

# ***ADDENDUM STRUCTURAL CALCS***

Kumar Residence  
4034 85th Ave SE  
Mercer Island, WA



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Project: Kumar Residence (4034 85th Ave SE)

By: JDA

Proj No: 187-2020

Date: 1/4/2022

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### Summary

See page 2 for lateral design of canopy structure. Lateral force is resisted by cantilevered by six timber columns, in two rows of three. Middle columns each take 20.83% of total load (652#) , and end columns take 14.56% (456#) of total load applied at top of column (6'-10.5"). Resulting moments (4,483 lb-ft and 3,138 lb-ft) are resisted by 8x8 DF columns with MPB88Z column based embedded into foundation wall. Columns have an  $S=70.3125$  cu-in, resulting in a maximum moment of 766 psi, which is less than 1000 psi minimum bending stress.

See pages 3 - 8 for framing design. Use GL 3.5x10.5 perimeter beams. Download on column is very minimal, can see from inspection combined bending and compression is OK.

Partial height retaining walls shall be constructed per detail 7/S3.1. At 8x8 column locations, provide 20"x20" pilaster with (8)#5 verticals and #3 ties @ 4" o.c to ensure 6" minimum cover on embedded column base is provided.

See pages 9 - 15 for retaining wall calculations.



Subject: Calculation Overview

Project: Kumar Residence

Client: CenterLine

Project No.: 187-2020

Date: 1/4/2022

Project: 4034 85th Ave SE  
 Proj No: 187-2021

By: JDA  
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R	1.5		ASCE 7-16 Table 12.2-1
$\Omega_0$	1.5		
$C_d$	1.5		
V	3.1	Kips	= $C_s W$ - ASCE 7-16 (12.8-1)
$C_s$	0.754		
	0.754		= $S_{ds} / (R/I_e)$ - ASCE 7-16 (12.8-2)
	3.713		< $S_{d1} / T(R/I_e)$ - if $T < T_L$ , ASCE 7-16 (12.8-3)
	-		< $S_{d1} T_L / T_2(R/I_e)$ - if $T > T_L$ , ASCE 7-16 (12.8-3)
	0.050		> $0.044 S_{ds} I_e$ - ASCE 7-16 (12.8-5)
	0.01		> $0.01$ - ASCE 7-16 (12.8-5)
	-		> $0.5 S_1 / (R/I_e)$ - if $S_1 > 0.6g$ , ASCE 7-16 (12.8-6)
W	4	Kips	
$I_e$	1		ATC Hazard
$F_v$	1.892		Table 11.4-2 and Section 11.4.8 Exception
$F_a$	1.2		ATC Hazard
$S_S$	1.414	g	ATC Hazard
$S_1$	0.492	g	ATC Hazard
$S_{MS}$	1.697	g	ATC Hazard
$S_{M1}$	0.930864	g	= $F_a S_1$ - ASCE 7-16 (11.4-1)
$S_{DS}$	1.131	g	ATC Hazard
$S_{D1}$	0.620576	g	= $2/3 S_{M1}$ - ASCE 7-16 (11.4-4)
$S_{DC}$	D		
$T_a$	0.111	seconds	= $C_{thx}$ - ASCE 7-16 (12.8-7)
$C_t$	0.02		ASCE 7-16 Table 12.8-2
$h_n$	9.88	feet	
x	0.75		ASCE 7-16 Table 12.8-2
$T_L$	6	seconds	USGS Seismic Values
$T_S$	0.549	seconds	= $S_{D1} / S_{MS}$ , ASCE 7-16 (11.4-3)
$1.5T_S$	0.823	seconds	



## ATC Hazards by Location

### Search Information

**Address:** 4034 85th Ave SE, Mercer Island, WA 98040, USA  
**Coordinates:** 47.5734906, -122.2252591  
**Elevation:** 326 ft  
**Timestamp:** 2021-07-26T04:34:38.783Z  
**Hazard Type:** Seismic  
**Reference Document:** ASCE7-16  
**Risk Category:** II  
**Site Class:** D-default

### Basic Parameters

Name	Value	Description
$S_S$	1.414	$MCE_R$ ground motion (period=0.2s)
$S_1$	0.492	$MCE_R$ ground motion (period=1.0s)
$S_{MS}$	1.697	Site-modified spectral acceleration value
$S_{M1}$	* null	Site-modified spectral acceleration value
$S_{DS}$	1.131	Numeric seismic design value at 0.2s SA
$S_{D1}$	* null	Numeric seismic design value at 1.0s SA

\* See Section 11.4.8

### Additional Information

Name	Value	Description
SDC	* null	Seismic design category
$F_a$	1.2	Site amplification factor at 0.2s
$F_v$	* null	Site amplification factor at 1.0s
$CR_S$	0.902	Coefficient of risk (0.2s)
$CR_1$	0.897	Coefficient of risk (1.0s)
PGA	0.605	$MCE_G$ peak ground acceleration
$F_{PGA}$	1.2	Site amplification factor at PGA
$PGA_M$	0.726	Site modified peak ground acceleration
$T_L$	6	Long-period transition period (s)
$SsRT$	1.414	Probabilistic risk-targeted ground motion (0.2s)
$SsUH$	1.567	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
$SsD$	3.618	Factored deterministic acceleration value (0.2s)
$S1RT$	0.492	Probabilistic risk-targeted ground motion (1.0s)
$S1UH$	0.548	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
$S1D$	1.445	Factored deterministic acceleration value (1.0s)
PGAd	1.233	Factored deterministic acceleration value (PGA)

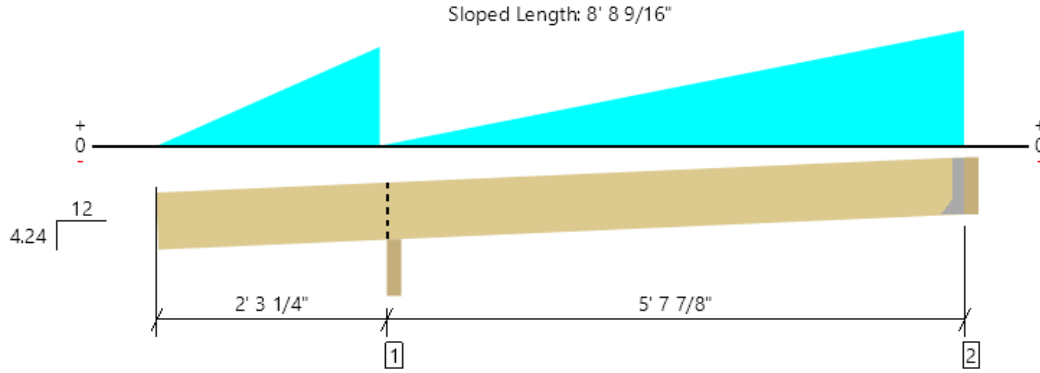
\* See Section 11.4.8

Level			
Member Name	Results	Current Solution	Comments
Hip Truss	Passed		
Hip Master Truss	Passed		
Roof: Drop Beam	Passed	1 piece(s) 3 1/2" x 12" 24F-V4 DF Glulam	
Roof: Drop Beam	Passed	1 piece(s) 3 1/2" x 10 1/2" 24F-V4 DF Glulam	
Free Standing Post	Passed	1 piece(s) 8 x 8 SP No.1	

ForteWEB Software Operator	Job Notes
Javid Abdi Atlas Consulting Engineers (206) 427-7233 javiddabdi@yahoo.com	



Level, Hip Truss



All locations are measured from the outside face of left support (or left cantilever end). All dimensions are horizontal.

Member Length : 8' 8 1/8"

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	213 @ 7' 11 1/8"	3281 (1.50")	Passed (6%)	--	1.0 D + 1.0 S (Alt Spans)
Shear (lbs)	135 @ 3' 3 7/16"	4468	Passed (3%)	1.15	1.0 D + 1.0 S (All Spans)
Moment (Ft-lbs)	214 @ 5' 9 1/16"	5740	Passed (4%)	1.15	1.0 D + 1.0 S (Alt Spans)
Live Load Defl. (in)	0.002 @ 5' 4"	0.292	Passed (L/999+)	--	1.0 D + 1.0 S (Alt Spans)
Total Load Defl. (in)	0.003 @ 5' 4 9/16"	0.390	Passed (L/999+)	--	1.0 D + 1.0 S (Alt Spans)

System : Roof  
 Member Type : Flush Beam  
 Building Use : Residential  
 Building Code : IBC 2015  
 Design Methodology : ASD  
 Member Pitch : 4.24/12

- Deflection criteria: LL (L/240) and TL (L/180).
- Overhang deflection criteria: LL (2L/240) and TL (2L/180).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Snow	Total	
1 - Beveled Plate - SPF	3.50"	3.50"	1.50"	138	143	281	Blocking
2 - Hanger on 9 1/4" SPF beam	3.50"	Hanger <sup>1</sup>	1.50"	86	126	212	See note <sup>1</sup>

- Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.
- At hanger supports, the Total Bearing dimension is equal to the width of the material that is supporting the hanger
- <sup>1</sup> See Connector grid below for additional information and/or requirements.

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	8' 5" o/c	
Bottom Edge (Lu)	8' 5" o/c	

- Maximum allowable bracing intervals based on applied load.

Connector: Simpson Strong-Tie							
Support	Model	Seat Length	Top Fasteners	Face Fasteners	Member Fasteners	Accessories	
2 - Face Mount Hanger	LSSR410Z	1.88"	N/A	22-16dx2.5	18-16dx2.5		

- Refer to manufacturer notes and instructions for proper installation and use of all connectors.

Vertical Loads	Location (Side)	Tributary Width	Dead (0.90)	Snow (1.15)	Comments
0 - Self Weight (PLF)	0 to 7' 11 1/8"	N/A	8.2	--	
1 - Tapered (PLF)	0 to 2' 3 1/4"	N/A	0.0 to 35.9	0.0 to 56.7	Generated from Roof Geometry
2 - Tapered (PLF)	2' 3 1/4" to 7' 11 1/8"	N/A	0.0 to 37.5	0.0 to 70.7	Generated from Roof Geometry

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The product application, input design loads, dimensions and support information have been provided by ForteWEB Software Operator

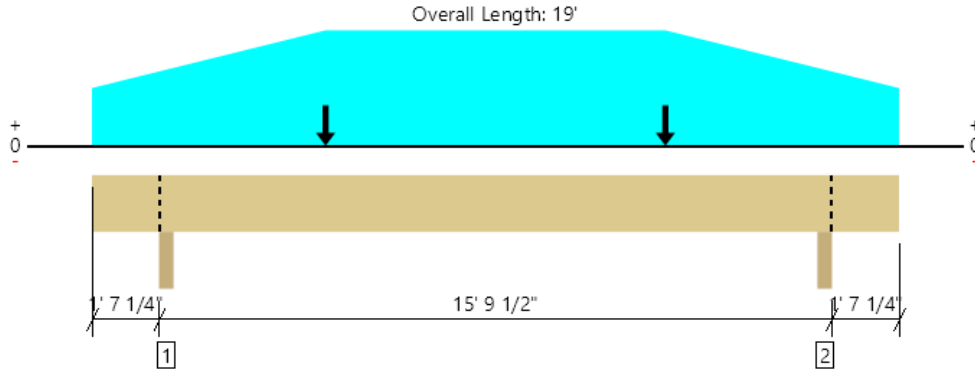
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File Name: Kumar Cabana

Level, Hip Master Truss



All locations are measured from the outside face of left support (or left cantilever end). All dimensions are horizontal.

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	1653 @ 1' 9"	7656 (3.50")	Passed (22%)	--	1.0 D + 1.0 S (Adj Spans)
Shear (lbs)	1354 @ 16' 4"	4468	Passed (30%)	1.15	1.0 D + 1.0 S (Adj Spans)
Moment (Ft-lbs)	5826 @ 9' 6"	5740	Passed (102%)	1.15	1.0 D + 1.0 S (Alt Spans)
Live Load Defl. (in)	0.373 @ 9' 6"	0.775	Passed (L/498)	--	1.0 D + 1.0 S (Alt Spans)
Total Load Defl. (in)	0.646 @ 9' 6"	1.033	Passed (L/288)	--	1.0 D + 1.0 S (Alt Spans)

System : Roof  
 Member Type : Drop Beam  
 Building Use : Residential  
 Building Code : IBC 2015  
 Design Methodology : ASD  
 Member Pitch : 0/12

- Deflection criteria: LL (L/240) and TL (L/180).
- Overhang deflection criteria: LL (2L/240) and TL (2L/180).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Snow	Total	
1 - Beam - GLB	3.50"	3.50"	1.50"	710	943	1653	Blocking
2 - Beam - GLB	3.50"	3.50"	1.50"	710	943	1653	Blocking

• Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	6" o/c	
Bottom Edge (Lu)	19' o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Tributary Width	Dead (0.90)	Snow (1.15)	Comments
0 - Self Weight (PLF)	0 to 19'	N/A	8.2	--	
1 - Uniform (PSF)	5' 6" to 13' 6" (Top)	2' 1/8"	16.8	25.0	Default Load
2 - Tapered (PSF)	0 to 5' 6" (Top)	0 to 2' 1/8"	16.8	25.0	Default Load
3 - Tapered (PSF)	13' 6" to 19' (Top)	2' 1/8" to 0	16.8	25.0	Default Load
4 - Uniform (PSF)	0 to 19' (Top)	2'	16.8	25.0	Default Load
5 - Point (lb)	13' 6" (Front)	N/A	86	126	Linked from: Roof: Hip/Valley Beam, Support 2
6 - Point (lb)	5' 6" (Front)	N/A	86	126	Linked from: Roof: Hip/Valley Beam, Support 2

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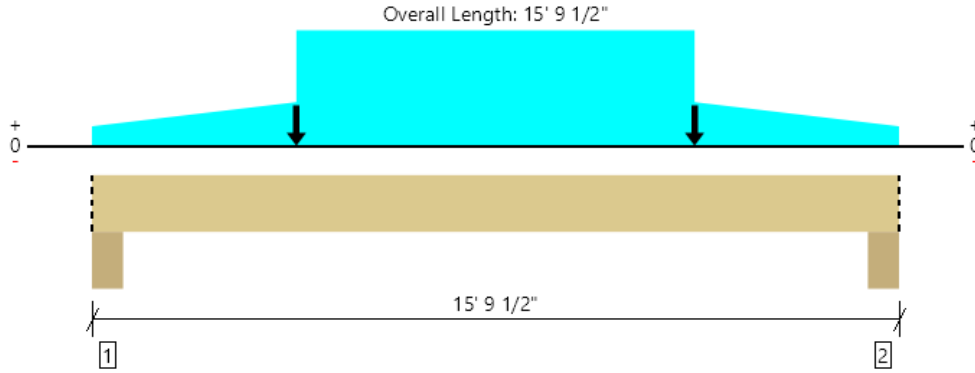
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The product application, input design loads, dimensions and support information have been provided by ForteWEB Software Operator

ForteWEB Software Operator	Job Notes
Javid Abdi Atlas Consulting Engineers (206) 427-7233 javiddabdi@yahoo.com	



Level, Roof: Drop Beam  
 1 piece(s) 3 1/2" x 12" 24F-V4 DF Glulam



All locations are measured from the outside face of left support (or left cantilever end). All dimensions are horizontal.

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	3713 @ 6"	17063 (7.50")	Passed (22%)	--	1.0 D + 1.0 S (All Spans)
Shear (lbs)	3560 @ 1' 7 1/2"	8533	Passed (42%)	1.15	1.0 D + 1.0 S (All Spans)
Pos Moment (Ft-lbs)	15256 @ 7' 10 3/4"	19320	Passed (79%)	1.15	1.0 D + 1.0 S (All Spans)
Live Load Defl. (in)	0.391 @ 7' 10 3/4"	0.740	Passed (L/454)	--	1.0 D + 1.0 S (All Spans)
Total Load Defl. (in)	0.679 @ 7' 10 3/4"	0.986	Passed (L/262)	--	1.0 D + 1.0 S (All Spans)

System : Roof  
 Member Type : Drop Beam  
 Building Use : Residential  
 Building Code : IBC 2015  
 Design Methodology : ASD  
 Member Pitch : 0/12

- Deflection criteria: LL (L/240) and TL (L/180).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- Critical positive moment adjusted by a volume factor of 1.00 that was calculated using length L = 14' 9 1/2".
- The effects of positive or negative camber have not been accounted for when calculating deflection.
- The specified glulam is assumed to have its strong laminations at the bottom of the beam. Install with proper side up as indicated by the manufacturer.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Snow	Total	
1 - Column - DF	7.50"	7.50"	1.63"	1585	2128	3713	Blocking
2 - Column - DF	7.50"	7.50"	1.63"	1585	2128	3713	Blocking

- Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	15' 10" o/c	
Bottom Edge (Lu)	15' 10" o/c	

- Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Tributary Width	Dead (0.90)	Snow (1.15)	Comments
0 - Self Weight (PLF)	0 to 15' 9 1/2"	N/A	10.2	--	
1 - Uniform (PSF)	4' to 11' 9 1/2" (Top)	9' 6"	16.8	25.0	Default Load
2 - Tapered (PSF)	0 to 4' (Top)	1' 7 1/4" to 3' 7"	16.8	25.0	Default Load
3 - Tapered (PSF)	11' 9 1/2" to 15' 9 1/2" (Top)	3' 7" to 1' 7 1/4"	16.8	25.0	Default Load
4 - Point (lb)	4' (Front)	N/A	710	943	Linked from: Hip Master Truss, Support 1
5 - Point (lb)	11' 9 1/2" (Front)	N/A	710	943	Linked from: Hip Master Truss, Support 1

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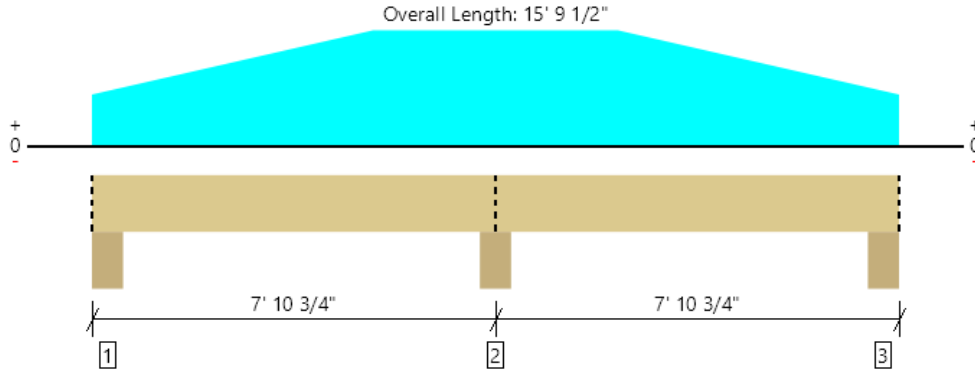
The product application, input design loads, dimensions and support information have been provided by ForteWEB Software Operator

ForteWEB Software Operator	Job Notes
Javid Abdi Atlas Consulting Engineers (206) 427-7233 javiddabdi@yahoo.com	



Level, Roof: Drop Beam

1 piece(s) 3 1/2" x 10 1/2" 24F-V4 DF Glulam



All locations are measured from the outside face of left support (or left cantilever end). All dimensions are horizontal.

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	1355 @ 7' 10 3/4"	17063 (7.50")	Passed (8%)	--	1.0 D + 1.0 S (All Spans)
Shear (lbs)	488 @ 9' 1"	7466	Passed (7%)	1.15	1.0 D + 1.0 S (All Spans)
Pos Moment (Ft-lbs)	553 @ 12' 2 5/16"	14792	Passed (4%)	1.15	1.0 D + 1.0 S (All Spans)
Neg Moment (Ft-lbs)	-956 @ 7' 10 3/4"	11402	Passed (8%)	1.15	1.0 D + 1.0 S (All Spans)
Live Load Defl. (in)	0.005 @ 11' 10 5/8"	0.370	Passed (L/999+)	--	1.0 D + 1.0 S (All Spans)
Total Load Defl. (in)	0.007 @ 11' 11 11/16"	0.493	Passed (L/999+)	--	1.0 D + 1.0 S (All Spans)

System : Roof  
 Member Type : Drop Beam  
 Building Use : Residential  
 Building Code : IBC 2015  
 Design Methodology : ASD  
 Member Pitch : 0/12

- Deflection criteria: LL (L/240) and TL (L/180).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- Critical positive moment adjusted by a volume factor of 1.00 that was calculated using length L = 5' 10 3/8".
- Critical negative moment adjusted by a volume factor of 1.00 that was calculated using length L = 3' 6 15/16".
- The effects of positive or negative camber have not been accounted for when calculating deflection.
- The specified glulam is assumed to have its strong laminations at the bottom of the beam. Install with proper side up as indicated by the manufacturer.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Snow	Total	
1 - Column - DF	7.50"	7.50"	1.50"	160	213	373	Blocking
2 - Column - DF	7.50"	7.50"	1.50"	594	762	1356	Blocking
3 - Column - DF	7.50"	7.50"	1.50"	160	213	373	Blocking

• Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	15' 10" o/c	
Bottom Edge (Lu)	15' 10" o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Tributary Width	Dead (0.90)	Snow (1.15)	Comments
0 - Self Weight (PLF)	0 to 15' 9 1/2"	N/A	8.9	--	
1 - Uniform (PSF)	5' 6" to 10' 3 1/2" (Top)	3' 7 3/8"	16.8	25.0	Default Load
2 - Tapered (PSF)	0 to 5' 6" (Top)	1' 7 1/4" to 3' 7 3/8"	16.8	25.0	Default Load
3 - Tapered (PSF)	10' 3 1/2" to 15' 9 1/2" (Top)	3' 7 3/8" to 1' 7 1/4"	16.8	25.0	Default Load

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1/5/2022 5:17:33 PM UTC  
 ForteWEB v3.2, Engine: V8.2.0.17, Data: V8.1.0.16

File Name: Kumar Cabana



Level, Free Standing Post  
1 piece(s) 8 x 8 SP No.1

Post Height: 6'



Design Results	Actual	Allowed	Result	LDF	Load: Combination
Slenderness	10	50	Passed (19%)	--	--
Compression (lbs)	4367	51050	Passed (9%)	1.15	1.0 D + 1.0 S
Base Bearing (lbs)	4367	1670625	Passed (0%)	--	1.0 D + 1.0 S
Bending/Compression	0.06	1	Passed (6%)	1.15	1.0 D + 1.0 S

- Input axial load eccentricity for this design is 16.67% of applicable member side dimension.
- Applicable calculations are based on NDS.

Supports	Type	Material
Base	Plate	Steel

Member Type : Free Standing Post  
Building Code : IBC 2015  
Design Methodology : ASD

Max Unbraced Length	Comments
Full Member Length	No bracing assumed.

Drawing is Conceptual

Vertical Loads	Dead (0.90)	Snow (1.15)	Comments
1 - Point (lb)	1585	2128	Linked from: Roof: Drop Beam, Support 1
2 - Point (lb)	138	143	Linked from: Hip Truss, Support 1
3 - Point (lb)	160	213	Linked from: Roof: Drop Beam, Support 1

**Weyerhaeuser Notes**

Weyerhaeuser warrants that the sizing of its products will be in accordance with Weyerhaeuser product design criteria and published design values. Weyerhaeuser expressly disclaims any other warranties related to the software. Use of this software is not intended to circumvent the need for a design professional as determined by the authority having jurisdiction. The designer of record, builder or framer is responsible to assure that this calculation is compatible with the overall project. Accessories (Rim Board, Blocking Panels and Squash Blocks) are not designed by this software. Products manufactured at Weyerhaeuser facilities are third-party certified to sustainable forestry standards. Weyerhaeuser Engineered Lumber Products have been evaluated by ICC-ES under evaluation reports ESR-1153 and ESR-1387 and/or tested in accordance with applicable ASTM standards. For current code evaluation reports, Weyerhaeuser product literature and installation details refer to [www.woyehaeuser.com/woodproducts/document-library](http://www.woyehaeuser.com/woodproducts/document-library).

The product application, input design loads, dimensions and support information have been provided by ForteWEB Software Operator

ForteWEB Software Operator	Job Notes
Javid Abdi Atlas Consulting Engineers (206) 427-7233 javiddabdi@yahoo.com	



### CANTILEVER RETAINING WALL EXTERNAL STABILITY

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

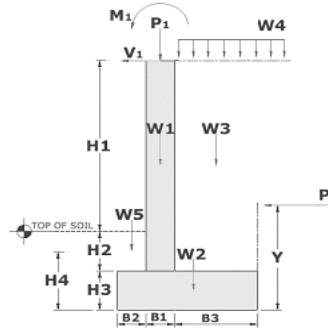
#### SOIL DATA

w	130	(pcf)	soil unit weight
phi	35	(deg)	soil internal angle of friction
del	0	(deg)	surface angle incline
	0.5		coeff. friction w/Concrete
	0.819		cosine(phi)
	1.000		cosine(del)
Ca	0.269	35 psf	coeff. of active pressure
Cp	1.923	250 psf	coeff. of passive pressure

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

#### WALL GEOMETRY

H1	3.8333333	(ft)	soil retained
H2	0.6666667	(ft)	soil depth above toe
H3	0.8333333	(ft)	footing thickness
H4	1	(ft)	passive pressure soil depth
B1	0.6666667	(ft)	wall width
B2	0.5	(ft)	toe width
B3	1.75	(ft)	heel width
H	5.3333333	(ft)	total height
B	2.9166667	(ft)	total base
	150	(pcf)	concrete unit weight



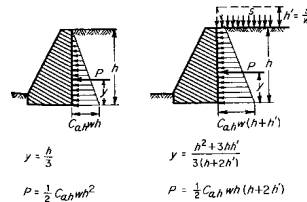
#### EXTERNAL LOADS

P <sub>applied</sub>	0	(lb/ft)
V <sub>applied</sub>	0	(lb/ft)
M <sub>applied</sub>	0	(lb-ft / ft)
Surcharge	36	(psf)

#### LOAD CALCULATIONS

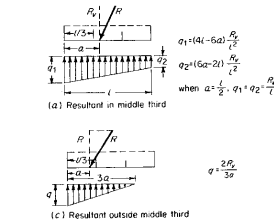
##### lateral soil force and overturning moment

H <sub>prime</sub>	0.28	(ft)	converted surcharge
Y	1.86	(ft)	distance to soil load resultant
P	550	(lbs)	soil load resultant
	1020	(lb-ft)	M <sub>o</sub> , soil + surcharge
	0	(lb-ft)	M <sub>o</sub> , external load
	1,020	(lb-ft)	total overturning Moment



##### wall restoring forces

component	weight (#)	arm (ft)	moment (#-ft)
w1 (concrete)	450	0.83	375
w2 (concrete)	365	1.46	532
w3 (heel soil)	1024	2.04	2090
w4 (surcharge)	63	2.04	129
w5 (toe soil)	43	0.25	11
P applied	0	0.83	0
vert. force	1,945	moment	3,136



##### lateral sliding resistance

	125	(lb)	passive pressure sliding resistance
	973	(lb)	soil friction force
	1098	(lb)	total sliding resistance

#### STABILITY FACTOR OF SAFETY CHECKS

	1.5	F.S. overturning
	1.5	F.S. sliding
overturning	3.07	OK
sliding	2.00	OK
		(PP+F)/(Ph+V)

#### SOIL BEARING

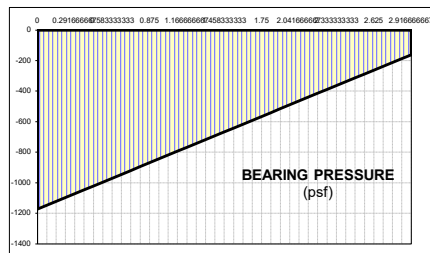
a	1.09	(ft)	distance to resultant
	0.97' to 1.94'		middle third of footing
q1	1172	(psf)	bearing pressure @ toe
q2	162	(psf)	bearing pressure @ heel

#### FACTORED (1.7) STEM LOAD FORCES

	4.5	(ft)	H1 + H2
	1.58	(ft)	line of action (above base)
	398	(lbs)	P (arm only)
	398	(lbs)	Ph (arm only)
	1.1	(kip-ft)	Mu (arm moment)

#### FACTORED (1.7) FOOTING LOADS

	0.2	(kip-ft)	Mu @ Toe (Bot Reinf)
	0.9	(kip-ft)	Mu @ Heel (Bot Reinf)
	0.92	(kip)	Vu @ Toe
	1.38	(kip)	Vu @ Heel



#### Footing

∅Vc	7.969	10" thick
As	0.24	#4 @ 10"
a	0.0004	
∅Mn	7.56	k-ft
	0.8	4-#4
	0.0022857	Reinf. Ratio
	0.002	Reinf. Ratio

#### Wall

∅Vc	6.831	8" thick
As	0.15	#4 @ 16" oc
a	0.0002	
∅Mn	4.05	k-ft
	0.001563	Reinf. Ratio

LRFD soil 1698.0571 psf @ Wall interface  
1992.4 'psf @ Toe

1305.6 psf @ Wall interface  
275.4 'psf @ Heel

73.58571429 # in Toe @ 0.33333333 ft from Wall  
849.0285714 # in Toe @ 0.25 ft from Wall

901.425 # in Toe @ 0.583333 ft from Wall  
481.95 # in Toe @ 0.875 ft from Wall

### CANTILEVER RETAINING WALL EXTERNAL STABILITY

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

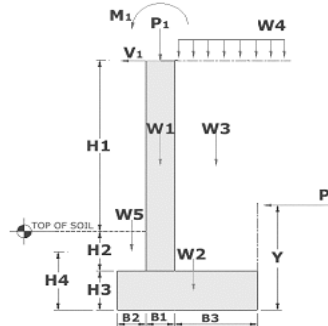
#### SOIL DATA

w	130	(pcf)	soil unit weight
phi	35	(deg)	soil internal angle of friction
del	0	(deg)	surface angle incline
	0.5		coeff. friction w/Concrete
	0.819		cosine(phi)
	1.000		cosine(del)
Ca	0.269	35 psf	coeff. of active pressure
Cp	1.923	250 psf	coeff. of passive pressure

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

#### WALL GEOMETRY

H1	4.8333333	(ft)	soil retained
H2	0.6666667	(ft)	soil depth above toe
H3	0.8333333	(ft)	footing thickness
H4	1	(ft)	passive pressure soil depth
B1	0.6666667	(ft)	wall width
B2	0.5	(ft)	toe width
B3	2.25	(ft)	heel width
H	6.3333333	(ft)	total height
B	3.4166667	(ft)	total base
	150	(pcf)	concrete unit weight



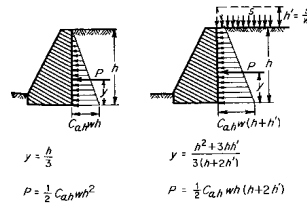
#### EXTERNAL LOADS

P <sub>applied</sub>	0	(lb/ft)
V <sub>applied</sub>	0	(lb/ft)
M <sub>applied</sub>	0	(lb-ft / ft)
Surcharge	44	(psf)

#### LOAD CALCULATIONS

##### lateral soil force and overturning moment

H <sub>prime</sub>	0.34	(ft)	converted surcharge
Y	2.21	(ft)	distance to soil load resultant
P	777	(lbs)	soil load resultant
	1720	(lb-ft)	M <sub>o</sub> , soil + surcharge
	0	(lb-ft)	M <sub>o</sub> , external load
	1,720	(lb-ft)	total overturning Moment



##### wall restoring forces

component	weight (#)	arm (ft)	moment (#-ft)
w1 (concrete)	550	0.83	458
w2 (concrete)	427	1.71	730
w3 (heel soil)	1609	2.29	3687
w4 (surcharge)	99	2.29	227
w5 (toe soil)	43	0.25	11
P applied	0	0.83	0
vert. force	2,728	moment	5,112

##### lateral sliding resistance

125	(lb)	passive pressure sliding resistance
1364	(lb)	soil friction force
1489	(lb)	total sliding resistance

#### STABILITY FACTOR OF SAFETY CHECKS

	1.5	F.S. overturning
	1.5	F.S. sliding
overturning	2.97	OK
sliding	1.92	OK
		(PP+F)/(Ph+V)

#### SOIL BEARING

a	1.24	(ft)	distance to resultant
	1.14' to 2.28'		middle third of footing
q1	1455	(psf)	bearing pressure @ toe
q2	142	(psf)	bearing pressure @ heel

#### FACTORED (1.7) STEM LOAD FORCES

5.5	(ft)	H1 + H2
1.93	(ft)	line of action (above base)
595	(lbs)	P (arm only)
595	(lbs)	Ph (arm only)
2.0	(kip-ft)	Mu (arm moment)

#### FACTORED (1.7) FOOTING LOADS

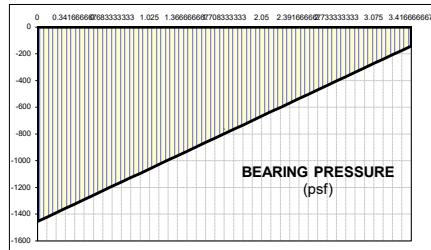
0.3	(kip-ft)	Mu @ Toe (Bot Reinf)
1.9	(kip-ft)	Mu @ Heel (Bot Reinf)
1.16	(kip)	Vu @ Toe
2.20	(kip)	Vu @ Heel

#### Footings

øVc	7.969	10" thick
As	0.24	#4 @ 10"
a	0.0004	
øMn	7.56	k-ft
	1	5-#4
	0.002439	Reinf. Ratio
	0.002	Reinf. Ratio

#### Wall

øVc	6,831	8" thick
As	0.15	#4 @ 16" oc
a	0.0002	
øMn	4.05	k-ft
	0.001563	Reinf. Ratio



LRFD soil 2146.8512 psf @ Wall interface  
2473.5 'psf @ Toe

1711.319512 psf @ Wall interface  
241.4 'psf @ Heel

81.66219512 # in Toe @ 0.33333333 ft from Wall  
1073.42561 # in Toe @ 0.25 ft from Wall

1653.659451 # in Toe @ 0.75 ft from Wall  
543.15 # in Toe @ 1.125 ft from Wall

### CANTILEVER RETAINING WALL EXTERNAL STABILITY

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

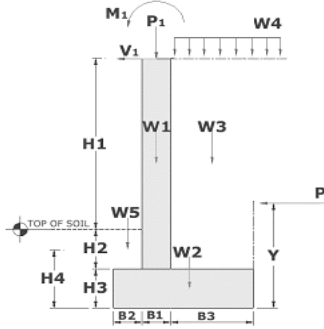
#### SOIL DATA

w	130	(pcf)	soil unit weight
phi	35	(deg)	soil internal angle of friction
del	0	(deg)	surface angle incline
	0.5		coeff. friction w/Concrete
	0.819		cosine(phi)
	1.000		cosine(del)
Ca	0.269	35 psf	coeff. of active pressure
Cp	1.923	250 psf	coeff. of passive pressure

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

#### WALL GEOMETRY

H1	5.8333333	(ft)	soil retained
H2	0.6666667	(ft)	soil depth above toe
H3	0.8333333	(ft)	footing thickness
H4	1	(ft)	passive pressure soil depth
B1	0.6666667	(ft)	wall width
B2	0.5	(ft)	toe width
B3	2.75	(ft)	heel width
H	7.3333333	(ft)	total height
B	3.9166667	(ft)	total base
	150	(pcf)	concrete unit weight



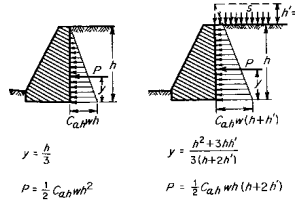
#### EXTERNAL LOADS

P <sub>applied</sub>	0	(lb/ft)
V <sub>applied</sub>	0	(lb/ft)
M <sub>applied</sub>	0	(lb-ft / ft)
Surcharge	52	(psf)

#### LOAD CALCULATIONS

##### lateral soil force and overturning moment

H <sub>prime</sub>	0.40	(ft)	converted surcharge
Y	2.56	(ft)	distance to soil load resultant
P	1044	(lbs)	soil load resultant
	2670	(lb-ft)	M <sub>o</sub> , soil + surcharge
	0	(lb-ft)	M <sub>o</sub> , external load
	2,670	(lb-ft)	total overturning Moment



##### wall restoring forces

component	weight (#)	arm (ft)	moment (#-ft)
w1 (concrete)	650	0.83	542
w2 (concrete)	490	1.96	959
w3 (heel soil)	2324	2.54	5906
w4 (surcharge)	143	2.54	363
w5 (toe soil)	43	0.25	11
P applied	0	0.83	0
vert. force	3,650	moment	7,781

##### lateral sliding resistance

125	(lb)	passive pressure sliding resistance
1825	(lb)	soil friction force
1950	(lb)	total sliding resistance

#### STABILITY FACTOR OF SAFETY CHECKS

	1.5	F.S. overturning
	1.5	F.S. sliding
overturning	2.91	OK
sliding	1.87	OK
		(PP+F)/(Ph+V)

#### SOIL BEARING

a	1.40	(ft)	distance to resultant
	1.31' to 2.61'		middle third of footing
q1	1729	(psf)	bearing pressure @ toe
q2	135	(psf)	bearing pressure @ heel

#### FACTORED (1.7) STEM LOAD FORCES

6.5	(ft)	H1 + H2
2.29	(ft)	line of action (above base)
830	(lbs)	P (arm only)
830	(lbs)	Ph (arm only)
3.2	(kip-ft)	Mu (arm moment)

#### FACTORED (1.7) FOOTING LOADS

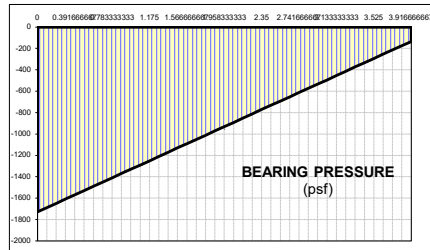
0.4	(kip-ft)	Mu @ Toe (Bot Reinf)
3.3	(kip-ft)	Mu @ Heel (Bot Reinf)
1.38	(kip)	Vu @ Toe
3.25	(kip)	Vu @ Heel

#### Footings

øVc	7.969	10" thick
As	0.24	#4 @ 10"
a	0.0004	
øMn	7.56	k-ft
	1	5-#4
	0.0021277	Reinf. Ratio
	0.002	Reinf. Ratio

#### Wall

øVc	6.831	8" thick
As	0.2	#4 @ 12" oc
a	0.0003	
øMn	5.40	k-ft
	0.002083	Reinf. Ratio



LRFD soil 2593.3681 psf @ Wall interface  
2939.3 psf @ Toe

2132.125532 psf @ Wall interface  
229.5 psf @ Heel

86.48297872 # in Toe @ 0.33333333 ft from Wall  
1296.684043 # in Toe @ 0.25 ft from Wall

2616.110106 # in Toe @ 0.916667 ft from Wall  
631.125 # in Toe @ 1.375 ft from Wall

### CANTILEVER RETAINING WALL EXTERNAL STABILITY

limitations: uses Rankine coefficients for noncohesive soils, external moment at top of wall does not contribute to restoring moment (overturning only), no deflection or service load checks, soil on low side of wall does not brace wall against overturning (sliding only)  
 reference: Nilson & Winter, Design of Concrete Structures, 11th Edition, page 680  
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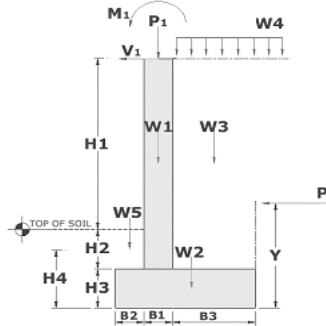
#### SOIL DATA

w	130	(pcf)	soil unit weight
phi	35	(deg)	soil internal angle of friction
del	0	(deg)	surface angle incline
	0.5		coeff. friction w/Concrete
	0.819		cosine(phi)
	1.000		cosine(del)
Ca	0.269	35 psf	coeff. of active pressure
Cp	1.923	250 psf	coeff. of passive pressure

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

#### WALL GEOMETRY

H1	6.8333333	(ft)	soil retained
H2	0.6666667	(ft)	soil depth above toe
H3	0.8333333	(ft)	footing thickness
H4	1	(ft)	passive pressure soil depth
B1	0.6666667	(ft)	wall width
B2	0.5	(ft)	toe width
B3	3.25	(ft)	heel width
H	8.3333333	(ft)	total height
B	4.4166667	(ft)	total base
	150	(pcf)	concrete unit weight



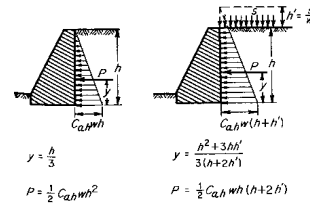
#### EXTERNAL LOADS

P <sub>applied</sub>	0	(lb/ft)
V <sub>applied</sub>	0	(lb/ft)
M <sub>applied</sub>	0	(lb-ft / ft)
Surcharge	60	(psf)

#### LOAD CALCULATIONS

##### lateral soil force and overturning moment

H <sub>prime</sub>	0.46	(ft)	converted surcharge
Y	2.92	(ft)	distance to soil load resultant
P	1349	(lbs)	soil load resultant
	3940	(lb-ft)	M <sub>o</sub> , soil + surcharge
	0	(lb-ft)	M <sub>o</sub> , external load
	3,940	(lb-ft)	total overturning Moment



##### wall restoring forces

component	weight (#)	arm (ft)	moment (#-ft)
w1 (concrete)	750	0.83	625
w2 (concrete)	552	2.21	1219
w3 (heel soil)	3169	2.79	8846
w4 (surcharge)	195	2.79	544
w5 (toe soil)	43	0.25	11
P applied	0	0.83	0
vert. force	4,709	moment	11,245

##### lateral sliding resistance

125	(lb)	passive pressure sliding resistance
2355	(lb)	soil friction force
2480	(lb)	total sliding resistance

#### STABILITY FACTOR OF SAFETY CHECKS

	1.5	F.S. overturning
	1.5	F.S. sliding
overturning	2.85	OK
sliding	1.84	OK
		(PP+F)/(Ph+V)

#### SOIL BEARING

a	1.55	(ft)	distance to resultant
	1.47' to 2.94'		middle third of footing
q1	2020	(psf)	bearing pressure @ toe
q2	113	(psf)	bearing pressure @ heel

#### FACTORED (1.7) STEM LOAD FORCES

7.5	(ft)	H1 + H2
2.64	(ft)	line of action (above base)
1105	(lbs)	P (arm only)
1105	(lbs)	Ph (arm only)
5.0	(kip-ft)	Mu (arm moment)

#### FACTORED (1.7) FOOTING LOADS

0.4	(kip-ft)	Mu @ Toe (Bot Reinf)
5.2	(kip-ft)	Mu @ Heel (Bot Reinf)
1.63	(kip)	Vu @ Toe
4.50	(kip)	Vu @ Heel

#### Footings

øVc	7.969	10" thick
As	0.31	#5 @ 12"
a	0.0005	
øMn	9.76	k-ft
	1.24	4-#5
	0.0023396	Reinf. Ratio
	0.0025833	Reinf. Ratio

#### Wall

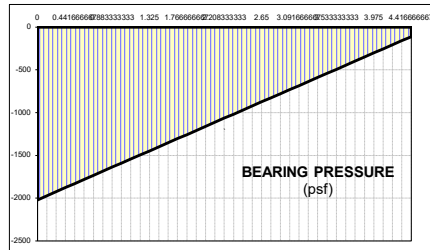
øVc	6.831	8" thick
As	0.2325	#5 @ 16" oc
a	0.0003	
øMn	6.28	k-ft
	0.002422	Reinf. Ratio

LRFD soil 3066.9925 psf @ Wall interface  
3434 'psf @ Toe

2577.649057 psf @ Wall interface  
192.1 'psf @ Heel

91.75188679 # in Toe @ 0.33333333 ft from Wall  
1533.496226 # in Toe @ 0.25 ft from Wall

3876.517217 # in Toe @ 1.083333 ft from Wall  
624.325 # in Toe @ 1.625 ft from Wall



## CANTILEVER RETAINING WALL EXTERNAL STABILITY

limitations: uses Rankine coefficients for noncohesive soils, external moment at top of wall does not contribute to restoring moment (overturning only), no deflection or service load checks, soil on low side of wall does not brace wall against overturning (sliding only)  
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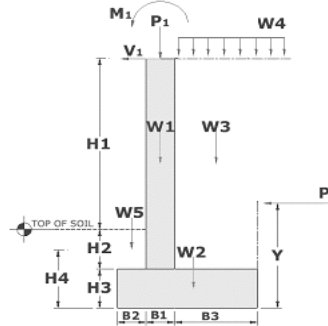
### SOIL DATA

w	130	(pcf)	soil unit weight
phi	35	(deg)	soil internal angle of friction
del	0	(deg)	surface angle incline
	0.5		coeff. friction w/Concrete
	0.819		cosine(phi)
	1.000		cosine(del)
Ca	0.269	35 psf	coeff. of active pressure
Cp	1.923	250 psf	coeff. of passive pressure

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

### WALL GEOMETRY

H1	8	(ft)	soil retained
H2	0.5	(ft)	soil depth above toe
H3	1	(ft)	footing thickness
H4	1	(ft)	passive pressure soil depth
B1	0.6666667	(ft)	wall width
B2	0.5	(ft)	toe width
B3	4	(ft)	heel width
H	9.5	(ft)	total height
B	5.1666667	(ft)	total base
	150	(pcf)	concrete unit weight



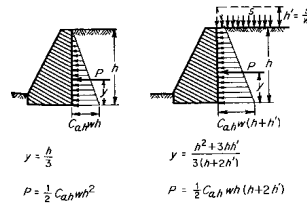
### EXTERNAL LOADS

P <sub>applied</sub>	0	(lb/ft)
V <sub>applied</sub>	0	(lb/ft)
M <sub>applied</sub>	0	(lb-ft / ft)
Surcharge	68	(psf)

### LOAD CALCULATIONS

#### lateral soil force and overturning moment

H <sub>prime</sub>	0.52	(ft)	converted surcharge
Y	3.32	(ft)	distance to soil load resultant
P	1752	(lbs)	soil load resultant
	5820	(lb-ft)	M <sub>o</sub> , soil + surcharge
	0	(lb-ft)	M <sub>o</sub> , external load
	5,820	(lb-ft)	total overturning Moment



#### wall restoring forces

component	weight (#)	arm (ft)	moment (#-ft)
w1 (concrete)	850	0.83	708
w2 (concrete)	775	2.58	2002
w3 (heel soil)	4420	3.17	13997
w4 (surcharge)	272	3.17	861
w5 (toe soil)	33	0.25	8
P applied	0	0.83	0
vert. force	6,350	moment	17,577

#### lateral sliding resistance

125	(lb)	passive pressure sliding resistance
3175	(lb)	soil friction force
3300	(lb)	total sliding resistance

### STABILITY FACTOR OF SAFETY CHECKS

	1.5	F.S. overturning
	1.5	F.S. sliding
overturning	3.02	OK
sliding	1.88	OK
		(PP+F)/(Ph+V)

### SOIL BEARING

a	1.85	(ft)	distance to resultant
	1.72' to 3.44'		middle third of footing
q1	2276	(psf)	bearing pressure @ toe
q2	182	(psf)	bearing pressure @ heel

### FACTORED (1.7) STEM LOAD FORCES

8.5	(ft)	H1 + H2
2.99	(ft)	line of action (above base)
1419	(lbs)	P (arm only)
1419	(lbs)	Ph (arm only)
7.2	(kip-ft)	Mu (arm moment)

### FACTORED (1.7) FOOTING LOADS

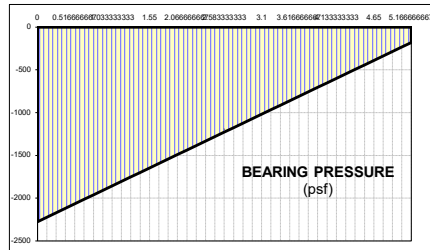
0.5	(kip-ft)	Mu @ Toe (Bot Reinf)
9.8	(kip-ft)	Mu @ Heel (Bot Reinf)
1.85	(kip)	Vu @ Toe
6.75	(kip)	Vu @ Heel

### Footing

øVc	7.969	10" thick
As	0.31	#5 @ 12"
a	0.0005	
øMn	12.55	k-ft
	1.86	6-#5
	0.0025	Reinf. Ratio
	0.0021528	Reinf. Ratio

### Wall

øVc	6.831	8" thick
As	0.31	#5 @ 12" oc
a	0.0005	
øMn	8.37	k-ft
	0.003229	Reinf. Ratio



LRFD soil 3524.7032 psf @ Wall interface  
3869.2 'psf @ Toe

3065.374194 psf @ Wall interface  
309.4 'psf @ Heel

86.12419355 # in Toe @ 0.33333333 ft from Wall  
1762.351613 # in Toe @ 0.25 ft from Wall

5511.948387 # in Toe @ 1.333333 ft from Wall  
1237.6 # in Toe @ 2 ft from Wall

### CANTILEVER RETAINING WALL EXTERNAL STABILITY

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

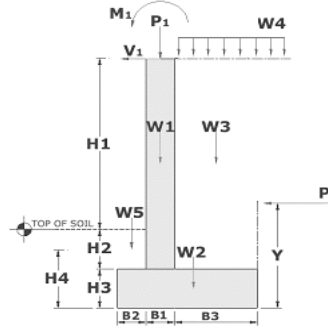
#### SOIL DATA

w	130	(pcf)	soil unit weight
phi	35	(deg)	soil internal angle of friction
del	0	(deg)	surface angle incline
	0.5		coeff. friction w/Concrete
	0.819		cosine(phi)
	1.000		cosine(del)
Ca	0.269	35 psf	coeff. of active pressure
Cp	1.923	250 psf	coeff. of passive pressure

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

#### WALL GEOMETRY

H1	9	(ft)	soil retained
H2	0.5	(ft)	soil depth above toe
H3	1	(ft)	footing thickness
H4	1	(ft)	passive pressure soil depth
B1	0.6666667	(ft)	wall width
B2	1	(ft)	toe width
B3	4.25	(ft)	heel width
H	10.5	(ft)	total height
B	5.9166667	(ft)	total base
	150	(pcf)	concrete unit weight



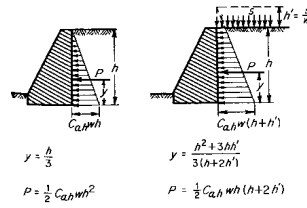
#### EXTERNAL LOADS

P <sub>applied</sub>	0	(lb/ft)
V <sub>applied</sub>	0	(lb/ft)
M <sub>applied</sub>	0	(lb-ft / ft)
Surcharge	76	(psf)

#### LOAD CALCULATIONS

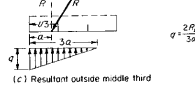
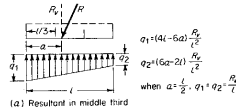
##### lateral soil force and overturning moment

H <sub>prime</sub>	0.58	(ft)	converted surcharge
Y	3.67	(ft)	distance to soil load resultant
P	2143	(lbs)	soil load resultant
	7860	(lb-ft)	M <sub>o</sub> , soil + surcharge
	0	(lb-ft)	M <sub>o</sub> , external load
	7,860	(lb-ft)	total overturning Moment



##### wall restoring forces

component	weight (#)	arm (ft)	moment (#-ft)
w1 (concrete)	950	1.33	1267
w2 (concrete)	888	2.96	2626
w3 (heel soil)	5249	3.79	19902
w4 (surcharge)	323	3.79	1225
w5 (toe soil)	65	0.50	33
P applied	0	1.33	0
vert. force	7,474	moment	25,051



##### lateral sliding resistance

125	(lb)	passive pressure sliding resistance
3737	(lb)	soil friction force
3862	(lb)	total sliding resistance

#### STABILITY FACTOR OF SAFETY CHECKS

	1.5	F.S. overturning
	1.5	F.S. sliding
overturning	3.19	OK
sliding	1.80	OK
		(PP+F)/(Ph+V)

#### SOIL BEARING

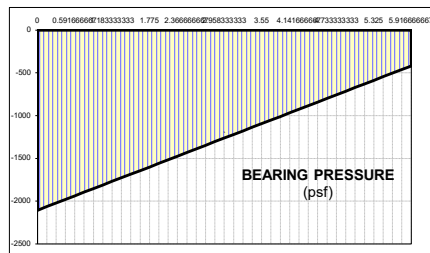
a	2.30	(ft)	distance to resultant
	1.97' to 3.94'		middle third of footing
q1	2107	(psf)	bearing pressure @ toe
q2	420	(psf)	bearing pressure @ heel

#### FACTORED (1.7) STEM LOAD FORCES

9.5	(ft)	H1 + H2
3.34	(ft)	line of action (above base)
1772	(lbs)	P (arm only)
1772	(lbs)	Ph (arm only)
10.1	(kip-ft)	Mu (arm moment)

#### FACTORED (1.7) FOOTING LOADS

1.7	(kip-ft)	Mu @ Toe (Bot Reinf)
12.6	(kip-ft)	Mu @ Heel (Bot Reinf)
3.34	(kip)	Vu @ Toe
7.41	(kip)	Vu @ Heel



#### Footing

∅Vc	7,969	10" thick
As	0.372	#5 @ 10"
a	0.0005	
∅Mn	15.07	k-ft
	1.86	6-#5
	0.0021831	Reinf. Ratio
	0.0025833	Reinf. Ratio

#### Wall

∅Vc	6,831	8" thick
As	0.413333	#5 @ 9" oc
a	0.0006	
∅Mn	11.16	k-ft
	0.004306	Reinf. Ratio

LRFD soil 3097.1845 psf @ Wall interface  
 3581.9 'psf @ Toe

2774.040845 psf @ Wall interface  
 714 'psf @ Heel

242.3577465 # in Toe @ 0.66666667 ft from Wall  
 3097.184507 # in Toe @ 0.5 ft from Wall

4377.586796 # in Toe @ 1.416667 ft from Wall  
 3034.5 # in Toe @ 2.125 ft from Wall

## CANTILEVER RETAINING WALL EXTERNAL STABILITY

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

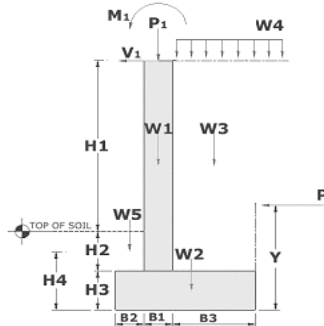
### SOIL DATA

w	130	(pcf)	soil unit weight
phi	35	(deg)	soil internal angle of friction
del	0	(deg)	surface angle incline
	0.5		coeff. friction w/Concrete
	0.819		cosine(phi)
	1.000		cosine(del)
Ca	0.269	35 psf	coeff. of active pressure
Cp	1.923	250 psf	coeff. of passive pressure

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

### WALL GEOMETRY

H1	10.25	(ft)	soil retained
H2	0.25	(ft)	soil depth above toe
H3	1.25	(ft)	footing thickness
H4	1	(ft)	passive pressure soil depth
B1	0.6666667	(ft)	wall width
B2	1	(ft)	toe width
B3	5.25	(ft)	heel width
H	11.75	(ft)	total height
B	6.9166667	(ft)	total base
	150	(pcf)	concrete unit weight



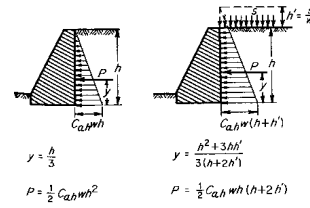
### EXTERNAL LOADS

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

### LOAD CALCULATIONS

#### lateral soil force and overturning moment

H <sub>prime</sub>	0.00	(ft)	converted surcharge
Y	3.92	(ft)	distance to soil load resultant
P	2416	(lbs)	soil load resultant
	9470	(lb-ft)	M <sub>o</sub> , soil + surcharge
	0	(lb-ft)	M <sub>o</sub> , external load
	9,470	(lb-ft)	total overturning Moment



#### wall restoring forces

component	weight (#)	arm (ft)	moment (#-ft)
w1 (concrete)	1050	1.33	1400
w2 (concrete)	1297	3.46	4485
w3 (heel soil)	7166	4.29	30755
w4 (surcharge)	0	4.29	0
w5 (toe soil)	33	0.50	16
P applied	0	1.33	0
vert. force	9,546	moment	36,656

#### lateral sliding resistance

125	(lb)	passive pressure sliding resistance
4773	(lb)	soil friction force
4898	(lb)	total sliding resistance

### STABILITY FACTOR OF SAFETY CHECKS

	1.5	F.S. overturning
	1.5	F.S. sliding
overturning	3.87	OK
sliding	2.03	OK
		(PP+F)/(Ph+V)

### SOIL BEARING

a	2.85	(ft)	distance to resultant
	2.31' to 4.61'		middle third of footing
q1	2108	(psf)	bearing pressure @ toe
q2	652	(psf)	bearing pressure @ heel

### FACTORED (1.7) STEM LOAD FORCES

10.5	(ft)	H1 + H2
3.50	(ft)	line of action (above base)
1929	(lbs)	P (arm only)
1929	(lbs)	Ph (arm only)
11.5	(kip-ft)	Mu (arm moment)

### FACTORED (1.7) FOOTING LOADS

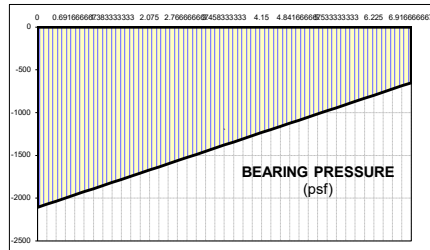
1.7	(kip-ft)	Mu @ Toe (Bot Reinf)
23.9	(kip-ft)	Mu @ Heel (Bot Reinf)
3.40	(kip)	Vu @ Toe
10.75	(kip)	Vu @ Heel

### Footings

∅Vc	7,969	10" thick
As	0.465	#5 @ 8"
a	0.0007	
∅Mn	25.11	k-ft
	2.79	6-#5
	0.002241	Reinf. Ratio
	0.0025833	Reinf. Ratio

### Wall

∅Vc	6,831	8" thick
As	0.465	#5 @ 8" oc
a	0.0007	
∅Mn	12.55	k-ft
	0.004844	Reinf. Ratio



LRFD soil 3225.7398 psf @ Wall interface  
3583.6 'psf @ Toe

2987.166265 psf @ Wall interface  
1108.4 'psf @ Heel

178.9301205 # in Toe @ 0.66666667 ft from Wall  
3225.739759 # in Toe @ 0.5 ft from Wall

4931.761446 # in Toe @ 1.75 ft from Wall  
5819.1 # in Toe @ 2.625 ft from Wall