NICKERSON
ENGINEERING

Structural Calculations for:

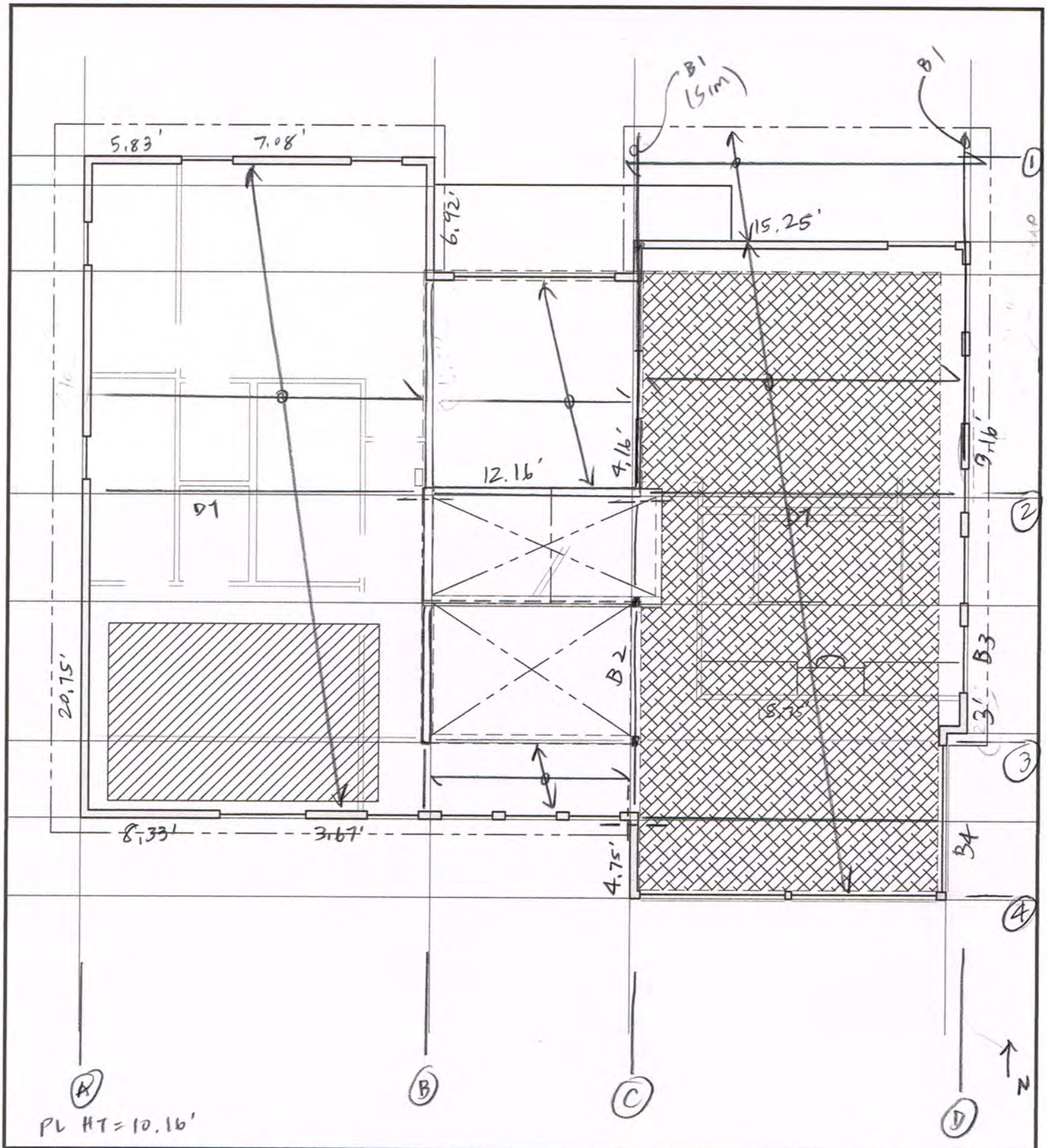
Yang Residence
REV01

Project Address:
7431 E Mercer Way
Mercer Island, WA 98040

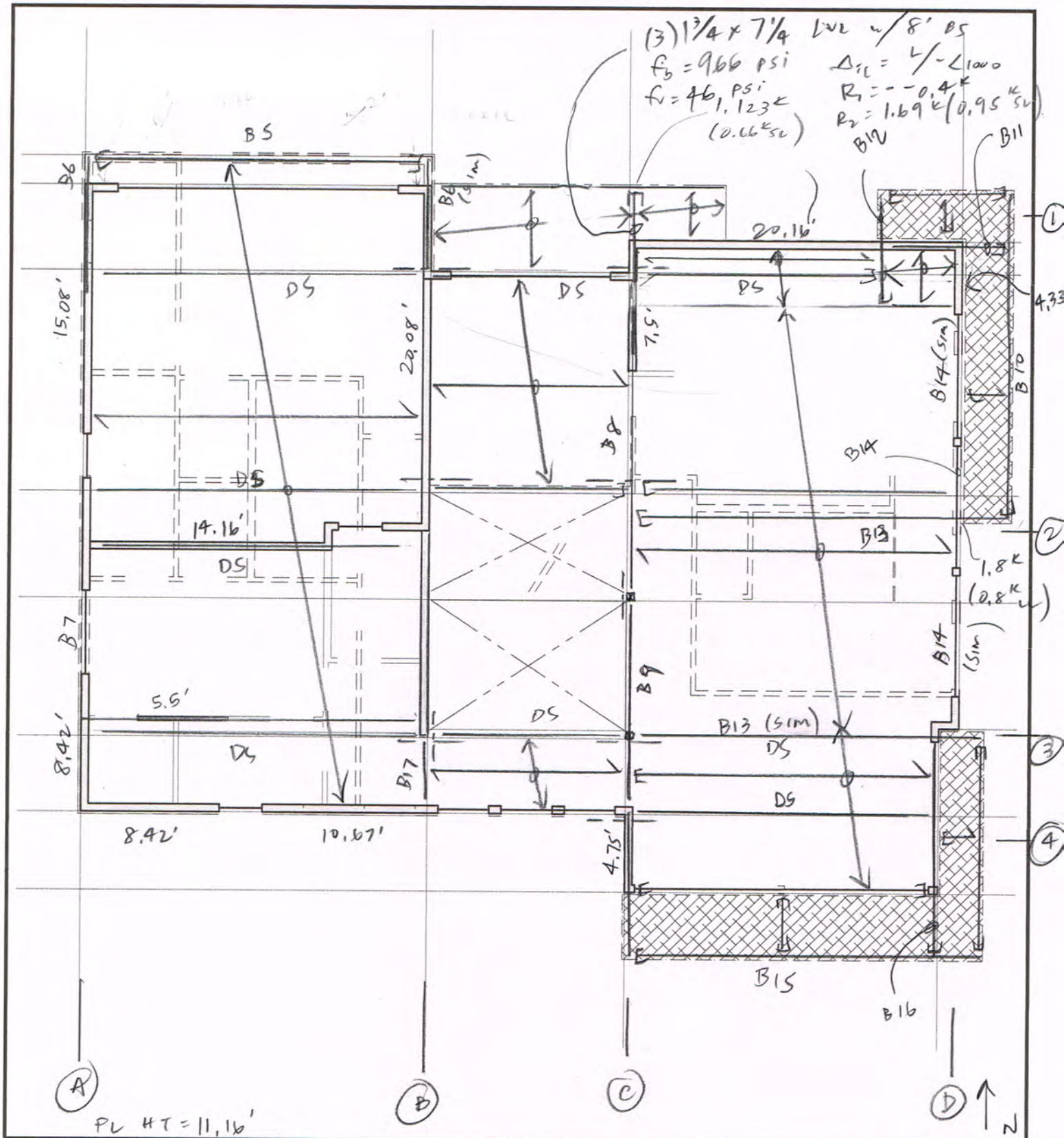
Structural Engineering by:

Nickerson Engineering
2221 Everett Ave, #202
Everett, WA 98201

Design per:
2015 International Building Code



nickerson engineering 2221 Everett Ave #202 Everett, WA 98201 425.610.4425	Description: ROOF FRAMING PLAN Project: YANG RESIDENCE Job No.: 19-065 Date:	Sheet KP1 Scale: 1/8" = 1'-0"



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Description	UPPER FLOOR FRAMING PLAN
Project	YANG RESIDENCE
Job No.	19-065
Date	
Sheet	KP2
Scale:	1/8" = 1'-0"

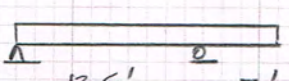
DESIGN CRITERIA

CODE : 2015 IBC
SNOW LOAD : 25 PSF
LIVE LOAD : 40 PSF (60 PSF @ DECKS)
ROOF DL : 15 PSF
DECK DL : 15 PSF
FLOOR DL : 12 PSF
ALLOWABLE SOIL BEARING : 2000 PSF (PER GEOTECH REPORT BY CASCADE GEOTECHNW DATED 12/5/18)

1½" GYP CRETE : 13 PSF
(@ UPPER FLOOR)

ROOF FRAMING

B1



D+L : UNBAL. SPAN W/ DST CASE

$w = 75\left(\frac{20}{2} + 1.16\right) = 837^{PLF}\ (670^{PLF\ LL})$

$f_b = 1133$ psi
$f_v = 132$ psi
$\Delta_{TL} = L/<1000$

5¼ x 16 PSL
$R_1 = 4.26^K\ (3.31^K\ LL)$
$R_2 = 13.44^K\ (10.42^K\ LL)$
$(R_1 = -0.262^K$ UNBAL. SPAN$)$

B2 D+L:

$l = 9'$
$w = 75\left(\frac{20}{2}\right) = 750^{PLF}\ (600^{PLF\ LL})$
$f_b = 1686$ psi
$f_v = 124$ psi
$\Delta_{TL} = L/681$

3½ x 11⅞ LSL
$R = 3.424^K$
$(2.7^K\ LL)$

B3 D+L

$l = 4.5'$
$w = 837^{PLF}\ (670^{PLF\ LL})$
$f_b = 835$ psi < 1300 psi
$f_v = 112$ psi
$\Delta_{TL} = L/>1000$

4x8
$R = 1.90^K$
$(1.51^K\ LL)$

B4 D+L

$l = 9.5'$
$w = 75\left(\frac{19}{2}\right) = 713^{PLF}\ (570^{PLF\ LL})$
$f_b = 1173$ psi
$f_v = 97$ psi
$\Delta_{TL} = L/682$

3½ x 11⅞ LSL
$R = 3.44^K$
$(2.71^K\ LL)$

PROJECT YANG RES.
DATE 6/27/19
PROJ. NO. 19-065
DESIGN CKS
SHEET 91

UPPER FLOOR FRAMING

B5 D+L:

$\ell = 20.08'$

$w = 15(3) + 102 + 65(1.33) = 233^{PLF}$ (53.2^{PLF}_{LL})

$f_b = 1238$ psi

$f_v = 61$ psi

$\Delta_{TL} = L/275$

5¼ × 11⅞ PSL

$R = 2.54^K$ (0.534^K LL)

D+S:

$w = 40(3) + 102 + 15(1.33) = 242^{PLF}$ (75^{PLF}_{SL})

$f_b = 1282$ psi

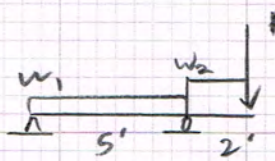
$f_v = 63$ psi

$\Delta_{TL} = L/273$

5¼ × 11⅞ PSL

$R = 2.63^K$ (0.753^K SL)

B6



D+L:

$w_1 = 25(20/2) = 250$ PLF DL

$w_2 = 65(20/2) + 102 + 15(21/2 + 2)$

$w_2 = 940$ PLF (400 PLF LL)

$P = 1.47^K$ DL

$f_b = 473$ psi

$f_v = 82$ psi

$\Delta_{TL} = L/<1000$

5¼ × 11⅞ PSL

$R_1 = -0.3^K$

$R_2 = 5.034^K$ (0.96^K_{LL})

B6 CONT...

D+0.75(S+L)

$w_1 = 25(20/2) = 250$ PLF DL

$w_2 = 55(20/2) + 102 + 33.75(12.5)$

$w_2 = 1074$ PLF (534 PLF LL)

$P = 1,358^K$ (0.563^K LL)

$f_b = 479$ psi

$f_v = 85$ psi

$\Delta_{TL} = L/<1000$

5¼ × 11⅞ PSL

$R_1 = -0.31^K$

$R_2 = 5.2^K$

B7

D+0.75(S+L):

$\ell = 6'$

$w = 33.75(12.5) + 102 + 55(21/2)$

$w = 1101.4$ PLF (549.4 PLF LL)

$f_b = 1418$ psi

$f_v = 177$ psi

$\Delta_{TL} = L/>1000$

3½ × 9 GLB

$R = 3.342^K$ (1.65^K LL)

PROJECT YANG RES.

DATE 6/27/19

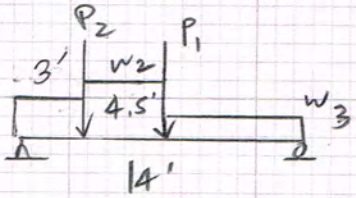
PROJ. NO. 19-065

DESIGN CKS

SHEET 62

UPPER FLR FRMG CONT...

B8



D+L - GOVERNS

$W_1 = 65(32.5/2) = 1056.3^{PLF}\ (650^{PLF}\ LL)$

$W_2 = 75(32.5/2) + 10(10.16+4) + 65(32.5/2)$

$W_2 = 2417\ PLF\ (1625\ PLF\ LL)$

$W_3 = 65(20/2) = 650\ PLF\ (400^{PLF}\ LL)$

$P_1 = [15(7/2) + 10(10.16+4)](12.5/2)$
$+ 75(20/2)(7/2) = 3.84^K (2.1^K\ LL)$

$P_2 = 75(32.5/2)(4.5/2) = 2.74^K (2.194^K\ LL)$

W10X26 $\quad b = 8"\ \ d = 10\frac{1}{8}"$

$R_1 = 14.73^K\ (9,614^K\ LL)$

$R_2 = 10.5^K\ (6,543^K\ LL)$

W10x26 OK
$b = 5\frac{3}{4}"$
$d = 10\frac{3}{8}"$
$R_1 = 14.726^K$ (9.614 LL)
$R_2 = 10.5^K$ (6.5)

ALT OPTION
W 8x58
$b = 8\frac{1}{4}"$
$d = 8\frac{3}{4}"$
OK

SEE B8 (D+L) OUTPUT ON PG 64

D+W

$W_1 = 406.3^{PLF}$ DL

$W_2 = 792$ PLF DL

$W_3 = 250$ PLF DL

$P_1 = 1.74^K_{DL} + 2.43^K_{(W)} = 4.17^K$

$P_2 = 0.546^K$ DL

W10 x 26 $\quad R_1 = 6.2^K\ (1.128^K\ W)$
$R_2 = 5.25^K\ (1.3^K\ W)$

SEE B8 (D+W) OUTPUT ON 65

B8 CONT...

1.15D + 1.0E - OVERSTRENGTH - f_b Check only

$W_1 = 467$ PLF

$W_2 = 911$ PLF

$W_3 = 288$ PLF

$P_1 = 2.0^K + 2.5(2.773) = 8.93^K$

$P_2 = 0.63^K$

W10X26

SEE B8 (OVERSTRENGTH) OUTPUT ON PG 66

B9 D+L

$l = 9'$

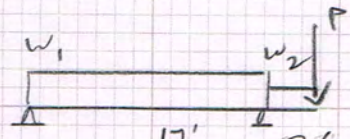
$W = 65(20/2) = 650^{PLF}\ (400^{PLF}\ LL)$

$f_b = 659$ PSI $\quad 5\frac{1}{4} \times 11\frac{7}{8}$ PSL

$f_v = 72.5$ PSI $\quad R = 3,013^K$ $(1.8^K\ LL)$

$\Delta_{TL} = L/>1000$

B10



D+L:

$w_1 = 75(3/2) + 40 = 153^{PLF}\ (90^{PLF}\ LL)$

$w_2 = 40$ PLF DL

$P = 75(3/2)(8/2) = 0.45^K\ (0.36^K\ LL)$

$f_b = 865$ PSI

$f_v = 49$ PSI $\quad 5\frac{1}{2} \times 9$ GLB

$\Delta_{TL} = L/372$ $\quad R_1 = 1.29^K\ (0.691^K\ LL)$
$R_2 = 2.14^K\ (1.2^K\ LL)$

PROJECT YANG RES.

DATE 6/27/19

PROJ. NO. 19-065

DESIGN CKS

SHEET G3

Yang Residence — Upper Floor Framing Plan

B8 (D+L) — Date: 6/28/19

Selection **W 10x 26 50 ksi Wide Flange Steel** — Lateral Support: Lc = 5.2 ft max.

Conditions Actual Size is 5-3/4 x 10-3/8 in.

Min Bearing Length R1= 0.9 in. R2= 0.9 in. (1.0) DL Defl= 0.17 in Recom Camber= 0.25 in

Data

Beam Span	14.0 ft	Reaction 1 LL	9614 #	Reaction 2 LL	6543 #
Beam Wt per ft	26.0 #	Reaction 1 TL	14726 #	Reaction 2 TL	10489 #
Bm Wt Included	364 #	Maximum V	14726 #		
Max Moment	54939 '#	Max V (Reduced)	N/A		
TL Max Defl	L / 240	TL Actual Defl	L / 365		
LL Max Defl	L / 480	LL Actual Defl	L / 569		

Attributes

	Section (in³)	Shear (in²)	TL Defl (in)	LL Defl
Actual	27.90	2.69	0.46	0.30
Critical	19.98	0.74	0.70	0.35
Status	OK	OK	OK	OK
Ratio	72%	27%	66%	84%

Values

	Fb (psi)	Fv (psi)	E (psi x mil)
Ref. Value Fy	50000	50000	29.0
Adjusted Values	33000	20000	29.0

Adjustments

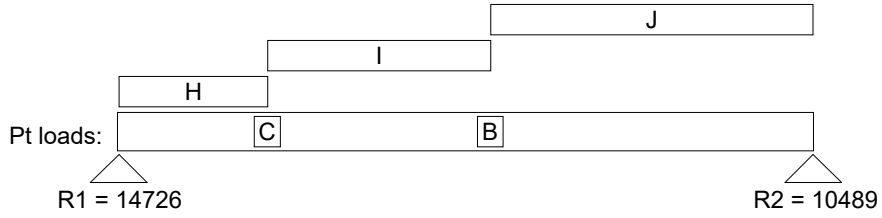
YP Factor, Lc 0.66 0.40

At Point Loads: Provide these minimum bearing lengths in inches or provide web stiffeners.

B = 0.9 C = 0.9

Loads

Point LL	Point TL	Distance	Par Unif LL	Par Unif TL	Start	End
2100	B = 3840	7.5	650	H = 1056	0	3.0
2194	C = 2740	3.0	1625	I = 2417	3.0	7.5
			400	J = 650	7.5	14.0



SPAN = 14 FT

Uniform and partial uniform loads are lbs per lineal ft.

Yang Residence — Upper Floor Framing Plan

B8 (D+W) — Date: 6/28/19

Selection **W 10x 26 50 ksi Wide Flange Steel** — Lateral Support: Lc = 5.2 ft max.

Conditions Actual Size is 5-3/4 x 10-3/8 in.

Min Bearing Length R1= 0.9 in. R2= 0.9 in. (1.0) DL Defl= 0.17 in Recom Camber= 0.25 in

Data

Beam Span	14.0 ft	Reaction 1 LL	1128 #	Reaction 2 LL	1302 #
Beam Wt per ft	26.0 #	Reaction 1 TL	6240 #	Reaction 2 TL	5248 #
Bm Wt Included	364 #	Maximum V	6240 #		
Max Moment	28276 '#	Max V (Reduced)	N/A		
TL Max Defl	L / 240	TL Actual Defl	L / 757		
LL Max Defl	L / 480	LL Actual Defl	L / >1000		

Attributes

	Section (in³)	Shear (in²)	TL Defl (in)	LL Defl
Actual	27.90	2.69	0.22	0.06
Critical	10.28	0.31	0.70	0.35
Status	OK	OK	OK	OK
Ratio	37%	12%	32%	16%

Values

	Fb (psi)	Fv (psi)	E (psi x mil)
Ref. Value Fy	50000	50000	29.0
Adjusted Values	33000	20000	29.0

Adjustments

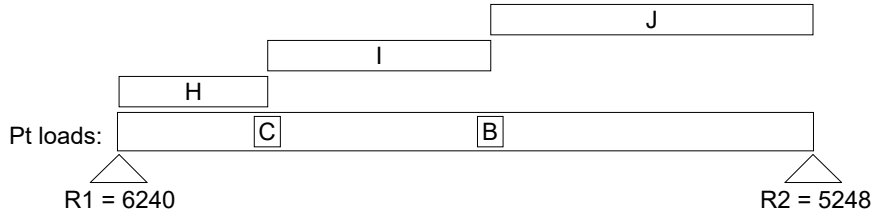
YP Factor, Lc 0.66 0.40

At Point Loads: Provide these minimum bearing lengths in inches or provide web stiffeners.

B = 0.9 C = 0.9

Loads

Point LL	Point TL	Distance	Par Unif TL	Start	End
2430	B = 4170	7.5	H = 406	0	3.0
	C = 546	3.0	I = 792	3.0	7.5
			J = 250	7.5	14.0



SPAN = 14 FT

Uniform and partial uniform loads are lbs per lineal ft.

Yang Residence — Upper Floor Framing Plan

B8 (Overstrengthn) — Date: 6/28/19

Selection **W 10x 26 50 ksi Wide Flange Steel** — Lateral Support: Lc = 5.2 ft max.

Conditions Actual Size is 5-3/4 x 10-3/8 in.

Min Bearing Length R1= 0.9 in. R2= 0.9 in. (1.0) DL Defl= 0.35 in Recom Camber= 0.53 in

Data

Beam Span	14.0 ft				
Beam Wt per ft	26.0 #	Reaction 1 TL	9071 #	Reaction 2 TL	8226 #
Bm Wt Included	364 #	Maximum V	9071 #		
Max Moment	46810 '#	Max V (Reduced)	N/A		
TL Max Defl	L / 240	TL Actual Defl	L / 479		

Attributes

	Section (in³)	Shear (in²)	TL Defl (in)
Actual	27.90	2.69	0.35
Critical	17.02	0.45	0.70
Status	OK	OK	OK
Ratio	61%	17%	50%

Values

	Fb (psi)	Fv (psi)	E (psi x mil)
Ref. Value Fy	50000	50000	29.0
Adjusted Values	33000	20000	29.0

Adjustments

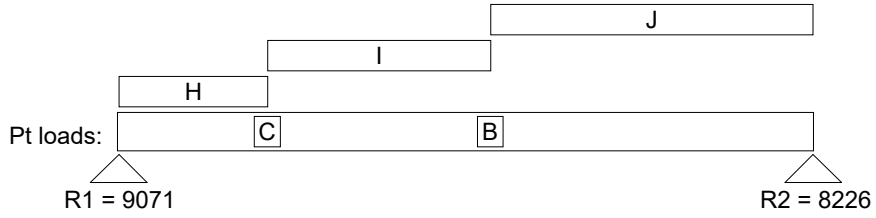
YP Factor, Lc 0.66 0.40

At Point Loads: Provide these minimum bearing lengths in inches or provide web stiffeners.

B = 0.9 C = 0.9

Loads

Point TL	Distance	Par Unif TL	Start	End
B = 8930	7.5	H = 467	0	3.0
C = 630	3.0	I = 911	3.0	7.5
		J = 288	7.5	14.0

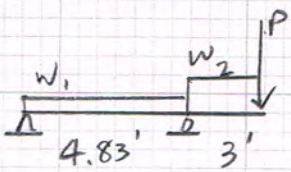


SPAN = 14 FT

Uniform and partial uniform loads are lbs per lineal ft.

UPPER FLR FRMG CONT...

B11



D+L: $W_1 = 22.5$ PLF DL

$W_2 = 75(3/2) = 113$ PLF (90 PLF LL)

$P = 2.14^k$ (1.2^k LL)

$f_b = 1399$ psi

$f_v = 82$ psi

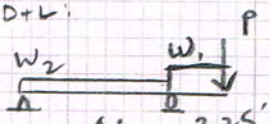
$\Delta_{TL} = L/<1000$

5½ x 9 GLB

$R_1 = -1.6^k$

$R_2 = 4.27^k$ (2.423^k_{LL})

B12 D+L:



$P = 75(3/2)(8/2) = 0.45^k$ (0.36^k LL)

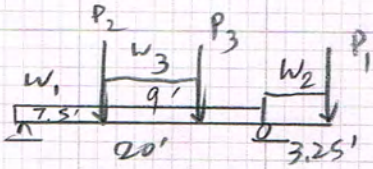
$W_1 = 40$ PLF DL $W_2 = 13.3$ PLF DL

$f_b = 412$ psi 4x10

$f_v = 28$ psi $R_1 = -0.39^k$

$\Delta_{TL} = L/<1000$ $R_2 = 1.08^k$ (0.653^k_{LL})

B13



D+L:

$P_2 = 0.67^k$ (0.48^k_{LL}) $W_1 = 65(1.33) = 86.5$ PLF (53.2 PLF LL)

$P_3 = 0.358^k$ (0.22^k_{LL}) $W_2 = 40$ PLF DL $W_3 = 65(5.5/2) = 179$ PLF (110 PLF LL)

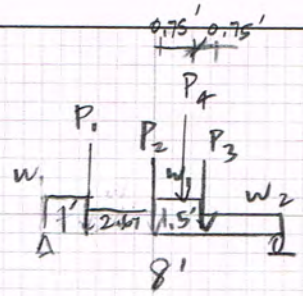
$P_1 = 1.29^k$ (0.691^k LL)

$f_b = 897$ psi 5¼ X 11⅞ PSL

$f_v = 56$ psi $R_1 = 1.65^k$ (0.921^k LL)

$\Delta_{TL} = L/452$ $R_2 = 3.82^k$ (1.98^k LL)

B14



D+L

$W_1 = 75(20/2) + 10(4+10.2) + 65(20/2) + 75(3/2) = 1655$ PLF (1090 PLF LL)

$W_2 = 65(20/2) + 75(3/2) = 763$ PLF (490 PLF LL)

$P_1 = P_2 = [75(20/2) + 40]\, 2.67/2 = 1.055^k$ (0.801^k LL)

$P_3 = [75(20/2) + 40]\, 4.08/2 = 1.612^k$ (1.224^k LL)

$P_4 = 3.82$ ~~2.621~~ ^{k} (1.98 ~~1.354~~ ^{k} LL)

W8 x 21 $b = 5\frac{1}{4}$"

$d = 8\frac{1}{4}$"

$R_1 = 8.35^k$ (5.4^k LL)

$R_2 = 7.7^k$ (4.85^k LL)

SEE B14 OUTPUT ON PG 68

D+W

$W_1 = 565$ PLF DL

$W_2 = 273$ PLF DL

$P_1 = 0.254 + 0.243(9.08) = 2.5^k$ (2.21)

$P_2 = 0.254^k$ DL

$P_3 = 0.39^k$ DL

$P_4 = 1.84$ ~~1.287~~ ^{k} DL

W8x21. $R_1 = 7.04^k$ (4.33^k_{LL})

$R_2 = 3.163^k$ (0.62^k_{LL})

SEE B14 (D+W) OUTPUT ON PG 69

PROJECT YANG RES.

DATE 6/27/19

PROJ. NO. 19-065

DESIGN CKS

SHEET 67

Yang Residence — Upper Floor Framing Plan

B14 (D+L) — Date: 6/28/19

Selection **W 8x 21 50 ksi Wide Flange Steel** — Lateral Support: Lc = 4.7 ft max.

Conditions Actual Size is 5-1/4 x 8-1/4 in.

Min Bearing Length R1= 0.8 in. R2= 0.8 in. (1.0) DL Defl= 0.04 in Recom Camber= 0.06 in

Data

Beam Span	8.0 ft	Reaction 1 LL	5379 #	Reaction 2 LL	4847 #
Beam Wt per ft	21.0 #	Reaction 1 TL	8345 #	Reaction 2 TL	7699 #
Bm Wt Included	168 #	Maximum V	8345 #		
Max Moment	21056 '#	Max V (Reduced)	N/A		
TL Max Defl	L / 360	TL Actual Defl	L / 923		
LL Max Defl	L / 480	LL Actual Defl	L / >1000		

Attributes

	Section (in³)	Shear (in²)	TL Defl (in)	LL Defl
Actual	18.20	2.07	0.10	0.07
Critical	7.66	0.42	0.27	0.20
Status	OK	OK	OK	OK
Ratio	42%	20%	39%	33%

Values

	Fb (psi)	Fv (psi)	E (psi x mil)
Ref. Value Fy	50000	50000	29.0
Adjusted Values	33000	20000	29.0

Adjustments

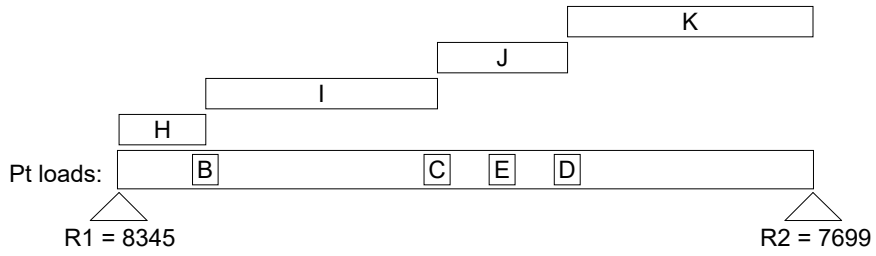
YP Factor, Lc 0.66 0.40

At Point Loads: Provide these minimum bearing lengths in inches or provide web stiffeners.

B = 0.8 C = 0.8 D = 0.8 E = 0.8

Loads

Point LL	Point TL	Distance	Par Unif LL	Par Unif TL	Start	End
801	B = 1055	1.0	1090	H = 1655	0	1.0
801	C = 1055	3.67	490	I = 763	1.0	3.67
1224	D = 1612	5.17	1090	J = 1655	3.67	5.17
1980	E = 3820	4.42	490	K = 763	5.17	8.0



SPAN = 8 FT

Uniform and partial uniform loads are lbs per lineal ft.

Yang Residence — Upper Floor Framing Plan

B14 (D+W) — Date: 6/28/19

Selection **W 8x 21 50 ksi Wide Flange Steel** — Lateral Support: Lc = 4.7 ft max.

Conditions Actual Size is 5-1/4 x 8-1/4 in.

Min Bearing Length R1= 0.8 in. R2= 0.8 in. (1.0) DL Defl= 0.04 in Recom Camber= 0.06 in

Data

Beam Span	8.0 ft	Reaction 1 LL	1934 #	Reaction 2 LL	276 #
Beam Wt per ft	21.0 #	Reaction 1 TL	4927 #	Reaction 2 TL	3111 #
Bm Wt Included	168 #	Maximum V	4927 #		
Max Moment	8933 '#	Max V (Reduced)	N/A		
TL Max Defl	L / 360	TL Actual Defl	L / >1000		
LL Max Defl	L / 480	LL Actual Defl	L / >1000		

Attributes

	Section (in³)	Shear (in²)	TL Defl (in)	LL Defl
Actual	18.20	2.07	0.05	<0.01
Critical	3.25	0.25	0.27	0.20
Status	OK	OK	OK	OK
Ratio	18%	12%	17%	4%

Values

	Fb (psi)	Fv (psi)	E (psi x mil)
Ref. Value Fy	50000	50000	29.0
Adjusted Values	33000	20000	29.0

Adjustments

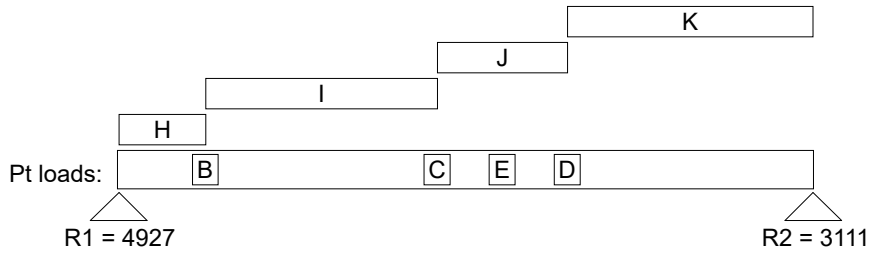
YP Factor, Lc 0.66 0.40

At Point Loads: Provide these minimum bearing lengths in inches or provide web stiffeners.

B = 0.8 C = 0.8 D = 0.8 E = 0.8

Loads

Point LL	Point TL	Distance	Par Unif TL	Start	End
2210	B = 2500	1.0	H = 565	0	1.0
	C = 254	3.67	I = 273	1.0	3.67
	D = 390	5.17	J = 565	3.67	5.17
	E = 1840	4.42	K = 263	5.17	8.0



SPAN = 8 FT

Uniform and partial uniform loads are lbs per lineal ft.

UPPER FLR FRMG CONT,...

B14 CONT...

1.15D+Ω$_o$E - OVERSTRENGTH - f_b check only

$W_1 = 650$ PLF

$W_2 = 314$ PLF

$P_1 = 0.292 + 2.5(3.74) = 9.642^K$

$P_2 = 0.292^K$

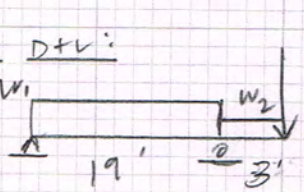
$P_3 = 0.45^K$

$P_4 = 2.12^K$

W8x21 OK

SEE B14 (OVERSTRENGTH) OUTPUT ON G11

B15 D+L:



$W_1 = 75(4/2) + 40 = 190$ PLF (120^{PLF}_{LL})

$W_2 = 40$ PLF DL

$P = [75(13/2) + 40](14/2) = 1.068^K$ (0.63^K_{LL})

C12x20.7

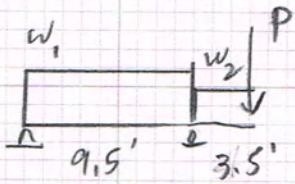
C12x20.7

$R_1 = 1.754^K$ (1.041^K_{LL})

$R_2 = 3.35^K$ (1.87^K_{LL})

SEE B15 OUTPUT ON PG G13

B16



D+L:

$W_1 = 65(19/2) + 75(3/2) = 730^{PLF}$ (470^{PLF}_{LL})

$W_2 = 75(3/2) = 113$ PLF (90^{PLF}_{LL})

$P = 3.34^K$ (1.87^K_{LL})

W8x21 $b = 5\frac{1}{4}"$

$d = 8\frac{1}{4}"$

$R_1 = 2.25^K$ (1.49^K_{LL})

$R_2 = 8.693^K$ (5.164^K_{LL})

SEE B16 OUTPUT ON G12

B17 D+L:

$l = 4.67'$

$W = 65(33/2) = 1073^{PLF}$ (660^{PLF}_{LL})

$f_b = 826$ psi (2) 2x10

$f_v = 136$ psi $R = 2.521^K$ (1.541^K_{LL})

$\Delta_{LL} = L/>1000$

PROJECT YANG RES.

DATE 6/27/19

PROJ. NO. 19-065

DESIGN CKS

SHEET G10

Yang Residence — Upper Floor Framing Plan

B14 (Overstrength) — Date: 6/28/19

Selection **W 8x 21 50 ksi Wide Flange Steel** — Lateral Support: Lc = 4.7 ft max.

Conditions Actual Size is 5-1/4 x 8-1/4 in.

Min Bearing Length R1= 0.8 in. R2= 0.8 in. (1.0) DL Defl= 0.08 in Recom Camber= 0.12 in

Data

Beam Span	8.0 ft				
Beam Wt per ft	21.0 #	Reaction 1 TL	11583 #	Reaction 2 TL	4441 #
Bm Wt Included	168 #	Maximum V	11583 #		
Max Moment	13451 '#	Max V (Reduced)	N/A		
TL Max Defl	L / 360	TL Actual Defl	L / >1000		

Attributes

	Section (in³)	Shear (in²)	TL Defl (in)
Actual	18.20	2.07	0.08
Critical	4.89	0.58	0.27
Status	OK	OK	OK
Ratio	27%	28%	29%

Values

	Fb (psi)	Fv (psi)	E (psi x mil)
Ref. Value Fy	50000	50000	29.0
Adjusted Values	33000	20000	29.0

Adjustments

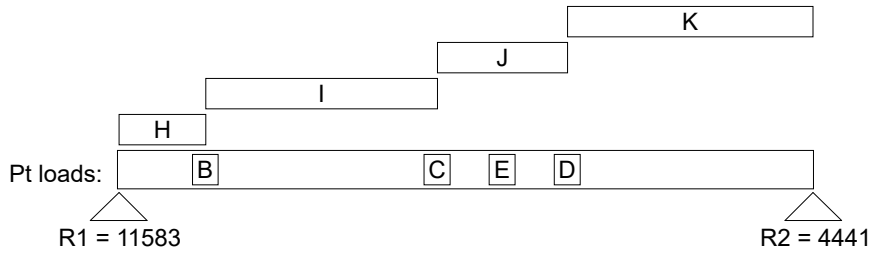
YP Factor, Lc 0.66 0.40

At Point Loads: Provide these minimum bearing lengths in inches or provide web stiffeners.

B = 0.8 C = 0.8 D = 0.8 E = 0.8

Loads

Point TL	Distance	Par Unif TL	Start	End
B = 9642	1.0	H = 650	0	1.0
C = 292	3.67	I = 314	1.0	3.67
D = 450	5.17	J = 650	3.67	5.17
E = 2120	4.42	K = 314	5.17	8.0



SPAN = 8 FT

Uniform and partial uniform loads are lbs per lineal ft.

Yang Residence — Upper Floor Framing Plan

B16 — Date: 6/28/19

Selection **W 8x 21 50 ksi Wide Flange Steel** — Lateral Support: Lc = 4.7 ft max.

Conditions Actual Size is 5-1/4 x 8-1/4 in., Overhang

Min Bearing Length R1= 0.8 in. R2= 0.8 in. (1.0) DL Defl= 0.04 in.

Data

Beam Span	9.5 ft	Reaction 1 LL	1486 #	Reaction 2 LL	5164 #
Beam Wt per ft	21.0 #	Reaction 1 TL	2250 #	Reaction 2 TL	8693 #
Bm Wt Included	273 #	Maximum V	4884 #	Overhang Length	3.5 ft
Max Moment	12511 '#	Max V (Reduced)	N/A	Total Beam Length	13.0 ft
TL Max Defl	L / 360	TL Actual Defl	L / >1000	OH TL Actual Defl	L / >1000
LL Max Defl	L / 480	LL Actual Defl	L / >1000	OH LL Actual Defl	L / >1000

Attributes

	Section (in³)	Shear (in²)	TL Defl (in)	LL Defl	OH TL Defl	OH LL Defl
Actual	18.20	2.07	0.01	<0.01	0.07	0.04
Critical	4.53	0.24	0.32	0.24	0.23	0.18
Status	OK	OK	OK	OK	OK	OK
Ratio	25%	12%	2%	3%	31%	20%

Values

	Fb (psi)	Fv (psi)	E (psi x mil)
Ref. Value Fy	50000	50000	29.0
Adjusted Values	33000	20000	29.0

Adjustments

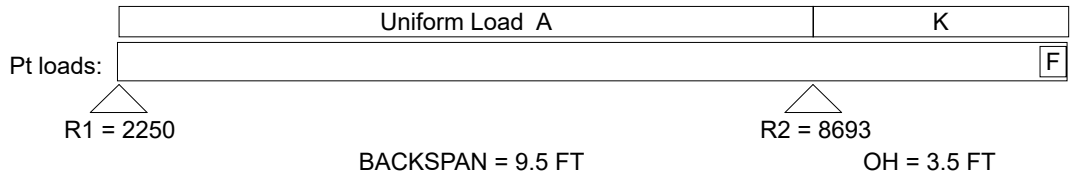
YP Factor, Lc 0.66 0.40

At Point Loads: Provide these minimum bearing lengths in inches or provide web stiffeners.

F = 0.8

Loads Uniform LL: 470 Uniform TL: 730 = A (Uniform Ld on Backspan)

Point LL	Point TL	Distance	Par Unif LL	Par Unif TL	Start	End
1870	F = 3340 (OH)	3.5	90	K = 113 (OH)	0	3.5



Uniform and partial uniform loads are lbs per lineal ft. Overhanging load distances are from R2.

Yang Residence — Upper Floor Framing

B15 — Date: 6/28/19

Selection **C 12x 20.7 50 ksi Steel Channel** — Lateral Support: Lu = 4.1 ft max.

Conditions Actual Size is 3 x 12 in., Overhang

Min Bearing Length R1= 1.1 in. R2= 1.1 in. (1.0) DL Defl= 0.05 in.

Data

Beam Span	19.0 ft	Reaction 1 LL	1041 #	Reaction 2 LL	1869 #
Beam Wt per ft	20.7 #	Reaction 1 TL	1819 #	Reaction 2 TL	3435 #
Bm Wt Included	455 #	Maximum V	2185 #	Overhang Length	3.0 ft
Max Moment	7705 '#	Max V (Reduced)	N/A	Total Beam Length	22.0 ft
TL Max Defl	L / 360	TL Actual Defl	L / >1000	OH TL Actual Defl	L / < -1000
LL Max Defl	L / 480	LL Actual Defl	L / >1000	OH LL Actual Defl	L / < -1000

Attributes

	Section (in³)	Shear (in²)	TL Defl (in)	LL Defl	OH TL Defl	OH LL Defl
Actual	21.50	3.38	0.13	0.07	-0.05	-0.03
Critical	3.08	0.11	0.63	0.48	0.20	0.15
Status	OK	OK	OK	OK	OK	OK
Ratio	14%	3%	20%	16%	25%	19%

Values

	Fb (psi)	Fv (psi)	E (psi x mil)
Ref. Value Fy	50000	50000	29.0
Adjusted Values	30000	20000	29.0

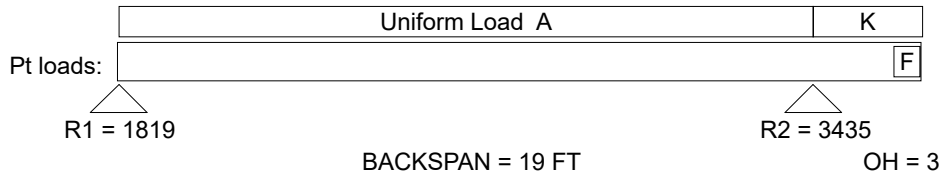
Adjustments

YP Factor, Lu 0.60 0.40

At Point Loads: Provide these minimum bearing lengths in inches or provide web stiffeners.
F = 1.1

Loads Uniform LL: 120 Uniform TL: 190 = A (Uniform Ld on Backspan)

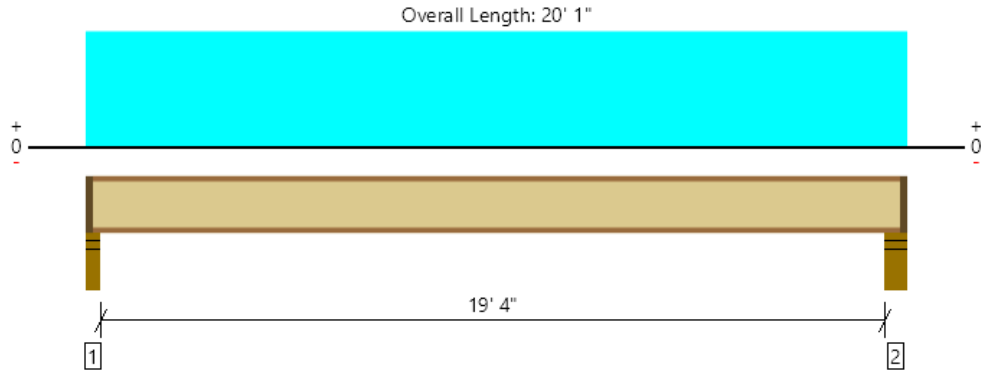
Point LL	Point TL	Distance	Par Unif TL	Start	End
630	F = 1068 (OH)	3.0	K = 40 (OH)	0	3.0



Uniform and partial uniform loads are lbs per lineal ft. Overhanging load distances are from R2.

Roof Deck, Deck: Joist

1 piece(s) 11 7/8" TJI® 560 @ 16" OC



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)	981 @ 2 1/2"	1265 (1.75")	Passed (78%)	1.00	1.0 D + 1.0 L (All Spans)
Shear (lbs)	967 @ 3 1/2"	2050	Passed (47%)	1.00	1.0 D + 1.0 L (All Spans)
Moment (Ft-lbs)	4753 @ 9' 11 1/2"	9500	Passed (50%)	1.00	1.0 D + 1.0 L (All Spans)
Live Load Defl. (in)	0.419 @ 9' 11 1/2"	0.488	Passed (L/558)	--	1.0 D + 1.0 L (All Spans)
Total Load Defl. (in)	0.524 @ 9' 11 1/2"	0.975	Passed (L/446)	--	1.0 D + 1.0 L (All Spans)
TJ-Pro™ Rating	50	45	Passed	--	--

System : Floor
Member Type : Joist
Building Use : Residential
Building Code : IBC 2015
Design Methodology : ASD

- Deflection criteria: LL (L/480) and TL (L/240).
- Top Edge Bracing (Lu): Top compression edge must be braced at 8' 1" o/c unless detailed otherwise.
- Bottom Edge Bracing (Lu): Bottom compression edge must be braced at 19' 10" o/c unless detailed otherwise.
- A structural analysis of the deck has not been performed.
- Deflection analysis is based on composite action with a single layer of 23/32" Weyerhaeuser Edge™ Panel (24" Span Rating) that is glued and nailed down.
- Additional considerations for the TJ-Pro™ Rating include: 1/2" Gypsum ceiling.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Floor Live	Total	
1 - Stud wall - HF	3.50"	1.75"	1.75"	199	797	996	1 3/4" Rim Board
2 - Stud wall - HF	5.50"	3.75"	1.75"	203	810	1013	1 3/4" Rim Board

- Rim Board is assumed to carry all loads applied directly above it, bypassing the member being designed.

Vertical Load	Location (Side)	Spacing	Dead (0.90)	Floor Live (1.00)	Comments
1 - Uniform (PSF)	0 to 20' 1"	16"	15.0	60.0	Default Load

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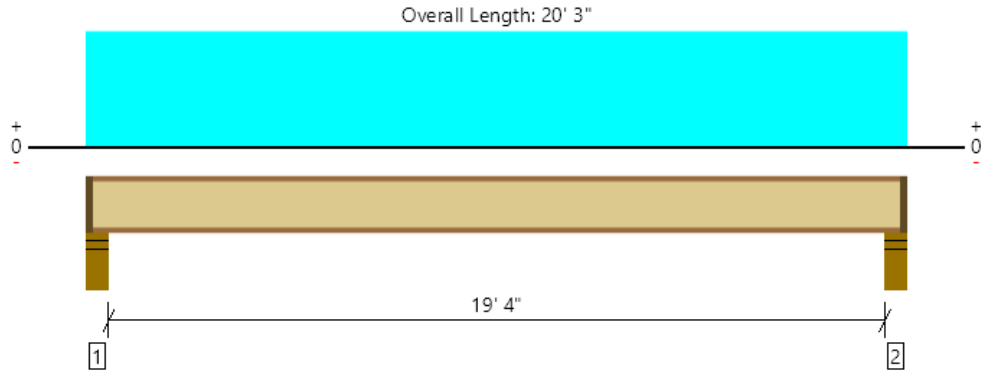
The product application, input design loads, dimensions and support information have been provided by CKS

Weyerhaeuser SUSTAINABLE FORESTRY INITIATIVE

ForteWEB Software Operator	Job Notes
Chris Simpliciano Nickerson Engineering, LLC (425) 610-4425 simpliciano@nickersonengineering.com	

Upper Floor, Floor: Joist (19.33' Span)
1 piece(s) 11 7/8" TJI® 560 @ 16" OC



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)	865 @ 4 1/2"	1725 (3.50")	Passed (50%)	1.00	1.0 D + 1.0 L (All Spans)
Shear (lbs)	838 @ 5 1/2"	2050	Passed (41%)	1.00	1.0 D + 1.0 L (All Spans)
Moment (Ft-lbs)	4119 @ 10' 1 1/2"	9500	Passed (43%)	1.00	1.0 D + 1.0 L (All Spans)
Live Load Defl. (in)	0.280 @ 10' 1 1/2"	0.488	Passed (L/837)	--	1.0 D + 1.0 L (All Spans)
Total Load Defl. (in)	0.454 @ 10' 1 1/2"	0.975	Passed (L/515)	--	1.0 D + 1.0 L (All Spans)
TJ-Pro™ Rating	50	45	Passed	--	--

System : Floor
Member Type : Joist
Building Use : Residential
Building Code : IBC 2015
Design Methodology : ASD

- Deflection criteria: LL (L/480) and TL (L/240).
- Top Edge Bracing (Lu): Top compression edge must be braced at 8' 9" o/c unless detailed otherwise.
- Bottom Edge Bracing (Lu): Bottom compression edge must be braced at 20' o/c unless detailed otherwise.
- A structural analysis of the deck has not been performed.
- Deflection analysis is based on composite action with a single layer of 23/32" Weyerhaeuser Edge™ Panel (24" Span Rating) that is glued and nailed down.
- Additional considerations for the TJ-Pro™ Rating include: 1/2" Gypsum ceiling.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Floor Live	Total	
1 - Stud wall - HF	5.50"	3.75"	1.75"	338	540	878	1 3/4" Rim Board
2 - Stud wall - HF	5.50"	3.75"	1.75"	338	540	878	1 3/4" Rim Board

- Rim Board is assumed to carry all loads applied directly above it, bypassing the member being designed.

Vertical Load	Location (Side)	Spacing	Dead (0.90)	Floor Live (1.00)	Comments
1 - Uniform (PSF)	0 to 20' 3"	16"	25.0	40.0	Default Load

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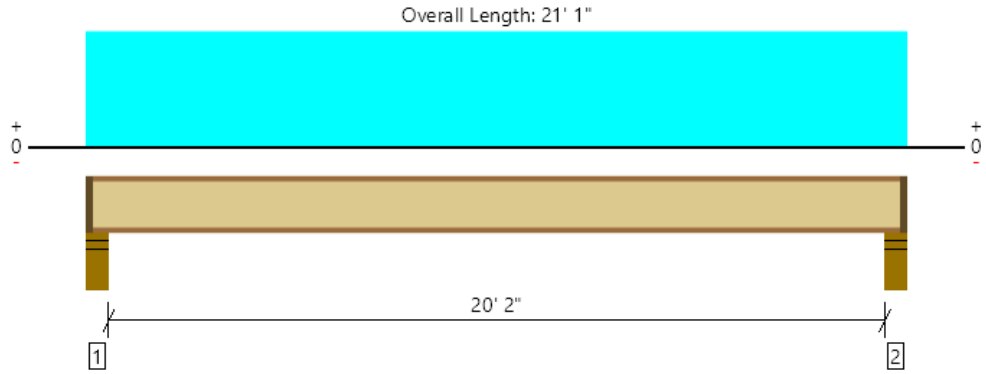
The product application, input design loads, dimensions and support information have been provided by CKS

Weyerhaeuser SUSTAINABLE FORESTRY INITIATIVE

ForteWEB Software Operator	Job Notes
Chris Simpliciano Nickerson Engineering, LLC (425) 610-4425 simpliciano@nickersonengineering.com	

Upper Floor, Floor: Joist (20.16' Span)
1 piece(s) 11 7/8" TJI® 560 @ 16" OC



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)	901 @ 4 1/2"	1725 (3.50")	Passed (52%)	1.00	1.0 D + 1.0 L (All Spans)
Shear (lbs)	874 @ 5 1/2"	2050	Passed (43%)	1.00	1.0 D + 1.0 L (All Spans)
Moment (Ft-lbs)	4479 @ 10' 6 1/2"	9500	Passed (47%)	1.00	1.0 D + 1.0 L (All Spans)
Live Load Defl. (in)	0.327 @ 10' 6 1/2"	0.508	Passed (L/747)	--	1.0 D + 1.0 L (All Spans)
Total Load Defl. (in)	0.531 @ 10' 6 1/2"	1.017	Passed (L/459)	--	1.0 D + 1.0 L (All Spans)
TJ-Pro™ Rating	47	45	Passed	--	--

System : Floor
Member Type : Joist
Building Use : Residential
Building Code : IBC 2015
Design Methodology : ASD

- Deflection criteria: LL (L/480) and TL (L/240).
- Top Edge Bracing (Lu): Top compression edge must be braced at 8' 4" o/c unless detailed otherwise.
- Bottom Edge Bracing (Lu): Bottom compression edge must be braced at 20' 10" o/c unless detailed otherwise.
- A structural analysis of the deck has not been performed.
- Deflection analysis is based on composite action with a single layer of 23/32" Weyerhaeuser Edge™ Panel (24" Span Rating) that is glued and nailed down.
- Additional considerations for the TJ-Pro™ Rating include: 1/2" Gypsum ceiling.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Floor Live	Total	
1 - Stud wall - HF	5.50"	3.75"	1.75"	351	562	913	1 3/4" Rim Board
2 - Stud wall - HF	5.50"	3.75"	1.75"	351	562	913	1 3/4" Rim Board

- Rim Board is assumed to carry all loads applied directly above it, bypassing the member being designed.

Vertical Load	Location (Side)	Spacing	Dead (0.90)	Floor Live (1.00)	Comments
1 - Uniform (PSF)	0 to 21' 1"	16"	25.0	40.0	Default Load

Weyerhaeuser Notes

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The product application, input design loads, dimensions and support information have been provided by CKS

Weyerhaeuser SUSTAINABLE FORESTRY INITIATIVE

ForteWEB Software Operator	Job Notes
Chris Simpliciano Nickerson Engineering, LLC (425) 610-4425 simpliciano@nickersonengineering.com	

Seismic Design Loads (ASCE 7-10)

for a Wood Framed Structure

OCCUPANCY CAT.	II	Table 1.5-1
IMP. FACTOR	1	Table 1.5-2
SITE CLASS	D	Table 20.3-1
R =	6.5	Table 12.2-1
h =	27.24	ft

S_S =	1.452	2010 ASCE 7 Standard (http://geohazards.usgs.gov/designmaps)
S_1 =	0.553	2010 ASCE 7 Standard (http://geohazards.usgs.gov/designmaps)
S_{MS} =	1.452	Table 11.4-1
S_{M1} =	0.83	Table 11.4-2
S_{DS}=	0.968	
S_{D1}=	0.553333333	

Period, T=	0.238470863	Eqn. 12.8-7
C_s=	0.148923077	Eqn. 12.8-2
C_{smax}=	0.356975289	Eqn. 12.8-3
C_{smin}=	0.01	Eqn. 12.8-5

Base Shear, V =	**10518 lbs**	**(ASD)**

Shearwalls	DL (psf)	A (sq.ft.)	W (#'s)	h_x (ft)	$W*h_x$	C_{vx}	**Lat. Load (lbs)**
2nd Flr Shearwalls	25	2300	57500	23.5	1351250	0.727537	**7653**
1st Flr Shearwalls	20	2170	43400	11.66	506044	0.272463	**2866**
		Sum=	100900	Sum=	1857294		

Diaphragm Forces (per ASCE 7-10 12.10.1.1)

level	lower limit	upper limit	sum F	sum W	calc'd force	**Diaphragm Load (lbs)**
Roof	7792.4	15584.8	7653	57500	7652.6	**7792**
2nd	5881.568	11763.14	10518	100900	4524.3	**5882**

Wind Design Loads (ASCE 7-10)

Directional Procedure

ALL wind directions

Exposure	C			Roof Angle =	0	degrees
V=	110	mph		Ground to top of roof	27.24	ft
K_d=	0.85		Table 26.6-1	Bottom of roof to top of roof	0	ft
I=	1		Table 1.5-2	(mean roof height) h=	27.24	ft
G=	0.85		Section 26.9			

Topography from Figure 26.8-1

Terrain=		(ridge, hill, escarpment)
Site=		(**UP**wind or **DOWN**wind)
H=		ft height of topography
L_h=		ft distance from H/2 to crest>0
x=		ft distance from crest to site
z=		ft Height from bottom of topo. to site
μ=	1.5	
γ=	4	
K_1 value =	1.05	
$K_{1=}$		
$K_{2=}$		
$K_{3=}$		

$K_{zt}= (1+K_1K_2K_3)^2 =$ **1.00** **Per Mercer Island Wind Map**

Pressure Coefficients from Figure 27.4-1:

Bldg Face	C_p
Windward Wall	0.8
Leeward Wall	-0.5
Windward Roof	0
Leeward Roof	-0.6

*Note= Cp values are conservative worst case values

Pressures:

Ht	K_z	$0.6*q_z^{**}$	$P_{ww\ walls}$	$P_{lwwalls}$	**P_{walls} (psf)**
0-15	0.85	13.43	9.13	6.58	**15.71**
15-20	0.9	14.22	9.67	6.58	**16.25**
20-25	0.94	14.85	10.10	6.58	**16.68**
25-30	0.98	15.48	10.53	6.58	**17.11**
30-40	1.04	16.43	11.17	6.58	**17.75**

P_{roof} (psf)

7.90

****NOTE: Wind pressures are ASD**

Wind Forces **Yang Residence**

LEVEL	NORTH TO SOUTH				EAST TO WEST			
Second Floor Shearwalls	Pressures		Wind Area	Force	Pressures		Wind Area	Force
	P_{roof} =	7.90	0.00	0	P_{roof} =	7.90	0.00	0
	P_{30-40} =	17.75	0.00	0	P_{30-40} =	17.75	0.00	0
	P_{25-30} =	17.11	64.13	1097.097197	P_{25-30} =	17.11	84.38	1443.521931
	P_{20-25} =	16.68	265.63	4430.096184	P_{20-25} =	16.68	231.58	3862.220662
	P_{15-20} =	16.25	148.55	2413.63983	P_{15-20} =	16.25	125.49	2038.961038
	P_{0-15} =	15.71	0.00	0	P_{0-15} =	15.71	0.00	0
			SUM	7940.833211			SUM	7344.703631
First Floor Shearwalls	Pressures		Wind Area	Force	Pressures		Wind Area	Force
	P_{roof} =	7.90	0.00	0	P_{roof} =	7.90	0.00	0
	P_{30-40} =	17.75	0.00	0	P_{30-40} =	17.75	0.00	0
	P_{25-30} =	17.11	0.00	0	P_{25-30} =	17.11	0.00	0
	P_{20-25} =	16.68	0.00	0	P_{20-25} =	16.68	0.00	0
	P_{15-20} =	16.25	121.28	1970.556974	P_{15-20} =	16.25	103.03	1674.031044
	P_{0-15} =	15.71	503.40	7908.853126	P_{0-15} =	15.71	424.70	6672.407474
			SUM	9879.4101			SUM	8346.438519

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Shear Wall Lengths **Yang Residence**
Second Floor Shearwalls

	h_{max}	wall 1	wall 2	wall 3	wall 4	wall 5	wall 6	wall 7	wall 8	wall 9	wall 10	SUM
grid 1	10.16	5.83	7.08	15.25								28.16
aspect ratio reduc		5.83	7.08	15.25								28.16
grid 2	10.16	12.16										12.16
aspect ratio reduc		12.16										12.16
grid 3	10.16	15.75										15.75
aspect ratio reduc		15.75										15.75
grid 4	10.16	8.33	3.67									12
aspect ratio reduc		8.33	2.651358									10.98135827
grid 5												0
aspect ratio reduc												0
grid 6												0
aspect ratio reduc												0
grid A	10.16	20.75										20.75
aspect ratio reduc		20.75										20.75
grid B	10.16	6.92										6.92
aspect ratio reduc		6.92										6.92
grid C	10.16	4.16	4.75									8.91
aspect ratio reduc		3.406614173	4.441437									7.848051181
grid D	10.16	3.16	3									6.16
aspect ratio reduc		1.965669291	1.771654									3.737322835
grid E												0
aspect ratio reduc												0
grid F												0
aspect ratio reduc												0

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Shear Wall Lengths **Yang Residence**
First Floor Shearwalls

	h_{max}	wall 1	wall 2	wall 3	wall 4	wall 5	wall 6	wall 7	wall 8	wall 9	wall 10	SUM
grid 1	11.16	20.16	2	2								24.16
aspect ratio reduc		20.16	1.142857	1.142857								22.44571429
grid 2	11.16	14.16										14.16
aspect ratio reduc		14.16										14.16
grid 3	11.16	5.5										5.5
aspect ratio reduc		5.421146953										5.421146953
grid 4	11.16	8.42	10.67									19.09
aspect ratio reduc		8.42	10.67									19.09
grid 5												0
aspect ratio reduc												0
grid 6												0
aspect ratio reduc												0
grid A	11.16	15.08	8.42									23.5
aspect ratio reduc		15.08	8.42									23.5
grid B	11.16	20.08										20.08
aspect ratio reduc		20.08										20.08
grid C	11.16	7.16	4.75									11.91
aspect ratio reduc		7.16	4.043459									11.20345878
grid D	11.16	4										4
aspect ratio reduc		2.867383513										2.867383513
grid E												0
aspect ratio reduc												0
grid F												0
aspect ratio reduc												0

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FORCE DISTRIBUTION **Yang Residence**

SECOND FLOOR SHEARWALLS

story shears: Vs = 7653 Vw = 7345 east to west
Vw = 7941 north to south

	grid	$V_{seismic}$ (lbs)	V_{wind} (lbs)	$\sum l_{wall\ S}$ (ft)	$\sum l_{wall\ W}$ (ft)	$v_{u\ S}$ (plf)	$v_{u\ W}$ (plf)	SW	h (ft)	DL(lbs)	uplift (lbs)	holdown
E to W	1	1701	1632	28.16	28.16	**60**	58	SW1	10.16	194	419	NONE
	2	3019	2897	12.16	12.16	**248**	238	SW2	10.16	308	2214	(2)CS16
	3	2126	2040	15.75	15.75	**135**	130	SW1	10.16	110	1262	(1)CS16
	4	808	775	10.98136	12	**74**	65	SW1	10.16	435	313	NONE
	5											
	6											
N to S	A	1480	1536	20.75	20.75	71	**74**	SW1	10.16	1790	-1038	NONE
	B	2382	2472	6.92	6.92	344	**357**	SW3	10.16	566	3064	(2)CS16
	C	2346	2435	7.848051	8.91	**299**	273	SW2	10.16	265	2773	(2)CS16
	D	1444	1498	3.737323	6.16	**386**	243	SW3	10.16	183	3742	HTT5
	E											
	F											

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FORCE DISTRIBUTION **Yang Residence**

FIRST FLOOR SHEARWALLS

story shears: Vs = 10518 Vw = 15691 east to west
Vw = 17820 north to south

	grid	$V_{seismic}$ (lbs)	V_{wind} (lbs)	$\sum l_{wall\ S}$ (ft)	$\sum l_{wall\ W}$ (ft)	$v_{u\ S}$ (plf)	$v_{u\ W}$ (plf)	SW	h (ft)	DL(lbs)	uplift (lbs)	holdown
E to W	1	2576	3843	22.44571	24.16	115	**159**	SW1	11.16	76	1699	HTT5
	2	4240	6324	14.16	14.16	299	**447**	SW3	11.16	535	4449	HDQ8
	3	2683	4003	5.421147	5.5	495	**728**	SW4	11.16	208	7914	HDQ8
	4	1020	1521	19.09	19.09	53	**80**	SW1	11.16	318	571	NONE
	5											
	6											
N to S	A	2034	3446	23.5	23.5	87	**147**	SW1	11.16	596	1041	HTT5
	B	3275	5548	20.08	20.08	163	**276**	SW2	11.16	1855	1228	HTT5
	C	3225	5464	11.20346	11.91	288	**459**	SW4	11.16	319	7573	HDQ8
	D	1985	3362	2.867384	4	692	**841**	SW4	11.16	299	9082	HDQ8
	E											
	F											

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Cantilevered Retaining Wall

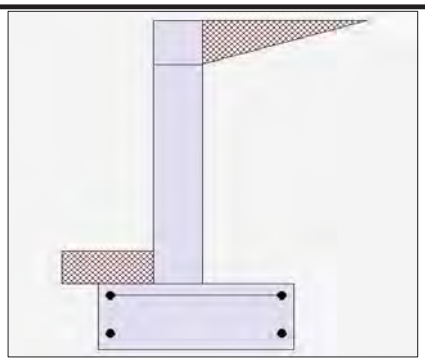
Code: IBC 2018,ACI 318-14,TMS 402-16

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	=	1,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing||Soil Friction	=	0.525
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 psf
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	=	8.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	40.000
Total Seismic Force	=	200.000

Design Summary

Wall Stability Ratios

Overturning	=	2.10	OK
Sliding	=	1.83	OK
Total Bearing Load	=	1,474 lbs	
...resultant ecc.	=	6.36 in	
Soil Pressure @ Toe	=	1,220 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	1,500 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,709 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	0.5 psi	OK
Footing Shear @ Heel	=	5.2 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	577.5 lbs	
less 100% Passive Force	= -	281.3 lbs	
less 100% Friction Force	= -	773.9 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 2018,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Stem Construction

		3rd	2nd	Bottom
		Stem OK	Stem OK	Stem OK
Design Height Above Ftg	ft =	4.00	3.33	0.00
Wall Material Above "Ht"	=	Concrete	Concrete	Concrete
Design Method	=	LRFD	LRFD	LRFD
Thickness	=	8.00	8.00	8.00
Rebar Size	=	# 4	# 4	# 4
Rebar Spacing	=	12.00	12.00	12.00
Rebar Placed at	=	Edge	Edge	Edge
Design Data				
fb/FB + fa/Fa	=	**-0.001**	**0.001**	**0.168**
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =		39.4	608.0
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =		11.8	917.3
Moment.....Allowable	ft-# =	5,359.5	5,359.5	5,412.6
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =		0.5	8.1
Shear.....Allowable	psi =	67.1	67.1	75.0
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =	6.25	6.25	6.25
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =	100.0	100.0	100.0
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	2,000.0	2,000.0	2,500.0
Fy	psi =	60,000.0	60,000.0	60,000.0

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Concrete Stem Rebar Area Details

3rd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0 in2/ft		
(4/3) * As :	0 in2/ft	Min Stem T&S Reinf Area 0.000 in2	
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.000 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@ 0.00 in	#4@ 0.00 in
Provided Area :	0.2 in2/ft	#5@ 0.00 in	#5@ 0.00 in
Maximum Area :	0.6773 in2/ft	#6@ 0.00 in	#6@ 0.00 in

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0004 in2/ft		
(4/3) * As :	0.0006 in2/ft	Min Stem T&S Reinf Area 0.129 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 :	0.6773 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0344 in2/ft		
(4/3) * As :	0.0458 in2/ft	Min Stem T&S Reinf Area 0.639 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	=	0.75 ft
Heel Width	=	1.92
Total Footing Width	=	2.67
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	=	1,709	0	psf
Mu' : Upward	=	5,170	1,410	ft-#
Mu' : Downward	=	861	7,352	ft-#
Mu: Design	=	146	6	ft-#
Actual 1-Way Shear	=	0.49	5.21	psi
Allow 1-Way Shear	=	40.00	40.00	psi

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 4 @ 18.00 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: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: No key defined

Min footing T&S reinf Area 0.69 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

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

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)	437.5	1.67	729.2			
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 =	140.0	2.50	350.0			
=						
Soil Over HL (ab. water tbl)				626.7	2.04	1,280.5
Soil Over HL (bel. water tbl)					2.04	1,280.5
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 =				46.9	0.38	17.6
Surcharge Over Toe =						
Stem Weight(s) =				400.0	1.08	433.3
Earth @ Stem Transitions =						
Footing Weight =				400.5	1.34	534.7
Key Weight =						
Vert. Component =						
Total =	577.5	**O.T.M.** =	1,079.2	**Total =** 1,474.0 lbs	**R.M.=**	2,266.1

Resisting/Overturning Ratio = **2.10**
Vertical Loads used for Soil Pressure = 1,474.0 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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)	0.000	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.

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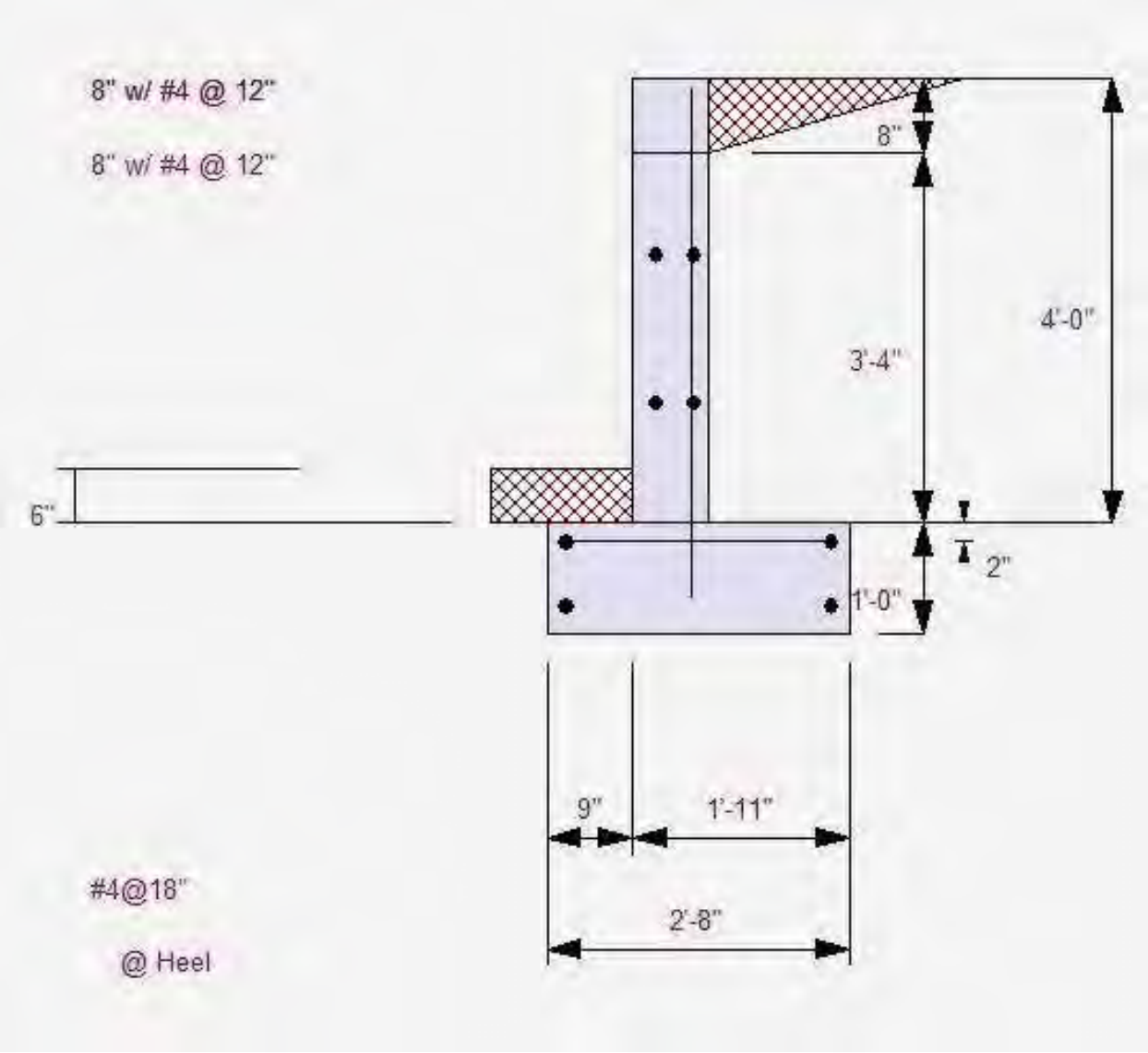
Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16



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Cantilevered Retaining Wall

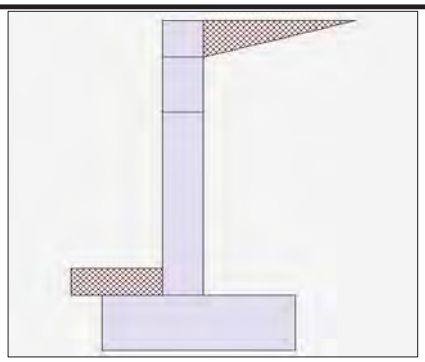
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	5.00 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	=	1,995.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing||Soil Friction	=	0.525
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 psf
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	=	8.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	48.000
Total Seismic Force	=	288.000

Design Summary

Wall Stability Ratios

Overturning	=	2.00	OK
Sliding	=	1.59	OK
Total Bearing Load	=	1,978 lbs	
...resultant ecc.	=	7.74 in	
Soil Pressure @ Toe	=	1,402 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	1,995 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,963 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	3.8 psi	OK
Footing Shear @ Heel	=	7.8 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	831.6 lbs	
less 100% Passive Force	= -	281.3 lbs	
less 100% Friction Force	= -	1,038.2 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

		3rd	2nd	Bottom
		Stem OK	Stem OK	Stem OK
Design Height Above Ftg	ft =	4.33	3.33	0.00
Wall Material Above "Ht"	=	Concrete	Concrete	Concrete
Design Method	=	LRFD	LRFD	LRFD
Thickness	=	8.00	8.00	8.00
Rebar Size	=	# 4	# 4	# 4
Rebar Spacing	=	12.00	12.00	12.00
Rebar Placed at	=	Edge	Edge	Edge
Design Data				
fb/FB + fa/Fa	=	**0.002**	**0.020**	**0.325**
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	44.7	158.2	940.0
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	13.6	110.4	1,766.7
Moment.....Allowable	ft-# =	5,359.5	5,359.5	5,412.6
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	0.6	2.1	12.5
Shear.....Allowable	psi =	67.1	67.1	75.0
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =	6.25	6.25	6.25
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =	100.0	100.0	100.0
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	2,000.0	2,000.0	2,500.0
Fy	psi =	60,000.0	60,000.0	60,000.0

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Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

3rd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0005 in2/ft		
(4/3) * As :	0.0007 in2/ft	Min Stem T&S Reinf Area 0.129 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 :	0.6773 in2/ft	#6@ 27.50 in	#6@ 55.00 in

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0041 in2/ft		
(4/3) * As :	0.0055 in2/ft	Min Stem T&S Reinf Area 0.192 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 :	0.6773 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0662 in2/ft		
(4/3) * As :	0.0883 in2/ft	Min Stem T&S Reinf Area 0.639 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	=	1.00 ft
Heel Width	=	2.17
Total Footing Width	=	3.17
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	=	1,963	0	psf
Mu' : Upward	=	10,388	2,137	ft-#
Mu' : Downward	=	1,530	12,611	ft-#
Mu: Design	=	309	64	ft-#
Actual 1-Way Shear	=	3.84	7.79	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: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: No key defined

Min footing T&S reinf Area 0.82 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

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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)		630.0	2.00	1,260.0	Soil Over HL (ab. water tbl)	939.6	2.42	2,272.2
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		2.42	2,272.2
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	=	62.5	0.50	31.3
Seismic Earth Load	=	201.6	3.00	604.8	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	500.0	1.33	666.7
					Earth @ Stem Transitions	=			
					Footing Weight	=	475.5	1.59	753.7
					Key Weight	=			
					Vert. Component	=			
Total	=	831.6	**O.T.M.** =	1,864.8	**Total =**		1,977.6 lbs	**R.M.=**	3,723.8

Resisting/Overturning Ratio = **2.00**
Vertical Loads used for Soil Pressure = 1,977.6 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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)	0.000	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.

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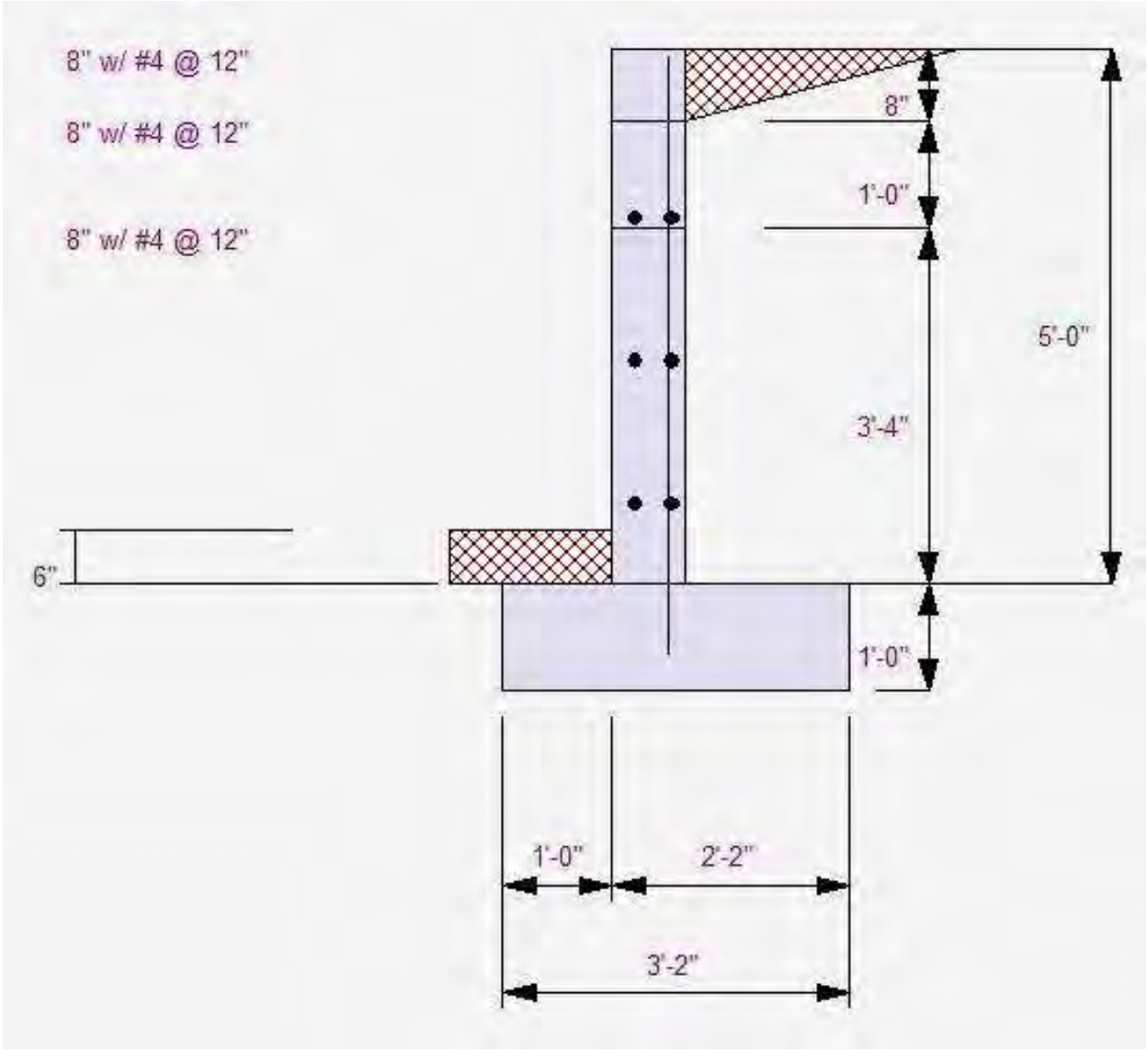
Cantilevered Retaining Wall

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



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Cantilevered Retaining Wall

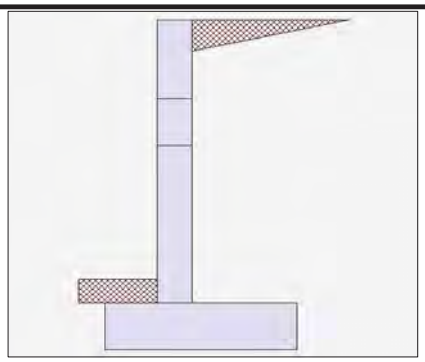
Code: IBC 2015,ACI 318-14,ACI 530-13

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	=	1,995.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing||Soil Friction	=	0.525
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 psf
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	=	8.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	56.000
Total Seismic Force	=	392.000

Design Summary

Wall Stability Ratios

Overturning	=	1.98	OK
Sliding	=	1.51	OK
Total Bearing Load	=	2,716 lbs	
...resultant ecc.	=	9.25 in	
Soil Pressure @ Toe	=	1,701 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	1,995 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,382 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	4.8 psi	OK
Footing Shear @ Heel	=	10.8 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	1,131.9 lbs	
less 100% Passive Force	= -	281.3 lbs	
less 100% Friction Force	= -	1,425.6 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

		3rd	2nd	Bottom
		Stem OK	Stem OK	Stem OK
Design Height Above Ftg	ft =	4.33	3.33	0.00
Wall Material Above "Ht"	=	Concrete	Concrete	Concrete
Design Method	=	LRFD	LRFD	LRFD
Thickness	=	8.00	8.00	8.00
Rebar Size	=	# 4	# 4	# 4
Rebar Spacing	=	12.00	12.00	12.00
Rebar Placed at	=	Edge	Edge	Edge
Design Data				
fb/FB + fa/Fa	=	**0.022**	**0.069**	**0.558**
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	171.6	349.1	1,344.0
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	121.6	377.3	3,024.0
Moment.....Allowable	ft-# =	5,359.5	5,359.5	5,412.6
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	2.3	4.7	17.9
Shear.....Allowable	psi =	67.1	67.1	75.0
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =	6.25	6.25	6.25
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =	100.0	100.0	100.0
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	2,000.0	2,000.0	2,500.0
Fy	psi =	60,000.0	60,000.0	60,000.0

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Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

3rd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0046 in2/ft		
(4/3) * As :	0.0061 in2/ft	Min Stem T&S Reinf Area 0.321 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 :	0.6773 in2/ft	#6@ 27.50 in	#6@ 55.00 in

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0141 in2/ft		
(4/3) * As :	0.0188 in2/ft	Min Stem T&S Reinf Area 0.192 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 :	0.6773 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1133 in2/ft		
(4/3) * As :	0.1511 in2/ft	Min Stem T&S Reinf Area 0.639 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	=	1.00 ft
Heel Width	=	2.67
Total Footing Width	=	3.67
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	=	2,382	0	psf
Mu' : Upward	=	12,799	5,297	ft-#
Mu' : Downward	=	1,530	26,006	ft-#
Mu: Design	=	390	89	ft-#
Actual 1-Way Shear	=	4.84	10.80	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: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: No key defined

Min footing T&S reinf Area 0.95 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

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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)		857.5	2.33	2,000.8	Soil Over HL (ab. water tbl)	1,502.5	2.67	4,009.2
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		2.67	4,009.2
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	=	62.5	0.50	31.3
Seismic Earth Load	=	274.4	3.50	960.4	Surcharge Over Toe	=			
	=				Stem Weight(s)	=	600.0	1.33	800.0
					Earth @ Stem Transitions	=			
					Footing Weight	=	550.5	1.84	1,010.2
					Key Weight	=			
					Vert. Component	=			
Total	=	1,131.9	**O.T.M.** =	2,961.2	**Total =**		2,715.5 lbs	**R.M.=**	5,850.6

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

Resisting/Overturning Ratio = **1.98**
Vertical Loads used for Soil Pressure = 2,715.5 lbs

If seismic is included, the OTM and sliding ratios be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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)	0.000	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.

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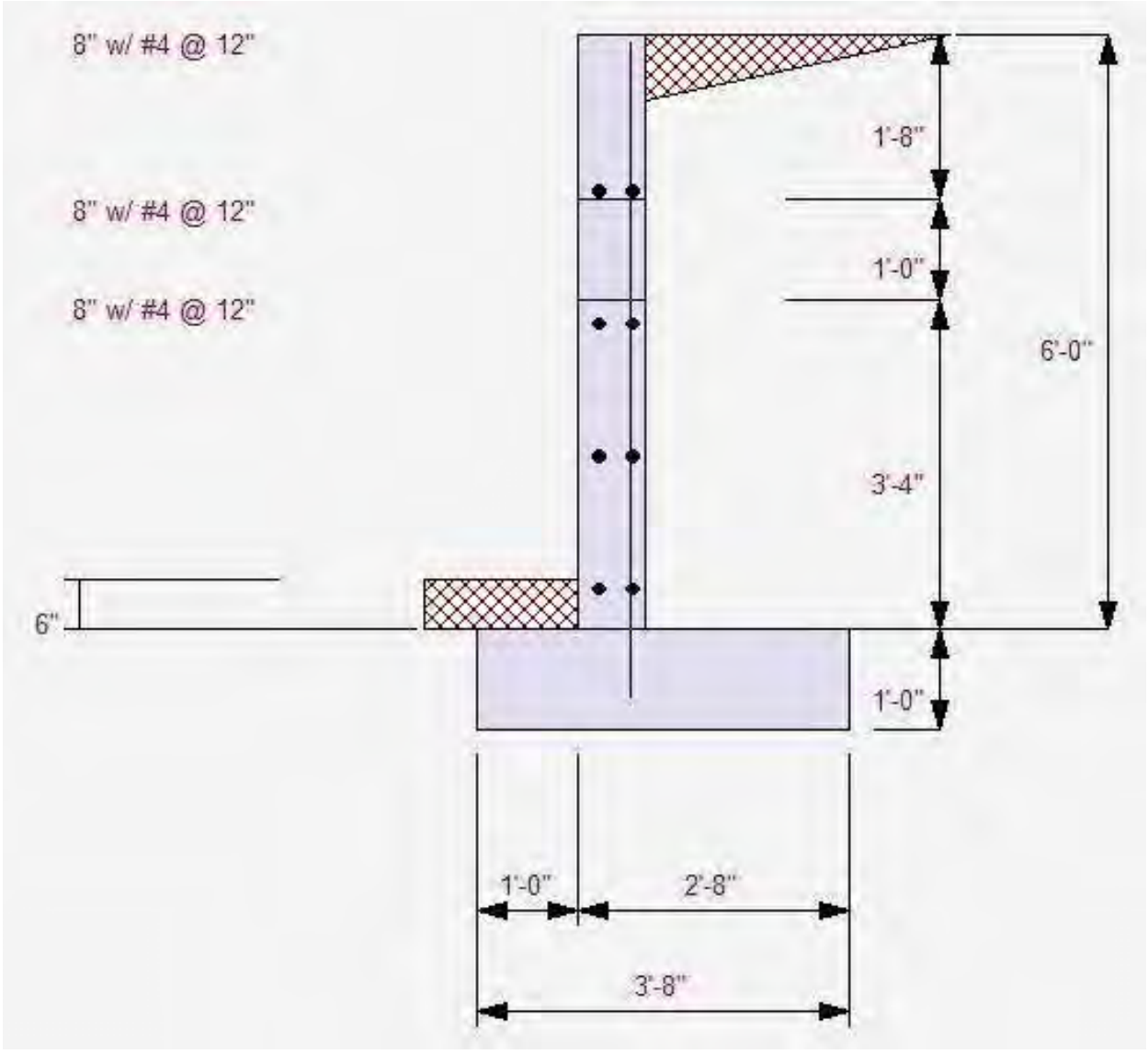

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Cantilevered Retaining Wall

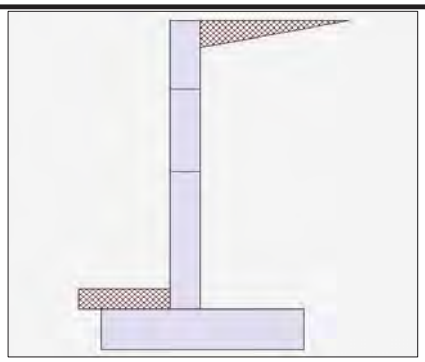
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	7.00 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	=	1,995.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing||Soil Friction	=	0.525
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 psf
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	=	8.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	64.000
Total Seismic Force	=	512.000

Design Summary

Wall Stability Ratios

Overturning	=	2.11 OK
Sliding	=	1.41 Ratio < 1.5!
Total Bearing Load	=	3,428 lbs
...resultant ecc.	=	9.40 in
Soil Pressure @ Toe	=	1,602 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	1,995 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,243 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	11.6 psi OK
Footing Shear @ Heel	=	13.3 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	1,478.4 lbs
less 100% Passive Force	= -	281.3 lbs
less 100% Friction Force	= -	1,799.9 lbs
Added Force Req'd	=	0.0 lbs OK
....for 1.5 Stability	=	136.4 lbs NG

OK, FS > 1.1

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

		3rd	2nd	Bottom
		Stem OK	Stem OK	Stem OK
Design Height Above Ftg	ft =	5.33	3.33	0.00
Wall Material Above "Ht"	=	Concrete	Concrete	Concrete
Design Method	=	LRFD	LRFD	LRFD
Thickness	=	8.00	8.00	8.00
Rebar Size	=	# 4	# 4	# 4
Rebar Spacing	=	10.00	10.00	10.00
Rebar Placed at	=	Edge	Edge	Edge
Design Data				
fb/FB + fa/Fa	=	**0.020**	**0.139**	**0.739**
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	185.0	612.0	1,820.0
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	132.7	892.4	4,769.3
Moment.....Allowable	ft-# =	6,367.7	6,367.7	6,444.1
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	2.5	8.2	24.3
Shear.....Allowable	psi =	67.1	67.1	75.0
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =	6.25	6.25	6.25
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =	100.0	100.0	100.0
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	2,000.0	2,000.0	2,500.0
Fy	psi =	60,000.0	60,000.0	60,000.0

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Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

3rd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.005 in2/ft		
(4/3) * As :	0.0066 in2/ft	Min Stem T&S Reinf Area 0.321 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 :	0.24 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6773 in2/ft	#6@ 27.50 in	#6@ 55.00 in

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0334 in2/ft		
(4/3) * As :	0.0446 in2/ft	Min Stem T&S Reinf Area 0.384 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 :	0.24 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6773 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1787 in2/ft		
(4/3) * As :	0.2383 in2/ft	Min Stem T&S Reinf Area 0.639 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 :	0.2383 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.24 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	=	1.50 ft
Heel Width	=	2.92
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	=	2,243	0	psf
Mu' : Upward	=	26,738	9,899	ft-#
Mu' : Downward	=	3,443	37,472	ft-#
Mu: Design	=	935	366	ft-#
Actual 1-Way Shear	=	11.58	13.34	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: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
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

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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)	1,120.0	2.67	2,986.7			
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 =	358.4	4.00	1,433.6			
=						
Total =	1,478.4	**O.T.M.** =	4,420.3			
				Soil Over HL (ab. water tbl)	1,971.7	3.29	6,493.4
				Soil Over HL (bel. water tbl)		3.29	6,493.4
				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 =	93.8	0.75	70.3
				Surcharge Over Toe =			
				Stem Weight(s) =	700.0	1.83	1,283.3
				Earth @ Stem Transitions =			
				Footing Weight =	663.0	2.21	1,465.2
				Key Weight =			
				Vert. Component =			
				Total =	3,428.4 lbs	**R.M.=**	9,312.2

Resisting/Overturning Ratio = **2.11**
Vertical Loads used for Soil Pressure = 3,428.4 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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)	0.000	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.

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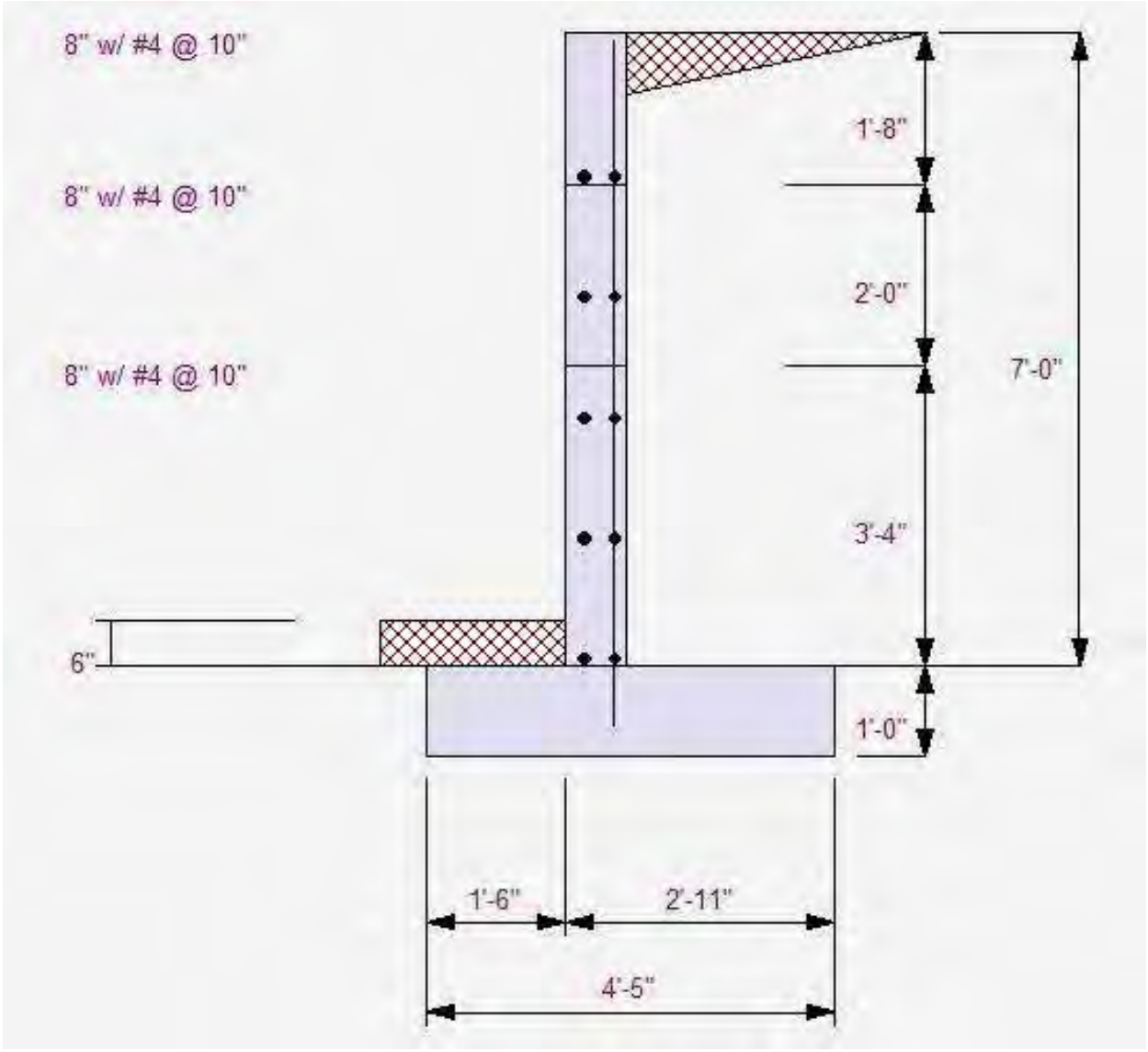
Cantilevered Retaining Wall

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



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Cantilevered Retaining Wall

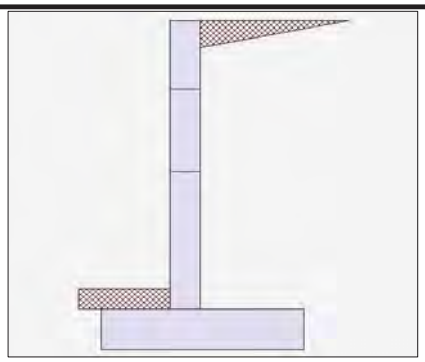
Code: IBC 2015,ACI 318-14,ACI 530-13

Criteria

Retained Height	=	7.00 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	=	1,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	450.0 psf/ft
Soil Density, Heel	=	125.00 pcf
Soil Density, Toe	=	125.00 pcf
Footing||Soil Friction	=	0.525
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 psf
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	=	3.12	OK
Sliding	=	1.86	OK
Total Bearing Load	=	3,428 lbs	
...resultant ecc.	=	4.38 in	
Soil Pressure @ Toe	=	1,160 psf	OK
Soil Pressure @ Heel	=	391 psf	OK
Allowable	=	1,500 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,624 psf	
ACI Factored @ Heel	=	548 psf	
Footing Shear @ Toe	=	8.2 psi	OK
Footing Shear @ Heel	=	7.7 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	1,120.0 lbs	
less 100% Passive Force	= -	281.3 lbs	
less 100% Friction Force	= -	1,799.9 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

		3rd	2nd	Bottom
		Stem OK	Stem OK	Stem OK
Design Height Above Ftg	ft =	5.33	3.33	0.00
Wall Material Above "Ht"	=	Concrete	Concrete	Concrete
Design Method	=	LRFD	LRFD	LRFD
Thickness	=	8.00	8.00	8.00
Rebar Size	=	# 4	# 4	# 4
Rebar Spacing	=	10.00	10.00	10.00
Rebar Placed at	=	Edge	Edge	Edge
Design Data				
fb/FB + fa/Fa	=	**0.006**	**0.071**	**0.496**
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	78.1	377.1	1,372.0
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	43.5	461.4	3,201.3
Moment.....Allowable	ft-# =	6,367.7	6,367.7	6,444.1
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	1.0	5.0	18.3
Shear.....Allowable	psi =	67.1	67.1	75.0
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =	6.25	6.25	6.25
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =	100.0	100.0	100.0
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =	2,000.0	2,000.0	2,500.0
Fy	psi =	60,000.0	60,000.0	60,000.0

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Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

3rd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0016 in2/ft		
(4/3) * As :	0.0022 in2/ft	Min Stem T&S Reinf Area 0.321 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 :	0.24 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6773 in2/ft	#6@ 27.50 in	#6@ 55.00 in

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0173 in2/ft		
(4/3) * As :	0.023 in2/ft	Min Stem T&S Reinf Area 0.384 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 :	0.24 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6773 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1199 in2/ft		
(4/3) * As :	0.1599 in2/ft	Min Stem T&S Reinf Area 0.639 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 :	0.24 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	=	1.50 ft
Heel Width	=	2.92
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	=	1,624	548	psf
Mu' : Upward	=	20,280	22,263	ft-#
Mu' : Downward	=	3,443	37,472	ft-#
Mu: Design	=	935	366	ft-#
Actual 1-Way Shear	=	8.23	7.66	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: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
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

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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)	1,120.0	2.67	2,986.7			
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)				1,971.7	3.29	6,493.4
Soil Over HL (bel. water tbl)					3.29	6,493.4
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 =				93.8	0.75	70.3
Surcharge Over Toe =						
Stem Weight(s) =				700.0	1.83	1,283.3
Earth @ Stem Transitions =						
Footing Weight =				663.0	2.21	1,465.2
Key Weight =						
Vert. Component =						
Total =	1,120.0	**O.T.M.** =	2,986.7	**Total =** 3,428.4 lbs	**R.M.=**	9,312.2

Resisting/Overturning Ratio = **3.12**
Vertical Loads used for Soil Pressure = 3,428.4 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)	0.000	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.

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Cantilevered Retaining Wall

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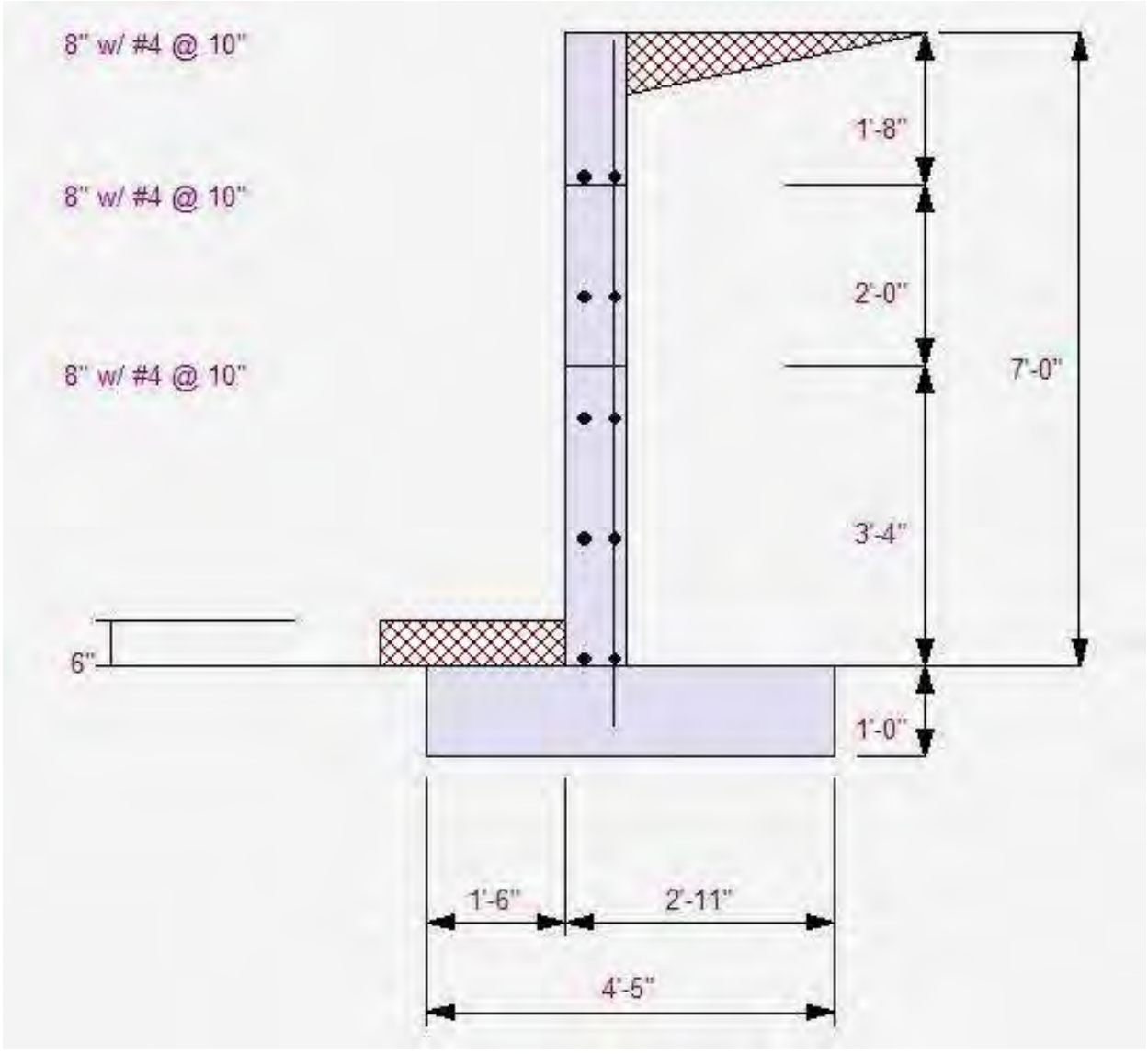
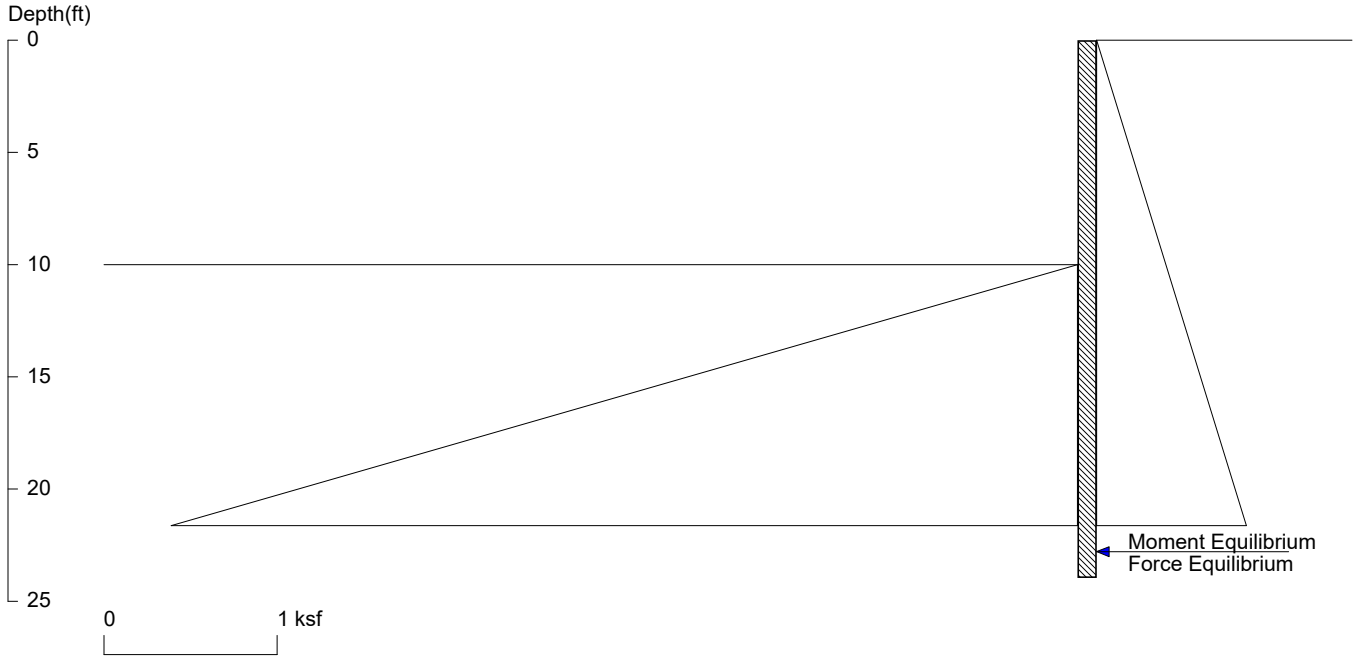


10'-0" MAX Catchment Wall (FOS=1.5)



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File: Z:_PROJECTS\2019\19-065 Yang Residence\2. Calculations\Shoring\10ft max catchment wall NO seismic.sh8

Wall Height=10.0 Pile Diameter=2.0 Pile Spacing=8.0 Wall Type: 2. Soldier Pile, Drilled

PILE LENGTH: Min. Embedment=13.95 Min. Pile Length=23.95
MOMENT IN PILE: Max. Moment=123.45 per Pile Spacing=8.0 at Depth=16.10

PILE SELECTION:
Request Min. Section Modulus = 44.9 in3/pile=735.61 cm3/pile, Fy= 50 ksi = 345 MPa, Fb/Fy=0.66
W16X31 has Section Modulus = 47.2 in3/pile=773.47 cm3/pile. It is greater than Min. Requirements!
Top Deflection = 0.98(in) based on E (ksi)=29000.00 and I (in4)/pile=375.0

DRIVING PRESSURES (ACTIVE, WATER, & SURCHARGE):

Z1	P1	Z2	P2	Slope
0	0	800	32.000	.04

PASSIVE PRESSURES: Pressures below will be divided by a Factor of Safety =1.5

Z1	P1	Z2	P2	Slope
10	0	800	355.500	.45

ACTIVE SPACING:

No.	Z depth	Spacing
1	0.00	8.00
2	10.00	2.00

PASSIVE SPACING:

No.	Z depth	Spacing
1	10.00	4.00

UNITS: Width,Spacing,Diameter,Length,and Depth - ft; Force - kip; Moment - kip-ft
Friction,Bearing,and Pressure - ksf; Pres. Slope - kip/ft3; Deflection - in