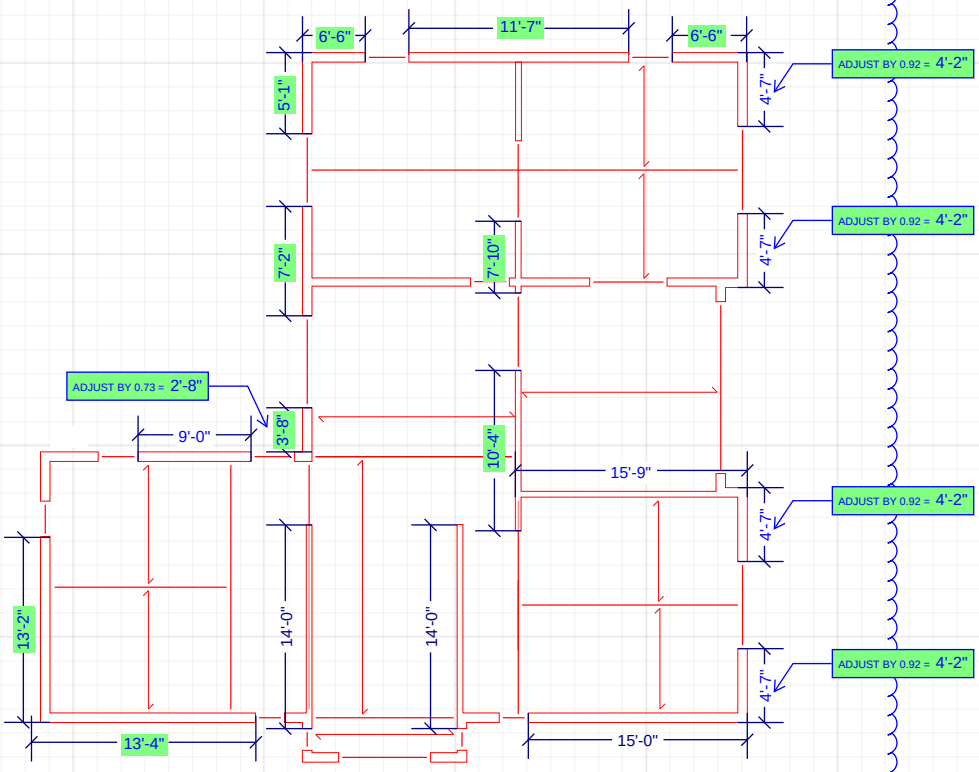
Seismic Story Shear

10.5 k

7.8 k

4.4 k

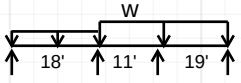
Total Base Shear = 22.6 k



N-S Direction

Roof

w_E = 126 plf, 273 plf
w_W = 98 plf

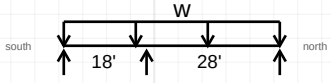


V	1.1 k	2.7 k	4.1 k	2.6 k
L	13.17'	28.92'	32.17'	16.75'
v	84 plf	93 plf	127 plf	155 plf
OT	---	---	---	---
W_ HD	W6 ---	W6 ---	W6 ---	W6 ---

E-W Direction

Roof

w_E = 228 plf
w_W = 98 plf



V	2.1 k	5.2 k	3.2 k
L	28.42'	24.75'	24.58'
v	74 plf	210 plf	130 plf
OT	---	2.0 k	---
W_ HD	W6 ---	W6 (2)CS16	W6 ---

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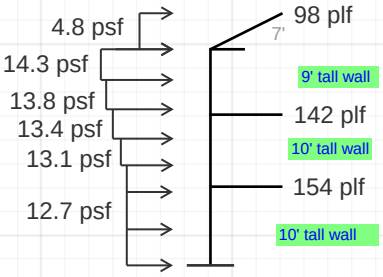
4
SHEET

Lateral Design

Wind Pressure Distribution



Base Shear = 18.9 k

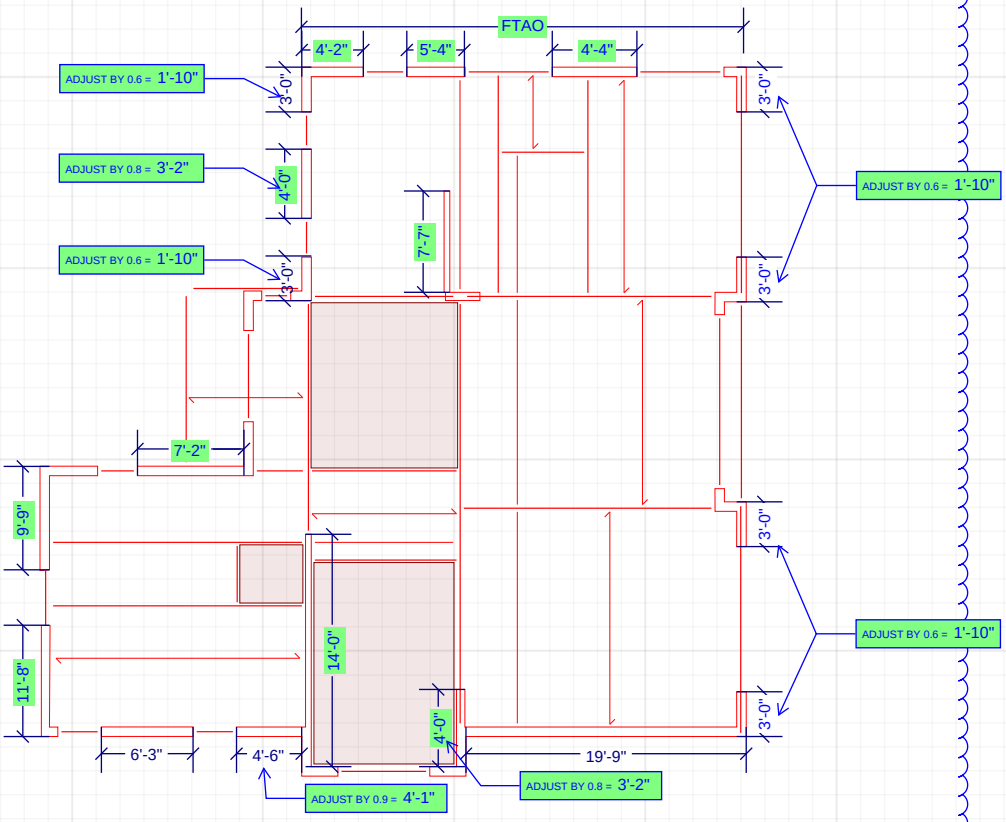
Seismic Story Shear

10.5 k

7.8 k

4.4 k

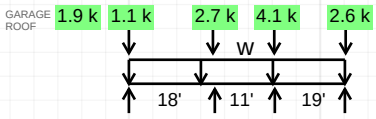
Total Base Shear = 22.6 k



N-S Direction

Upper Floor

w_E = 162 plf
w_w = 142 plf

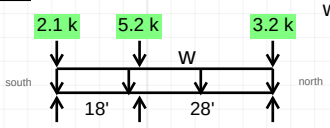


V	4.5 k	5.0 k	6.5 k	4.1 k
L	21.42'	20.83'	10.75'	7.33'
v	208 plf	240 plf	605 plf	560 plf
OT	2.4 k	2.5 k	6.0 k	5.5 k
W_HD	W6 (2)CS16	W4 (2)CS16/ HDU2	W2-10 HDU8	W2 HDU5

E-W Direction

Upper Floor

w_E = 170 plf
w_w = 142 plf



V	3.6 k	9.1 k	5.6 k
L	30.1'	7.17'	11.41'
v	120 plf	1270 plf	443 plf
OT	---	14.3 k	
W_HD	W6 ---	2W2-10 HDU14	W3 HDU2

FTAO (SEE FOLLOWING PAGE)

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DESIGN

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Force Transfer Around Openings Calculator

THREE OPENINGS

The force transfer around openings (FTAO) method of shear wall analysis is an approach that aims to reinforce the wall such that it performs as if there was no opening. This approach lends certain advantages over segmented shear walls: more versatility, because it allows for narrower wall segments while still meeting the height-to-width ratios and, often, fewer required hold-downs.

Project Information

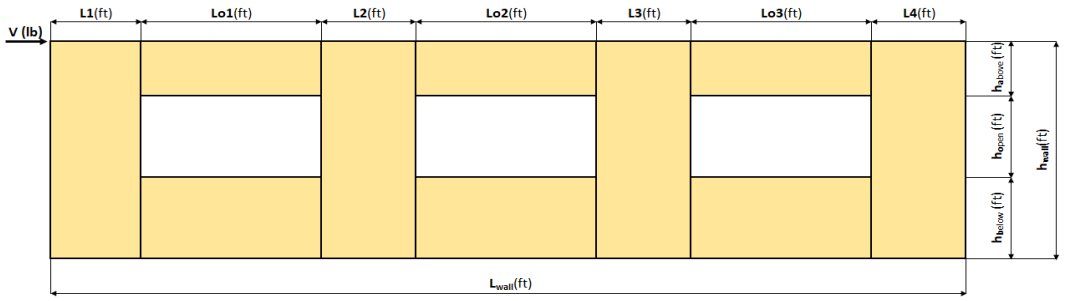
Code: **Date:**

Designer:

Client:

Project:

Wall Line: UPPER FLOOR GRID A



Shear Wall Calculation Variables

V	5600 lbf	Opening 1		Opening 2		Opening 3		Adj. Factor Method =	2bs/h
L1	4.17 ft	h_a1	2.17 ft	h_a2	2.17 ft	h_a3	2.17 ft	Wall Pier Aspect Ratio	Adj. Factor
L2	5.33 ft	h_o1	6.00 ft	h_o2	6.00 ft	h_o3	6.00 ft	P1=h_o/L1= 1.44	N/A
L3	4.33 ft	h_b1	2.00 ft	h_b2	2.00 ft	h_b3	2.00 ft	P2=h_o/L2= 1.13	N/A
L4	3.00 ft	Lo1	3.00 ft	Lo2	5.50 ft	Lo3	5.50 ft	P3=h_o/L3= 1.39	N/A
h_{wall}	10.17 ft							P4=h_o/L4= 2.00	N/A
L_{wall}	30.83 ft								

1. Hold-down forces: $H = Vh_{wall}/L_{wall}$ 1847 lbf

2. Unit shear above + below opening

First opening: va1 = vb1 = H/(h_a1+h_b1) =	443 plf
Second opening: va2 = vb2 = H/(h_a2+h_b2) =	443 plf
Third opening: va3 = vb3 = H/(h_a3+h_b3) =	443 plf

3. Total boundary force above + below openings

First opening: O1 = va1 x (Lo1) =	1329 lbf
Second opening: O2 = va2 x (Lo2) =	2436 lbf
Third opening: O3 = va3 x (Lo3) =	2436 lbf

4. Corner forces

F1 = O1(L1)/(L1+L2) =	583 lbf
F2 = O1(L2)/(L1+L2) =	746 lbf
F3 = O2(L2)/(L2+L3) =	1344 lbf
F4 = O2(L3)/(L2+L3) =	1092 lbf
F5 = O3(L3)/(L3+L4) =	1439 lbf
F6 = O3(L4)/(L3+L4) =	997 lbf

5. Tributary length of openings

T1 = (L1*Lo1)/(L1+L2) =	1.32 ft
T2 = (L2*Lo1)/(L1+L2) =	1.68 ft
T3 = (L2*Lo2)/(L2+L3) =	3.03 ft
T4 = (L3*Lo2)/(L2+L3) =	2.47 ft
T5 = (L3*Lo3)/(L3+L4) =	3.25 ft
T6 = (L4*Lo3)/(L3+L4) =	2.25 ft

6. Unit shear beside opening

v1 = (V/L)(L1+T1)/L1 =	239 plf
v2 = (V/L)(T2+L2+T3)/L2 =	342 plf
v3 = (V/L)(T4+L3+T5)/L3 =	421 plf
v4 = (V/L)(T6+L4)/L4 =	318 plf
Check v1*L1+v2*L2+v3*L3+v4*L4=V?	5600 lbf **OK**

7. Resistance to corner forces

R1 = v1*L1 =	997 lbf
R2 = v2*L2 =	1825 lbf
R3 = v3*L3 =	1824 lbf
R4 = v4*L4 =	954 lbf

8. Difference corner force + resistance

R1-F1 =	413 lbf
R2-F2-F3 =	-265 lbf
R3-F4-F5 =	-707 lbf
R4-F6 =	-43 lbf

9. Unit shear in corner zones

vc1 = (R1-F1)/L1 =	99 plf
vc2 = (R2-F2-F3)/L2 =	-50 plf
vc3 = (R3-F4-F5)/L3 =	-163 plf
vc4 = (R4-F6)/L4 =	-14 plf

Project Information

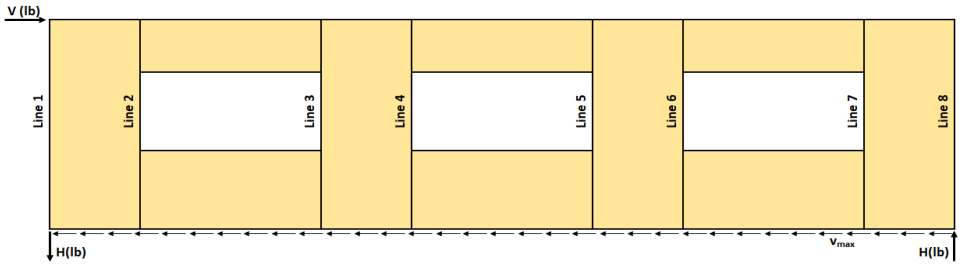
Code: **Date:**

Designer:

Client:

Project:

Wall Line: UPPER FLOOR GRID A



Check Summary of Shear Values for Three Openings

Line 1: $vc1(h_a1+h_b1)+v1(h_o1)=H$?		413	1434	1847 lbf
Line 2: $va1(h_a1+h_b1)-vc1(h_a1+h_b1)-v1(h_o1)=0$?	1847	413	1434	0
Line 3: $vc2(h_a1+h_b1)+v2(h_o1)-va1(h_a1+h_b1)=0$?	-207	2055	1847	0
Line 4: $va2(h_a2+h_b2)-v2(h_o2)-vc2(h_a2+h_b2)=0$?	1847	2055	-207	0
Line 5: $va2(h_a2+h_b2)-vc3(h_a2+h_b2)-v3(h_o2)=0$?	1847	-681	2528	0
Line 6: $va3(h_a3+h_b3)-v3(h_o3)-vc3(h_a3+h_b3)=0$?	1847	2528	-681	0
Line 7: $va3(h_a3+h_b3)-vc4(h_a3+h_b3)-v4(h_o3)=0$?	1847	-60	1908	0
Line 8: $vc4(h_a3+h_b3)+v4(h_o3)=H$?		-60	1908	1847 lbf

Design Summary*

Req. Sheathing Capacity	443 plf
Req. Strap Force	1439 lbf
Req. HD Force (H)	1847 lbf
Req. Shear Wall Anchorage Force (v_{max})	182 plf

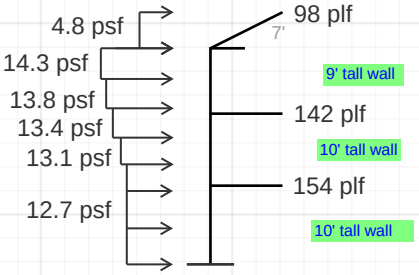
W3
CS16
HDU2

4-Term Deflection		3-Term Deflection	
4-Term Story Drift %		3-Term Story Drift %	

***The Design Summary assumes that the shear wall is designed as blocked.**

Lateral Design

Wind Pressure Distribution



Base Shear = 18.9 k

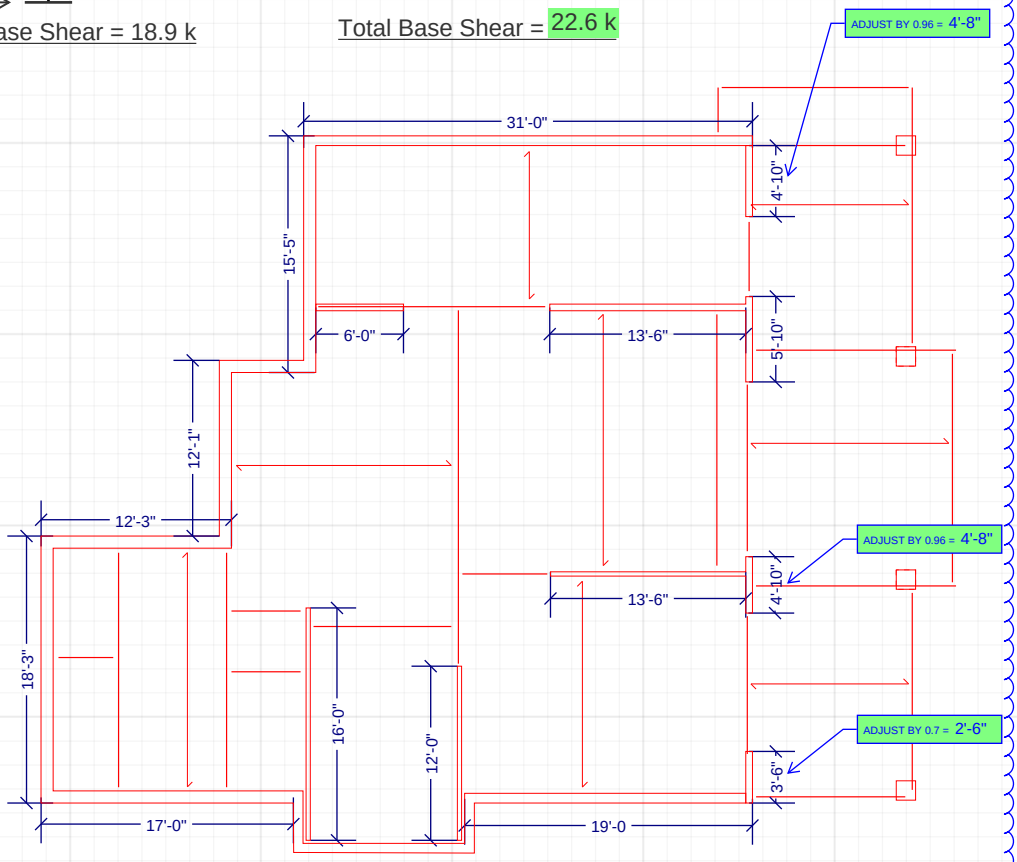
Seismic Story Shear

10.5 k

7.8 k

4.4 k

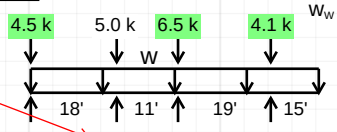
Total Base Shear = 22.6 k



N-S Direction

Main Floor

w_E = 70 plf
w_w = 154 plf



ENGINEER NOTE: LESS THAN PREVIOUS CALC, THEREFORE NO CHANGE

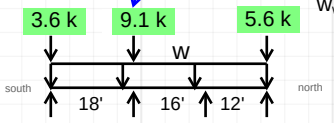
V	5.1 k	6.0 k	7.6 k	5.8 k
L	18.25'	27.5'	12'	17.67'
v	333 plf	237 plf	633 plf	328 plf
OT	---	2.5 k	6.3 k	3.3 k
W_ HD	CONC WALL	W6 HDU4	W2-10 HDU8	W3 HDU4

E-W Direction

Main Floor

Load from above goes into conc wall below.

w_E = 96 plf
w_w = 154 plf



V	4.5 k	1.7 k	1.4 k	6.2 k
L	38'	13.5'	19.5'	31'
v	124 plf	126 plf	72 plf	200 plf
OT	---	---	---	---
W_ HD	CONC WALL	W6 ---	W6 ---	CONC WALL

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PROJECT

08/06/21
DATE

01519-2021-06
PROJ. #

DMR
DESIGN

6
SHEET

Lateral Design

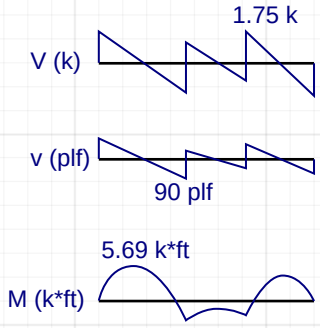
Diaphragm Design (25% increase in chord/collector forces)

25% increase in seismic forces per ASCE 7-16, 12.3.3.4

N-S Direction

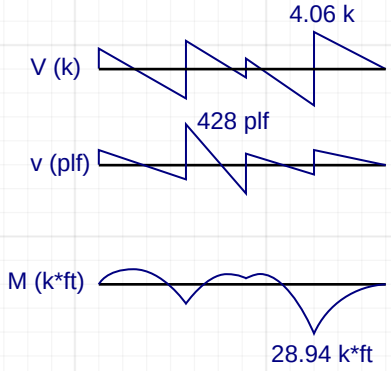
Roof

w_E = ~~144 plf~~ 180 plf
w_W = 98 plf



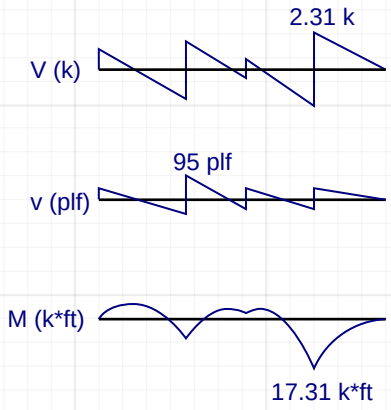
Upper Floor

w_E = ~~206 plf~~ 258 plf
w_W = 142 plf



Main Floor

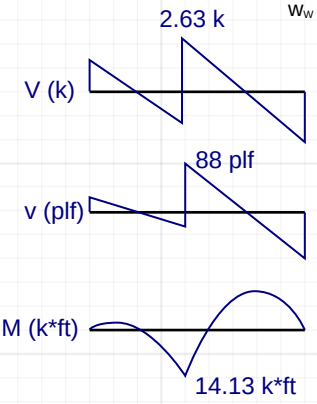
w_E = ~~98 plf~~ 123 plf
w_W = 154 plf



E-W Direction

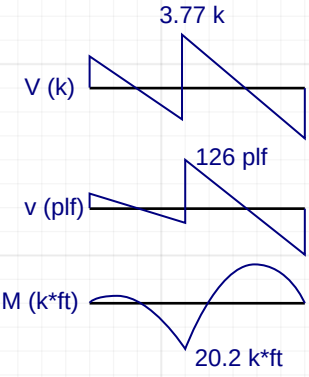
Roof

w_E = ~~150 plf~~ 188 plf
w_W = 98 plf



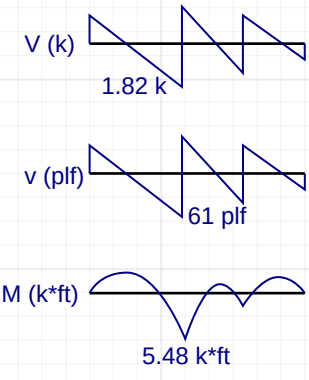
Upper Floor

w_E = ~~215 plf~~ 269 plf
w_W = 142 plf



Main Floor

w_E = ~~135 plf~~ 169 plf
w_W = 154 plf



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Criteria Sheet

Codes

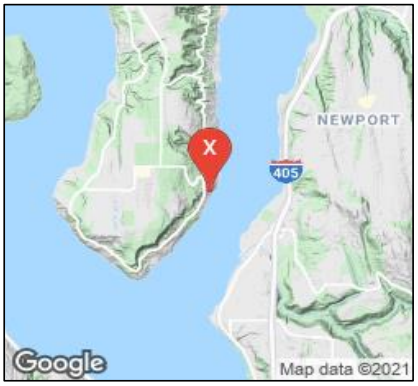
Structural	IBC 2018
Loading	ASCE 7-16
Wood:	NDS 2018
Steel:	AISC 360-16
Concrete:	ACI 318-14
Masonry:	TMS 402/602-16

Project Location

Street & Number	9611 SE 72nd St
City:	Mercer Island
State:	WA
ZIP:	98040
Latitude:	47.5380 N
Longitude:	-122.2114 W
Ground Elevation	48 ft

Occupancy Category

Risk Category: II ASCE 7 Table 1.5-1



Seismic Load Summary:

Analysis Procedure: Equivalent Lateral Force Procedure

Lateral System: Light-frame (wood) Walls Sheathed with Wood Structural Panels Rated for Shear Resistance

R:	6.50	C_d=	4
Base Shear V =	2 kips	Ω_o=	2.5
S_S=	1.451	S_1=	0.501
S_{DS}=	1.16	S_{D1}=	0.57
C_s=	0.179	I_E=	1.0

Story Information

# Stories Above Grade (Including Mezzanine Levels)	2

Horizontal and Vertical Irregularities:

Is the building a "Regular Structure"? (No horizontal or vertical irregularities): Yes

Wind Load Summary:

V= 98 K_{ZT}= 1.00

Exposure = C

Dead Loads:

Roof		Floor	
Roofing	2.5 psf	Finish Floor	1 psf
1/2" Sheathing	1.8 psf	1.5" Gypcrete	18.75 psf
Trusses @ 24" oc	2.5 psf	3/4" Sheathing	2.7 psf
Misc./Mech.	1 psf	Joists @ 16" oc	2.2 psf
Ceiling Finish	2.8 psf	Misc./Mech.	2 psf
Solar Panels	5	Ceiling Finish	2.8
	15 psf		29.45 psf
Use	15 psf	Use	30 psf

Live Loads:

Snow	25	psf
Floor	40	psf

Soils:

Soils Report Provided? No To be approved by the authority having jurisdiction, per 11.8.2 exception.

Allowable Bearing	3000	psf	Active	55/35	pcf (Restrained/Unrestrained)
Sliding, μ	0.5		Seismic Surcharge	6H	

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Seismic Design

ASCE 7-16 Seismic Analysis Equivalent Lateral Force Procedure

Seismic Force Resisting System Per Table 12.2-1		
	System	Bearing Wall Systems
	Type:	Light-frame (wood) Walls Sheathed with Wood Structural Panels Rated for Shear Resistance

Seismic Design Cat.	D	
Risk Category	II	I, II, or III, or IV per Table 1.5-1
Site Class	D (Default)	Assumed default soil properties, per 11.4.3.
Diaphragm Flexibility	Flexible	

Section 12.8.1.3 Exceptions

Regular Structure	Yes
≤ 5 Stories above grade	Yes
T ≤ 0.5s	Yes
ρ = 1.0	No
Not Site Class E or F	Yes
Risk Category I or II	Yes

If all exceptions are met, S_{DS} may be taken as 1, but not less than 0.7*(Calculated S_{DS})

S_S	1.451 g	2% in 50 yr, Latitude & Longitude lookup
S_1	0.501 g	2% in 50 yr, Latitude & Longitude lookup
R	6.50	
C_d	4.0	
Ω_o	2.5	
I_e	1.00	Table 1.5-2
h_n	12.0 ft	
Ct	0.02	Table 12.8-2
x	0.75	Table 12.8-2
T_a	0.13 sec	
T	0.13 sec	Eq. 12.8-7
T_0	0.10 sec	
T_S	0.49 sec	
T_L	6.00 sec	
F_a	1.20	Table 11.4-1
F_v	1.70	Table 11.4-2
S_{MS}	1.74 g	Eq. 11.4-1
S_{M1}	0.85 g	Eq. 11.4-2
S_{DS}	1.161 g	Eq. 11.4-3
S_{D1}	0.568 g	Eq. 11.4-4
C_s	***0.179 Controls***	Eq. 12.8-2
	0.677	Eq. 12.8-3 need not exceed, T < T_L
	0.010	Eq. 12.8-5 or 12.8-6 minimum
C_s, design	0.179	Section 11.4.8 Exception 2 Applied
Bldg. Weight	12.5 k	
V = C_SW	2.2 k	Eq. 12.8-1, Strength Level Base Shear
V = C_{Sasd}W	1.6 k	Eq. 12.8-1 ASD Base Shear

Building Period Per Alternate Analysis

T (sec)	

Per Geotech Report

F_a	
F_v	

$$T_a = C_t h_n^x \quad \text{Eq. 12.8.7}$$

$$S_{MS} = F_a S_S \quad \text{Eq. 11.4-1}$$
$$S_{M1} = F_v S_1 \quad \text{Eq. 11.4-2}$$
$$S_{DS} = {}^2/_3\, S_{MS} \quad \text{Eq. 11.4-3}$$
$$S_{D1} = {}^2/_3\, S_{M1} \quad \text{Eq. 11.4-4}$$

$$C_S = \frac{S_{DS}}{(R/I_e)} \quad \text{Eq. 12.8-2}$$
$$C_S = \frac{S_{D1}}{T(R/I_e)} \quad \text{Eq. 12.8-3}$$
$$C_S = \frac{S_{D1} T_L}{T^2 (R/I_e)} \quad \text{Eq. 12.8-4}$$
$$C_S \geq 0.044 S_{DS} I_e \quad \text{Eq. 12.8-5}$$
$$C_S \geq 0.01 \quad \text{Eq. 12.8-5}$$
$$C_S \geq 0.5 \frac{S_1}{(R/I_e)} \quad \text{Eq. 12.8-6}$$

$$C_{VX} = w_x h_x^k / \sum_{i=1}^{n} w_x h_i^k \quad \text{Eq. 12.8-12}$$

$$F_{px} = {}^{\sum_{i=x}^{n} F_i}/_{\sum_{i=x}^{n} w_i}\, w_{px} \quad \text{Eq. 12.10-1}$$
$$F_{px} \geq 0.2 S_{DS} I_e w_{px} \quad \text{Eq. 12.10-2}$$
$$F_{px} \leq 0.4 S_{DS} I_e w_{px} \quad \text{Eq. 12.10-3}$$

Vertical Distribution ASD ρ= 1.3 k= 1.000

Level	h_x (ft)	W_x (k)	h_x^k (ft)	$W_x h_x^k$	Story Shear ASD			Diaphragm Force (ρ not included)				
					C_{vx} (%)	F_x (k)	SV (k)	$F_{px,calc}$	$F_{px,min}$	$F_{px,max}$	$F_{px,design}$	γ=F_{px}/F_x
Roof	12.0	12.54	12.0	150	1.000	2.0	**2.0**	1.6	2.0	4.1	**2.0**	1.00
Σ		12.5		150		**2.0**						

Wind Design - MWFRS

ASCE 7 Chapter 27 - Directional Procedure

Design Method	ASD

Wind Coefficients

Exposure	C	
V=	98	mph
K_d=	0.85	Table 26.6-1
K_h=	0.85	Table 26.10-1
K_e=	1.00	Table 26.9-1
G=	0.85	26.9.4

Location and Building Dimensions

Calculate Kzt?	No	
Kzt	1.00	
Roof Type	Gable	
Roof Angle - Transverse Dir	0	degrees
Roof Angle - Long Dir	26.6	degrees
Ground to top of roof	19	ft
Bot of roof to top of roof	7	ft
Mean Roof Height, h	15.5	ft
Short Plan Dimension	22.5	ft
Long Plan Dimension	38	ft
Parapet ?	No	
Ground to top of parapet		ft
Average Parapet Height		ft
Ht of 2nd Level Above Grade	12	ft

Velocity Pressure at Mean Roof Height, q_h =	17.8	psf

Transverse Wind Pressures

L/B = 0.59 h/L = 0.69

Pressure Coefficients from Figure 27.3-1:

Bldg Face	C_p
Windward Wall	0.8
Leeward Wall	-0.50
Windward Roof	-1.05 / -0.18
Leeward Roof	-0.58

Wall Pressures (Unfactored): ASD

Ht	K_z	q_z	$P_{ww\ walls}$	P_{lwalls}	**P_{walls} (psf)**
0-15	0.85	17.73	12.06	7.58	**11.8**
15-20	0.9	18.78	12.77	7.58	**12.2**
20-25	0.94	19.61	13.33	7.58	**12.5**
25-30	0.98	20.44	13.90	7.58	**12.9**
30-40	1.04	21.70	14.75	7.58	**13.4**
41-50	1.09	22.74	15.46	7.58	**13.8**
51-60	1.13	23.57	16.03	7.58	**14.2**
61-70	1.17	24.41	16.60	7.58	**14.5**
71-80	1.21	25.24	17.16	7.58	**14.8**
81-90	1.24	25.87	17.59	7.58	**15.1**
91-100	1.26	26.29	17.87	7.58	**15.3**

Roof Pressures (Unfactored) ASD

Windward		Leeward	**Horiz Proj (psf)**
Max	Min		
-2.7	-15.9	-8.7	**4.80**

Longitudinal Wind Pressures

L/B = 1.69 h/L = 0.41

Pressure Coefficients from Figure 27.4-1:

Bldg Face	C_p
Windward Wall	0.8
Leeward Wall	-0.36
Windward Roof	-0.24 / 0.24
Leeward Roof	-0.60

Wall Pressures (Unfactored): ASD

Ht	K_z	q_z	$P_{ww\ walls}$	P_{lwalls}	**P_{walls} (psf)**
0-15	0.85	17.73	12.06	5.49	**10.53**
15-20	0.9	18.78	12.77	5.49	**10.95**
20-25	0.94	19.61	13.33	5.49	**11.30**
25-30	0.98	20.44	13.90	5.49	**11.64**
30-40	1.04	21.70	14.75	5.49	**12.15**
41-50	1.09	22.74	15.46	5.49	**12.57**
51-60	1.13	23.57	16.03	5.49	**12.91**
61-70	1.17	24.41	16.60	5.49	**13.25**
71-80	1.21	25.24	17.16	5.49	**13.59**
81-90	1.24	25.87	17.59	5.49	**13.85**
91-100	1.26	26.29	17.87	5.49	**14.02**

Roof Pressures (Unfactored) ASD

Windward		Leeward	**Horiz Proj (psf)**
Max	Min		
3.6	-3.7	-9.1	**4.80**

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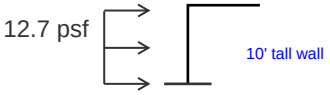
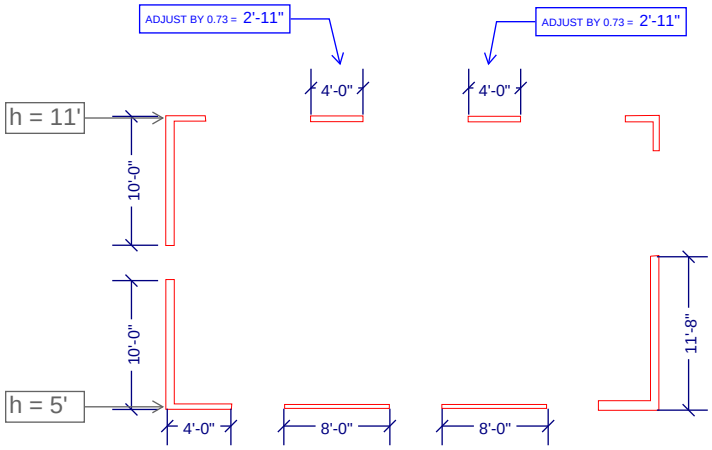
Lateral Design

Seismic Story Shear



Base Shear = 1.3 k

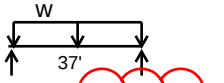
W = 20psf(1065 sf) = 21300 lb
V = C_s*W
V = 0.179*21.3 k = 3.8 k



N-S Direction

Garage

w_E = 103 plf
w_W = 35 plf



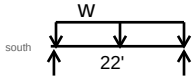
V	1.9 k	1.9 k
L	20'	11.67'
v	95 plf	163 plf
OT	---	
W_	W6	
HD	---	

SEE PAGE 5

E-W Direction

Garage

w_E = 172 plf
w_W = 82 plf



V	1.9 k	1.9 k
L	20'	5.83'
v	95 plf	325 plf
OT	---	3.6 k
W_	W6	W4
HD	---	HDU4

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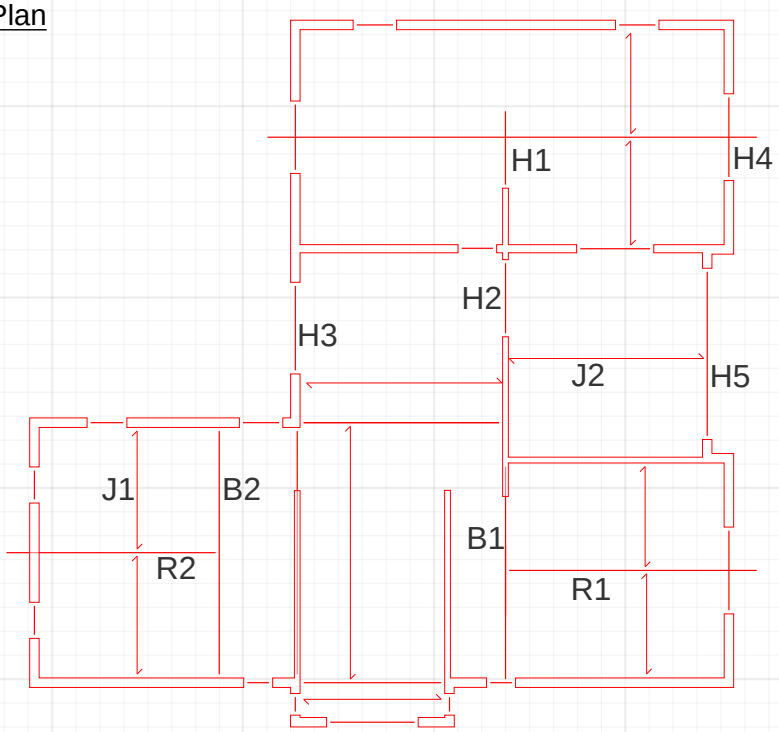
Gravity Design

Roof Framing Key Plan



Roof Framing Calcs

J1

L= 8.5' w= 80 plf Rxn= 0.34 k

f_b= 660 psi Δ= 0.15"
f_v= 40 psi L/672 2x8 @ 24" oc

J2

L= 14' w= 80 plf Rxn= 0.56 k

f_b= 894 psi Δ= 0.36"
f_v= 45 psi L/471 LSL 1.75x9.5 @ 24" oc

R1

L= 15' w= 300 plf Rxn= 2.25 k

f_b= 1463 psi Δ= 0.61"
f_v= 66 psi L/295 GL 5.125x9

R2

L= 13' w= 340 plf Rxn= 2.21 k

f_b= 1246 psi Δ= 0.39"
f_v= 64 psi L/400 GL 5.125x9

B1

L= 15' P= 2.3 k (@ mid-span) Rxn= 1.75 k

f_b= 1061 psi Δ= 0.28"
f_v= 41 psi L/645 GL 5.125x12

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Gravity Design

Roof Framing Calcs (cont)

B2

L= 17' P= 2.3 k (@ mid-span) Rxn= 1.83 k

f_b= 1236 psi Δ= 0.42"
f_v= 43 psi L/486 GL 5.125x12

H1

L= 6' P= 4.5 k (@ 3.5') Rxn= 2.63 k

f_b= 1138 psi Δ= 0.06"
f_v= 85 psi L/1200 GL 5.125x9

H2

L= 6' w= 600 plf Rxn= 1.8 k

f_b= 757 psi Δ= 0.07"
f_v= 72 psi L/1060 (2)2x10

H3

L= 6.5' w= 280 plf Rxn= 0.56 k

f_b= 675 psi Δ= 0.09"
f_v= 51 psi L/859 (2)2x8

H4

L= 6' P= 2.3 k (@ mid-span) Rxn= 1.15 k

f_b= 829 psi Δ= 0.05"
f_v= 53 psi L/1394 4x10

H5

L= 12' w= 300 plf Rxn= 1.8 k

DCR_M: 0.04 Δ= 0.09"
DCR_V: 0.11 L/1600 W6x25

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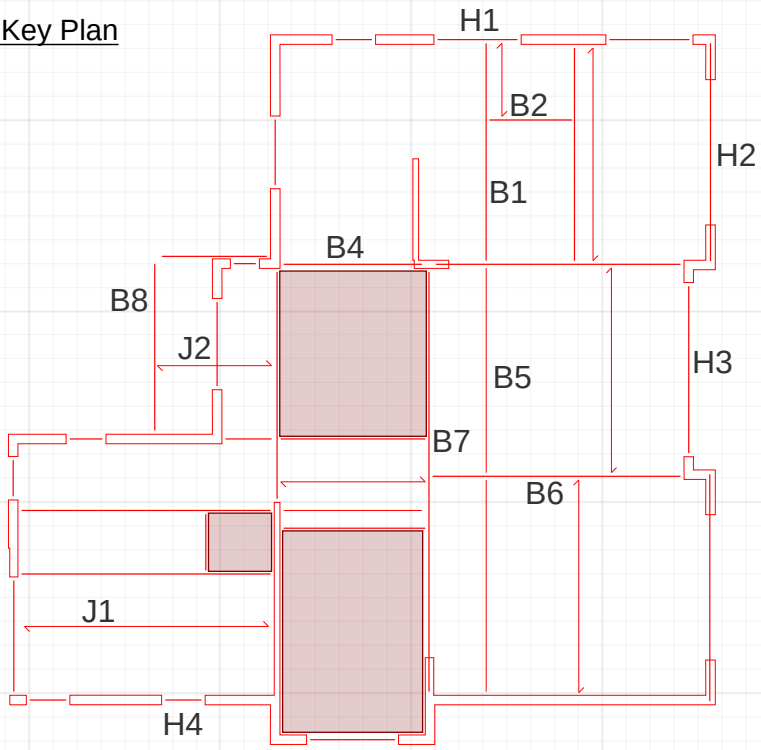
Gravity Design

Upper Floor Framing Key Plan

DL = 32 psf
LL = 40/60 psf



Upper Floor Framing Calcs

J1
L= 18' w= 96 plf Rxn= 0.86 k

16" TJI 230 @ 16" oc

J2
L= 9' w= 125 plf Rxn= 0.56 k

f_b= 369 psi Δ= 0.05"
f_v= 32 psi L/2215 LSL 1.75x11.875 @ 16" oc

B1
L= 15' w= 600 plf P= 3.9 k (@ 9') Rxn= 5.9 k

f_b= 1620 psi Δ= 0.21"
f_v= 108 psi L/571 (3)LVL 1.75x16

B2
L= 6' w= 540 plf Rxn= 1.6 k

f_b= 195 psi Δ= 0.01"
f_v= 24 psi L/8467 LSL 3.5x16

B3 - NOT IN KEY PLAN

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Gravity Design

Upper Floor Framing Calcs (cont)

B4

L= 9' w= 700 plf Rxn= 3.15 k

f_b= 570 psi Δ= 0.04"
f_v= 59 psi L/2497 LSL 3.5x16

B5

L= 15' w= 700 plf P= 1.8 k (@ 6') Rxn= 6.0 k

f_b= 1364 psi Δ= 0.28"
f_v= 96 psi L/644 (3) LVL 1.75x16

B6

L= 18' w= 1.38 klf P= 9.8 k (@ 3.5') Rxn= 20.3 k

DCR_M: 0.08 Δ= 0.21"
DCR_V: 0.18 L/1029 W14x68

B7

L= 17' w= 150 plf P= 20.3 k (@ 2') Rxn= 20.74 k

DCR_M: 0.14 Δ= 0.09"
DCR_V: 0.18 L/2519 W14x68

B8

L= 12' w= 420 plf Rxn= 2.52 k

f_b= 1103 psi Δ= 0.26"
f_v= 76 psi L/556 LSL 3.5x11.875

H1

L= 6' w= 700 plf P= 4.5 k (@ 2.5') Rxn= 5.1 k

f_b= 707 psi Δ= 0.03"
f_v= 112 psi L/2725 LSL 3.5x16

H2

L= 10' w= 150 plf P= 1.2 k (@ 1.5'/8.5') Rxn= 1.9 k

f_b= 613 psi Δ= 0.06"
f_v= 46 psi L/1907 LSL 3.5x16

H3

L= 12' w= 400 plf Rxn= 2.4 k

f_b= 579 psi Δ= 0.10"
f_v= 50 psi L/1429 LSL 3.5x16

H4

L= 4.5' w= 700 plf Rxn= 1.58 k

f_b= 809 psi Δ= 0.05"
f_v= 79 psi L/1036 (2) 2x8

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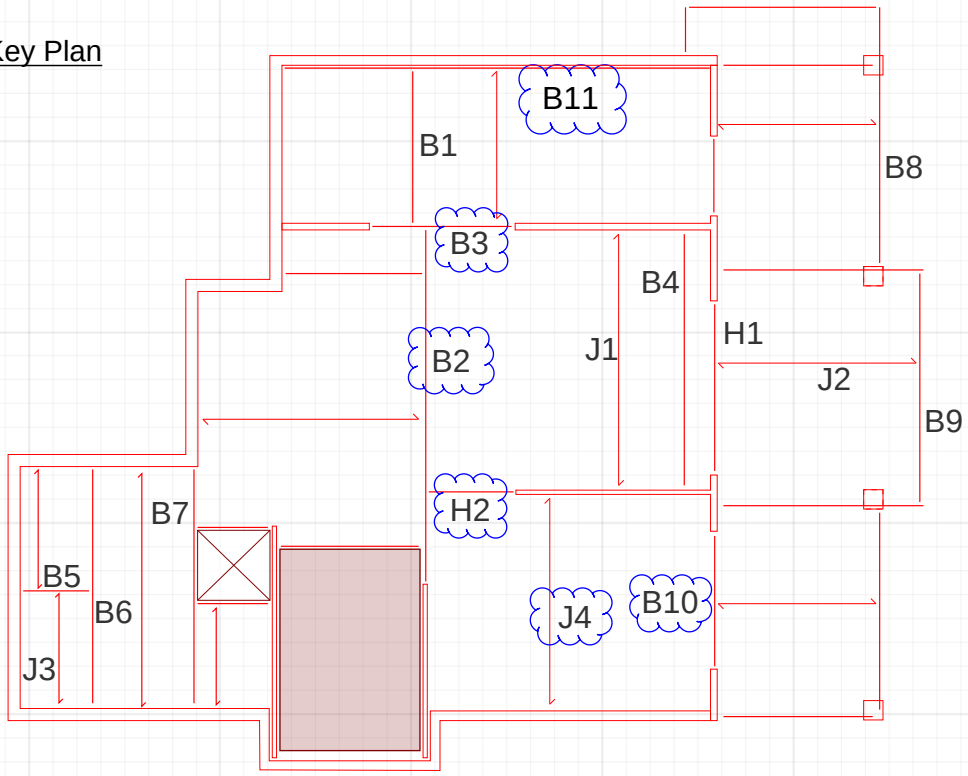
Gravity Design

Main Floor Framing Key Plan

DL = 32 psf
LL = 40/60 psf



Main Floor Framing Calcs

J1
L= 18' w= 96 plf Rxn= 0.86 k
16" TJI 230 @ 16" oc

J2
L= 15' w= 125 plf Rxn= 0.94 k
f_b= 767 psi Δ= 0.24"
f_v= 50 psi L/754
LSL 1.75x14 @ 16" oc

J3
L= 8' w= 150 plf Rxn= 0.6 k
f_b= 252 psi Δ= 0.02"
f_v= 26 psi L/4307
LSL 1.75x14 @ 16" oc

B1
L= 11' w= 96 plf P= 11.4 k (@ 3' eqk.) Rxn= 8.7 k
f_b= 2082 psi Δ= 0.23"
f_v= 232 psi L/565
LSL 3.5x16

B2
L= 25' w= 768 plf P= 23.5 k (@ 4') P= 20.75 k (@ 21') Rxn= 34.7 k
DCR_M: 0.16 Δ= 0.39"
DCR_V: 0.10 L/773
W14x159

J4
L= 15' w= 96 plf P= 664 # (@ 14.5') Rxn= 1.56 k
16" TJI 360 @ 16" oc

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Gravity Design

Main Floor Framing Calcs (cont)

B3

L= 10' w= 1080 plf P= 23.5 k (@ 4') Rxn= 26.2 k

DCR_M: 0.25 Δ= 0.05"

DCR_V: 0.21 L/2450 W14x90

B4

L= 18' w= 96 plf P= 16.7 k (@ 5') Rxn= 12.93 k

DCR_M: 0.36 Δ= 0.14"

DCR_V: 0.11 L/1565 W14x68

B5

L= 5' w= 764 plf Rxn= 1.9 k

f_b= 192 psi Δ= 0.01"

f_v= 24 psi L/10000+ LSL 3.5x16

B6

L= 17' w= 150 plf P= 1.9 k (@ 8') Rxn= 2.3 k

f_b= 1081 psi Δ= 0.33"

f_v= 56 psi L/613 LSL 3.5x16

B7

L= 17' w= 576 plf (@ 0'-5') P= 1.1 k (@ 9.5') Rxn= 3.4 k

f_b= 940 psi Δ= 0.31"

f_v= 69 psi L/666 (3) LVL 1.75x16

B8

L= 14' (+4' cant.) w= 552 plf Rxn= 6.4 k

f_b= 798 psi Δ= 0.16"

f_v= 72 psi L/876 (3) LVL 1.75x13

B9

L= 17' w= 690 plf Rxn= 5.86 k

f_b= 1308 psi Δ= 0.41"

f_v= 77 psi L/504 LSL 3.5x11.875

H1

L= 12' w= 690 plf Rxn= 4.2 k

f_b= 652 psi Δ= 0.10"

f_v= 51 psi L/1432 (3) LVL 5.25x14

H2

L= 6' w= 1224 plf Rxn= 3.67 k

f_b= 443 psi Δ= 0.02"

f_v= 55 psi L/3735 LSL 3.5x16

B10

L= 10' w= 528 plf Rxn= 2.6 k

f_b= 530 psi Δ= 0.06"

f_v= 71 psi L/10000+ LSL 3.5x16

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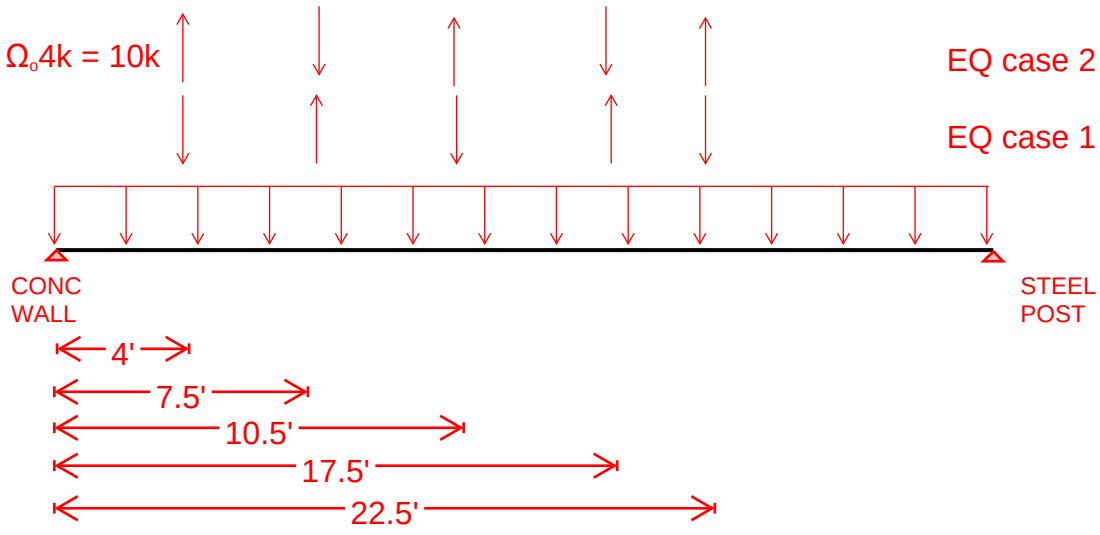
B11

LOADS:

ROOF: DL = 15 PSF
SL = 25 PSF
FLOOR: DL = 32 PSF
LL = 40 PSF

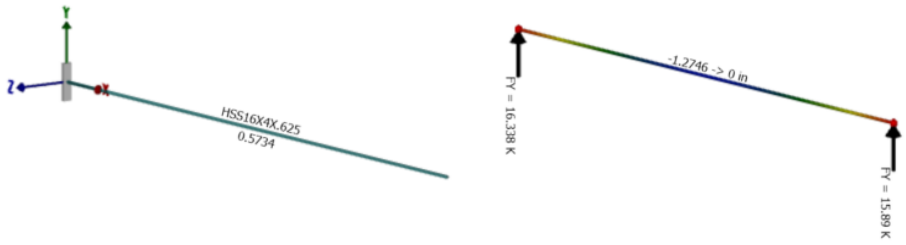
ROOF: DL = 15 PSF (7'/2) = 52 plf
SL = 25 PSF (7'/2) = 88 plf
UPPER: DL = 32 PSF (14'-9"/2) = 236 plf
LL = 40 PSF (14'-9"/2) = 295 plf
MAIN: DL = 32 PSF (11'/2) = 176 plf
LL = 40 PSF (11'/2) = 220 plf

TOTAL = 1067 PLF



Defl. max = D+L/240 = 1.52 in

HSS16X4X5/8
Defl = 1.3 in
DCR = 0.57



STEEL COLUMN
L = 12'-6"
P = 15.9K

USE HSS4X4X5/16 POST

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STRUCTURAL ENGINEERING

PROJECT

DATE

PROJ. # NMH

DESIGN

SHEET

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

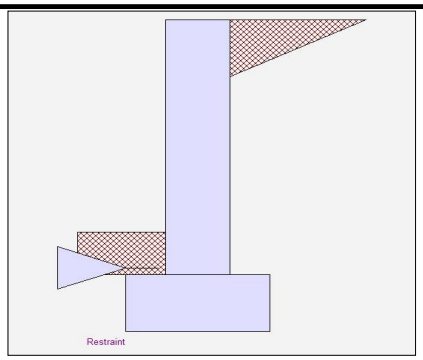
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	3.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Design Summary

Wall Stability Ratios

Overturning	=	1.87	OK
Slab Resists All Sliding !			
Total Bearing Load	=	605 lbs	
...resultant ecc.	=	4.01 in	
Soil Pressure @ Toe	=	971 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,359 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	0.7 psi	OK
Footing Shear @ Heel	=	3.1 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	235.3 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

			Stem OK
Design Height Above Ftg	ft =		0.00
Wall Material Above "Ht"	=		Concrete
Design Method	=		LRFD
Thickness	=		8.00
Rebar Size	=		# 4
Rebar Spacing	=		18.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.068**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		252.0
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		252.0
Moment.....Allowable	=		3,655.6
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		3.4
Shear.....Allowable	psi =		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		6.25
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		100.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		Medium Weight
Masonry Design Method	=		ASD
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0094 in2/ft	
(4/3) * As :	0.0126 in2/ft	Min Stem T&S Reinf Area 0.576 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0012bh : 0.0012(12)(8) :	0.1152 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1152 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.1333 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	0.42 ft
Heel Width	=	1.08
Total Footing Width	=	1.50
Footing Thickness	=	8.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,359	0	psf
Mu' : Upward	=	1,277	1	ft-#
Mu' : Downward	=	206	49	ft-#
Mu: Design	=	89	48	ft-#
Actual 1-Way Shear	=	0.70	3.08	psi
Allow 1-Way Shear	=	40.00	40.00	psi

Toe Reinforcing = None Spec'd
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi'5'lambda'sqrt(fc)'Sm
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.26 in2
Min footing T&S reinf Area per foot 0.17 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 13.89 in	#4@ 27.78 in
#5@ 21.53 in	#5@ 43.06 in
#6@ 30.56 in	#6@ 61.11 in

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	235.3	1.22	287.6			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				155.0	1.29	200.5
Soil Over HL (bel. water tbl)					1.29	200.5
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.21	
Surcharge Over Toe =						
Stem Weight(s) =				300.0	0.75	226.0
Earth @ Stem Transitions =						
Footing Weight =				150.0	0.75	112.5
Key Weight =						
Vert. Component =						
Total =	235.3	**O.T.M.** =	287.6	**Total =**	605.0 lbs	**R.M.=** 539.0

Resisting/Overturning Ratio = **1.87**
Vertical Loads used for Soil Pressure = 605.0 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.054	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

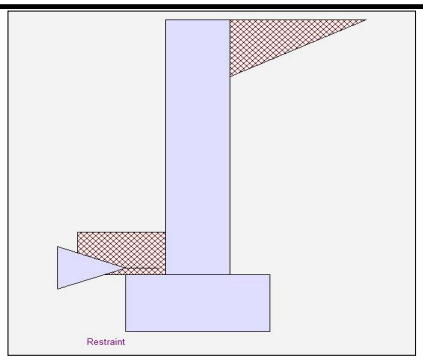
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	3.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used (Multiplier used on soil density)	=	6.000
Uniform Seismic Force	=	22.000
Total Seismic Force	=	80.667

Design Summary

Wall Stability Ratios

Overturning	=	1.38	Ratio < 1.5!

Slab Resists All Sliding !

Total Bearing Load	=	605	lbs
...resultant ecc.	=	6.07	in
Soil Pressure @ Toe	=	1,650 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	4,000	psf

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	2,310	psf
ACI Factored @ Heel	=	0	psf
Footing Shear @ Toe	=	1.3 psi	OK
Footing Shear @ Heel	=	3.3 psi	OK
Allowable	=	75.0	psi

Sliding Calcs

Lateral Sliding Force	=	291.7 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =		0.00
Wall Material Above "Ht"	=		Concrete
Design Method	=		LRFD
Thickness	=		8.00
Rebar Size	=		# 4
Rebar Spacing	=		18.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.096**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		318.0
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		351.0
Moment.....Allowable	=		3,655.6
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		4.2
Shear.....Allowable	psi =		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		6.25
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		100.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		Medium Weight
Masonry Design Method	=		ASD
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0132 in2/ft	
(4/3) * As :	0.0175 in2/ft	Min Stem T&S Reinf Area 0.576 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0012bh : 0.0012(12)(8) :	0.1152 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1152 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.1333 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	0.42 ft
Heel Width	=	1.08
Total Footing Width	=	1.50
Footing Thickness	=	8.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,310	0	psf
Mu' : Upward	=	1,978	0	ft-#
Mu' : Downward	=	206	49	ft-#
Mu: Design	=	148	49	ft-#
Actual 1-Way Shear	=	1.26	3.27	psi
Allow 1-Way Shear	=	40.00	40.00	psi

Toe Reinforcing = None Spec'd
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi'5'lambda'sqrt(fc)'Sm
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.26 in2
Min footing T&S reinf Area per foot 0.17 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 13.89 in	#4@ 27.78 in
#5@ 21.53 in	#5@ 43.06 in
#6@ 30.56 in	#6@ 61.11 in

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		235.3	1.22	287.6	Soil Over HL (ab. water tbl)	155.0	1.29	200.5
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		1.29	200.5
Hydrostatic Force					Watre Table			
Buoyant Force	=				Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=	0.21	
Seismic Earth Load	=	56.5	1.83	103.5	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	300.0	0.75	226.0
					Earth @ Stem Transitions	=			
Total	=	291.7	**O.T.M.** =	391.1	Footing Weight	=	150.0	0.75	112.5
					Key Weight	=			
					Vert. Component	=			
					Total =		605.0 lbs	**R.M.=**	539.0

Resisting/Overturning Ratio = **1.38**
Vertical Loads used for Soil Pressure = 605.0 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.092	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

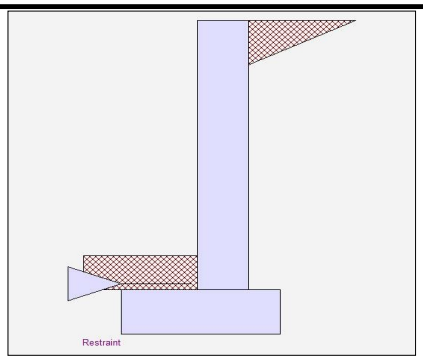
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Design Summary

Wall Stability Ratios

Overturning	=	1.92	OK
Slab Resists All Sliding !			
Total Bearing Load	=	815 lbs	
...resultant ecc.	=	4.47 in	
Soil Pressure @ Toe	=	813 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,139 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	6.4 psi	OK
Footing Shear @ Heel	=	3.7 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	381.1 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

	Bottom
	Stem OK
Design Height Above Ftg ft =	0.00
Wall Material Above "Ht" =	Concrete
Design Method =	LRFD
Thickness =	8.00
Rebar Size =	# 4
Rebar Spacing =	18.00
Rebar Placed at =	Edge
Design Data	
fb/FB + fa/Fa =	**0.163**
Total Force @ Section	
Service Level lbs =	
Strength Level lbs =	448.0
Moment....Actual	
Service Level ft-# =	
Strength Level ft-# =	597.3
Moment.....Allowable =	3,655.6
Shear.....Actual	
Service Level psi =	
Strength Level psi =	6.0
Shear.....Allowable psi =	75.0
Anet (Masonry) in2 =	
Rebar Depth 'd' in =	6.25
Masonry Data	
f'm psi =	
Fs psi =	
Solid Grouting =	
Modular Ratio 'n' =	
Wall Weight psf =	100.0
Short Term Factor =	
Equiv. Solid Thick. =	
Masonry Block Type =	Medium Weight
Masonry Design Method =	ASD
Concrete Data	
f'c psi =	2,500.0
Fy psi =	60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0224 in2/ft	
(4/3) * As :	0.0298 in2/ft	Min Stem T&S Reinf Area 0.768 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0012bh : 0.0012(12)(8) :	0.1152 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1152 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.1333 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	1.08
Total Footing Width	=	2.08
Footing Thickness	=	8.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,139	0	psf
Mu' : Upward	=	5,695	4	ft-#
Mu' : Downward	=	1,170	62	ft-#
Mu: Design	=	377	58	ft-#
Actual 1-Way Shear	=	6.43	3.69	psi
Allow 1-Way Shear	=	40.00	40.00	psi

Toe Reinforcing = None Spec'd
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi'5'lambda'sqrt(fc)'Sm
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.36 in2
Min footing T&S reinf Area per foot 0.17 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 13.89 in	#4@ 27.78 in
#5@ 21.53 in	#5@ 43.06 in
#6@ 30.56 in	#6@ 61.11 in

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	381.1	1.56	592.8			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				206.7	1.87	387.2
Soil Over HL (bel. water tbl)					1.87	387.2
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.50	
Surcharge Over Toe =						
Stem Weight(s) =				400.0	1.33	533.3
Earth @ Stem Transitions =						
Footing Weight =				208.0	1.04	216.3
Key Weight =						
Vert. Component =						
Total =	381.1	**O.T.M.** =	592.8	**Total =** 814.7 lbs	**R.M.=**	1,136.8

Resisting/Overturning Ratio = **1.92**
Vertical Loads used for Soil Pressure = 814.7 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.043	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

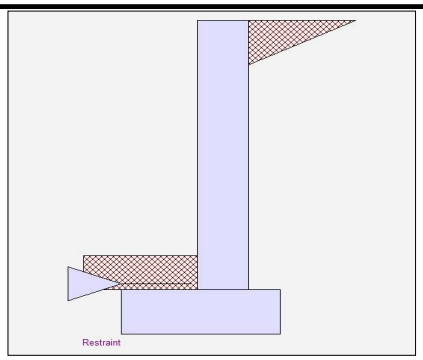
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	7.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	32.667
Total Seismic Force	=	152.444

Design Summary

Wall Stability Ratios

Overturning	=	1.35 Ratio < 1.5!
Slab Resists All Sliding !		
Total Bearing Load	=	815 lbs
...resultant ecc.	=	8.14 in
Soil Pressure @ Toe	=	1,500 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	4,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,100 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	11.1 psi OK
Footing Shear @ Heel	=	4.1 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	487.8 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =		0.00
Wall Material Above "Ht"	=		Concrete
Design Method	=		LRFD
Thickness	=		8.00
Rebar Size	=		# 4
Rebar Spacing	=		18.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.234**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		578.7
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		858.7
Moment.....Allowable	=		3,655.6
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		7.7
Shear.....Allowable	psi =		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		6.25
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		100.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		Medium Weight
Masonry Design Method	=		ASD
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0322 in2/ft	
(4/3) * As :	0.0429 in2/ft	Min Stem T&S Reinf Area 0.768 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0012bh : 0.0012(12)(8) :	0.1152 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1152 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.1333 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	1.08
Total Footing Width	=	2.08
Footing Thickness	=	8.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,100	0	psf
Mu' : Upward	=	8,733	0	ft-#
Mu' : Downward	=	1,170	62	ft-#
Mu: Design	=	630	62	ft-#
Actual 1-Way Shear	=	11.07	4.13	psi
Allow 1-Way Shear	=	40.00	40.00	psi

Toe Reinforcing = None Spec'd
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi'5'lambda'sqrt(fc)'Sm
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.36 in2
Min footing T&S reinf Area per foot 0.17 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 13.89 in	#4@ 27.78 in
#5@ 21.53 in	#5@ 43.06 in
#6@ 30.56 in	#6@ 61.11 in

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	381.1	1.56	592.8			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
Seismic Earth Load =	106.7	2.33	249.0			
=						
				Soil Over HL (ab. water tbl)	206.7	1.87	387.2
				Soil Over HL (bel. water tbl)		1.87	387.2
				Watre Table			
				Sloped Soil Over Heel =			
				Surcharge Over Heel =			
				Adjacent Footing Load =			
				Axial Dead Load on Stem =			
				* Axial Live Load on Stem =			
				Soil Over Toe =		0.50	
				Surcharge Over Toe =			
				Stem Weight(s) =	400.0	1.33	533.3
				Earth @ Stem Transitions =			
				Footing Weight =	208.0	1.04	216.3
				Key Weight =			
				Vert. Component =			
Total =	487.8	**O.T.M.** =	841.8	**Total =**	814.7 lbs	**R.M.=**	1,136.8

Resisting/Overturning Ratio = **1.35**
Vertical Loads used for Soil Pressure = 814.7 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.080	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

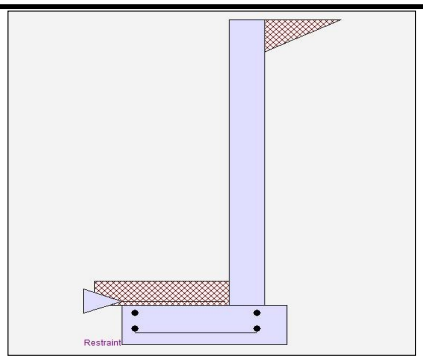
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Design Summary

Wall Stability Ratios

Overturning	=	1.55	OK
Slab Resists All Sliding !			
Total Bearing Load	=	1,295 lbs	
...resultant ecc.	=	9.01 in	
Soil Pressure @ Toe	=	1,094 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,531 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	15.1 psi	OK
Footing Shear @ Heel	=	4.5 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	817.2 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

			Stem OK
Design Height Above Ftg	ft =		0.00
Wall Material Above "Ht"	=		Concrete
Design Method	=		LRFD
Thickness	=		8.00
Rebar Size	=		# 5
Rebar Spacing	=		12.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.248**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		1,008.0
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		2,016.0
Moment.....Allowable	=		8,121.3
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		13.6
Shear.....Allowable	psi =		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		6.19
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		100.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		Medium Weight
Masonry Design Method	=		ASD
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0763 in2/ft	
(4/3) * As :	0.1018 in2/ft	Min Stem T&S Reinf Area 1.152 in2
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.31 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	2.00 ft
Heel Width	=	1.08
Total Footing Width	=	3.08
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,531	0	psf
Mu' : Upward	=	26,401	0	ft-#
Mu' : Downward	=	5,400	90	ft-#
Mu: Design	=	1,750	90	ft-#
Actual 1-Way Shear	=	15.14	4.52	psi
Allow 1-Way Shear	=	75.00	40.00	psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 5
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.67 in2
Min footing T&S reinf Area per foot 0.22 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	817.2	2.28	1,861.3			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				310.0	2.87	890.7
Soil Over HL (bel. water tbl)					2.87	890.7
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					1.00	
Surcharge Over Toe =						
Stem Weight(s) =				600.0	2.33	1,400.0
Earth @ Stem Transitions =						
Footing Weight =				385.0	1.54	592.9
Key Weight =						
Vert. Component =						
Total =	817.2	**O.T.M.** =	1,861.3	**Total =** 1,295.0 lbs	**R.M.=**	2,883.6

Resisting/Overturning Ratio = **1.55**
Vertical Loads used for Soil Pressure = 1,295.0 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.059	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

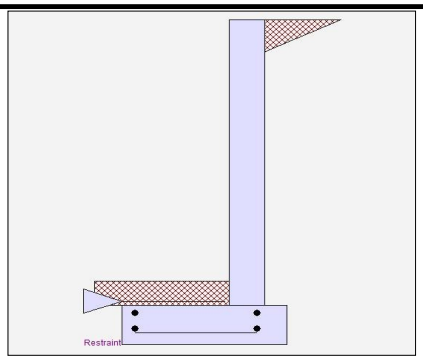
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	6.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	41.000
Total Seismic Force	=	280.167

Design Summary

Wall Stability Ratios

Overturning	=	1.14 Ratio < 1.5!
Slab Resists All Sliding !		
Total Bearing Load	=	1,295 lbs
...resultant ecc.	=	15.22 in
Soil Pressure @ Toe	=	3,174 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	4,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	4,443 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	18.6 psi OK
Footing Shear @ Heel	=	4.5 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	1,013.3 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =	0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	LRFD
Thickness	=	8.00
Rebar Size	=	# 5
Rebar Spacing	=	12.00
Rebar Placed at	=	Edge
Design Data		
fb/FB + fa/Fa	=	**0.339**
Total Force @ Section		
Service Level	lbs =	
Strength Level	lbs =	1,254.0
Moment....Actual		
Service Level	ft-# =	
Strength Level	ft-# =	2,754.0
Moment.....Allowable	=	8,121.3
Shear.....Actual		
Service Level	psi =	
Strength Level	psi =	16.9
Shear.....Allowable	psi =	75.0
Anet (Masonry)	in2 =	
Rebar Depth 'd'	in =	6.19
Masonry Data		
f'm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Wall Weight	psf =	100.0
Short Term Factor	=	
Equiv. Solid Thick.	=	
Masonry Block Type	=	Medium Weight
Masonry Design Method	=	ASD
Concrete Data		
f'c	psi =	2,500.0
Fy	psi =	60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1043 in2/ft	
(4/3) * As :	0.139 in2/ft	Min Stem T&S Reinf Area 1.152 in2
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.31 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	2.00 ft
Heel Width	=	1.08
Total Footing Width	=	3.08
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	4,443	0	psf
Mu' : Upward	=	37,594	0	ft-#
Mu' : Downward	=	5,400	90	ft-#
Mu: Design	=	2,683	90	ft-#
Actual 1-Way Shear	=	18.57	4.52	psi
Allow 1-Way Shear	=	75.00	40.00	psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 5
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.67 in2
Min footing T&S reinf Area per foot 0.22 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	817.2	2.28	1,861.3			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
Seismic Earth Load =	196.1	3.42	670.1			
=						
Soil Over HL (ab. water tbl)				310.0	2.87	890.7
Soil Over HL (bel. water tbl)					2.87	890.7
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					1.00	
Surcharge Over Toe =						
Stem Weight(s) =				600.0	2.33	1,400.0
Earth @ Stem Transitions =						
Footing Weight =				385.0	1.54	592.9
Key Weight =						
Vert. Component =						
Total =	1,013.3	**O.T.M.** =	2,531.4	**Total =** 1,295.0 lbs	**R.M.=**	2,883.6

Resisting/Overturning Ratio = **1.14**
Vertical Loads used for Soil Pressure = 1,295.0 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.172	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

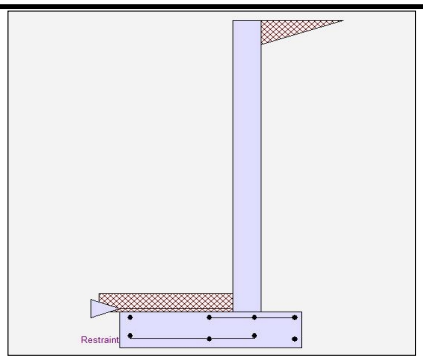
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Design Summary

Wall Stability Ratios

Overturning	=	1.84	OK
Slab Resists All Sliding !			
Total Bearing Load	=	2,455 lbs	
...resultant ecc.	=	9.06 in	
Soil Pressure @ Toe	=	1,128 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,580 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	18.6 psi	OK
Footing Shear @ Heel	=	10.6 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	1,417.5 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

	Bottom
	Stem OK
Design Height Above Ftg ft =	0.00
Wall Material Above "Ht" =	Concrete
Design Method =	LRFD
Thickness =	8.00
Rebar Size =	# 5
Rebar Spacing =	12.00
Rebar Placed at =	Edge
Design Data	
fb/FB + fa/Fa =	**0.588**
Total Force @ Section	
Service Level lbs =	
Strength Level lbs =	1,792.0
Moment....Actual	
Service Level ft-# =	
Strength Level ft-# =	4,778.7
Moment.....Allowable =	8,121.3
Shear.....Actual	
Service Level psi =	
Strength Level psi =	24.1
Shear.....Allowable psi =	75.0
Anet (Masonry) in2 =	
Rebar Depth 'd' in =	6.19
Masonry Data	
f'm psi =	
Fs psi =	
Solid Grouting =	
Modular Ratio 'n' =	
Wall Weight psf =	100.0
Short Term Factor =	
Equiv. Solid Thick. =	
Masonry Block Type =	Medium Weight
Masonry Design Method =	ASD
Concrete Data	
f'c psi =	2,500.0
Fy psi =	60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1809 in2/ft	
(4/3) * As :	0.2413 in2/ft	Min Stem T&S Reinf Area 1.536 in2
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2413 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.31 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	2.75 ft
Heel Width	=	1.66
Total Footing Width	=	4.41
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,580	0	psf
Mu' : Upward	=	56,583	49	ft-#
Mu' : Downward	=	11,571	681	ft-#
Mu: Design	=	3,751	632	ft-#
Actual 1-Way Shear	=	18.60	10.64	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Key: No key defined

Min footing T&S reinf Area 1.14 in2
Min footing T&S reinf Area per foot 0.26 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,417.5	3.00	4,252.5	Soil Over HL (ab. water tbl)	993.3	3.91	3,887.2
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		3.91	3,887.2
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =		1.38	
=				Surcharge Over Toe =			
				Stem Weight(s) =	800.0	3.08	2,466.7
				Earth @ Stem Transitions =			
Total =	1,417.5	**O.T.M.** =	4,252.5	Footing Weight =	661.5	2.21	1,458.6
				Key Weight =			
				Vert. Component =			
				Total =	2,454.8 lbs	**R.M.=**	7,812.5

Resisting/Overturning Ratio = 1.84
Vertical Loads used for Soil Pressure = 2,454.8 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.057	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

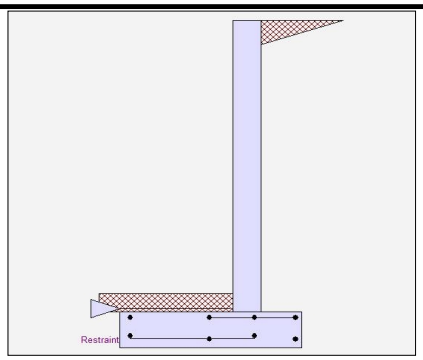
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	6.000
(Multiplier used on soil density)		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Uniform Seismic Force	=	54.000
Total Seismic Force	=	486.000

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Design Summary

Wall Stability Ratios

Overturning	=	1.36 Ratio < 1.5!
Slab Resists All Sliding !		

Total Bearing Load	=	2,466 lbs	
...resultant ecc.	=	16.40 in	
Soil Pressure @ Toe	=	1,950 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	4,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,730 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	27.0 psi	OK
Footing Shear @ Heel	=	12.1 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	1,757.7 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =	0.00	
Wall Material Above "Ht"	=	Concrete	
Design Method	=	LRFD	
Thickness	=	8.00	
Rebar Size	=	# 5	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Edge	
Design Data			
fb/FB + fa/Fa	=	**0.801**	
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =	2,224.0	
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =	6,506.7	
Moment.....Allowable	=	8,121.3	
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =	30.0	
Shear.....Allowable	psi =	75.0	
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	6.19	
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	100.0	
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =	2,500.0	
Fy	psi =	60,000.0	

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.2464 in2/ft	
(4/3) * As :	0.3285 in2/ft	Min Stem T&S Reinf Area 1.536 in2
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2475 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.31 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	2.75 ft
Heel Width	=	1.67
Total Footing Width	=	4.42
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,730	0	psf
Mu' : Upward	=	79,002	0	ft-#
Mu' : Downward	=	11,571	695	ft-#
Mu: Design	=	5,619	695	ft-#
Actual 1-Way Shear	=	26.99	12.15	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Key: No key defined

Min footing T&S reinf Area 1.15 in2
Min footing T&S reinf Area per foot 0.26 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		1,417.5	3.00	4,252.5	Soil Over HL (ab. water tbl)	1,003.3	3.92	3,931.4
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		3.92	3,931.4
Hydrostatic Force					Watre Table			
Buoyant Force	=				Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=	1.38	
Seismic Earth Load	=	340.2	4.50	1,530.9	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	800.0	3.08	2,466.7
					Earth @ Stem Transitions	=			
					Footing Weight	=	663.0	2.21	1,465.2
					Key Weight	=			
					Vert. Component	=			
Total	=	1,757.7	**O.T.M.** =	5,783.4	**Total =**		2,466.3 lbs	**R.M.=**	7,863.3

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Resisting/Overturning Ratio = **1.36**
Vertical Loads used for Soil Pressure = 2,466.3 lbs

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.098	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

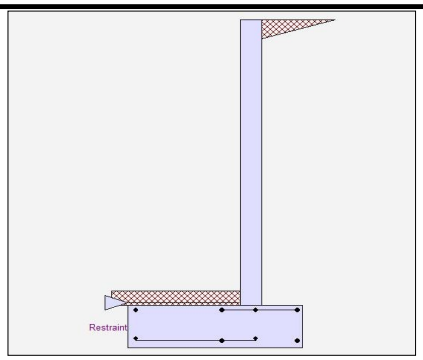
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Design Summary

Wall Stability Ratios

Overturning	=	1.65	OK
Slab Resists All Sliding !			
Total Bearing Load	=	3,786 lbs	
...resultant ecc.	=	14.21 in	
Soil Pressure @ Toe	=	1,655 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,316 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	18.0 psi	OK
Footing Shear @ Heel	=	11.7 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	2,314.4 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

			Stem OK
Design Height Above Ftg	ft =		0.00
Wall Material Above "Ht"	=		Concrete
Design Method	=		LRFD
Thickness	=		8.00
Rebar Size	=		# 7
Rebar Spacing	=		12.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.712**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		2,800.0
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		9,333.3
Moment.....Allowable	=		13,107.2
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		41.9
Shear.....Allowable	psi =		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		5.56
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		100.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		Medium Weight
Masonry Design Method	=		ASD
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.3955 in2/ft		
(4/3) * As :	0.5274 in2/ft	Min Stem T&S Reinf Area 1.920 in2	
200bd/fy : 200(12)(5.5625)/60000 :	0.2225 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.3955 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.6 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.7535 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	3.50 ft
Heel Width	=	1.92
Total Footing Width	=	5.42
Footing Thickness	=	18.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,316	0	psf
Mu' : Upward	=	126,854	6	ft-#
Mu' : Downward	=	25,358	1,390	ft-#
Mu: Design	=	8,458	1,384	ft-#
Actual 1-Way Shear	=	18.00	11.70	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 6 @ 13.58 in
Heel Reinforcing = # 6 @ 13.58 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Heel: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Key: No key defined

Min footing T&S reinf Area 2.11 in2
Min footing T&S reinf Area per foot 0.39 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.17 in	#4@ 12.35 in
#5@ 9.57 in	#5@ 19.14 in
#6@ 13.58 in	#6@ 27.16 in

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	2,314.4	3.83	8,871.8	Soil Over HL (ab. water tbl)	1,566.7	4.79	7,509.6
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		4.79	7,509.6
Hydrostatic Force				Watre Table			
Buoyant Force =				Sloped Soil Over Heel =			
Surcharge over Heel =				Surcharge Over Heel =			
Surcharge Over Toe =				Adjacent Footing Load =			
Adjacent Footing Load =				Axial Dead Load on Stem =			
Added Lateral Load =				* Axial Live Load on Stem =			
Load @ Stem Above Soil =				Soil Over Toe =		1.75	
=				Surcharge Over Toe =			
				Stem Weight(s) =	1,000.0	3.83	3,833.3
				Earth @ Stem Transitions =			
				Footing Weight =	1,219.5	2.71	3,304.8
				Key Weight =			
				Vert. Component =			
Total =	2,314.4	**O.T.M.** =	8,871.8	**Total =**	3,786.2 lbs	**R.M.=**	14,647.7

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Resisting/Overturning Ratio = **1.65**
Vertical Loads used for Soil Pressure = 3,786.2 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.085	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

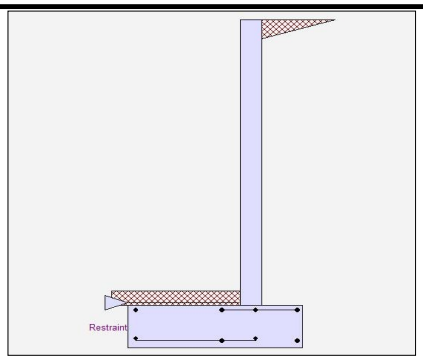
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	6.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	69.000
Total Seismic Force	=	793.500

Design Summary

Wall Stability Ratios

Overturning	=	1.21 Ratio < 1.5!
Slab Resists All Sliding !		

Total Bearing Load	=	3,786	lbs
...resultant ecc.	=	24.34	in
Soil Pressure @ Toe	=	3,701 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	4,000	psf
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	5,182	psf
ACI Factored @ Heel	=	0	psf
Footing Shear @ Toe	=	25.6 psi	OK
Footing Shear @ Heel	=	11.9 psi	OK
Allowable	=	75.0	psi

Sliding Calcs

Lateral Sliding Force	=	2,869.8 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =	0.00	
Wall Material Above "Ht"	=	Concrete	
Design Method	=	LRFD	
Thickness	=	8.00	
Rebar Size	=	# 7	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Edge	
Design Data			
fb/FB + fa/Fa	=	**0.975**	
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =	3,490.0	
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =	12,783.3	
Moment.....Allowable	=	13,107.2	
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =	52.3	
Shear.....Allowable	psi =	75.0	
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	5.56	
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	100.0	
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =	2,500.0	
Fy	psi =	60,000.0	

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.5417 in2/ft		
(4/3) * As :	0.7223 in2/ft	Min Stem T&S Reinf Area 1.920 in2	
200bd/fy : 200(12)(5.5625)/60000 :	0.2225 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.5417 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.6 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.7535 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	3.50 ft
Heel Width	=	1.92
Total Footing Width	=	5.42
Footing Thickness	=	18.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	5,182	0	psf
Mu' : Upward	=	179,247	0	ft-#
Mu' : Downward	=	25,358	1,390	ft-#
Mu: Design	=	12,824	1,390	ft-#
Actual 1-Way Shear	=	25.59	11.93	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 6 @ 13.58 in
Heel Reinforcing = # 6 @ 13.58 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Heel: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Key: No key defined

Min footing T&S reinf Area 2.11 in2
Min footing T&S reinf Area per foot 0.39 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.17 in	#4@ 12.35 in
#5@ 9.57 in	#5@ 19.14 in
#6@ 13.58 in	#6@ 27.16 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	2,314.4	3.83	8,871.8			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
Seismic Earth Load =	555.5	5.75	3,193.8			
=						
Soil Over HL (ab. water tbl)				1,566.7	4.79	7,509.6
Soil Over HL (bel. water tbl)					4.79	7,509.6
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					1.75	
Surcharge Over Toe =						
Stem Weight(s) =				1,000.0	3.83	3,833.3
Earth @ Stem Transitions =						
Footing Weight =				1,219.5	2.71	3,304.8
Key Weight =						
Vert. Component =						
Total =	2,869.8	**O.T.M.** =	12,065.6	**Total =** 3,786.2 lbs	**R.M.=**	14,647.7

Resisting/Overturning Ratio = **1.21**
Vertical Loads used for Soil Pressure = 3,786.2 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.190	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

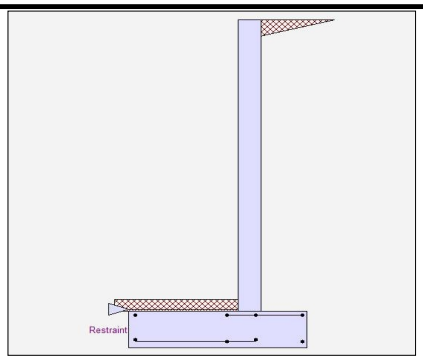
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	12.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Design Summary

Wall Stability Ratios

Overturning	=	1.78	OK
Slab Resists All Sliding !			
Total Bearing Load	=	5,463 lbs	
...resultant ecc.	=	14.41 in	
Soil Pressure @ Toe	=	1,777 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,488 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	24.9 psi	OK
Footing Shear @ Heel	=	16.7 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	3,189.4 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

			Stem OK
Design Height Above Ftg	ft =		0.00
Wall Material Above "Ht"	=		Concrete
Design Method	=		LRFD
Thickness	=		10.00
Rebar Size	=		# 7
Rebar Spacing	=		8.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.612**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		4,032.0
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		16,128.0
Moment.....Allowable	=		26,327.0
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		44.4
Shear.....Allowable	psi =		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		7.56
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		125.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		Medium Weight
Masonry Design Method	=		ASD
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.4948 in2/ft	
(4/3) * As :	0.6597 in2/ft	Min Stem T&S Reinf Area 2.880 in2
200bd/fy : 200(12)(7.5625)/60000 :	0.3025 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.4948 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.9 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.0245 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	4.00 ft
Heel Width	=	2.50
Total Footing Width	=	6.50
Footing Thickness	=	18.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,488	0	psf
Mu' : Upward	=	187,056	153	ft-#
Mu' : Downward	=	33,120	2,875	ft-#
Mu: Design	=	12,828	2,722	ft-#
Actual 1-Way Shear	=	24.92	16.67	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 6 @ 12.00 in
Heel Reinforcing = # 6 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Heel: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Key: No key defined

Min footing T&S reinf Area 2.53 in2
Min footing T&S reinf Area per foot 0.39 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.17 in	#4@ 12.35 in
#5@ 9.57 in	#5@ 19.14 in
#6@ 13.58 in	#6@ 27.16 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	3,189.4	4.50	14,352.2			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				2,500.0	5.67	14,166.7
Soil Over HL (bel. water tbl)					5.67	14,166.7
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					2.00	
Surcharge Over Toe =						
Stem Weight(s) =				1,500.0	4.42	6,625.0
Earth @ Stem Transitions =						
Footing Weight =				1,462.5	3.25	4,753.1
Key Weight =						
Vert. Component =						
Total =	3,189.4	**O.T.M.** =	14,352.2	**Total =** 5,462.5 lbs	**R.M.=**	25,544.8

Resisting/Overturning Ratio = **1.78**
Vertical Loads used for Soil Pressure = 5,462.5 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.091	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-07.RPX

Cantilevered Retaining Wall

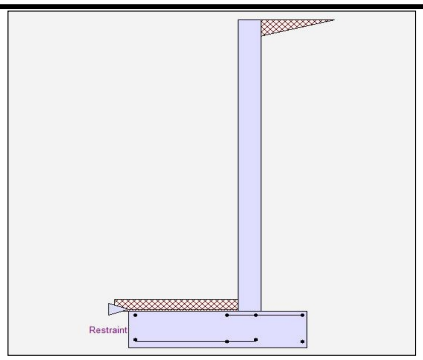
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	12.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.450
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	6.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	81.000
Total Seismic Force	=	1,093.500

Design Summary

Wall Stability Ratios

Overturning	=	1.31	Ratio < 1.5!
Slab Resists All Sliding !			
Total Bearing Load	=	5,463 lbs	
...resultant ecc.	=	25.76 in	
Soil Pressure @ Toe	=	3,301 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	4,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	4,622 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	36.9 psi	OK
Footing Shear @ Heel	=	18.5 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	3,954.8 lbs

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

			Stem OK
Design Height Above Ftg	ft =		0.00
Wall Material Above "Ht"	=		Concrete
Design Method	=		LRFD
Thickness	=		10.00
Rebar Size	=		# 7
Rebar Spacing	=		8.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.834**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		5,004.0
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		21,960.0
Moment.....Allowable	=		26,327.0
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		55.1
Shear.....Allowable	psi =		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		7.56
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		125.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		Medium Weight
Masonry Design Method	=		ASD
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.6737 in2/ft	
(4/3) * As :	0.8982 in2/ft	Min Stem T&S Reinf Area 2.880 in2
200bd/fy : 200(12)(7.5625)/60000 :	0.3025 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.6737 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.9 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.0245 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	4.00 ft
Heel Width	=	2.50
Total Footing Width	=	6.50
Footing Thickness	=	18.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	4,622	0	psf
Mu' : Upward	=	265,846	0	ft-#
Mu' : Downward	=	33,120	2,875	ft-#
Mu: Design	=	19,394	2,875	ft-#
Actual 1-Way Shear	=	36.94	18.55	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 6 @ 12.00 in
Heel Reinforcing = # 6 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 5.92 in, #5@ 9.18 in, #6@ 13.03 in, #7@ 17.76 in, #8@ 23.39 in, #9@ 29.
Heel: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Key: No key defined

Min footing T&S reinf Area 2.53 in2
Min footing T&S reinf Area per foot 0.39 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.17 in	#4@ 12.35 in
#5@ 9.57 in	#5@ 19.14 in
#6@ 13.58 in	#6@ 27.16 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	3,189.4	4.50	14,352.2			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
Seismic Earth Load =	765.5	6.75	5,166.8			
=						
Total =	3,954.8	**O.T.M.** =	19,519.0			
Soil Over HL (ab. water tbl)				2,500.0	5.67	14,166.7
Soil Over HL (bel. water tbl)					5.67	14,166.7
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					2.00	
Surcharge Over Toe =						
Stem Weight(s) =				1,500.0	4.42	6,625.0
Earth @ Stem Transitions =						
Footing Weight =				1,462.5	3.25	4,753.1
Key Weight =						
Vert. Component =						
Total =				5,462.5 lbs	**R.M.=**	25,544.8

Resisting/Overturning Ratio = **1.31**
Vertical Loads used for Soil Pressure = 5,462.5 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.169	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

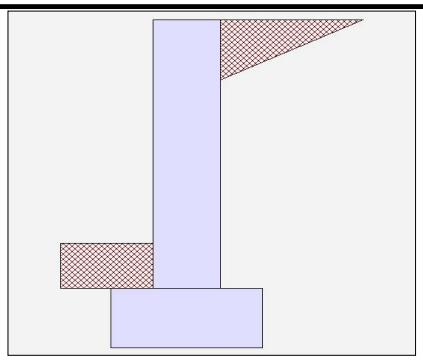
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	3.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Design Summary

Wall Stability Ratios

Overturning	=	1.87	OK
Sliding	=	1.52	OK
Total Bearing Load	=	605 lbs	
...resultant ecc.	=	4.03 in	
Soil Pressure @ Toe	=	979 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,370 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	0.6 psi	OK
Footing Shear @ Heel	=	3.1 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	235.3 lbs	
less 100% Passive Force	= -	54.2 lbs	
less 100% Friction Force	= -	302.3 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =	0.00	
Wall Material Above "Ht"	=	Concrete	
Design Method	=	LRFD	
Thickness	=	8.00	
Rebar Size	=	# 4	
Rebar Spacing	=	18.00	
Rebar Placed at	=	Edge	
Design Data			
fb/FB + fa/Fa	=	**0.068**	
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =	252.0	
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =	252.0	
Moment.....Allowable	=	3,655.6	
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =	3.4	
Shear.....Allowable	psi =	75.0	
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	6.25	
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	100.0	
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =	2,500.0	
Fy	psi =	60,000.0	

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0094 in2/ft	
(4/3) * As :	0.0126 in2/ft	Min Stem T&S Reinf Area 0.576 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0012bh : 0.0012(12)(8) :	0.1152 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1152 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.1333 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	0.42 ft
Heel Width	=	1.08
Total Footing Width	=	1.50
Footing Thickness	=	8.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,370	0	psf
Mu' : Upward	=	1,263	1	ft-#
Mu' : Downward	=	202	49	ft-#
Mu: Design	=	88	48	ft-#
Actual 1-Way Shear	=	0.64	3.09	psi
Allow 1-Way Shear	=	40.00	40.00	psi

Toe Reinforcing = None Spec'd
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi'5'lambda'sqrt(fc)'Sm
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.26 in2
Min footing T&S reinf Area per foot 0.17 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 13.89 in	#4@ 27.78 in
#5@ 21.53 in	#5@ 43.06 in
#6@ 30.56 in	#6@ 61.11 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	235.3	1.22	287.6			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				155.0	1.29	199.8
Soil Over HL (bel. water tbl)					1.29	199.8
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.21	
Surcharge Over Toe =						
Stem Weight(s) =				300.0	0.75	224.8
Earth @ Stem Transitions =						
Footing Weight =				149.6	0.75	111.9
Key Weight =						
Vert. Component =						
Total =	235.3	**O.T.M.** =	287.6	**Total =** 604.6 lbs	**R.M.=**	536.5

Resisting/Overturning Ratio = **1.87**
Vertical Loads used for Soil Pressure = 604.6 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.055	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

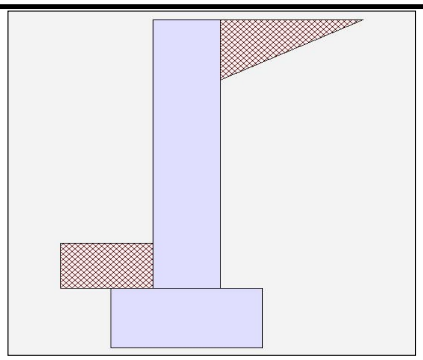
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	3.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	6.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	22.000
Total Seismic Force	=	80.667

Design Summary

Wall Stability Ratios

Overturning	=	1.37	Ratio < 1.5!
Sliding	=	1.22	Ratio < 1.5!
Total Bearing Load	=	605 lbs	
...resultant ecc.	=	6.09 in	
Soil Pressure @ Toe	=	1,675 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	4,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,345 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	1.2 psi	OK
Footing Shear @ Heel	=	3.3 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	291.7 lbs	
less 100% Passive Force	= -	54.2 lbs	
less 100% Friction Force	= -	302.3 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	81.2 lbs	NG

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

			Stem OK
Design Height Above Ftg	ft =		0.00
Wall Material Above "Ht"	=		Concrete
Design Method	=		LRFD
Thickness	=		8.00
Rebar Size	=		# 4
Rebar Spacing	=		18.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.096**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		318.0
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		351.0
Moment.....Allowable	=		3,655.6
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		4.2
Shear.....Allowable	psi =		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		6.25
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		100.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		Medium Weight
Masonry Design Method	=		ASD
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0132 in2/ft	
(4/3) * As :	0.0175 in2/ft	Min Stem T&S Reinf Area 0.576 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0012bh : 0.0012(12)(8) :	0.1152 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1152 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.1333 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	0.42 ft
Heel Width	=	1.08
Total Footing Width	=	1.50
Footing Thickness	=	8.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,345	0	psf
Mu' : Upward	=	1,967	0	ft-#
Mu' : Downward	=	202	49	ft-#
Mu: Design	=	147	49	ft-#
Actual 1-Way Shear	=	1.17	3.27	psi
Allow 1-Way Shear	=	40.00	40.00	psi
Toe Reinforcing	=	None Spec'd		
Heel Reinforcing	=	None Spec'd		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu	=	0.00		ft-lbs
Footing Allow. Torsion, phi Tu	=	0.00		ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: phiMn = phi'5'lambda'sqrt(fc)'Sm
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.26 in2
Min footing T&S reinf Area per foot 0.17 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 13.89 in	#4@ 27.78 in
#5@ 21.53 in	#5@ 43.06 in
#6@ 30.56 in	#6@ 61.11 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		235.3	1.22	287.6	Soil Over HL (ab. water tbl)	155.0	1.29	199.8
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		1.29	199.8
Hydrostatic Force					Watre Table			
Buoyant Force	=				Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=	0.21	
Seismic Earth Load	=	56.5	1.83	103.5	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	300.0	0.75	224.8
					Earth @ Stem Transitions	=			
					Footing Weight	=	149.6	0.75	111.9
					Key Weight	=			
					Vert. Component	=			
Total	=	291.7	**O.T.M.** =	391.1	**Total =**		604.6 lbs	**R.M.=**	536.5

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Resisting/Overturning Ratio = **1.37**
Vertical Loads used for Soil Pressure = 604.6 lbs

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.093	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

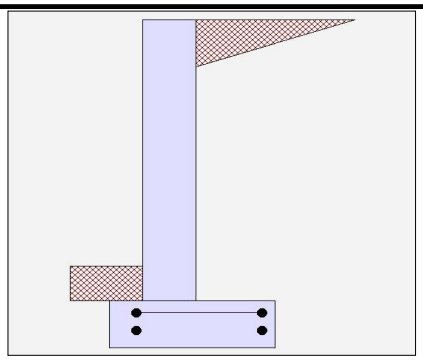
Code: IBC 2012,ACI 318-11,ACI 530-11

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	350.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Design Summary

Wall Stability Ratios

Overturning	=	2.21	OK
Sliding	=	1.62	OK
Total Bearing Load	=	1,110 lbs	
...resultant ecc.	=	4.74 in	
Soil Pressure @ Toe	=	1,143 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,600 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	1.0 psi	OK
Footing Shear @ Heel	=	6.3 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	381.1 lbs	
less 100% Passive Force	= -	63.2 lbs	
less 100% Friction Force	= -	555.1 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2012,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

			Stem OK
Design Height Above Ftg	ft =		0.00
Wall Material Above "Ht"	=		Concrete
Design Method	=		LRFD
Thickness	=		8.00
Rebar Size	=		# 4
Rebar Spacing	=		18.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.163**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		448.0
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		597.3
Moment.....Allowable	=		3,655.6
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		6.0
Shear.....Allowable	psi =		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		6.25
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		100.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		Medium Weight
Masonry Design Method	=		ASD
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

Cantilevered Retaining Wall

Code: IBC 2012,ACI 318-11,ACI 530-11

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0224 in2/ft	
(4/3) * As :	0.0298 in2/ft	Min Stem T&S Reinf Area 0.768 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0012bh : 0.0012(12)(8) :	0.1152 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1152 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.1333 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	0.42 ft
Heel Width	=	1.67
Total Footing Width	=	2.09
Footing Thickness	=	8.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,600	0	psf
Mu' : Upward	=	1,542	88	ft-#
Mu' : Downward	=	202	362	ft-#
Mu: Design	=	112	275	ft-#
Actual 1-Way Shear	=	1.03	6.32	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 4 @ 12.00 in
Heel Reinforcing = # 4 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 13.88 in, #5@ 21.52 in, #6@ 30.55 in, #7@ 41.66 in, #8@ 54.86 in, #9@ 6
Heel: #4@ 13.88 in, #5@ 21.52 in, #6@ 30.55 in, #7@ 41.66 in, #8@ 54.86 in, #9@ 6
Key: No key defined

Min footing T&S reinf Area 0.36 in2
Min footing T&S reinf Area per foot 0.17 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 13.89 in	#4@ 27.78 in
#5@ 21.53 in	#5@ 43.06 in
#6@ 30.56 in	#6@ 61.11 in

Cantilevered Retaining Wall

Code: IBC 2012,ACI 318-11,ACI 530-11

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	381.1	1.56	592.8			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				501.7	1.58	794.8
Soil Over HL (bel. water tbl)					1.58	794.8
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.21	
Surcharge Over Toe =						
Stem Weight(s) =				400.0	0.75	299.7
Earth @ Stem Transitions =						
Footing Weight =				208.6	1.04	217.6
Key Weight =						
Vert. Component =						
Total =	381.1	**O.T.M.** =	592.8	**Total =** 1,110.3 lbs	**R.M.=**	1,312.1

Resisting/Overturning Ratio = **2.21**
Vertical Loads used for Soil Pressure = 1,110.3 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.061	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

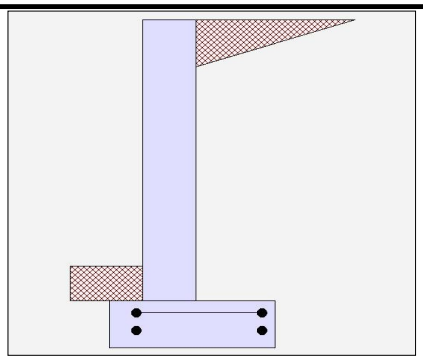
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	6.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	28.000
Total Seismic Force	=	130.667

Design Summary

Wall Stability Ratios

Overturning	=	1.63 OK
Sliding	=	1.29 Ratio < 1.5!
Total Bearing Load	=	1,110 lbs
...resultant ecc.	=	7.05 in
Soil Pressure @ Toe	=	1,625 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	4,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,274 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	1.5 psi OK
Footing Shear @ Heel	=	9.9 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	472.6 lbs
less 100% Passive Force	= -	54.2 lbs
less 100% Friction Force	= -	555.1 lbs
Added Force Req'd	=	0.0 lbs OK
....for 1.5 Stability	=	99.6 lbs NG

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =	0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	LRFD
Thickness	=	8.00
Rebar Size	=	# 4
Rebar Spacing	=	18.00
Rebar Placed at	=	Edge
Design Data		
fb/FB + fa/Fa	=	**0.224**
Total Force @ Section		
Service Level	lbs =	
Strength Level	lbs =	560.0
Moment....Actual		
Service Level	ft-# =	
Strength Level	ft-# =	821.3
Moment.....Allowable	=	3,655.6
Shear.....Actual		
Service Level	psi =	
Strength Level	psi =	7.5
Shear.....Allowable	psi =	75.0
Anet (Masonry)	in2 =	
Rebar Depth 'd'	in =	6.25
Masonry Data		
f'm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Wall Weight	psf =	100.0
Short Term Factor	=	
Equiv. Solid Thick.	=	
Masonry Block Type	=	Medium Weight
Masonry Design Method	=	ASD
Concrete Data		
f'c	psi =	2,500.0
Fy	psi =	60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0308 in2/ft	
(4/3) * As :	0.041 in2/ft	Min Stem T&S Reinf Area 0.768 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0012bh : 0.0012(12)(8) :	0.1152 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1152 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.1333 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	0.42 ft
Heel Width	=	1.67
Total Footing Width	=	2.09
Footing Thickness	=	8.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,274	0	psf
Mu' : Upward	=	2,122	6	ft-#
Mu' : Downward	=	202	362	ft-#
Mu: Design	=	160	356	ft-#
Actual 1-Way Shear	=	1.53	9.93	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 4 @ 12.00 in
Heel Reinforcing = # 4 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 13.88 in, #5@ 21.52 in, #6@ 30.55 in, #7@ 41.66 in, #8@ 54.86 in, #9@ 6
Heel: #4@ 13.88 in, #5@ 21.52 in, #6@ 30.55 in, #7@ 41.66 in, #8@ 54.86 in, #9@ 6
Key: No key defined

Min footing T&S reinf Area 0.36 in2
Min footing T&S reinf Area per foot 0.17 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 13.89 in	#4@ 27.78 in
#5@ 21.53 in	#5@ 43.06 in
#6@ 30.56 in	#6@ 61.11 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		381.1	1.56	592.8	Soil Over HL (ab. water tbl)	501.7	1.58	794.8
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		1.58	794.8
Hydrostatic Force					Watre Table			
Buoyant Force	=				Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=	0.21	
Seismic Earth Load	=	91.5	2.33	213.4	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	400.0	0.75	299.7
					Earth @ Stem Transitions	=			
Total	=	472.6	**O.T.M.** =	806.3	Footing Weight	=	208.6	1.04	217.6
					Key Weight	=			
					Vert. Component	=			
					Total =		1,110.3 lbs	**R.M.=**	1,312.1

Resisting/Overturning Ratio = **1.63**
Vertical Loads used for Soil Pressure = 1,110.3 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.087	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

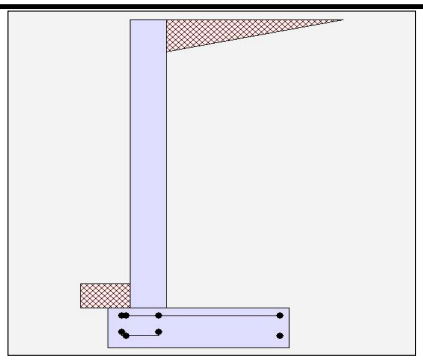
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Design Summary

Wall Stability Ratios

Overturning	=	2.63	OK
Sliding	=	1.80	OK
Total Bearing Load	=	2,708 lbs	
...resultant ecc.	=	6.62 in	
Soil Pressure @ Toe	=	1,614 psf	OK
Soil Pressure @ Heel	=	8 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,259 psf	
ACI Factored @ Heel	=	11 psf	
Footing Shear @ Toe	=	0.4 psi	OK
Footing Shear @ Heel	=	7.0 psi	OK
Allowable	=	94.9 psi	

Sliding Calcs

Lateral Sliding Force	=	817.2 lbs	
less 100% Passive Force	= -	116.7 lbs	
less 100% Friction Force	= -	1,353.8 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

			Stem OK
Design Height Above Ftg	ft =	0.00	
Wall Material Above "Ht"	=	Concrete	
Design Method	=	LRFD	
Thickness	=	8.00	
Rebar Size	=	# 4	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Edge	
Design Data			
fb/FB + fa/Fa	=	**0.367**	
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =	1,008.0	
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =	2,016.0	
Moment.....Allowable	=	5,492.3	
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =	13.4	
Shear.....Allowable	psi =	94.9	
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	6.25	
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	100.0	
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =	4,000.0	
Fy	psi =	60,000.0	

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.0755 in2/ft	
(4/3) * As :	0.1007 in2/ft	Min Stem T&S Reinf Area 1.152 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	1.3547 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	0.42 ft
Heel Width	=	2.92
Total Footing Width	=	3.34
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 4,000 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,259	11	psf
Mu' : Upward	=	2,291	1,311	ft-#
Mu' : Downward	=	238	2,666	ft-#
Mu: Design	=	171	1,355	ft-#
Actual 1-Way Shear	=	0.39	7.03	psi
Allow 1-Way Shear	=	94.87	94.87	psi

Toe Reinforcing = # 4 @ 12.00 in
Heel Reinforcing = # 4 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 5
Heel: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 5
Key: No key defined

Min footing T&S reinf Area 0.72 in2
Min footing T&S reinf Area per foot 0.22 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	817.2	2.28	1,861.3			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				1,690.0	2.21	3,740.5
Soil Over HL (bel. water tbl)					2.21	3,740.5
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.21	
Surcharge Over Toe =						
Stem Weight(s) =				600.0	0.75	452.0
Earth @ Stem Transitions =						
Footing Weight =				417.5	1.67	697.2
Key Weight =						
Vert. Component =						
Total =	817.2	**O.T.M.** =	1,861.3	**Total =** 2,707.5 lbs	**R.M.=**	4,889.8

Resisting/Overturning Ratio = **2.63**
Vertical Loads used for Soil Pressure = 2,707.5 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.081	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

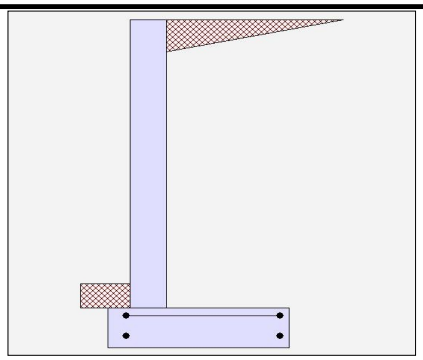
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	6.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	41.000
Total Seismic Force	=	280.167

Design Summary

Wall Stability Ratios

Overturning	=	1.93 OK
Sliding	=	1.45 Ratio < 1.5!
Total Bearing Load	=	2,707 lbs
...resultant ecc.	=	9.61 in
Soil Pressure @ Toe	=	2,081 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	4,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,913 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	0.4 psi OK
Footing Shear @ Heel	=	11.9 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	1,013.3 lbs
less 100% Passive Force	= -	116.7 lbs
less 100% Friction Force	= -	1,353.5 lbs
Added Force Req'd	=	0.0 lbs OK
....for 1.5 Stability	=	49.7 lbs NG

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =		0.00
Wall Material Above "Ht"	=		Concrete
Design Method	=		LRFD
Thickness	=		8.00
Rebar Size	=		# 4
Rebar Spacing	=		12.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.508**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		1,254.0
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		2,754.0
Moment.....Allowable	=		5,412.6
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		16.7
Shear.....Allowable	psi =		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		6.25
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		100.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=		Medium Weight
Masonry Design Method	=		ASD
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1032 in2/ft	
(4/3) * As :	0.1376 in2/ft	Min Stem T&S Reinf Area 1.152 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.1728 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.2 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	0.42 ft
Heel Width	=	2.92
Total Footing Width	=	3.34
Footing Thickness	=	10.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,913	0	psf
Mu' : Upward	=	2,864	654	ft-#
Mu' : Downward	=	234	2,666	ft-#
Mu: Design	=	219	2,012	ft-#
Actual 1-Way Shear	=	0.40	11.93	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 4 @ 12.00 in
Heel Reinforcing = # 4 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 5
Heel: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 5
Key: No key defined

Min footing T&S reinf Area 0.72 in2
Min footing T&S reinf Area per foot 0.22 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	817.2	2.28	1,861.3			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
Seismic Earth Load =	196.1	3.42	670.1			
=						
Soil Over HL (ab. water tbl)				1,690.0	2.21	3,733.8
Soil Over HL (bel. water tbl)					2.21	3,733.8
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.21	
Surcharge Over Toe =						
Stem Weight(s) =				600.0	0.75	449.6
Earth @ Stem Transitions =						
Footing Weight =				417.0	1.67	695.6
Key Weight =						
Vert. Component =						
Total =	1,013.3	**O.T.M.** =	2,531.4	**Total =** 2,707.0 lbs	**R.M.=**	4,878.9

Resisting/Overturning Ratio = **1.93**
Vertical Loads used for Soil Pressure = 2,707.0 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.104	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

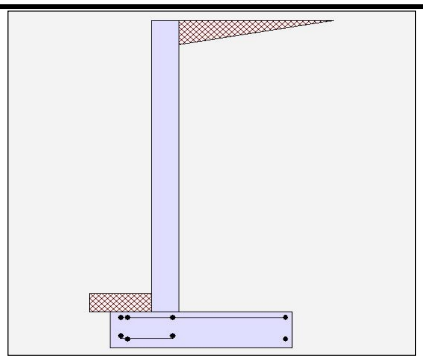
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Design Summary

Wall Stability Ratios

Overturning	=	2.56	OK
Sliding	=	1.62	OK
Total Bearing Load	=	4,212 lbs	
...resultant ecc.	=	7.58 in	
Soil Pressure @ Toe	=	1,773 psf	OK
Soil Pressure @ Heel	=	135 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,482 psf	
ACI Factored @ Heel	=	189 psf	
Footing Shear @ Toe	=	6.1 psi	OK
Footing Shear @ Heel	=	11.5 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	1,417.5 lbs	
less 100% Passive Force	= -	187.5 lbs	
less 100% Friction Force	= -	2,105.9 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

			Stem OK
Design Height Above Ftg	ft =	0.00	
Wall Material Above "Ht"	=	Concrete	
Design Method	=	LRFD	
Thickness	=	8.00	
Rebar Size	=	# 5	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Edge	
Design Data			
fb/FB + fa/Fa	=	**0.588**	
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =	1,792.0	
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =	4,778.7	
Moment.....Allowable	=	8,121.3	
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =	24.1	
Shear.....Allowable	psi =	75.0	
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	6.19	
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	100.0	
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =	2,500.0	
Fy	psi =	60,000.0	

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1809 in2/ft	
(4/3) * As :	0.2413 in2/ft	Min Stem T&S Reinf Area 1.536 in2
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2413 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.31 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	3.42
Total Footing Width	=	4.42
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,482	189	psf
Mu' : Upward	=	13,851	2,512	ft-#
Mu' : Downward	=	1,530	5,216	ft-#
Mu: Design	=	1,027	2,703	ft-#
Actual 1-Way Shear	=	6.08	11.51	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Key: No key defined

Min footing T&S reinf Area 1.14 in2
Min footing T&S reinf Area per foot 0.26 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,417.5	3.00	4,252.5			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				2,749.3	3.04	8,361.6
Soil Over HL (bel. water tbl)					3.04	8,361.6
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.50	
Surcharge Over Toe =						
Stem Weight(s) =				800.0	1.33	1,066.7
Earth @ Stem Transitions =						
Footing Weight =				662.4	2.21	1,462.6
Key Weight =						
Vert. Component =						
Total =	1,417.5	**O.T.M.** =	4,252.5	**Total =** 4,211.7 lbs	**R.M.=**	10,890.9

Resisting/Overturning Ratio = **2.56**
Vertical Loads used for Soil Pressure = 4,211.7 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.089	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

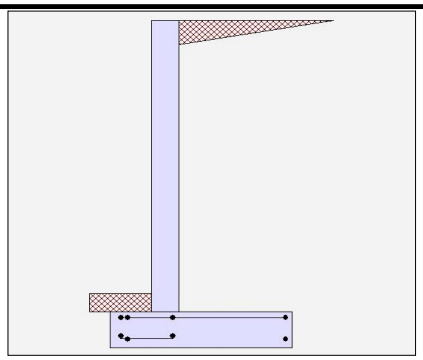
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	6.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	54.000
Total Seismic Force	=	486.000

Design Summary

Wall Stability Ratios

Overturning	=	1.88	OK
Sliding	=	1.30	Ratio < 1.5!
Total Bearing Load	=	4,212 lbs	
...resultant ecc.	=	11.94 in	
Soil Pressure @ Toe	=	2,315 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	4,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	3,242 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	8.1 psi	OK
Footing Shear @ Heel	=	18.1 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	1,757.7 lbs	
less 100% Passive Force	= -	187.5 lbs	
less 100% Friction Force	= -	2,105.9 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	343.2 lbs	NG

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

	Bottom
	Stem OK
Design Height Above Ftg ft =	0.00
Wall Material Above "Ht" =	Concrete
Design Method =	LRFD
Thickness =	8.00
Rebar Size =	# 5
Rebar Spacing =	12.00
Rebar Placed at =	Edge
Design Data	
fb/FB + fa/Fa =	**0.801**
Total Force @ Section	
Service Level lbs =	
Strength Level lbs =	2,224.0
Moment....Actual	
Service Level ft-# =	
Strength Level ft-# =	6,506.7
Moment.....Allowable =	8,121.3
Shear.....Actual	
Service Level psi =	
Strength Level psi =	30.0
Shear.....Allowable psi =	75.0
Anet (Masonry) in2 =	
Rebar Depth 'd' in =	6.19
Masonry Data	
f'm psi =	
Fs psi =	
Solid Grouting =	
Modular Ratio 'n' =	
Wall Weight psf =	100.0
Short Term Factor =	
Equiv. Solid Thick. =	
Masonry Block Type =	Medium Weight
Masonry Design Method =	ASD
Concrete Data	
f'c psi =	2,500.0
Fy psi =	60,000.0

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.2464 in2/ft	
(4/3) * As :	0.3285 in2/ft	Min Stem T&S Reinf Area 1.536 in2
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2475 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.31 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	3.42
Total Footing Width	=	4.42
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	3,242	0	psf
Mu' : Upward	=	17,667	1,138	ft-#
Mu' : Downward	=	1,530	5,216	ft-#
Mu: Design	=	1,345	4,078	ft-#
Actual 1-Way Shear	=	8.10	18.09	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Key: No key defined

Min footing T&S reinf Area 1.14 in2
Min footing T&S reinf Area per foot 0.26 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	1,417.5	3.00	4,252.5			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
Seismic Earth Load =	340.2	4.50	1,530.9			
=						
				Soil Over HL (ab. water tbl)	2,749.3	3.04	8,361.6
				Soil Over HL (bel. water tbl)		3.04	8,361.6
				Watre Table			
				Sloped Soil Over Heel =			
				Surcharge Over Heel =			
				Adjacent Footing Load =			
				Axial Dead Load on Stem =			
				* Axial Live Load on Stem =			
				Soil Over Toe =		0.50	
				Surcharge Over Toe =			
				Stem Weight(s) =	800.0	1.33	1,066.7
				Earth @ Stem Transitions =			
				Footing Weight =	662.4	2.21	1,462.6
				Key Weight =			
				Vert. Component =			
Total =	1,757.7	**O.T.M.** =	5,783.4	**Total =**	4,211.7 lbs	**R.M.=**	10,890.9

Resisting/Overturning Ratio = **1.88**
Vertical Loads used for Soil Pressure = 4,211.7 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.117	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

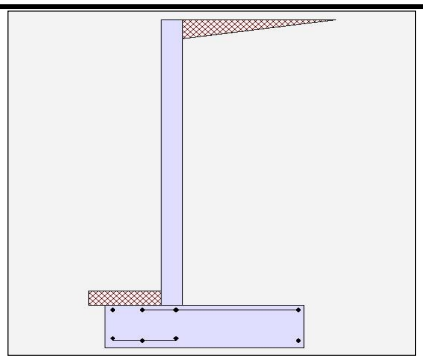
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Design Summary

Wall Stability Ratios

Overturning	=	2.98	OK
Sliding	=	1.72	OK
Total Bearing Load	=	7,074 lbs	
...resultant ecc.	=	7.14 in	
Soil Pressure @ Toe	=	1,811 psf	OK
Soil Pressure @ Heel	=	483 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,536 psf	
ACI Factored @ Heel	=	676 psf	
Footing Shear @ Toe	=	6.5 psi	OK
Footing Shear @ Heel	=	10.6 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	2,314.4 lbs	
less 100% Passive Force	= -	450.0 lbs	
less 100% Friction Force	= -	3,537.0 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =	0.00	
Wall Material Above "Ht"	=	Concrete	
Design Method	=	LRFD	
Thickness	=	8.00	
Rebar Size	=	# 7	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Edge	
Design Data			
fb/FB + fa/Fa	=	**0.712**	
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =	2,800.0	
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =	9,333.3	
Moment.....Allowable	=	13,107.2	
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =	41.9	
Shear.....Allowable	psi =	75.0	
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	5.56	
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	100.0	
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =	2,500.0	
Fy	psi =	60,000.0	

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.3955 in2/ft	
(4/3) * As :	0.5274 in2/ft	Min Stem T&S Reinf Area 1.920 in2
200bd/fy : 200(12)(5.5625)/60000 :	0.2225 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.3955 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.6 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.7535 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	1.75 ft
Heel Width	=	4.42
Total Footing Width	=	6.17
Footing Thickness	=	18.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,536	676	psf
Mu' : Upward	=	43,366	7,403	ft-#
Mu' : Downward	=	6,339	12,441	ft-#
Mu: Design	=	3,086	5,038	ft-#
Actual 1-Way Shear	=	6.49	10.65	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 7 @ 12.00 in
Heel Reinforcing = # 6 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Heel: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Key: No key defined

Min footing T&S reinf Area 2.40 in2
Min footing T&S reinf Area per foot 0.39 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.17 in	#4@ 12.35 in
#5@ 9.57 in	#5@ 19.14 in
#6@ 13.58 in	#6@ 27.16 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	2,314.4	3.83	8,871.8			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				4,686.7	4.29	20,112.0
Soil Over HL (bel. water tbl)					4.29	20,112.0
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.88	
Surcharge Over Toe =						
Stem Weight(s) =				1,000.0	2.08	2,083.3
Earth @ Stem Transitions =						
Footing Weight =				1,387.4	3.08	4,277.2
Key Weight =						
Vert. Component =						
Total =	2,314.4	**O.T.M.** =	8,871.8	**Total =** 7,074.0 lbs	**R.M.=**	26,472.6

Resisting/Overturning Ratio = **2.98**
Vertical Loads used for Soil Pressure = 7,074.0 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.082	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

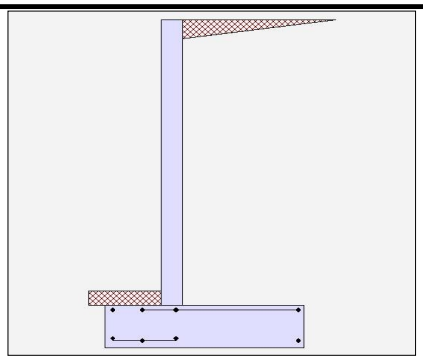
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	6.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	69.000
Total Seismic Force	=	793.500

Design Summary

Wall Stability Ratios

Overturning	=	2.19	OK
Sliding	=	1.39	Ratio < 1.5!
Total Bearing Load	=	7,074 lbs	
...resultant ecc.	=	12.56 in	
Soil Pressure @ Toe	=	2,316 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	4,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	3,242 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	8.5 psi	OK
Footing Shear @ Heel	=	16.2 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	2,869.8 lbs	
less 100% Passive Force	= -	450.0 lbs	
less 100% Friction Force	= -	3,537.0 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	317.7 lbs	NG

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =	0.00	
Wall Material Above "Ht"	=	Concrete	
Design Method	=	LRFD	
Thickness	=	8.00	
Rebar Size	=	# 7	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Edge	
Design Data			
fb/FB + fa/Fa	=	**0.975**	
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =	3,490.0	
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =	12,783.3	
Moment.....Allowable	=	13,107.2	
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =	52.3	
Shear.....Allowable	psi =	75.0	
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	5.56	
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	100.0	
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =	2,500.0	
Fy	psi =	60,000.0	

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.5417 in2/ft		
(4/3) * As :	0.7223 in2/ft	Min Stem T&S Reinf Area 1.920 in2	
200bd/fy : 200(12)(5.5625)/60000 :	0.2225 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft	
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.5417 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.6 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.7535 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	1.75 ft
Heel Width	=	4.42
Total Footing Width	=	6.17
Footing Thickness	=	18.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	3,242	0	psf
Mu' : Upward	=	53,882	4,455	ft-#
Mu' : Downward	=	6,339	12,441	ft-#
Mu: Design	=	3,962	7,986	ft-#
Actual 1-Way Shear	=	8.49	16.22	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 7 @ 12.00 in
Heel Reinforcing = # 6 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Heel: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Key: No key defined

Min footing T&S reinf Area 2.40 in2
Min footing T&S reinf Area per foot 0.39 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.17 in	#4@ 12.35 in
#5@ 9.57 in	#5@ 19.14 in
#6@ 13.58 in	#6@ 27.16 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	2,314.4	3.83	8,871.8			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
Seismic Earth Load =	555.5	5.75	3,193.8			
=						
Total =	2,869.8	**O.T.M.** =	12,065.6			
Soil Over HL (ab. water tbl)				4,686.7	4.29	20,112.0
Soil Over HL (bel. water tbl)					4.29	20,112.0
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.88	
Surcharge Over Toe =						
Stem Weight(s) =				1,000.0	2.08	2,083.3
Earth @ Stem Transitions =						
Footing Weight =				1,387.4	3.08	4,277.2
Key Weight =						
Vert. Component =						
				Total = 7,074.0 lbs	**R.M.=**	26,472.6

Resisting/Overturning Ratio = **2.19**
Vertical Loads used for Soil Pressure = 7,074.0 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.104	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

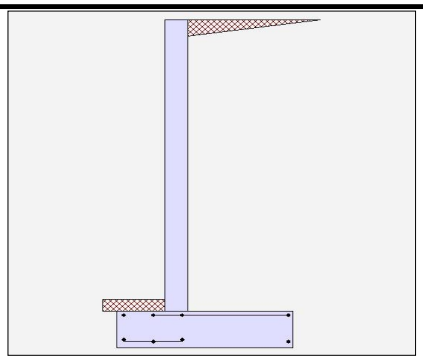
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	12.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Design Summary

Wall Stability Ratios

Overturning	=	2.35	OK
Sliding	=	1.50	OK
Total Bearing Load	=	8,693 lbs	
...resultant ecc.	=	11.72 in	
Soil Pressure @ Toe	=	2,592 psf	OK
Soil Pressure @ Heel	=	118 psf	OK
Allowable	=	3,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	3,629 psf	
ACI Factored @ Heel	=	165 psf	
Footing Shear @ Toe	=	9.7 psi	OK
Footing Shear @ Heel	=	17.9 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	3,189.4 lbs	
less 100% Passive Force	= -	450.0 lbs	
less 100% Friction Force	= -	4,346.3 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

			Stem OK
Design Height Above Ftg	ft =	0.00	
Wall Material Above "Ht"	=	Concrete	
Design Method	=	LRFD	
Thickness	=	10.00	
Rebar Size	=	# 7	
Rebar Spacing	=	9.00	
Rebar Placed at	=	Edge	
Design Data			
fb/FB + fa/Fa	=	**0.676**	
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =	4,032.0	
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =	16,128.0	
Moment.....Allowable	=	23,826.6	
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =	44.4	
Shear.....Allowable	psi =	75.0	
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	7.56	
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	125.0	
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =	2,500.0	
Fy	psi =	60,000.0	

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.4948 in2/ft	
(4/3) * As :	0.6597 in2/ft	Min Stem T&S Reinf Area 2.880 in2
200bd/fy : 200(12)(7.5625)/60000 :	0.3025 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.4948 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.8 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.0245 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	1.75 ft
Heel Width	=	4.67
Total Footing Width	=	6.42
Footing Thickness	=	18.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	3,629	165	psf
Mu' : Upward	=	60,893	6,276	ft-#
Mu' : Downward	=	6,339	15,203	ft-#
Mu: Design	=	4,546	8,928	ft-#
Actual 1-Way Shear	=	9.69	17.94	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 7 @ 12.00 in
Heel Reinforcing = # 6 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Heel: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Key: No key defined

Min footing T&S reinf Area 2.49 in2
Min footing T&S reinf Area per foot 0.39 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.17 in	#4@ 12.35 in
#5@ 9.57 in	#5@ 19.14 in
#6@ 13.58 in	#6@ 27.16 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	3,189.4	4.50	14,352.2			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
=						
Soil Over HL (ab. water tbl)				5,749.0	4.50	25,868.6
Soil Over HL (bel. water tbl)					4.50	25,868.6
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.88	
Surcharge Over Toe =						
Stem Weight(s) =				1,500.0	2.17	3,250.0
Earth @ Stem Transitions =						
Footing Weight =				1,443.6	3.21	4,631.1
Key Weight =						
Vert. Component =						
Total =	3,189.4	**O.T.M.** =	14,352.2	**Total =** 8,692.6 lbs	**R.M.=**	33,749.7

Resisting/Overturning Ratio = **2.35**
Vertical Loads used for Soil Pressure = 8,692.6 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.135	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

This Wall in File: K:\2021\01519-2021-06 Huber Residence\Calcs\Typical Detail Co-04-06.RPX

Cantilevered Retaining Wall

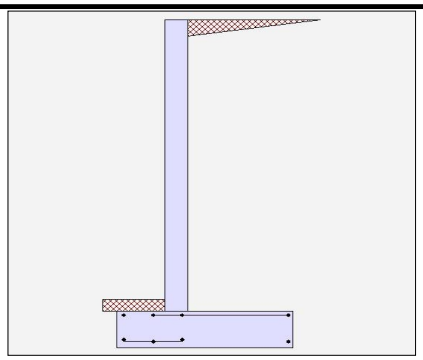
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	12.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	4,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	300.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.500
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
Used for Sliding & Overturning		

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)
Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs
Footing Width	=	0.00 ft
Eccentricity	=	0.00 in
Wall to Ftg CL Dist	=	0.00 ft
Footing Type		Line Load
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs
Axial Live Load	=	0.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	6.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	81.000
Total Seismic Force	=	1,093.500

Design Summary

Wall Stability Ratios

Overturning	=	1.73	OK
Sliding	=	1.21	Ratio < 1.5!
Total Bearing Load	=	8,693 lbs	
...resultant ecc.	=	18.85 in	
Soil Pressure @ Toe	=	3,540 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	4,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	4,956 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	13.4 psi	OK
Footing Shear @ Heel	=	28.0 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	3,954.8 lbs	
less 100% Passive Force	= -	450.0 lbs	
less 100% Friction Force	= -	4,346.3 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	1,135.9 lbs	NG

Vertical component of active lateral soil pressure IS NOT considered in the calculation of soil bearing

Load Factors

Building Code	IBC 2015,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

Bottom

Stem OK

Design Height Above Ftg	ft =	0.00	
Wall Material Above "Ht"	=	Concrete	
Design Method	=	LRFD	
Thickness	=	10.00	
Rebar Size	=	# 7	
Rebar Spacing	=	9.00	
Rebar Placed at	=	Edge	
Design Data			
fb/FB + fa/Fa	=	**0.921**	
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =	5,004.0	
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =	21,960.0	
Moment.....Allowable	=	23,826.6	
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =	55.1	
Shear.....Allowable	psi =	75.0	
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =	7.56	
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =	125.0	
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =	2,500.0	
Fy	psi =	60,000.0	

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.6737 in2/ft	
(4/3) * As :	0.8982 in2/ft	Min Stem T&S Reinf Area 2.880 in2
200bd/fy : 200(12)(7.5625)/60000 :	0.3025 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.6737 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.8 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.0245 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	1.75 ft
Heel Width	=	4.67
Total Footing Width	=	6.42
Footing Thickness	=	18.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	4,956	0	psf
Mu' : Upward	=	80,246	2,122	ft-#
Mu' : Downward	=	6,339	15,203	ft-#
Mu: Design	=	6,159	13,082	ft-#
Actual 1-Way Shear	=	13.42	27.95	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 7 @ 12.00 in
Heel Reinforcing = # 6 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Heel: #4@ 6.17 in, #5@ 9.56 in, #6@ 13.58 in, #7@ 18.51 in, #8@ 24.38 in, #9@ 30.
Key: No key defined

Min footing T&S reinf Area 2.49 in2
Min footing T&S reinf Area per foot 0.39 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.17 in	#4@ 12.35 in
#5@ 9.57 in	#5@ 19.14 in
#6@ 13.58 in	#6@ 27.16 in

Cantilevered Retaining Wall

Code: IBC 2015,ACI 318-14,ACI 530-13

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	3,189.4	4.50	14,352.2			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
Seismic Earth Load =	765.5	6.75	5,166.8			
=						
Total =	3,954.8	**O.T.M.** =	19,519.0			
Soil Over HL (ab. water tbl)				5,749.0	4.50	25,868.6
Soil Over HL (bel. water tbl)					4.50	25,868.6
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.88	
Surcharge Over Toe =						
Stem Weight(s) =				1,500.0	2.17	3,250.0
Earth @ Stem Transitions =						
Footing Weight =				1,443.6	3.21	4,631.1
Key Weight =						
Vert. Component =						
Total =				8,692.6 lbs	**R.M.=**	33,749.7

Resisting/Overturning Ratio = **1.73**
Vertical Loads used for Soil Pressure = 8,692.6 lbs

* Axial live load NOT included in total displayed, or used for overturning resistance, but is included for soil pressure calculation.

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

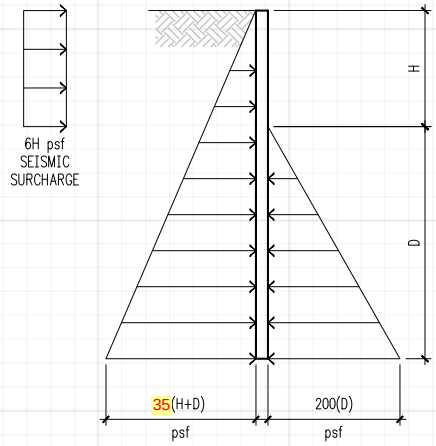
(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.184	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe, because the wall would then tend to rotate into the retained soil.

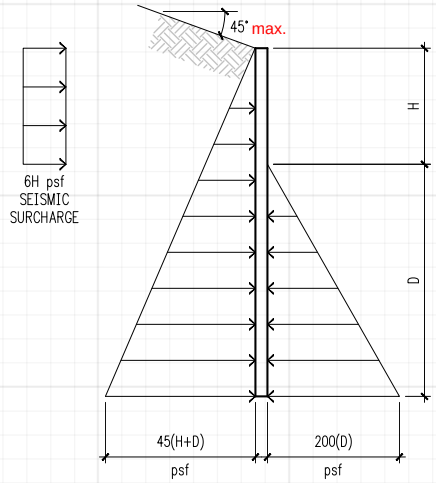
Shoring Design

Level Backfill Diagram



NOTES:
1. ACTIVE PRESSURE ABOVE EXCAVATION ACTS OVER (1) PILE SPACING, ACTIVE PRESSURE BELOW EXCAVATION ACTS OVER (1) PILE DIAMETER.
2. PASSIVE PRESSURE BELOW EXCAVATION ACTS OVER (2) PILE DIAMETERS.
3. PASSIVE PRESSURES ARE ULTIMATE, A FACTOR OF SAFETY OF 1.5 IS USED W/ SEISMIC LOADS, A FACTOR OF SAFETY OF 1.5 IS USED W/O SEISMIC LOADS.
4. ACTIVE PRESSURE ASSUMES LEVEL BACKFILL.
5. LAGGING DESIGN IS BASED ON 50% OF ACTIVE PRESSURES.

Sloped Backfill Diagram



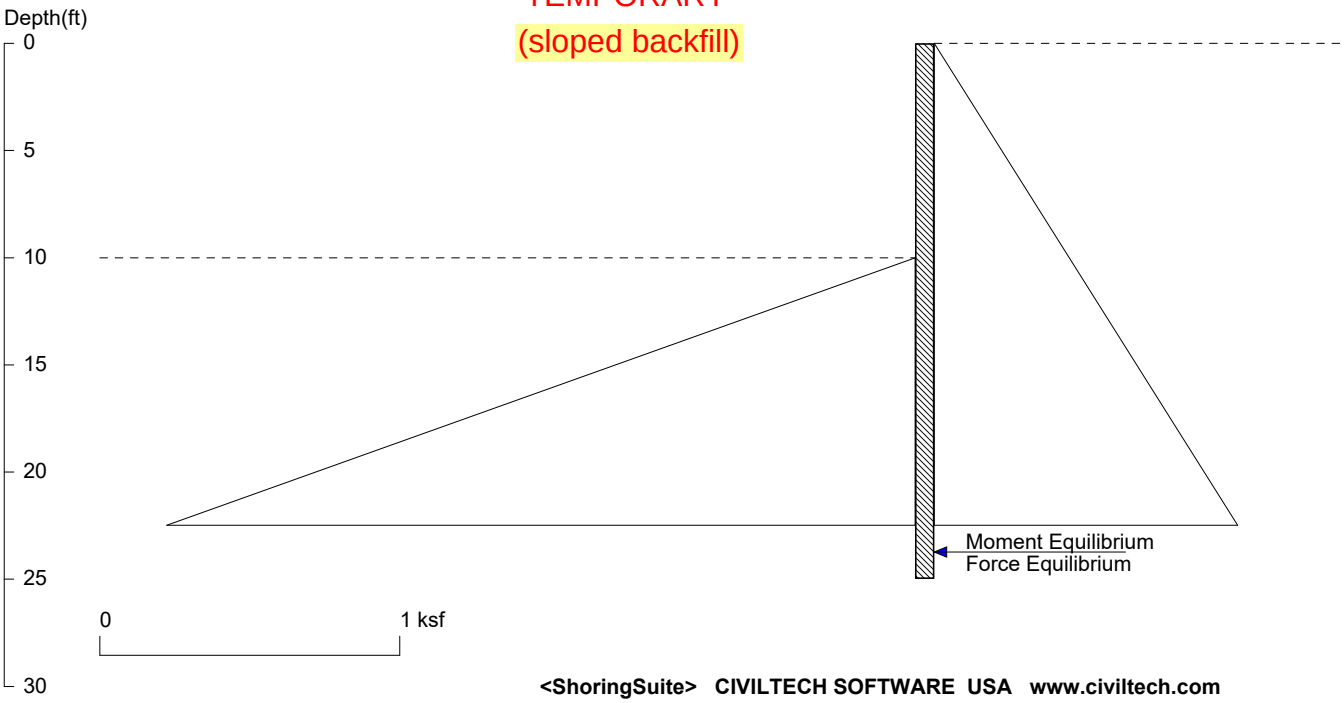
NOTES:
1. ACTIVE PRESSURE ABOVE EXCAVATION ACTS OVER (1) PILE SPACING, ACTIVE PRESSURE BELOW EXCAVATION ACTS OVER (1) PILE DIAMETER.
2. PASSIVE PRESSURE BELOW EXCAVATION ACTS OVER (2) PILE DIAMETERS.
3. PASSIVE PRESSURES ARE ULTIMATE, A FACTOR OF SAFETY OF 1.5 IS USED W/ SEISMIC LOADS, A FACTOR OF SAFETY OF 1.5 IS USED W/O SEISMIC LOADS.
4. ACTIVE PRESSURE ASSUMES SLOPED BACKFILL.
5. LAGGING DESIGN IS BASED ON 50% OF ACTIVE PRESSURES.

Pile Design Summary

MARK	AUGER DIA. (min.)	WIDE FLANGE SIZE	MAX. HEIGHT H	MIN. EMBED D	TEMP. OR PERM.
P1	30"ø	W14x43	10'–0"	15'–0"	T
P2–P6	30"ø	W14x43	10'–0"	15'–0"	P
P7-P12	30" ø	W16x89	12'-0"	20'-0"	P
P13-P15	30" ø	W16x36	10'-0"	14'-3"	T
P16-P20	30" ø	W18x65	13'-0"	18'-6"	P

SWENSON SAY FAGET
SEATTLE 2124 Third Ave, Suite 100, Seattle, WA 98121 | O 206.443.6212
TACOMA 934 Broadway, Suite 100, Tacoma, WA 98402 | O 253.284.9470
ssfengineers.com

P1-P6
TEMPORARY
(sloped backfill)



Licensed to 4324324234 3424343 Date: 9/10/2021
File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\garage wall_temp.sh8

Wall Height=10.0 Pile Diameter=2.5 Pile Spacing=7.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=14.98 Min. Pile Length=24.98
MOMENT IN PILE: Max. Moment=110.86 per Pile Spacing=7.0 at Depth=16.63

PILE SELECTION:
Request Min. Section Modulus = 56.0 in3/pile=917.54 cm3/pile, Fy= 36 ksi = 248 MPa, Fb/Fy=0.66
W14X43 has Section Modulus = 62.6 in3/pile=1025.83 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.83(in) based on E (ksi)=29000.00 and I (in4)/pile=428.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	100	4.500	.045

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
10	0	100	18.00	.2

ACTIVE SPACING:

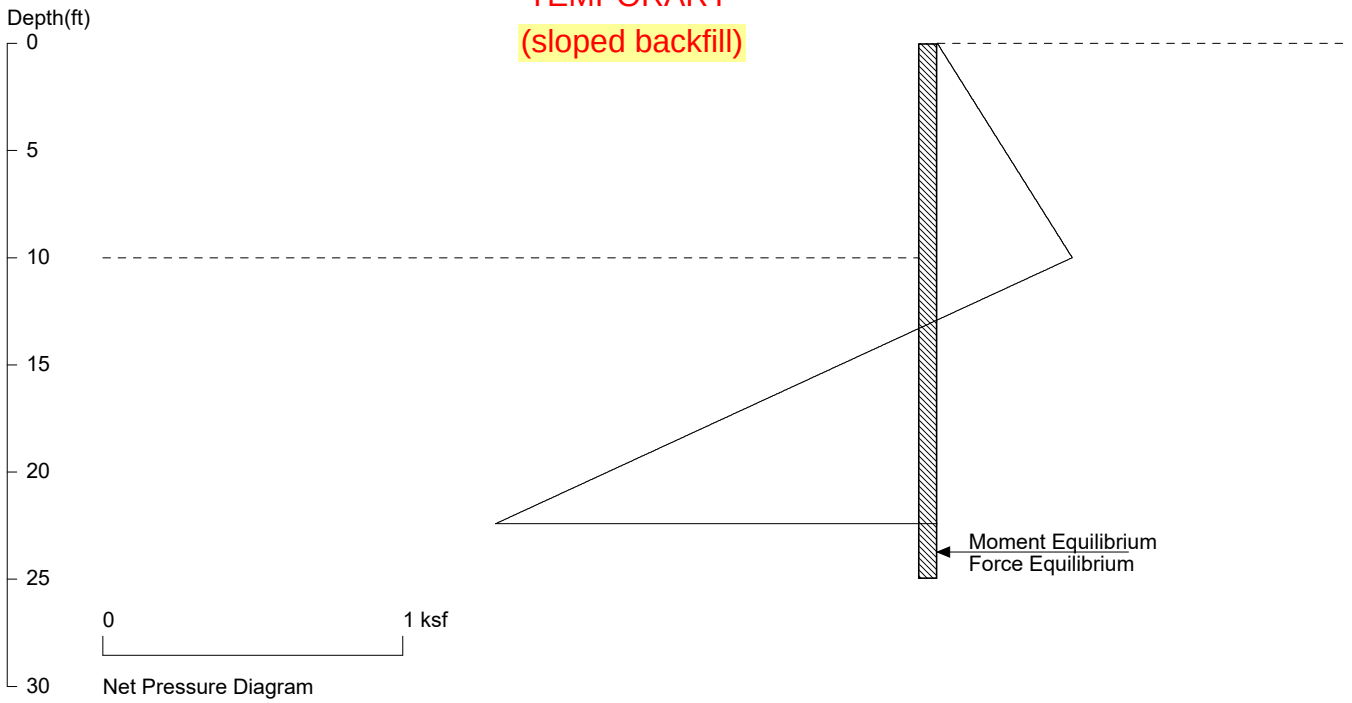
No.	Z depth	Spacing
1	0.00	7.00
2	8.00	2.50

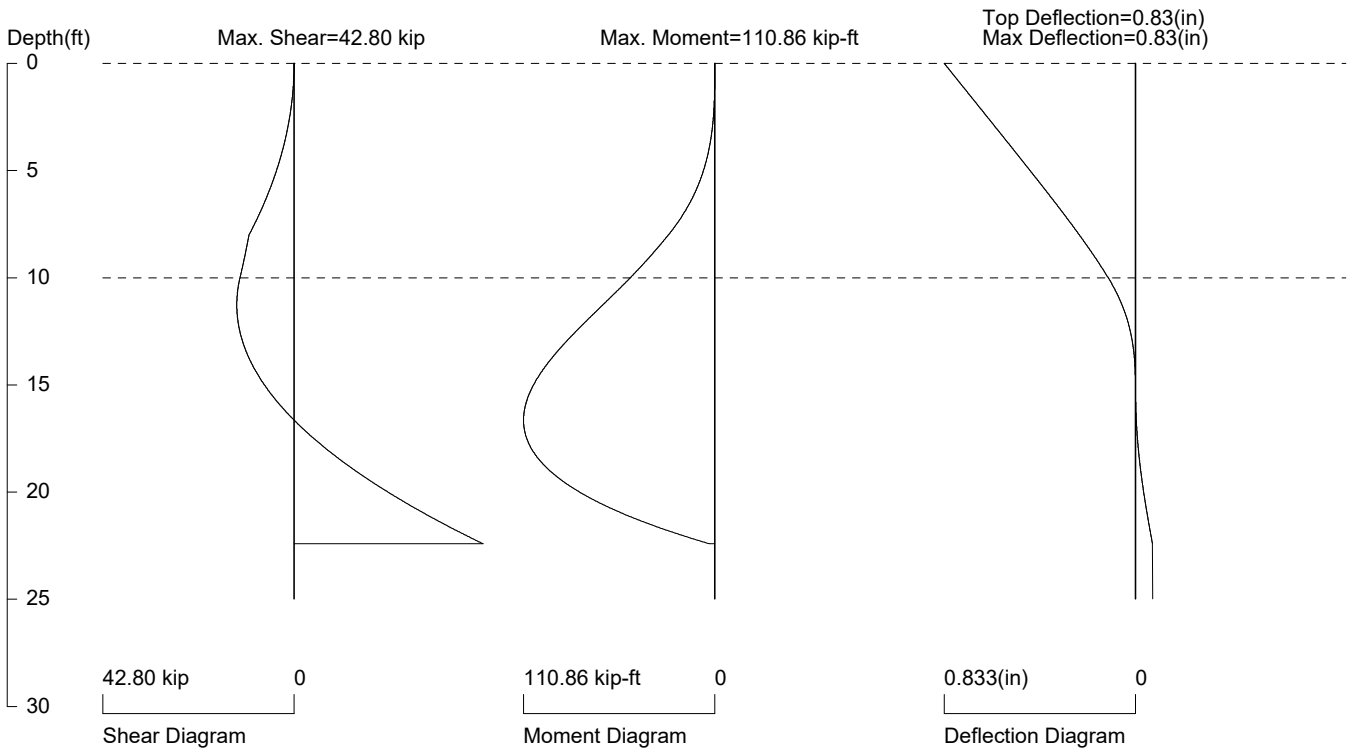
PASSIVE SPACING:

No.	Z depth	Spacing
1	8.00	5.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

P1-P6
TEMPORARY
(sloped backfill)





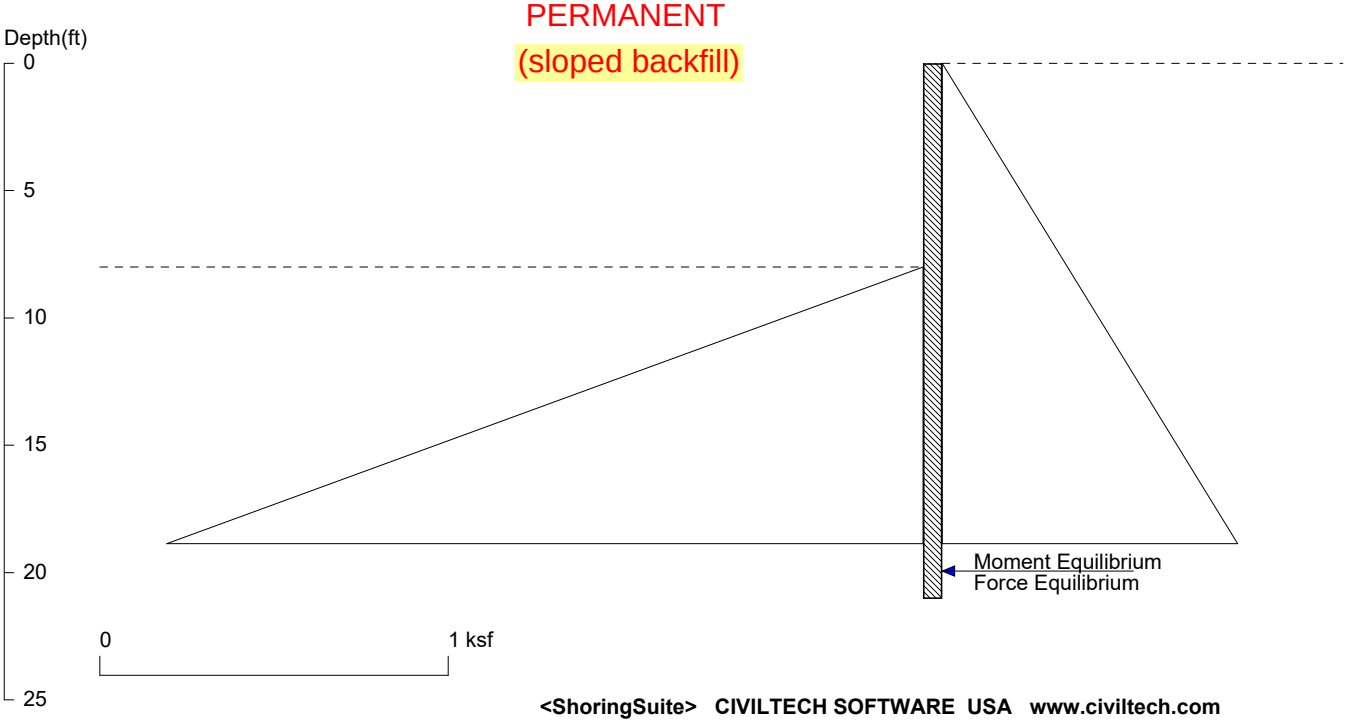
PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.0 foot or meter

User Input Pile, W14X43: E (ksi)=29000.0, I (in4)/pile=428.0

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\garage wall_temp.sh8

P2-P6
PERMANENT
(sloped backfill)



Licensed to 4324324234 3424343 Date: 9/10/2021
File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\garage wall_perm.sh8

Wall Height=8.0 Pile Diameter=2.5 Pile Spacing=7.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=13.03 Min. Pile Length=21.03
MOMENT IN PILE: Max. Moment=71.64 per Pile Spacing=7.0 at Depth=13.89

PILE SELECTION:
Request Min. Section Modulus = 36.2 in3/pile=592.89 cm3/pile, Fy= 36 ksi = 248 MPa, Fb/Fy=0.66
W14X43 has Section Modulus = 62.6 in3/pile=1025.83 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.36(in) based on E (ksi)=29000.00 and I (in4)/pile=428.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	100	4.500	.045

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
8	0	100	18.40	.2

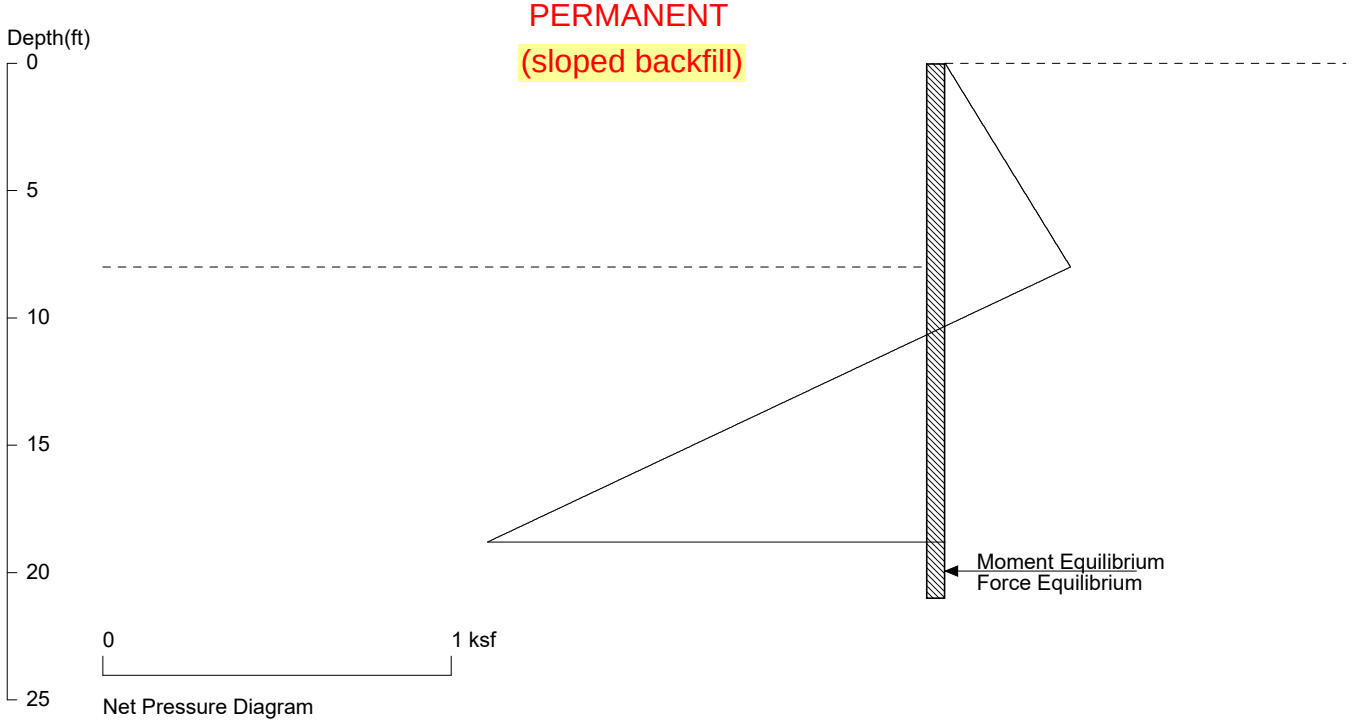
ACTIVE SPACING:

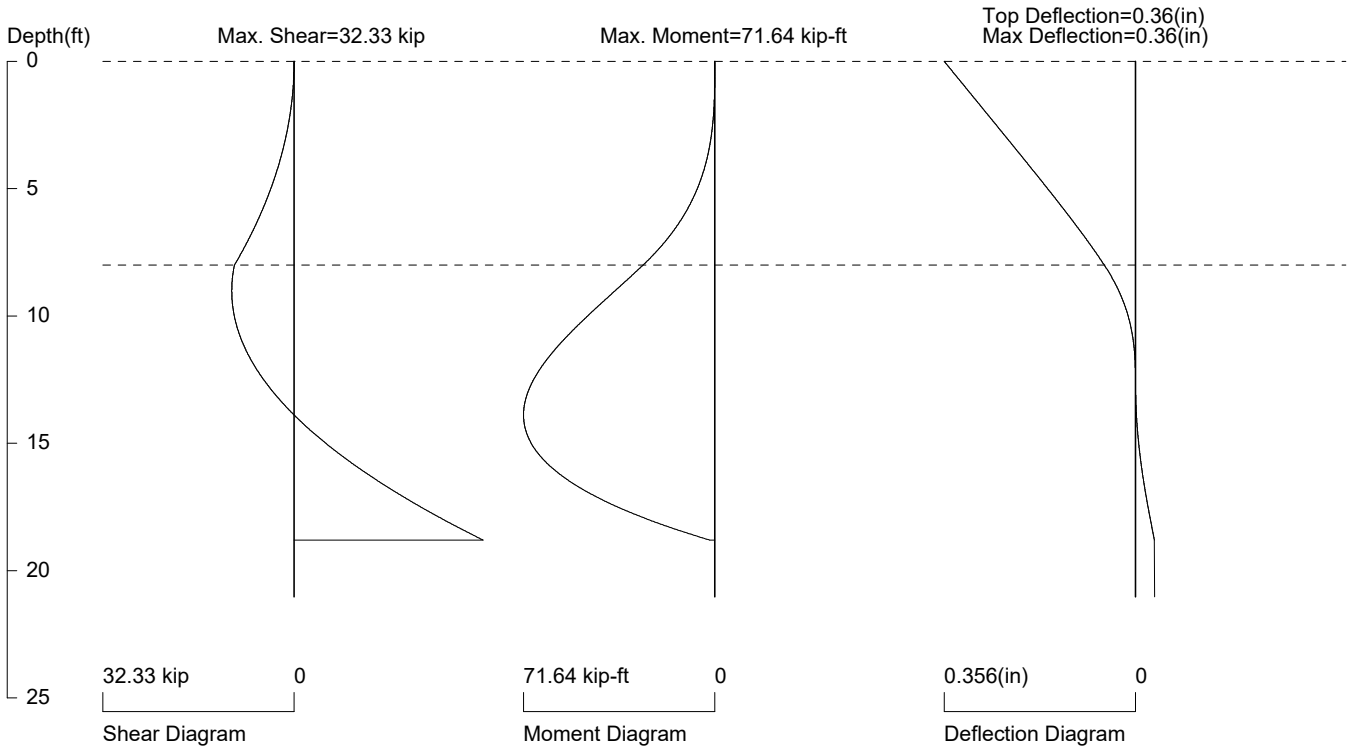
No.	Z depth	Spacing
1	0.00	7.00
2	8.00	2.50

PASSIVE SPACING:

No.	Z depth	Spacing
1	8.00	5.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in





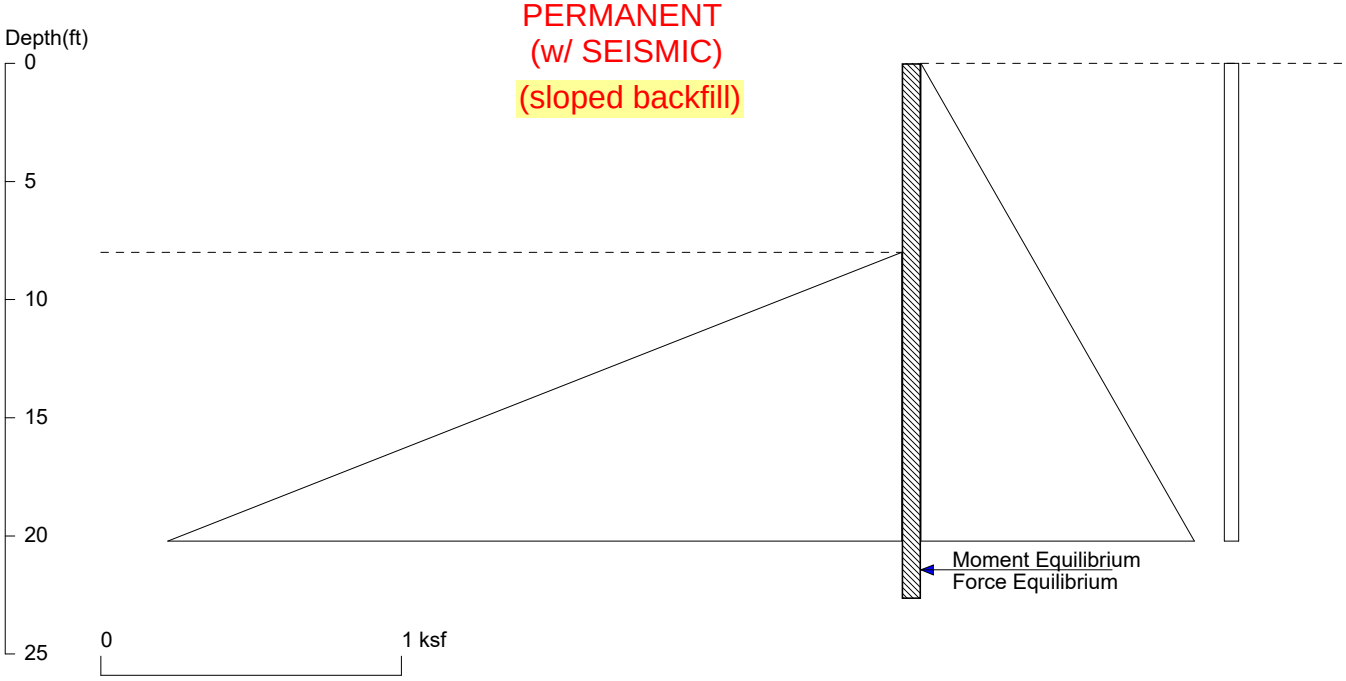
PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.0 foot or meter

User Input Pile, W14X43: E (ksi)=29000.0, I (in4)/pile=428.0

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\garage wall_perm.sh8

P2-P6
PERMANENT
(w/ SEISMIC)
(sloped backfill)



Licensed to 4324324234 3424343 Date: 9/10/2021
File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\garage wall_perm EQK.sh8

Wall Height=8.0 Pile Diameter=2.5 Pile Spacing=7.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=14.66 Min. Pile Length=22.66
MOMENT IN PILE: Max. Moment=101.59 per Pile Spacing=7.0 at Depth=14.64

PILE SELECTION:
Request Min. Section Modulus = 51.3 in3/pile=840.82 cm3/pile, Fy= 36 ksi = 248 MPa, Fb/Fy=0.66
W14X43 has Section Modulus = 62.6 in3/pile=1025.83 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.56(in) based on E (ksi)=29000.00 and I (in4)/pile=428.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	100	4.500	.045
*	eqk			
0	.048	100	0.048	

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
8	0	100	18.40	.2

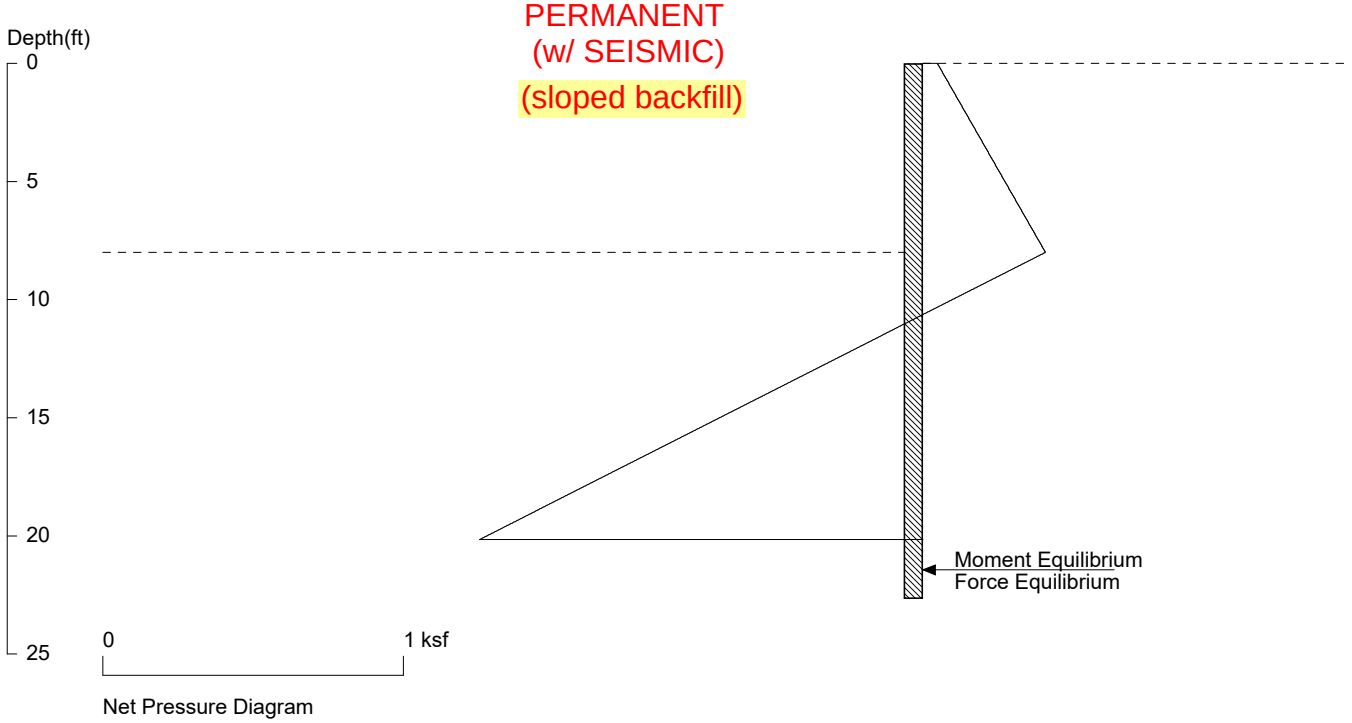
ACTIVE SPACING:

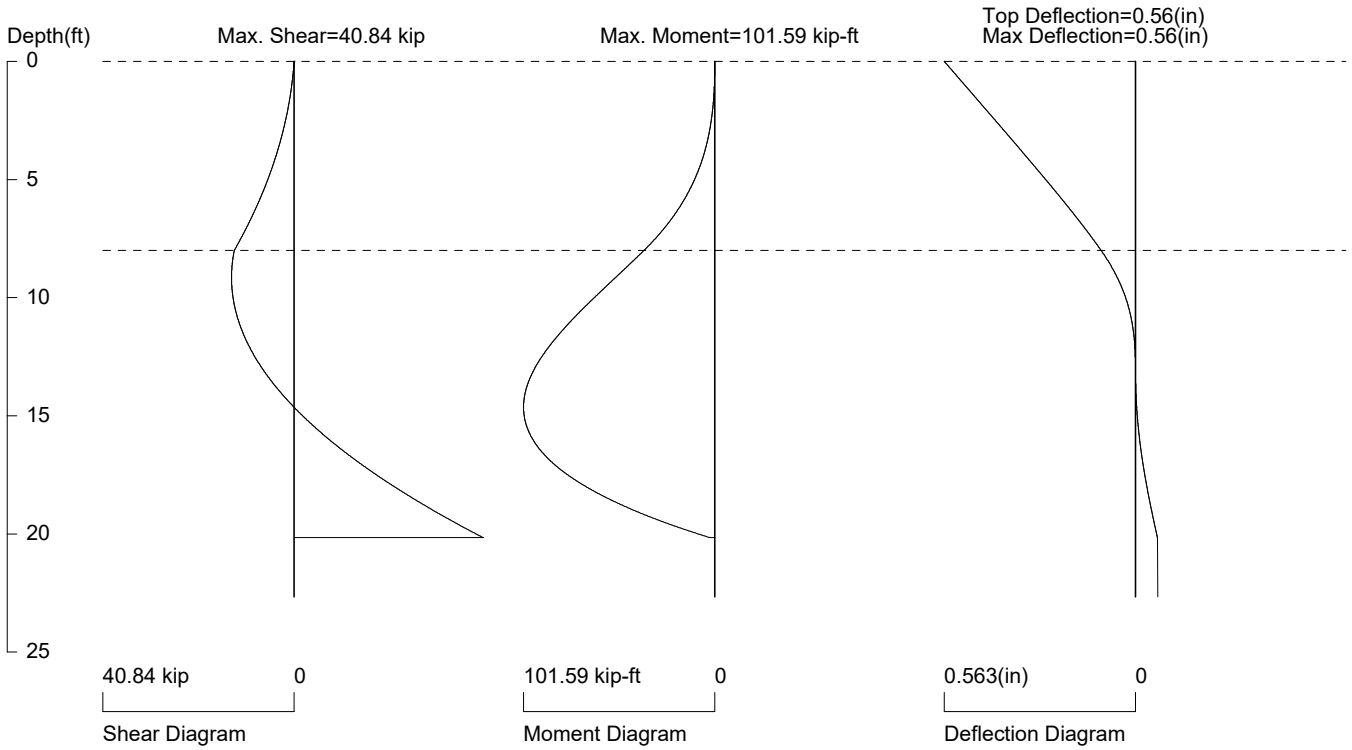
No.	Z depth	Spacing
1	0.00	7.00
2	8.00	2.50

PASSIVE SPACING:

No.	Z depth	Spacing
1	8.00	5.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in





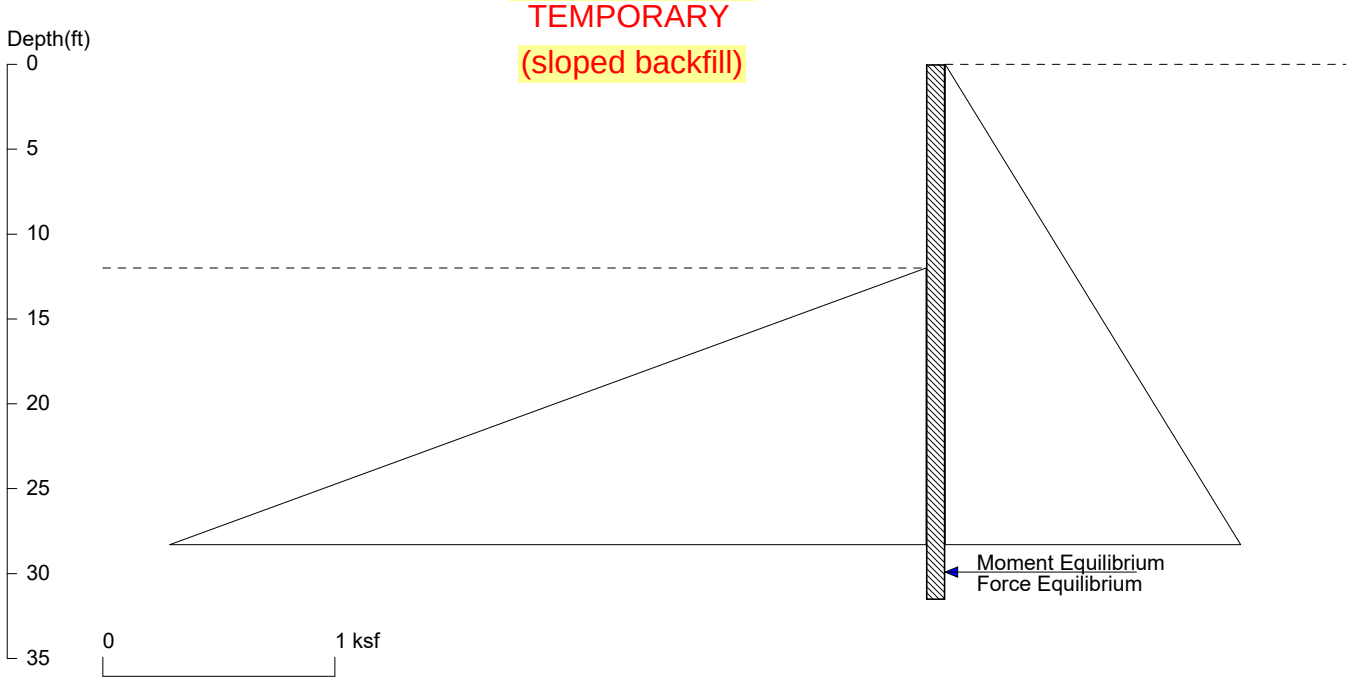
PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.0 foot or meter

User Input Pile, W14X43: E (ksi)=29000.0, I (in4)/pile=428.0

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\garage wall_perm EQK.sh8

P7-P12
TEMPORARY
(sloped backfill)



Licensed to 4324324234 3424343 Date: 9/10/2021
File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\trash wall temp.sh8

Wall Height=12.0 Pile Diameter=2.5 Pile Spacing=7.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=19.55 Min. Pile Length=31.55
MOMENT IN PILE: Max. Moment=241.78 per Pile Spacing=7.0 at Depth=20.83

PILE SELECTION:
Request Min. Section Modulus = 122.1 in3/pile=2001.02 cm3/pile, Fy= 36 ksi = 248 MPa, Fb/Fy=0.66
W16X89 has Section Modulus = 155.0 in3/pile=2539.99 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.86(in) based on E (ksi)=29000.00 and I (in4)/pile=1300.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	100	4.500	.045

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
12	0	100	17.60	.2

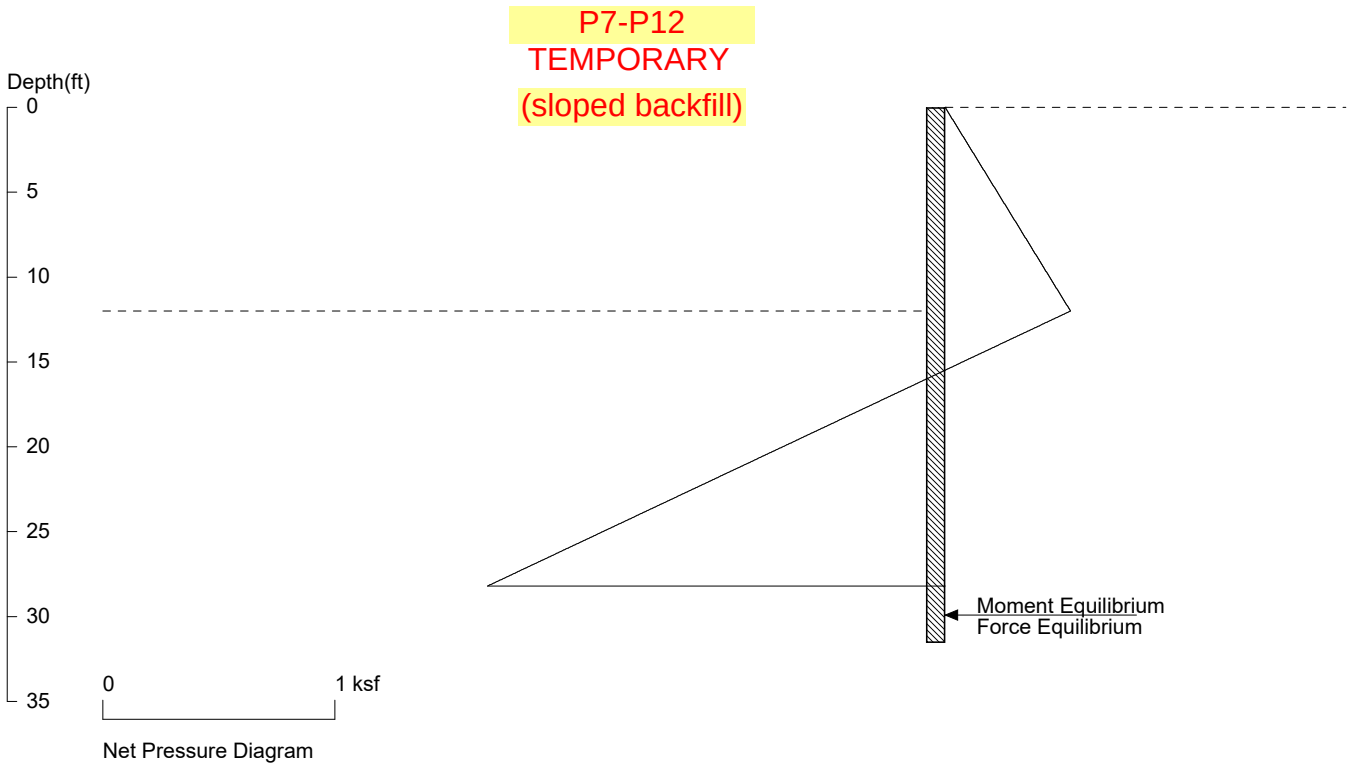
ACTIVE SPACING:

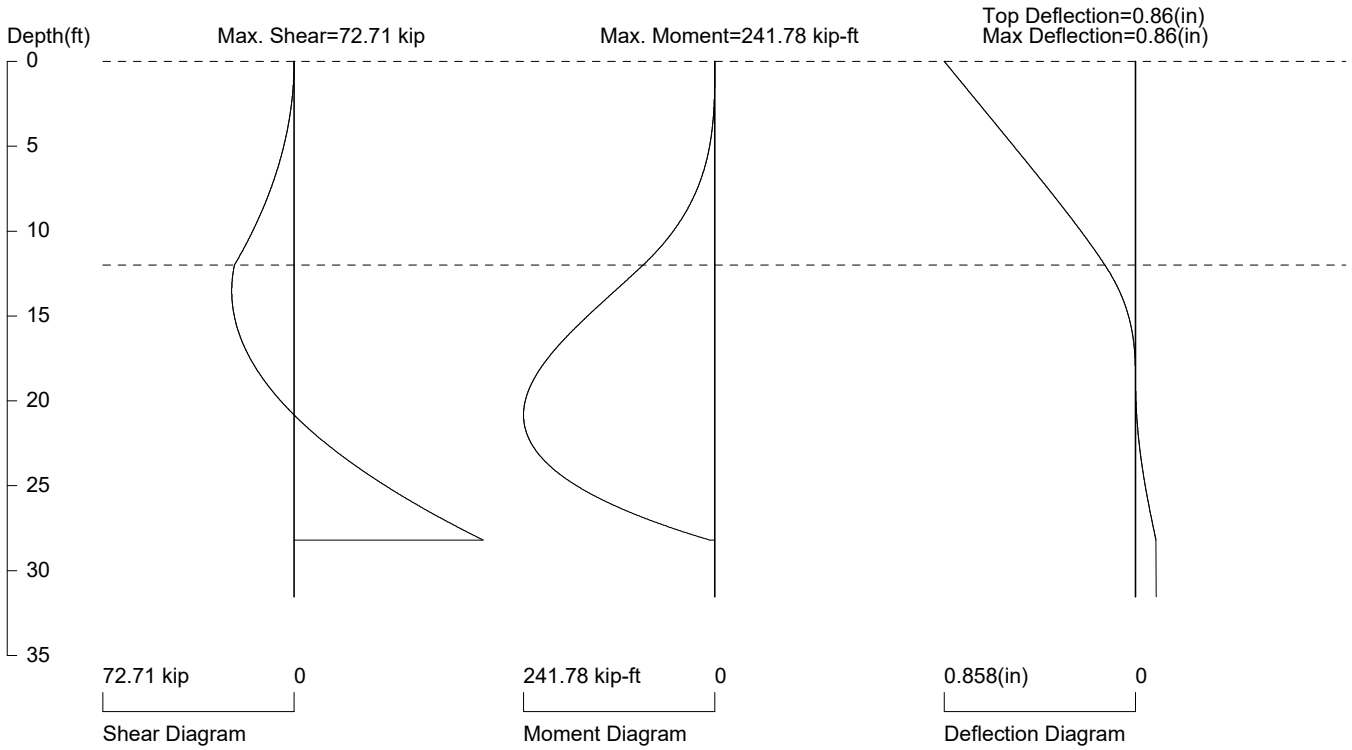
No.	Z depth	Spacing
1	0.00	7.00
2	12.00	2.50

PASSIVE SPACING:

No.	Z depth	Spacing
1	12.00	5.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in





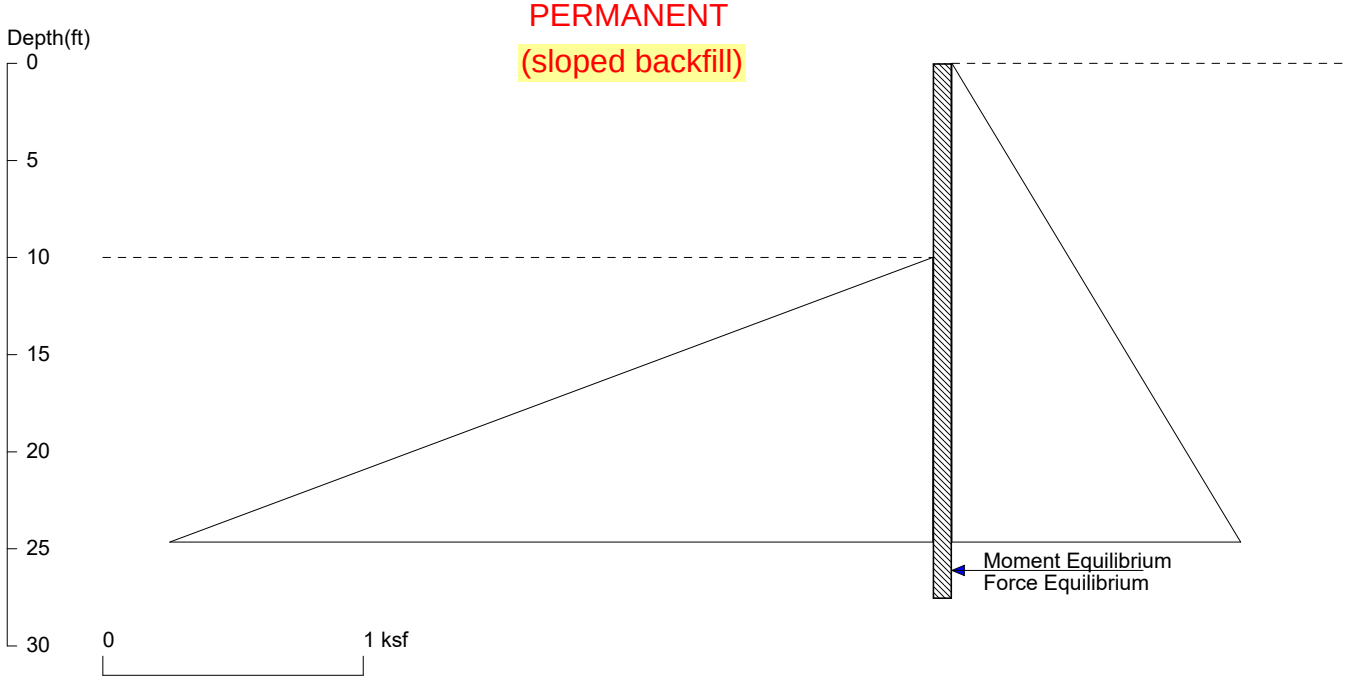
PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.0 foot or meter

User Input Pile, W16X89: E (ksi)=29000.0, I (in4)/pile=1300.0

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\trash wall temp.sh8

P7-P12
PERMANENT
(sloped backfill)



Licensed to 4324324234 3424343 Date: 9/10/2021
File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\trash wall perm.sh8

Wall Height=10.0 Pile Diameter=2.5 Pile Spacing=7.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=17.57 Min. Pile Length=27.57
MOMENT IN PILE: Max. Moment=169.87 per Pile Spacing=7.0 at Depth=18.12

PILE SELECTION:
Request Min. Section Modulus = 85.8 in3/pile=1405.89 cm3/pile, Fy= 36 ksi = 248 MPa, Fb/Fy=0.66
W16X89 has Section Modulus = 155.0 in3/pile=2539.99 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.42(in) based on E (ksi)=29000.00 and I (in4)/pile=1300.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	100	4.500	.045

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
10	0	100	18.00	.2

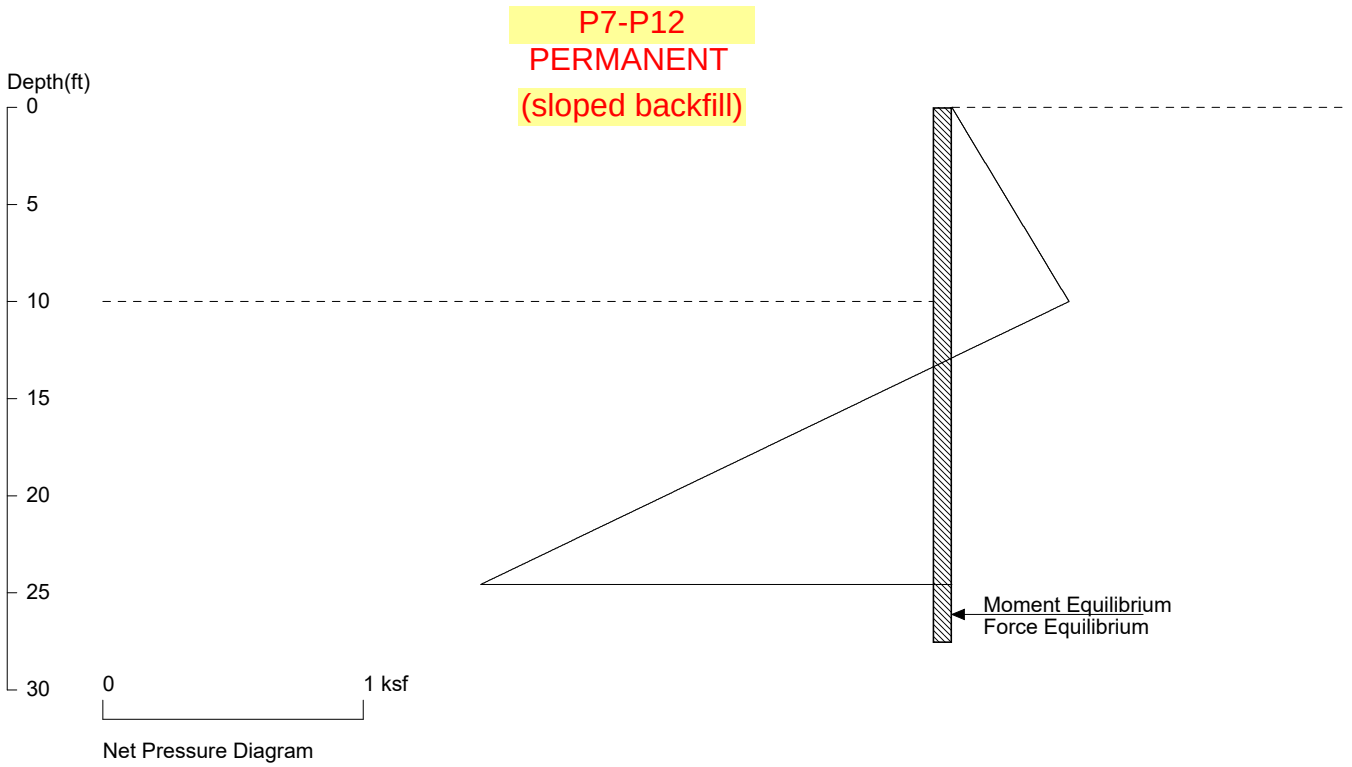
ACTIVE SPACING:

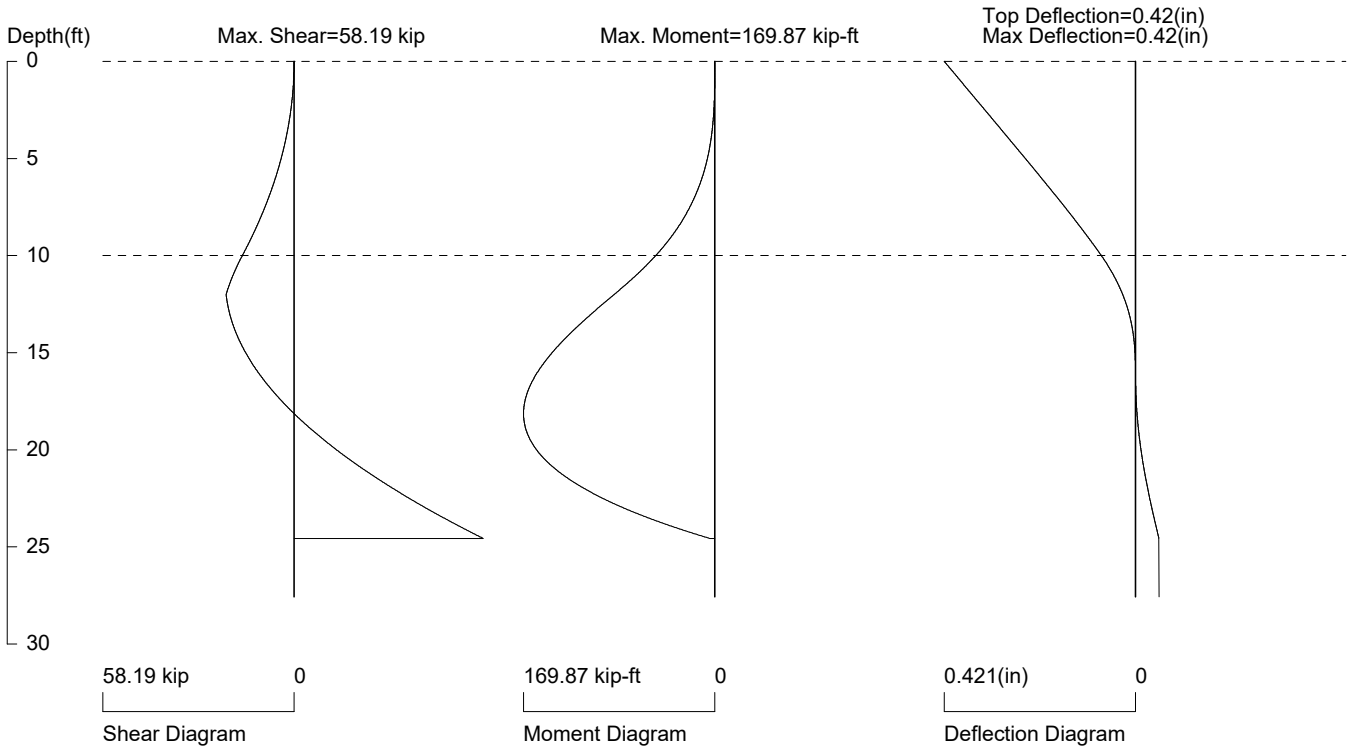
No.	Z depth	Spacing
1	0.00	7.00
2	12.00	2.50

PASSIVE SPACING:

No.	Z depth	Spacing
1	10.00	5.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in



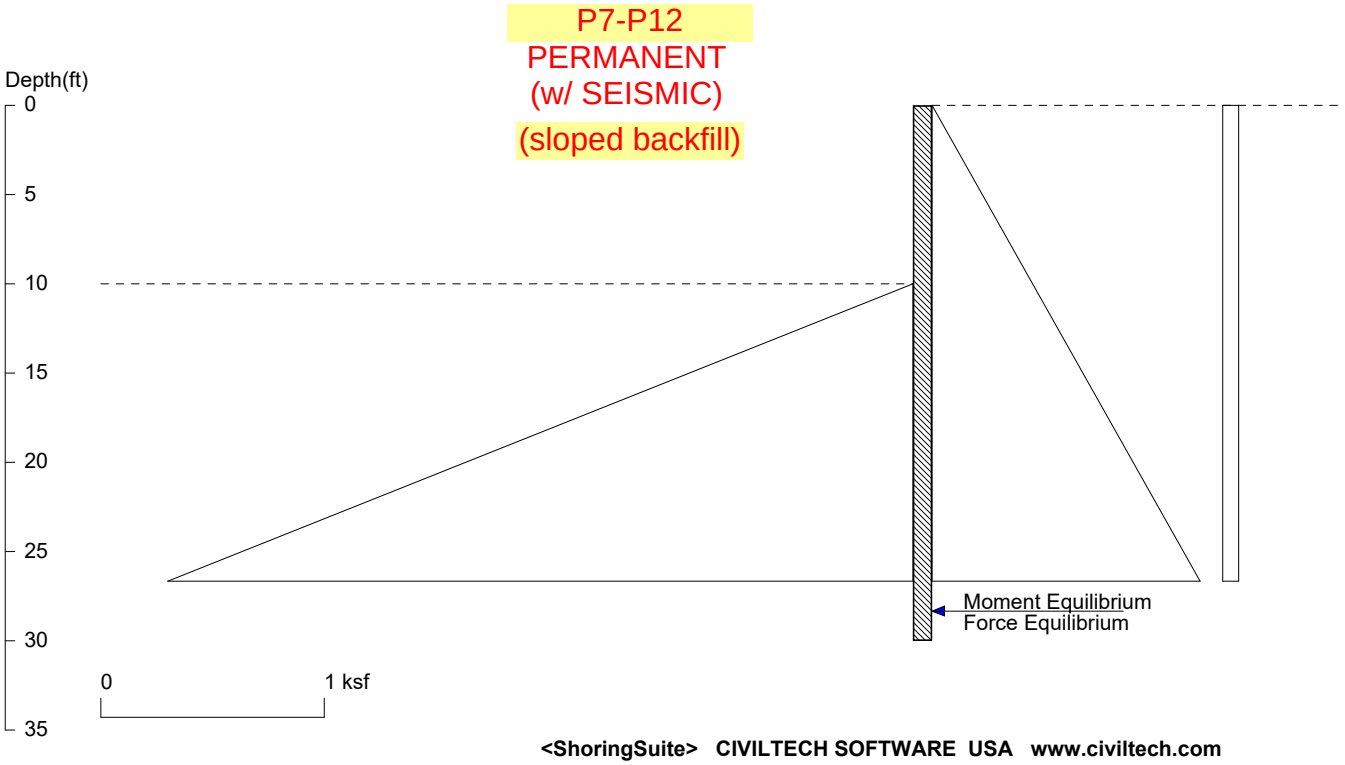


PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.0 foot or meter

User Input Pile, W16X89: E (ksi)=29000.0, I (in4)/pile=1300.0

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\trash wall perm.sh8



Licensed to 4324324234 3424343 Date: 9/10/2021

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\trash wall perm EQK.sh8

Wall Height=10.0 Pile Diameter=2.5 Pile Spacing=7.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=20.01 Min. Pile Length=30.01
MOMENT IN PILE: Max. Moment=250.73 per Pile Spacing=7.0 at Depth=19.26

PILE SELECTION:
Request Min. Section Modulus = 126.6 in3/pile=2075.13 cm3/pile, Fy= 36 ksi = 248 MPa, Fb/Fy=0.66
W16X89 has Section Modulus = 155.0 in3/pile=2539.99 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.72(in) based on E (ksi)=29000.00 and I (in4)/pile=1300.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	100	4.500	.045
*	eqk			
0	.072	100	0.072	0

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
10	0	100	18.00	.2

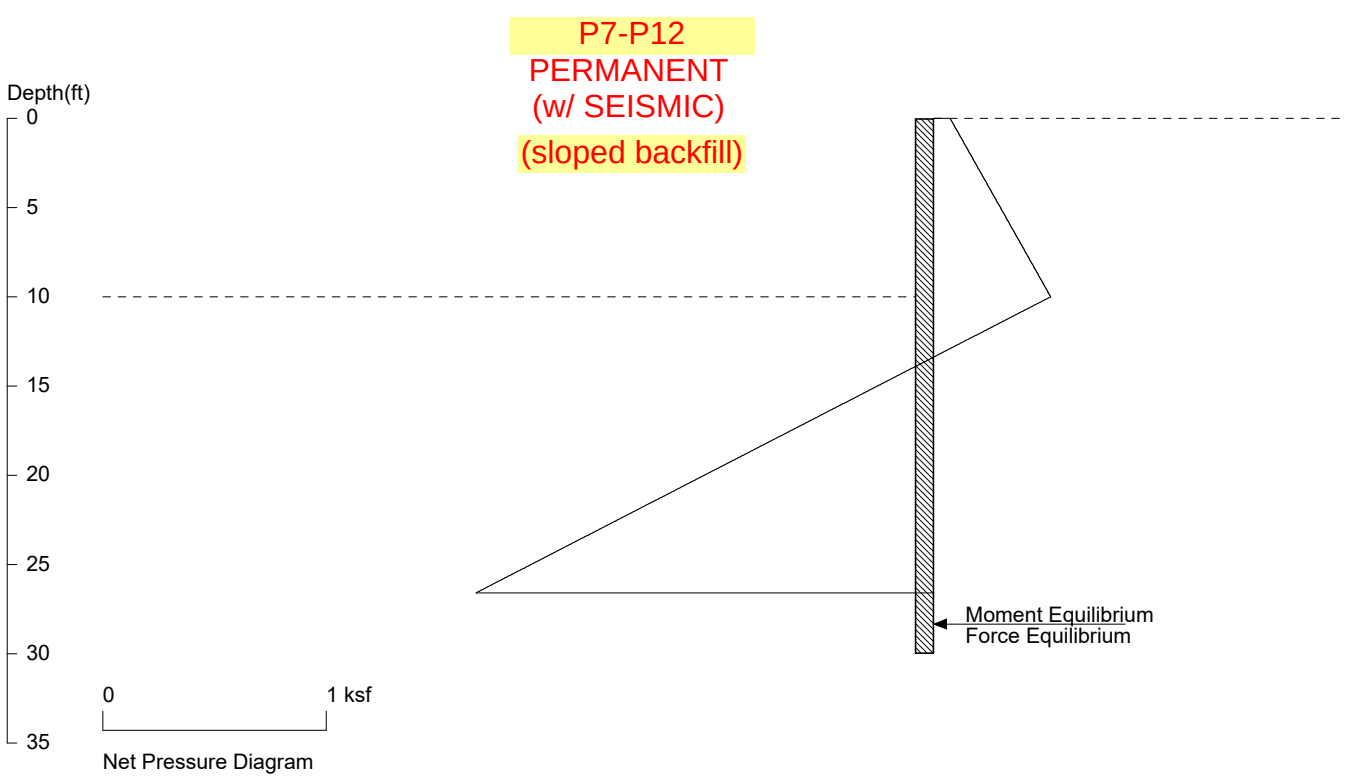
ACTIVE SPACING:

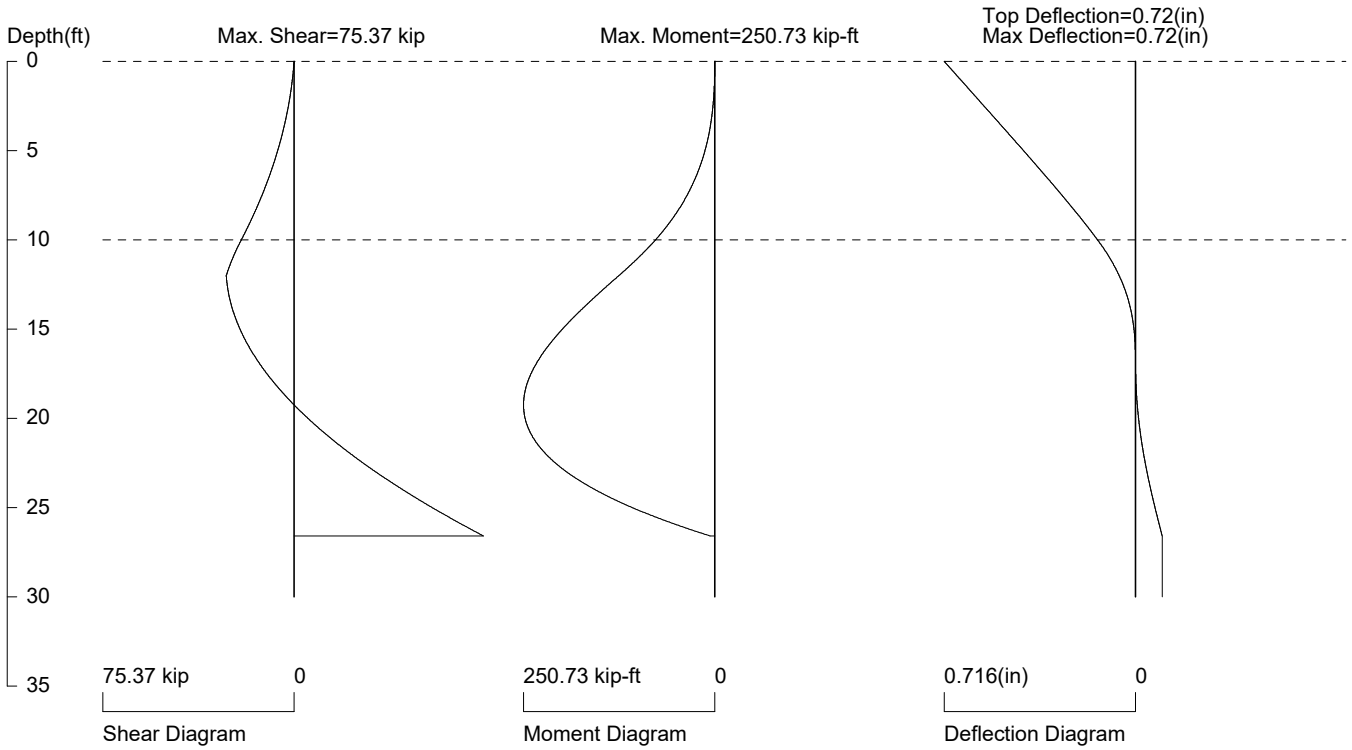
No.	Z depth	Spacing
1	0.00	7.00
2	12.00	2.50

PASSIVE SPACING:

No.	Z depth	Spacing
1	10.00	5.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in





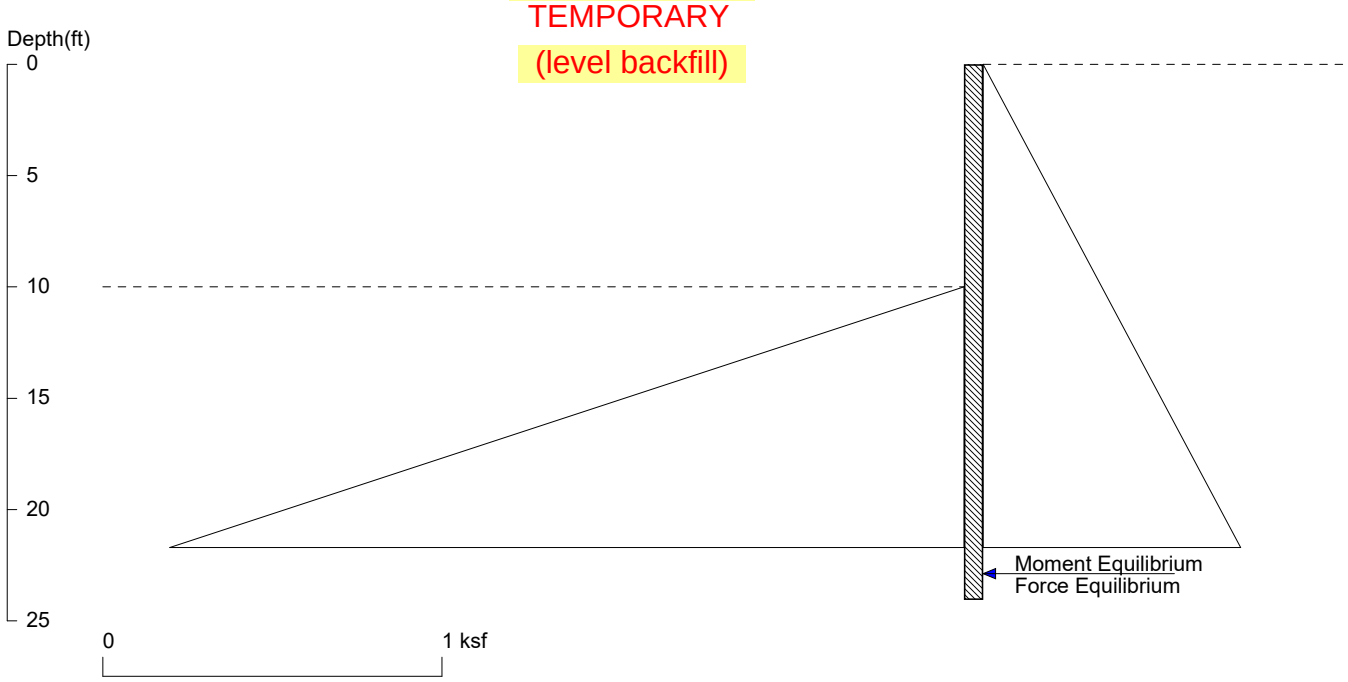
PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.0 foot or meter

User Input Pile, W16X89: E (ksi)=29000.0, I (in4)/pile=1300.0

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\trash wall perm EQK.sh8

P13-P15
TEMPORARY
(level backfill)



Licensed to 4324324234 3424343 Date: 9/10/2021
File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\Temporary basement shoring.sh8

Wall Height=10.0 Pile Diameter=2.5 Pile Spacing=7.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=14.05 Min. Pile Length=24.05
MOMENT IN PILE: Max. Moment=97.36 per Pile Spacing=7.0 at Depth=16.23

PILE SELECTION:
Request Min. Section Modulus = 49.2 in3/pile=805.75 cm3/pile, Fy= 36 ksi = 248 MPa, Fb/Fy=0.66
W16X36 has Section Modulus = 56.5 in3/pile=925.87 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.65(in) based on E (ksi)=29000.00 and I (in4)/pile=448.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	100	3.500	0.035

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
10	0	100	18.00	.2

ACTIVE SPACING:

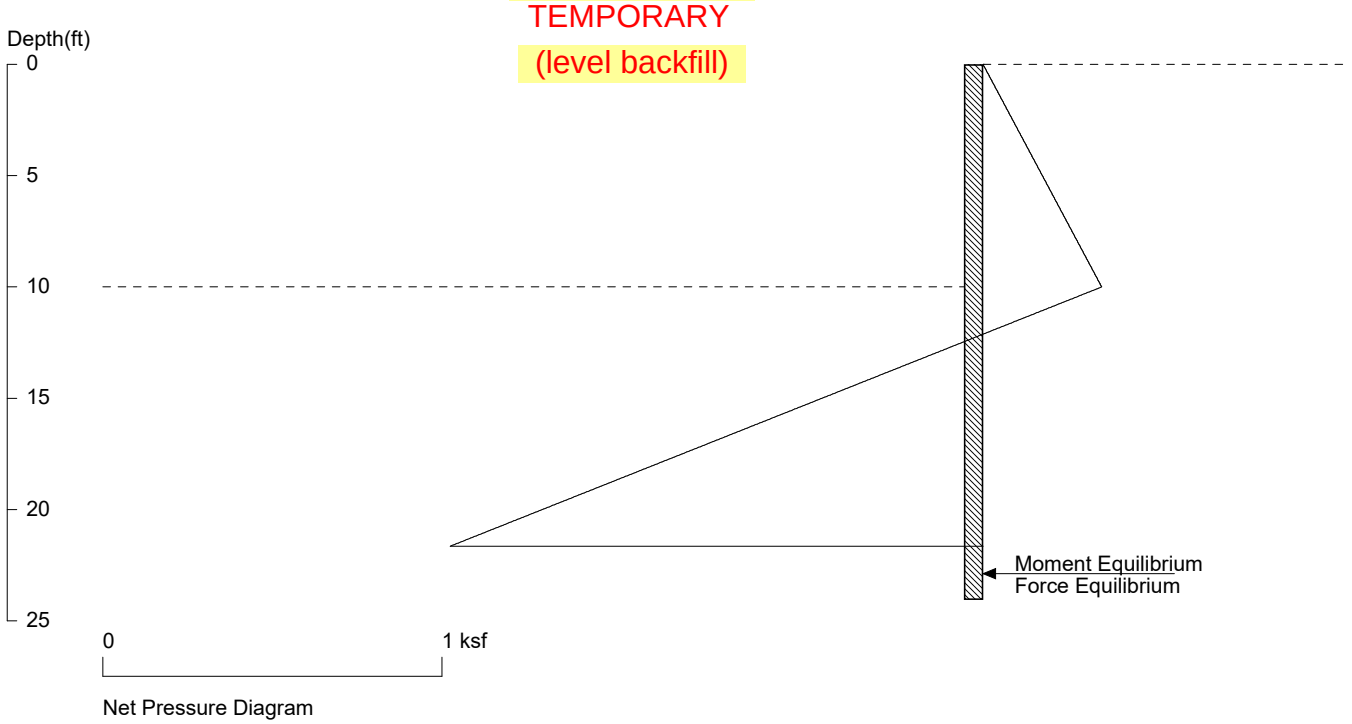
No.	Z depth	Spacing
1	0.00	7.00
2	10.00	2.50

PASSIVE SPACING:

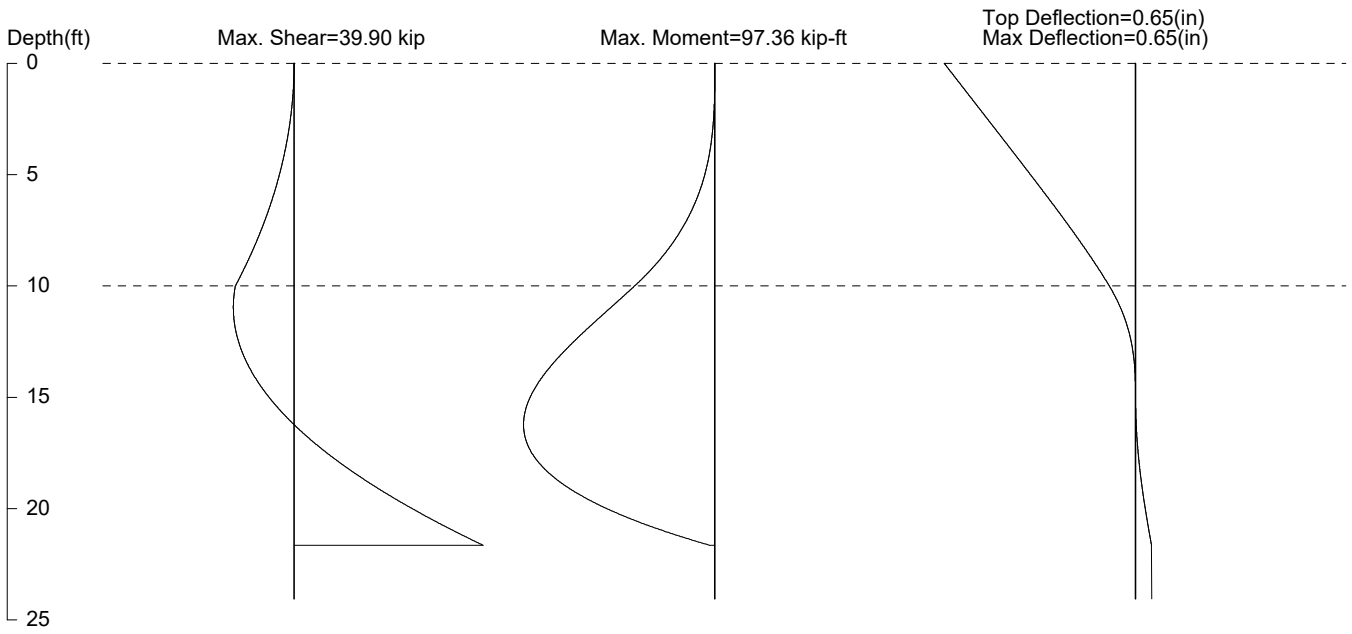
No.	Z depth	Spacing
1	10.00	5.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

P13-P15
TEMPORARY
(level backfill)



Net Pressure Diagram



Shear Diagram | Moment Diagram | Deflection Diagram

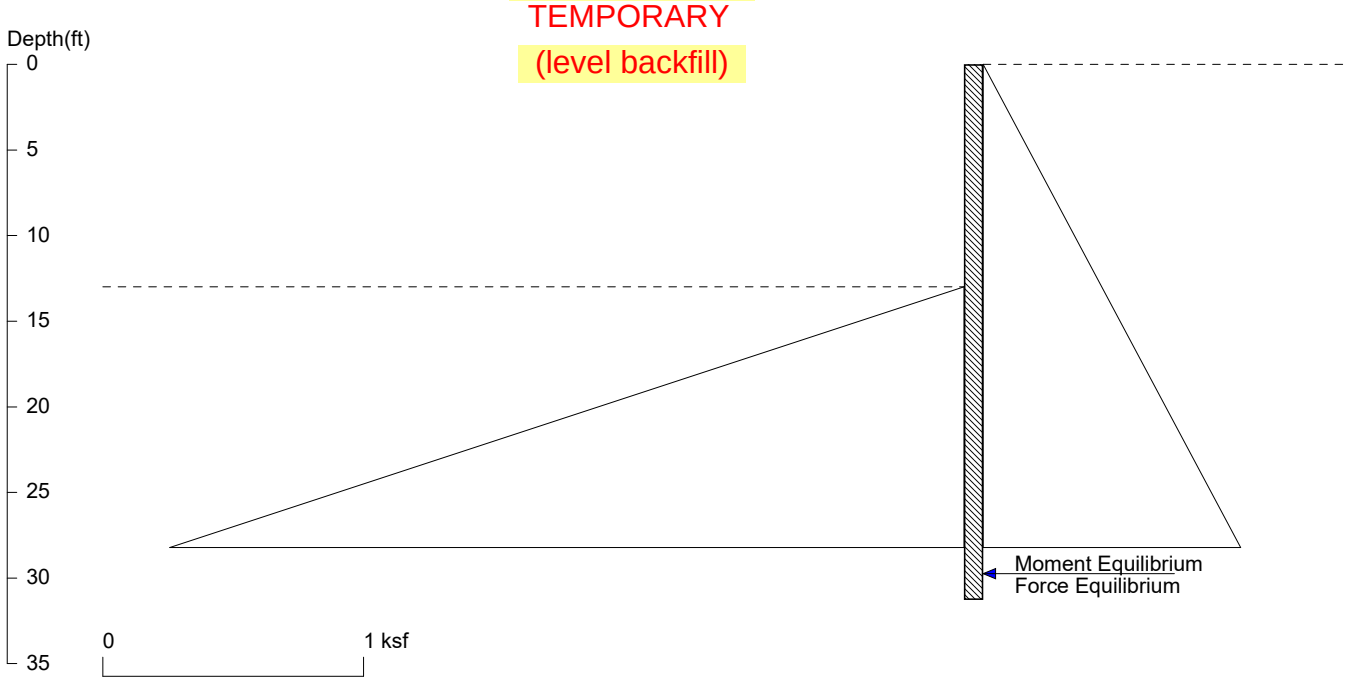
PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.0 foot or meter

User Input Pile, W16X36: E (ksi)=29000.0, I (in4)/pile=448.0

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\Temporary basement shoring.sh8

P16-P20
TEMPORARY
(level backfill)



Licensed to 4324324234 3424343 Date: 9/10/2021
File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\north basement wall_temp.sh8

Wall Height=13.0 Pile Diameter=2.5 Pile Spacing=7.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=18.27 Min. Pile Length=31.27
MOMENT IN PILE: Max. Moment=213.89 per Pile Spacing=7.0 at Depth=21.10

VERTICAL BEARING CAPACITY: Vertical Loading=0.0, Resistance=292.7, Vertical Factor of Safety=999.00

PILE SELECTION:
Request Min. Section Modulus = 108.0 in3/pile=1770.24 cm3/pile, Fy= 36 ksi = 248 MPa, Fb/Fy=0.66
W18X65 has Section Modulus = 117.0 in3/pile=1917.28 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.99(in) based on E (ksi)=29000.00 and I (in4)/pile=1070.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	100	3.500	.035

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
13	0	100	17.40	.2

ACTIVE SPACING:

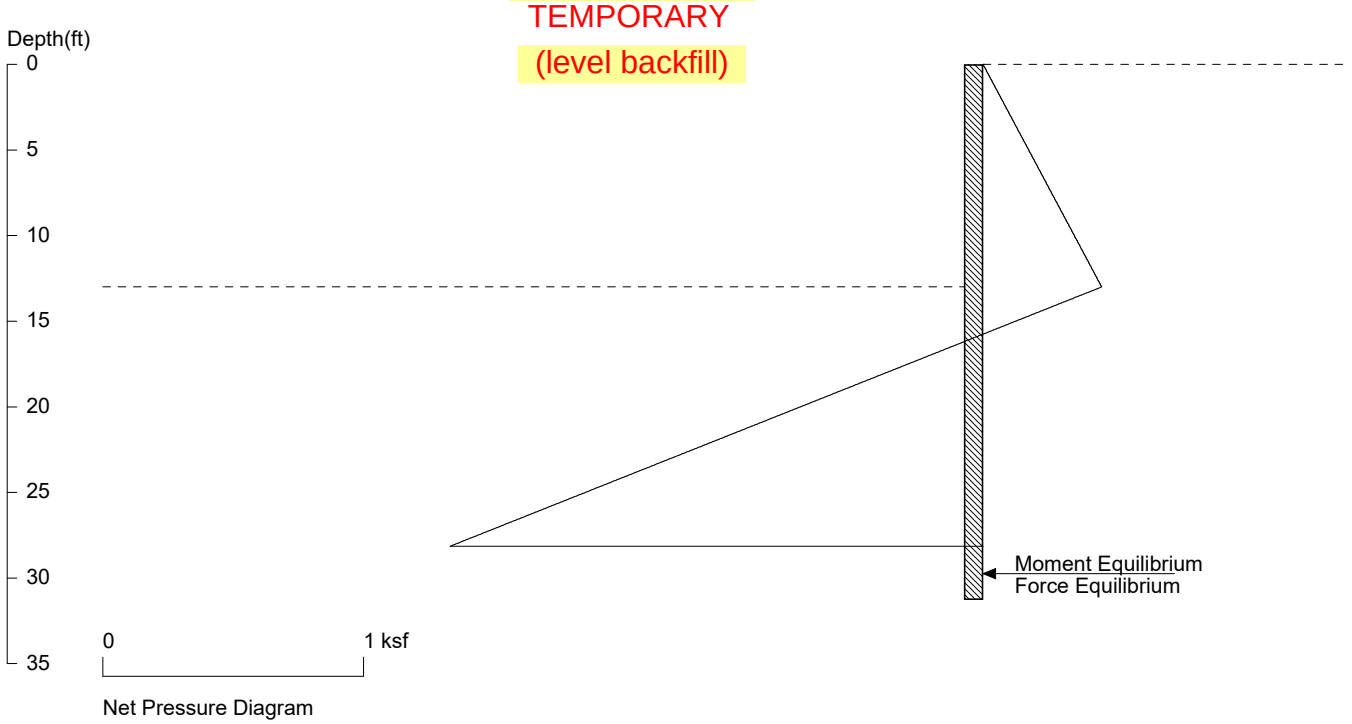
No.	Z depth	Spacing
1	0.00	7.00
2	13.00	2.50

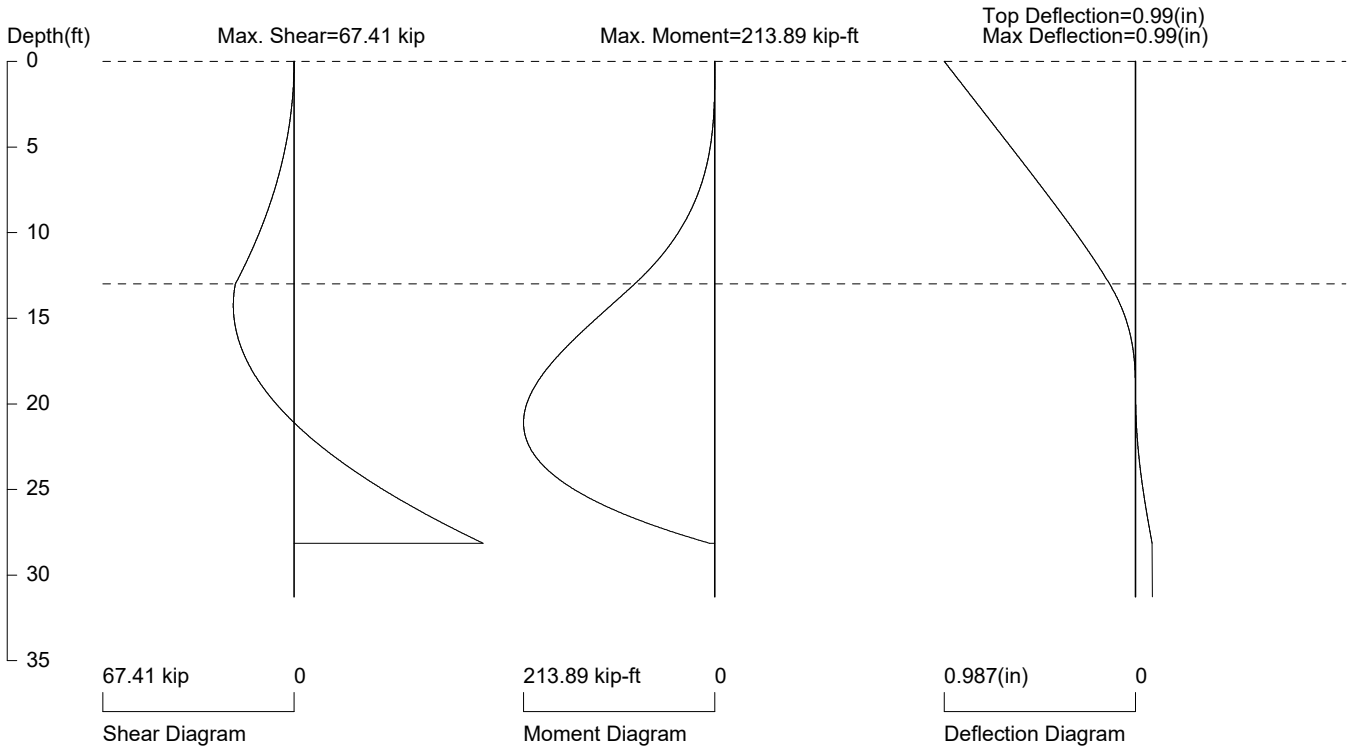
PASSIVE SPACING:

No.	Z depth	Spacing
1	13.00	5.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

P16-P20
TEMPORARY
(level backfill)





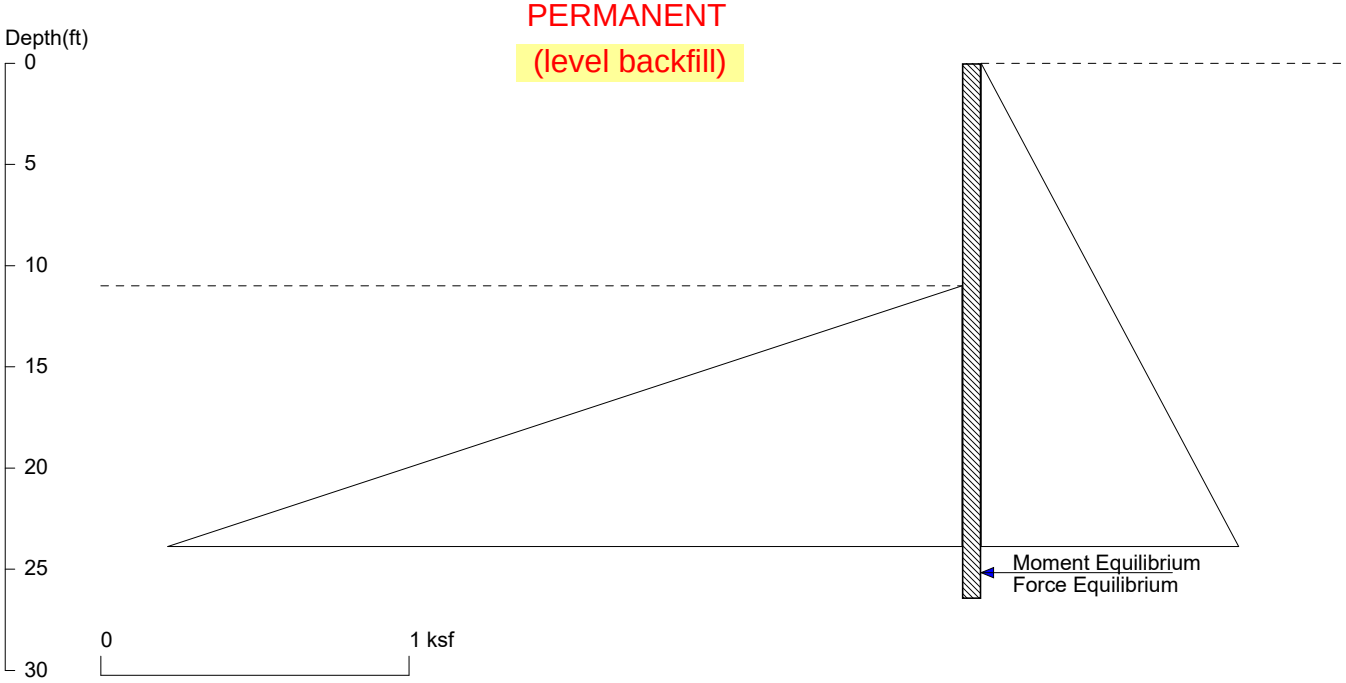
PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.0 foot or meter

User Input Pile, W18X65: E (ksi)=29000.0, I (in4)/pile=1070.0

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\north basement wall_temp.sh8

P16-P20
PERMANENT
(level backfill)



Licensed to 4324324234 3424343 Date: 9/10/2021
File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\north basement wall_perm.sh8

Wall Height=11.0 Pile Diameter=2.5 Pile Spacing=7.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=15.46 Min. Pile Length=26.46
MOMENT IN PILE: Max. Moment=129.58 per Pile Spacing=7.0 at Depth=17.86

VERTICAL BEARING CAPACITY: Vertical Loading=0.0, Resistance=0.2, Vertical Factor of Safety=999.00

PILE SELECTION:
Request Min. Section Modulus = 65.4 in3/pile=1072.46 cm3/pile, Fy= 36 ksi = 248 MPa, Fb/Fy=0.66
W18X65 has Section Modulus = 117.0 in3/pile=1917.28 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.43(in) based on E (ksi)=29000.00 and I (in4)/pile=1070.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	100	3.500	.035

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
11	0	100	17.80	.2

ACTIVE SPACING:

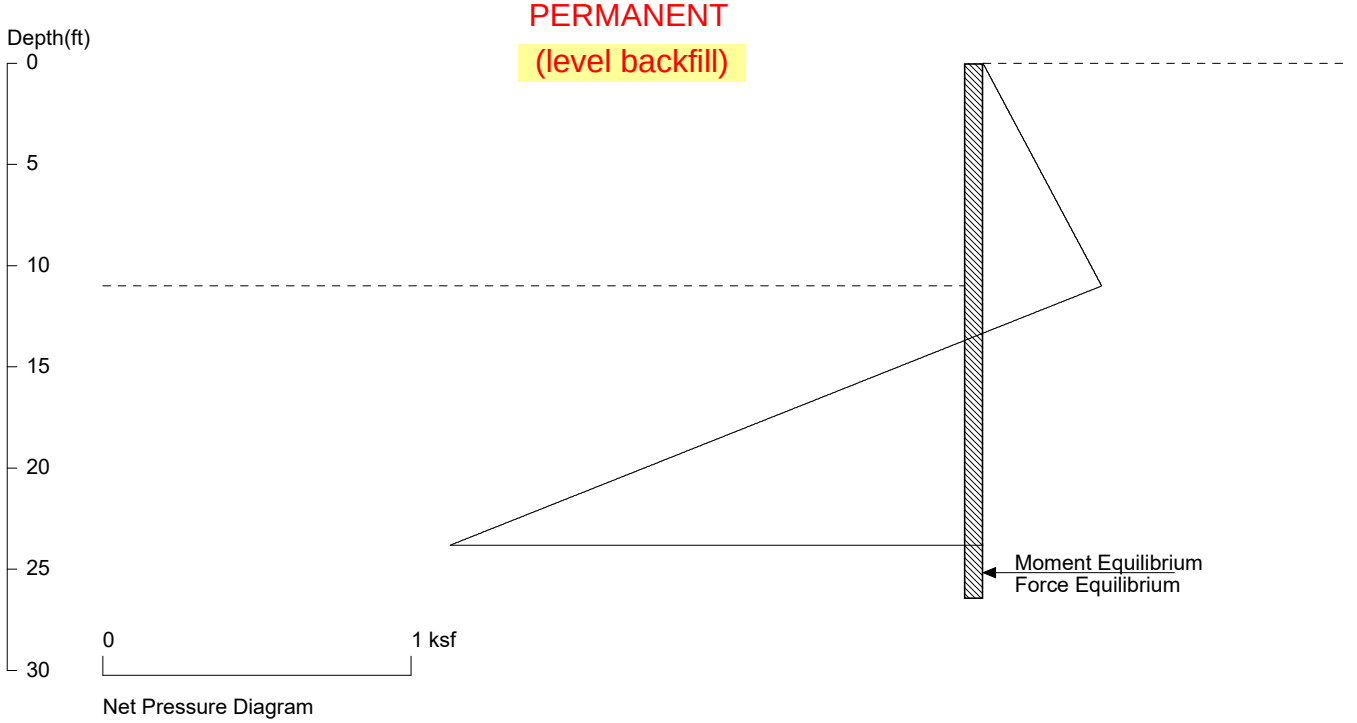
No.	Z depth	Spacing
1	0.00	7.00
2	11.00	2.50

PASSIVE SPACING:

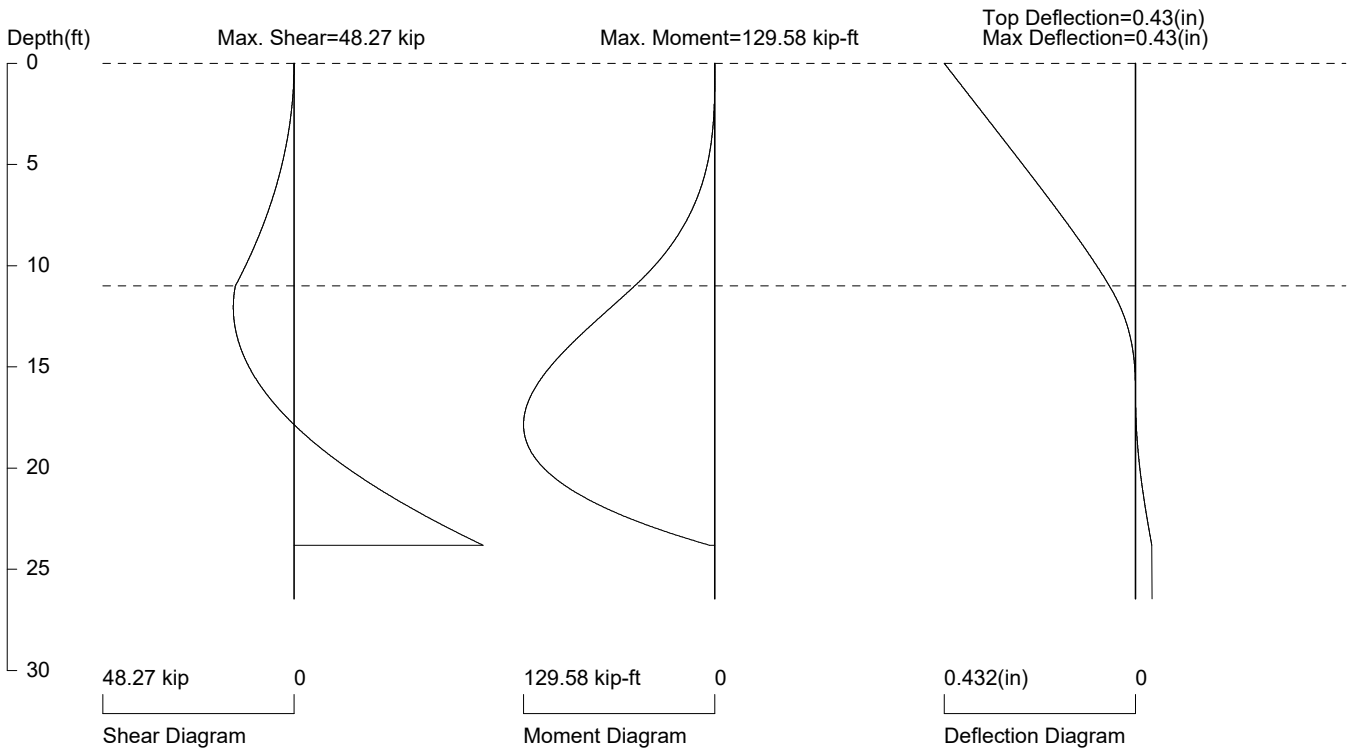
No.	Z depth	Spacing
1	11.00	5.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

P16-P20
PERMANENT
(level backfill)



Net Pressure Diagram



Shear Diagram | Moment Diagram | Deflection Diagram

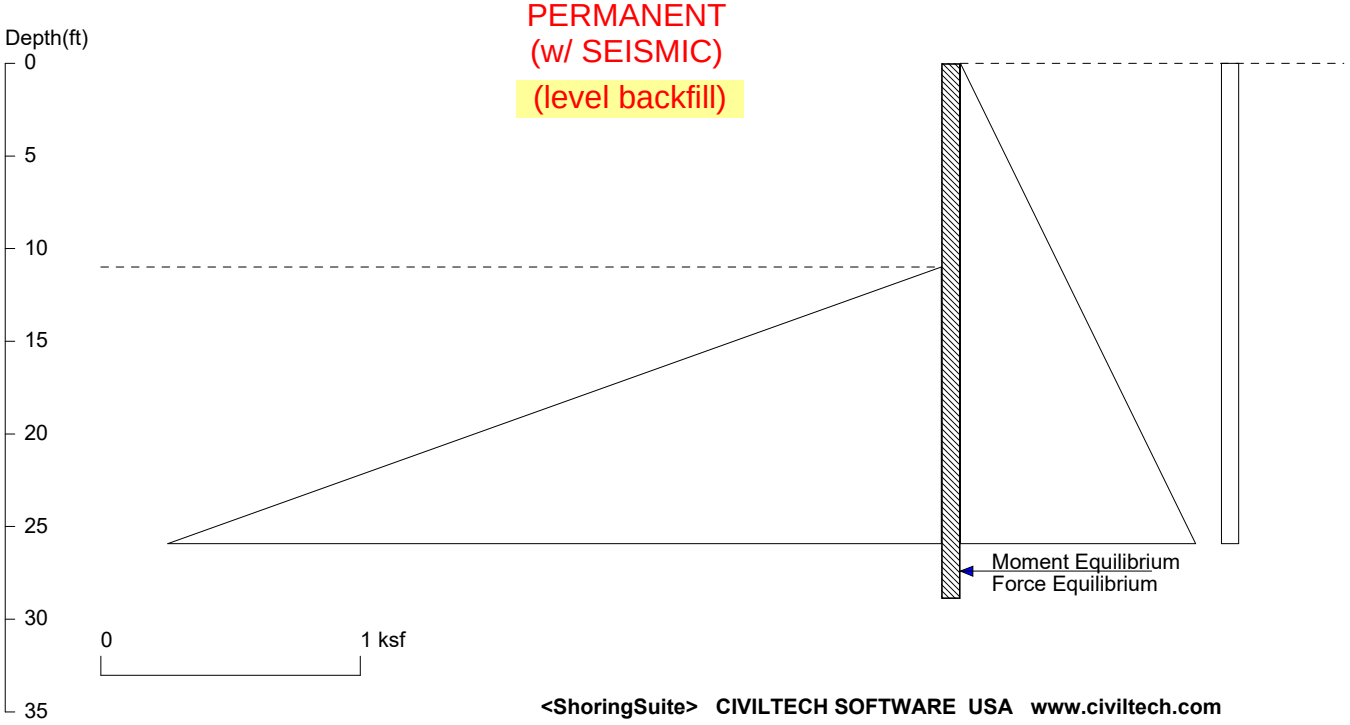
PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.0 foot or meter

User Input Pile, W18X65: E (ksi)=29000.0, I (in4)/pile=1070.0

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\north basement wall_perm.sh8

P16-P20
PERMANENT
(w/ SEISMIC)
(level backfill)



Licensed to 4324324234 3424343 Date: 9/10/2021
File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\north basement wall_perm EQK.sh8

Wall Height=11.0 Pile Diameter=2.5 Pile Spacing=7.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=17.90 Min. Pile Length=28.90
MOMENT IN PILE: Max. Moment=199.76 per Pile Spacing=7.0 at Depth=18.94

VERTICAL BEARING CAPACITY: Vertical Loading=0.0, Resistance=0.2, Vertical Factor of Safety=999.00

PILE SELECTION:
Request Min. Section Modulus = 100.9 in3/pile=1653.23 cm3/pile, Fy= 36 ksi = 248 MPa, Fb/Fy=0.66
W18X65 has Section Modulus = 117.0 in3/pile=1917.28 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.77(in) based on E (ksi)=29000.00 and I (in4)/pile=1070.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	100	3.500	0.035
*	eq			
0	.066	100	0.066	0

PASSIVE PRESSURES:

Z1	P1	Z2	P2	Slope
11	0	100	17.80	.2

ACTIVE SPACING:

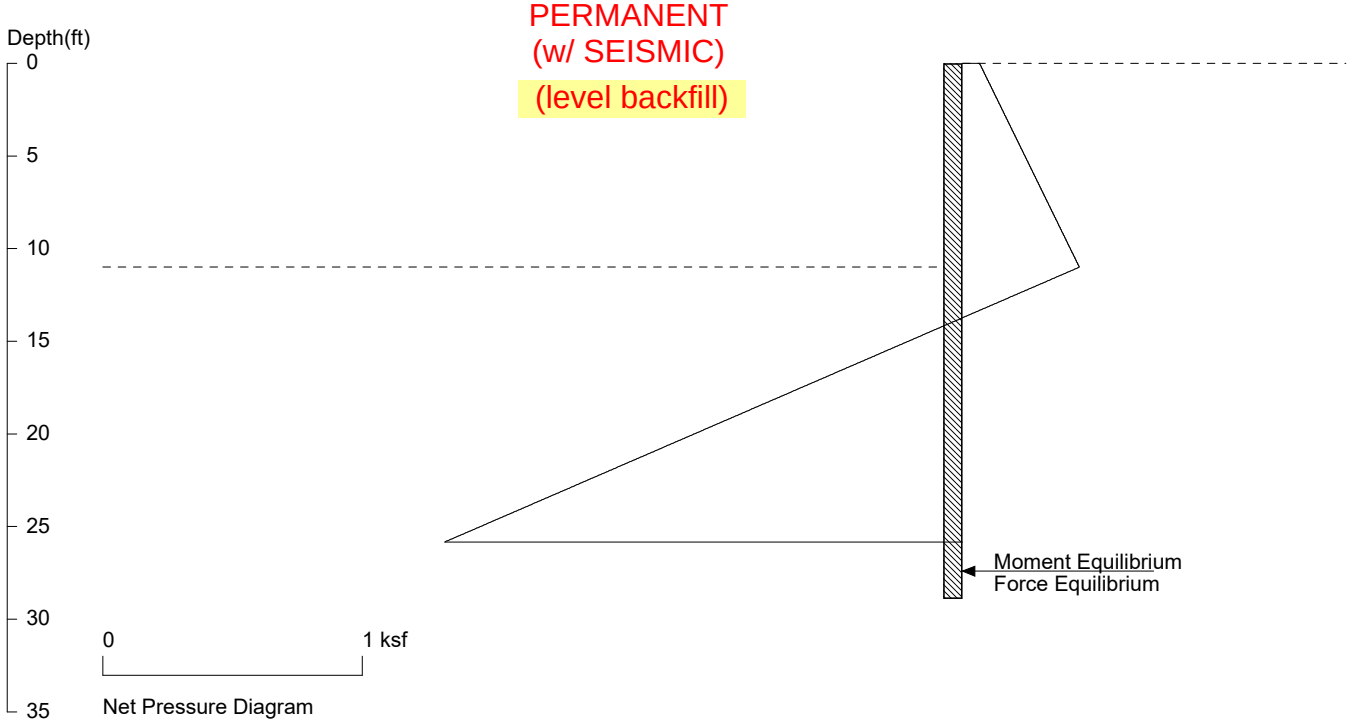
No.	Z depth	Spacing
1	0.00	7.00
2	11.00	2.50

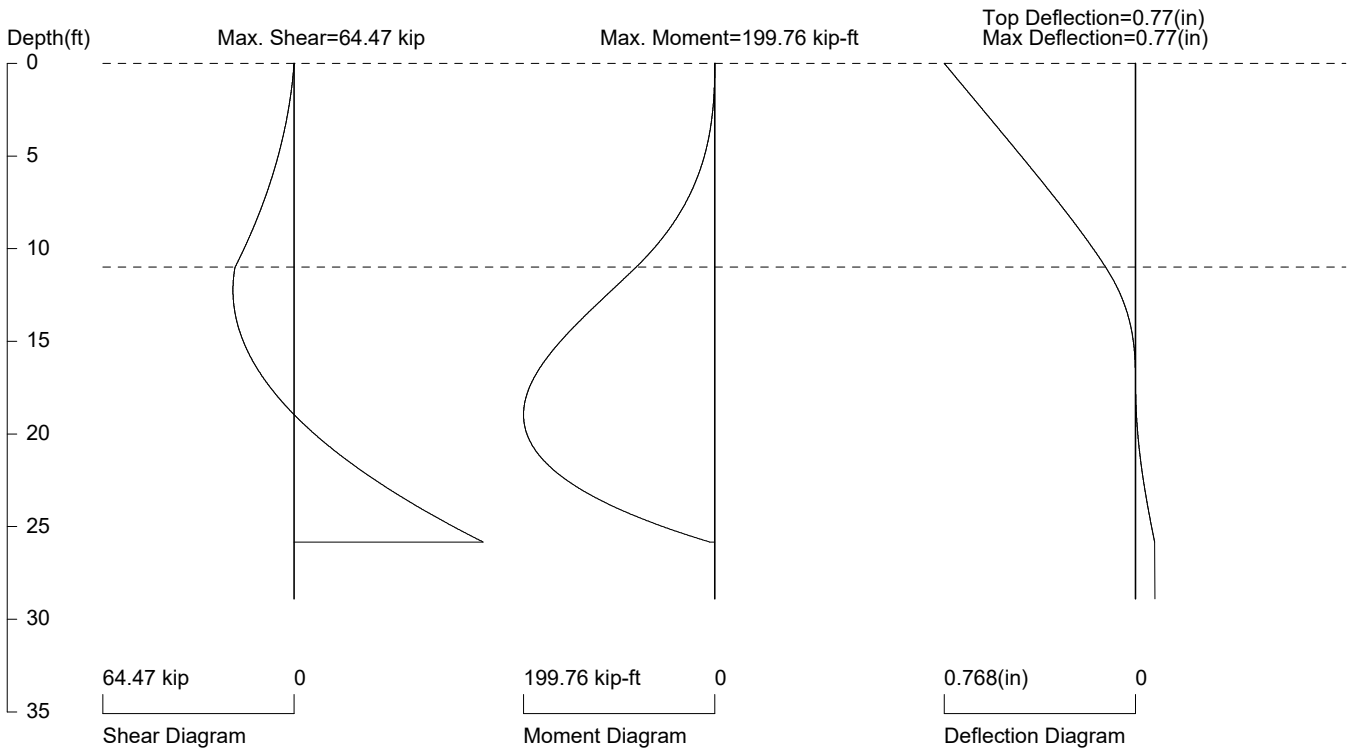
PASSIVE SPACING:

No.	Z depth	Spacing
1	11.00	5.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in

P16-P20
PERMANENT
(w/ SEISMIC)
(level backfill)





PRESSURE, SHEAR, MOMENT, AND DEFLECTION DIAGRAMS

Based on pile spacing: 7.0 foot or meter

User Input Pile, w18x65: E (ksi)=29000.0, I (in4)/pile=1070.0

File: K:\2021\01519-2021-06 Huber Residence\Calcs\shoring\north basement wall_perm EQK.sh8

Concrete Lagging Design

Ver 1.4

Reinforced Concrete Beams (ACI 318-2005)

Ultimate Forces:

Mu	2.56	kip-ft
Vu	1.28	kips
Pu	0.0	kips

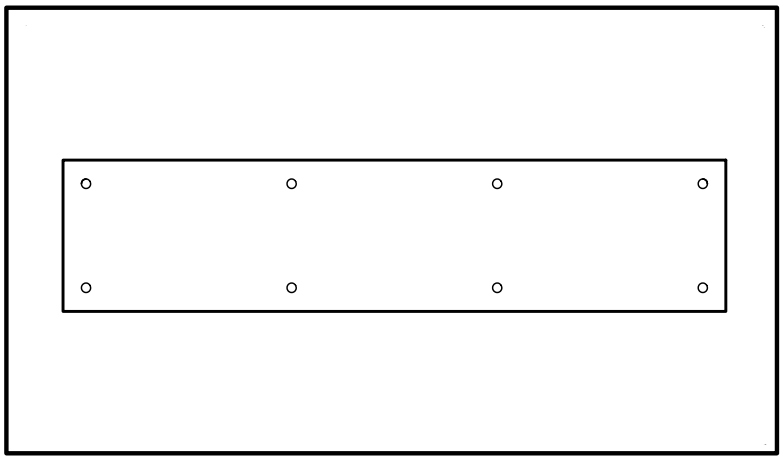
Beam ID:	**Lagging**
Project:	Huber Shoring
Date:	03/10/22
Engineer :	DMR

Reinforcement Summary

1 LAYER OF (4) #4 TENSION

Geometry:

Length	8	ft
Width	36	in
Height	8	in
Fixity Type	Pin-Pin	
Member Type	Beam	
T-Beam Slab	0	in
B,flange	0.0	auto or in
b,eff	36.0	in



Concrete:

F'c	2500	psi
β_1	0.850	
Ec	2850	ksi

Steel:

Fy	60	ksi
Es	29000	ksi
Inter-Layer Clearance	1	in
Bottom Cover	1.0	in
Side Cover	1	in
Consider ρ'	No	
As' Location	Web	

"Compression" REINF	Count	Bar Number	Depth to bar	As / bar	As / Layer	d	Diameter	Horiz Clr	Spacing Check
Extreme-most Layer	4	4	auto	0.20	0.80	1.25	0.500	10.66	(OK)
2nd Layer	0	0	auto	0.00	0.00	0.00	0.000	n/a	
3rd Layer	0	0	auto	0.00	0.00	0.00	0.000	n/a	
4th Layer	0	0	auto	0.00	0.00	0.00	0.000	n/a	
Tension REINF									
4th Layer	0	0	auto	0.00	0.00	0.00	0	n/a	
3rd Layer	0	0	auto	0.00	0.00	0.00	0	n/a	
2nd Layer	0	0	auto	0.00	0.00	0.00	0	n/a	
Extreme-most Layer	4	4	auto	0.20	0.80	6.75	0.5	10.66	(OK)
			in or auto	in^2	in^2	in	in	in	

Global:

d	6.75	in		d'	1.25 in
As	0.80	in^2		As'	0.80 in^2
As min	0.81	in^2	N/A	ρ (rho)	0.33 %

Internal Axial Forces:

Equilibrate Section Macro

s,max	11.94	in	(OK)
c	0.74	in	
Extreme Fiber εs	0.0244		
ϕ	0.90	Tension Controlled	
Mn	26	kip-ft	
ϕMn	**23.17**	kip-ft	
Mu	**2.56**	kip-ft	(OK)

Strain Compatibility - Axial Force Equilibrium - Moment Capacity

Layer	depth (in)	strain	stress (ksi)	Area (in^2)	Force (kips)	Moment (k-in)
Comp Web	0.31	0.00300	2.13	22.59	48	- - -
Comp Flange						
As'1						
As'2						
As'3						
As'4						
As4						
As3						
As2						
As1	6.75	-0.02443	-60.00	0.8	-48	309
				Σ	0.00	309

Transverse Shear REINF — Shear Reinf is not required per 11.5.6.1

Fy	60	ksi
Transverse Bar Mark	0	
Spacing,$_T$	6	in
# Legs,$_T$	2	
A_{VT}/layer	0.00	in^2

Longitudinal Skin REINF

Required?	No	
Maximum Spacing		in
Side Bars	0	mark
Number of Side Bar Pairs	0	# or "Above"
Spacing,$_L$	N/A	in

Shear:

Vn,max	122 kips	=	10.00*sqrt(f'c)*bw*d
Vc	24 kips	=	2.00*sqrt(f'c)*bw*d
Vs	0 kips	=	0.00*sqrt(f'c)*bw*d
ϕVn	**18.23** kips		
Vu	**1.28** kips		(OK)

Deflections:

L/h max	16	No Deflection Calculations Req'd	
L/h actual	12		
Check Anyway	Yes		
L/Δ Limit	360		
Ma, DL	2	ft-kip	
Ma, DL+LL	3	ft-kip	
Loading Type	Distributed		
Ec	2850	ksi	
Ie DL	1536	in^4	
Ie DL+LL	1536	in^4	
Δ DL	0.005	in	0.005 in
Δ DL+LL	0.007	in	0.007 in

Auto-Calculated Deflections:

Allowed Deflection	**0.27**	in (OK)
Total Long Term Deflection	**0.02**	in

fr	375	psi		
b,eff	36	in		
Ig	1536	in^4		
Mcr	12.0	ft-kip		
n	10.18			
Ac,d	243	in^2		
Icrack	265	in^4		
ρ'	0.00329			
λ	1.72			
Slab Depth	0	in		
Compression Zone Entirely W/in Slab?	No			

Uncracked Ixx Calculation

	Beam	Slab	
Ybar	4.00	0.00	in
Area	288	0	in^2
A*Ybar	1152	0	in^3
Ybar,G	4.00	in	
Iself	1536	0	in^4
AY^2+Iself	1536	0	in^4
I,gross		1536	in^4

Cracked Moment of Inertia Calculation

	Beam	Slab	Top Steel	Bottom Steel	
Ybar /c	0.50	0.00	1.00	1.00	in
Ybar	0.00	0.00	-1.25	-6.75	in
Area /c	36.00	0.00	0.00	0.00	in^2
Area	0.00	0.00	7.34	8.14	in^2
A*Ybar /c^2	18.00	0.00	0.00	0.00	in^3
A*Ybar /c	0.00	0.00	7.34	8.14	in^3
A*Ybar	0.00	0.00	-9.18	-54.95	in^3
c	1.51	in			
Ybar	0.75	0.00	0.26	-5.24	in
Area	54.21	0.00	7.34	8.14	in^2
Iself	10	0	---	---	in^4
AY^2	31	0	0	224	in^4
Icrack				265	in^4

Icrack/Igross 17%