Merrell Design Services
Practical Structural Solutions

CHESHIRE CUSTOM HOME

Framing and Foundations

7615 E. Mercer Way, Mercer Island, WA 98040

Prepared for: FormWorks Design Build

1 9/16/22, Incorporate plan review comments

2 12/7/22, Revise to pile foundation

3 2/22/23, Revise to 3" piles and add helicals

Date: September 12th, 2022

By: Kevin J. Haiar P.E.

2 3

August 12th, 2021

Summary

The project involves a new two-story wood framed custom home with basement and involves a total footprint of about 48 ft x 40 ft. The house includes two decks, a large cantilevered roof overhang, and some site retaining walls. The framing system consists of 12" deep engineering joists and involves conventional wood shear walls for lateral resistance to wind and seismic forces. Footings involve 3" diameter steel pin piles driven to refusal. The piles are used for gravity support only and are embedded in grade beams. Battered helical piles are used for resistance to lateral forces and settlement due to seismic liquefaction event.

Design Codes

2018 International Building Code
ASCE/SEI 7-16
NDS Wood Design 2015
ACI 318 Concrete 2014

Design Criteria

Roof Snow Load:	25 psf + 5 psf rain on snow
Importance Factor:	1.0
Wind Speed:	110 mph
Wind Exposure:	C
Seismic Design Category:	D
Seismic Ss:	1.472
Seismic S1:	0.566
Allowable Pile Capacity:	4 kips
Allowable Helical Capacity:	9 kips
Seismic Liquefaction Settlement (per Geotech):	16 inches

2

3

Climatic and Geographic Design Criteria

IRC TABLE R301.2 (1)
Climatic and Geographic Design Criteria

Roof Snow Load[a]	Wind Design[b]		Seismic Design Category[c]	Subject to Damage From:			Outside Design Temp–Heat/Cool	Ice Barrier Under-layment Required	Flood Hazards[e]	Air Freezing Index	Mea Ann Tem
	Speed	Topographic Effects		Weathering[d]	Frost Line Depth	Termite Decay					
25 psf	110 mph	See footnote[b]	D2	Moderate	12"	Slight to Moderate	24°F/83°F	No	NA	113	53°

A. When using this roof snow load it will be left to the engineer's judgment whether to consider drift or sliding snow. However, rain on snow surcharge of 5 psf must be considered for roof slopes less than 5 degrees.
B. Wind exposure category and Topographic effects (Wind Speed-up Kzt factor) shall be determined on a site-specific basis by the Engineer of Record (components and cladding need not consider topographic effects unless otherwise determined by the engineer of record).
C. From IRC Table 301.2(1).
D. Weathering may require a higher strength concrete or grade of masonry than necessary to satisfy the structural requirements of this code. The grade of masonry units shall be determined from ASTM C 34, C 55, C 62, C 73, C 90, C 129, C 145, C 216 or C 652.
E. The City of Mercer Island participates in the National Flood Insurance Program (NFIP); Regular Program (No Special Flood Hazard Area). Further NFIP participation information: CID 530083, Initial FHBM Identified 06/28/74, Initial FIRM Identified 05/16/95, Current Effective Map Date (NSFHA), Reg-Emer Date 06/30/97.

Gravity Loads

Roof Dead Loads:	Weight (psf)
Roofing	1.0
Decking	2.0
Roof Joists/Trusses	2.0
Insulation	1.0
Gyp Ceiling	2.5
Mech/Elec	1.5
Misc.	5.0
Total Roof Dead Load	**15.0**

Floor Dead Loads:	Weight (psf)
Flooring	1.0
Gypcrete/overlay (2")	19.2
Joists	2.0
Gyp Ceiling	2.5
Mech/Elec	1.5
Misc.	3.8
Total Floor Dead Load	**30.0**

Roof Live Loads:	Weight (psf)
Roof Live Load	20.0
Snow Load + 5psf rain on snow	30.0

Floor Live Loads:	Weight (psf)
Residential 2	40

Ext. Wall Dead Loads:	Weight (psf)
6" studs	1.8
Sheathing, 15/32"	1.5
Insulation	1.2
Ext finish (siding)	3
Misc	2.5
Total Wall Load	**10**

Grade Beam Loading:

Grid 2 - Worst Case Loading

Tributary	20	ft
Dead	1499	lbs
Live	1600	lbs
Snow	600	lbs
D+L	3099	lbs
D+0.75L+0.75S	3149	lbs
Allowable Pin Pile Capacity	4000	lbs
Maximum pile spacing	1.27	ft

3 **At Grid 2 Provide 2" Dia Sch 80 pin piles in two rows at 24" oc staggered (12" nominal spacing) (Alternate: 3" dia Sch 40 piles)**

2

Grade Beam Loading Cont'd:

Grid 1 & 3 Exterior Bearing Lines

Tributary	11.75	ft
Dead	880	lbs
Live	940	lbs
Snow	353	lbs
D+L	1820	lbs
D+0.75L+0.75S	1850	lbs
Allowable Pin Pile Capacity	4000	lbs
Maximum pile spacing	2.16	ft

At Grid 1 and 3 Provide 2" Dia Sch 80 pin piles in two rows at 48" oc staggered (24" nominal spacing) Alternate: 3" dia Sch 40 piles

3

Non-bearing and Exterior Framing Lines (A, B, B', & C)

Provide same pile spacing and layout as per Grid 1 and 3 exterior bearing lines

At Grid A, B, B', C Provide 2" Dia Sch 80 pin piles in two rows at 48" oc staggered (24" nominal spacing)
Alternate: 3" dia Sch 40 piles

Grade Beam Loading - Concentrated Loads:

Column/HD Reactions

Location	Grid Location	Load (k)	No of Add Piles
Garage (BM6)	1 - east	6.5	1
Basement Slider/windows (BM7)	B & B' - south	0.8	0
Main Flr Bifold Door (BM4)	B/2 & B.5/2	2.9	0
Roof East Overhangs (BM3)	1/C, 2/C	6.8	1
Hold-down reactions	B/2, C/2	1.02	0

For reactions greater than 4 k and less than 8 k provide one additoional pile at location of concentrated loads in addition to evenly spaced piles at grade beams

Grade Beam Loading - Retaining Wall Loads:

Consider retaining wall footing soil pressure distribution and determine tributary soil pressure per 4 kip allowable pile load

Footing Total Width	7	ft
Heel width	4.5	ft
Toe width	2.5	ft
Max brg at toe	1651	psf
Min brg at heel	853	psf
Pile Capacity	4	k

Proportion pile spacing to maximize 4 kip capacity
Consider toe strip of 1.5 ft width, center strip of 2 ft width, and heel strip of 3.5 ft width.

	Avg pressure	Pile spacing (4k cap)	
Toe Strip	1561	2.6	**Provide 3 rows of piles spaced 2.5 ft OC max**
Center Strip	1351	3.0	
Heel Strip	1021	3.9	

Pile Head Punching Shear Check

ACI Section 22.6 for two way shear

Sec 22.6.5

Table 22.6.5.2—Calculation of v_c for two-way shear

v_c		
Least of (a), (b), and (c):	$4\lambda\sqrt{f'_c}$	(a)
	$\left(2+\frac{4}{\beta}\right)\lambda\sqrt{f'_c}$	(b)
	$\left(2+\frac{\alpha_s d}{b_o}\right)\lambda\sqrt{f'_c}$	(c)

Note: β is the ratio of long side to short side of the column, concentrated load, or reaction area and α_s is given in 22.6.5.3.

F'c	3000	psi	b	15 in
β	1		d	9 in
λ	1		ϕ	0.75
α	20			
Eqn a	88.7	kips		
Eqn b	133.1	kips		
Eqn c	68.5	kips	**PUNCHING SHEAR OK**	

Steel Column

Project File: TJ_Mercer.ec6

DESCRIPTION: Pipe Piles Capacity

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combinations Used : IBC 2021

General Information

Steel Section Name : **Pipe2xS**

Analysis Method :	Allowable Strength
Steel Stress Grade	
Fy : Steel Yield	35.0 ksi
E : Elastic Bending Modulus	29,000.0 ksi

Overall Column Height	40.0 ft
Top & Bottom Fixity	Top & Bottom Pinned

Brace condition for deflection (buckling) along columns :
X-X (width) axis :
Unbraced Length for buckling ABOUT Y-Y Axis = 5 ft, K = 1.0
Y-Y (depth) axis :
Unbraced Length for buckling ABOUT X-X Axis = 5 ft, K = 1.0

Applied Loads

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

Column self weight included : 201.20 lbs * Dead Load Factor
AXIAL LOADS . . .
Axial Load at 40.0 ft, D = 1.0, L = 3.0 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = 0.1950 : 1

Load Combination	+D+L
Location of max.above base	0.0 ft
At maximum location values are . . .	
Pa : Axial	4.201 k
Pn / Omega : Allowable	21.545 k
Ma-x : Applied	0.0 k-ft
Mn-x / Omega : Allowable	1.684 k-ft
Ma-y : Applied	0.0 k-ft
Mn-y / Omega : Allowable	1.684 k-ft

PASS Maximum Shear Stress Ratio 0.0 : 1

Load Combination	0.0
Location of max.above base	0.0 ft
At maximum location values are . . .	
Va : Applied	0.0 k
Vn / Omega : Allowable	0.0 k

Maximum Load Reactions . .

Top along X-X	0.0 k
Bottom along X-X	0.0 k
Top along Y-Y	0.0 k
Bottom along Y-Y	0.0 k

Maximum Load Deflections . . .

Along Y-Y 0.0 in at 0.0 ft above base
for load combination :

Along X-X 0.0 in at 0.0 ft above base
for load combination :

Load Combination Results

Load Combination	Maximum Axial + Bending Stress Ratios: Stress Ratio	Status	Location	Cbx	Cby	KxLx/Ry	KyLy/Rx	Maximum Shear Ratios: Stress Ratio	Status	Location
D Only	0.056	PASS	0.00 ft	1.00	1.00	77.82	0.00	0.000	PASS	0.00 ft
+D+L	0.195	PASS	0.00 ft	1.00	1.00	77.82	0.00	0.000	PASS	0.00 ft
+D+0.750L	0.160	PASS	0.00 ft	1.00	1.00	77.82	0.00	0.000	PASS	0.00 ft
+0.60D	0.033	PASS	0.00 ft	1.00	1.00	77.82	0.00	0.000	PASS	0.00 ft

Maximum Reactions

Note: Only non-zero reactions are listed.

Load Combination	Axial Reaction @ Base (k)	X-X Axis Reaction @ Base (k)	X-X Axis Reaction @ Top (k)	Y-Y Axis Reaction @ Base (k)	Y-Y Axis Reaction @ Top (k)	Mx - End Moments @ Base (k-ft)	Mx - End Moments @ Top (k-ft)	My - End Moments @ Base (k-ft)	My - End Moments @ Top (k-ft)
D Only	1.201								
+D+L	4.201								
+D+0.750L	3.451								
+0.60D	0.721								
L Only	3.000								

Extreme Reactions

Item	Extreme Value	Axial Reaction @ Base (k)	X-X Axis Reaction @ Base (k)	X-X Axis Reaction @ Top (k)	Y-Y Axis Reaction @ Base (k)	Y-Y Axis Reaction @ Top (k)	Mx - End Moments @ Base (k-ft)	Mx - End Moments @ Top (k-ft)	My - End Moments @ Base (k-ft)	My - End Moments @ Top (k-ft)
Axial @ Base	Maximum	4.201								
"	Minimum	0.721								

Steel Column

Project File: TJ_Mercer.ec6

DESCRIPTION: Pipe Piles Capacity

Extreme Reactions

Item	Extreme Value	Axial Reaction @ Base	X-X Axis Reaction @ Base	@ Top	k	Y-Y Axis Reaction @ Base	@ Top	Mx - End Moments @ Base	@ Top	k-ft	My - End Moments @ Base	@ Top
Reaction, X-X Axis Base	Maximum	1.201										
"	Minimum	1.201										
Reaction, Y-Y Axis Base	Maximum	1.201										
"	Minimum	1.201										
Reaction, X-X Axis Top	Maximum	1.201										
"	Minimum	1.201										
Reaction, Y-Y Axis Top	Maximum	1.201										
"	Minimum	1.201										
Moment, X-X Axis Base	Maximum	1.201										
"	Minimum	1.201										
Moment, Y-Y Axis Base	Maximum	1.201										
"	Minimum	1.201										
Moment, X-X Axis Top	Maximum	1.201										
"	Minimum	1.201										
Moment, Y-Y Axis Top	Maximum	1.201										
"	Minimum	1.201										

Maximum Deflections for Load Combinations

Load Combination	Max. X-X Deflection	Distance	Max. Y-Y Deflection	Distance
D Only	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+L	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+0.750L	0.0000 in	0.000 ft	0.000 in	0.000 ft
+0.60D	0.0000 in	0.000 ft	0.000 in	0.000 ft
L Only	0.0000 in	0.000 ft	0.000 in	0.000 ft

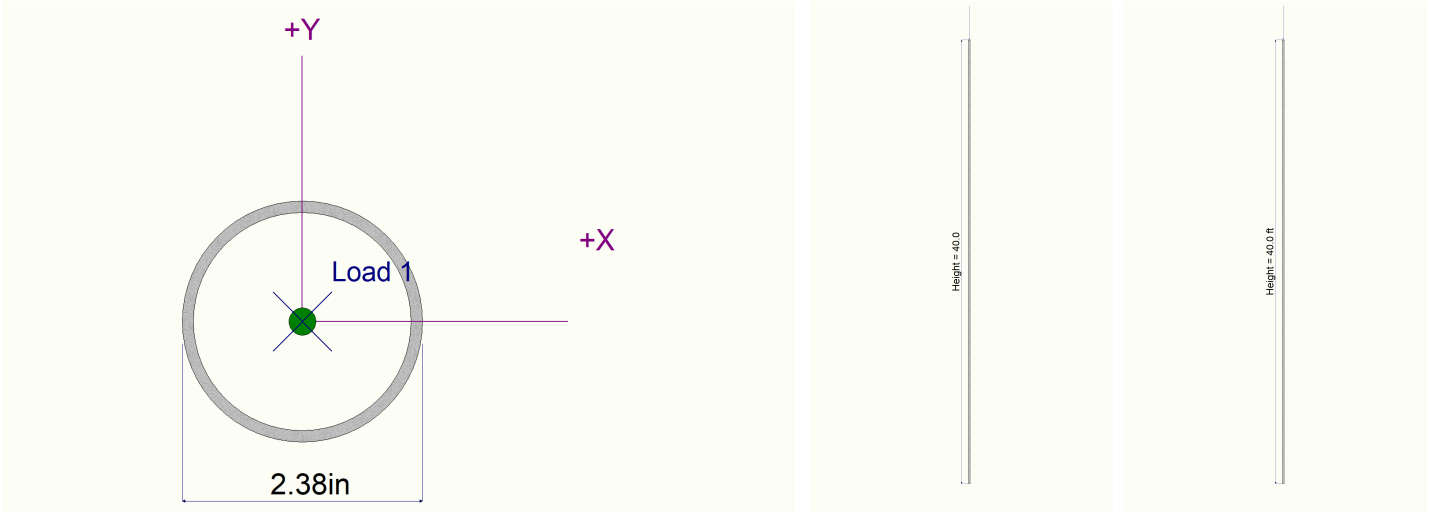
Steel Section Properties : Pipe2xS

Depth	=	2.375 in	I xx	=	0.83 in^4	J	=	1.650 in^4
			S xx	=	0.70 in^3			
Diameter	=	2.375 in	R xx	=	0.771 in			
Wall Thick	=	0.219 in	Zx	=	0.964 in^3			
Area	=	1.400 in^2	I yy	=	0.827 in^4			
Weight	=	5.030 plf	S yy	=	0.696 in^3			
			R yy	=	0.771 in			
Ycg	=	0.000 in						

Steel Column

DESCRIPTION: Pipe Piles Capacity

Sketches



Steel Column

Project File: TJ_Mercer.ec6

DESCRIPTION: 3" Pipe Piles Capacity w/ 18ft unbraced condition for liquefaction

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combinations Used : IBC 2021

General Information

Steel Section Name : **Pipe3STD**

Analysis Method :	Allowable Strength
Steel Stress Grade	
Fy : Steel Yield	35.0 ksi
E : Elastic Bending Modulus	29,000.0 ksi

Overall Column Height	40.0 ft
Top & Bottom Fixity	Top Fixed, Bottom Fixed

Brace condition for deflection (buckling) along columns :
X-X (width) axis :
Unbraced Length for buckling ABOUT Y-Y Axis = 18 ft, K = 0.65
Y-Y (depth) axis :
Unbraced Length for buckling ABOUT X-X Axis = 18 ft, K = 0.65

Applied Loads

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

Column self weight included : 303.20 lbs * Dead Load Factor
AXIAL LOADS . . .
Axial Load at 40.0 ft, D = 1.0, L = 3.0 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.2067** : 1

Load Combination	+D+L
Location of max.above base	0.0 ft
At maximum location values are . . .	
Pa : Axial	4.303 k
Pn / Omega : Allowable	20.816 k
Ma-x : Applied	0.0 k-ft
Mn-x / Omega : Allowable	3.825 k-ft
Ma-y : Applied	0.0 k-ft
Mn-y / Omega : Allowable	3.825 k-ft

PASS Maximum Shear Stress Rati **0.0** : 1

Load Combination	0.0
Location of max.above base	0.0 ft
At maximum location values are . . .	
Va : Applied	0.0 k
Vn / Omega : Allowable	0.0 k

Maximum Load Reactions . .

Top along X-X	0.0 k
Bottom along X-X	0.0 k
Top along Y-Y	0.0 k
Bottom along Y-Y	0.0 k

Maximum Load Deflections . . .

Along Y-Y 0.0 in at 0.0ft above base
for load combination :

Along X-X 0.0 in at 0.0ft above base
for load combination :

Load Combination Results

Load Combination	Maximum Axial + Bending Stress Ratios: Stress Ratio	Status	Location	Cbx	Cby	KxLx/Ry	KyLy/Rx	Maximum Shear Ratios: Stress Ratio	Status	Location
D Only	0.063	PASS	0.00 ft	1.00	1.00	120.00	0.00	0.000	PASS	0.00 ft
+D+L	0.207	PASS	0.00 ft	1.00	1.00	120.00	0.00	0.000	PASS	0.00 ft
+D+0.750L	0.171	PASS	0.00 ft	1.00	1.00	120.00	0.00	0.000	PASS	0.00 ft
+0.60D	0.038	PASS	0.00 ft	1.00	1.00	120.00	0.00	0.000	PASS	0.00 ft

Maximum Reactions

Note: Only non-zero reactions are listed.

Load Combination	Axial Reaction @ Base	X-X Axis Reaction @ Base	X-X Axis Reaction @ Top	Y-Y Axis Reaction @ Base	Y-Y Axis Reaction @ Top	Mx - End Moments @ Base	Mx - End Moments @ Top	My - End Moments @ Base	My - End Moments @ Top
D Only	1.303								
+D+L	4.303								
+D+0.750L	3.553								
+0.60D	0.782								
L Only	3.000								

Extreme Reactions

Item	Extreme Value	Axial Reaction @ Base	X-X Axis Reaction @ Base	X-X Axis Reaction @ Top	Y-Y Axis Reaction @ Base	Y-Y Axis Reaction @ Top	Mx - End Moments @ Base	Mx - End Moments @ Top	My - End Moments @ Base	My - End Moments @ Top
Axial @ Base	Maximum	4.303								
"	Minimum	0.782								

Steel Column

Project File: TJ_Mercer.ec6

DESCRIPTION: 3" Pipe Piles Capacity w/ 18ft unbraced condition for liquefaction

Extreme Reactions

Item	Extreme Value	Axial Reaction @ Base	X-X Axis Reaction @ Base	@ Top	k	Y-Y Axis Reaction @ Base	@ Top	Mx - End Moments @ Base	@ Top	k-ft	My - End Moments @ Base	@ Top
Reaction, X-X Axis Base	Maximum	1.303										
"	Minimum	1.303										
Reaction, Y-Y Axis Base	Maximum	1.303										
"	Minimum	1.303										
Reaction, X-X Axis Top	Maximum	1.303										
"	Minimum	1.303										
Reaction, Y-Y Axis Top	Maximum	1.303										
"	Minimum	1.303										
Moment, X-X Axis Base	Maximum	1.303										
"	Minimum	1.303										
Moment, Y-Y Axis Base	Maximum	1.303										
"	Minimum	1.303										
Moment, X-X Axis Top	Maximum	1.303										
"	Minimum	1.303										
Moment, Y-Y Axis Top	Maximum	1.303										
"	Minimum	1.303										

Maximum Deflections for Load Combinations

Load Combination	Max. X-X Deflection	Distance	Max. Y-Y Deflection	Distance
D Only	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+L	0.0000 in	0.000 ft	0.000 in	0.000 ft
+D+0.750L	0.0000 in	0.000 ft	0.000 in	0.000 ft
+0.60D	0.0000 in	0.000 ft	0.000 in	0.000 ft
L Only	0.0000 in	0.000 ft	0.000 in	0.000 ft

Steel Section Properties : Pipe3STD

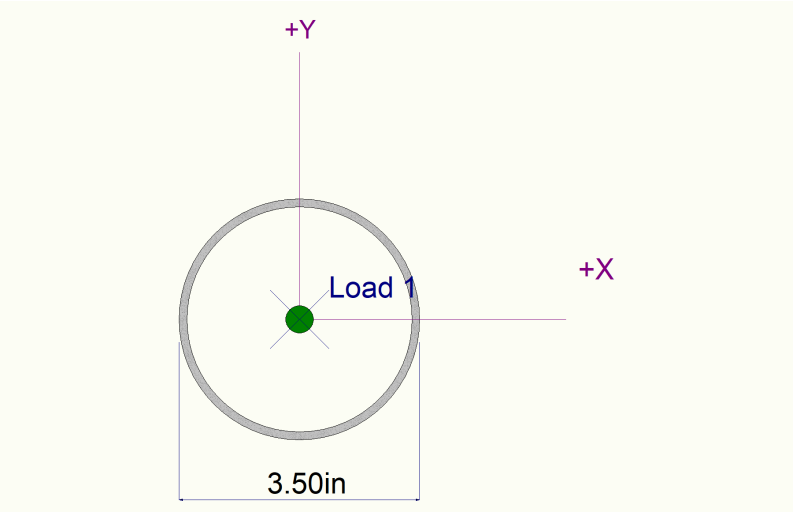
Depth	=	3.500 in	I xx	=	2.85 in^4	J	=	5.690 in^4
			S xx	=	1.63 in^3			
Diameter	=	3.500 in	R xx	=	1.170 in			
Wall Thick	=	0.216 in	Zx	=	2.190 in^3			
Area	=	2.070 in^2	I yy	=	2.850 in^4			
Weight	=	7.580 plf	S yy	=	1.630 in^3			
			R yy	=	1.170 in			
Ycg	=	0.000 in						

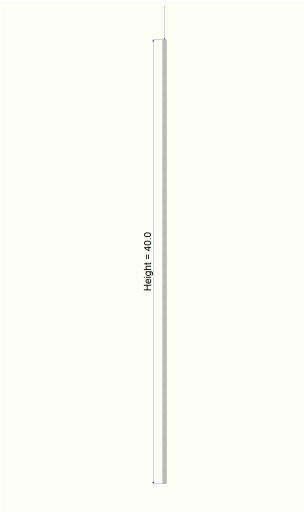
Steel Column

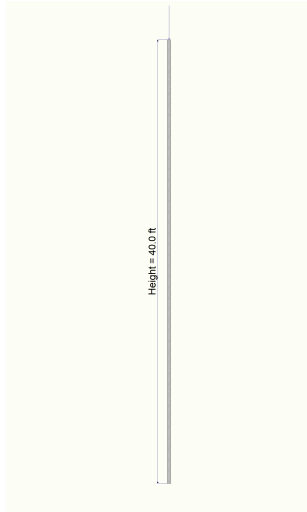
Project File: TJ_Mercer.ec6

DESCRIPTION: 3" Pipe Piles Capacity w/ 18ft unbraced condition for liquefaction

Sketches



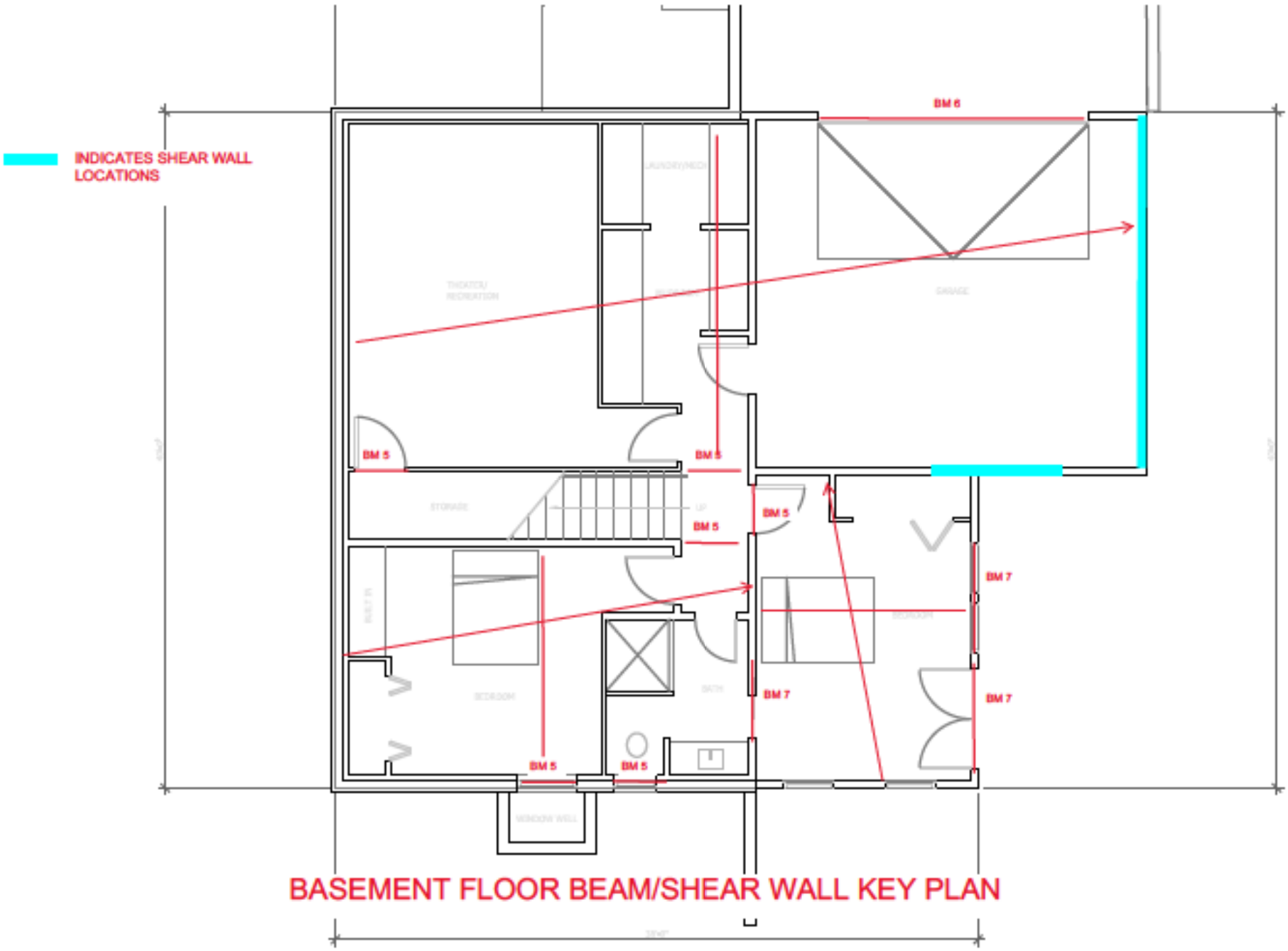




Roof & Floor Framing Beams

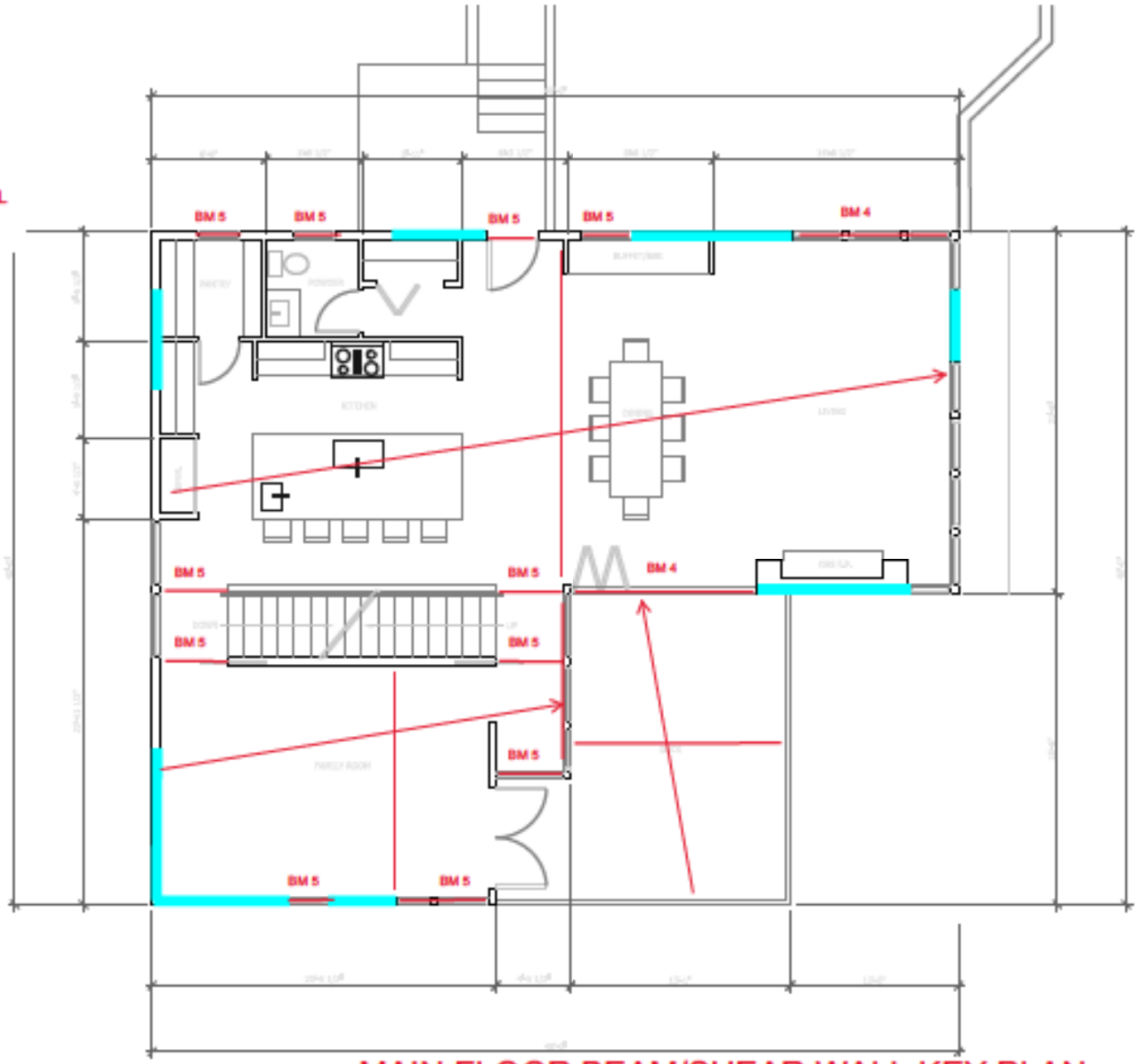
BM #	Description	location	Span	Roof Trib	R DL	Roof S	Roof Live	Floor Trib	FL Live	FL Dead	FL Live	Beam Size	Reactions
			ft	ft	PLF	PLF	PLF	ft	PSF	PLF	PLF		
BM 1	Typ Rf Ext Hdr	Roof Grid 3	5.5	7.5	112.5	225	150	0	0	0	0	(2) 2x10 DFL #2	773
Bm 2	Typ Rf Int Hdr	Roof Grid 2	3	20	300	600	400	0	0	0	0	(2) 2x10 DFL #2	1125
BM 3	Rf East Cantilever	Rf grid 1 & 2	19	10.5	157.5	315	210	0	0	0	0	GL 5.125x10.5 V8	6891
BM 4	2nd flr ext hdr	2nd grid 1 & 2	11.25	10	150	300	200	11	40	330	440	GL 5.125x10.5 V4	2923
BM 5	Typ frl hdr	1st & 2nd, all grids	5.5	10	150	300	200	10	40	300	400	(2) 2x10 DFL #2	1347
BM 6	Garage hdr	1st flr grid 1	16.5	10	150	300	200	20	40	599	800	GL 5.125x18 V4	6512
BM 7	Deck beam	1st flr grid B'	6.5	0	0	0	0	7	40	210	280	(2) 2x10 DFL #2	812

NOTES:
1. SEE ENERCALC OUTPUT SHEETS FOR BEAM DESIGNS
2. TOTAL LOAD INCLUDES LOAD CASES D+L, D=0.75*L+0.75*S



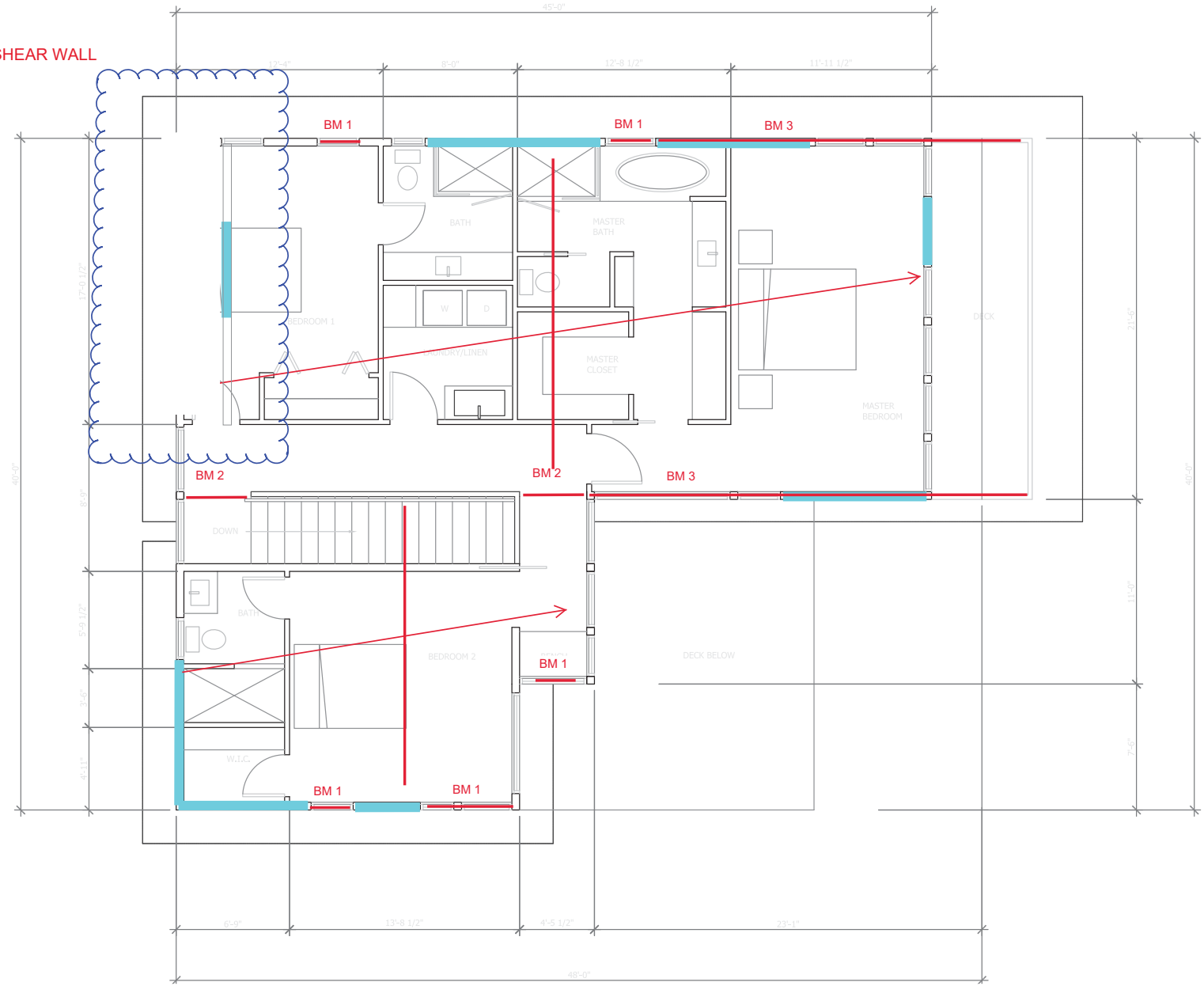
BASEMENT FLOOR BEAM/SHEAR WALL KEY PLAN

INDICATES SHEAR WALL LOCATIONS



MAIN FLOOR BEAM/SHEAR WALL KEY PLAN

INDICATES SHEAR WALL LOCATIONS



SECOND FLOOR BEAM/SHEAR WALL KEY PLAN

RedSpec™ by RedBuilt™
v7.1.12

Project: Project
Location: Mercer Island, WA
Folder: Folder
Date: 8/8/21 6:10 PM
Designer: KJH
Comment:

Type: FLOOR JOISTS

11.875" Red-I58™ @ 16" o.c. with Glued Sheathing

This product meets or exceeds the set design controls for the application and loads listed

DESIGN CONTROLS	%	Design	Allow.	DOL	Combination	Pattern	Pass/Fail
Shear (lb)	55%	980	1785	Floor(100%)	1.0D+1.0L	All Spans	PASS
Positive Moment (ft-lb)	82%	5145	6255	Floor(100%)	1.0D+1.0L	All Spans	PASS

DEFLECTIONS (in)	%	Design	Allow.	Design	Allow.	Combination	Pattern	Pass/Fail
Span Live	99%	0.519	0.525	L / 486	L / 480	1.0D+1.0L	All Spans	PASS
Span Total	86%	0.908	1.050	L / 278	L / 240	1.0D+1.0L	All Spans	PASS

FloorChoice™ Rating: 0.9

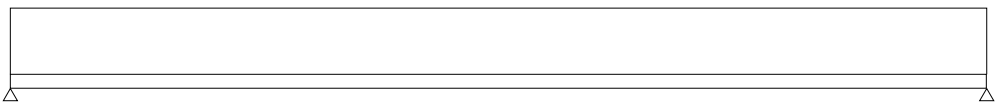
Performance rating is based on: 24 oc (23/32", 3/4") sheathing, glued and nailed, 1 1/2" Lightweight Concrete topping, 1 Row Blocking, 1/2" Gypsum ceiling, simple span, rigid supports. RedSpec has not performed a structural analysis of the sheathing.

SUPPORTS	Support 1	Support 2
Live Reaction, Critical (lb) (DOL%)	560 (100)	560 (100)
Dead Reaction (lb)	420	420
Total Reaction (lb) (DOL%)	980 (100)	980 (100)
Bearing	Bottom	Flush
Support	Wall	Wall
Req'd Bearing, No Stiffeners (in)	1.75	1.75
Req'd Bearing, Stiffeners (in)	-	-

HANGERS	Model	Top	Face	Member	Header	Size
Right	None Selected					

SPANS AND LOADS

Dimensions represent horizontal design spans.



21'- 0.0"

APPLICATION LOADS

Type	Units	DOL	Live	Dead	Partition	Tributary	Member Type
Uniform	psf	Floor(100%)	40	30	0	16"	Glued Floor Joist

NOTES

- Building code and design methodology: 2018 IBC ASD (US).
- Product Acceptance: ICC-ES ESR-2994 and LABC/LARC Supplement.
- Deflection analysis is based on composite action with 24 oc (23/32", 3/4") sheathing, glued and nailed.
- Continuous lateral support required at top edge. Lateral support at bottom edge shall be per RedBuilt recommendations.

C:\Users\Kevin\Dropbox\MDS_SHARED\DESIGN PROJECTS-MDS\MDS PROJECTS 2021\21-045 Mercer Island Custom Home\CALCS\REDBUILT\Mercer.red

RedSpec™ by RedBuilt™
v7.1.12

Project: Project
Location: Mercer Island, WA
Folder: Folder
Date: 8/8/21 6:11 PM
Designer: KJH
Comment:

Type: ROOF JOISTS

11.875" Red-I45L™ @ 16" o.c.

This product meets or exceeds the set design controls for the application and loads listed

DESIGN CONTROLS	%	Design	Allow.	DOL	Combination	Pattern	Pass/Fail
Shear (lb)	32%	630	1955	Snow(115%)	1.0D+1.0S	All Spans	PASS
Positive Moment (ft-lb)	91%	3308	3651	Snow(115%)	1.0D+1.0S	All Spans	PASS

DEFLECTIONS (in)	%	Design	Allow.	Design	Allow.	Combination	Pattern	Pass/Fail
Span Live	95%	0.668	0.700	L / 377	L / 360	1.0D+1.0S	All Spans	PASS
Span Total	95%	1.002	1.050	L / 252	L / 240	1.0D+1.0S	All Spans	PASS

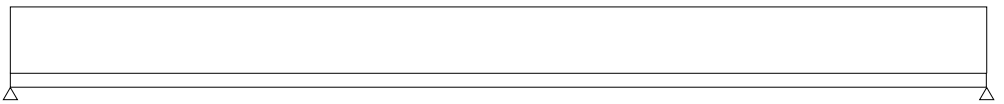
SUPPORTS	Support 1	Support 2
Live Reaction, Critical (lb) (DOL%)	420 (115)	420 (115)
Dead Reaction (lb)	210	210
Total Reaction (lb) (DOL%)	630 (115)	630 (115)
Bearing	Bottom	Flush
Support	Wall	Wall
Req'd Bearing, No Stiffeners (in)	1.75	1.75
Req'd Bearing, Stiffeners (in)	-	-

HANGERS	Model	Top	Face	Member	Header	Size
Right	None Selected					

SPANS AND LOADS

Dimensions represent horizontal design spans.

Member Slope: 0/12



21'- 0.0"

APPLICATION LOADS

Type	Units	DOL	Live	Dead	Partition	Tributary	Member Type
Uniform	psf	Snow(115%)	30	15	0	16"	Snow Roof Joist

NOTES

- Building code and design methodology: 2018 IBC ASD (US).
- Product Acceptance: ICC-ES ESR-2994 and LABC/LARC Supplement.
- Continuous lateral support required at top edge. Lateral support at bottom edge shall be per RedBuilt recommendations.

C:\Users\Kevin\Dropbox\MDS_SHARED\DESIGN PROJECTS-MDS\MDS PROJECTS 2021\21-045 Mercer Island Custom Home\CALCS\REDBUILT\Mercer.red

Wood Column

DESCRIPTIO Typical Stud Design (2x6's at 16" oc)

Code References

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combinations Used : ASCE 7-10

General Information

Analysis Metho	Allowable Stress Design				
End Fixities	Top & Bottom Pinned				
Overall Column Heigh	9 ft				
(Used for non-slender calculations)					
Wood Specie	Douglas Fir-South				
Wood Grade	No.2				
Fb +	850 psi	Fv	180 psi		
Fb -	850 psi	Ft	525 psi		
Fc - Prll	1350 psi	Density	28.72 pcf		
Fc - Perp	520 psi				

E : Modulus of Elasticity . . . x-x Bending y-y Bending Axial

Basic	1200	1200	1200	ksi
Minimum	440	440		

Wood Section Name	**2x6**		
Wood Grading/Manuf.	Graded Lumber		
Wood Member Type	Sawn		
Exact Width	**1.50** in	Allow Stress Modification Factors	
Exact Depth	**5.50** in	Cf or Cv for Bending	1.30
Area	8.250 in^2	Cf or Cv for Compressio	1.10
Ix	20.797 in^4	Cf or Cv for Tension	1.30
Iy	1.547 in^4	Cm : Wet Use Factor	1.0
		Ct : Temperature Fact	1.0
		Cfu : Flat Use Factor	1.0
		Kf : Built-up columns	1.0 *NDS 15.3.2*
		Use Cr : Repetitive	No

Brace condition for deflection (buckling) along columns :
X-X (width) axis Fully braced against buckling ABOUT Y-Y Axis
Y-Y (depth) axis Unbraced Length for buckling ABOUT X-X Axis = 9

Applied Loads

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

Column self weight included : 14.809 lbs * Dead Load Factor
AXIAL LOADS . . .
Axial Load at 9.0 ft, D = 1.50, L = 1.60, S = 0.60 k
BENDING LOADS . . .
Lat. Uniform Load creating Mx-x, W = 0.040 k/ft

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.4895 : 1**

Load Combination	+D+L
Governing NDS Forumla	Comp Only, fc/Fc'
Location of max.above base	0.0 ft
At maximum location values are .	
Applied Axial	3.115 k
Applied Mx	0.0 k-ft
Applied My	0.0 k-ft
Fc : Allowable	771.29 psi

PASS Maximum Shear Stress Ratio = **0.06818 : 1**

Load Combination	+D+0.60W
Location of max.above base	9.0 ft
Applied Design Shear	19.636 psi
Allowable Shear	288.0 psi

Maximum SERVICE Lateral Load Reactions . .

Top along Y-Y	0.180 k	Bottom along Y-Y	0.180 k
Top along X-X	0.0 k	Bottom along X-X	0.0 k

Maximum SERVICE Load Lateral Deflections . . .

Along Y-Y 0.2392 in at 4.530 ft above base
for load combination : W Only
Along X-X 0.0 in at 0.0 ft above base
for load combination : n/a

Other Factors used to calculate allowable stresses . . .

	Bending	Compression	Tension

Load Combination Results

Load Combination	C_D	C_P	Maximum Axial + Bending Stress Ratios			Maximum Shear Ratios		
			Stress Ratio	Status	Location	Stress Ratio	Status	Location
D Only	0.900	0.560	0.2455	PASS	0.0 ft	0.0	PASS	9.0 ft
+D+L	1.000	0.519	0.4895	PASS	0.0 ft	0.0	PASS	9.0 ft
+D+S	1.150	0.467	0.3212	PASS	0.0 ft	0.0	PASS	9.0 ft
+D+0.750L	1.250	0.437	0.4054	PASS	0.0 ft	0.0	PASS	9.0 ft
+D+0.750L+0.750S	1.150	0.467	0.4807	PASS	0.0 ft	0.0	PASS	9.0 ft
+D+0.60W	1.600	0.356	0.3184	PASS	4.470 ft	0.06818	PASS	9.0 ft
+D+0.750L+0.450W	1.600	0.356	0.4037	PASS	4.470 ft	0.05114	PASS	9.0 ft
+D+0.750L+0.750S+0.450W	1.600	0.356	0.4829	PASS	4.470 ft	0.05114	PASS	9.0 ft
+0.60D+0.60W	1.600	0.356	0.2641	PASS	4.470 ft	0.06818	PASS	9.0 ft

Wood Column

DESCRIPTIO Typical Stud Design (2x6's at 16" oc)

Load Combination Results

Load Combination	C_D	C_P	Maximum Axial + Bending Stress Ratios			Maximum Shear Ratios		
			Stress Ratio	Status	Location	Stress Ratio	Status	Location
+0.60D	1.600	0.356	0.1304	PASS	0.0 ft	0.0	PASS	9.0 ft

Wood Column

DESCRIPTIO Double Stud Post

Code References

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combinations Used : ASCE 7-16

General Information

Analysis Metho	Allowable Stress Design		
End Fixities	Top & Bottom Pinned		
Overall Column Heigh	9 ft		
(Used for non-slender calculations)			
Wood Specie	Douglas Fir-South		
Wood Grade	No.2		
Fb +	850 psi	Fv	180 psi
Fb -	850 psi	Ft	525 psi
Fc - Prll	1350 psi	Density	28.72 pcf
Fc - Perp	520 psi		

E : Modulus of Elasticity . . .	x-x Bending	y-y Bending	Axial
Basic	1200	1200	1200 ksi
Minimum	440	440	

Wood Section Name	**2-2x6**		
Wood Grading/Manuf.	Graded Lumber		
Wood Member Type	Sawn		
Exact Width	**3.0** in	Allow Stress Modification Factors	
Exact Depth	**5.50** in	Cf or Cv for Bending	1.30
Area	16.50 in^2	Cf or Cv for Compressio	1.10
Ix	41.594 in^4	Cf or Cv for Tension	1.30
Iy	12.375 in^4	Cm : Wet Use Factor	1.0
		Ct : Temperature Fact	1.0
		Cfu : Flat Use Factor	1.0
		Kf : Built-up columns	1.0 *NDS 15.3.2*
		Use Cr : Repetitive	No

Brace condition for deflection (buckling) along columns :
X-X (width) axis Fully braced against buckling ABOUT Y-Y Axis
Y-Y (depth) axis Unbraced Length for buckling ABOUT X-X Axis = 9

Applied Loads

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

Column self weight included : 29.618 lbs * Dead Load Factor
AXIAL LOADS . . .
Axial Load at 9.0 ft, D = 3.0, L = 4.0 k
BENDING LOADS . . .
Lat. Uniform Load creating Mx-x, W = 0.160 k/ft

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.7230 : 1**

Load Combination	+D+0.750L+0.450W
Governing NDS Formula	Comp + Mxx, NDS Eq. 3.9-3
Location of max.above base	4.470 ft
At maximum location values are .	
Applied Axial	6.030 k
Applied Mx	0.7290 k-ft
Applied My	0.0 k-ft
Fc : Allowable	844.78 psi

PASS Maximum Shear Stress Ratio = **0.1364 : 1**

Load Combination	+D+0.60W
Location of max.above base	9.0 ft
Applied Design Shear	39.273 psi
Allowable Shear	288.0 psi

Maximum SERVICE Lateral Load Reactions . .

Top along Y-Y	0.720 k	Bottom along Y-Y	0.720 k
Top along X-X	0.0 k	Bottom along X-X	0.0 k

Maximum SERVICE Load Lateral Deflections . . .

Along Y-Y 0.4783 in at 4.530 ft above base
for load combination : W Only
Along X-X 0.0 in at 0.0 ft above base
for load combination : n/a

Other Factors used to calculate allowable stresses . . .

	Bending	Compression	Tension

Load Combination Results

Load Combination	C_D	C_P	Maximum Axial + Bending Stress Ratios: Stress Ratio	Status	Location	Maximum Shear Ratios: Stress Ratio	Status	Location
D Only	0.900	0.560	0.2455	PASS	0.0 ft	0.0	PASS	9.0 ft
+D+L	1.000	0.519	0.5524	PASS	0.0 ft	0.0	PASS	9.0 ft
+D+0.750L	1.250	0.437	0.4501	PASS	0.0 ft	0.0	PASS	9.0 ft
+D+0.60W	1.600	0.356	0.5896	PASS	4.470 ft	0.1364	PASS	9.0 ft
+D+0.750L+0.450W	1.600	0.356	0.7230	PASS	4.470 ft	0.1023	PASS	9.0 ft
+0.60D+0.60W	1.600	0.356	0.5112	PASS	4.470 ft	0.1364	PASS	9.0 ft
+0.60D	1.600	0.356	0.1304	PASS	0.0 ft	0.0	PASS	9.0 ft

Wood Column

Lic. # : KW-06011847 — Merrell Design Services PLLC

DESCRIPTIO Double Stud Post

Code References

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combinations Used : ASCE 7-10

General Information

Analysis Metho	Allowable Stress Design		
End Fixities	Top & Bottom Pinned		
Overall Column Heigh	10 ft		
(Used for non-slender calculations)			
Wood Specie	Douglas Fir-Larch		
Wood Grade	No.2		
Fb +	900 psi	Fv	180 psi
Fb -	900 psi	Ft	575 psi
Fc - Prll	1350 psi	Density	31.21 pcf
Fc - Perp	625 psi		

E : Modulus of Elasticity . . . x-x Bending y-y Bending Axial

Basic	1600	1600	1600 ksi
Minimum	580	580	

Wood Section Name	**2-2x6**		
Wood Grading/Manuf.	Graded Lumber		
Wood Member Type	Sawn		
Exact Width	**3.0** in	Allow Stress Modification Factors	
Exact Depth	**5.50** in	Cf or Cv for Bending	1.30
Area	16.50 in^2	Cf or Cv for Compressio	1.10
Ix	41.594 in^4	Cf or Cv for Tension	1.30
Iy	12.375 in^4	Cm : Wet Use Factor	1.0
		Ct : Temperature Fact	1.0
		Cfu : Flat Use Factor	1.0
		Kf : Built-up columns	1.0 *NDS 15.3.2*
		Use Cr : Repetitive	No

Brace condition for deflection (buckling) along columns :
X-X (width) axis: Fully braced against buckling ABOUT Y-Y Axis
Y-Y (depth) axis: Fully braced against buckling ABOUT X-X Axis

Applied Loads

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

Column self weight included : 35.761 lbs * Dead Load Factor
AXIAL LOADS . . .
Axial Load at 10.0 ft, D = 3.0, L = 3.0, S = 3.0 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.2674 : 1**

Load Combination	+D+0.750L+0.750S
Governing NDS Forumla	Comp Only, fc/Fc'
Location of max.above base	0.0 ft
At maximum location values are .	
Applied Axial	7.536 k
Applied Mx	0.0 k-ft
Applied My	0.0 k-ft
Fc : Allowable	1,707.75 psi

PASS Maximum Shear Stress Ratio = **0.0 : 1**

Load Combination	+0.60D
Location of max.above base	10.0 ft
Applied Design Shear	0.0 psi
Allowable Shear	288.0 psi

Maximum SERVICE Lateral Load Reactions . .

Top along Y-Y	0.0 k	Bottom along Y-Y	0.0 k
Top along X-X	0.0 k	Bottom along X-X	0.0 k

Maximum SERVICE Load Lateral Deflections . . .

Along Y-Y 0.0 in at 0.0 ft above base
for load combination : n/a
Along X-X 0.0 in at 0.0 ft above base
for load combination : n/a

Other Factors used to calculate allowable stresses . . .

	Bending	Compression	Tension

Load Combination Results

Load Combination	C_D	C_P	Maximum Axial + Bending Stress Ratios: Stress Ratio	Status	Location	Maximum Shear Ratios: Stress Ratio	Status	Location
D Only	0.900	1.000	0.1377	PASS	0.0 ft	0.0	PASS	10.0 ft
+D+L	1.000	1.000	0.2463	PASS	0.0 ft	0.0	PASS	10.0 ft
+D+S	1.150	1.000	0.2142	PASS	0.0 ft	0.0	PASS	10.0 ft
+D+0.750L	1.250	1.000	0.1726	PASS	0.0 ft	0.0	PASS	10.0 ft
+D+0.750L+0.750S	1.150	1.000	0.2674	PASS	0.0 ft	0.0	PASS	10.0 ft
+0.60D	1.600	1.000	0.04646	PASS	0.0 ft	0.0	PASS	10.0 ft

Wood Beam

Lic. # : KW-06011847 — Merrell Design Services PLLC

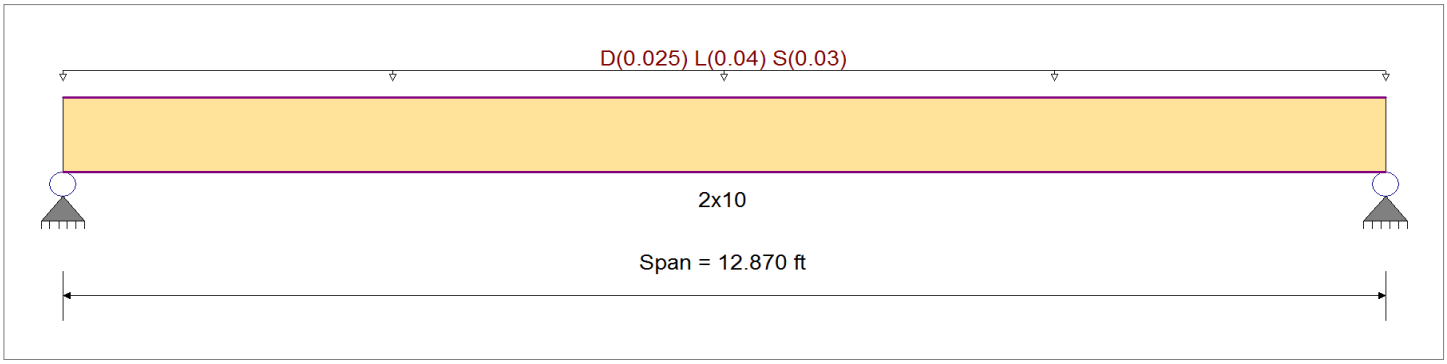
DESCRIPTIO Deck Joists

CODE REFERENCES

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combination Set : ASCE 7-10

Material Properties

Analysis Metho	Allowable Stress Design	Fb +	900 psi	*E : Modulus of Elasti*	
Load Combinati	ASCE 7-10	Fb -	900 psi	Ebend- xx	1600 ksi
		Fc - Prll	1350 psi	Eminbend - x	580 ksi
Wood Species	Douglas Fir-Larch	Fc - Perp	625 psi		
Wood Grade	No.2	Fv	180 psi		
		Ft	575 psi	Density	31.21 pcf
Beam Bracing	Beam is Fully Braced against lateral-torsional buckling			Repetitive Member Stress Increa	



Applied Loads

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

Beam self weight calculated and added to loads
Uniform Load : D = 0.0250, L = 0.040, S = 0.030 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.714 : 1	Maximum Shear Stress Ratio	=	0.239 : 1
Section used for this span		2x10	Section used for this span		2x10
fb: Actual	=	935.10 psi	fv: Actual	=	49.47 psi
Fb: Allowable	=	1,309.28 psi	Fv: Allowable	=	207.00 psi
Load Combination		+D+0.750L+0.750S	Load Combination		+D+0.750L+0.750S
Location of maximum on span	=	6.435 ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.157 in	Ratio =	984 >=360
Max Upward Transient Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.316 in	Ratio =	489 >=240
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 12.870 ft	1	0.317	0.106	0.90	1.100	1.00	1.15	1.00	1.00	1.00	0.58	325.31	1024.65	0.16	17.21	162.00
+D+L					1.100	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 12.870 ft	1	0.694	0.232	1.00	1.100	1.00	1.15	1.00	1.00	1.00	1.41	789.91	1138.50	0.39	41.79	180.00
+D+S					1.100	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 12.870 ft	1	0.515	0.172	1.15	1.100	1.00	1.15	1.00	1.00	1.00	1.20	673.76	1309.28	0.33	35.64	207.00
+D+0.750L					1.100	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 12.870 ft	1	0.473	0.158	1.25	1.100	1.00	1.15	1.00	1.00	1.00	1.20	673.76	1423.13	0.33	35.64	225.00
+D+0.750L+0.750S					1.100	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 12.870 ft	1	0.714	0.239	1.15	1.100	1.00	1.15	1.00	1.00	1.00	1.67	935.10	1309.28	0.46	49.47	207.00
+0.60D					1.100	1.00	1.15	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 12.870 ft	1	0.107	0.036	1.60	1.100	1.00	1.15	1.00	1.00	1.00	0.35	195.18	1821.60	0.10	10.33	288.00

Wood Beam

DESCRIPTIO Deck Joists

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+0.750L+0.750S	1	0.3158	6.482		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.518	0.518
Overall MINimum	0.193	0.193
D Only	0.180	0.180
+D+L	0.438	0.438
+D+S	0.373	0.373
+D+0.750L	0.373	0.373
+D+0.750L+0.750S	0.518	0.518
+0.60D	0.108	0.108
L Only	0.257	0.257
S Only	0.193	0.193

Wood Beam

DESCRIPTIO Beam 1

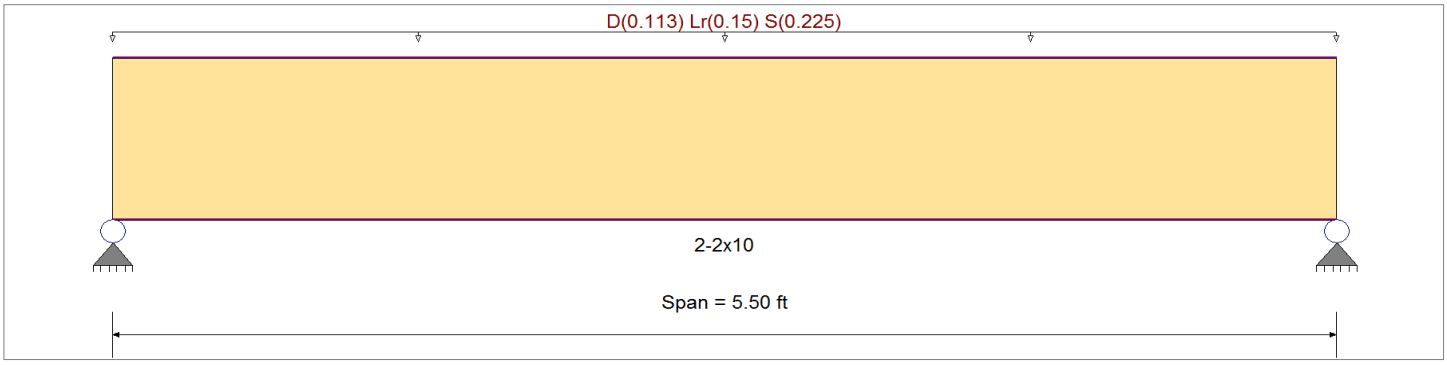
CODE REFERENCES

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combination Set : ASCE 7-10

Material Properties

Analysis Metho	Allowable Stress Design	Fb +	900 psi	*E : Modulus of Elasti*	
Load Combinati	ASCE 7-10	Fb -	900 psi	Ebend- xx	1600 ksi
		Fc - Prll	1350 psi	Eminbend - x	580 ksi
Wood Species	Douglas Fir-Larch	Fc - Perp	625 psi		
Wood Grade	No.2	Fv	180 psi		
		Ft	575 psi	Density	31.21 pcf

Beam Bracing Beam is Fully Braced against lateral-torsional buckling



Applied Loads

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

Beam self weight calculated and added to loads
Uniform Load : D = 0.1130, Lr = 0.150, S = 0.2250 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.320 : 1	Maximum Shear Stress Ratio	=	0.179 : 1	
Section used for this span		2-2x10	Section used for this span		2-2x10	
fb: Actual	=	364.87 psi	fv: Actual	=	36.95 psi	
Fb: Allowable	=	1,138.50 psi	Fv: Allowable	=	207.00 psi	
Load Combination		+D+S	Load Combination		+D+S	
Location of maximum on span	=	2.750 ft	Location of maximum on span	=	4.737 ft	
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1	

Maximum Deflection

Max Downward Transient Deflection	0.015 in	Ratio =	4484 >=360
Max Upward Transient Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.023 in	Ratio =	2932 >=240
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.142	0.079	0.90	1.100	1.00	1.00	1.00	1.00	1.00	0.45	126.23	891.00	0.24	12.78	162.00
+D+Lr					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.231	0.128	1.25	1.100	1.00	1.00	1.00	1.00	1.00	1.02	285.32	1237.50	0.53	28.90	225.00
+D+S					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.320	0.179	1.15	1.100	1.00	1.00	1.00	1.00	1.00	1.30	364.87	1138.50	0.68	36.95	207.00
+D+0.750Lr					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.198	0.111	1.25	1.100	1.00	1.00	1.00	1.00	1.00	0.88	245.55	1237.50	0.46	24.87	225.00
+D+0.750S					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.268	0.149	1.15	1.100	1.00	1.00	1.00	1.00	1.00	1.09	305.21	1138.50	0.57	30.91	207.00
+0.60D					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.048	0.027	1.60	1.100	1.00	1.00	1.00	1.00	1.00	0.27	75.74	1584.00	0.14	7.67	288.00

Wood Beam

DESCRIPTIO Beam 1

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S	1	0.0225	2.770		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.946	0.946
Overall MINimum	0.619	0.619
D Only	0.327	0.327
+D+Lr	0.740	0.740
+D+S	0.946	0.946
+D+0.750Lr	0.637	0.637
+D+0.750S	0.791	0.791
+0.60D	0.196	0.196
Lr Only	0.413	0.413
S Only	0.619	0.619

Wood Beam

DESCRIPTIO Beam 2

CODE REFERENCES

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combination Set : ASCE 7-10

Material Properties

Analysis Metho: Allowable Stress Design
Load Combinati: ASCE 7-10

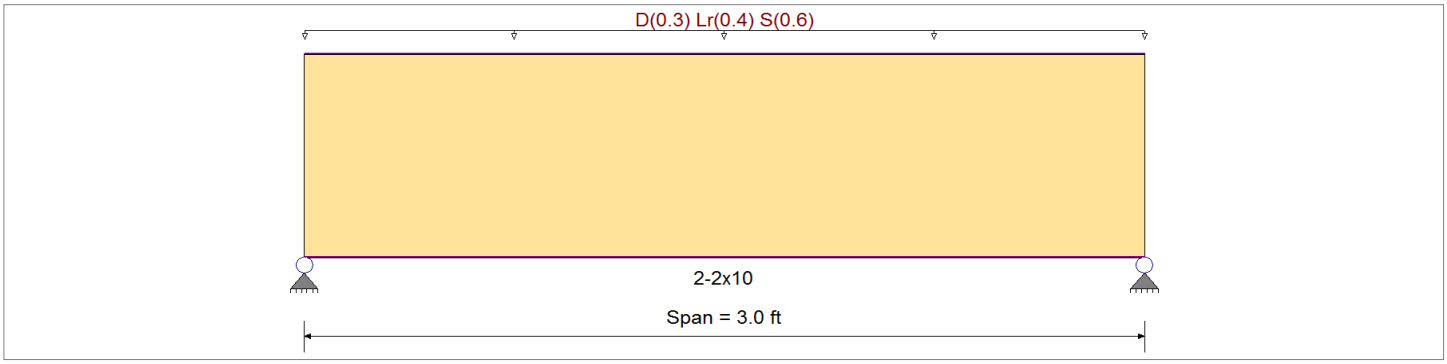
Wood Species: Douglas Fir-Larch
Wood Grade: No.2

Beam Bracing: Beam is Fully Braced against lateral-torsional buckling

Fb +	900.0 psi
Fb -	900.0 psi
Fc - Prll	1,350.0 psi
Fc - Perp	625.0 psi
Fv	180.0 psi
Ft	575.0 psi

E : Modulus of Elasti

Ebend- xx	1,600.0 ksi
Eminbend - x	580.0 ksi
Density	31.210 pcf



Applied Loads

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

Beam self weight calculated and added to loads
Uniform Load : D = 0.30, Lr = 0.40, S = 0.60 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.251 : 1	Maximum Shear Stress Ratio	=	0.174 : 1
Section used for this span		2-2x10	Section used for this span		2-2x10
fb: Actual	=	285.90 psi	fv: Actual	=	35.93 psi
Fb: Allowable	=	1,138.50 psi	Fv: Allowable	=	207.00 psi
Load Combination		+D+S	Load Combination		+D+S
Location of maximum on span	=	1.500 ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.003 in	Ratio =	10361 >=360
Max Upward Transient Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.005 in	Ratio =	6862 >=240
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 3.0 ft	1	0.108	0.075	0.90	1.100	1.00	1.00	1.00	1.00	1.00	0.34	96.57	891.00	0.22	12.13	162.00
+D+Lr					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 3.0 ft	1	0.180	0.124	1.25	1.100	1.00	1.00	1.00	1.00	1.00	0.79	222.79	1237.50	0.52	28.00	225.00
+D+S					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 3.0 ft	1	0.251	0.174	1.15	1.100	1.00	1.00	1.00	1.00	1.00	1.02	285.90	1138.50	0.66	35.93	207.00
+D+0.750Lr					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 3.0 ft	1	0.155	0.107	1.25	1.100	1.00	1.00	1.00	1.00	1.00	0.68	191.23	1237.50	0.44	24.03	225.00
+D+0.750S					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 3.0 ft	1	0.210	0.145	1.15	1.100	1.00	1.00	1.00	1.00	1.00	0.85	238.57	1138.50	0.55	29.98	207.00
+0.60D					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 3.0 ft	1	0.037	0.025	1.60	1.100	1.00	1.00	1.00	1.00	1.00	0.21	57.94	1584.00	0.13	7.28	288.00

Wood Beam

DESCRIPTIO Beam 2

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S	1	0.0052	1.511		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	1.359	1.359
Overall MINimum	0.900	0.900
D Only	0.459	0.459
+D+Lr	1.059	1.059
+D+S	1.359	1.359
+D+0.750Lr	0.909	0.909
+D+0.750S	1.134	1.134
+0.60D	0.275	0.275
Lr Only	0.600	0.600
S Only	0.900	0.900

Wood Beam

DESCRIPTIO Beam 3

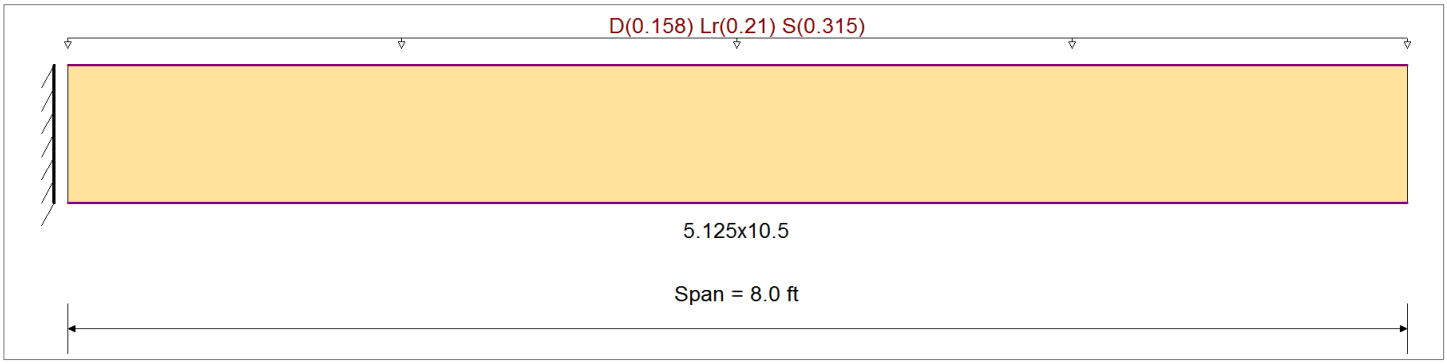
CODE REFERENCES

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combination Set : ASCE 7-10

Material Properties

Analysis Metho	Allowable Stress Design	Fb +	2,400.0 psi	*E : Modulus of Elasti*	
Load Combinati	ASCE 7-10	Fb -	2,400.0 psi	Ebend- xx	1,800.0 ksi
		Fc - Prll	1,650.0 psi	Eminbend - x	950.0 ksi
Wood Species	DF/DF	Fc - Perp	650.0 psi	Ebend- yy	1,600.0 ksi
Wood Grade	24F-V8	Fv	265.0 psi	Eminbend - y	850.0 ksi
		Ft	1,100.0 psi	Density	31.210 pcf

Beam Bracing Beam is Fully Braced against lateral-torsional buckling



Applied Loads

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

Beam self weight calculated and added to loads
Uniform Load : D = 0.1580, Lr = 0.210, S = 0.3150 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.716	: 1	Maximum Shear Stress Ratio	=	0.317	: 1
Section used for this span		5.125x10.5		Section used for this span		5.125x10.5	
fb: Actual	=	1,976.29	psi	fv: Actual	=	96.64	psi
Fb: Allowable	=	2,760.00	psi	Fv: Allowable	=	304.75	psi
Load Combination		+D+S		Load Combination		+D+S	
Location of maximum on span	=	0.000	ft	Location of maximum on span	=	0.000	ft
Span # where maximum occurs	=	Span # 1		Span # where maximum occurs	=	Span # 1	

Maximum Deflection

Max Downward Transient Deflection	0.312 in	Ratio =	614	>=360
Max Upward Transient Deflection	0.000 in	Ratio =	0	<360
Max Downward Total Deflection	0.481 in	Ratio =	398	>=240
Max Upward Total Deflection	0.000 in	Ratio =	0	<240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.320	0.142	0.90	1.000	1.00	1.00	1.00	1.00	1.00	5.43	691.83	2160.00	1.21	33.83	238.50
+D+Lr					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.516	0.229	1.25	1.000	1.00	1.00	1.00	1.00	1.00	12.15	1,548.13	3000.00	2.72	75.70	331.25
+D+S					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.716	0.317	1.15	1.000	1.00	1.00	1.00	1.00	1.00	15.51	1,976.29	2760.00	3.47	96.64	304.75
+D+0.750Lr					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.445	0.197	1.25	1.000	1.00	1.00	1.00	1.00	1.00	10.47	1,334.06	3000.00	2.34	65.23	331.25
+D+0.750S					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.600	0.266	1.15	1.000	1.00	1.00	1.00	1.00	1.00	12.99	1,655.17	2760.00	2.90	80.94	304.75
+0.60D					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 8.0 ft	1	0.108	0.048	1.60	1.000	1.00	1.00	1.00	1.00	1.00	3.26	415.10	3840.00	0.73	20.30	424.00

Wood Beam

DESCRIPTIO Beam 3

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S	1	0.4807	8.000		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.877	
Overall MINimum	2.520	
D Only	1.357	
+D+Lr	3.037	
+D+S	3.877	
+D+0.750Lr	2.617	
+D+0.750S	3.247	
+0.60D	0.814	
Lr Only	1.680	
S Only	2.520	

Wood Beam

DESCRIPTIO Beam 4

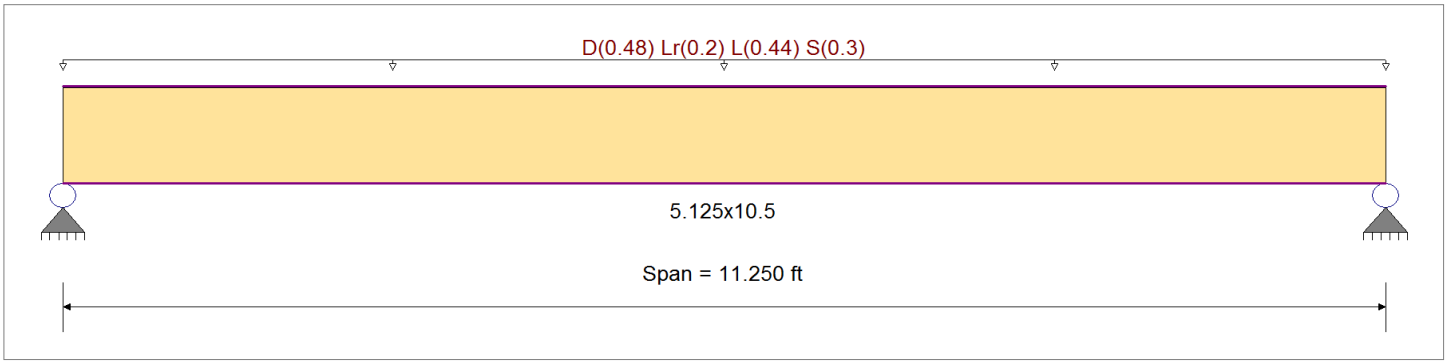
CODE REFERENCES

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combination Set : ASCE 7-10

Material Properties

Analysis Metho	Allowable Stress Design	Fb +	2400 psi	*E : Modulus of Elasti*	
Load Combinati	ASCE 7-10	Fb -	1850 psi	Ebend- xx	1800 ksi
		Fc - Prll	1650 psi	Eminbend - x	950 ksi
Wood Species	DF/DF	Fc - Perp	650 psi	Ebend- yy	1600 ksi
Wood Grade	24F-V4	Fv	265 psi	Eminbend - y	850 ksi
		Ft	1100 psi	Density	31.21 pcf

Beam Bracing Beam is Fully Braced against lateral-torsional buckling



Applied Loads

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

Uniform Load : D = 0.480, Lr = 0.20, L = 0.440, S = 0.30 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.773 : 1		Maximum Shear Stress Ratio	=	0.461 : 1	
Section used for this span		5.125x10.5		Section used for this span		5.125x10.5	
fb: Actual	=	1,854.65	psi	fv: Actual	=	122.14	psi
Fb: Allowable	=	2,400.00	psi	Fv: Allowable	=	265.00	psi
Load Combination		+D+L		Load Combination		+D+L	
Location of maximum on span	=	5.625	ft	Location of maximum on span	=	10.388	ft
Span # where maximum occurs	=	Span # 1		Span # where maximum occurs	=	Span # 1	

Maximum Deflection

Max Downward Transient Deflection	0.179 in	Ratio =	753	>=360
Max Upward Transient Deflection	0.000 in	Ratio =	0	<360
Max Downward Total Deflection	0.422 in	Ratio =	320	>=240
Max Upward Total Deflection	0.000 in	Ratio =	0	<240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 11.250 ft	1	0.448	0.267	0.90	1.000	1.00	1.00	1.00	1.00	1.00	7.59	967.65	2160.00	2.29	63.72	238.50
+D+L					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.250 ft	1	0.773	0.461	1.00	1.000	1.00	1.00	1.00	1.00	1.00	14.55	1,854.65	2400.00	4.38	122.14	265.00
+D+Lr					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.250 ft	1	0.457	0.273	1.25	1.000	1.00	1.00	1.00	1.00	1.00	10.76	1,370.83	3000.00	3.24	90.28	331.25
+D+S					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.250 ft	1	0.570	0.340	1.15	1.000	1.00	1.00	1.00	1.00	1.00	12.34	1,572.42	2760.00	3.71	103.55	304.75
+D+0.750Lr+0.750L					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.250 ft	1	0.645	0.385	1.25	1.000	1.00	1.00	1.00	1.00	1.00	15.19	1,935.29	3000.00	4.57	127.45	331.25
+D+0.750L+0.750S					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.250 ft	1	0.756	0.451	1.15	1.000	1.00	1.00	1.00	1.00	1.00	16.37	2,086.49	2760.00	4.93	137.41	304.75
+0.60D					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 11.250 ft	1	0.151	0.090	1.60	1.000	1.00	1.00	1.00	1.00	1.00	4.56	580.59	3840.00	1.37	38.23	424.00

Wood Beam

DESCRIPTIO Beam 4

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+0.750L+0.750S	1	0.4216	5.666		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	5.822	5.822
Overall MINimum	1.688	1.688
D Only	2.700	2.700
+D+L	5.175	5.175
+D+Lr	3.825	3.825
+D+S	4.388	4.388
+D+0.750Lr+0.750L	5.400	5.400
+D+0.750L+0.750S	5.822	5.822
+0.60D	1.620	1.620
Lr Only	1.125	1.125
L Only	2.475	2.475
S Only	1.688	1.688

Merrell Design Services
Practical Structural Solutions

Project Title: Mercer Island Custom Home
Engineer: KJH
Project ID: 21-045
Project Descr: Framing and Foundations

Printed: 9 AUG 2021, 12:29AM

Wood Beam

Lic. # : KW-06011847 — Merrell Design Services PLLC

DESCRIPTIO Beam 5

CODE REFERENCES

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combination Set : ASCE 7-10

Material Properties

Analysis Metho: Allowable Stress Design
Load Combinati: ASCE 7-10

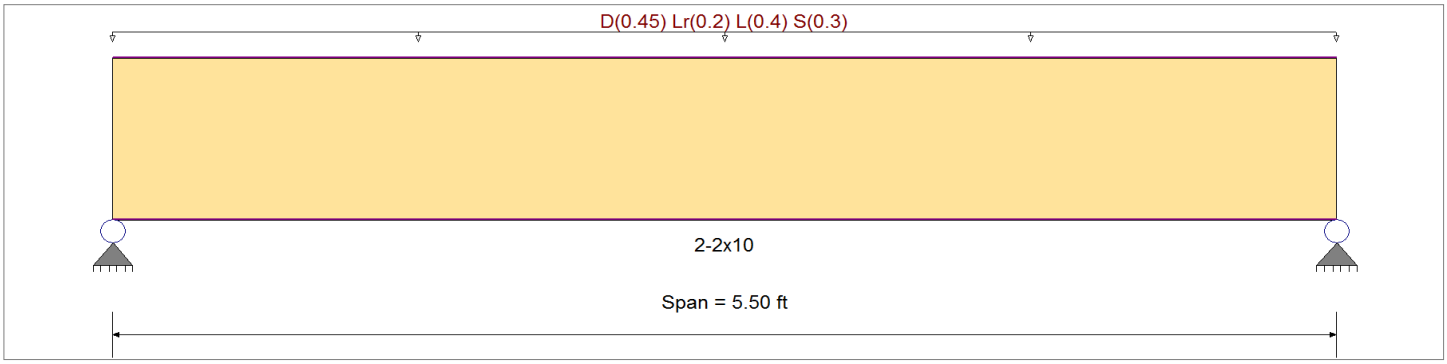
Wood Species: Douglas Fir-Larch
Wood Grade: No.2

Beam Bracing: Beam is Fully Braced against lateral-torsional buckling

Fb +	900.0 psi
Fb -	900.0 psi
Fc - Prll	1,350.0 psi
Fc - Perp	625.0 psi
Fv	180.0 psi
Ft	575.0 psi

E : Modulus of Elasti

Ebend- xx	1,600.0 ksi
Eminbend - x	580.0 ksi
Density	31.210 pcf



Applied Loads

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

Beam self weight calculated and added to loads
Uniform Load : D = 0.450, Lr = 0.20, L = 0.40, S = 0.30 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.917 : 1	Maximum Shear Stress Ratio	=	0.511 : 1
Section used for this span		2-2x10	Section used for this span		2-2x10
fb: Actual	=	907.91 psi	fv: Actual	=	91.95 psi
Fb: Allowable	=	990.00 psi	Fv: Allowable	=	180.00 psi
Load Combination		+D+L	Load Combination		+D+L
Location of maximum on span	=	2.750 ft	Location of maximum on span	=	4.737 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.026 in	Ratio =	2522 >=360
Max Upward Transient Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.064 in	Ratio =	1028 >=240
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.543	0.302	0.90	1.100	1.00	1.00	1.00	1.00	1.00	1.72	483.66	891.00	0.91	48.98	162.00
+D+L					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.917	0.511	1.00	1.100	1.00	1.00	1.00	1.00	1.00	3.24	907.91	990.00	1.70	91.95	180.00
+D+Lr					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.562	0.313	1.25	1.100	1.00	1.00	1.00	1.00	1.00	2.48	695.79	1237.50	1.30	70.47	225.00
+D+S					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.704	0.392	1.15	1.100	1.00	1.00	1.00	1.00	1.00	2.86	801.85	1138.50	1.50	81.21	207.00
+D+0.750Lr+0.750L					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.777	0.433	1.25	1.100	1.00	1.00	1.00	1.00	1.00	3.43	960.94	1237.50	1.80	97.32	225.00
+D+0.750L+0.750S					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 5.50 ft	1	0.914	0.509	1.15	1.100	1.00	1.00	1.00	1.00	1.00	3.71	1,040.49	1138.50	1.95	105.38	207.00
+0.60D					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00

Wood Beam

DESCRIPTIO Beam 5

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
Length = 5.50 ft	**1**	0.183	0.102	1.60	1.100	1.00	1.00	1.00	1.00	1.00	1.03	290.20	1584.00	0.54	29.39	288.00

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+0.750L+0.750S	1	0.0642	2.770		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	2.698	2.698
Overall MINimum	0.825	0.825
D Only	1.254	1.254
+D+L	2.354	2.354
+D+Lr	1.804	1.804
+D+S	2.079	2.079
+D+0.750Lr+0.750L	2.492	2.492
+D+0.750L+0.750S	2.698	2.698
+0.60D	0.752	0.752
Lr Only	0.550	0.550
L Only	1.100	1.100
S Only	0.825	0.825

Merrell Design Services
Practical Structural Solutions

Project Title: Mercer Island Custom Home
Engineer: KJH
Project ID: 21-045
Project Descr: Framing and Foundations

Printed: 9 AUG 2021, 12:29AM

Wood Beam

Lic. # : KW-06011847 — Merrell Design Services PLLC

DESCRIPTIO Beam 6

CODE REFERENCES

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combination Set : ASCE 7-10

Material Properties

Analysis Metho: Allowable Stress Design
Load Combinati: ASCE 7-10

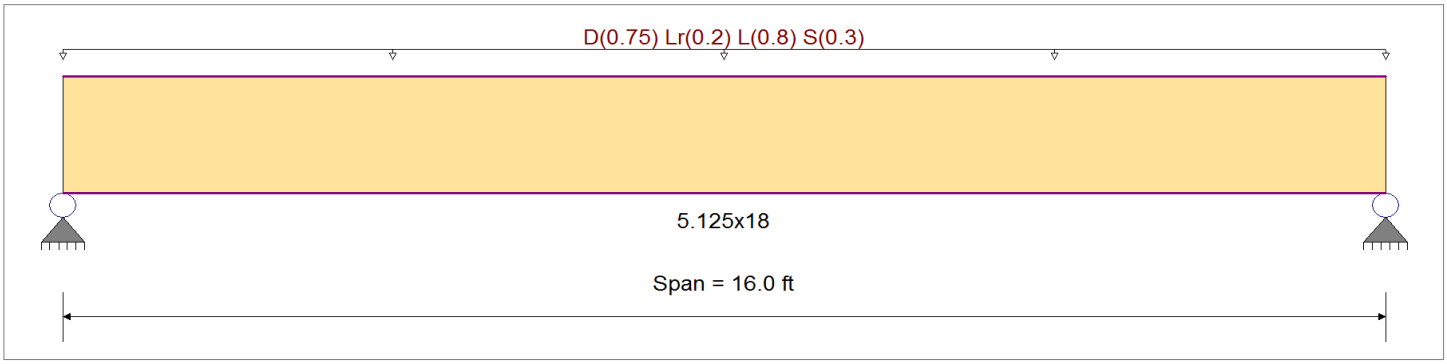
Wood Species: DF/DF
Wood Grade: 24F-V4

Beam Bracing: Beam is Fully Braced against lateral-torsional buckling

Fb +	2,400.0 psi
Fb -	1,850.0 psi
Fc - Prll	1,650.0 psi
Fc - Perp	650.0 psi
Fv	265.0 psi
Ft	1,100.0 psi

E : Modulus of Elasti

Ebend- xx	1,800.0 ksi
Eminbend - x	950.0 ksi
Ebend- yy	1,600.0 ksi
Eminbend - y	850.0 ksi
Density	31.210 pcf



Applied Loads

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

Beam self weight calculated and added to loads
Uniform Load : D = 0.750, Lr = 0.20, L = 0.80, S = 0.30 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.920 : 1	Maximum Shear Stress Ratio	=	0.630 : 1
Section used for this span		5.125x18	Section used for this span		5.125x18
fb: Actual	=	2,178.42 psi	fv: Actual	=	166.96 psi
Fb: Allowable	=	2,368.17 psi	Fv: Allowable	=	265.00 psi
Load Combination		+D+L	Load Combination		+D+L
Location of maximum on span	=	8.000 ft	Location of maximum on span	=	14.540 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.265 in	Ratio =	725 >=360
Max Upward Transient Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.528 in	Ratio =	363 >=240
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 16.0 ft	1	0.501	0.343	0.90	0.987	1.00	1.00	1.00	1.00	1.00	24.64	1,068.39	2131.35	5.04	81.88	238.50
+D+L					0.987	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 16.0 ft	1	0.920	0.630	1.00	0.987	1.00	1.00	1.00	1.00	1.00	50.24	2,178.42	2368.17	10.27	166.96	265.00
+D+Lr					0.987	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 16.0 ft	1	0.455	0.311	1.25	0.987	1.00	1.00	1.00	1.00	1.00	31.04	1,345.90	2960.21	6.34	103.15	331.25
+D+S					0.987	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 16.0 ft	1	0.545	0.373	1.15	0.987	1.00	1.00	1.00	1.00	1.00	34.24	1,484.65	2723.39	7.00	113.79	304.75
+D+0.750Lr+0.750L					0.987	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 16.0 ft	1	0.712	0.488	1.25	0.987	1.00	1.00	1.00	1.00	1.00	48.64	2,109.04	2960.21	9.94	161.64	331.25
+D+0.750L+0.750S					0.987	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 16.0 ft	1	0.813	0.557	1.15	0.987	1.00	1.00	1.00	1.00	1.00	51.04	2,213.11	2723.39	10.43	169.62	304.75
+0.60D					0.987	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00

Wood Beam

DESCRIPTIO Beam 6

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
Length = 16.0 ft	**1**	0.169	0.116	1.60	0.987	1.00	1.00	1.00	1.00	1.00	14.78	641.04	3789.06	3.02	49.13	424.00

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+0.750L+0.750S	1	0.5277	8.058		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	12.760	12.760
Overall MINimum	2.400	2.400
D Only	6.160	6.160
+D+L	12.560	12.560
+D+Lr	7.760	7.760
+D+S	8.560	8.560
+D+0.750Lr+0.750L	12.160	12.160
+D+0.750L+0.750S	12.760	12.760
+0.60D	3.696	3.696
Lr Only	1.600	1.600
L Only	6.400	6.400
S Only	2.400	2.400

Wood Beam

DESCRIPTIO Beam 7

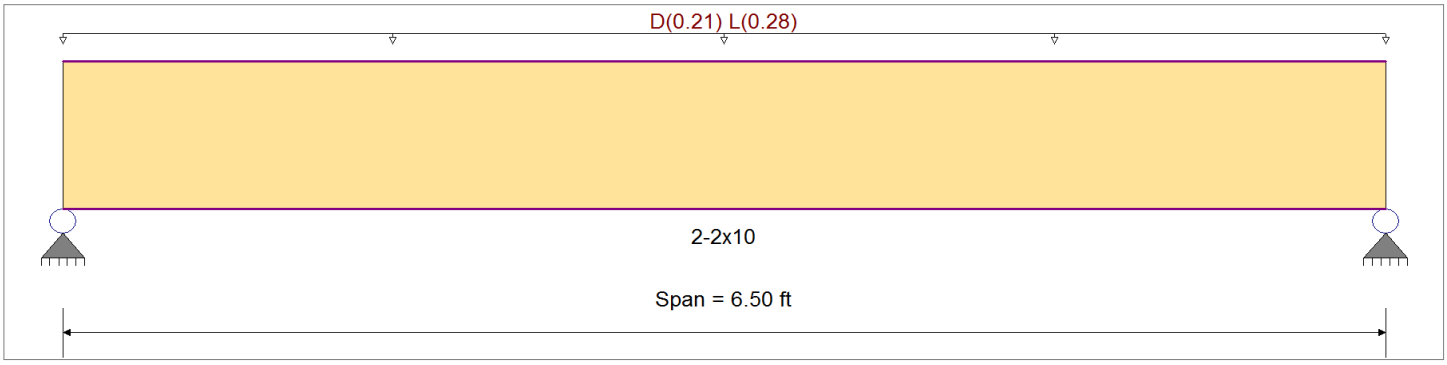
CODE REFERENCES

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combination Set : ASCE 7-10

Material Properties

Analysis Metho	Allowable Stress Design	Fb +	900 psi	*E : Modulus of Elasti*	
Load Combinati	ASCE 7-10	Fb -	900 psi	Ebend- xx	1600 ksi
		Fc - Prll	1350 psi	Eminbend - x	580 ksi
Wood Species	Douglas Fir-Larch	Fc - Perp	625 psi		
Wood Grade	No.2	Fv	180 psi		
		Ft	575 psi	Density	31.21 pcf

Beam Bracing: Beam is Fully Braced against lateral-torsional buckling



Applied Loads

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

Beam self weight calculated and added to loads
Uniform Load : D = 0.210, L = 0.280 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.742 : 1	Maximum Shear Stress Ratio	=	0.371 : 1
Section used for this span		2-2x10	Section used for this span		2-2x10
fb: Actual	=	734.78 psi	fv: Actual	=	66.78 psi
Fb: Allowable	=	990.00 psi	Fv: Allowable	=	180.00 psi
Load Combination		+D+L	Load Combination		+D+L
Location of maximum on span	=	3.250 ft	Location of maximum on span	=	5.741 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.036 in	Ratio =	2183 >=360
Max Upward Transient Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.063 in	Ratio =	1232 >=240
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 6.50 ft	1	0.359	0.180	0.90	1.100	1.00	1.00	1.00	1.00	1.00	1.14	320.00	891.00	0.54	29.08	162.00
+D+L					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.50 ft	1	0.742	0.371	1.00	1.100	1.00	1.00	1.00	1.00	1.00	2.62	734.78	990.00	1.24	66.78	180.00
+D+0.750L					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.50 ft	1	0.510	0.255	1.25	1.100	1.00	1.00	1.00	1.00	1.00	2.25	631.09	1237.50	1.06	57.36	225.00
+0.60D					1.100	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 6.50 ft	1	0.121	0.061	1.60	1.100	1.00	1.00	1.00	1.00	1.00	0.68	192.00	1584.00	0.32	17.45	288.00

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.0633	3.274		0.0000	0.000

Wood Beam

DESCRIPTIO Beam 7

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	1.612	1.612
Overall MINimum	0.910	0.910
D Only	0.702	0.702
+D+L	1.612	1.612
+D+0.750L	1.385	1.385
+0.60D	0.421	0.421
L Only	0.910	0.910

Wood Beam

DESCRIPTIO Grid C second flr shear tfer beam

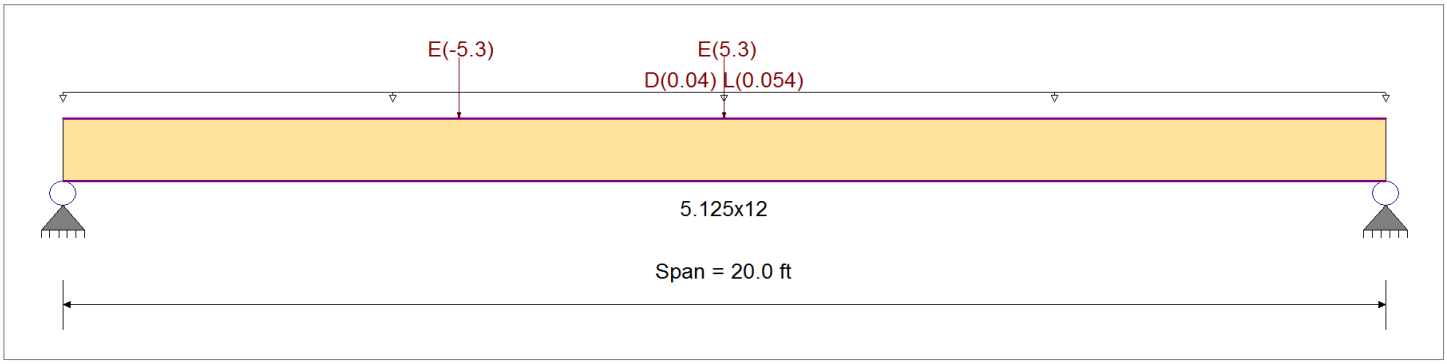
CODE REFERENCES

Calculations per NDS 2015, IBC 2015, CBC 2016, ASCE 7-10
Load Combination Set : ASCE 7-10

Material Properties

Analysis Metho	Allowable Stress Design	Fb +	2,400.0 psi	*E : Modulus of Elasti*	
Load Combinati	ASCE 7-10	Fb -	2,400.0 psi	Ebend- xx	1,800.0 ksi
		Fc - Prll	1,650.0 psi	Eminbend - x	950.0 ksi
Wood Species	DF/DF	Fc - Perp	650.0 psi	Ebend- yy	1,600.0 ksi
Wood Grade	24F-V8	Fv	265.0 psi	Eminbend - y	850.0 ksi
		Ft	1,100.0 psi	Density	31.210 pcf

Beam Bracing Beam is Fully Braced against lateral-torsional buckling



Applied Loads

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

Beam self weight calculated and added to loads
Uniform Load : D = 0.040, L = 0.0540 , Tributary Width = 1.0 ft
Point Load : E = 5.30 k @ 10.0 ft
Point Load : E = -5.30 k @ 6.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.261 : 1		Maximum Shear Stress Ratio	=	0.183 : 1	
Section used for this span		5.125x12		Section used for this span		5.125x12	
fb: Actual	=	1,000.63	psi	fv: Actual	=	77.52	psi
Fb: Allowable	=	3,840.00	psi	Fv: Allowable	=	424.00	psi
Load Combination		+D+0.750L+0.5250E		Load Combination		+D+0.70E	
Location of maximum on span	=	10.000	ft	Location of maximum on span	=	6.058	ft
Span # where maximum occurs	=	Span # 1		Span # where maximum occurs	=	Span # 1	

Maximum Deflection

Max Downward Transient Deflection	0.258 in	Ratio =	930 >=360
Max Upward Transient Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.387 in	Ratio =	620 >=240
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
D Only													0.00	0.00	0.00	0.00
Length = 20.0 ft	1	0.120	0.049	0.90	1.000	1.00	1.00	1.00	1.00	1.00	2.67	260.14	2160.00	0.48	11.77	238.50
+D+L					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 20.0 ft	1	0.218	0.089	1.00	1.000	1.00	1.00	1.00	1.00	1.00	5.37	523.56	2400.00	0.97	23.69	265.00
+D+0.750L					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 20.0 ft	1	0.153	0.063	1.25	1.000	1.00	1.00	1.00	1.00	1.00	4.69	457.70	3000.00	0.85	20.71	331.25
+D+0.70E					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 20.0 ft	1	0.256	0.183	1.60	1.000	1.00	1.00	1.00	1.00	1.00	10.09	984.05	3840.00	3.18	77.52	424.00
+D+0.750L+0.5250E					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 20.0 ft	1	0.261	0.149	1.60	1.000	1.00	1.00	1.00	1.00	1.00	10.26	1,000.63	3840.00	2.60	63.31	424.00
+0.60D					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00

Wood Beam

DESCRIPTIO Grid C second flr shear tfer beam

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	fb	F'b	Shear Values V	fv	F'v
Length = 20.0 ft	**1**	0.041	0.017	1.60	1.000	1.00	1.00	1.00	1.00	1.00	1.60	156.09	3840.00	0.29	7.06	424.00
+0.60D+0.70E					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 20.0 ft	**1**	0.229	0.178	1.60	1.000	1.00	1.00	1.00	1.00	1.00	9.02	879.99	3840.00	3.09	75.47	424.00

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+0.750L+0.5250E	1	0.3865	10.949		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	1.073	1.495
Overall MINimum	0.540	1.060
D Only	0.533	0.533
+D+L	1.073	1.073
+D+0.750L	0.938	0.938
+D+0.70E	-0.209	1.275
+D+0.750L+0.5250E	0.382	1.495
+0.60D	0.320	0.320
+0.60D+0.70E	-0.422	1.062
L Only	0.540	0.540
E Only	-1.060	1.060

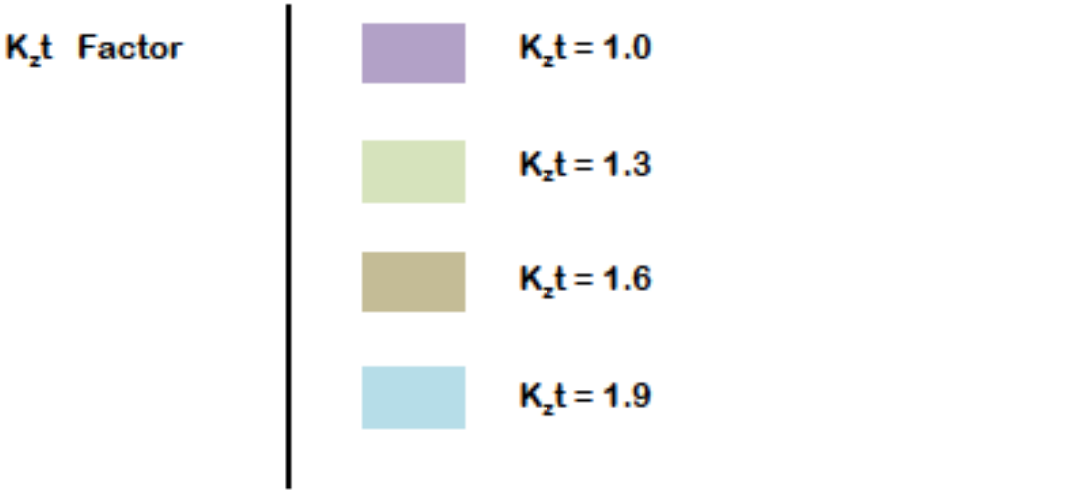
WIND EXPOSURE CATEGORIES & WIND SPEED-UP FACTORS
(ICC Section 1609 & ASCE 7-05 Chapter 6)

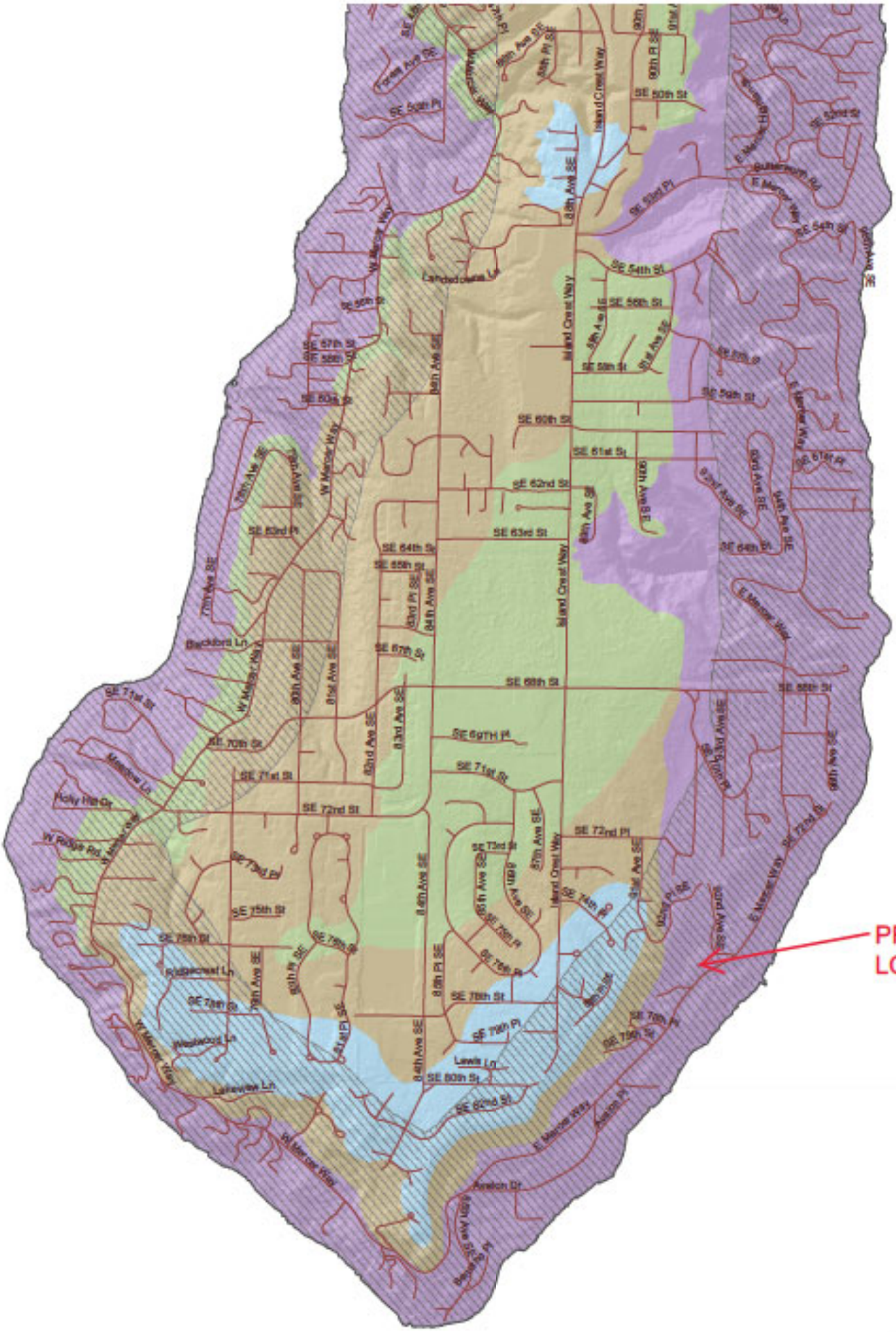
It is the responsibility of the Owner (or their Design Professional) to review site conditions and determine the Kzt factor to be utilized for each specific project. The Kzt factors and wind exposure categories indicated on this map are the minimum values accepted by the City of Mercer Island without requiring the design professional to submit additional calculations and supporting topographic documentation (to verify the values utilized in their wind load determination).

Please note – The Kzt values indicated on this map are approximations based upon periodic calculations of representative samplings around Mercer Island. These values are intended for City of Mercer Island's plan review purposes only.

WIND EXPOSURE CATEGORIES:

WIND SPEED-UP (TOPOGRAPHIC EFFECT) - K_zt Factor :




PROJECT
LOCATION

Merrell Design Services
Practical Structural Solutions

Project Title: Mercer Island Custom Home
Engineer: KJH
Project ID: 21-045
Project Descr: Framing and Foundations

Printed: 9 AUG 2021, 12:36AM

ASCE 7-16 Wind Forces Chpt 28, Pt2 & Chpt 30, Pt2

Lic. # : KW-06011847 — Merrell Design Services PLLC

DESCRIPTIO Wind forces - Mercer Island

General Design Values

Calculations per ASCE 7-16

V : Basic Wind Speed per Sect 26.5-1 or 2	**110.0**	mph
User specified minimum design pressu	10.0	psf
Occupancy per Table 1.5-1	II	All Buildings and other structures except those listed
Exposure Category per 26.7	Exposure C	
Topographic Factor Kzt per 26.8	**1.00**	

Main Force Resisting System Valu

MRH : Mean Roof Height	30.0	ft
Roof Slope Angle	0 to 5	degrees

Lambda MWFRS: per Figure 26. **1.40**

Component & Cladding Values

Effective Wind Area of Component & Clad	10.0	ft^2
Roof pitch for cladding pressu	Flat/Hip/Gable Roof	
LHD : Least Horizontal Dimension	40.0	ft
a = max (0.04 * LHD, 3, min(0.10 * LHD, 0.4*MRH))	**4.00**	ft

Lambda Componant & Cladding : per Figur **1.40**

Design Wind Pressures

Horizontal Pressures . . .

Zone: A =	26.88 psf		Zone: C =	17.78 psf	
Zone: B =	-14.00 psf		Zone: D =	-10.00 psf	

Vertical Pressures . . .

Zone: E =	-32.34 psf		Zone: G =	-22.40 psf	
Zone: F =	-18.34 psf		Zone: H =	-14.14 psf	

Overhangs . . .

Zone: Eoh =	-45.22 psf		Zone: Goh =	-35.42 psf	

ASCE 7-16 Section 28.5.4 Minimum Design Wind Loads requires that the load effects of the design wind pressures from Section 28.5.3 shall not be less than a minimum load defined by assuming the pressures, ps, for zones A and C equal to +16 psf, Zones B and D equal to +8 psf, while assuming ps for Zones E, F, G, and H are equal to 0 psf.

Component & Cladding Design Wind Pres

*Design Wind Pressure = Lambda * Kzt * Ps30 pe*

Roof Pressures	Positive	Negative		Overhang Pressures	Negative	
Zone 1	12.460	-48.580	psf	Zone 1	***	psf
Zone 1'	12.460	-27.860	psf	Zone 1'	***	psf
Zone 2	12.460	-63.980	psf	Zone 2	-53.900	psf
Zone 2e	***	***	psf	Zone 2e	***	psf
Zone 2n	***	***	psf	Zone 2n	***	psf
Zone 2r	***	***	psf	Zone 2r	***	psf
Zone 3	12.460	-87.220	psf	Zone 3	-73.080	psf
Zone 3e	***	***	psf	Zone 3e	***	psf
Zone 3r	***	***	psf	Zone 3r	***	psf

Wall Pressures

Wall Zone 4 :	***	***	psf
Wall Zone 5 :	***	***	psf

'*** : There is no value in Figure 30.4-1 Tabular Values

Merrell Design Services
Practical Structural Solutions

Project Title: Mercer Island Custom Home
Engineer: KJH
Project ID: 21-045
Project Descr: Framing and Foundations

Printed: 9 AUG 2021, 12:29AM

ASCE Seismic Base Shear

Lic. # : KW-06011847 — Merrell Design Services PLLC

Mercer Island EQ

Risk Category

Calculations per ASCE 7-16

Risk Category of Building or Other Structure : "II" : All Buildings and other structures except those listed as Category I, III, and IV — *SCE 7-16, Page 4, Table 1.5-1*

Seismic Importance Factor = 1 — *ASCE 7-16, Page 5, Table 1.5-2*

ASCE 7-16 11.4.2

Max. Ground Motions, 5% Damping

S_S = 1.472 g, 0.2 sec response
S_1 = 0.5664 g, 1.0 sec response

Latitude = 47.569 deg North
Longitude = 122.232 deg West
Location : Mercer Island, WA 98040

Site Class, Site Coeff. and Design Category

Site Classification "D" : Shear Wave Velocity 600 to 1,200 ft/sec = **D** (Based on Testing) — *ASCE 7-16 Table 20.3-1*

Site Coefficients Fa & Fv — Fa = 1.00, Fv = 1.77 — *ASCE 7-16 Table 11.4-1 & 11.4-2*
(using straight-line interpolation from table val

Maximum Considered Earthquake Accelerat
S_{MS} = Fa * Ss = 1.472 — *ASCE 7-16 Eq. 11.4-1*
S_{M1} = Fv * S1 = 1.000 — *ASCE 7-16 Eq. 11.4-2*

Design Spectral Acceleration
$S_{DS} = S_{MS} * 2/3$ = 0.981 — *ASCE 7-16 Eq. 11.4-3*
$S_{D1} = S_{M1} * 2/3$ = 0.667 — *ASCE 7-16 Eq. 11.4-4*

Seismic Design Category = **D** — *E 7-16 Table 11.6-1 & -2*

Resisting System

ASCE 7-16 Table 12.2-1

Basic Seismic Force Resisting System : **Bearing Wall Systems**
15.Light-frame (wood) walls sheathed w/wood structural panels rated for shear resistance.

Response Modification Coefficient " I " = 6.50
System Overstrength Factor " Wo " = 3.00
Deflection Amplification Factor " Cd " = 4.00

NOTE! See ASCE 7-16 for all applicable footnc

Building height Limits :
Category "A & B" Limit: No Limit
Category "C" Limit: No Limit
Category "D" Limit: Limit = 65
Category "E" Limit: Limit = 65
Category "F" Limit: Limit = 65

Lateral Force Procedure

ASCE 7-16 Section 12.8.2

Equivalent Lateral Force Procedure

The "Equivalent Lateral Force Procedure" is being used according to the provisions of ASCE 7-16 12.8

Determine Building Period

Use ASCE 12.8-7

Structure Type for Building Period Calcula: All Other Structural Systems
" Ct " value = 0.020
" x " value = 0.75
" hn " : Height from base to highest leve 30.0 ft
" Ta " Approximate fundemental period using Eq. 12.8-7 : Ta = Ct * (hn ^ x) = 0.256 sec
"TL" : Long-period transition period per ASCE 7-16 Maps 22-14 -> 22-17 6.000 sec

= 0.256 sec

" Cs " Response Coefficient

ASCE 7-16 Section 12.8.1.1

S_{DS} : Short Period Design Spectral Response = 0.981
" R " : Response Modification Factor = 6.50
" I " : Seismic Importance Factor = 1

From Eq. 12.8-2, Preliminary Cs = 0.151
From Eq. 12.8-3 & 12.8-4 , Cs need not exce = 0.400
From Eq. 12.8-5 & 12.8-6, Cs not be less than = 0.043

Cs : Seismic Response Coefficient = = **0.1510**

Seismic Base Shear

ASCE 7-16 Section 12.8.1

Cs = 0.1510 from 12.8.1.1

W (see Sum Wi below) = 161.50 k

Seismic Base Shear V = Cs * W = 24.38 k

ASCE Seismic Base Shear

Vertical Distribution of Seismic Forces

ASCE 7-16 Section 12.8.3

" k " : hx exponent based on Ta = 1.00

Table of building Weights by Floor Level...

Level #	Wi : Weight	Hi : Height	(Wi * Hi^k)	Cvx	Fx=Cvx * V	Sum Story Shear	Sum Story Moment
3	31.30	30.00	939.00	0.3124	7.62	7.62	0.00
2	69.50	21.00	1,459.50	0.4856	11.84	19.46	68.56
1	60.70	10.00	607.00	0.2020	4.92	24.38	282.60

Sum Wi = 161.50 k Sum Wi * Hi = 3,005.50 k-ft Total Base Shear = 24.38 k

Base Moment = 526.4 k-ft

Diaphragm Forces : Seismic Design Category "B" to "F"

ASCE 7-16 12.10.1.1

Level #	Wi	Fi	Sum Fi	Sum Wi	Fpx : Calcd	Fpx : Min	Fpx : Max	Fpx	Dsgn. Force
3	31.30	7.62	7.62	31.30	7.62	6.14	12.29	7.62	7.62
2	69.50	11.84	19.46	100.80	13.42	13.64	27.28	13.64	13.64
1	60.70	4.92	24.38	161.50	9.16	11.91	23.83	11.91	11.91

Wpx . . . . . Weight at level of diaphragm and other structure elements attached to it.
Fi . . . . . Design Lateral Force applied at the level.
Sum Fi . . . . . Sum of "Lat. Force" of current level plus all levels above
MIN Req'd Force @ Level . . . $0.20 * S_{DS} * I * Wpx$
MAX Req'd Force @ Level . . . $0.40 * S_{DS} * I * Wpx$
Fpx : Design Force @ Level . Wpx * SUM(x->n) Fi / SUM(x->n) wi, x = Current level, n = Top Level

Lateral Force Distribution

Main Wind Force (ult):	17.78 psf	(zone c)
Main Wind Force (service):	10.668 psf	(zone c)
Bldg Width	40 ft	
Bldg Length	48 ft	
1st Flr Width	48 ft	
2nd Flr Length	48 ft	

Seismic Mass

Roof	31300 lbs
2nd	69500 lbs
1st	60700 lbs

					Transverse Loads		Longitudinal Loads		
Level	Seismic Weight	Seismic Force	Service Level Forces	Wind Trib ht	Svc Lvl EQ Unit Forces Trans	Service Wind Loads Trans	Svc Lvl EQ Unit Forces Long	Service Wind Loads Long	Floor ht
	(k)	(k)	(k)	ft	lbs/ft	lbs/ft	lbs/ft	lbs/ft	ft
Roof	31300	8.84	6.19	7.5	**129**	**80**	**155**	**80**	9
2nd	69500	13.75	9.63	10	**201**	**107**	**286**	**107**	11
Main	60700	5.72	4.00	5	**83**	**53**	**119**	**53**	10
Total		**28.31**	**19.82**						

Seismic loads control lateral loads in both directions

Transverse Wind Total **11.5** k

Longitude Wind Total **9.6** k

Transverse Direction Shear Walls

Grid	Roof Trib width (ft)	Roof (lbs)	Lenth of SW (ft)	2nd floor walls (lb/ft)	SW Type	DL Resistance lbs/ft	HD force lbs	HD Type	1st Trib width (ft)	1st Floor (lbs)	Lenth of SW (ft)	1st Floor walls (lb/ft)	SW Type	DL Resistance lbs/ft	HD force lbs	HD Type	Basement Trib width (ft)	Basement (lbs)	Lenth of SW (ft)	Basement walls (lb/ft)	SW Type	DL Resistance lbs/ft	HD force lbs	HD Type
A	22.5	2901	9	**322**	**W4**	**66**	**2388**	**MST27**	24	4813	31	**249**	**W6**	**84**	**2277**	**HUD2**	24	2002	40	**170**		**84**	**1277**	
C	22.5	2901	4	**725**	**2W4**	**66**	**6178**	**(2) MST27 OR HDU8**	24	2002	4	**1226**	**2W2**	**125**	**5257**	**MSTC66/HDU5**	24	2002	21.5	**321**	**W4**	**84**	**28**	**NA**

Line A: Wall top plate acts as collector element along line A
Line C: Double joist acts as a collector/drag to transfer loads to shear wall.

Line A: No drag required
Line C: glulam beam acts as collector/drag element.

Line C: No drag required

Longitudinal Direction Shear Walls

Grid	Roof Trib width (ft)	Roof (lbs)	Lenth of SW (ft)	2nd floor walls (lb/ft)	SW Type	DL Resistance lbs/ft	HD force lbs	HD Type	1st Trib width (sq ft)	1st Floor (lbs)	Lenth of SW (ft)	1st Floor walls (lb/ft)	SW Type	DL Resistance lbs/ft	HD force lbs	HD Type	Basement Trib width (sq ft)	Basement (lbs)	Lenth of SW (ft)	Basement walls (lb/ft)	SW Type	DL Resistance lbs/ft	HD force lbs	HD Type
1	10	1547	20.17	**77**	**W6**	**138**	**0**	**NA**	10	2865	18.25	**242**	**W6**	**372**	**27**	**NA**	10	2865	18.25	314		606	0	
2	20	3094	4	**774**	**2W3**	**138**	**6686**	**(2) MST27**	20	5729	9	**980**	**2W3**	**372**	**12204**	**(2) MST72**	20	2383	23	**487**	**W3**	**750**	**1024**	**HDU2**
3	10	1547	12	**129**	**W6**	**120**	**440**	**LSTA30**	10	2865	12	**368**	**W4**	**354**	**3080**	**NA**	10	2865	12	477	W6	588	3872	NA

Line 2: Glulam acts as drag element

Line 2: Glulam acts as drag element

Line 2: Header acts as drag element.

First floor diaphragm loads

Transverse	E= 0.143	lbs/ft		Transverse	E= 0.15052632	k/ft
	H= 1.13	lbs/ft			H= 1.13	k/ft
	1.273	lbs/ft			1.28052632	k/ft

Sample Calc: Critical diaphragm along line 2 around N side of stair opening

Load transferred =	9	ft	11.5247368 kips
Length of diaphgram=	8	ft	
Required strength	1.440592	KIPS/FT	High load diaphragm required

Global Lateral Resistance

Based on previous analysis the passive resistance of the grade beams will provide suiltable capacity for total lateral resistance. However, post liquefaction settlement of 16" will reduce passive resistance, thus helical anchors will be utilized for global resistance.

Helical Anchors Allowable Soil Capacity ((2) 12" dia helices w/ 4.5" shaft)	9000 lbs	(Per Terra Associates, Inc)
North-South and East-West Direction:		
Global lateral load (seismic)	19820 lbs	
Helical Latera capacity AT 3:1	2848 lbs	
Min No of Helicals Each dir	7	

For N-S dir provide (3) helical anchors at grids 1 and 2 and (2) helicals at grid 3 for total of (8) helicals.

For E-W dir provide (3) helical anchors at grid A and B'/C and (2) at grid B for total of (8) helicals.

2

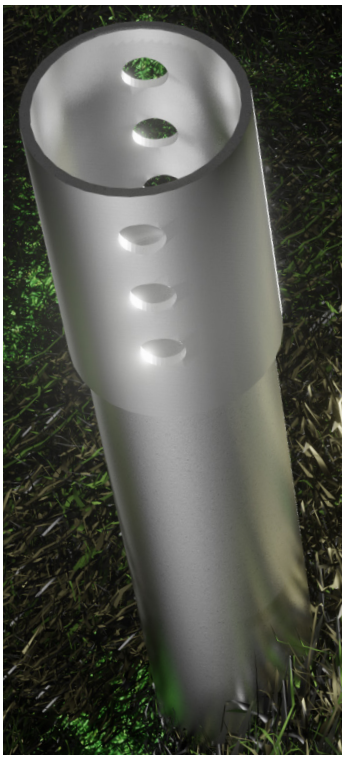
3

Punching shear check (ACI 22.6.5.2)

depth, d	5 in	
Conc strength, f'c	2500 psi	
Critical section, bo	44 in	
phi	0.75	
phi*Vc	33000 lbs	< 9000 lbs, OK

Table 22.6.5.2—Calculation of v_c for two-way shear

v_c		
Least of (a), (b), and (c):	$4\lambda\sqrt{f'_c}$	(a)
	$\left(2+\frac{4}{\beta}\right)\lambda\sqrt{f'_c}$	(b)
	$\left(2+\frac{\alpha_s d}{b_o}\right)\lambda\sqrt{f'_c}$	(c)



BOLTED DISPLACEMENT PILES

The MPS Excalibur displacement pile is fabricated with high strength steel to support the greatest loads. The pile designs are fully customizable, from the length and wall thickness, to the driver plate quantity and diameter. We can even custom place the bolt-hole configuration to match your current installation tooling.

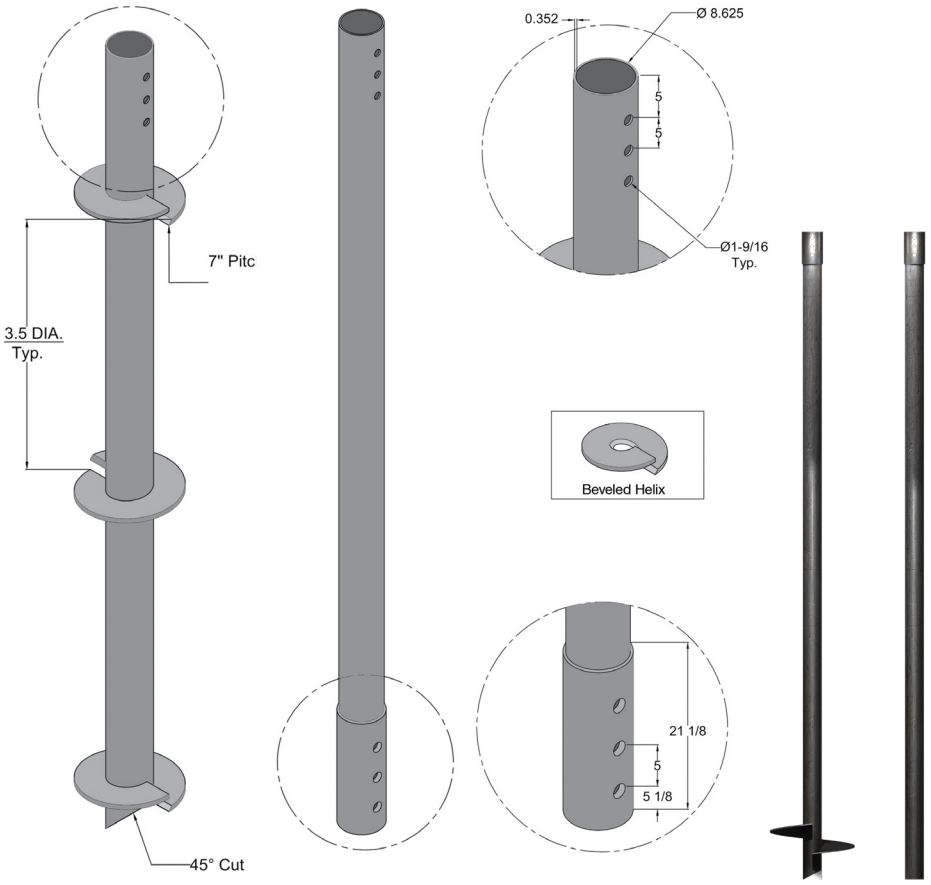
APPLICATIONS

- Retaining Walls
- SOE Walls
- Geothermal
- Weak Soils

CUSTOM PILE DESIGN

Everything on our bolted piles is customizable in order to best match your foundation design. Our flexible approach allows you to get the right pile to match your needs on the jobsite.

DESIGN EXAMPLE



PILE CAPACITIES

EXCALIBUR DISPLACEMENT PILES

PIPE OD (IN)	WALL THICKNESS (IN)	WEIGHT PER LINEAR FOOT (LBS)	ULTIMATE AXIAL CAPACITY (KIPS)	ULTIMATE INSTALLATION TORQUE (FT-LBS)	ESTIMATED KT (FT^{-1})
4.5	0.290	13.5	184	35,000	6
5.5	0.415	23	318	65,000	5
7	0.408	29	406	122,000	4
7.625	0.500	38	537	150,000	3.9
9.625	0.545	54	746	250,000	3.1

80 ksi yield strength steel

Estimated axial capacity in field = Installation torque x KT

EXCALIBUR PRESSURE GROUTED DISPLACEMENT PILES

PIPE OD (IN)	WALL THICKNESS (IN)	WEIGHT PER LINEAR FOOT (LBS)	ULTIMATE INSTALLATION TORQUE (FT-LBS)	GROUT COLUMN DIAMETER (IN)	ESTIMATED GROUT TAKE (YD^3 PER FT)	ULTIMATE COMPRESSION CAPACITY (KIPS)	ULTIMATE TENSION CAPACITY (KIPS)
4.5	0.290	13.5	35,000	16	0.05	428	169
5.5	0.415	23	65,000	18	0.07	607	292
7	0.408	29	122,000	20	0.08	764	372
7.625	0.500	38	150,000	22	0.1	958	492
9.625	0.545	54	250,000	24	0.11	1,230	684

80 ksi yield strength steel

5 ksi grout

Grout column diameters can be increased or decreased as needed

This Wall in File:

Enercalc EARTH (c) 1987-2019, Build 11.20.03.31
License : KW-06011847
License To : tj, KW-06011847

Restrained Retaining Wall

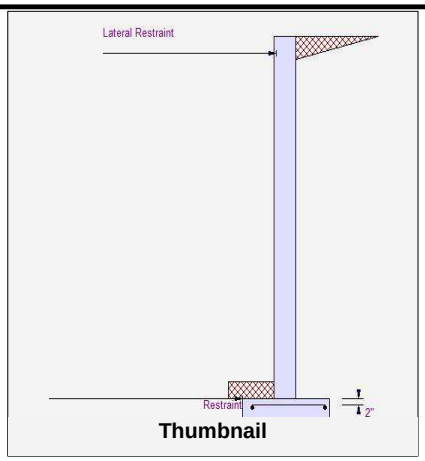
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	10.50 ft
Wall height above soil	=	0.00 ft
Total Wall Height	=	10.50 ft
Top Support Height	=	10.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
At-Rest Heel Pressure	=	32.0 psf/ft
Passive Pressure	=	150.0 psf/ft
Soil Density	=	110.00 pcf
Footing||Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Thumbnail

Surcharge Loads

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

Axial Load Applied to Stem

Axial Dead Load	=	750.0 lbs
Axial Live Load	=	800.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Uniform 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) (Strength Level)
Wind on Exposed Stem	=	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

K_h Soil Density Multiplier = 0.200 g Added seismic per unit area = 161.7 psf

Design Summary

Total Bearing Load	=	4,557 lbs	
...resultant ecc.	=	0.00 in	
Soil Pressure @ Toe	=	1,519 psf	OK
Soil Pressure @ Heel	=	1,519 psf	OK
Allowable	=	2,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,929 psf	
ACI Factored @ Heel	=	1,929 psf	
Footing Shear @ Toe	=	1.4 psi	OK
Footing Shear @ Heel	=	11.7 psi	OK
Allowable	=	82.2 psi	
Reaction at Top	=	1,066.2 lbs	
Reaction at Bottom	=	2,863.9 lbs	

Sliding Calcs
Lateral Sliding Force = 2,863.9 lbs

Concrete Stem Construction

Thickness = 8.00 in Fy = 60,000 psi
Wall Weight = 96.7 psf f'c = 3,000 psi
Stem is FIXED to top of footing

		@ Top Support	Mmax Between Top & Base	@ Base of Wall
		Stem OK	Stem OK	Stem OK
Design Height Above Ftg	=	10.00 ft	5.94 ft	0.00 ft
Rebar Size	=	# 6	# 6	# 6
Rebar Spacing	=	12.00 in	12.00 in	12.00 in
Rebar Placed at	=	Center	Center	Center
Rebar Depth 'd'	=	4.00 in	4.00 in	4.00 in
Design Data				
fb/FB + fa/Fa	=	0.004	0.466	0.935
Mu....Actual	=	29.9 ft-#	3,288.1 ft-#	6,606.0 ft-#
Mn * Phi.....Allowable	=	7,063.3 ft-#	7,063.3 ft-#	7,063.3 ft-#
Shear Force @ this height	=	1,478.7 lbs		3,647.3 lbs
Shear.....Actual	=	30.81 psi		75.98 psi
Shear.....Allowable	=	82.16 psi		82.16 psi

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

This Wall in File:

Enercalc EARTH (c) 1987-2019, Build 11.20.03.31
License : KW-06011847
License To : tj, KW-06011847

Restrained Retaining Wall

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

Concrete Stem Rebar Area Details

Top Support	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0018 in2/ft		
(4/3) * As :	0.0024 in2/ft	Min Stem T&S Reinf Area 1.920 in2	
200bd/fy : 200(12)(4)/60000 :	0.16 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 :	0.44 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6503 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Mmax Between Ends	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1985 in2/ft		
(4/3) * As :	0.2646 in2/ft	Min Stem T&S Reinf Area 0.779 in2	
200bd/fy : 200(12)(4)/60000 :	0.16 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 :	0.1985 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.44 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6503 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Base Support	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.3988 in2/ft		
(4/3) * As :	0.5317 in2/ft	Min Stem T&S Reinf Area 1.141 in2	
200bd/fy : 200(12)(4)/60000 :	0.16 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 :	0.3988 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.44 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6503 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Strengths & Dimensions

Toe Width	=	1.17 ft
Heel Width	=	1.83
Total Footing Width	=	3.00
Footing Thickness	=	16.00 in
Key Width	=	12.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	2.00 ft

f'c = 3,000 psi Fy = 60,000 psi
Footing Concrete Density = 145.00 pcf
Min. As % = 0.0018
Cover @ Top = 2.00 in @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,929	1,929	psf
Mu' : Upward	=	1,313	0	ft-#
Mu' : Downward	=	203	1,101	ft-#
Mu: Design	=	1,110	1,101	ft-#
Actual 1-Way Shear	=	1.36	11.65	psi
Allow 1-Way Shear	=	82.16	82.16	psi

Other Acceptable Sizes & Spacings:

Toe: # 6 @ 13.58 in -or- phiMn = phi'5'lambda'sqrt(fc)'Sm
Heel: # 6 @ 16.00 in -or- phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: Slab Resists Sliding -or- Slab Resists Sliding - No Force on

Min footing T&S reinf Area 1.04 in2
Min footing T&S reinf Area per foot 0.35 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.94 in	#4@ 13.89 in
#5@ 10.76 in	#5@ 21.53 in
#6@ 15.28 in	#6@ 30.56 in

This Wall in File:

Enercalc EARTH (c) 1987-2019, Build 11.20.03.31
License : KW-06011847
License To : tj, KW-06011847

Restrained Retaining Wall

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

Summary of Forces on Footing : Slab RESISTS sliding, stem is FIXED at footing

Forces acting on footing for soil pressure

>>> Sliding Forces are restrained by the adjacent slab

Load & Moment Summary For Footing : For Soil Pressure Calcs

Moment @ Top of Footing Applied from Stem			=		-4,344.2	ft-#
Surcharge Over Heel	=	lbs	ft		ft-#	
Adjacent Footing Load	=	lbs	ft		ft-#	
Axial Dead Load on Stem	=	1,550.0 lbs	1.50 ft		2,325.0	ft-#
Soil Over Toe	=	64.2 lbs	0.58 ft		37.4	ft-#
Surcharge Over Toe	=	lbs	ft		ft-#	
Stem Weight	=	1,015.0 lbs	1.50 ft		1,522.5	ft-#
Soil Over Heel	=	1,347.5 lbs	2.42 ft		3,256.5	ft-#
Footing Weight	=	580.0 lbs	1.50 ft		870.5	ft-#
Total Vertical Force	=	4,556.7 lbs	Base Moment	=	3,667.7	ft-#

Soil Pressure Resulting Moment = 0.0 ft-#

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

Rebar Lap & Embedment Lengths Information

(Applying TMS 402 provisions) or (Applying IBC modifications to TMS 402 provisions)

Stem Design Segment Near Top Support
Stem Design Height: 10.00 ft above top of footing

Lap Splice length for #6 bar specified in this stem design segment =	25.63 in
Development length for #6 bar specified in this stem design segment =	19.72 in

---

Stem Design Segment at Mmax Between Ends
Stem Design Height: 5.94 ft above top of footing

Lap Splice length for #6 bar specified in this stem design segment =	25.63 in
Development length for #6 bar specified in this stem design segment =	19.72 in

---

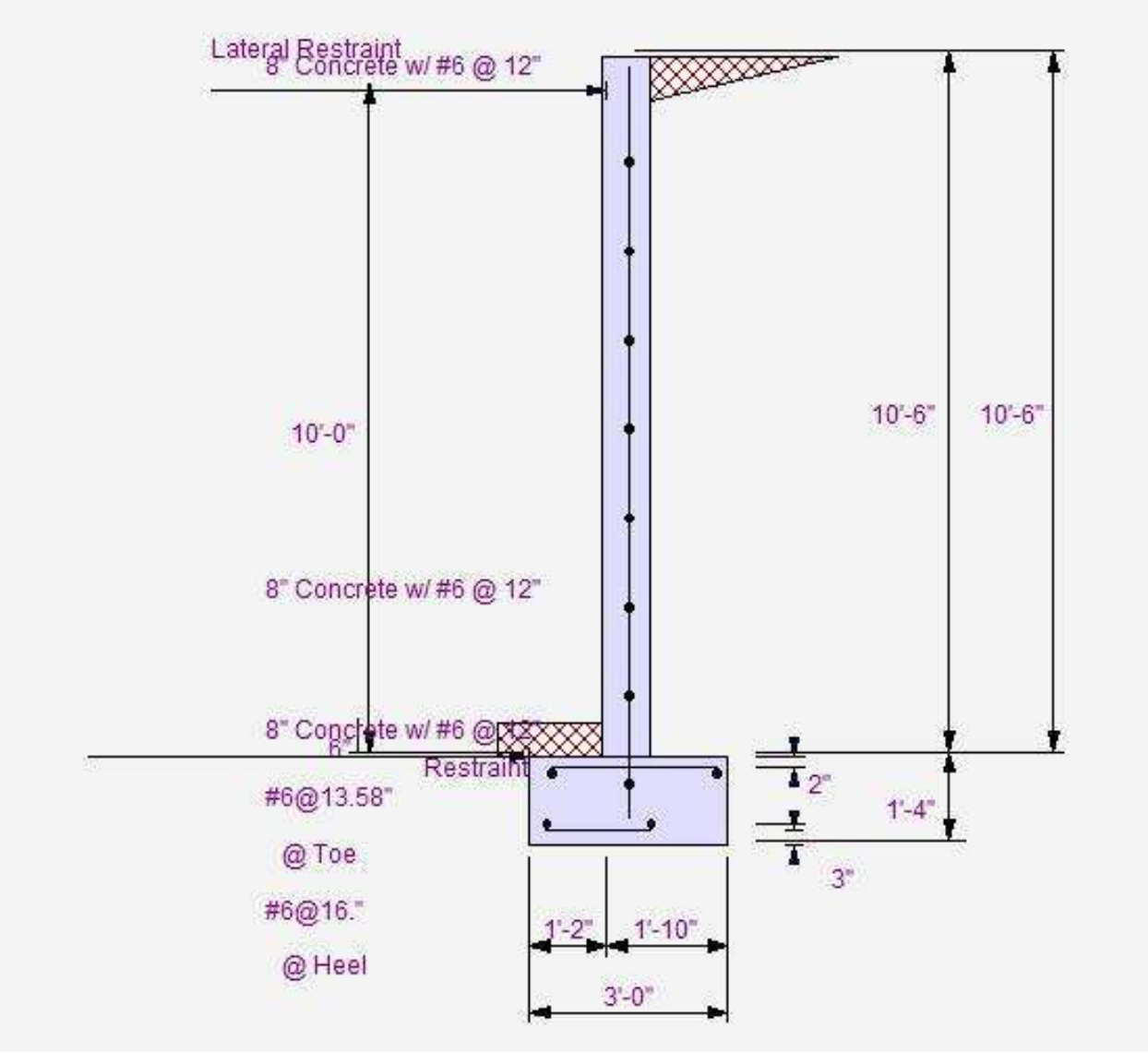
Stem Design Segment at Base Support
Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #6 bar specified in this stem design segment =	25.63 in
Development length for #6 bar specified in this stem design segment =	19.72 in
Hooked embedment length into footing for #6 bar specified in this stem design segment =	10.42 in
As Provided =	0.4400 in2/ft
As Required =	0.3988 in2/ft

Enercalc EARTH (c) 1987-2019, Build 11.20.03.31
License : KW-06011847
License To : tj, KW-06011847

Restrained Retaining Wall

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

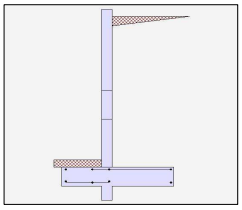


Enercalc EARTH (c) 1987-2019, Build 11.20.03.31
License : KW-06011847
License To : tj, KW-06011847

Cantilevered Retaining Wall

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

Criteria



Retained Height	=	10.50 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	6.00 in
Water height over heel	=	0.0 ft

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

Soil Data and Lateral Earth Pressure

Allow Soil Bearing	=	2,000.0 psf	Soil Density, Heel	=	110.00 pcf
Equivalent Fluid Pressure Method			Soil Density, Toe	=	110.00 pcf
Active Heel Pressure	=	32.0 psf/ft	Footing||Soil Friction	=	0.350
	=		Soil height to ignore for passive pressure	=	6.00 in
Passive Pressure	=	150.0 psf/ft			

Surcharge Loads

Surcharge Over Heel	=	0.0 psf	Surcharge Over Toe	=	40.0 psf
Used To Resist Sliding & Overturning			Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	750.0 lbs	Axial Load Eccentricity	=	0.0 in
Axial Live Load	=	800.0 lbs			

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

Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

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

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	0.200	Uniform Seismic Force	=	2.367
(Multiplier used on soil density)			Total Seismic Force	=	28.006

Stem Weight Seismic Load

F_p / W_p Weight Multiplier	=	0.200 g	Added seismic base force	=	-154.0 lbs

Seismic Self-Weight acts left-to-right toward retention side.

Enercalc EARTH (c) 1987-2019, Build 11.20.03.31
License : KW-06011847
License To : tj, KW-06011847

Cantilevered Retaining Wall

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

Wall Design Summary

Stability Ratios

Overturning	=	5.11	OK
Sliding	=	1.52	OK

Soil Bearing

Total Bearing Load	=	8,765 lbs	
...resultant ecc.	=	4.46 in	
Soil Pressure @ Toe	=	1,651 psf	OK
Soil Pressure @ Heel	=	853 psf	OK
Allowable	=	2,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,311 psf	
ACI Factored @ Heel	=	1,195 psf	
Footing Shear @ Toe	=	17.6 psi	OK
Footing Shear @ Heel	=	13.1 psi	OK
Allowable	=	75.0 psi	

Sliding

Resisting Forces

Vertical Forces	Force	
Soil Over Heel (above water table, if any)	4,427.5	lbs
Soil Over Heel (below water table, if any)	0.0	
Water Over Heel	0.0	
Buoyant Force	0.0	
Sloped Soil Over Heel	0.0	
Surcharge Over Heel	0.0	
Adjacent Footing Load	0.0	
Axial Dead Load on Stem	1,550.0	
Axial Live Load on Stem *	Omit	
Soil Over Toe	137.5	
Surcharge Over Toe	100.0	
Stem Weight(s)	1,100.0	
Earth @ Stem Transitions	0.0	
Footing Weight	1,353.3	
Key Weight	96.7	
Vert. Component **	1,040.7	
Total Vertical Loads	9,005.7	lbs

Sliding Forces

Lateral Forces	Force	
Heel Active Pressure (above water table, if any)	2,240.4	lbs
Heel Active Pressure (below water table, if any)	0.0	
Hydrostatic Force	0.0	
* Heel Active Pressure	2,240.4	
Surcharge over Heel	0.0	
Adjacent Footing	0.0	
Surcharge Over Toe	0.0	
Load @ Stem Above Soil	0.0	
Added Lateral Load	0.0	
Seismic Load	19.6	
Seismic-Self-weight	-154.0	
Lateral on Key	0.0	
Totals =	2,106.0	lbs

*Includes water table effect

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

Sliding Calcs

Lateral Sliding Force	=	2,106.0	lbs	
less 6 % Passive Force	=	- 44.9	lbs	
less 100% Friction Force	=	- 3,152.0	lbs	
Added Force Req'd	=	0.0	lbs	OK
....for 1.5 Stability	=	0.0	lbs	OK

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

Overturning

Resisting Moments

Resisting Moments	Force		Distance		Moment	
Soil Over Heel (above water table, if any)	4,427.5	lbs	5.08	ft	22,506.5	ft-#
Soil Over Heel (below water table, if any)	0.0					
Water Table	0.0					
Soil Over Heel	4,427.5		5.08		22,506.5	
Sloped Soil Over Heel	0.0					
Surcharge Over Heel	0.0					
Adjacent Footing Load	0.0					
Axial Dead Load on Stem	1,550.0		2.83		2,125.0	
Axial Live Load on Stem *	800.0		2.83		2,266.7	
Soil Over Toe	137.5		1.25		171.9	
Surcharge Over Toe	100.0		1.25		125.0	
Stem Weight(s)	1,100.0		2.83		3,116.7	
Earth @ Stem Transitions	0.0					
Footing Weight	1,353.3		3.50		4,736.7	
Key Weight	96.7		2.83		273.9	
Vert. Component	1,040.7		7.00		7,284.8	
Total Vertical Loads	9,005.7	lbs				
Resisting Moment					**40,340.4**	ft-#
Eccentricity					**1.2**	in

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

Overturning

Overturning Moments

Overturning Moments	Force		Distance		Moment	
Heel Active Pressure (above water table, if any)	2,240.4	lbs	3.94	ft	8,837.3	ft-#
Heel Active Pressure (below water table, if any)	0.0					
Hydrostatic Force	0.0					
Buoyant Force	0.0					
Surcharge over Heel	0.0					
Adjacent Footing	0.0					
Surcharge Over Toe	0.0					
Load @ Stem Above Soil	0.0					
Added Lateral Load	0.0					
Seismic Load	19.6		5.92		116.0	
Seismic-Self-weight	-154.0		6.83		-1,052.3	
Totals =	2,106.0	lbs				
Overturning Moment					7,901.0	ft-#

Enercalc EARTH (c) 1987-2019, Build 11.20.03.31
License : KW-06011847
License To : tj, KW-06011847

Cantilevered Retaining Wall

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

Stem Design Summary

			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		=	# 6	# 6	# 6
Rebar Spacing		=	16.00	16.00	12.00
Rebar Placed at		=	Edge	Edge	Edge
Design Data					
fb/FB + fa/Fa		=	**0.116**	**0.343**	**0.870**
Total Force @ Section					
Service Level	lbs	=			
Strength Level	lbs	=	583.1	1,179.6	2,627.3
Moment....Actual					
Service Level	ft-#	=			
Strength Level	ft-#	=	889.3	2,617.9	8,798.9
Moment.....Allowable	ft-#	=	7,630.3	7,630.3	10,109.5
Shear.....Actual					
Service Level	psi	=			
Strength Level	psi	=	8.6	17.5	38.9
Shear.....Allowable	psi	=	67.1	67.1	75.0
Anet	in2	=			
Rebar Depth 'd'	in	=	5.63	5.63	5.63
Masonry Data					
f'm	psi	=			
Fy	psi	=	60,000		
Solid Grouting		=			
Modular Ratio 'n'		=			
Wall Weight	psf	=	100.0	100.0	100.0
Equiv. Solid Thick.		=			
Masonry Block Type		=	Medium Weight		
Masonry Design Method		=	LRFD		
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

Concrete Stem Rebar Area Details

3rd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.0372 in2/ft		
(4/3) * As :	0.0497 in2/ft	Min Stem T&S Reinf Area 1.089 in2	
200bd/fy : 200(12)(5.625)/60000 :	0.225 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 :	0.33 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6096 in2/ft	#6@ 27.50 in	#6@ 55.00 in

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1096 in2/ft		
(4/3) * As :	0.1462 in2/ft	Min Stem T&S Reinf Area 0.384 in2	
200bd/fy : 200(12)(5.625)/60000 :	0.225 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 :	0.33 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.6096 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.3685 in2/ft		
(4/3) * As :	0.4913 in2/ft	Min Stem T&S Reinf Area 0.639 in2	
200bd/fy : 200(12)(5.625)/60000 :	0.225 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 :	0.3685 in2/ft	#4@ 12.50 in	#4@ 25.00 in
Provided Area :	0.44 in2/ft	#5@ 19.38 in	#5@ 38.75 in
Maximum Area :	0.762 in2/ft	#6@ 27.50 in	#6@ 55.00 in

Footing Data

Toe Width	=	2.50 ft	f'c		=	2,500	psi
Heel Width	=	4.50	Fy		=	60,000	psi
Total Footing Width	=	7.00 ft	Footing Concrete Density		=	145.00	pcf
Footing Thickness	=	16.00 in	Min. As %		=	0.0018	
Key Width	=	8.00 in	Rebar Cover	@ Top	=	2.00	in
Key Depth	=	12.00 in		@ Bottom	=	3.00	in
Key Distance from Toe	=	2.50 ft					

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,311	1,195	psf
Mu' : Upward	=	81,686	10,276	ft-#
Mu' : Downward	=	13,575	18,271	ft-#
Mu: Design	=	5,676	-5,391	ft-#
Actual 1-Way Shear	=	17.61	13.06	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing	=	# 6 @ 12.00 in
Heel Reinforcing	=	# 6 @ 12.00 in
Key Reinforcing	=	None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 6.94 in, #5@ 10.76 in, #6@ 15.27 in, #7@ 20.83 in, #8@ 27.43 in, #9@ 34

Heel: #4@ 6.94 in, #5@ 10.76 in, #6@ 15.27 in, #7@ 20.83 in, #8@ 27.43 in, #9@ 34

Key: phiMn = phi'5'lambda'sqrt(fc)'Sm

Min footing T&S reinf Area	2.42	in2
Min footing T&S reinf Area per fo	0.35	in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.94 in	#4@ 13.89 in
#5@ 10.76 in	#5@ 21.53 in
#6@ 15.28 in	#6@ 30.56 in

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.

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)	0.072	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.

Rebar Lap & Embedment Lengths Information

Stem Design Segment: 3rd
Stem Design Height: 5.33 ft above top of footing

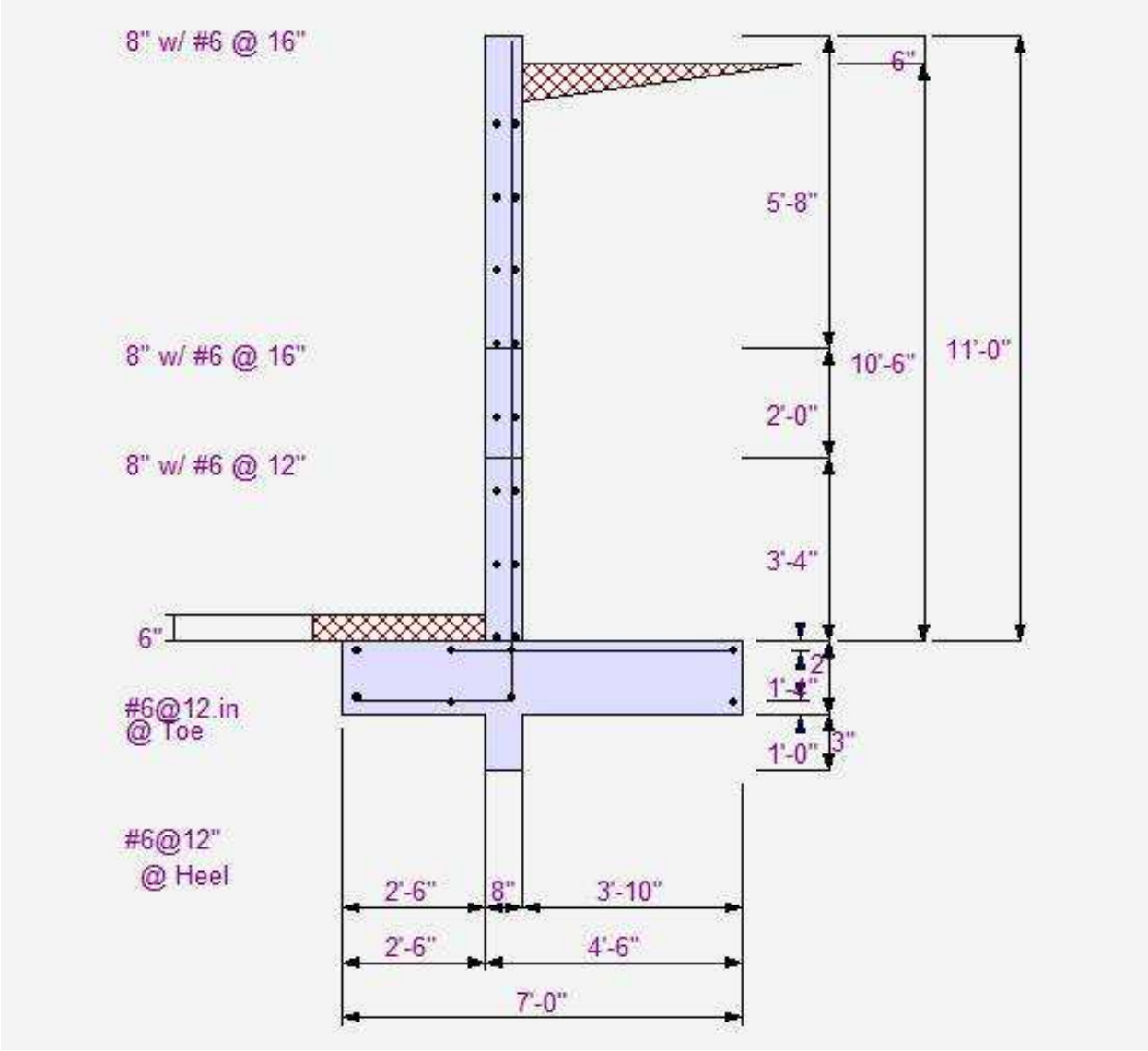
Lap Splice length for #6 bar specified in this stem design segment =	31.39 in
Development length for #6 bar specified in this stem design segment =	24.15 in

Stem Design Segment: 2nd
Stem Design Height: 3.33 ft above top of footing

Lap Splice length for #6 bar specified in this stem design segment =	31.39 in
Development length for #6 bar specified in this stem design segment =	24.15 in

Stem Design Segment: Bottom
Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #6 bar specified in this stem design segment =	28.08 in
Development length for #6 bar specified in this stem design segment =	21.60 in
Hooked embedment length into footing for #6 bar specified in this stem design segment =	10.55 in
As Provided =	0.4400 in2/ft
As Required =	0.3685 in2/ft


8" w/ #6 @ 16"
8" w/ #6 @ 16"
8" w/ #6 @ 12"
6"
#6@12.in
@ Toe
#6@12"
@ Heel
6"
5'-8"
10'-6"
11'-0"
2'-0"
3'-4"
2
1'-3"
3"
1'-0"
2'-6"
8"
3'-10"
2'-6"
4'-6"
7'-0"