tecinstruct LLC
4111 164th St SW
Unit 51
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Engineering

STRUCTURAL DESIGN

Owner:	Tyler & Sarah Hollenbeck
Project:	7701 SE 39th St Mercer Island, WA 98040
Description:	Alteration & Addition
Building Codes:	IBC/IRC 2018 ASCE 7-16
Structural Design/ EOR:	Roland Heimisch, P. E. Lic # 42479
Date	09/29/2022

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Engineering

1. LATERAL DESIGN

With the addition completely within the projected aree of the existing building, there are no additional wind loads.

With the additional floor area only ~ 12% of the total area, no seismic design was performed. All new exterior walls are callled out as P1-6 shear walls per inspection.

Engineering

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2. GRAVITY DESIGN

Project: 7701 SE 39th St, Mercer Island, WA 98040

2.1 Design Criteria

Dead Loads	**Roof**	Coating/Waterproofing	2.0
		Sheathing OSB/Plywood 15/32“	2.0
		Trusses / Framing	3.0
		Insulation R-38	1.2
		Gypsum Board 5/8“	2.8
		Miscellaneous (Sprinkler, HVAC etc)	1.5
		Total	12.5, say **15 psf**
	Floors Living	Finished Floor (carpet)	1.0
		Sheathing OSB/Plywood 3/4“	2.5
		Floor Joists / TJIs	2.5
		Insulation R-11	1.0
		Gypsum Board 5/8“	2.8
		Miscellaneous (Sprinkler, HVAC etc)	1.5
		Non bearing partitions	8.0
		Total	19.3, say **20 psf**
	Decks/Balconies	Decking	3.0
		Floor Joists / TJIs	2.5
		Miscellaneous (Railing/Waterproofing)	1.5
		Total	7.0 say **10 psf**
	Ext. Walls	Siding	3.0
		Sheathing 15/32“ OSB/Plywood	2.0
		2x6“ Studs @ 16“ o.c.	1.5
		Insulation R-21	0.6
		Gypsum Board 5/8“	2.8
		Total	9.9, say **10 psf**
	Int. Walls	2x4“ Studs @ 16“ o.c.	1.5
		Gypsum Board (2 sides) 5/8“	5.6
		Total	7.1, say **8 psf**
Live Loads		Roof	**20 psf**
		Living areas	**40 psf**
		Decks/Balconies	**60 psf**
Snow Load		Snow Ground Load	25 psf
		Snow Roof Load (no reduction applied)	**25 psf**

2.2 Key List

Key No. 01 **Rafters, HF No. 2, 2x10”, @ 24” o.c.**

Key No. 02 **Overframing, HF No. 2, 2x6”, @ 24” o.c.**

Key No. 03 **Header, DF No. 2, 4x8”**

Key No. 04 **Header, DF No. 2, 4x6”**

Key No. 05 **Ridge Beam, Glulam WS, 24F-1.8E, 3-1/2x12”**

Key No. 06 **Beam, DF No. 2, 4x12”**

Key No. 07 **Post, DF No. 2, 4x4”**

Key No. 08 **Spread Footing, fc = 2,500 psi, 24x24x8”**

Key No. 09 **Continuous Footing, fc = 2,500 psi, 16x8”**

Project: 7701 SE 39th St, Mercer Island, WA 98040

2.3 Roof

Key No. 01 Rafters, HF No. 2, 2x10”, @ 24” o.c.

Span:	L		=	13 ft
Load:	DL	10 psf added to DL for hanging the ceiling from the rafters		
			=	25 psf
	SL		=	25 psf

For calculation see design sheets

Key No. 02 Overframing, HF No. 2, 2x6”, @ 24” o.c.

Per span tables

Key No. 03 Header, DF No. 2, 4x8”

Span:	L		=	5 ft
Load:	roof w/ trib 13 ft			
	DL	13 x 25	=	325 plf
	SL	13 x 25	=	325 plf

For calculation see design sheets

Key No. 04 Header, DF No. 2, 4x6”

Span:	L		=	8 ft
Load:	roof w/ trib 3 ft			
	DL	3 x 25	=	75 plf
	SL	3 x 25	=	75 plf

For calculation see design sheets

Key No. 05 Ridge Beam, Glulam WS, 24F-1.8E, 3-1/2x12”

Span:	L		=	14 ft
Load:	roof w/ trib 13 ft			
	DL	13 x 25	=	325 plf
	SL	13 x 25	=	325 plf

For calculation see design sheets

Key No. 06 Beam, DF No. 2, 4x12”

Span:	L		=	5 ft
Load:	reaction from ridge beam 05			
	PDL	at L/2	=	2,300 lbs
	PSL		=	2,300 lbs

For calculation see design sheets

Project: 7701 SE 39th St, Mercer Island, WA 98040

Key No. 07 Post, DF No. 2, 4x4”

Height:	H	=	8 ft
Loads:	reaction from beam 06		
	PDL	=	1,130 lbs
	PLL	=	1,130 lbs

For calculation see design sheets

Posts continued in basement >> no additional load >> no separate calculation

Key No. 08 Spread Footing, fc = 2,500 psi, 24x24x8”

Load	from post 07		
	P	=	2,260 lbs
Soil pressure	2,260 / 4	=	565 psf < 1,500

Key No. 09 Continuous Footing, fc = 2,500 psi, 16x8”

Dimensions per prescriptive requirements for 2-story structures

Reinforcement:	(2) rebars # 4 longitudinal
	hooked verticals # 3 @ 18” o.c.

WoodWorks® SOFTWARE FOR WOOD DESIGN

7701 SE 39th St
Mercer Island
01 Rafter
Sep. 28, 2022 19:59

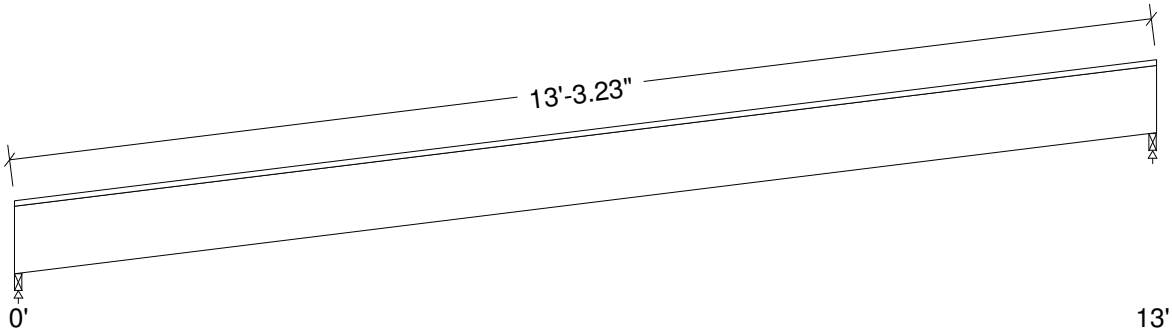
Design Check Calculation Sheet

WoodWorks Sizer 2019 (Update 4)

Loads:

Load	Type	Distribution	Pat-tern	Location [ft] Start	End	Magnitude Start	End	Unit
DL	Dead	Full Area				25.00(24.0")		psf
SL	Snow	Full Area				25.00(24.0")		psf

Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :



Unfactored:			
Dead	332		332
Snow	327		327
Factored:			
Total	659		659
Bearing:			
F'theta	413		413
Capacity			
Joist	659		659
Support	1245		1245
Des ratio			
Joist	1.00		1.00
Support	0.53		0.53
Load comb	#2		#2
Length	1.06		1.06
Min req'd	1.06		1.06
Cb	1.00		1.00
Cb min	1.00		1.00
Cb support	1.25		1.25
Fcp sup	625		625

Lumber-soft, Hem-Fir (N), No.1/No.2, 2x10 (1-1/2"x9-1/4")

Supports: All - Timber-soft Beam, D.Fir-L (N) No.2

Roof joist spaced at 24.0" c/c; Total length: 13'-4.75"; Clear span(horz): 12'-10.94"; Volume = 1.3 cu.ft.; Pitch: 2/12

Lateral support: top = continuous, bottom = at supports; Repetitive factor: applied where permitted (refer to online help);

This section PASSES the design code check.

Analysis vs. Allowable Stress and Deflection using NDS 2018 :

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear	fv = 61	Fv' = 167	psi	fv/Fv' = 0.37
Bending(+)	fb = 1193	Fb' = 1455	psi	fb/Fb' = 0.82
Dead Defl'n	0.21 = L/747			
Live Defl'n	0.21 = L/758	0.66 = L/240	in	0.32
Total Defl'n	0.42 = L/376	0.88 = L/180	in	0.48

Additional Data:

FACTORS:	F/E(psi)	CD	CM	Ct	CL	CF	Cfu	Cr	Cfrt	Ci	LC#
Fv'	145	1.15	1.00	1.00	-	-	-	-	1.00	1.00	2
Fb'+	1000	1.15	1.00	1.00	1.000	1.100	-	1.15	1.00	1.00	2
Fcp'	405	-	1.00	1.00	-	-	-	-	1.00	1.00	-
E'	1.6 million	1.00	1.00	-	-	-	-	1.00	1.00	2
Emin'	0.58 million	1.00	1.00	-	-	-	-	1.00	1.00	2

CRITICAL LOAD COMBINATIONS:

```
Shear     : LC #2  = D + S
Bending(+): LC #2  = D + S
Deflection: LC #2  = D + S  (live)
            LC #2  = D + S  (total)
Bearing   : Support 1 - LC #2 = D + S
            Support 2 - LC #2 = D + S
D=dead S=snow
All LC's are listed in the Analysis output
Load combinations: ASD Basic from ASCE 7-16 2.4 / IBC 2018 1605.3.1
```

CALCULATIONS:

```
V max = 646, V design = 566 lbs; M(+) = 2127 lbs-ft
  EIy = 158.29 lb-in^2
"Live" deflection is due to all non-dead loads (live, wind, snow…)
Total deflection = 1.0 dead + "live"
Bearing: Allowable bearing at an angle F'theta  calculated for each support
as per NDS 3.10.3
```

Design Notes:

1. Analysis and design are in accordance with the ICC International Building Code (IBC 2018) and the National Design Specification (NDS 2018), using Allowable Stress Design (ASD). Design values are from the NDS Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.
4. SLOPED BEAMS: level bearing is required for all sloped beams.

WoodWorks® SOFTWARE FOR WOOD DESIGN

7701 SE 39th St
Mercer Island
04 Header
Sep. 28, 2022 20:11

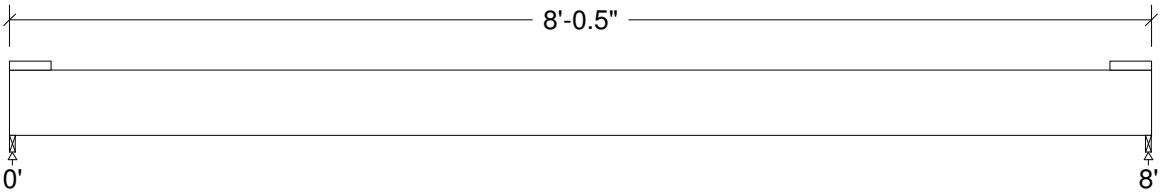
Design Check Calculation Sheet

WoodWorks Sizer 2019 (Update 4)

Loads:

Load	Type	Distribution	Pat-tern	Location [ft] Start	End	Magnitude Start	End	Unit
DL	Dead	Full UDL				75.0		plf
SL	Snow	Full UDL				75.0		plf

Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :



Unfactored:			
Dead	302		302
Snow	302		302
Factored:			
Total	603		603
Bearing:			
Capacity			
Beam	1094		1094
Support	1211		1211
Des ratio			
Beam	0.55		0.55
Support	0.50		0.50
Load comb	#2		#2
Length	0.50*		0.50*
Min req'd	0.50*		0.50*
Cb	1.00		1.00
Cb min	1.00		1.00
Cb support	1.11		1.11
Fcp sup	625		625

*Minimum bearing length setting used: 1/2" for end supports

Lumber-soft, D.Fir-L (N), No.1/No.2, 4x6 (3-1/2"x5-1/2")

Supports: All - Timber-soft Beam, D.Fir-L (N) No.2
Total length: 8'-0.5"; Clear span: 7'-11.5"; Volume = 1.1 cu.ft.
Lateral support: top = at supports, bottom = at supports;
This section PASSES the design code check.

Analysis vs. Allowable Stress and Deflection using NDS 2018 :

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear	fv = 41	Fv' = 207	psi	fv/Fv' = 0.20
Bending(+)	fb = 816	Fb' = 1271	psi	fb/Fb' = 0.64
Dead Defl'n	0.09 = < L/999			
Live Defl'n	0.09 = < L/999	0.27 = L/360	in	0.33
Total Defl'n	0.18 = L/539	0.40 = L/240	in	0.45

Additional Data:

FACTORS:	F/E(psi)	CD	CM	Ct	CL	CF	Cfu	Cr	Cfrt	Ci	LC#
Fv'	180	1.15	1.00	1.00	-	-	-	-	1.00	1.00	2
Fb'+	850	1.15	1.00	1.00	1.000	1.300	-	1.00	1.00	1.00	2
Fcp'	625	-	1.00	1.00	-	-	-	-	1.00	1.00	-
E'	1.6 million		1.00	1.00	-	-	-	-	1.00	1.00	2

CRITICAL LOAD COMBINATIONS:

```
 Shear     : LC #2  = D + S
 Bending(+): LC #2  = D + S
 Deflection: LC #2  = D + S  (live)
             LC #2  = D + S  (total)
 Bearing   : Support 1 - LC #2 = D + S
             Support 2 - LC #2 = D + S
 D=dead S=snow
 All LC's are listed in the Analysis output
 Load combinations: ASD Basic from ASCE 7-16 2.4 / IBC 2018 1605.3.1
```

CALCULATIONS:

```
 V max = 600, V design = 528 lbs; M(+) = 1200 lbs-ft
   EIy = 77.64 lb-in^2
 "Live" deflection is due to all non-dead loads (live, wind, snow…)
 Total deflection = 1.0 dead + "live"
```

Design Notes:

1. Analysis and design are in accordance with the ICC International Building Code (IBC 2018) and the National Design Specification (NDS 2018), using Allowable Stress Design (ASD). Design values are from the NDS Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.

WoodWorks® SOFTWARE FOR WOOD DESIGN

7701 SE 39th St
Mercer Island
05 Ridge Beam
Sep. 28, 2022 20:17

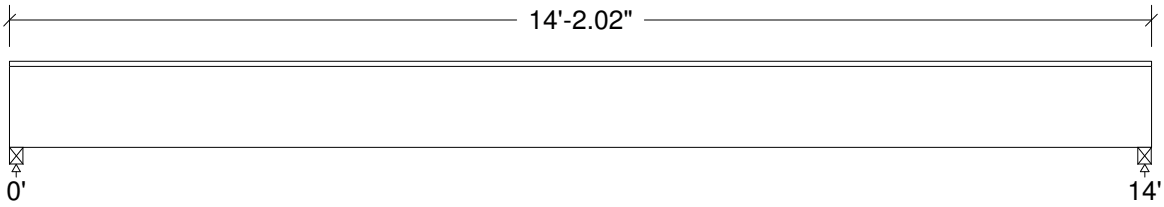
Design Check Calculation Sheet

WoodWorks Sizer 2019 (Update 4)

Loads:

Load	Type	Distribution	Pat-tern	Location [ft] Start	End	Magnitude Start	End	Unit
DL	Dead	Full UDL				325.0		plf
SL	Snow	Full UDL				325.0		plf

Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :



Unfactored:			
Dead	2302		2302
Snow	2302		2302
Factored:			
Total	4605		4605
Bearing:			
Capacity			
Beam	4605		4605
Support	4902		4902
Des ratio			
Beam	1.00		1.00
Support	0.94		0.94
Load comb	#2		#2
Length	2.02		2.02
Min req'd	2.02		2.02
Cb	1.00		1.00
Cb min	1.00		1.00
Cb support	1.11		1.11
Fcp sup	625		625

Glulam-Unbalan., West Species, 24F-1.8E WS, 3-1/2"x12"

Supports: All - Timber-soft Beam, D.Fir-L (N) No.2
Total length: 14'-2.0"; Clear span: 13'-10"; Volume = 4.1 cu.ft.; 8 laminations, 3-1/2" maximum width,
Lateral support: top = continuous, bottom = at supports;
This section PASSES the design code check.

Analysis vs. Allowable Stress and Deflection using NDS 2018 :

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear	fv = 137	Fv' = 305	psi	fv/Fv' = 0.45
Bending(+)	fb = 2275	Fb' = 2760	psi	fb/Fb' = 0.82
Dead Defl'n	0.31 = L/542			
Live Defl'n	0.31 = L/542	0.47 = L/360	in	0.66
Total Defl'n	0.62 = L/271	0.70 = L/240	in	0.88

Additional Data:

FACTORS:	F/E(psi)	CD	CM	Ct	CL	CV	Cfu	Cr	Cfrt	Notes	Cvr	LC#
Fv'	265	1.15	1.00	1.00	-	-	-	-	1.00	1.00	1.00	2
Fb'+	2400	1.15	1.00	1.00	1.000	1.000	-	-	1.00	1.00	-	2
Fcp'	650	-	1.00	1.00	-	-	-	-	1.00	-	-	-
E'	1.8 million		1.00	1.00	-	-	-	-	1.00	-	-	2
Eminy'	0.85 million		1.00	1.00	-	-	-	-	1.00	-	-	2

CRITICAL LOAD COMBINATIONS:

```
 Shear     : LC #2  = D + S
 Bending(+): LC #2  = D + S
 Deflection: LC #2  = D + S  (live)
             LC #2  = D + S  (total)
 Bearing   : Support 1 - LC #2 = D + S
             Support 2 - LC #2 = D + S
 D=dead S=snow
 All LC's are listed in the Analysis output
 Load combinations: ASD Basic from ASCE 7-16 2.4 / IBC 2018 1605.3.1
```

CALCULATIONS:

```
 V max = 4550, V design = 3845 lbs; M(+) = 15925 lbs-ft
   EIy = 907.19 lb-in^2
 "Live" deflection is due to all non-dead loads (live, wind, snow…)
 Total deflection = 1.0 dead + "live"
```

Design Notes:

1. Analysis and design are in accordance with the ICC International Building Code (IBC 2018) and the National Design Specification (NDS 2018), using Allowable Stress Design (ASD). Design values are from the NDS Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

WoodWorks® SOFTWARE FOR WOOD DESIGN

7701 SE 39th St
Mercer Island
06 Beam
Sep. 28, 2022 20:27

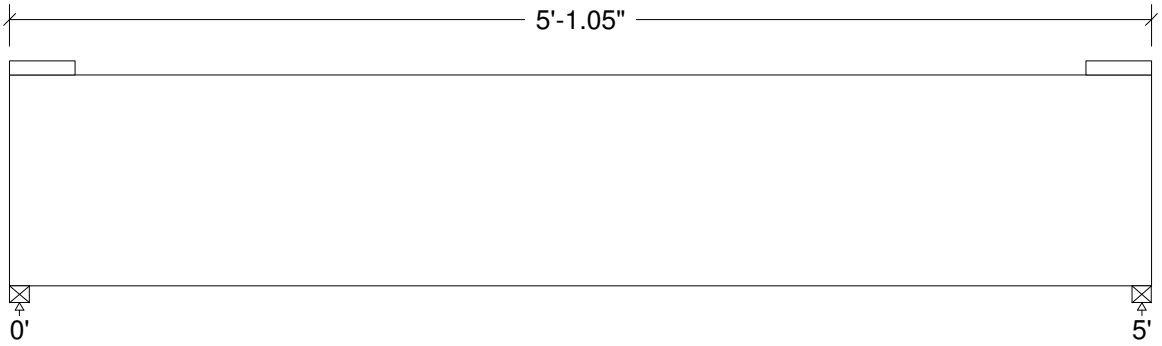
Design Check Calculation Sheet

WoodWorks Sizer 2019 (Update 4)

Loads:

Load	Type	Distribution	Pat-tern	Location [ft] Start	End	Magnitude Start	End	Unit
PDL	Dead	Point		2.50		2300		lbs
PSL	Snow	Point		2.50		2300		lbs

Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :



Unfactored:			
Dead	1172		1128
Snow	1172		1128
Factored:			
Total	2344		2256
Bearing:			
Capacity			
Beam	2344		2256
Support	2595		2498
Des ratio			
Beam	1.00		1.00
Support	0.90		0.90
Load comb	#2		#2
Length	1.07		1.03
Min req'd	1.07		1.03
Cb	1.00		1.00
Cb min	1.00		1.00
Cb support	1.11		1.11
Fcp sup	625		625

Lumber-soft, D.Fir-L (N), No.1/No.2, 4x12 (3-1/2"x11-1/4")

Supports: All - Timber-soft Beam, D.Fir-L (N) No.2

Total length: 5'-1.06"; Clear span: 4'-10.94"; Volume = 1.4 cu.ft.

Lateral support: top = at supports, bottom = at supports;

This section PASSES the design code check.

Analysis vs. Allowable Stress and Deflection using NDS 2018 :

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Shear	fv = 89	Fv' = 207	psi	fv/Fv' = 0.43
Bending(+)	fb = 934	Fb' = 1064	psi	fb/Fb' = 0.88
Dead Defl'n	0.02 = < L/999			
Live Defl'n	0.02 = < L/999	0.17 = L/360	in	0.09
Total Defl'n	0.03 = < L/999	0.25 = L/240	in	0.12

Additional Data:

FACTORS:	F/E(psi)	CD	CM	Ct	CL	CF	Cfu	Cr	Cfrt	Ci	LC#
Fv'	180	1.15	1.00	1.00	-	-	-	-	1.00	1.00	2
Fb'+	850	1.15	1.00	1.00	0.990	1.100	-	1.00	1.00	1.00	2
Fcp'	625	-	1.00	1.00	-	-	-	-	1.00	1.00	-
E'	1.6 million		1.00	1.00	-	-	-	-	1.00	1.00	2
Emin'	0.58 million		1.00	1.00	-	-	-	-	1.00	1.00	2

CRITICAL LOAD COMBINATIONS:

```
 Shear     : LC #2  = D + S
 Bending(+): LC #2  = D + S
 Deflection: LC #2  = D + S  (live)
             LC #2  = D + S  (total)
 Bearing   : Support 1 - LC #2 = D + S
             Support 2 - LC #2 = D + S
 D=dead S=snow
 All LC's are listed in the Analysis output
 Load combinations: ASD Basic from ASCE 7-16 2.4 / IBC 2018 1605.3.1
```

CALCULATIONS:

```
 V max = 2344, V design = 2344 lbs; M(+) = 5748 lbs-ft
   EIy = 664.44 lb-in^2
 "Live" deflection is due to all non-dead loads (live, wind, snow…)
 Total deflection = 1.0 dead + "live"
 Lateral stability(+):  Lu = 5'  Le = 10'-3.63"  RB = 10.7
```

Design Notes:

1. Analysis and design are in accordance with the ICC International Building Code (IBC 2018) and the National Design Specification (NDS 2018), using Allowable Stress Design (ASD). Design values are from the NDS Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.

WoodWorks® SOFTWARE FOR WOOD DESIGN

07 Post
Sep. 28, 2022 20:33

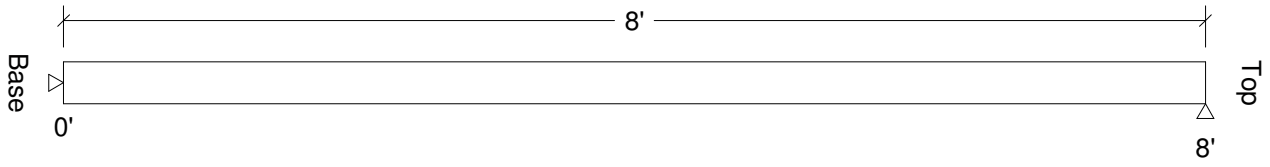
Design Check Calculation Sheet

WoodWorks Sizer 2019 (Update 4)

Loads:

Load	Type	Distribution	Location [ft] Start	End	Magnitude Start	End	Unit
PDL	Dead	Axial	(Ecc. = 0.00")		1130		lbs
PSL	Snow	Axial	(Ecc. = 0.00")		1130		lbs

Reactions (lbs):



Unfactored:			
Lateral:			
Dead			
Snow			
Axial:			
Dead	1130		1130
Snow	1130		1130
Factored:			
L->R			
Load comb	#1		#1

Lumber Post, D.Fir-L (N), No.1/No.2, 4x4 (3-1/2"x3-1/2")

Support: Non-wood

Total length: 8'; Volume = 0.7 cu.ft.

Pinned base; Ke x Lb: 1.0 x 8.0 = 8.0 ft; Ke x Ld: 1.0 x 8.0 = 8.0 ft;

This section PASSES the design code check.

Analysis vs. Allowable Stress and Deflection using NDS 2018 :

Criterion	Analysis Value	Design Value	Unit	Analysis/Design
Axial	fc = 184	Fc' = 581	psi	fc/Fc' = 0.32
Axial Bearing	fc = 184	Fc* = 1851	psi	fc/Fc* = 0.10

Additional Data:

FACTORS:	F/E(psi)	CD	CM	Ct	CL/CP	CF	Cfu	Cr	Cfrt	Ci	LC#
Fc'	1400	1.15	1.00	1.00	0.314	1.150	-	-	1.00	1.00	2
Fc*	1400	1.15	1.00	1.00	-	1.150	-	-	1.00	1.00	2

CRITICAL LOAD COMBINATIONS:

Axial : LC #2 = D + S

D=dead S=snow

All LC's are listed in the Analysis output

Load combinations: ASD Basic from ASCE 7-16 2.4 / IBC 2018 1605.3.1