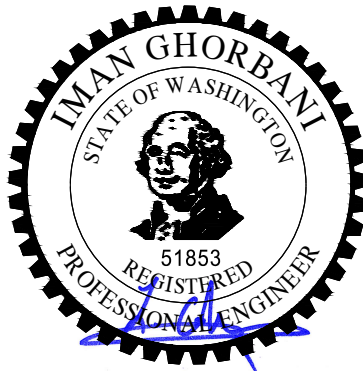


Gravity and Lateral Load
Calculation for New Deck
Design Located at: 2453 64th
Ave S Mercer Island 98040

By: Iman Ghorbani, PhD, PE
TecLoads, LLC
iman@teclloads.com

Date: 09/26/2024



EXP. 01/28/2025

Deck Level			
Member Name	Results (Max UTIL %)	Current Solution	Comments
Floor: Joist	Passed (62% M)	1 piece(s) 2 x 10 DF No.2 @ 16" OC	
Mid Joist @ Under mid Roof Post	Passed (94% ΔT)	1 piece(s) 4 x 10 DF No.2 @ 16" OC	
Side Joist @ Under Corner Roof Post	Passed (74% M)	1 piece(s) 4 x 10 DF No.2 @ 16" OC	
Floor: Drop Beam	Passed (79% M)	1 piece(s) 6 x 10 DF No.2	
Floor: Drop Beam just Dead load	Passed (13% M)	1 piece(s) 6 x 10 DF No.2	
Stair Landing Drop Beam	Passed (29% M)	1 piece(s) 4 x 10 DF No.2	
Base Post	Passed (44% f _c)	1 piece(s) 6 x 6 DF No.2	
Corner Post- Near Stair	Passed (16% f _c)	1 piece(s) 4 x 4 DF No.2	
Roof Level			
Member Name	Results (Max UTIL %)	Current Solution	Comments
Roof: Joist	Passed (58% M)	1 piece(s) 2 x 8 DF No.2 @ 16" OC	
Roof: Drop Beam	Passed (65% M)	1 piece(s) 4 x 8 DF No.2	
Roof: Drop Beam just Dead load	Passed (34% M)	1 piece(s) 4 x 8 DF No.2	
Mid Roof Post	Passed (38% f _c)	1 piece(s) 4 x 4 DF No.2	
Corner Roof Post	Passed (19% f _c)	1 piece(s) 4 x 4 DF No.2	

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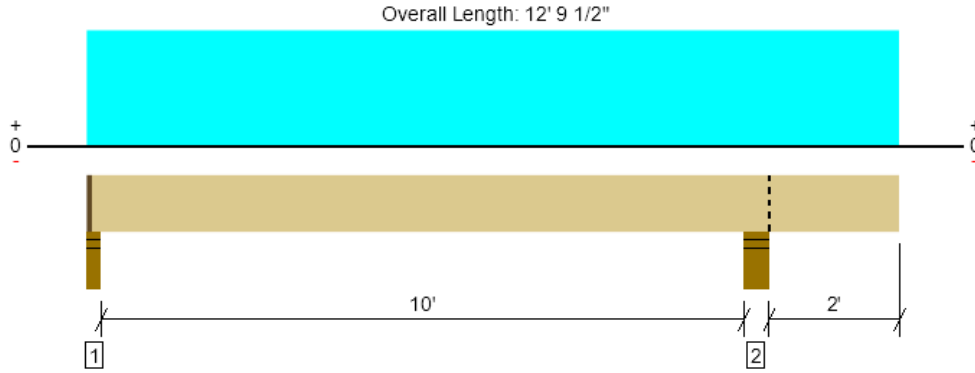
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File Name: 2453 64th Ave S Mercer Island 98040

Deck Level, Floor: Joist

1 piece(s) 2 x 10 DF No.2 @ 16" OC



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

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	502 @ 2 1/2"	2109 (2.25")	Passed (24%)	--	1.0 D + 1.0 L (Alt Spans)
Shear (lbs)	422 @ 9' 6 1/4"	1665	Passed (25%)	1.00	1.0 D + 1.0 L (All Spans)
Moment (Ft-lbs)	1261 @ 5' 4"	2029	Passed (62%)	1.00	1.0 D + 1.0 L (Alt Spans)
Live Load Defl. (in)	0.130 @ 5' 4 1/2"	0.258	Passed (L/956)	--	1.0 D + 1.0 L (Alt Spans)
Total Load Defl. (in)	0.153 @ 5' 4 5/16"	0.517	Passed (L/812)	--	1.0 D + 1.0 L (Alt Spans)
TJ-Pro™ Rating	N/A	N/A	N/A	--	N/A

Member Length : 12' 8 1/4"
 System : Floor
 Member Type : Joist
 Building Use : Residential
 Building Code : IBC 2021
 Design Methodology : ASD

- Deflection criteria: LL (L/480) and TL (L/240).
- Overhang deflection criteria: LL (2L/480) and TL (2L/240).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- A 15% increase in the moment capacity has been added to account for repetitive member usage.
- Applicable calculations are based on NDS.
- No composite action between deck and joist was considered in analysis.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Floor Live	Factored	
1 - Stud wall - DF	3.50"	2.25"	1.50"	82	430/-11	512	1 1/4" Rim Board
2 - Stud wall - DF	6.00"	6.00"	1.50"	123	613	736	Blocking

- Rim Board is assumed to carry all loads applied directly above it, bypassing the member being designed.
- Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	9' 11" o/c	
Bottom Edge (Lu)	12' 8" o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Load	Location (Side)	Spacing	Dead (0.90)	Floor Live (1.00)	Comments
1 - Uniform (PSF)	0 to 12' 9 1/2"	16"	12.0	60.0	Default Load

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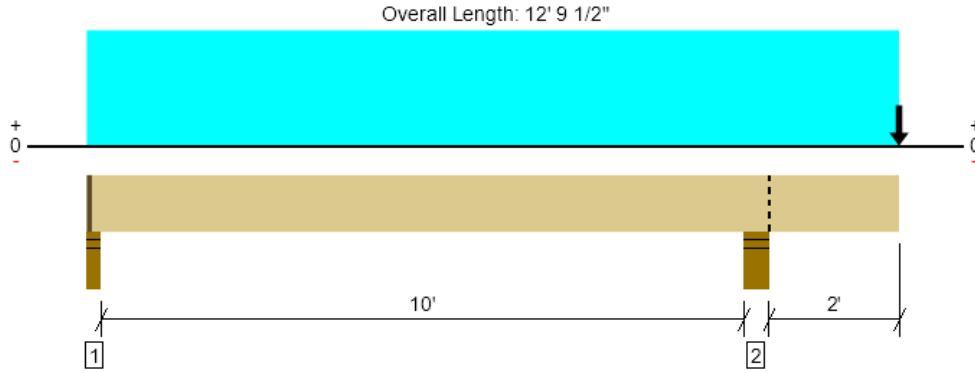
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Deck Level, Mid Joist @ Under mid Roof Post
1 piece(s) 4 x 10 DF No.2 @ 16" OC



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

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	2812 @ 10' 6 1/2"	13125 (6.00")	Passed (21%)	--	1.0 D + 0.75 L + 0.75 S (All Spans)
Shear (lbs)	2206 @ 11' 6 3/4"	4468	Passed (49%)	1.15	1.0 D + 1.0 S (All Spans)
Moment (Ft-lbs)	-4959 @ 10' 6 1/2"	5941	Passed (83%)	1.15	1.0 D + 1.0 S (All Spans)
Live Load Defl. (in)	0.141 @ 12' 9 1/2"	0.200	Passed (2L/384)	--	1.0 D + 1.0 S (All Spans)
Total Load Defl. (in)	0.211 @ 12' 9 1/2"	0.225	Passed (2L/256)	--	1.0 D + 1.0 S (All Spans)
TJ-Pro™ Rating	N/A	N/A	N/A	--	N/A

Member Length : 12' 8 1/4"
 System : Floor
 Member Type : Joist
 Building Use : Residential
 Building Code : IBC 2021
 Design Methodology : ASD

- Deflection criteria: LL (L/480) and TL (L/240).
- Overhang deflection criteria: LL (0.2") and TL (2L/240).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- A 15% increase in the moment capacity has been added to account for repetitive member usage.
- -394 lbs uplift at support located at 2 1/2". Strapping or other restraint may be required.
- Applicable calculations are based on NDS.
- No composite action between deck and joist was considered in analysis.

Supports	Bearing Length			Loads to Supports (lbs)				Accessories
	Total	Available	Required	Dead	Floor Live	Snow	Factored	
1 - Stud wall - DF	3.50"	2.25"	1.50"	-85	430/-11	-309	345/-394	1 1/4" Rim Board
2 - Stud wall - DF	6.00"	6.00"	1.50"	1058	613	1727	2812	Blocking

- Rim Board is assumed to carry all loads applied directly above it, bypassing the member being designed.
- Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	12' 8" o/c	
Bottom Edge (Lu)	12' 8" o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Spacing	Dead (0.90)	Floor Live (1.00)	Snow (1.15)	Comments
1 - Uniform (PSF)	0 to 12' 9 1/2"	16"	12.0	60.0	-	Default Load
2 - Point (lb)	12' 9 1/2"	N/A	768	-	1418	Linked from: Mid Roof Post, Support 1

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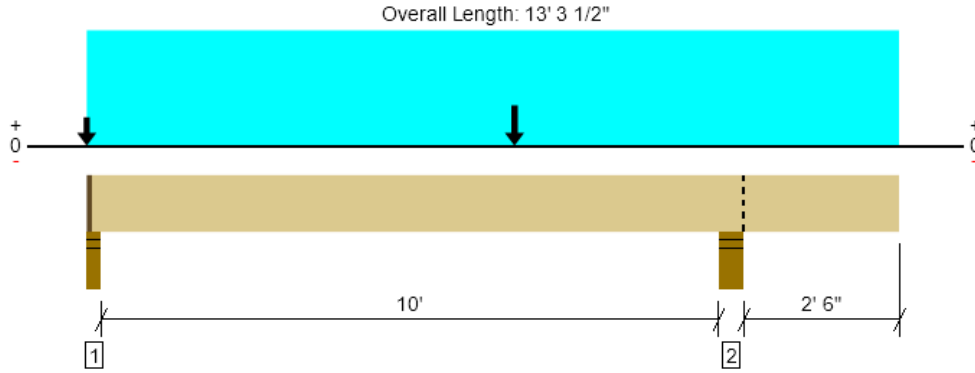
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Deck Level, Side Joist @ Under Corner Roof Post
1 piece(s) 4 x 10 DF No.2 @ 16" OC



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

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	901 @ 2 1/2"	4922 (2.25")	Passed (18%)	--	1.0 D + 1.0 L (Alt Spans)
Shear (lbs)	1202 @ 9' 6 1/4"	3885	Passed (31%)	1.00	1.0 D + 1.0 L (All Spans)
Moment (Ft-lbs)	3838 @ 7'	5166	Passed (74%)	1.00	1.0 D + 1.0 L (Alt Spans)
Live Load Defl. (in)	0.148 @ 5' 7 9/16"	0.258	Passed (L/840)	--	1.0 D + 1.0 L (Alt Spans)
Total Load Defl. (in)	0.174 @ 5' 7 1/2"	0.517	Passed (L/711)	--	1.0 D + 1.0 L (Alt Spans)
TJ-Pro™ Rating	N/A	N/A	N/A	--	N/A

Member Length : 13' 2 1/4"
 System : Floor
 Member Type : Joist
 Building Use : Residential
 Building Code : IBC 2021
 Design Methodology : ASD

- Deflection criteria: LL (L/480) and TL (L/240).
- Overhang deflection criteria: LL (2L/480) and TL (2L/240).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- A 15% increase in the moment capacity has been added to account for repetitive member usage.
- Applicable calculations are based on NDS.
- No composite action between deck and joist was considered in analysis.

Supports	Bearing Length			Loads to Supports (lbs)				Accessories
	Total	Available	Required	Dead	Floor Live	Snow	Factored	
1 - Stud wall - DF	3.50"	2.25"	1.50"	542	767/-21	849	1754	1 1/4" Rim Board
2 - Stud wall - DF	6.00"	6.00"	1.50"	256	1308	269	1564	Blocking

- Rim Board is assumed to carry all loads applied directly above it, bypassing the member being designed.
- Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	13' 2" o/c	
Bottom Edge (Lu)	13' 2" o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Spacing	Dead (0.90)	Floor Live (1.00)	Snow (1.15)	Comments
1 - Uniform (PSF)	0 to 13' 3 1/2"	16"	12.0	60.0	-	Default Load
2 - Point (lb)	7'	N/A	188	982	409	Linked from: Stair Landing Drop Beam, Support 1
3 - Point (lb)	0	N/A	398	-	709	Linked from: Corner Roof Post, Support 1

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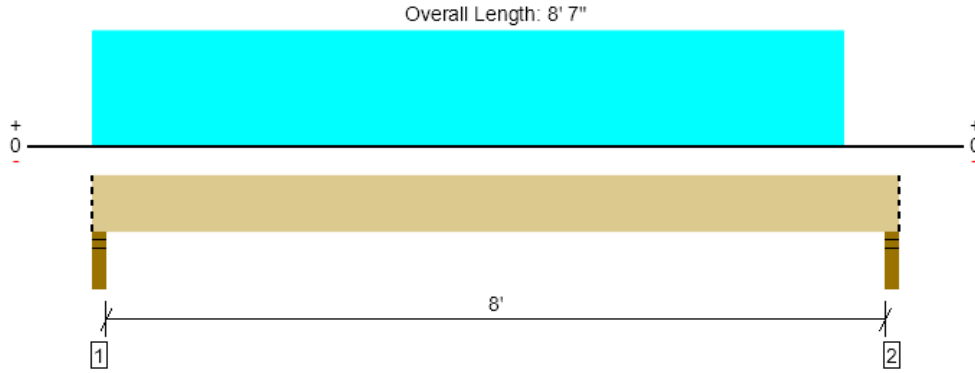
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Deck Level, Floor: Drop Beam
1 piece(s) 6 x 10 DF No.2



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

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	2420 @ 2"	8181 (3.50")	Passed (30%)	--	1.0 D + 1.0 L (All Spans)
Shear (lbs)	1819 @ 7' 6"	5922	Passed (31%)	1.00	1.0 D + 1.0 L (All Spans)
Moment (Ft-lbs)	4785 @ 4' 3 3/8"	6032	Passed (79%)	1.00	1.0 D + 1.0 L (All Spans)
Live Load Defl. (in)	0.093 @ 4' 3 3/8"	0.206	Passed (L/999+)	--	1.0 D + 1.0 L (All Spans)
Total Load Defl. (in)	0.115 @ 4' 3 3/8"	0.412	Passed (L/864)	--	1.0 D + 1.0 L (All Spans)

Member Length : 8' 7"
 System : Floor
 Member Type : Drop Beam
 Building Use : Residential
 Building Code : IBC 2021
 Design Methodology : ASD

- Deflection criteria: LL (L/480) and TL (L/240).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- Lumber grading provisions must be extended over the length of the member per NDS 4.2.5.5.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Floor Live	Factored	
1 - Stud wall - SPF	3.50"	3.50"	1.50"	452	1968	2420	Blocking
2 - Stud wall - SPF	3.50"	3.50"	1.50"	400	1710	2110	Blocking

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

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	8' 7" o/c	
Bottom Edge (Lu)	8' 7" o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Tributary Width	Dead (0.90)	Floor Live (1.00)	Comments
0 - Self Weight (PLF)	0 to 8' 7"	N/A	13.2	--	
1 - Uniform (PLF)	0 to 8' (Top)	N/A	92.3	459.8	Linked from: Floor: Joist, Support 2

• Side loads are assumed to not induce cross-grain tension.

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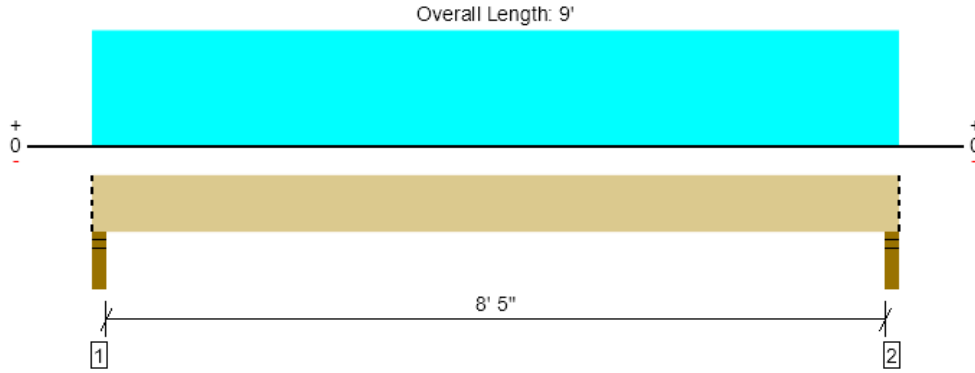
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Deck Level, Floor: Drop Beam just Dead load
1 piece(s) 6 x 10 DF No.2



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

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	330 @ 2"	8181 (3.50")	Passed (4%)	--	1.0 D (All Spans)
Shear (lbs)	250 @ 1' 1"	5330	Passed (5%)	0.90	1.0 D (All Spans)
Moment (Ft-lbs)	688 @ 4' 6"	5429	Passed (13%)	0.90	1.0 D (All Spans)
Live Load Defl. (in)	0.000 @ 0	0.217	Passed (2L/999+)	--	1.0 D (All Spans)
Total Load Defl. (in)	0.018 @ 4' 6"	0.433	Passed (L/999+)	--	1.0 D (All Spans)

Member Length : 9'
 System : Floor
 Member Type : Drop Beam
 Building Use : Residential
 Building Code : IBC 2021
 Design Methodology : ASD

- Deflection criteria: LL (L/480) and TL (L/240).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- Lumber grading provisions must be extended over the length of the member per NDS 4.2.5.5.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)		Accessories
	Total	Available	Required	Dead	Factored	
1 - Stud wall - SPF	3.50"	3.50"	1.50"	330	330	Blocking
2 - Stud wall - SPF	3.50"	3.50"	1.50"	330	330	Blocking

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

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	9' o/c	
Bottom Edge (Lu)	9' o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Tributary Width	Dead (0.90)	Comments
0 - Self Weight (PLF)	0 to 9'	N/A	13.2	
1 - Uniform (PSF)	0 to 9' (Front)	6'	10.0	Floor

• Side loads are assumed to not induce cross-grain tension.

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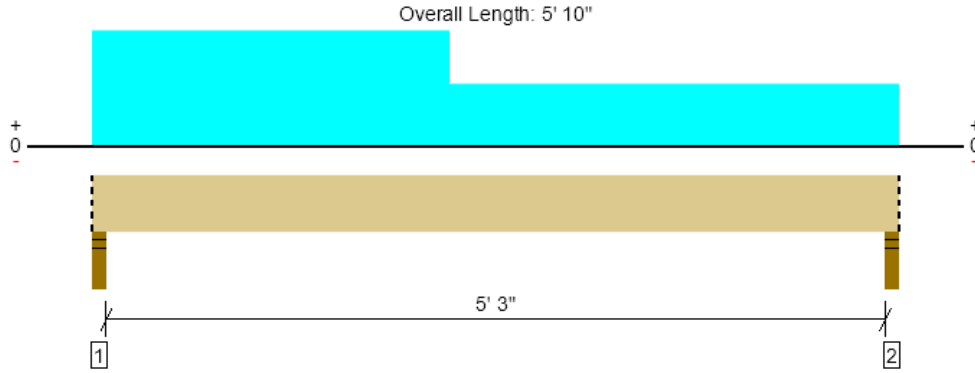
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Deck Level, Stair Landing Drop Beam
1 piece(s) 4 x 10 DF No.2



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

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	1231 @ 2"	5206 (3.50")	Passed (24%)	--	1.0 D + 0.75 L + 0.75 S (All Spans)
Shear (lbs)	677 @ 1' 3/4"	3885	Passed (17%)	1.00	1.0 D + 1.0 L (All Spans)
Moment (Ft-lbs)	1288 @ 2' 6 5/16"	4492	Passed (29%)	1.00	1.0 D + 1.0 L (All Spans)
Live Load Defl. (in)	0.017 @ 2' 10 5/16"	0.138	Passed (L/999+)	--	1.0 D + 0.75 L + 0.75 S (All Spans)
Total Load Defl. (in)	0.020 @ 2' 10 5/16"	0.275	Passed (L/999+)	--	1.0 D + 0.75 L + 0.75 S (All Spans)

Member Length : 5' 10"
 System : Floor
 Member Type : Drop Beam
 Building Use : Residential
 Building Code : IBC 2021
 Design Methodology : ASD

- Deflection criteria: LL (L/480) and TL (L/240).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)				Accessories
	Total	Available	Required	Dead	Floor Live	Snow	Factored	
1 - Stud wall - SPF	3.50"	3.50"	1.50"	188	982	409	1231	Blocking
2 - Stud wall - SPF	3.50"	3.50"	1.50"	142	708	295	894	Blocking

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

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	5' 10" o/c	
Bottom Edge (Lu)	5' 10" o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Tributary Width	Dead (0.90)	Floor Live (1.00)	Snow (1.15)	Comments
0 - Self Weight (PLF)	0 to 5' 10"	N/A	8.2	--	--	
1 - Uniform (PSF)	0 to 5' 10" (Front)	3' 6"	10.0	60.0	25.0	Floor
2 - Uniform (PSF)	0 to 2' 7" (Front)	3'	10.0	60.0	25.0	Floor

• Side loads are assumed to not induce cross-grain tension.

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 File Name: 2453 64th Ave S Mercer Island 98040

Deck Level, Base Post
1 piece(s) 6 x 6 DF No.2

Post Height: 9'



Design Results	Actual	Allowed	Result	LDF	Load: Combination
Slenderness	20	50	Passed (39%)	--	--
Compression (lbs)	8227	18526	Passed (44%)	1.15	1.0 D + 0.75 L + 0.75 S
Base Bearing (lbs)	8227	898425	Passed (1%)	--	1.0 D + 0.75 L + 0.75 S
Bending/Compression	N/A	1	Passed (N/A)	--	N/A

- Input axial load eccentricity for the design is zero
- Applicable calculations are based on NDS.

Supports	Type	Material
Base	Plate	Steel

Member Type : Free Standing Post
 Building Code : IBC 2021
 Design Methodology : ASD

Max Unbraced Length	Comments
Full Member Length	No bracing assumed.

Drawing is Conceptual

Vertical Loads	Dead (0.90)	Floor Live (1.00)	Snow (1.15)	Comments
1 - Point (lb)	370	-	709	Linked from: Roof: Drop Beam, Support 1
2 - Point (lb)	370	-	709	Linked from: Roof: Drop Beam, Support 2
3 - Point (lb)	1058	613	1727	Linked from: Mid Joist @ Under Roof Post, Support 2
4 - Point (lb)	452	1968	-	Linked from: Floor: Drop Beam, Support 1
5 - Point (lb)	400	1710	-	Linked from: Floor: Drop Beam, Support 2

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ForteWEB Software Operator	Job Notes
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Deck Level, Corner Post- Near Stair

1 piece(s) 4 x 4 DF No.2

Post Height: 9'



Design Results	Actual	Allowed	Result	LDF	Load: Combination
Slenderness	31	50	Passed (62%)	--	--
Compression (lbs)	894	5727	Passed (16%)	1.15	1.0 D + 0.75 L + 0.75 S
Base Bearing (lbs)	894	363825	Passed (0%)	--	1.0 D + 0.75 L + 0.75 S
Bending/Compression	N/A	1	Passed (N/A)	--	N/A

- Input axial load eccentricity for the design is zero
- Applicable calculations are based on NDS.

Supports	Type	Material
Base	Plate	Steel

Member Type : Free Standing Post
 Building Code : IBC 2021
 Design Methodology : ASD

Max Unbraced Length	Comments
Full Member Length	No bracing assumed.

Drawing is Conceptual

Vertical Load	Dead (0.90)	Floor Live (1.00)	Snow (1.15)	Comments
1 - Point (lb)	142	708	295	Linked from: Stair Landing Drop Beam, Support 2

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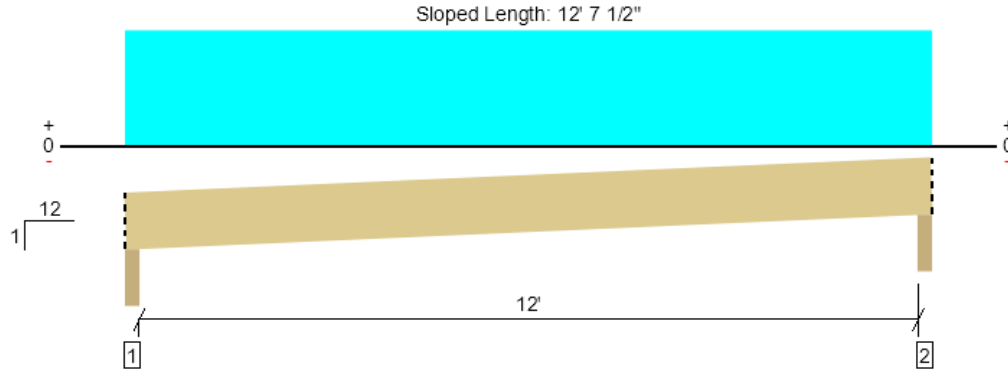
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Roof Level, Roof: Joist
1 piece(s) 2 x 8 DF No.2 @ 16" OC



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

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	311 @ 2 1/2"	2231 (3.50")	Passed (14%)	--	1.0 D + 1.0 S (All Spans)
Shear (lbs)	267 @ 10 3/4"	1501	Passed (18%)	1.15	1.0 D + 1.0 S (All Spans)
Moment (Ft-lbs)	914 @ 6' 3 1/2"	1564	Passed (58%)	1.15	1.0 D + 1.0 S (All Spans)
Live Load Defl. (in)	0.217 @ 6' 3 1/2"	0.407	Passed (L/675)	--	1.0 D + 1.0 S (All Spans)
Total Load Defl. (in)	0.322 @ 6' 3 1/2"	0.610	Passed (L/455)	--	1.0 D + 1.0 S (All Spans)

Member Length : 12' 8 1/8"
 System : Roof
 Member Type : Joist
 Building Use : Residential
 Building Code : IBC 2021
 Design Methodology : ASD
 Member Pitch : 1/12

- Deflection criteria: LL (L/360) and TL (L/240).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- A 15% increase in the moment capacity has been added to account for repetitive member usage.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Snow	Factored	
1 - Beveled Plate - SPF	3.50"	3.50"	1.50"	101	210	311	Blocking
2 - Beveled Plate - SPF	3.50"	3.50"	1.50"	101	210	311	Blocking

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

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	10' 11" o/c	
Bottom Edge (Lu)	12' 8" o/c	

- Maximum allowable bracing intervals based on applied load.
- Dimensions for lateral bracing intervals are measured along the length of the member for sloped conditions.

Vertical Load	Location (Side)	Spacing	Dead (0.90)	Snow (1.15)	Comments
1 - Uniform (PSF)	0 to 12' 7"	16"	12.0	25.0	Default Load

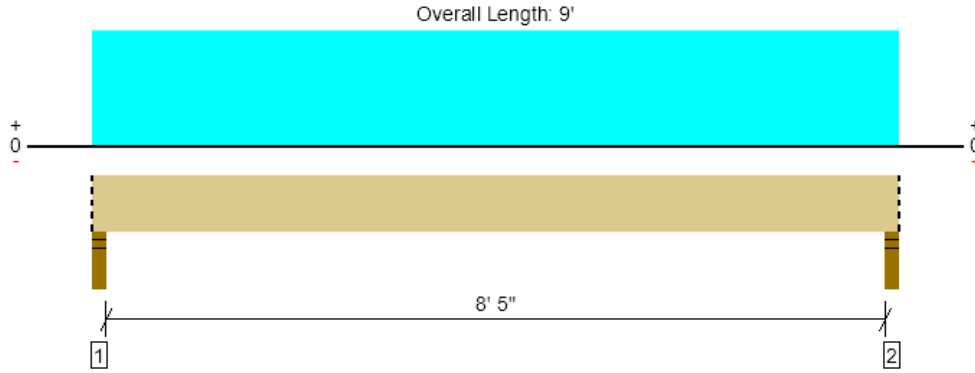
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 File Name: 2453 64th Ave S Mercer Island 98040

Roof Level, Roof: Drop Beam
1 piece(s) 4 x 8 DF No.2



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

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	1079 @ 2"	7656 (3.50")	Passed (14%)	--	1.0 D + 1.0 S (All Spans)
Shear (lbs)	864 @ 10 3/4"	3502	Passed (25%)	1.15	1.0 D + 1.0 S (All Spans)
Moment (Ft-lbs)	2250 @ 4' 6"	3438	Passed (65%)	1.15	1.0 D + 1.0 S (All Spans)
Live Load Defl. (in)	0.112 @ 4' 6"	0.289	Passed (L/925)	--	1.0 D + 1.0 S (All Spans)
Total Load Defl. (in)	0.171 @ 4' 6"	0.433	Passed (L/608)	--	1.0 D + 1.0 S (All Spans)

Member Length : 9'
 System : Roof
 Member Type : Drop Beam
 Building Use : Residential
 Building Code : IBC 2021
 Design Methodology : ASD
 Member Pitch : 0/12

- Deflection criteria: LL (L/360) and TL (L/240).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)			Accessories
	Total	Available	Required	Dead	Snow	Factored	
1 - Stud wall - DF	3.50"	3.50"	1.50"	370	709	1079	Blocking
2 - Stud wall - DF	3.50"	3.50"	1.50"	370	709	1079	Blocking

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

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	9' o/c	
Bottom Edge (Lu)	9' o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Tributary Width	Dead (0.90)	Snow (1.15)	Comments
0 - Self Weight (PLF)	0 to 9'	N/A	6.4	--	
1 - Uniform (PLF)	0 to 9' (Front)	N/A	75.8	157.5	Linked from: Roof: Joist, Support 1

• Side loads are assumed to not induce cross-grain tension.

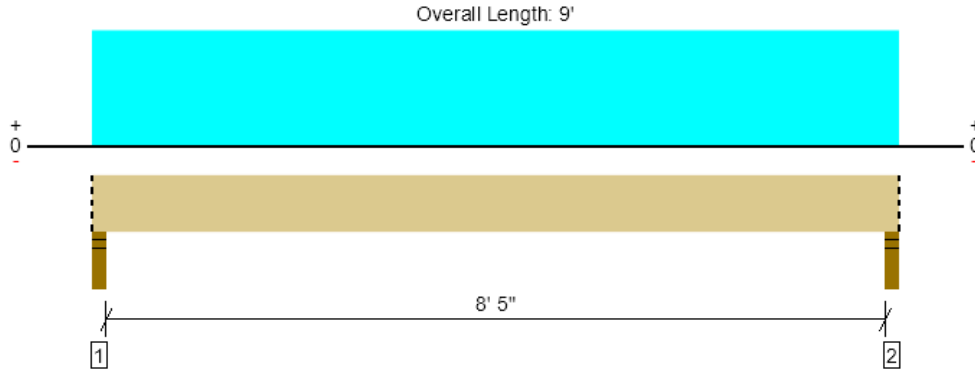
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Roof Level, Roof: Drop Beam just Dead load
1 piece(s) 4 x 8 DF No.2



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

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	434 @ 2"	5206 (3.50")	Passed (8%)	--	1.0 D (All Spans)
Shear (lbs)	348 @ 10 3/4"	2741	Passed (13%)	0.90	1.0 D (All Spans)
Moment (Ft-lbs)	905 @ 4' 6"	2691	Passed (34%)	0.90	1.0 D (All Spans)
Live Load Defl. (in)	0.000 @ 0	0.289	Passed (2L/999+)	--	1.0 D (All Spans)
Total Load Defl. (in)	0.069 @ 4' 6"	0.433	Passed (L/999+)	--	1.0 D (All Spans)

Member Length : 9'
 System : Roof
 Member Type : Drop Beam
 Building Use : Residential
 Building Code : IBC 2021
 Design Methodology : ASD
 Member Pitch : 0/12

- Deflection criteria: LL (L/360) and TL (L/240).
- Allowed moment does not reflect the adjustment for the beam stability factor.
- Applicable calculations are based on NDS.

Supports	Bearing Length			Loads to Supports (lbs)		Accessories
	Total	Available	Required	Dead	Factored	
1 - Stud wall - SPF	3.50"	3.50"	1.50"	434	434	Blocking
2 - Stud wall - SPF	3.50"	3.50"	1.50"	434	434	Blocking

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

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	9' o/c	
Bottom Edge (Lu)	9' o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Tributary Width	Dead (0.90)	Comments
0 - Self Weight (PLF)	0 to 9'	N/A	6.4	
1 - Uniform (PSF)	0 to 9' (Front)	6'	15.0	Roof

• Side loads are assumed to not induce cross-grain tension.

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Roof Level, Mid Roof Post
1 piece(s) 4 x 4 DF No.2

Post Height: 9'



Design Results	Actual	Allowed	Result	LDF	Load: Combination
Slenderness	31	50	Passed (62%)	--	--
Compression (lbs)	2158	5727	Passed (38%)	1.15	1.0 D + 1.0 S
Base Bearing (lbs)	2158	7656	Passed (28%)	--	1.0 D + 1.0 S
Bending/Compression	N/A	1	Passed (N/A)	--	N/A

- Input axial load eccentricity for the design is zero
- Applicable calculations are based on NDS.

Supports	Type	Material
Base	Beam	Douglas Fir-Larch

Member Type : Free Standing Post
 Building Code : IBC 2021
 Design Methodology : ASD

Max Unbraced Length	Comments
Full Member Length	No bracing assumed.

Drawing is Conceptual

Vertical Loads	Dead (0.90)	Snow (1.15)	Comments
1 - Point (lb)	370	709	Linked from: Roof: Drop Beam, Support 1
2 - Point (lb)	370	709	Linked from: Roof: Drop Beam, Support 2

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Roof Level, Corner Roof Post
1 piece(s) 4 x 4 DF No.2

Post Height: 9'



Design Results	Actual	Allowed	Result	LDF	Load: Combination
Slenderness	31	50	Passed (62%)	--	--
Compression (lbs)	1079	5727	Passed (19%)	1.15	1.0 D + 1.0 S
Base Bearing (lbs)	1079	7656	Passed (14%)	--	1.0 D + 1.0 S
Bending/Compression	N/A	1	Passed (N/A)	--	N/A

- Input axial load eccentricity for the design is zero
- Applicable calculations are based on NDS.

Supports	Type	Material
Base	Beam	Douglas Fir-Larch

Member Type : Free Standing Post
 Building Code : IBC 2021
 Design Methodology : ASD

Max Unbraced Length	Comments
Full Member Length	No bracing assumed.

Drawing is Conceptual

Vertical Load	Dead (0.90)	Snow (1.15)	Comments
1 - Point (lb)	370	709	Linked from: Roof: Drop Beam, Support 1

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**LATERAL LOAD AND FOUNDATION CALCULATIONS FOR
DECK STRUCTURE LOCATED AT 2453 64TH AVE S
MERCER ISLAND 98040**

Basis of Design

This document is showing the detail of design and calculations of framing and foundation for lateral and gravity loads according to IRC 2018, NDS 2018, IBC 2021, ASCE7-16, AISC 2015 and ACI 318-19.

The load distribution is as follow:

Floor Dead Load ----- 15 psf
Roof Dead Load-----15 psf
Roof Snow Load-----25 psf
Deck Live Load-----60 psf
Deck Dead Load-----15 psf

The maximum wind speed is assumed 110 MPH per ASCE-7-16 with exposure category B for risk category II per King County.

Ground peak accelerations is 0.598g and seismic design category D2.

The maximum bearing pressure on soil was considered at least 1500 psf . Concrete strength is assumed to be at least 2500 psi

Material Properties for Design

$f'_c := 2500 \cdot \text{psi}$	Concrete compressive strength
$f_y := 60 \cdot \text{ksi}$	Yield strength of rebar
$f_{\text{soil.bearing}} := 1500 \cdot \text{psf}$	Minimum soil bearing capacity
$\gamma_{\text{concrete}} := 150 \cdot \text{pcf}$	Concrete unit weight
$\gamma_{\text{steel}} := 490 \cdot \text{pcf}$	Steel unit weight
$E_s := 29000 \cdot \text{ksi}$	Young modulus of steel
$E_c := 57000 \cdot \sqrt{\frac{f'_c}{\text{psi}}} \cdot \text{psi} = (2.85 \cdot 10^3) \text{ ksi}$	Young modulus of concrete (ACI-318-14)

Load Assumptions

$LL_{\text{floor}} := 40 \cdot \text{psf}$	Floor live load
$DL_{\text{floor}} := 15 \cdot \text{psf}$	Floor dead load
$DL_{\text{roof}} := 15 \cdot \text{psf}$	Roof dead load
$LL_{\text{roof}} := 20 \cdot \text{psf}$	Roof live load
$SL_{\text{roof}} := 25 \cdot \text{psf}$	Roof snow load
$LL_{\text{deck}} := 60 \cdot \text{psf}$	Deck live load
$DL_{\text{deck}} := 15 \cdot \text{psf}$	Deck dead load

Lateral Load Calculation Parameters (SEISMIC & WIND)

Seismic Force Calculation on Building-ASCE7-16 for Wood Frame Structure

Site Class D was considered for this project according to IBC 1613.3.2

According to USGS Data for the site the seismic parameters are according to the followings

$PGA := 0.598$ Peak Ground Acceleration from USGS site

$S_{DS} := 1.118$ Design short period acceleration

$S_S := 1.398$ Short period spectral

$S_L := 0.487$ Long Period Spectral

$F_a := 1.2$ Table 11.4.1

$F_v := 1.8$ Table 11.4.2

$S_{MS} := F_a \cdot S_S = 1.678$ 11-4-1

$S_{MI} := F_v \cdot S_L = 0.877$ 11-4-2

$S_{DI} := \frac{2}{3} \cdot S_{MI} = 0.584$

$T_s := \frac{S_{DI}}{S_{DS}} \cdot s = 0.523 \text{ s}$

$h_{building} := 18 \cdot \text{ft}$ Height of deck

$$W_{ext} := 0$$

Weight of external walls

$$T_a := 0.02 \cdot \left(\frac{h_{building}}{ft} \right)^{0.75} \cdot s = 0.175 \text{ s}$$

Fundamental period of structure ASCE 7-16-12.8.7

$$T_L := 6 \cdot s$$

Long period Transition ACE 7-16- Fig 22-14

$$R := 6.5$$

Seismic Modification factor for light frame ASCE 7-16- Table 12.2.1

$$I := 1.0$$

Importance factor for residential building

$$\frac{T_a}{1.5 \cdot T_s} = 0.223$$

Ta is less than 1.5Ts. Equation ASCE 716- 12.8.2 should be used

$$C_S := \frac{S_{DS}}{\left(\frac{R}{I} \right)} = 0.172$$

Seismic Response Factor ASCE 7-16-12.8.1.1

$$C_{S,min} := .044 \cdot S_{DS} \cdot I = 0.049$$

Cs is more than minimum-OK

$$C_{S,Design} := \max(C_S, C_{S,min}) = 0.172$$

Force Distribution Along the Height

$$N_{story} := 2$$

Number of story including roof

$$i := 1 \dots N_{story}$$

$$j := 1 \dots N_{story}$$

$$W_1 := (310 \cdot \text{ft}^2) \cdot DL_{deck} = 4.65 \text{ kip}$$

Total dead weight of floor

$$W_2 := (310 \cdot \text{ft}^2) \cdot DL_{roof} = 4.65 \text{ kip}$$

Total dead weight of roof

$$h_{floor_1} := 9 \cdot \text{ft}$$

Height of first floor from ground

$$h_{floor_2} := h_{floor_1} + 9 \cdot \text{ft} = 18 \text{ ft}$$

Height of second floor from ground

$$V_{base_EQ.wall} := C_{S.Design} \cdot \sum_{i=1}^{N_{story}} W_i = 1.6 \text{ kip}$$

Total base shear due to seismic for all building

$$C_{v_i} := \frac{W_i \cdot h_{floor_i}}{\sum_{i=1}^{N_{story}} (W_i \cdot h_{floor_i})}$$

Story force distribution factor-
ASCE7-16-12.8-12

$$C_{v_i} = \begin{bmatrix} 0.333 \\ 0.667 \end{bmatrix}$$

$$F_i := C_{v_i} \cdot V_{base_EQ.wall}$$

Seismic force at each floor

$$F_i = \begin{bmatrix} 0.533 \\ 1.066 \end{bmatrix} \text{ kip}$$

$$V_{story_j} := \sum_{i=j}^{N_{story}} F_i$$

Shear at each floor

$$V_{story_j} = \begin{bmatrix} 1.6 \\ 1.066 \end{bmatrix} \text{ kip}$$

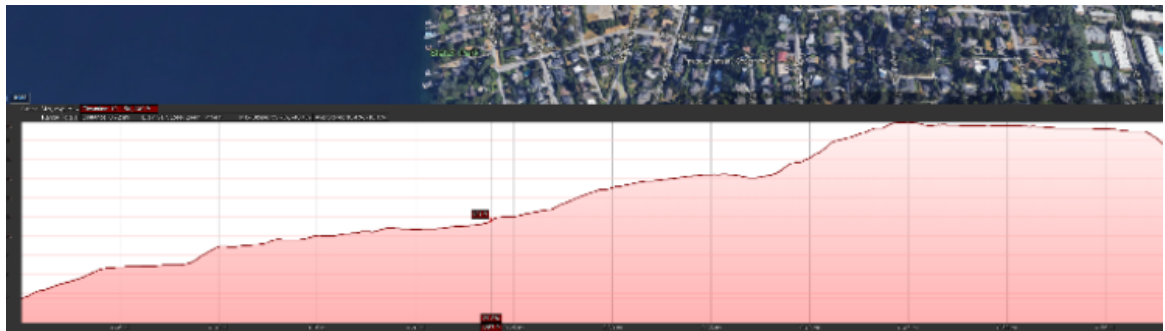
Wind Force Calculation on Building-ASCE7-16

$I := 1$	Risk category II for residential structure	ASCE7-16-Table 1.5.1
$V_{wind} := 110 \cdot \frac{mi}{hr}$	Wind speed	ASCE7-16-Fig 26.5.1B
$K_d := 0.85$	Wind directionality factor for buildings	ASCE7-16-Table 26.6-1

Exposure Category B was considered for this design according to king County

$L_{deck} := 25 \cdot ft$	House foot print dimension
$W_{deck} := 12 \cdot ft$	

Topographic Factor



$H_{zt} := 245 \cdot ft = 245 \text{ ft}$	Height of hill from lowest side
$L_h := 0.25 \cdot mi = (1.32 \cdot 10^3) \text{ ft}$	Distance from hill to location with half of hill height
$K_1 := 1.3 \cdot \frac{H_{zt}}{L_h} = 0.241$	From table 26.8-1 for Exposure B
$x := 0.25 \cdot mi$	Distance from crest to building

$$\mu_{upwind} := 1.5$$

From table 26.8-1

$$\mu_{downwind} := 1.5$$

From table 26.8-1-2D Escapement

$$\gamma := 3$$

2D Ridge

$$K_{2_upwind} := 1 - \frac{x}{L_h \cdot \mu_{upwind}} = 0.333$$

$$K_{2_downwind} := 1 - \frac{x}{L_h \cdot \mu_{downwind}} = 0.333$$

$$K_3 := e^{-\gamma \cdot \frac{h_{building}}{L_h}} = 0.96$$

$$K_{zt,upwind} := (1 + K_1 \cdot K_{2_upwind} \cdot K_3)^2 = 1.16 \quad \text{ASCE7-16- 26.8.2}$$

$$K_{zt,downwind} := (1 + K_1 \cdot K_{2_downwind} \cdot K_3)^2 = 1.16$$

$$K_{zt} := \max(K_{zt,downwind}, K_{zt,upwind}) = 1.16$$

$$K_e := 1.0$$

Ground elevation factor

ASCE7-16-26.9

$$GC_{pi} := 0$$

Internal Pressure Coefficient
for open deck

ASCE7-16-Table 26.13-1

$$K_z := 0.7$$

Velocity pressure exposure
coefficient-Assume 30 ft total
height for exposure B from
ground

ASCE7-16-Table 26.10-1

$$G := 0.85$$

Gust effect factor for other structure. 26.11.1

$$q_z := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot K_e \cdot \left(\frac{V_{wind}}{\frac{mi}{hr}} \right)^2 \cdot \frac{lbf}{ft^2} = 21.386 \text{ psf}$$

$$\theta_{roof} := \text{atan} \left(\frac{1}{12} \right) = 4.764 \text{ deg}$$

Approximate roof angle

$$GC_{r,v} := 1.9$$

Roof top structure and equipment for vertical load-29.4.1

$$GC_{r,h} := 1.5$$

Roof top structure and equipment for horizontal load-29.4.1

$$F_{v,wind} := q_z \cdot GC_{r,v} = 40.634 \text{ psf}$$

Vertical pressure load on roof. Upward or downward

$$F_{h,wind} := q_z \cdot GC_{r,h} = 32.08 \text{ psf}$$

Horizontal pressure load on deck structure

ASD load combination used for frame design :

- D+S
- D+ 0.6W
- D+0.7E
- D+0.75x0.6W+0.75L+0.75S
- D+0.75 x 0.7 E+0.75L+0.75S
- 0.6 D+0.6W
- 0.6D+0.7E

Check Base Posts for Lateral Loads Combined with Gravity

$Species_Type := "DOUGLAS FIR-LARCH"$

Type of lumber

$Classification := "Posts and Timbers"$

Classification of member

$Grade := "NO.2"$

Grade of lumber

$L_{element} := 9 \cdot ft$

Beam length

$b := 6 \cdot in$

Width of member

$d := 6 \cdot in$

Depth of member

$b' := 5.5 \cdot in$

Dressed width

$d' := 5.5 \cdot in = 5.5 \cdot in$

Dressed depth

$I_1 := \frac{1}{12} \cdot b' \cdot d'^3 = 76.255 \cdot in^4$

Moment of Inertia about strong axis

$I_2 := \frac{1}{12} \cdot b^3 \cdot d' = 76.255 \cdot in^4$

Moment of Inertia about weak axis

$S_1 := \frac{b' \cdot d'^2}{6} = 27.729 \cdot in^3$

Section modulus

$S_2 := \frac{b^2 \cdot d'}{6} = 27.729 \cdot in^3$

Section modulus

$F_b := SS(Species_Type, Classification, Grade, b, d)_0 \cdot psi = 750 \cdot psi$

Bending strength
stress

$F_t := SS(Species_Type, Classification, Grade, b, d)_1 \cdot psi = 475 \cdot psi$

Tensile strength stress

$F_v := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_2 \cdot \text{psi} = 170 \text{ psi}$	Shear strength stress
$F_{cp} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_3 \cdot \text{psi} = 625 \text{ psi}$	Compression stress perpendicular to grain
$F_c := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_4 \cdot \text{psi} = 700 \text{ psi}$	Compression stress parallel to grain
$E := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_5 \cdot \text{psi} = (1.3 \cdot 10^6) \text{ psi}$	Modulus of elasticity
$E_{min} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_6 \cdot \text{psi} = (4.7 \cdot 10^5) \text{ psi}$	Minimum module of elasticity
$\gamma_{wood} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_7 \cdot \gamma_w = 31.2 \text{ pcf}$	
$C_D := 1.6$	Load Duration Factor
$C_M := 1.0$	Wet service factor
$C_t := 1.0$	Temperature factor
$C_{Fb}(b, d) = 1$	Bending size factor
$C_{Ft}(b, d) = 1$	Tension size factor
$C_{Fc}(b, d) = 1$	Compression size factor
$C_{fu.1} := 1.0$	Flat use factor
$C_{fu.2} := 1.0$	Flat use factor
$C_i := 0.8$	Insizing factor
$C_r := 1.0$	Repetitive factor

$$C_b := 1.0$$

Bearing area factor

$$C_T := 1.0$$

Buckling stiffness factor

$$c := 0.8$$

Sawn Lumber

$$l_{e.comp.1} := 9 \cdot ft$$

Effective height for
compression

$$l_{e.comp.2} := 9 \cdot ft$$

Effective height
for compression

$$l_{e.Bend.1} := 9 \cdot ft$$

Effective length for bending

$$l_{e.Bend.2} := 9 \cdot ft$$

Effective length for bending

$$d_{r.2} := \min(b', d') = 5.5 \text{ in}$$

Gyration depth

$$d_{r.1} := \max(b', d') = 5.5 \text{ in}$$

Gyration depth

$$E' := E \cdot C_M \cdot C_t \cdot C_i = (1.04 \cdot 10^6) \text{ psi}$$

$$E'_{min} := E_{min} \cdot C_M \cdot C_t \cdot C_i \cdot C_T = (3.76 \cdot 10^5) \text{ psi}$$

$$R_{BE.1} := \sqrt{\frac{l_{e.Bend.1} \cdot d_{r.1}}{d_{r.2}^2}} = 4.431$$

$$R_{BE.2} := \sqrt{\frac{l_{e.Bend.2} \cdot d_{r.2}}{d_{r.1}^2}} = 4.431$$

$$F_{bE.1} := \frac{1.2 \cdot E'_{min}}{R_{BE.1}^2} = (2.298 \cdot 10^4) \text{ psi}$$

$$F_{bE.2} := \frac{1.2 \cdot E'_{min}}{R_{BE.2}^2} = (2.298 \cdot 10^4) \text{ psi}$$

$$F''_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fb}(b, d) \cdot C_i \cdot C_r = 960 \text{ psi}$$

$$C_{L.1} := \frac{1 + \left(\frac{F_{bE.1}}{F''_b}\right)}{1.9} - \sqrt{\left(\frac{1 + \left(\frac{F_{bE.1}}{F''_b}\right)}{1.9}\right)^2 - \frac{F_{bE.1}}{F''_b} \cdot \frac{1}{0.95}} = 0.998 \quad \text{Beam stability factor}$$

$$C_{L.2} := \frac{1 + \left(\frac{F_{bE.2}}{F''_b}\right)}{1.9} - \sqrt{\left(\frac{1 + \left(\frac{F_{bE.2}}{F''_b}\right)}{1.9}\right)^2 - \frac{F_{bE.2}}{F''_b} \cdot \frac{1}{0.95}} = 0.998 \quad \text{Beam stability factor}$$

$$F'_{b.1} := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{L.1} \cdot C_{Fb}(b, d) \cdot C_{fu.1} \cdot C_i \cdot C_r = 957.916 \text{ psi}$$

$$F'_{b.2} := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{L.2} \cdot C_{Fb}(b, d) \cdot C_{fu.2} \cdot C_i \cdot C_r = 957.916 \text{ psi}$$

$$F'_t := F_t \cdot C_D \cdot C_M \cdot C_t \cdot C_{Ft}(b, d) \cdot C_i = 608 \text{ psi}$$

$$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i = 217.6 \text{ psi}$$

$$F'_{cp} := F_{cp} \cdot C_M \cdot C_t \cdot C_i \cdot C_b = 500 \text{ psi}$$

$$F''_c := F_c \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fc}(b, d) \cdot C_i = 896 \text{ psi}$$

$$F_{cE.1} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_{e.comp.1}}{d_{r.1}}\right)^2} = 801.563 \text{ psi}$$

$$F_{cE.2} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_{e.comp.2}}{d_{r.2}}\right)^2} = 801.563 \text{ psi}$$

$$\frac{l_{e.comp.1}}{d_{r.1}} = 19.636$$

$$\frac{l_{e.comp.2}}{d_{r.2}} = 19.636$$

$$\text{if} \left(\max \left(\frac{l_{e.comp.1}}{d_{r.1}}, \frac{l_{e.comp.2}}{d_{r.2}} \right) \leq 50, \text{“OK”}, \text{“NOT GOOD”} \right) = \text{“OK”}$$

less than 50 OK

$$C_{p.1} := \frac{1 + \frac{F_{cE.1}}{F''_c}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE.1}}{F''_c}}{2 \cdot c} \right)^2 - \frac{F_{cE.1}}{F''_c}} = 0.651$$

$$C_{p.2} := \frac{1 + \frac{F_{cE.2}}{F''_c}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE.2}}{F''_c}}{2 \cdot c} \right)^2 - \frac{F_{cE.2}}{F''_c}} = 0.651$$

$$F'_c := F_c \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fc}(b, d) \cdot C_i \cdot \min(C_{p.1}, C_{p.2}) = 583.566 \text{ psi}$$

$$V_{post.wind} := F_{h.wind} \cdot \frac{12 \cdot ft}{2} \cdot (10 \cdot in + 8 \cdot in) \cdot 2 \cdot \frac{2}{6} = 0.192 \text{ kip}$$

Shear load at each base
post due to wind

$$V_{post.EQ} := 0.5 \cdot V_{story_1} \cdot \frac{2}{6} = 0.267 \text{ kip}$$

Shear load at each base post
due to seismic

$$M_{post.wind} := V_{post.wind} \cdot L_{element} = 1.732 \text{ kip} \cdot ft$$

Bending load on post due to wind

$$M_{post.EQ} := V_{post.EQ} \cdot L_{element} = 2.399 \text{ kip} \cdot ft$$

Bending load on post due to wind

$$P_{dead} := 3504 \cdot lbf$$

Dead load at post from ForteWeb

$$P_{wind} := -F_{v.wind} \cdot \frac{310 \cdot ft^2}{2} \cdot \frac{2}{6} = -2.099 \text{ kip}$$

Axial load on post due to vertical wind on roof

$$P_{EQ} := 0 \text{ kip}$$

$$P_{comp} := -P_{dead} + 0.75 \cdot 0.7 \cdot (\min(P_{wind}, P_{EQ})) = -4.606 \text{ kip}$$

Axial load at member

$$P_{ten} := -P_{dead} + 0.75 \cdot 0.7 \cdot (0.5 \cdot V_{story_1}) \cdot \frac{L_{element}}{25 \cdot ft} = -1.491 \cdot 10^4 \text{ N}$$

$$M_I := 0 \text{ kip} \cdot ft$$

Bending moment about major axis

$$M_2 := 0.75 \cdot 0.7 \cdot \max(M_{post.EQ}, M_{post.wind}) = 1.26 \text{ kip} \cdot \text{ft}$$

Bending moment about minor axis

$$V_1 := 0 \cdot \text{kip}$$

Shear for major bending

$$V_2 := 0.7 \cdot 0.75 \cdot (\max(V_{post.wind}, V_{post.EQ})) = 0.14 \text{ kip}$$

Shear for minor bending

$$f_c := \frac{|\min(0, P_{comp})|}{(b' \cdot d')}$$

$$f_c = 152.271 \text{ psi}$$

Maximum compression stress

$$f_{b,1} := \frac{M_1}{S_1} = 0 \text{ ksi}$$

$$f_{b,1} = 0 \text{ psi}$$

Maximum bending stress

$$f_{b,2} := \frac{M_2}{S_2} = (3.759 \cdot 10^6) \text{ Pa}$$

$$f_{b,2} = 545.138 \text{ psi}$$

Maximum bending stress

$$f_t := \frac{\max(0, P_{ten})}{(b' \cdot d')} = 0 \text{ Pa}$$

$$f_t = 0 \text{ psi}$$

Maximum tension stress

$$f_v := \frac{3 \cdot (\sqrt{V_1^2 + V_2^2})}{2 \cdot b' \cdot d'} = 6.94 \text{ psi}$$

Shear stress

$$\left(\frac{f_c}{F'_c}\right)^2 + \frac{f_{b.1}}{F'_{b.1} \cdot \left(1 - \frac{f_c}{F_{cE.1}}\right)} + \frac{f_{b.2}}{F'_{b.2} \cdot \left(1 - \left(\frac{f_c}{F_{cE.2}}\right) - \left(\frac{f_{b.1}}{F_{bE.1}}\right)^2\right)} = 77.06 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_c}{F_{cE.2}} + \left(\frac{f_{b.1}}{F_{bE.1}}\right)^2 = 19 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_t}{F'_t} + \left(\frac{f_{b.1}}{F'_{b.1}}\right) + \left(\frac{f_{b.2}}{F'_{b.2}}\right) = 56.91 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_v}{F'_v} = 3.19 \text{ 1\%}$$

Less than 1.0-OK

Check Top Posts for Lateral Loads Combined with Gravity

$Species_Type := "DOUGLAS\ FIR-LARCH"$	Type of lumber
$Classification := "Posts\ and\ Timbers"$	Classification of member
$Grade := "NO.2"$	Grade of lumber
$L_{element} := 9 \cdot ft$	Beam length
$b := 4 \cdot in$	Width of member
$d := 4 \cdot in$	Depth of member
$b' := 3.5 \cdot in$	Dressed width
$d' := 5.5 \cdot in = 5.5 \ in$	Dressed depth
$I_j := \frac{1}{12} \cdot b' \cdot d'^3 = 48.526 \ in^4$	Moment of Inertia about strong axis
$I_2 := \frac{1}{12} \cdot b^3 \cdot d' = 19.651 \ in^4$	Moment of Inertia about weak axis
$S_j := \frac{b' \cdot d'^2}{6} = 17.646 \ in^3$	Section modulus
$S_2 := \frac{b^2 \cdot d'}{6} = 11.229 \ in^3$	Section modulus
$F_b := SS(Species_Type, Classification, Grade, b, d) \cdot psi = 900 \ psi$	Bending strength stress

$F_t := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_1 \cdot \text{psi} = 575 \text{ psi}$	Tensile strength stress
$F_v := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_2 \cdot \text{psi} = 180 \text{ psi}$	Shear strength stress
$F_{cp} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_3 \cdot \text{psi} = 625 \text{ psi}$	Compression stress perpendicular to grain
$F_c := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_4 \cdot \text{psi} = (1.35 \cdot 10^3) \text{ psi}$	Compression stress parallel to grain
$E := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_5 \cdot \text{psi} = (1.6 \cdot 10^6) \text{ psi}$	Modulus of elasticity
$E_{min} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_6 \cdot \text{psi} = (5.8 \cdot 10^5) \text{ psi}$	Minimum module of elasticity
$\gamma_{wood} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_7 \cdot \gamma_w = 31.2 \text{ pcf}$	
$C_D := 1.6$	Load Duration Factor
$C_M := 1.0$	Wet service factor
$C_t := 1.0$	Temperature factor
$C_{Fb}(b, d) = 1.5$	Bending size factor
$C_{Ft}(b, d) = 1.5$	Tension size factor
$C_{Fc}(b, d) = 1.15$	Compression size factor
$C_{fu.1} := 1.0$	Flat use factor
$C_{fu.2} := 1.0$	Flat use factor

$$C_i := 0.8$$

Insizing factor

$$C_r := 1.0$$

Repetitive factor

$$C_b := 1.0$$

Bearing area factor

$$C_T := 1.0$$

Buckling stiffness factor

$$C := 0.8$$

Sawn Lumber

$$l_{e.comp.1} := 9 \cdot ft$$

Effective height for
compression

$$l_{e.comp.2} := 9 \cdot ft$$

Effective height
for compression

$$l_{e.Bend.1} := 9 \cdot ft$$

Effective length for bending

$$l_{e.Bend.2} := 9 \cdot ft$$

Effective length for bending

$$d_{r.2} := \min(b', d') = 3.5 \text{ in}$$

Gyration depth

$$d_{r.1} := \max(b', d') = 5.5 \text{ in}$$

Gyration depth

$$E := E \cdot C_M \cdot C_t \cdot C_i = (1.28 \cdot 10^6) \text{ psi}$$

$$E'_{min} := E_{min} \cdot C_M \cdot C_t \cdot C_i \cdot C_T = (4.64 \cdot 10^5) \text{ psi}$$

$$R_{BE.1} := \sqrt{\frac{l_{e.Bend.1} \cdot d_{r.1}}{d_{r.2}^2}} = 6.963$$

$$R_{BE.2} := \sqrt{\frac{l_{e.Bend.2} \cdot d_{r.2}}{d_{r.1}^2}} = 3.535$$

$$F_{bE.1} := \frac{1.2 \cdot E'_{min}}{R_{BE.1}^2} = (1.148 \cdot 10^4) \text{ psi}$$

$$F_{bE.2} := \frac{1.2 \cdot E'_{min}}{R_{BE.2}^2} = (4.456 \cdot 10^4) \text{ psi}$$

$$F''_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fb}(b, d) \cdot C_i \cdot C_r = (1.728 \cdot 10^3) \text{ psi}$$

$$C_{L.1} := \frac{1 + \left(\frac{F_{bE.1}}{F''_b}\right)}{1.9} - \sqrt{\left(\frac{1 + \left(\frac{F_{bE.1}}{F''_b}\right)}{1.9}\right)^2 - \frac{F_{bE.1}}{F''_b}} = 0.991 \quad \text{Beam stability factor}$$

$$C_{L.2} := \frac{1 + \left(\frac{F_{bE.2}}{F''_b}\right)}{1.9} - \sqrt{\left(\frac{1 + \left(\frac{F_{bE.2}}{F''_b}\right)}{1.9}\right)^2 - \frac{F_{bE.2}}{F''_b}} = 0.998 \quad \text{Beam stability factor}$$

$$F'_{b.1} := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{L.1} \cdot C_{Fb}(b, d) \cdot C_{fu.1} \cdot C_i \cdot C_r = (1.713 \cdot 10^3) \text{ psi}$$

$$F'_{b.2} := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{L.2} \cdot C_{Fb}(b, d) \cdot C_{fu.2} \cdot C_i \cdot C_r = (1.725 \cdot 10^3) \text{ psi}$$

$$F'_i := F_i \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fi}(b, d) \cdot C_i = (1.104 \cdot 10^3) \text{ psi}$$

$$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i = 230.4 \text{ psi}$$

$$F'_{cp} := F_{cp} \cdot C_M \cdot C_t \cdot C_i \cdot C_b = 500 \text{ psi}$$

$$F''_c := F_c \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fc}(b, d) \cdot C_i = (1.987 \cdot 10^3) \text{ psi}$$

$$F_{cE.1} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_{e.comp.1}}{d_{r.1}}\right)^2} = 989.163 \text{ psi}$$

$$F_{cE.2} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_{e.comp.2}}{d_{r.2}}\right)^2} = 400.57 \text{ psi}$$

$$\frac{l_{e.comp.1}}{d_{r.1}} = 19.636$$

$$\frac{l_{e.comp.2}}{d_{r.2}} = 30.857$$

$$\text{if} \left(\max \left(\frac{l_{e.comp.1}}{d_{r.1}}, \frac{l_{e.comp.2}}{d_{r.2}} \right) \leq 50, \text{“OK”}, \text{“NOT GOOD”} \right) = \text{“OK”}$$

less than 50 OK

$$C_{p.1} := \frac{1 + \frac{F_{cE.1}}{F''_c}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE.1}}{F''_c}}{2 \cdot c} \right)^2 - \frac{F_{cE.1}}{F''_c}} = 0.432$$

$$C_{p,2} := \frac{1 + \frac{F_{cE,2}}{F''_c}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE,2}}{F''_c}}{2 \cdot c}\right)^2 - \frac{F_{cE,2}}{c}} = 0.192$$

$$F'_d := F_c \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fc}(b, d) \cdot C_i \cdot \min(C_{p,1}, C_{p,2}) = 382.351 \text{ psi}$$

$$V_{post.wind} := F_{h.wind} \cdot \frac{12 \cdot f}{2} \cdot (8 \cdot in) \cdot 2 \cdot \frac{2}{6} = 0.086 \text{ kip} \quad \text{Shear load at each base post due to wind}$$

$$V_{post.EQ} := 0.5 \cdot V_{story_2} \cdot \frac{2}{6} = 0.178 \text{ kip} \quad \text{Shear load at each base post due to seismic}$$

$$M_{post.wind} := V_{post.wind} \cdot L_{element} = 0.77 \text{ kip} \cdot f \quad \text{Bending load on post due to wind}$$

$$M_{post.EQ} := V_{post.EQ} \cdot L_{element} = 1.6 \text{ kip} \cdot f \quad \text{Bending load on post due to wind}$$

$$P_{dead} := 1000 \cdot lb \cdot f \quad \text{Dead load at post from ForteWeb}$$

$$P_{wind} := -F_{v.wind} \cdot \frac{310 \cdot f^2}{2} \cdot \frac{2}{6} = -2.099 \text{ kip} \quad \text{Axial load on post due to vertical wind on roof}$$

$$P_{EQ} := 0 \text{ kip}$$

$$P_{comp} := -P_{dead} + 0.75 \cdot 0.7 \cdot (\min(P_{wind}, P_{EQ})) = -2.102 \text{ kip} \quad \text{Axial load at member}$$

$$P_{ten} := -P_{dead} + 0.75 \cdot 0.7 \cdot (0.5 \cdot V_{story_2}) \cdot \frac{L_{element}}{25 \cdot ft} = -0.899 \text{ kip}$$

$$M_1 := 0 \text{ kip} \cdot ft$$

Bending moment about major axis

$$M_2 := 0.75 \cdot 0.7 \cdot \max(M_{post.EQ}, M_{post.wind}) = 0.84 \text{ kip} \cdot ft$$

Bending moment about minor axis

$$V_1 := 0 \cdot kip$$

Shear for major bending

$$V_2 := 0.7 \cdot 0.75 \cdot (\max(V_{post.wind}, V_{post.EQ})) = 0.093 \text{ kip}$$

Shear for minor bending

$$f_c := \frac{|\min(0, P_{comp})|}{(b' \cdot d')}$$

$$f_c = 109.205 \text{ psi}$$

Maximum compression stress

$$f_{b,1} := \frac{M_1}{S_1} = 0 \text{ ksi}$$

$$f_{b,1} = 0 \text{ psi}$$

Maximum bending stress

$$f_{b,2} := \frac{M_2}{S_2} = (6.188 \cdot 10^6) \text{ Pa}$$

$$f_{b,2} = 897.438 \text{ psi}$$

Maximum bending stress

$$f_t := \frac{\max(0, P_{ten})}{(b' \cdot d')} = 0 \text{ Pa}$$

$$f_t = 0 \text{ psi}$$

Maximum tension stress

$$f_v := \frac{3 \cdot (\sqrt{V_1^2 + V_2^2})}{2 \cdot b' \cdot d'} = 7.271 \text{ psi}$$

Shear stress

$$\left(\frac{f_c}{F'_c}\right)^2 + \frac{f_{b.1}}{F'_{b.1} \cdot \left(1 - \frac{f_c}{F_{cE.1}}\right)} + \frac{f_{b.2}}{F'_{b.2} \cdot \left(1 - \left(\frac{f_c}{F_{cE.2}}\right) - \left(\frac{f_{b.1}}{F_{bE.1}}\right)^2\right)} = 79.7 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_c}{F_{cE.2}} + \left(\frac{f_{b.1}}{F_{bE.1}}\right)^2 = 27.26 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_t}{F'_t} + \left(\frac{f_{b.1}}{F'_{b.1}}\right) + \left(\frac{f_{b.2}}{F'_{b.2}}\right) = 52.04 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_v}{F'_v} = 3.16 \text{ 1\%}$$

Less than 1.0-OK

Check Base Beam for Lateral Loads Combined with Gravity

$Species_Type := "DOUGLAS\ FIR-LARCH"$

Type of lumber

$Classification := "Posts\ and\ Timbers"$

Classification of member

$Grade := "NO.2"$

Grade of lumber

$L_{element} := 8 \cdot ft + 5 \cdot in$

Beam length

$b := 6 \cdot in$

Width of member

$d := 12 \cdot in$

Depth of member

$b' := 5.5 \cdot in$

Dressed width

$d' := 11.5 \cdot in = ? \cdot in$

Dressed depth

$I_y := \frac{1}{12} \cdot b' \cdot d'^3 = 697.068 \cdot in^4$

Moment of Inertia about strong axis

$I_z := \frac{1}{12} \cdot b^3 \cdot d' = 159.443 \cdot in^4$

Moment of Inertia about weak axis

$S_y := \frac{b' \cdot d'^2}{6} = 121.229 \cdot in^3$

Section modulus

$S_z := \frac{b^2 \cdot d'}{6} = 57.979 \cdot in^3$

Section modulus

$F_b := SS(Species_Type, Classification, Grade, b, d)_0 \cdot psi = 750 \cdot psi$

Bending strength
stress

$F_t := SS(Species_Type, Classification, Grade, b, d)_1 \cdot psi = 475 \cdot psi$

Tensile strength stress

$$F_v := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_2 \cdot \text{psi} = 170 \text{ psi}$$

Shear strength stress

$$F_{cp} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_3 \cdot \text{psi} = 625 \text{ psi}$$

Compression stress perpendicular to grain

$$F_c := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_4 \cdot \text{psi} = 700 \text{ psi}$$

Compression stress parallel to grain

$$E := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_5 \cdot \text{psi} = (1.3 \cdot 10^6) \text{ psi}$$

Modulus of elasticity

$$E_{min} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_6 \cdot \text{psi} = (4.7 \cdot 10^5) \text{ psi}$$

Minimum module of elasticity

$$\gamma_{wood} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_7 \cdot \gamma_w = 31.2 \text{ pcf}$$

$$C_D := 1.6$$

Load Duration Factor

$$C_M := 1.0$$

Wet service factor

$$C_t := 1.0$$

Temperature factor

$$C_{Fb}(b, d) = 1$$

Bending size factor

$$C_{Ft}(b, d) = 1$$

Tension size factor

$$C_{Fc}(b, d) = 1$$

Compression size factor

$$C_{fu.1} := 1.0$$

Flat use factor

$$C_{fu.2} := 1.0$$

Flat use factor

$$C_i := 0.8$$

Insizing factor

$$C_r := 1.0$$

Repetitive factor

$$C_b := 1.0$$

Bearing area factor

$$C_T := 1.0$$

Buckling stiffness factor

$$C := 0.8$$

Sawn Lumber

$$l_{e.comp.1} := 9 \cdot ft$$

Effective height for
compression

$$l_{e.comp.2} := 16 \cdot in$$

Effective height
for compression

$$l_{e.Bend.1} := 9 \cdot ft$$

Effective length for bending

$$l_{e.Bend.2} := 16 \cdot in$$

Effective length for bending

$$d_{r.2} := \min(b', d') = 5.5 \text{ in}$$

Gyration depth

$$d_{r.1} := \max(b', d') = 11.5 \text{ in}$$

Gyration depth

$$E := E \cdot C_M \cdot C_t \cdot C_i = (1.04 \cdot 10^6) \text{ psi}$$

$$E'_{min} := E_{min} \cdot C_M \cdot C_t \cdot C_i \cdot C_T = (3.76 \cdot 10^5) \text{ psi}$$

$$R_{BE.1} := \sqrt{\frac{l_{e.Bend.1} \cdot d_{r.1}}{d_{r.2}^2}} = 6.408$$

$$R_{BE.2} := \sqrt{\frac{l_{e.Bend.2} \cdot d_{r.2}}{d_{r.1}^2}} = 0.816$$

$$F_{bE.1} := \frac{1.2 \cdot E'_{min}}{R_{BE.1}^2} = (1.099 \cdot 10^4) \text{ psi}$$

$$F_{bE.2} := \frac{1.2 \cdot E'_{min}}{R_{BE.2}^2} = (6.781 \cdot 10^5) \text{ psi}$$

$$F''_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fb}(b, d) \cdot C_i \cdot C_r = 960 \text{ psi}$$

$$C_{L.1} := \frac{1 + \left(\frac{F_{bE.1}}{F''_b}\right)}{1.9} - \sqrt{\left(\frac{1 + \left(\frac{F_{bE.1}}{F''_b}\right)}{1.9}\right)^2 - \frac{F_{bE.1}}{F''_b}} = 0.995 \quad \text{Beam stability factor}$$

$$C_{L.2} := \frac{1 + \left(\frac{F_{bE.2}}{F''_b}\right)}{1.9} - \sqrt{\left(\frac{1 + \left(\frac{F_{bE.2}}{F''_b}\right)}{1.9}\right)^2 - \frac{F_{bE.2}}{F''_b}} = 1 \quad \text{Beam stability factor}$$

$$F'_{b.1} := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{L.1} \cdot C_{Fb}(b, d) \cdot C_{fu.1} \cdot C_i \cdot C_r = 955.451 \text{ psi}$$

$$F'_{b.2} := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{L.2} \cdot C_{Fb}(b, d) \cdot C_{fu.2} \cdot C_i \cdot C_r = 959.932 \text{ psi}$$

$$F'_f := F_t \cdot C_D \cdot C_M \cdot C_t \cdot C_{Ft}(b, d) \cdot C_i = 608 \text{ psi}$$

$$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i = 217.6 \text{ psi}$$

$$F'_{cp} := F_{cp} \cdot C_M \cdot C_t \cdot C_i \cdot C_b = 500 \text{ psi}$$

$$F''_c := F_c \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fc}(b, d) \cdot C_i = 896 \text{ psi}$$

$$F_{cE.1} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_{e.comp.1}}{d_{r.1}}\right)^2} = (3.504 \cdot 10^3) \text{ psi}$$

$$F_{cE.2} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_{e.comp.2}}{d_{r.2}}\right)^2} = (3.652 \cdot 10^4) \text{ psi}$$

$$\frac{l_{e.comp.1}}{d_{r.1}} = 9.391$$

$$\frac{l_{e.comp.2}}{d_{r.2}} = 2.909$$

$$\text{if} \left(\max \left(\frac{l_{e.comp.1}}{d_{r.1}}, \frac{l_{e.comp.2}}{d_{r.2}} \right) \leq 50, \text{“OK”}, \text{“NOT GOOD”} \right) = \text{“OK”} \quad \text{less than 50 OK}$$

$$C_{p.1} := \frac{1 + \frac{F_{cE.1}}{F''_c}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE.1}}{F''_c}}{2 \cdot c} \right)^2 - \frac{F_{cE.1}}{c}} = 0.94$$

$$C_{p.2} := \frac{1 + \frac{F_{cE.2}}{F''_c}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE.2}}{F''_c}}{2 \cdot c} \right)^2 - \frac{F_{cE.2}}{c}} = 0.995$$

$$F'_d := F_c \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fc}(b, d) \cdot C_i \cdot \min(C_{p.1}, C_{p.2}) = 842.647 \text{ psi}$$

$$V_{post.wind} := F_{h.wind} \cdot \frac{12 \cdot ft}{2} \cdot (10 \cdot in + 8 \cdot in) \cdot 2 \cdot \frac{2}{6} = 0.192 \text{ kip}$$

Shear load at each
base post due to
wind

$$V_{post.EQ} := 0.5 \cdot V_{story_1} \cdot \frac{2}{6} = 0.267 \text{ kip}$$

Shear load at each base
post due to seismic

$$M_{post.wind} := V_{post.wind} \cdot 9 \cdot ft = 1.732 \text{ kip} \cdot ft$$

Bending load on post due to wind

$$M_{post.EQ} := V_{post.EQ} \cdot 9 \cdot ft = 2.399 \text{ kip} \cdot ft$$

Bending load on post due to wind

$$P_{dead} := 0 \text{ kip}$$

Dead load axial at post from ForteWeb

$$V_{dead} := 620 \cdot lbf$$

Dead load shear on beam from ForteWeb

$$M_{dead} := 1000 \cdot lbf \cdot ft$$

Dead load bending in beam

$$P_{wind} := 0 \text{ kip}$$

Axial load on post due to vertical wind on roof

$$P_{EQ} := 0 \text{ kip}$$

$$P_{comp} := -P_{dead} + 0.75 \cdot 0.7 \cdot (\min(P_{wind}, P_{EQ})) = 0 \text{ N}$$

Axial load at member

$$P_{ten} := 0 \text{ kip} = 0 \text{ N}$$

$$M_j := M_{dead} + \frac{0.7 \cdot 0.75 \cdot \max(M_{post.wind}, M_{post.EQ})}{2} = 1.63 \text{ kip} \cdot ft$$

Bending moment about major axis

$$M_2 := 0 \text{ kip} \cdot \text{ft} = 0 \text{ kip} \cdot \text{ft}$$

Bending moment about minor axis

$$V_1 := V_{dead} + \frac{0.7 \cdot 0.75 \cdot \max(M_{post.wind}, M_{post.EQ}) \cdot 2}{L_{element}} = 0.919 \text{ kip}$$

Shear for major bending

$$V_2 := 0 \text{ kip} = 0 \text{ kip}$$

Shear for minor bending

$$f_c := \frac{|\min(0, P_{comp})|}{(b' \cdot d')}$$

$$f_c = 0 \text{ psi}$$

Maximum compression stress

$$f_{b,1} := \frac{M_1}{S_1} = 0.161 \text{ ksi}$$

$$f_{b,1} = 161.332 \text{ psi}$$

Maximum bending stress

$$f_{b,2} := \frac{M_2}{S_2} = 0 \text{ Pa}$$

$$f_{b,2} = 0 \text{ psi}$$

Maximum bending stress

$$f_t := \frac{\max(0, P_{ten})}{(b' \cdot d')} = 0 \text{ Pa}$$

$$f_t = 0 \text{ psi}$$

Maximum tension stress

$$f_v := \frac{3 \cdot (\sqrt{V_1^2 + V_2^2})}{2 \cdot b' \cdot d'} = 21.802 \text{ psi}$$

Shear stress

$$\left(\frac{f_c}{F'_c}\right)^2 + \frac{f_{b.1}}{F'_{b.1} \cdot \left(1 - \frac{f_c}{F_{cE.1}}\right)} + \frac{f_{b.2}}{F'_{b.2} \cdot \left(1 - \left(\frac{f_c}{F_{cE.2}}\right) - \left(\frac{f_{b.1}}{F_{bE.1}}\right)^2\right)} = 16.89 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_c}{F_{cE.2}} + \left(\frac{f_{b.1}}{F_{bE.1}}\right)^2 = 0.02 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_t}{F'_t} + \left(\frac{f_{b.1}}{F'_{b.1}}\right) + \left(\frac{f_{b.2}}{F'_{b.2}}\right) = 16.89 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_v}{F'_v} = 10.02 \text{ 1\%}$$

Less than 1.0-OK

Check Roof Beam for Lateral Loads Combined with Gravity

$Species_Type := \text{"DOUGLAS FIR-LARCH"}$	Type of lumber
$Classification := \text{"Posts and Timbers"}$	Classification of member
$Grade := \text{"NO.2"}$	Grade of lumber
$L_{element} := 8 \cdot ft + 5 \cdot in$	Beam length
$b := 4 \cdot in$	Width of member
$d := 8 \cdot in$	Depth of member
$b' := 3.5 \cdot in$	Dressed width
$d' := 7.25 \cdot in = ? \cdot in$	Dressed depth
$I_J := \frac{1}{12} \cdot b' \cdot d'^3 = 111.148 \cdot in^4$	Moment of Inertia about strong axis
$I_2 := \frac{1}{12} \cdot b^3 \cdot d' = 25.904 \cdot in^4$	Moment of Inertia about weak axis
$S_J := \frac{b' \cdot d'^2}{6} = 30.661 \cdot in^3$	Section modulus
$S_2 := \frac{b^2 \cdot d'}{6} = 14.802 \cdot in^3$	Section modulus
$F_b := SS(Species_Type, Classification, Grade, b, d) \cdot psi = 900 \cdot psi$	Bending strength stress

$$F_t := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_1 \cdot \text{psi} = 575 \text{ psi} \quad \text{Tensile strength stress}$$

$$F_v := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_2 \cdot \text{psi} = 180 \text{ psi} \quad \text{Shear strength stress}$$

$$F_{cp} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_3 \cdot \text{psi} = 625 \text{ psi} \quad \text{Compression stress perpendicular to grain}$$

$$F_c := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_4 \cdot \text{psi} = (1.35 \cdot 10^3) \text{ psi} \quad \text{Compression stress parallel to grain}$$

$$E := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_5 \cdot \text{psi} = (1.6 \cdot 10^6) \text{ psi} \quad \text{Modulus of elasticity}$$

$$E_{min} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_6 \cdot \text{psi} = (5.8 \cdot 10^5) \text{ psi} \quad \text{Minimum module of elasticity}$$

$$\gamma_{wood} := SS(\text{Species_Type}, \text{Classification}, \text{Grade}, b, d)_7 \cdot \gamma_w = 31.2 \text{ pcf}$$

$$C_D := 1.6 \quad \text{Load Duration Factor}$$

$$C_M := 1.0 \quad \text{Wet service factor}$$

$$C_t := 1.0 \quad \text{Temperature factor}$$

$$C_{Fb}(b, d) = 1.3 \quad \text{Bending size factor}$$

$$C_{Ft}(b, d) = 1.2 \quad \text{Tension size factor}$$

$$C_{Fc}(b, d) = 1.05 \quad \text{Compression size factor}$$

$$C_{fu.1} := 1.0 \quad \text{Flat use factor}$$

$$C_{fu.2} := 1.0 \quad \text{Flat use factor}$$

$$C_i := 0.8$$

Insizing factor

$$C_r := 1.0$$

Repetitive factor

$$C_b := 1.0$$

Bearing area factor

$$C_T := 1.0$$

Buckling stiffness factor

$$c := 0.8$$

Sawn Lumber

$$l_{e.comp.1} := 9 \cdot ft$$

Effective height for
compression

$$l_{e.comp.2} := 16 \cdot in$$

Effective height
for compression

$$l_{e.Bend.1} := 9 \cdot ft$$

Effective length for bending

$$l_{e.Bend.2} := 16 \cdot in$$

Effective length for bending

$$d_{r.2} := \min(b', d') = 3.5 \text{ in}$$

Gyration depth

$$d_{r.1} := \max(b', d') = 7.25 \text{ in}$$

Gyration depth

$$E := E \cdot C_M \cdot C_t \cdot C_i = (1.28 \cdot 10^6) \text{ psi}$$

$$E'_{min} := E_{min} \cdot C_M \cdot C_t \cdot C_i \cdot C_T = (4.64 \cdot 10^5) \text{ psi}$$

$$R_{BEJ} := \sqrt{\frac{l_{e.Bend.1} \cdot d_{r.1}}{d_{r.2}^2}} = 7.995$$

$$R_{BE.2} := \sqrt{\frac{l_{e.Bend.2} \cdot d_{r.2}}{d_{r.1}^2}} = 1.032$$

$$F_{bE.1} := \frac{1.2 \cdot E'_{min}}{R_{BE.1}^2} = (8.711 \cdot 10^3) \text{ psi}$$

$$F_{bE.2} := \frac{1.2 \cdot E'_{min}}{R_{BE.2}^2} = (5.226 \cdot 10^5) \text{ psi}$$

$$F''_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fb}(b, d) \cdot C_i \cdot C_r = (1.498 \cdot 10^3) \text{ psi}$$

$$C_{L.1} := \frac{1 + \left(\frac{F_{bE.1}}{F''_b}\right)}{1.9} - \sqrt{\left(\frac{1 + \left(\frac{F_{bE.1}}{F''_b}\right)}{1.9}\right)^2 - \frac{F_{bE.1}}{F''_b}} = 0.99$$

Beam stability factor

$$C_{L.2} := \frac{1 + \left(\frac{F_{bE.2}}{F''_b}\right)}{1.9} - \sqrt{\left(\frac{1 + \left(\frac{F_{bE.2}}{F''_b}\right)}{1.9}\right)^2 - \frac{F_{bE.2}}{F''_b}} = 1$$

Beam stability factor

$$F'_{b.1} := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{L.1} \cdot C_{Fb}(b, d) \cdot C_{fu.1} \cdot C_i \cdot C_r = (1.482 \cdot 10^3) \text{ psi}$$

$$F'_{b.2} := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_{L.2} \cdot C_{Fb}(b, d) \cdot C_{fu.2} \cdot C_i \cdot C_r = (1.497 \cdot 10^3) \text{ psi}$$

$$F'_f := F_t \cdot C_D \cdot C_M \cdot C_t \cdot C_{Ft}(b, d) \cdot C_i = 883.2 \text{ psi}$$

$$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i = 230.4 \text{ psi}$$

$$F'_{cp} := F_{cp} \cdot C_M \cdot C_t \cdot C_i \cdot C_b = 500 \text{ psi}$$

$$F''_c := F_c \cdot C_D \cdot C_M \cdot C_t \cdot C_{Fc}(b, d) \cdot C_i = (1.814 \cdot 10^3) \text{ psi}$$

$$F_{cE.1} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_{e.comp.1}}{d_{r.1}}\right)^2} = (1.719 \cdot 10^3) \text{ psi}$$

$$F_{cE.2} := \frac{0.822 \cdot E'_{min}}{\left(\frac{l_{e.comp.2}}{d_{r.2}}\right)^2} = (1.825 \cdot 10^4) \text{ psi}$$

$$\frac{l_{e.comp.1}}{d_{r.1}} = 14.897$$

$$\frac{l_{e.comp.2}}{d_{r.2}} = 4.571$$

$$\text{if} \left(\max \left(\frac{l_{e.comp.1}}{d_{r.1}}, \frac{l_{e.comp.2}}{d_{r.2}} \right) \leq 50, \text{“OK”}, \text{“NOT GOOD”} \right) = \text{“OK”} \quad \text{less than 50 OK}$$

$$C_{p.1} := \frac{1 + \frac{F_{cE.1}}{F''_c}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE.1}}{F''_c}}{2 \cdot c} \right)^2 - \frac{F_{cE.1}}{c}} = 0.672$$

$$C_{p.2} := \frac{1 + \frac{F_{cE.2}}{F''_c}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE.2}}{F''_c}}{2 \cdot c} \right)^2 - \frac{F_{cE.2}}{c}} = 0.979$$

$$F'_d := F_c \cdot C_D \cdot C_M \cdot C_i \cdot C_{Fc}(b, d) \cdot C_i \cdot \min(C_{p,1}, C_{p,2}) = (1.219 \cdot 10^3) \text{ psi}$$

$$V_{post.wind} := F_{h.wind} \cdot \frac{12 \cdot f}{2} \cdot (8 \cdot in) \cdot 2 \cdot \frac{2}{6} = 0.086 \text{ kip}$$

Shear load at each base post
due to wind

$$V_{post.EQ} := 0.5 \cdot V_{story_2} \cdot \frac{2}{6} = 0.178 \text{ kip}$$

Shear load at each base post
due to seismic

$$M_{post.wind} := V_{post.wind} \cdot 9 \cdot f = 0.77 \text{ kip} \cdot f$$

Bending load on post due to wind

$$M_{post.EQ} := V_{post.EQ} \cdot 9 \cdot f = 1.6 \text{ kip} \cdot f$$

Bending load on post due to wind

$$P_{dead} := 0 \text{ kip}$$

Dead load axial at post from ForteWeb

$$V_{dead} := 500 \cdot lb \cdot f$$

Dead load shear on beam from ForteWeb

$$M_{dead} := 1000 \cdot lb \cdot f \cdot f$$

Dead load bending in beam

$$P_{wind} := 0 \text{ kip}$$

Axial load on post due to vertical wind on roof

$$P_{EQ} := 0 \text{ kip}$$

$$P_{comp} := -P_{dead} + 0.75 \cdot 0.7 \cdot (\min(P_{wind}, P_{EQ})) = 0 \text{ N}$$

Axial load at member

$$P_{ten} := 0 \text{ kip} = 0 \text{ N}$$

$$M_1 := M_{dead} + \frac{0.7 \cdot 0.75 \cdot \max(M_{post.wind}, M_{post.EQ})}{2} = 1.42 \text{ kip} \cdot \text{ft}$$

Bending moment about major axis

$$M_2 := 0 \text{ kip} \cdot \text{ft} = 0 \text{ kip} \cdot \text{ft}$$

Bending moment about minor axis

$$V_1 := V_{dead} + \frac{0.7 \cdot 0.75 \cdot \max(M_{post.wind}, M_{post.EQ}) \cdot 2}{L_{element}} = 0.7 \text{ kip}$$

Shear for major bending

Shear for minor bending

$$V_2 := 0 \text{ kip} = 0 \text{ kip}$$

$$f_c := \frac{|\min(0, P_{comp})|}{(b' \cdot d')}$$

$$f_c = 0 \text{ psi}$$

Maximum compression stress

$$f_{b,1} := \frac{M_1}{S_1} = 0.556 \text{ ksi}$$

$$f_{b,1} = 555.705 \text{ psi}$$

Maximum bending stress

$$f_{b,2} := \frac{M_2}{S_2} = 0 \text{ Pa}$$

$$f_{b,2} = 0 \text{ psi}$$

Maximum bending stress

$$f_t := \frac{\max(0, P_{ten})}{(b' \cdot d')} = 0 \text{ Pa}$$

$$f_t = 0 \text{ psi}$$

Maximum tension stress

$$f_v := \frac{3 \cdot (\sqrt{V_1^2 + V_2^2})}{2 \cdot b' \cdot d'} = 41.353 \text{ psi}$$

Shear stress

$$\left(\frac{f_c}{F'_c}\right)^2 + \frac{f_{b,1}}{F'_{b,1} \cdot \left(1 - \frac{f_c}{F_{cE,1}}\right)} + \frac{f_{b,2}}{F'_{b,2} \cdot \left(1 - \left(\frac{f_c}{F_{cE,2}}\right) - \left(\frac{f_{b,1}}{F_{bE,1}}\right)^2\right)} = 37.49 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_c}{F_{cE,2}} + \left(\frac{f_{b,1}}{F_{bE,1}}\right)^2 = 0.41 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_t}{F'_t} + \left(\frac{f_{b,1}}{F'_{b,1}}\right) + \left(\frac{f_{b,2}}{F'_{b,2}}\right) = 37.49 \text{ 1\%}$$

Less than 1.0- OK

$$\frac{f_v}{F'_v} = 17.95 \text{ 1\%}$$

Less than 1.0-OK

Design of Deck footing under 6x6 Posts

$$F_f := 8227 \cdot \text{lb}f \quad \text{Load from FortWeb}$$

$$W_{found} := 2.5 \cdot \text{ft} \quad \text{Foundation size}$$

$$D_{found} := 2.5 \cdot \text{ft}$$

$$d_f := 12 \cdot \text{in}$$

$$\frac{F_f + W_{found} \cdot D_{found} \cdot d_f \cdot \gamma_{concrete}}{W_{found} \cdot D_{found}} = (1.466 \cdot 10^3) \text{ psf}$$

OK less than 1500 psf

Check the Punching Shear:

$$\phi V_c := 0.75 \cdot 4 \cdot \sqrt{\frac{f'_c}{\text{psi}}} \cdot \left(8 \cdot \text{in} + \frac{d}{2} + 8 \cdot \text{in} + \frac{d}{2} \right) \cdot 2 \cdot (d_f - 3 \cdot \text{in}) \cdot \text{psi} = (6.48 \cdot 10^4) \text{ lb}f$$

$$\frac{F_f \cdot 1.6}{\phi V_c} = 0.203$$

Less than 1.0 ok to use 10" thick foundation (1.6 here is load factor)

Check the one way shear:

$$V_f := 1.6 \cdot \frac{F_f}{W_{found}} \cdot \left(\frac{D_{found}}{2} \right) = (6.582 \cdot 10^3) \text{ lb}f$$

$$\phi V_c := 0.75 \cdot 2 \cdot \sqrt{\frac{f'_c}{\text{psi}}} \cdot W_{found} \cdot (d_f - 3 \cdot \text{in}) \cdot \text{psi} = ? \text{ lb}f$$

$$\frac{V_f}{\phi V_c} = 0.325$$

Less than 1.0 OK

$$\frac{0.0018 \cdot W_{found} \cdot d_f}{0.2 \cdot in^2} = 3.24$$

Use 4#4 rebar

$$M_f := V_f \cdot \frac{D_{found}}{4} = (4.114 \cdot 10^3) \text{ lbf} \cdot \text{ft}$$

$$\phi M_n := 4 \cdot 0.2 \cdot in^2 \cdot f_y \cdot (d_f - 3 \cdot in) \cdot 0.9 \cdot 0.9 = (2.916 \cdot 10^4) \text{ lbf} \cdot \text{ft}$$

$$\frac{M_f}{\phi M_n} = 0.141$$