

Structural Calculations

for

ADDITIONS & ALTERATIONS

Knotz Residence

6020 94th Ave SE

Mercer Island, WA 98040

PERMIT SUBMITTAL

prepared by:

O.G. Engineering, PLLC

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Seattle, WA, 98134

(206) 290-4608

Job No. 22050

Date: 2/7/23



Date: 2/7/2023
 Job # 22050

Vertical Design Loads

Existing Roof	
Comp Shingle Roofing	3 psf
Sheathing	2
Trusses @24"o.c.	3
Insulation	0.2
5/8" Gypsum Board	2.8
Sum	11 psf
Slope:	4 :12
Slope Correction Factor	1.05
Subtotal	11.6 psf
M/E/P/misc.	1.4 psf
DL=	13 psf
SL=	25 psf

Addition Roof	
Comp Shingle Roofing	3 psf
5/8" Plywood	2
Rafters or Trusses @24"o.c.	3
Batt Insulation	0.4
5/8" Gypsum Board	2.8
Future Solar Panels	4 *
Sum	15.2 psf
Slope:	4 :12
Slope Correction Factor	1.05
Subtotal	16 psf
M/E/P/misc.	2 psf
DL=	18 psf
SL=	25 psf

**As required for solar-ready zone per WA State Building Building Code Amendments*

Existing Main Floor	
Flooring	4 psf
2x Car Decking	2
4x10 @48"o.c.	1.8
Batt Insulation	0.4
M/E/P/misc.	1.8
DL=	10 psf
LL=	40 psf

Living Areas

Addition Main Floor	
Flooring	4 psf
3/4" Plywood	2.4
Joists	2
Batt Insulation	0.4
M/E/P/misc.	1.2
DL=	10 psf
LL=	40 psf

Living Areas

Existing Brick Exterior Walls	
Brick Siding	39 psf
Sheathing	2
Studs	0.9
Batt Insulation	0.2
1/2" Gypsum Board	2.2
M/E/P/misc.	1.7
DL=	46 psf

Wood Exterior Walls	
Siding	3 psf
1/2" Plywood	1.6
Studs	1.4
Batt Insulation	0.2
1/2" Gypsum Board	2.2
M/E/P/misc.	1.6
DL=	10 psf

Interior Walls	
2 Layers 1/2" Gypsum Board	4.4 psf
2x4 @16"o.c.	0.9
M/E/P/misc.	1.7
DL=	7 psf

Date: 2/7/2023

Job # 22050

Seismic Design Loads

Seismic Design Parameters (ASCE 7-16 Section 12.8.1)			
Approximate Fundamental Period			
$T = T_a = C_t h_n^x$			
where:	$C_t =$	0.02	
	$h_n =$	22	
	$x =$	0.75	
	$T =$	0.20 s	
Seismic Response Coefficient			
	$S_s =$	1.45	
	$S_1 =$	0.50	
	$S_{ds} =$	1.16	
	$S_{d1} =$	0.50	
	$R =$	6.5	
	$\rho =$	1.3	
	$\Omega =$	2.5	
	$C_d =$	4	
	$I_e =$	1	
	$C_s = S_{ds}/(R/I_e) =$	0.18	W
	$T_L =$	6 s	> T
$C_{s,max} = S_{d1}/[T(R/I_e)]$	=	0.38	
$C_{s,min} = 0.044S_{ds}I_e$	=	0.051	
$C_{s,min} =$		0.01	
$S_1 <$	0.6		
$C_{s,min} = 0.5S_1/(R/I_e) =$	0.038		Ignore
$C_{s,min,gov} =$	0.051		
$C_{s,gov} =$	0.18	(LRFD)	

Effective Seismic Weight				
Floor	Area (sf)	w_{floor} (psf)	w_{walls} (psf) ¹	W (lbs)
Roof	3580	15	10	89500
UF/MF	2970	10	20	89100

Sum: 178600 lbs

¹Includes weight of interior/exterior walls as uniform area load

Base Shear (includes ρ) - LRFD Level			
$\rho V = \rho C_s W =$	0.232	W =	41435 lbs

Vertical Distribution of Base Shear (ASCE 7-16 Section 12.8.3) - LRFD Level						
Floor	W_x (lbs)	h_x (ft)	$w_x h_x^k$	C_{vx}	F_x (lbs)	F_x (psf)
Roof	89500	22	1969000	0.67	27665	7.7
UF/MF	89100	11	980100	0.33	13771	4.6
Sum:			2949100		41435	

Where $k =$

Diaphragm Forces (ASCE 7-16 Section 12.10.1.1, $\rho = 1.0$) - LRFD Level						
Floor	F_i (lbs)	ΣF_i	W_i (lbs)	ΣW_i	$\Sigma F_i / \Sigma W_i$	F_{px} (lbs)
Roof	21281	21281	89500	89500	0.24	21281
UF/MF	10593	31873	89100	178600	0.18	15901

Floor	F_{px} Min (lbs)	F_{px} Max (lbs)	F_{px} Gov (lbs)	F_{px} Gov (psf)
Roof	20764	41528	21281	5.9
UF/MF	20671	41342	20671	7.0

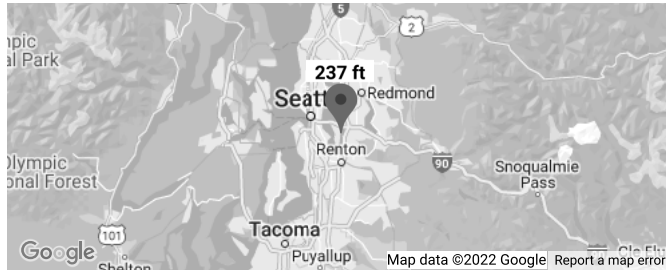
 This is a beta release of the new ATC Hazards by Location website. Please [contact us](#) with feedback.

 The ATC Hazards by Location website will not be updated to support ASCE 7-22. [Find out why.](#)

ATC Hazards by Location

Search Information

Address: 6020 94th Ave SE, Mercer Island, WA 98040, USA
Coordinates: 47.5493405, -122.2138369
Elevation: 237 ft
Timestamp: 2022-12-28T01:46:11.598Z
Hazard Type: Seismic
Reference Document: ASCE7-16
Risk Category: II
Site Class: D-default



Basic Parameters

Name	Value	Description
S _S	1.451	MCE _R ground motion (period=0.2s)
S ₁	0.503	MCE _R ground motion (period=1.0s)
S _{MS}	1.741	Site-modified spectral acceleration value
S _{M1}	* null	Site-modified spectral acceleration value
S _{DS}	1.161	Numeric seismic design value at 0.2s SA
S _{D1}	* null	Numeric seismic design value at 1.0s SA

* See Section 11.4.8

Additional Information

Name	Value	Description
SDC	* null	Seismic design category
F _a	1.2	Site amplification factor at 0.2s
F _v	* null	Site amplification factor at 1.0s
CR _S	0.902	Coefficient of risk (0.2s)
CR ₁	0.899	Coefficient of risk (1.0s)
PGA	0.621	MCE _G peak ground acceleration
F _{PGA}	1.2	Site amplification factor at PGA
PGA _M	0.746	Site modified peak ground acceleration
T _L	6	Long-period transition period (s)
SsRT	1.451	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.609	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	4.273	Factored deterministic acceleration value (0.2s)
S1RT	0.503	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.56	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	1.645	Factored deterministic acceleration value (1.0s)
PGA _d	1.424	Factored deterministic acceleration value (PGA)

* See Section 11.4.8

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Please note that the ATC Hazards by Location website will not be updated to support ASCE 7-22. [Find out why.](#)

Disclaimer

ASCE 7-16 Wind Forces, Chapter 27, Part 1

Project File: 22050_Knotz.ec6

LIC# : KW-06018000, Build:20.22.10.25

O.G. ENGINEERING, PLLC

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DESCRIPTION: Knotz Residence

MWFRS

Basic Values

Risk Category	2 per ASCE 7-16 Table 1.5-1	Horizontal Dim. in North-South Direction (B or L)	42.0 ft
V : Basic Wind Speed	97.0 per ASCE 7-16 Fig. 26.5-1 & 26.5-2	Horizontal Dim. in East-West Direction (B or L)	86.0 ft
Kd : Directionality Factor	0.850 per ASCE 7-16 Table 26.6-1	h : Mean Roof height	= 22.0 ft
Exposure Category	per ASCE 7-16 Section 26.7	Topographic Factor per ASCE 7-16 Sec 26.8 & Figure 26.8-1	
North : Exposure C	East : Exposure C	North : K1 =	K2 = K3 = Kzt = 1.000
South : Exposure C	West : Exposure C	South : K1 =	K2 = K3 = Kzt = 1.000
		East : K1 =	K2 = K3 = Kzt = 1.000
		West : K1 =	K2 = K3 = Kzt = 1.000
Building Period & Flexibility Category	User has specified the building frequency is >= 1 Hz, therefore considered RIGID for both North-South and East-West directions.		

Building Story Data

Level Description	hi ft	Story Ht ft	$E_R : X$ ft	$E_R : X$ ft
Roof	22.00	11.00	0.000	0.000
UF/MF	11.00	11.00	0.000	0.000

Gust Factor

For wind coming from direction indicated

North =	0.850	South =	0.850
East =	0.850	West =	0.850

Enclosure

Check if Building Qualifies as "Open"

	North Wall	South Wall	East Wall	West Wall	Roof	Total
Agross	1.0 ft^2	1.0 ft^2	1.0 ft^2	1.0 ft^2	1.0 ft^2	5.0 ft^2
Aopenings	0.0 ft^2	0.0 ft^2	0.0 ft^2	0.0 ft^2	0.0 ft^2	0.0 ft^2
Aopenings >= 0.8 * Agross ?	No	No	No	No		

All four Agross values must be non-zero Building does NOT qualify as "Open"

User has specified the Building is to be considered Enclosed when NORTH elevation receives positive

User has specified the Building is to be considered Enclosed when SOUTH elevation receives positive

User has specified the Building is to be considered Enclosed when EAST elevation receives positive

User has specified the Building is to be considered Enclosed when WEST elevation receives positive

Velocity Pressures

When the following walls experience leeward or sidewall pressures, the value of Kh shall be (per Table 26.10-1) :

North Wall = 0.9202 psf South Wall : 0.9202 psf East Wall = 0.9202psf West Wall = 0.9202 psf

When the following walls experience leeward or sidewall pressures, the value of qh shall be (per Eq 26.10-1) :

North Wall = 18.839 psf South Wall : 18.839 psf East Wall = 18.839psf West Wall = 18.839 psf

qz : Windward Wall Velocity Pressures at various heights per Eq. 27.3-1

Height Above Base (ft)	North Elevation		South Elevation		East Elevation		West Elevation	
	Kz	qz	Kz	qz	Kz	qz	Kz	qz
0.00	0.849	17.38	0.849	17.38	0.849	17.38	0.849	17.38
4.00	0.849	17.38	0.849	17.38	0.849	17.38	0.849	17.38
8.00	0.849	17.38	0.849	17.38	0.849	17.38	0.849	17.38
12.00	0.849	17.38	0.849	17.38	0.849	17.38	0.849	17.38

ASCE 7-16 Wind Forces, Chapter 27, Part 1

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16.00	0.860	17.62	0.860	17.62	0.860	17.62	0.860	17.62
20.00	0.902	18.47	0.902	18.47	0.902	18.47	0.902	18.47

Pressure Coefficients

GCpi Values when elevation receives positive external pressure

GCpi : Internal pressure coefficient, per sec. 26.13 and Table 26.13-1

	North	South	East	West
+/-	0.180	+/- 0.180	+/- 0.180	+/- 0.180

Specify Cp Values from Figure 27.3-1 for Windward, Leeward & Side Walls

Cp Values when elevation receives positive external pressure

	North	South	East	West
Windward Wall	0.80	0.80	0.80	0.80
Leeward Wall	-0.50	-0.50	-0.50	-0.50
Side Walls	-0.70	-0.70	-0.70	-0.70

Wind Pressures

Wind Pressures when NORTH Elevation receives positive external wind pressure

	Positive Internal	Negative Internal
Leeward Wall Pressures	-11.398 psf	-4.616 psf
Side Wall Pressures	-14.601 psf	-7.818 psf
Windward Wall Pressures . .	Positive Internal	Negative Internal
Height Above Base (ft)	Pressure (psf)	Pressure (psf)
0.00		8.43 15.21
4.00		8.43 15.21
8.00		8.43 15.21
12.00		8.43 15.21
16.00		8.59 15.37
20.00		9.17 15.95

Wind Pressures when SOUTH Elevation receives positive external wind pressure

	Positive Internal	Negative Internal
Leeward Wall Pressures	-11.398 psf	-4.616 psf
Side Wall Pressures	-14.601 psf	-7.818 psf
Windward Wall Pressures . .	Positive Internal	Negative Internal
Height Above Base (ft)	Pressure (psf)	Pressure (psf)
0.00		8.43 15.21
4.00		8.43 15.21
8.00		8.43 15.21
12.00		8.43 15.21
16.00		8.59 15.37
20.00		9.17 15.95

Wind Pressures when EAST Elevation receives positive external wind pressure

	Positive Internal	Negative Internal
Leeward Wall Pressures	-11.398 psf	-4.616 psf
Side Wall Pressures	-14.601 psf	-7.818 psf
Windward Wall Pressures . .	Positive Internal	Negative Internal
Height Above Base (ft)	Pressure (psf)	Pressure (psf)
0.00		8.43 15.21
4.00		8.43 15.21
8.00		8.43 15.21

ASCE 7-16 Wind Forces, Chapter 27, Part 1

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DESCRIPTION: Knotz Residence

12.00	8.43	15.21
16.00	8.59	15.37
20.00	9.17	15.95

Wind Pressures when WEST Elevation receives positive external wind pressure

	Positive Internal	Negative Internal
Leeward Wall Pressures	-11.398 psf	-4.616 psf
Side Wall Pressures	-14.601 psf	-7.818 psf

Windward Wall Pressures . .	Positive Internal Pressure (psf)	Negative Internal Pressure (psf)
Height Above Base (ft)		
0.00	8.43	15.21
4.00	8.43	15.21
8.00	8.43	15.21
12.00	8.43	15.21
16.00	8.59	15.37
20.00	9.17	15.95

Story Forces for Design Wind Load Cases

Values below are calculated based on a building with dimensions B x L x h as defined on the "Basic Values" tab.

Load Case	Windward Wall	Building level	Ht. Range	Trib. Height	Wind Shear Components (k)			Eccentricity for (ft)	
					In "Y" Direction	In "X" Direction	M Shear	"X" Shear Mt, (ft-k)	
CASE 1	North	Level 2	16.50' -> 22.0	5.50	-9.68	---	---	---	---
CASE 1	North	Level 1	5.50' -> 16.50'	11.00	-18.77	---	---	---	---
CASE 1	South	Level 2	16.50' -> 22.0	5.50	9.68	---	---	---	---
CASE 1	South	Level 1	5.50' -> 16.50'	11.00	18.77	---	---	---	---
CASE 1	East	Level 2	16.50' -> 22.0	5.50	---	-4.73	---	---	---
CASE 1	East	Level 1	5.50' -> 16.50'	11.00	---	-9.17	---	---	---
CASE 1	West	Level 2	16.50' -> 22.0	5.50	---	4.73	---	---	---
CASE 1	West	Level 1	5.50' -> 16.50'	11.00	---	9.17	---	---	---
CASE 2	North	Level 2	16.50' -> 22.0	5.50	-7.26	---	---	12.41	90.1
CASE 2	North	Level 1	5.50' -> 16.50'	11.00	-14.08	---	---	12.41	174.7
CASE 2	South	Level 2	16.50' -> 22.0	5.50	7.26	---	---	12.41	90.1
CASE 2	South	Level 1	5.50' -> 16.50'	11.00	14.08	---	---	12.41	174.7
CASE 2	East	Level 2	16.50' -> 22.0	5.50	---	-3.54	6.06	---	21.5
CASE 2	East	Level 1	5.50' -> 16.50'	11.00	---	-6.88	6.06	---	41.7
CASE 2	West	Level 2	16.50' -> 22.0	5.50	---	3.54	6.06	---	21.5
CASE 2	West	Level 1	5.50' -> 16.50'	11.00	---	6.88	6.06	---	41.7
CASE 3	North & East	Level 2	16.50' -> 22.0	5.50	-7.26	-3.54	---	---	---
CASE 3	North & East	Level 1	5.50' -> 16.50'	11.00	-14.08	-6.88	---	---	---
CASE 3	North & West	Level 2	16.50' -> 22.0	5.50	-7.26	3.54	---	---	---
CASE 3	North & West	Level 1	5.50' -> 16.50'	11.00	-14.08	6.88	---	---	---
CASE 3	South & West	Level 2	16.50' -> 22.0	5.50	7.26	3.54	---	---	---
CASE 3	South & West	Level 1	5.50' -> 16.50'	11.00	14.08	6.88	---	---	---
CASE 3	South & East	Level 2	16.50' -> 22.0	5.50	7.26	-3.54	---	---	---
CASE 3	South & East	Level 1	5.50' -> 16.50'	11.00	14.08	-6.88	---	---	---
CASE 4	North & East	Level 2	16.50' -> 22.0	5.50	-5.45	-2.66	6.06	12.41	83.7

ASCE 7-16 Wind Forces, Chapter 27, Part 1

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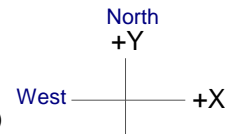
DESCRIPTION: Knotz Residence

CASE 4	North & East	Level 1	5.50' -> 16.5'	11.00	-10.57	-5.16	6.06	12.41	162.4
CASE 4	North & West	Level 2	16.50' -> 22.0	5.50	-5.45	2.66	6.06	12.41	83.7
CASE 4	North & West	Level 1	5.50' -> 16.5'	11.00	-10.57	5.16	6.06	12.41	162.4
CASE 4	South & West	Level 2	16.50' -> 22.0	5.50	5.45	2.66	6.06	12.41	83.7
CASE 4	South & West	Level 1	5.50' -> 16.5'	11.00	10.57	5.16	6.06	12.41	162.4
CASE 4	South & East	Level 2	16.50' -> 22.0	5.50	5.45	-2.66	6.06	12.41	83.7
CASE 4	South & East	Level 1	5.50' -> 16.5'	11.00	10.57	-5.16	6.06	12.41	162.4
Min per ASCE 27.1.	North	Level 2	16.50' -> 22.0	5.50	-7.57	---	---	---	---
Min per ASCE 27.1.	North	Level 1	5.50' -> 16.5'	11.00	-15.14	---	---	---	---
Min per ASCE 27.1.	South	Level 2	16.50' -> 22.0	5.50	7.57	---	---	---	---
Min per ASCE 27.1.	South	Level 1	5.50' -> 16.5'	11.00	15.14	---	---	---	---
Min per ASCE 27.1.	East	Level 2	16.50' -> 22.0	5.50	---	-3.70	---	---	---
Min per ASCE 27.1.	East	Level 1	5.50' -> 16.5'	11.00	---	-7.39	---	---	---
Min per ASCE 27.1.	West	Level 2	16.50' -> 22.0	5.50	---	3.70	---	---	---
Min per ASCE 27.1.	West	Level 1	5.50' -> 16.5'	11.00	---	7.39	---	---	---

Base Shear for Design Wind Load Cas

Values below are calculated based on a building with dimensions B x L x h as defined on the "General" tab.

Load Case	Windward Wall	Leeward Wall	Wind Base Shear Components (k)		Mt, (ft-k)
			In "Y" Direction	In "X" Direction	
Case 1	North	South	-28.45	---	---
Case 1	South	North	28.45	---	---
Case 1	East	West	---	-13.89	---
Case 1	West	East	---	13.89	---
Case 2	North	South	-21.33	---	/- 264.8
Case 2	South	North	21.33	---	/- 264.8
Case 2	East	West	---	-10.42	+/- 63.2
Case 2	West	East	---	10.42	+/- 63.2
Case 3	North & East	South & West	-21.33	-10.42	---
Case 3	North & West	South & East	-21.33	10.42	---
Case 3	South & West	North & East	21.33	10.42	---
Case 3	South & East	North & West	21.33	-10.42	---
Case 4	North & East	South & West	-16.01	-7.82	/- 246.2
Case 4	North & West	South & East	-16.01	7.82	/- 246.2
Case 4	South & West	North & East	16.01	7.82	/- 246.2
Case 4	South & East	North & West	16.01	-7.82	/- 246.2
Min per ASCE 27.1.5	North	South	-22.70	---	---
Min per ASCE 27.1.5	South	North	22.70	---	---
Min per ASCE 27.1.5	East	West	---	-11.09	---
Min per ASCE 27.1.5	West	East	---	11.09	---



ROOF FRAMING

(ELEMENTS NOT EXPLICITLY CALCD BY INSPECTION)

RR1 RAFTERSSPAN = $16\frac{1}{2}$ " max.

$$W = \frac{18 + 25 \text{ PSF}}{\text{OL SL}} \quad \text{USE } 2 \times 12 @ 24" \text{ o.c.}$$

RB2 ROOF BEAMSPAN = $32\frac{1}{2}$ "

$$W = \frac{18 + 25 \text{ PSF}}{\text{OL SL}} \quad \text{TRBS} = 19\frac{1}{2}"$$

USE $5\frac{1}{2} \times 24$ PLRH3 ROOF HEADERSPAN = $12\frac{1}{2}$ "

$$W = \frac{18 + 25 \text{ PSF}}{\text{OL SL}} \quad \text{TRBS} = 11\frac{1}{2}"$$

USE $3\frac{1}{2} \times 12$ GLBRB4 ROOF BEAMSPAN = $10\frac{1}{2}$ "

$$W = \frac{18 + 25 \text{ PSF}}{\text{OL SL}} \quad \text{TRBS} = 11\frac{1}{2}"$$

USE 4×12 RB5 ROOF BEAMSPAN = $21\frac{1}{2}$ "

$$W = \frac{18 + 25 \text{ PSF}}{\text{OL SL}} \quad \text{TRBS} = 3'$$

USE $3\frac{1}{2} \times 11\frac{1}{4}$ SL

$$P = \frac{\text{RB4}}{\text{OL SL}} + \frac{1440}{\text{SL}} \quad \text{OR} = 6'$$

RH7 ROOF HEADERSPAN = $8\frac{1}{2}$ "

$$W = \frac{18 + 25 \text{ PSF}}{\text{OL SL}} \quad \text{TRBS} = 16\frac{1}{2}"$$

USE 4×10

MAIN FLOOR FRAMINGMFB1 MAIN FLOOR JOIST

SPAN = 14'-9"

$$w = \frac{(10+10) \text{ psf}}{2 \text{ ft}}$$

USE 2x12 @ 16" o.c.MFB2 MAIN FLOOR BEAM

SPAN = 8'-3"

$$w = \frac{\text{MF}}{2 \text{ ft}} \left(\frac{15 \text{ ft}}{2} \right) + \frac{\text{R}}{\text{DL SL}} \left(2'6" + \frac{2'6"}{2} \right) + \frac{\text{W}}{\text{DL}} (11')$$

USE 4x10

$$= \frac{250}{\text{DL}} + \frac{300}{\text{W}} + \frac{90 \text{ #/ft}}{\text{SL}}$$

MFB3 MAIN FLOOR JOISTS

SPAN = 11'-6"

$$w = \frac{(10+10) \text{ psf}}{2 \text{ ft}}$$

USE 2x10 @ 16" o.c.

FOUNDATIONS

(F1) CRAWLER FOUNDATION WAY

$$W = \frac{(8+25)^2}{DL \cdot L} \left(\frac{\#1}{2} + 3'\right) + \left(\frac{10+10}{a} \cdot \frac{MF}{a}\right) \left(\frac{11}{2}\right) + \left(\frac{10}{DL}\right) (7')$$

$$= \frac{350}{DL} + \frac{220}{L} + \frac{290}{L} \#1/ft$$

USE 1/6" WIDE STEEL #16GOOD FOR 1/6" 12x2000^{AST} = 2670 OK #1/ft

Multiple Simple Beam

Project File: 22050_Knotz.ec6

LIC# : KW-06018000, Build:20.22.12.28

O.G. ENGINEERING, PLLC

(c) ENERCALC INC 1983-2022

Description : Roof Framing

Wood Beam Design : RR1 - Rafters

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16

BEAM Size : 2x12, Sawn, Fully Braced

Using Allowable Stress Design with IBC 2021 Load Combinations, Major Axis Bending

Wood Species : Hem-Fir

Wood Grade : No.2

Fb - Tension	850.0 psi	Fc - Prll	1,300.0 psi	Fv	150.0 psi	Ebend- xx	1,300.0 ksi	Density	26.840 pcf
Fb - Compr	850.0 psi	Fc - Perp	405.0 psi	Ft	525.0 psi	Eminbend - xx	470.0 ksi		

Applied Loads

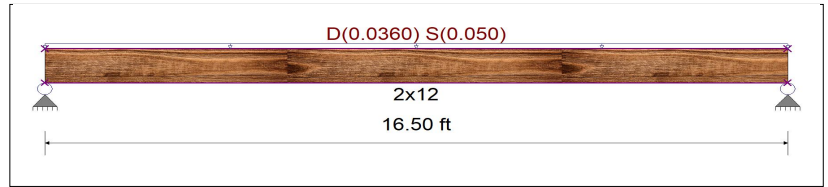
Unif Load: D = 0.0180, S = 0.0250 k/ft, Trib= 2.0 ft

Design Summary

Max fb/Fb Ratio = **0.987** : 1
 fb : Actual : 1,109.97 psi at 8.250 ft in Span # 1
 Fb : Allowable : 1,124.13 psi
 Load Comb : +D+S

Max fv/FvRatio = **0.366** : 1
 fv : Actual : 63.07 psi at 0.000 ft in Span # 1
 Fv : Allowable : 172.50 psi
 Load Comb : +D+S

Max Reactions (k)	D	Lr	L	S	W	E	H
Left Support	0.30			0.41			
Right Support	0.30			0.41			



Max Deflections

Transient Downward	0.362 in	Total Downward	0.623 in
Ratio	546	Ratio	317
LC: S Only		LC: +D+S	
Transient Upward	0.000 in	Total Upward	0.000 in
Ratio	9999	Ratio	9999
LC:		LC:	

Wood Beam Design : RB2 - Roof Beam

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16

BEAM Size : 5.25x24, Parallam PSL, Fully Braced

Using Allowable Stress Design with IBC 2021 Load Combinations, Major Axis Bending

Wood Species : iLevel Truss Joist

Wood Grade : Parallam PSL 2.2E

Fb - Tension	2,900.0 psi	Fc - Prll	2,900.0 psi	Fv	290.0 psi	Ebend- xx	2,200.0 ksi	Density	45.070 pcf
Fb - Compr	2,900.0 psi	Fc - Perp	750.0 psi	Ft	2,025.0 psi	Eminbend - xx	1,118.19 ksi		

Applied Loads

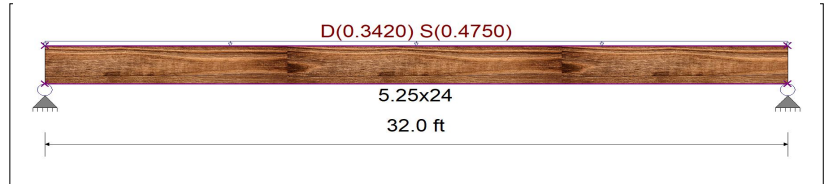
Unif Load: D = 0.0180, S = 0.0250 k/ft, Trib= 19.0 ft

Design Summary

Max fb/Fb Ratio = **0.806** : 1
 fb : Actual : 2,489.90 psi at 16.000 ft in Span # 1
 Fb : Allowable : 3,088.03 psi
 Load Comb : +D+S

Max fv/FvRatio = **0.467** : 1
 fv : Actual : 155.62 psi at 0.000 ft in Span # 1
 Fv : Allowable : 333.50 psi
 Load Comb : +D+S

Max Reactions (k)	D	Lr	L	S	W	E	H
Left Support	5.47			7.60			
Right Support	5.47			7.60			



Max Deflections

Transient Downward	0.847 in	Total Downward	1.456 in
Ratio	453	Ratio	263
LC: S Only		LC: +D+S	
Transient Upward	0.000 in	Total Upward	0.000 in
Ratio	9999	Ratio	9999
LC:		LC:	

Multiple Simple Beam

Project File: 22050_Knotz.ec6

LIC#: KW-06018000, Build:20.22.12.28

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Wood Beam Design : RH3 - Roof Header

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16

BEAM Size : **3.5x12, GLB, Fully Braced**

Using Allowable Stress Design with IBC 2021 Load Combinations, Major Axis Bending

Wood Species : DF/DF

Wood Grade : 24F-V8

Fb - Tension 2,400.0 psi Fc - Prll 1,650.0 psi Fv 265.0 psi Ebend- xx 1,800.0 ksi Density 31.210 pcf
 Fb - Compr 2,400.0 psi Fc - Perp 650.0 psi Ft 1,100.0 psi Eminbend - xx 950.0 ksi

Applied Loads

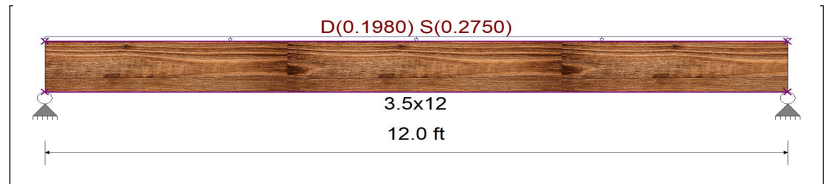
Unif Load: D = 0.0180, S = 0.0250 k/ft, Trib= 11.0 ft

Design Summary

Max fb/Fb Ratio = **0.441** : 1
 fb : Actual : 1,216.29 psi at 6.000 ft in Span # 1
 Fb : Allowable : 2,760.00 psi
 Load Comb : +D+S

Max fv/FvRatio = **0.333** : 1
 fv : Actual : 101.36 psi at 12.000 ft in Span # 1
 Fv : Allowable : 304.75 psi
 Load Comb : +D+S

Max Reactions (k)	D	Lr	L	S	W	E	H
Left Support	1.19			1.65			
Right Support	1.19			1.65			



Max Deflections

Transient Downward	0.142 in	Total Downward	0.245 in
Ratio	1012	Ratio	588
LC: S Only		LC: +D+S	
Transient Upward	0.000 in	Total Upward	0.000 in
Ratio	9999	Ratio	9999
LC:		LC:	

Wood Beam Design : RB4 - Roof Beam

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16

BEAM Size : **4x12, Sawn, Fully Braced**

Using Allowable Stress Design with IBC 2021 Load Combinations, Major Axis Bending

Wood Species : Douglas Fir-Larch

Wood Grade : No.1

Fb - Tension 1,000.0 psi Fc - Prll 1,500.0 psi Fv 180.0 psi Ebend- xx 1,700.0 ksi Density 31.210 pcf
 Fb - Compr 1,000.0 psi Fc - Perp 625.0 psi Ft 675.0 psi Eminbend - xx 620.0 ksi

Applied Loads

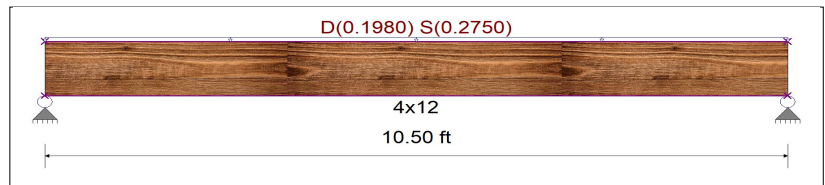
Unif Load: D = 0.0180, S = 0.0250 k/ft, Trib= 11.0 ft

Design Summary

Max fb/Fb Ratio = **0.838** : 1
 fb : Actual : 1,059.52 psi at 5.250 ft in Span # 1
 Fb : Allowable : 1,265.00 psi
 Load Comb : +D+S

Max fv/FvRatio = **0.457** : 1
 fv : Actual : 94.60 psi at 10.500 ft in Span # 1
 Fv : Allowable : 207.00 psi
 Load Comb : +D+S

Max Reactions (k)	D	Lr	L	S	W	E	H
Left Support	1.04			1.44			
Right Support	1.04			1.44			



Max Deflections

Transient Downward	0.107 in	Total Downward	0.184 in
Ratio	1176	Ratio	683
LC: S Only		LC: +D+S	
Transient Upward	0.000 in	Total Upward	0.000 in
Ratio	9999	Ratio	9999
LC:		LC:	

Multiple Simple Beam

Project File: 22050_Knotz.ec6

LIC#: KW-06018000, Build:20.22.12.28

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Wood Beam Design : RB5 - Roof Beam

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16

BEAM Size : **3.5x11.25, Parallam PSL, Fully Braced**

Using Allowable Stress Design with IBC 2021 Load Combinations, Major Axis Bending

Wood Species : iLevel Truss Joist

Wood Grade : Parallam PSL 2.2E

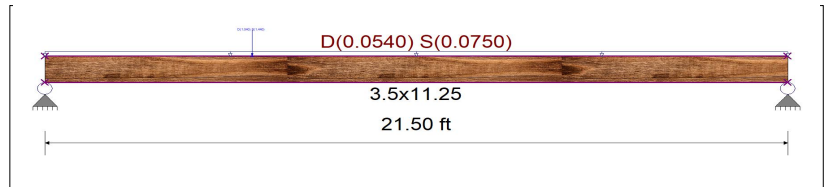
Fb - Tension	2,900.0 psi	Fc - Prll	2,900.0 psi	Fv	290.0 psi	Ebend- xx	2,200.0 ksi	Density	45.070 pcf
Fb - Compr	2,900.0 psi	Fc - Perp	750.0 psi	Ft	2,025.0 psi	Eminbend - xx	1,118.19 ksi		

Applied Loads

Unif Load: D = 0.0180, S = 0.0250 k/ft, Trib= 3.0 ft
 1Point: D = 1.040, S = 1.440 k @ 6.0 ft

Design Summary

Max fb/Fb Ratio = **0.815** : 1
 fb : Actual : 2,718.37 psi at 6.020 ft in Span # 1
 Fb : Allowable : 3,335.00 psi
 Load Comb : +D+S
 Max fv/FvRatio = **0.363** : 1
 fv : Actual : 120.94 psi at 0.000 ft in Span # 1
 Fv : Allowable : 333.50 psi
 Load Comb : +D+S



Max Reactions (k)	D	Lr	L	S	W	E	H
Left Support	1.33			1.84			
Right Support	0.87			1.21			

Max Deflections

Transient Downward	0.826 in	Total Downward	1.421 in
Ratio	312	Ratio	181
LC: S Only		LC: +D+S	
Transient Upward	0.000 in	Total Upward	0.000 in
Ratio	9999	Ratio	9999
LC:		LC:	

Wood Beam Design : RH7 - Roof Header

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16

BEAM Size : **4x10, Sawn, Fully Braced**

Using Allowable Stress Design with IBC 2021 Load Combinations, Major Axis Bending

Wood Species : Douglas Fir-Larch

Wood Grade : No.1

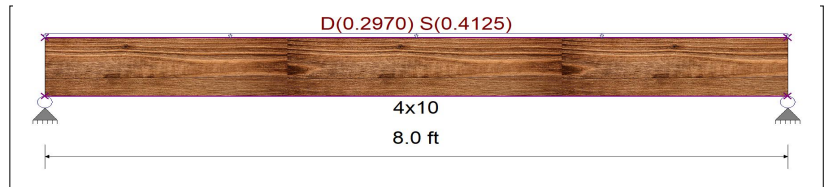
Fb - Tension	1,000.0 psi	Fc - Prll	1,500.0 psi	Fv	180.0 psi	Ebend- xx	1,700.0 ksi	Density	31.210 pcf
Fb - Compr	1,000.0 psi	Fc - Perp	625.0 psi	Ft	675.0 psi	Eminbend - xx	620.0 ksi		

Applied Loads

Unif Load: D = 0.0180, S = 0.0250 k/ft, Trib= 16.50 ft

Design Summary

Max fb/Fb Ratio = **0.989** : 1
 fb : Actual : 1,364.66 psi at 4.000 ft in Span # 1
 Fb : Allowable : 1,380.00 psi
 Load Comb : +D+S
 Max fv/FvRatio = **0.635** : 1
 fv : Actual : 131.49 psi at 0.000 ft in Span # 1
 Fv : Allowable : 207.00 psi
 Load Comb : +D+S



Max Reactions (k)	D	Lr	L	S	W	E	H
Left Support	1.19			1.65			
Right Support	1.19			1.65			

Max Deflections

Transient Downward	0.097 in	Total Downward	0.168 in
Ratio	985	Ratio	573
LC: S Only		LC: +D+S	
Transient Upward	0.000 in	Total Upward	0.000 in
Ratio	9999	Ratio	9999
LC:		LC:	

Multiple Simple Beam

Project File: 22050_Knotz.ec6

LIC#: KW-06018000, Build:20.22.12.28

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Description : Main Floor Framing

Wood Beam Design : MFJ1 - Main Floor Joists

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16

BEAM Size : **2x12, Sawn, Fully Braced**

Using Allowable Stress Design with IBC 2021 Load Combinations, Major Axis Bending

Wood Species : Hem-Fir

Wood Grade : No.2

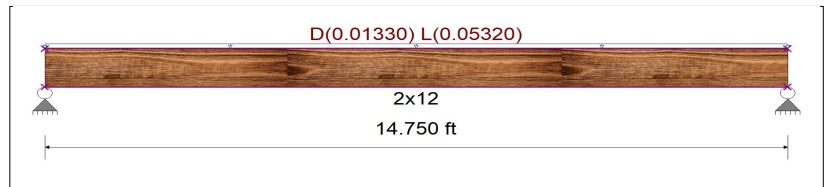
Fb - Tension	850.0 psi	Fc - Prll	1,300.0 psi	Fv	150.0 psi	Ebend- xx	1,300.0 ksi	Density	26.840 pcf
Fb - Compr	850.0 psi	Fc - Perp	405.0 psi	Ft	525.0 psi	Eminbend - xx	470.0 ksi		

Applied Loads

Unif Load: D = 0.010, L = 0.040 k/ft, Trib= 1.330 ft

Design Summary

Max fb/Fb Ratio = **0.702** : 1
 fb : Actual : 685.89 psi at 7.375 ft in Span # 1
 Fb : Allowable : 977.50 psi
 Load Comb : +D+L
 Max fv/FvRatio = **0.291** : 1
 fv : Actual : 43.59 psi at 0.000 ft in Span # 1
 Fv : Allowable : 150.00 psi
 Load Comb : +D+L



Max Reactions (k)	D	Lr	L	S	W	E
Left Support	0.10		0.39			
Right Support	0.10		0.39			

Max Deflections

Transient Downward	0.246 in	Total Downward	0.308 in
Ratio	718	Ratio	575
LC: L Only		LC: +D+L	
Transient Upward	0.000 in	Total Upward	0.000 in
Ratio	9999	Ratio	9999
LC:		LC:	

Wood Beam Design : MFB2 - Main Floor Beam

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16

BEAM Size : **4x10, Sawn, Fully Braced**

Using Allowable Stress Design with IBC 2021 Load Combinations, Major Axis Bending

Wood Species : Douglas Fir-Larch

Wood Grade : No.1

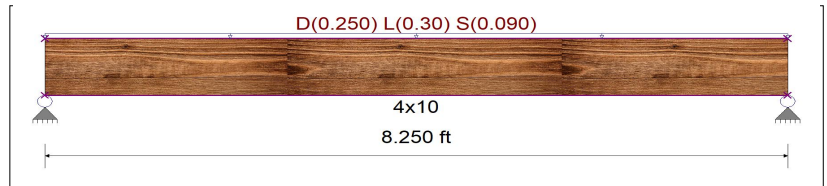
Fb - Tension	1,000.0 psi	Fc - Prll	1,500.0 psi	Fv	180.0 psi	Ebend- xx	1,700.0 ksi	Density	31.210 pcf
Fb - Compr	1,000.0 psi	Fc - Perp	625.0 psi	Ft	675.0 psi	Eminbend - xx	620.0 ksi		

Applied Loads

Unif Load: D = 0.250, L = 0.30, S = 0.090 k/ft, Trib= 1.0 ft

Design Summary

Max fb/Fb Ratio = **0.938** : 1
 fb : Actual : 1,125.02 psi at 4.125 ft in Span # 1
 Fb : Allowable : 1,200.00 psi
 Load Comb : +D+L
 Max fv/FvRatio = **0.584** : 1
 fv : Actual : 105.12 psi at 0.000 ft in Span # 1
 Fv : Allowable : 180.00 psi
 Load Comb : +D+L



Max Reactions (k)	D	Lr	L	S	W	E
Left Support	1.03		1.24	0.37		
Right Support	1.03		1.24	0.37		

Max Deflections

Transient Downward	0.080 in	Total Downward	0.147 in
Ratio	1235	Ratio	674
LC: L Only		LC: +D+L	
Transient Upward	0.000 in	Total Upward	0.000 in
Ratio	9999	Ratio	9999
LC:		LC:	

Multiple Simple Beam

Project File: 22050_Knotz.ec6

LIC# : KW-06018000, Build:20.22.12.28

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Wood Beam Design : MFJ1 - Main Floor Joists

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16

BEAM Size : **2x10, Sawn, Fully Braced**

Using Allowable Stress Design with IBC 2021 Load Combinations, Major Axis Bending

Wood Species : Hem-Fir

Wood Grade : No.2

Fb - Tension	850.0 psi	Fc - Prll	1,300.0 psi	Fv	150.0 psi	Ebend- xx	1,300.0 ksi	Density	26.840 pcf
Fb - Compr	850.0 psi	Fc - Perp	405.0 psi	Ft	525.0 psi	Eminbend - xx	470.0 ksi		

Applied Loads

Unif Load: D = 0.010, L = 0.040 k/ft, Trib= 1.330 ft

Design Summary

Max fb/Fb Ratio = **0.574** : 1
 fb : Actual : 616.72 psi at 5.750 ft in Span # 1
 Fb : Allowable : 1,075.25 psi
 Load Comb : +D+L

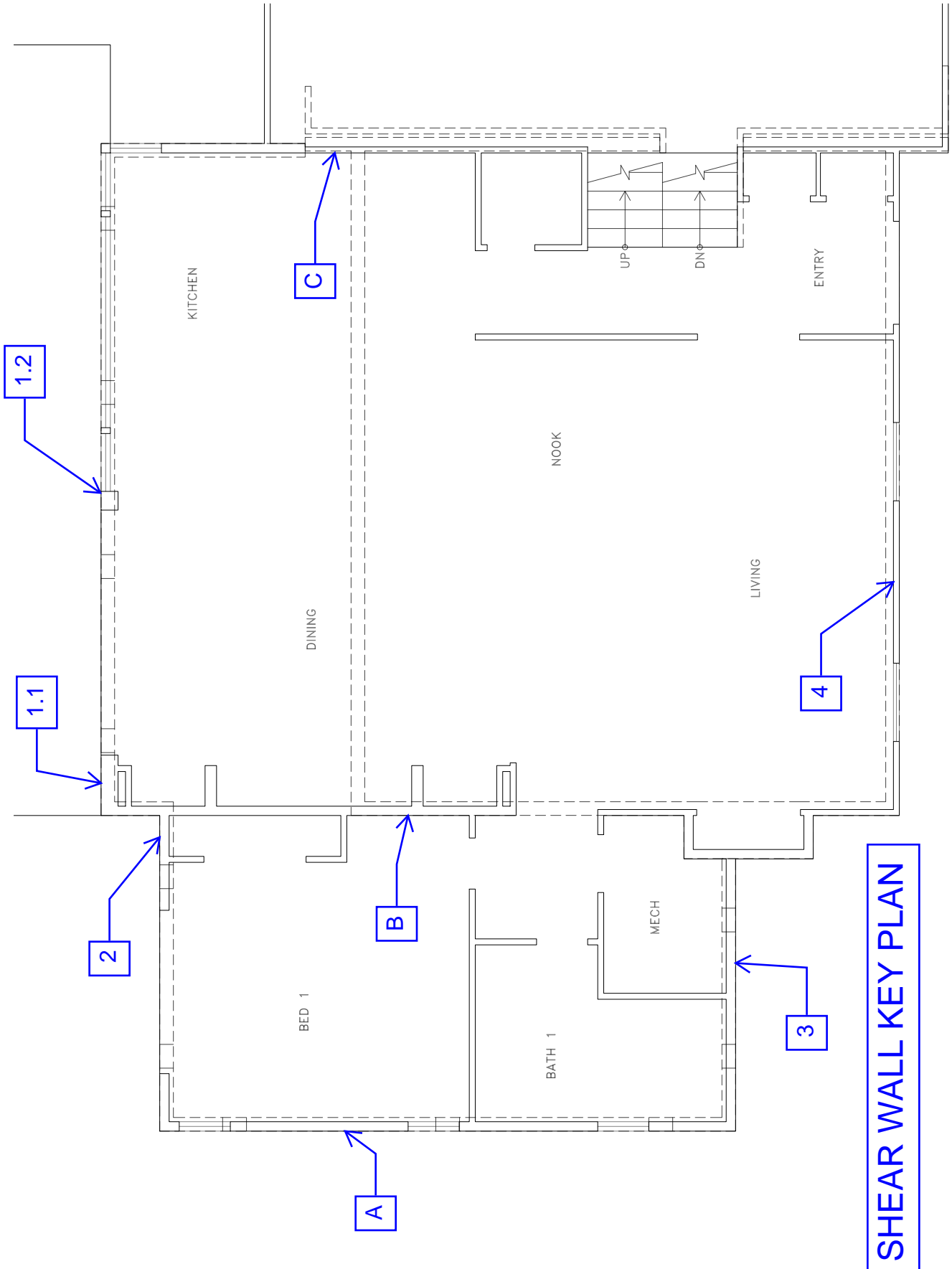
Max fv/FvRatio = **0.276** : 1
 fv : Actual : 41.34 psi at 0.000 ft in Span # 1
 Fv : Allowable : 150.00 psi
 Load Comb : +D+L

Max Reactions (k)	<u>D</u>	<u>Lr</u>	<u>L</u>	<u>S</u>	<u>W</u>	<u>E</u>	<u>H</u>
Left Support	0.08		0.31				
Right Support	0.08		0.31				



Max Deflections

Transient Downward	0.164 in	Total Downward	0.205 in
Ratio	843	Ratio	674
	LC: L Only		LC: +D+L
Transient Upward	0.000 in	Total Upward	0.000 in
Ratio	9999	Ratio	9999
	LC:		LC:



SHEAR WALL KEY PLAN

Plywood Shear Wall Design

Refer to Shear Wall Key Plans

Story Forces - ASD Level	
Floor	F_x (psf)
Roof	5.4
UF/MF	3.2

Plywood Grade	
CD-X	Struct 1 or CD-X

15/32" Plywood, w/ 10d nails, min. 1-1/2" penetration into framing members

R_d (Dead Load Resistance Factor) = 0.6-0.14 S_{ds} = 0.44

Wall Mark Capacity (Grade Struct 1)		
Wall Mark	Edge Nailing	Capacity (plf)
1	6"o.c.	340
2	4"o.c.	510
3	3"o.c.	665
4	2"o.c.	870
Dbl 2	4"o.c. Both Sides	1020
Dbl 3	3"o.c. Both Sides	1330
Dbl 4	2"o.c. Both Sides	1740

Wall Mark Capacity (Grade CD-X)		
Wall Mark	Edge Nailing	Capacity (plf)
1	6"o.c.	310
2	4"o.c.	460
3	3"o.c.	600
4	2"o.c.	770
Dbl 2	4"o.c. Both Sides	920
Dbl 3	3"o.c. Both Sides	1200
Dbl 4	2"o.c. Both Sides	1540

Holdown Schedule	
Holdown	Capacity (lb)
HDU2	3075
HDU4	4565
HDU5	5645
HDU8	7870
MSTC40	2690
MSTC52	4225
MSTC66	5850

Notes

- 1) V_{abv} = Shear wall on story above that adds shear to subject wall
- 2) V_{abv} = Shear demand from wall on story above
- 3) V_{cur} = Shear demand from current story = $A_T \times F_x$
- 4) V = Total shear demand in wall = $V_{abv} + V_{cur}$
- 5) v = unit shear demand = V / L
- 6) Allowable shear reduction multiplier of $2xL/h$ for walls w/ $h > 2L$ (=1 if $h < 2L$)
- 7) OTM = Wall overturning moment = $V \times h$
- 8) w_{DL} = Distributed resisting dead load on top of wall
- 9) $P_{DL,END}$ = Minimum resisting point dead load on end of wall
- 10) RM = Resisting Moment from w_{DL} & $P_{DL,END}$, multiplied by R_d above
- 11) T_{end} = Tension at end of wall from current story shear = $(OTM - RM) / L$
- 12) T_{abv} = Tension from wall holdown on story above
- 13) $T = T_{end} + T_{abv}$

Roof Diaphragm

Walls in North-South Direction												
Wall	L (ft)	h (ft)	A _T (sf)	Wall _{abv} ¹	V _{abv} ² (lbs)	V _{cur} ³ (lbs)	V [*] (lb)	v ^o (plf)	Wall Mark	h>2L?	2xL/h ^o	Capacity (plf)
A	8	9.5	270	none	0	1461	1461	183	1	no	1	310
B	8	9.5	1070	none	0	5788	5788	723	4	no	1	770
C	7	9.5	1630	none	0	8817	8817	1260	DBL 4	no	1	1540

Holdowns for Walls in North-South Direction									
Wall	OTM' (lb-ft)	w _{DL} ⁸ (plf)	P _{DLEND} ⁹ (lb)	RM ¹⁰ (lb-ft)	T _{end} ¹¹ (lb)	T _{abv} ¹² (lb)	T ¹³ (lb)	Holdown	Capacity
A	13875	120	480	3361	1314		1314	HDU2	3075
B	54985	120	480	3361	6453		6453	HDU8	7870
C	83763	120	480	2757	11572		11572	HDU14	14445

Walls in East-West Direction												
Wall	L (ft)	h (ft)	A _T (sf)	Wall _{abv} ¹	V _{abv} ² (lbs)	V _{cur} ³ (lbs)	V [*] (lb)	v ^o (plf)	Wall Mark	h>2L?	2xL/h ^o	Capacity (plf)
1.1	3	9.5	420	none	0	2272	2272	757	DBL 4	yes	0.63	973
1.2	2.75	9.5	380	none	0	2056	2056	747	DBL 4	yes	0.58	892
2	4.5	9.5	270	none	0	1461	1461	325	2	yes	0.95	436
3	13.25	9.5	270	none	0	1461	1461	110	1	no	1	310
4	8	9.5	800	none	0	4327	4327	541	3	no	1	600

Holdowns for Walls in East-West Direction									
Wall	OTM' (lb-ft)	w _{DL} ⁸ (plf)	P _{DLEND} ⁹ (lb)	RM ¹⁰ (lb-ft)	T _{end} ¹¹ (lb)	T _{abv} ¹² (lb)	T ¹³ (lb)	Holdown	Capacity
1.1	21583	290	870	1713	6623		6623	HDU8	7870
1.2	19528	290	870	1527	6546		6546	HDU8	7870
2	13875	380	720	3101	2394		2394	HDU2	3075
3	13875	380	720	18772	-370		-370	NONE	#N/A
4	41111	350	700	7352	4220		4220	HDU4	4565