

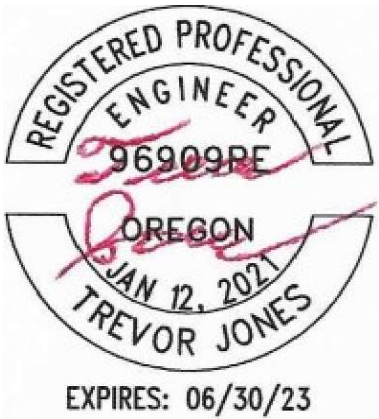


CIVIL/STRUCTURAL ENGINEERING DEPARTMENT

**STRUCTURAL CALCULATIONS
CALDWELL RESIDENCE
ROOF IMPROVEMENTS AT PV PANELS**

5612 NE Church St
Portland, Oregon

August 25, 2022



DESIGN PARAMETERS:

- 2010 Oregon Solar Installation Specialty Code
- 2019 Oregon Structural Specialty Code
- 2017 Oregon Residential Specialty Code

ROOF DEAD LOAD..... 8 psf
SOLAR DEAD LOAD..... 2.42 psf
LIVE (SNOW) LOAD..... 20 psf (non-reducible)

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Roof PV7C Analysis.....	1-18



Subject: CALDWELL RESIDENCE ROOF **PV7C**
 Engineer: TAJ Eng. Tech: David Chinyama
 Date: 12/03/2022

CIVIL/STRUCTURAL ENGINEERING DEPARTMENT

Project Notes

* Point load locations and tributary areas have been measured by hand from the plans. Although multiple loading conditions exist, the one that has been selected for analysis is believed to be the most conservative, based on engineering judgement, considering point load locations, quantity, and magnitudes, and location of intermediate supports (if any).

Distributed Loading

Existing Dead Load - Rafter/TC

Asphalt Shingles	3	psf
1/2" Plywood	1.5	psf
Framing	--	psf*
M,E, & Misc	0.5	psf
Total Existing Dead Load - TC*	5	psf

* - framing accounted for with member self-weight in RISA, not included in this calc.

Existing Dead Load - Joist/BC

1/2" Gypsum	1.5	psf
Blown-In Insulation	0.5	psf
Framing	--	psf*
Total Existing Dead Load - BC*	2	psf
Solar Panel Dead Load	2.42	psf

Snow Load

Sloped Roof Snow Load	20.0	psf
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Note: Roof Live Load will not govern over snow loads, and is therefore not treated in this analysis. ($p_{snow} = p_{RLL}$, but $C_{d,snow} < C_{d,RLL}$. Also, RLL may be removed where panels are located per the IBC, while snow loads are non-reducible.)

Line and Point Loading

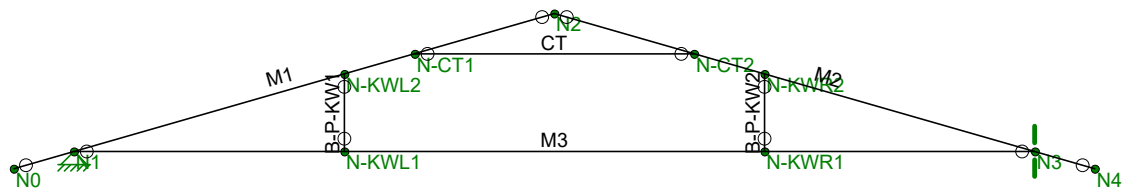
Line Loads

Tributary Width	2	ft
<u>Dead Load - TC</u>	10	plf
<u>Dead Load - BC</u>	4	plf
<u>Snow Load</u>	40	plf

	<u>Start Loc</u>	<u>End Loc</u>	
Snow Shade Locations	0.50	12.00	ft from rafter end

Point Loads

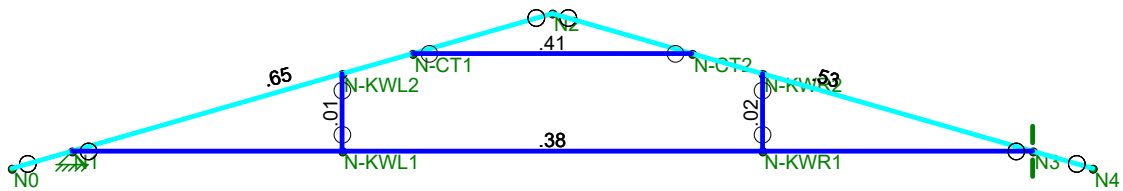
	Trib area (ft ²)	Location (ft)	Solar pt load	Snow pt load	
Load #1	4.32	1.92	10.5	86.4	lbs
Load #2	7.38	4.75	17.9	147.6	lbs
Load #3	4.52	7.75	10.9384	90.4	lbs
Load #4	7.28	10.75	17.6176	145.6	lbs



Solgen Power	Caldwell Roof PV7C - Panels Added	SK - 1
TAJ		Dec 3, 2022 at 6:25 PM
		Caldwell fix 12-3-22.r2d

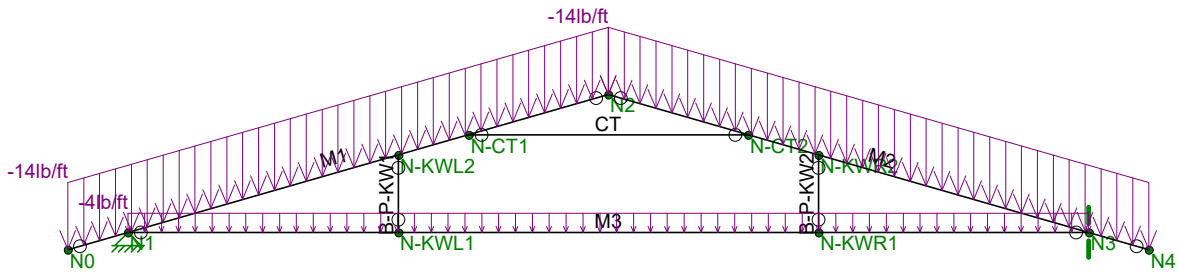


Code Check (Env)	
No Calc	
> 1.0	
.90-1.0	
.75-.90	
.50-.75	
0-.50	



Member Code Checks Displayed (Enveloped)
Envelope Only Solution

Solgen Power	Caldwell Roof PV7C - Panels Added	SK - 2
TAJ		Dec 3, 2022 at 6:25 PM
		Caldwell fix 12-3-22.r2d



Loads: BLC 1, DL
Envelope Only Solution

Solgen Power

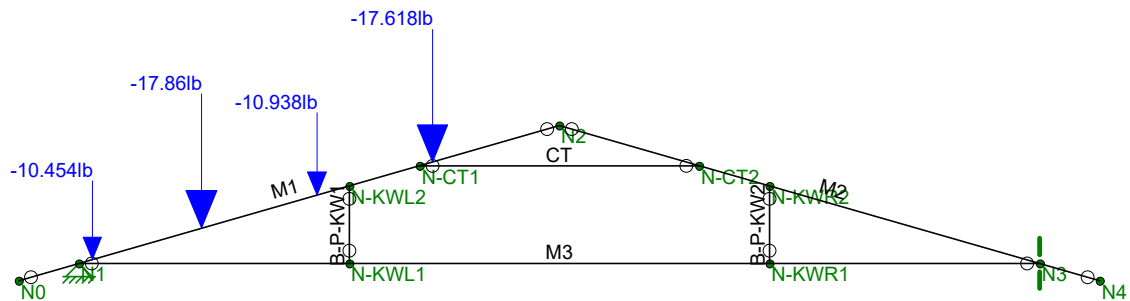
TAJ

Caldwell Roof PV7C - Panels Added

SK - 3

Dec 3, 2022 at 6:25 PM

Caldwell fix 12-3-22.r2d



Loads: BLC 2, DL - Solar
Envelope Only Solution

Solgen Power

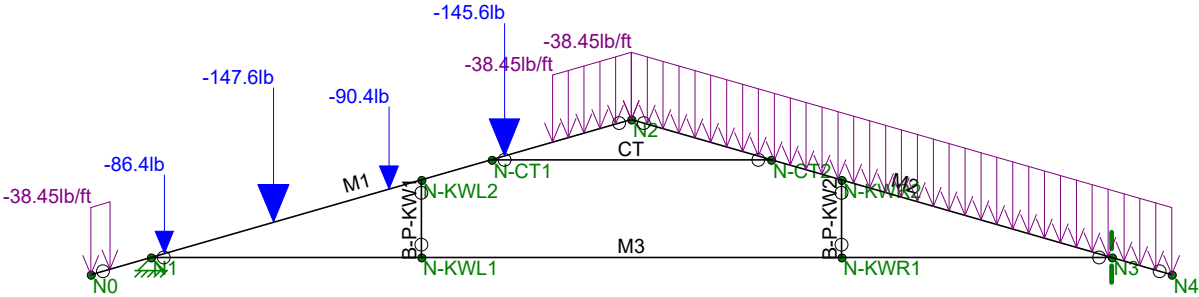
TAJ

Caldwell Roof PV7C - Panels Added

SK - 4

Dec 3, 2022 at 6:26 PM

Caldwell fix 12-3-22.r2d



Loads: BLC 3, SL
Envelope Only Solution

Solgen Power

TAJ

Caldwell Roof PV7C - Panels Added

SK - 5

Dec 3, 2022 at 6:26 PM

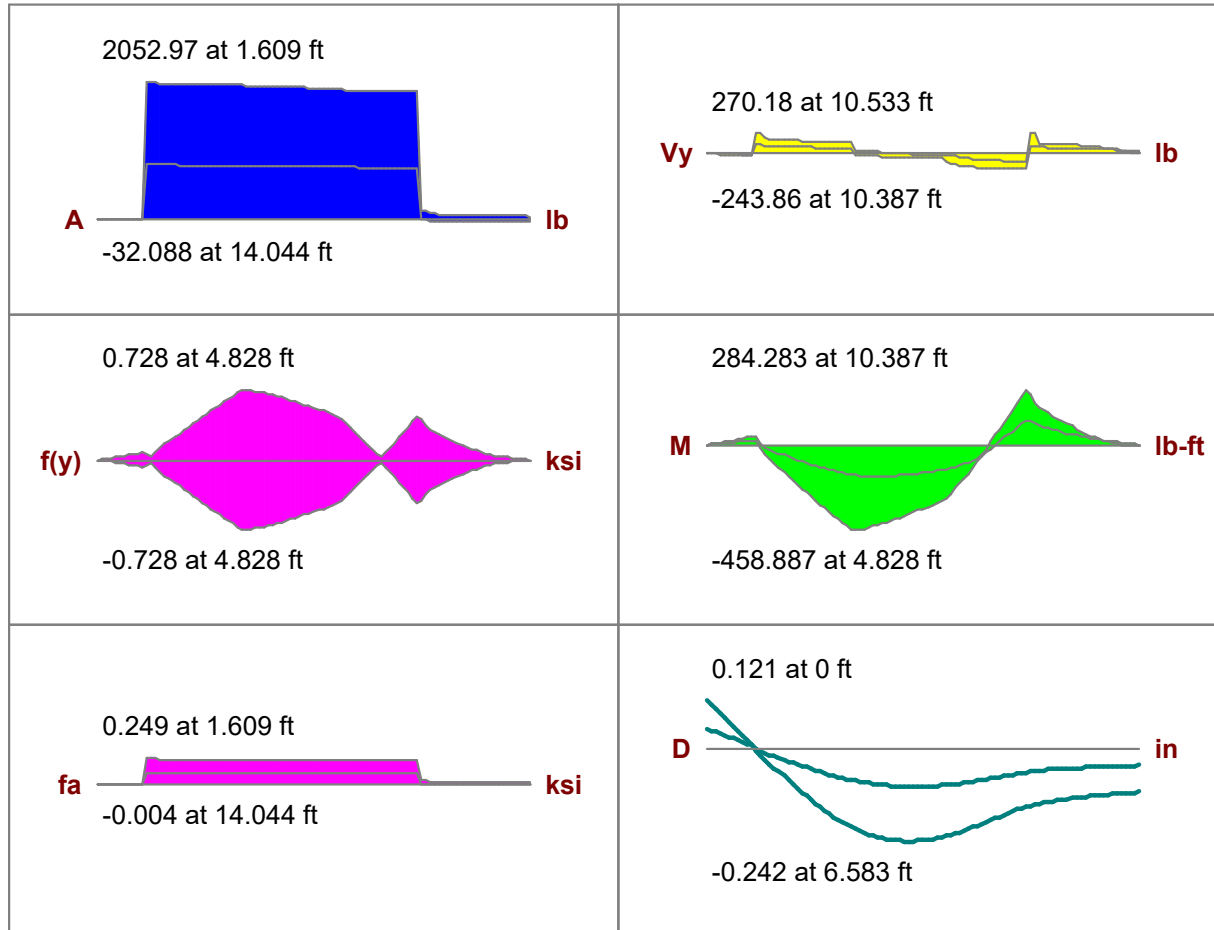
Caldwell fix 12-3-22.r2d

Member: **M1**Shape: **2x6**Material: **DF**Length: **14.044 ft**I Joint: **N0**J Joint: **N2**

Envelope

Code Check: **0.649 (LC 2)**

Report Based On 97 Sections

**AWC NDS-18: ASD Code Check**Max Bending Check **0.649 (LC 2)**Location **4.828 ft**Equation **3.9-3**CD **1.15** RB **5.416**Cr **1** Cfu **1**Max Shear Check **0.237 (LC 2)**Location **10.533 ft**Max Defl Ratio **L/645**CL **0.997**CP **0.75**

	(ksi)	Cm	Ct	CF
Fc'	1.28	1	1	1.1
Ft'	0.86	1	1	1.3
Fb'	1.342	1	1	1.3
Fv'	0.207	1	1	
E'	1600	1	1	

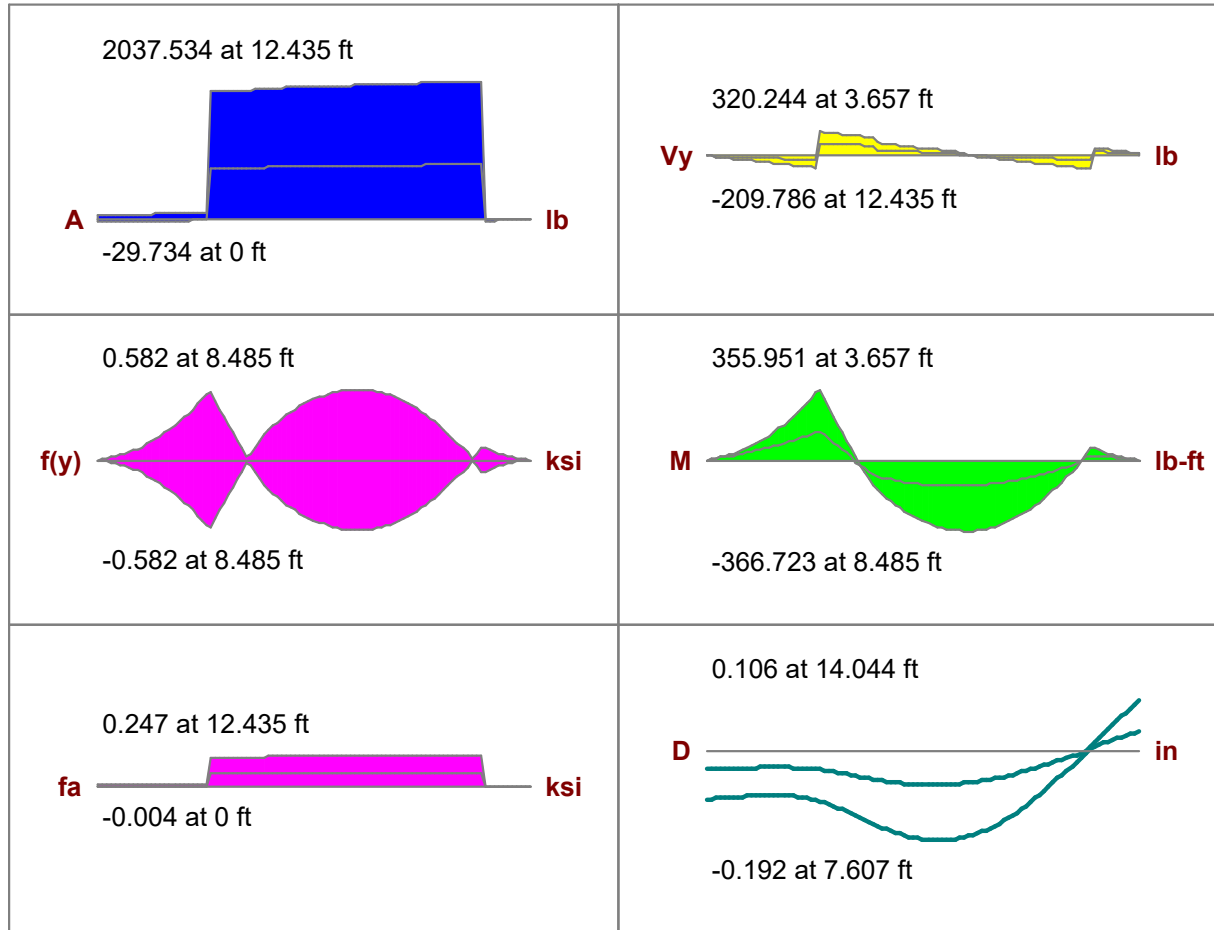
Lb	1 ft	7.022 ft
le/d	8	15.321
Sway	No	No
Le-Bending Top	1 ft	
Le-Bending Bot	7.022 ft	

Member: **M2**Shape: **2x6**Material: **DF**Length: **14.044 ft**I Joint: **N2**J Joint: **N4**

Envelope

Code Check: **0.526 (LC 2)**

Report Based On 97 Sections

**AWC NDS-18: ASD Code Check**Max Bending Check **0.526 (LC 2)**Location **8.485 ft**Equation **3.9-3**CD **1.15** RB **5.416**Cr **1** Cfu **1**Max Shear Check **0.281 (LC 2)**Location **3.657 ft**Max Defl Ratio **L/815**CL **0.997**CP **0.75**

	(ksi)	Cm	Ct	CF
Fc'	1.28	1	1	1.1
Ft'	0.86	1	1	1.3
Fb'	1.342	1	1	1.3
Fv'	0.207	1	1	
E'	1600	1	1	

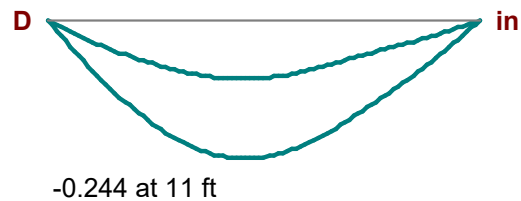
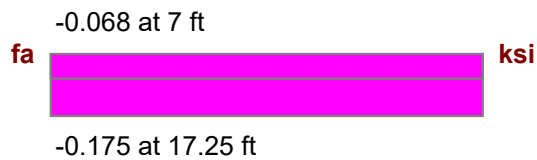
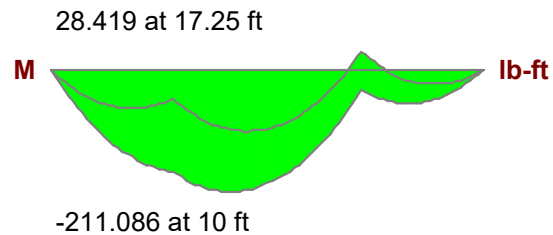
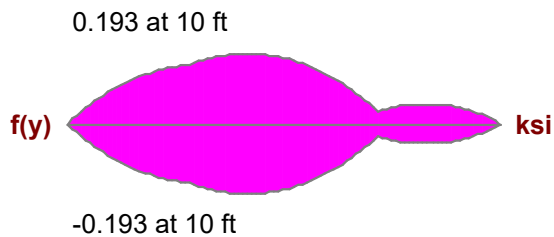
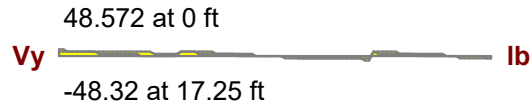
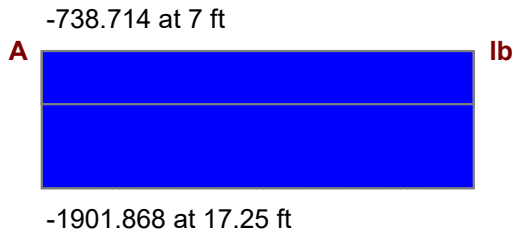
Lb	1 ft	7.022 ft
le/d	8	15.321
Sway	No	No
Le-Bending Top	1 ft	
Le-Bending Bot	7.022 ft	

Member: **M3**Shape: **2x8**Material: **DF**Length: **24 ft**I Joint: **N1**J Joint: **N3**

Envelope

Code Check: **0.376 (LC 2)**

Report Based On 97 Sections

**AWC NDS-18: ASD Code Check**Max Bending Check **0.376 (LC 2)**Location **10 ft**Equation **3.9-1**CD **1.15** RB **6.218**Cr **1** Cfu **1**Max Shear Check **0.032 (LC 1)**Location **17.25 ft**Max Defl Ratio **L/1182**CL **0.996**CP **0.179**

	(ksi)	Cm	Ct	CF
Fc'	0.292	1	1	1.05
Ft'	0.793	1	1	1.2
Fb'	1.237	1	1	1.2
Fv'	0.18	1	1	
E'	1600	1	1	

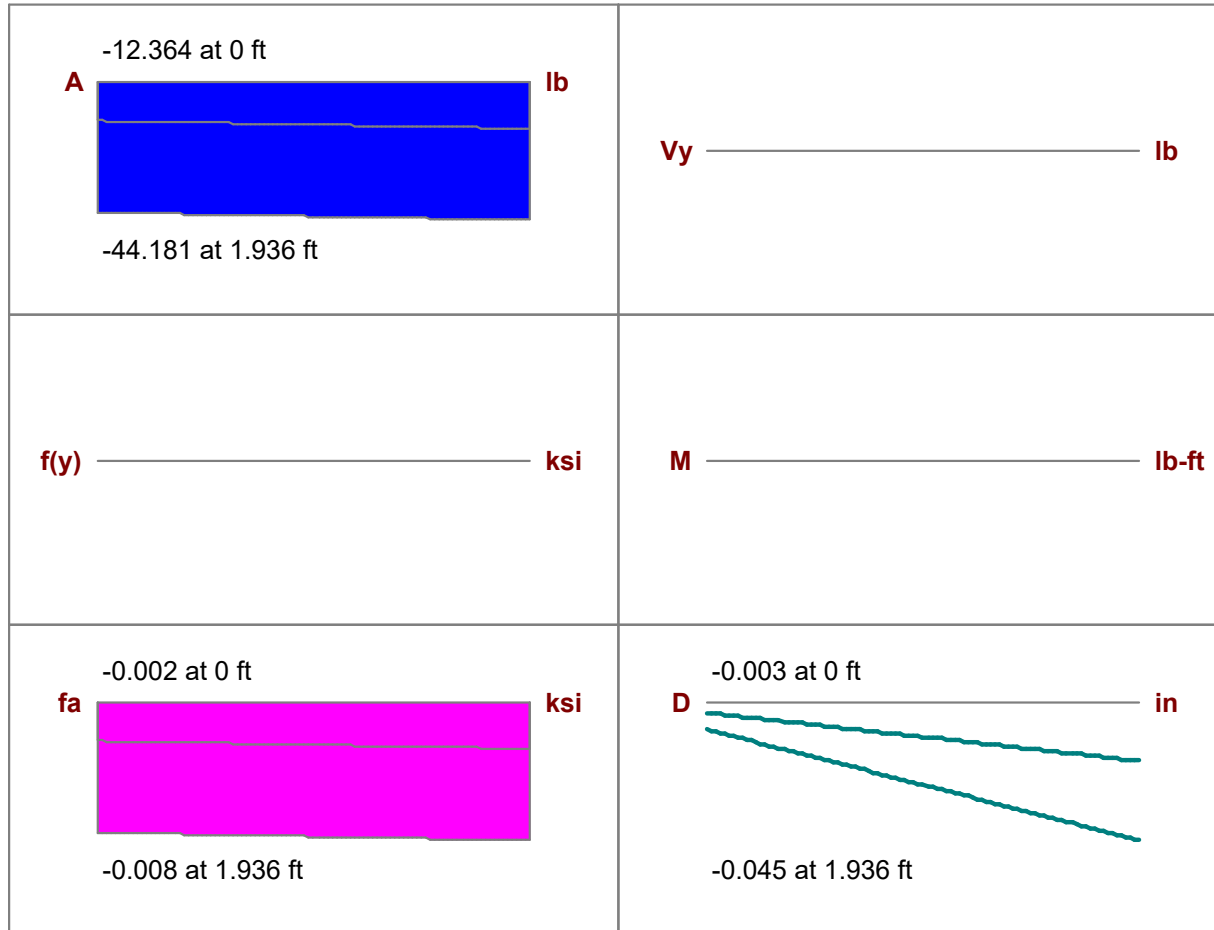
Lb	1 ft	24 ft
le/d	8	39.724
Sway	No	No
Le-Bending Top	1 ft	
Le-Bending Bot	24 ft	

Member: **B-P-KW1**Shape: **2x4**Material: **DF**Length: **1.936 ft**I Joint: **N-KWL1**J Joint: **N-KWL2**

Envelope

Code Check: **0.010 (LC 1)**

Report Based On 97 Sections

**AWC NDS-18: ASD Code Check**Max Bending Check **0.010 (LC 1)**Location **1.936 ft**Equation **3.9-1**CD **1** RB **6.011**Cr **1** Cfu **1**Max Shear Check **0.000 (LC 2)**Location **1.936 ft**Max Defl Ratio **L/10000**CL **0.996**CP **0.771**

	(ksi)	Cm	Ct	CF
Fc'	1.197	1	1	1.15
Ft'	0.863	1	1	1.5
Fb'	1.345	1	1	1.5
Fv'	0.207	1	1	
E'	1600	1	1	

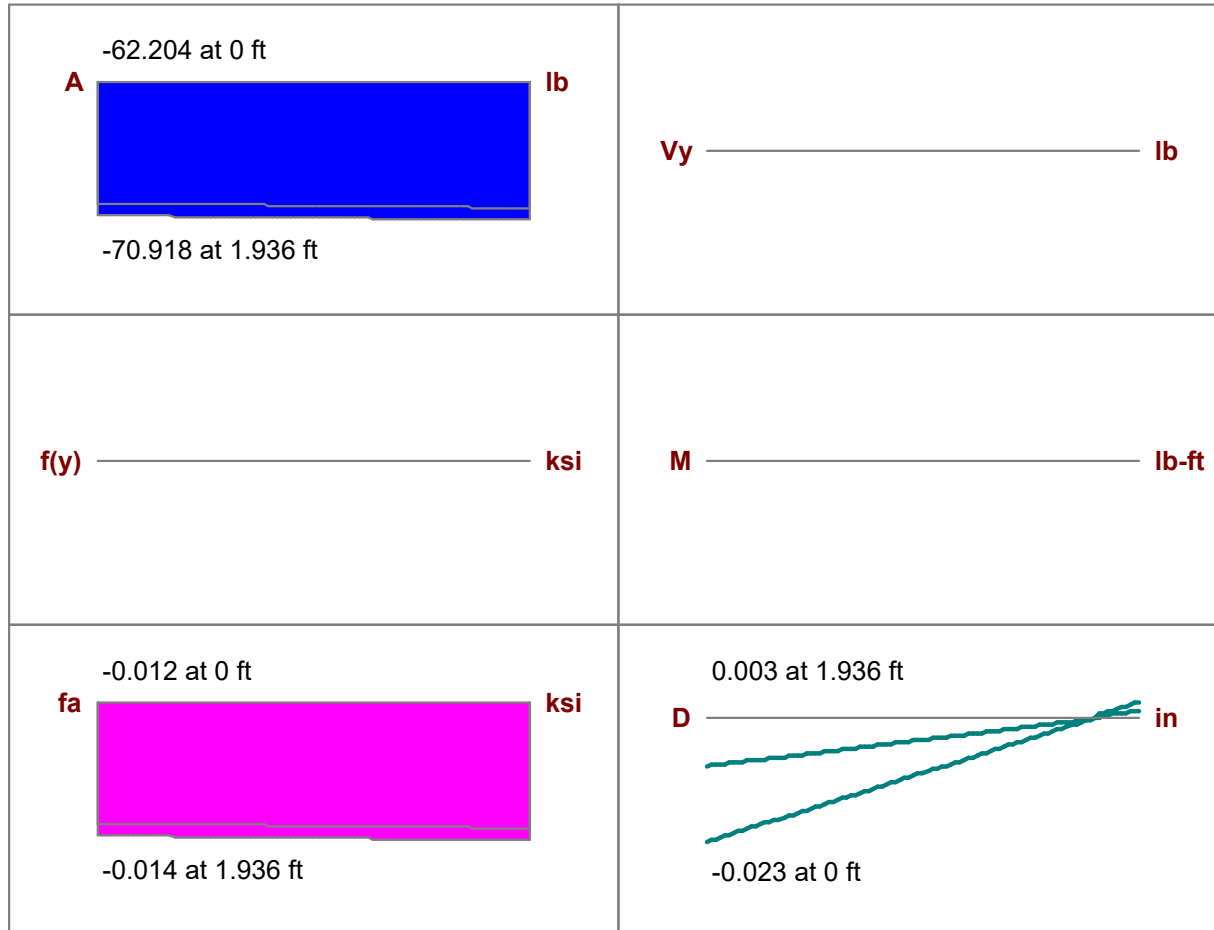
	Out	In
Lb	1.936 ft	1.936 ft
le/d	15.484	6.636
Sway	No	No
Le-Bending Top	1.936 ft	
Le-Bending Bot	1.936 ft	

Member: **B-P-KW2**Shape: **2x4**Material: **DF**Length: **1.936 ft**I Joint: **N-KWR1**J Joint: **N-KWR2**

Envelope

Code Check: **0.016 (LC 1)**

Report Based On 97 Sections

**AWC NDS-18: ASD Code Check**Max Bending Check **0.016 (LC 1)**Location **1.936 ft**Equation **3.9-1**CD **1** RB **6.011**Cr **1** Cfu **1**Max Shear Check **0.000 (LC 2)**Location **1.936 ft**Max Defl Ratio **L/10000**CL **0.996**CP **0.771**

	(ksi)	Cm	Ct	CF
Fc'	1.197	1	1	1.15
Ft'	0.863	1	1	1.5
Fb'	1.345	1	1	1.5
Fv'	0.207	1	1	
E'	1600	1	1	

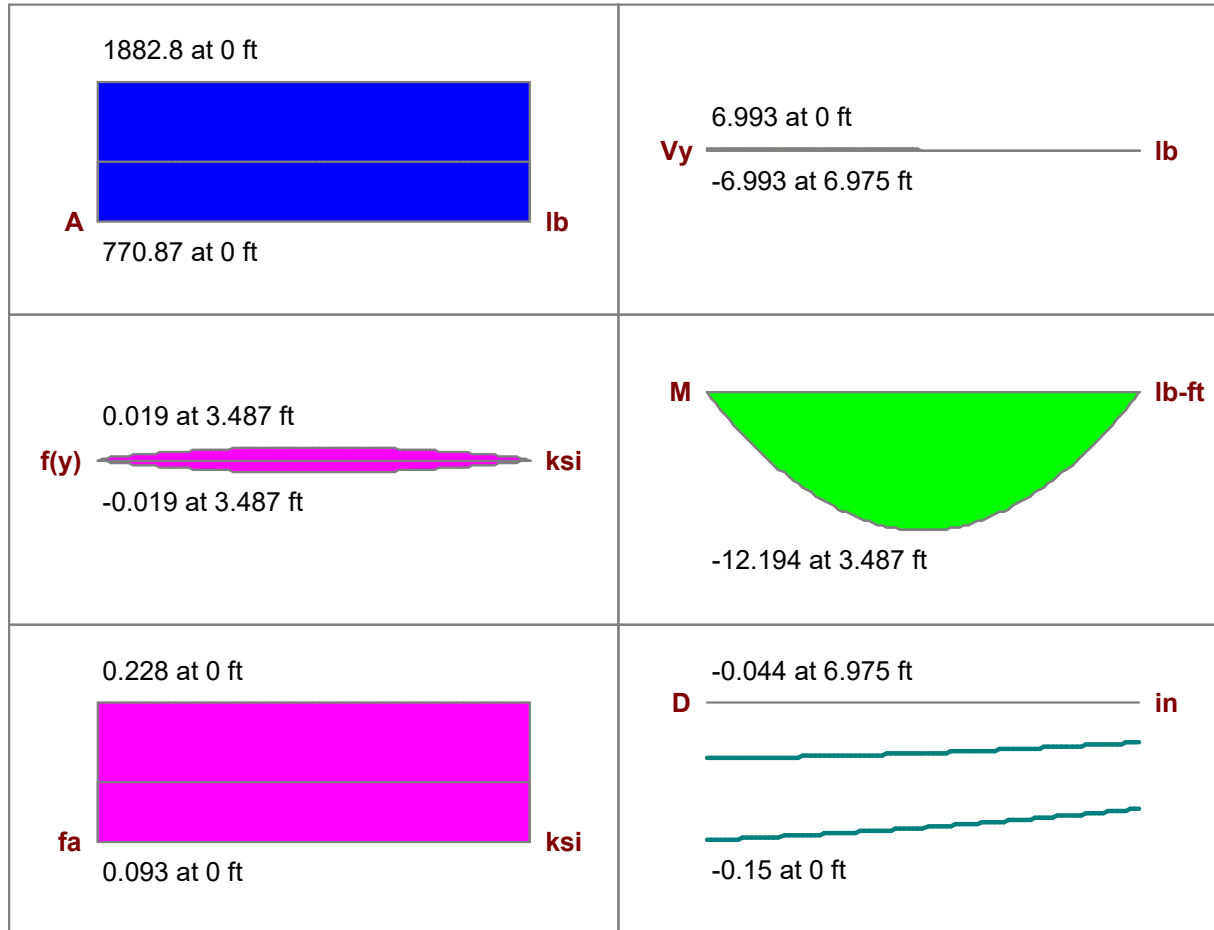
	Out	In
Lb	1.936 ft	1.936 ft
le/d	15.484	6.636
Sway	No	No
Le-Bending Top	1.936 ft	
Le-Bending Bot	1.936 ft	

Member: **CT**Shape: **2X6**Material: **DF**Length: **6.975 ft**I Joint: **N-CT1**J Joint: **N-CT2**

Envelope

Code Check: **0.406 (LC 2)**

Report Based On 97 Sections

**AWC NDS-18: ASD Code Check**Max Bending Check **0.406 (LC 2)**Location **6.975 ft**Equation **3.6.3**CD **1.15** RB **14.304**Cr **1** Cfu **1**Max Shear Check **0.007 (LC 1)**Location **6.975 ft**Max Defl Ratio **L/10000**CL **0.97**CP **0.329**

	(ksi)	Cm	Ct	CF
Fc'	0.562	1	1	1.1
Ft'	0.86	1	1	1.3
Fb'	1.305	1	1	1.3
Fv'	0.18	1	1	
E'	1600	1	1	

	Out	In
Lb	3.487 ft	3.487 ft
le/d	27.9	7.609
Sway	No	No
Le-Bending Top	6.975 ft	
Le-Bending Bot	6.975 ft	

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Increase Nailing Capacity for Wind?	Yes
Merge Tolerance (in)	0.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automatically Iterate Stiffness for Walls?	Yes
Max Iterations for Wall Stiffness	3
Gravity Acceleration (ft/sec^2)	32.2
Wall Mesh Size (in)	12
Eigensolution Convergence Tol. (1.E-)	4
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 15th (360-16): ASD
Adjust Stiffness?	Yes(Iterative)
Cold Formed Steel Code	AISI S100-16: ASD
Wood Code	AWC NDS-18: ASD
Wood Temperature	< 100F
Concrete Code	ACI 318-19
Masonry Code	TMS 402-16: ASD
Aluminum Code	AA ADM1-15: ASD - Building
Number of Shear Regions	4
Region Spacing Increment (in)	4
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR SET ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

Wood Material Properties

	Label	Type	Database	Species	Grade	Cm	Emod	Nu	Therm (/... Dens[k/ft^3]
1	DF	Solid Sawn	Visually Gr...	Douglas Fir-Larch	No.2		1	0.3	0.3 0.035
2	SP	Solid Sawn	Visually Gr...	Southern Pine	No.1		1	0.3	0.3 0.035
3	HF	Solid Sawn	Visually Gr...	Hem-Fir	No.1		1	0.3	0.3 0.035
4	SPF	Solid Sawn	Visually Gr...	Spruce-Pine-fir	No.1		1	0.3	0.3 0.035
5	24F-1.8E DF B...	Glulam	NDS Table...	24F-1.8E_DF_BAL	na		1	0.3	0.3 0.035
6	24F-1.8E DF U...	Glulam	NDS Table...	24F-1.8E_DF_UNB...	na		1	0.3	0.3 0.035
7	24F-1.8E SP B...	Glulam	NDS Table...	24F-1.8E_SP_BAL	na		1	0.3	0.3 0.035
8	24F-1.8E SP U...	Glulam	NDS Table...	24F-1.8E_SP_UNB...	na		1	0.3	0.3 0.035
9	1.3E-1600F_V...	SCL	Boise Cas...	1.3E-1600F_VERS...	na		1	0.3	0.3 0.035
10	1.35E LSL_Sol...	SCL	Louisiana ...	1.35E LSL_SolidSt...	na		1	0.3	0.3 0.035
11	1.3E_RIGIDLA...	SCL	Roseburg ...	1.3E_RIGIDLAM L...	na		1	0.3	0.3 0.035
12	2.0E_DF Parall...	SCL	TrusJoist	2.0E_DF Parallam ...	na		1	0.3	0.3 0.035
13	LVL_PRL_1.5...	Custom	N/A	LVL_PRL_1.5E_22...	na		1	0.3	0.3 0.035
14	LVL_Microlam...	Custom	N/A	LVL_Microllam_1.9...	na		1	0.3	0.3 0.035
15	PSL_Parallam...	Custom	N/A	PSL_Parallam_2.0...	na		1	0.3	0.3 0.035
16	LSL_TimberStr...	Custom	N/A	LSL_TimberStrand...	na		1	0.3	0.3 0.035

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N0	-1.5	-0.430118	0
2	N1	0	0	0
3	N2	12	3.440945	0
4	N3	24	0	0
5	N4	25.5	-0.430118	0
6	N-CT1	8.512586	2.440945	0
7	N-CT2	15.487414	2.440945	0
8	N-KWL1	6.75	0	0
9	N-KWL2	6.75	1.935531	0
10	N-KWR1	17.25	0	0
11	N-KWR2	17.25	1.935531	0

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	DL	DL		-1			3
2	DL - Solar	DL				4	
3	SL	SL				4	3

Load Combinations

	Description	Sol..	PD..	SR..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..	BLC Fact..
1	DL	Yes	Y		DL	1														
2	DL + SL	Yes	Y		DL	1	SL	1												

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N0	N2		Rafter / TC	None	None	DF	Typical
2	M2	N2	N4		Rafter / TC	None	None	DF	Typical
3	M3	N1	N3		Joist / BC	None	None	DF	Typical
4	CT	N-CT1	N-CT2		Collar Tie	None	None	DF	Typical
5	B-P-KW1	N-KWL1	N-KWL2		Brace/post/knee...	None	None	DF	Typical
6	B-P-KW2	N-KWR1	N-KWR2		Brace/post/knee...	None	None	DF	Typical

Wood Design Parameters

	Label	Shape	Length[ft]	Le-out[ft]	Le-in[ft]	le-bend to...	le-bend bo...	K-out	K-in	CV	Cr	Out sway	In sway
1	M1	Rafter / TC	14.044	1	Segment	Lb out	Segment						
2	M2	Rafter / TC	14.044	1	Segment	Lb out	Segment						
3	M3	Joist / BC	24	1		Lb out							
4	CT	Collar Tie	6.975	3.487	3.487								
5	B-P-KW1	Brace/post...	1.936			Lb out							
6	B-P-KW2	Brace/post...	1.936			Lb out							

Envelope Wood Code Checks

	Member	Shape	Code ...	Loc[ft]	LC	Shear ...	Loc[ft]	LC	Fc' [ksi]	Ft' [ksi]	Fb' [ksi]	Fv' [ksi]	RB	CL	CP	Eqn
1	M1	2x6	0.649	4.828	2	0.237	10.533	2	1.28	0.86	1.342	0.207	5.416	0.997	0.75	3.9-3
2	M2	2x6	0.526	8.485	2	0.281	3.657	2	1.28	0.86	1.342	0.207	5.416	0.997	0.75	3.9-3
3	M3	2x8	0.376	10	2	0.032	17.25	1	0.292	0.793	1.237	0.18	6.218	0.996	0.179	3.9-1
4	CT	2X6	0.406	6.975	2	0.007	6.975	1	0.562	0.86	1.305	0.18	14.304	0.97	0.329	3.6.3
5	B-P-KW1	2x4	0.01	1.936	1	0	1.936	2	1.197	0.863	1.345	0.207	6.011	0.996	0.771	3.9-1

Envelope Wood Code Checks (Continued)

Member	Shape	Code ...	Loc[ft]	LC	Shear ...	Loc[ft]	LC	Fc' [ksi]	Ft' [ksi]	Fb' [ksi]	Fv' [ksi]	RB	CL	CP	Egn	
6	B-P-KW2	2x4	0.016	1.936	1	0	1.936	2	1.197	0.863	1.345	0.207	6.011	0.996	0.771	3.9-1



Subject:
Date:
Engineer:

CALDWELL RESIDENCE ROOF 1

12/03/2022

TAJ

Eng. Tech:

David Chinyama

CIVIL/STRUCTURAL ENGINEERING DEPARTMENT

Connection Analysis

The purpose of this calculation is to verify the connections - either existing or as retrofit - are adequate for the required design loads.

HEEL CONNECTION

Connection Demand**

1901

lbs

** - from RISA analysis. Tension in joist/bottom chord at member ends.

Existing Connection

of connectors

4

(assumed)

Connector Size & Type

16d Common Wire Nail

(assumed)

Existing Connection Capacity

648

lbs (Note: nail capacity = 162 lbs per next page)

RETROFIT REQ'D

Connection Retrofit (if applies)

of connectors

2

(top and bottom)

Connector Size & Type

Simpson A34

Base Capacity (F1, Cd = 1.15*)

892

lbs

Cr, repetitive member factor

1.15

Increase in Connection Capacity

2051.6

lbs

Total Connection Capacity

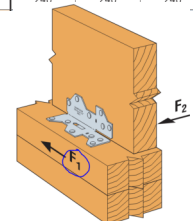
2699.6

lbs

OK

* - linear interpolation between 1.00 and 1.25 values, below:

Model No.	Type of Connection	Fasteners (in.)	Direction of Load	DF/SP Allowable Loads		
				Floor (100)	Roof (125)	(160)
A34	1	(8) 0.131 x 1 1/2	F ₁	395	480	545
			F ₂ ^a	395	430	430
	1	(8) #9 x 1 1/2 SD	F ₁	640	640	640
			F ₂	495	495	495
			Uplift	240	240	240



SPLICE CEILING JOIST IF REQ'D

Max. Tension in Joist:

1901

lbs

Capacity of Existing Connection:

486

lbs

(assume each existing splice has (3) existing 16d nails)

Retrofit:

MSTA12

Add'l capacity (Cd = 1.6):

1504

lbs

Total Capacity w/ Retrofit:

1990

lbs

OK



Subject:
Date:
Engineer:

CALDWELL RESIDENCE ROOF 1

12/03/2022

TAJ

Eng. Tech:

David Chinyama

CIVIL/STRUCTURAL ENGINEERING DEPARTMENT

Connection Analysis

The purpose of this calculation is to verify the connections - either existing or as retrofit - are adequate for the required design loads.

COLLAR TIE CONNECTION

Connection Demand**

1882

lbs

Existing Connection

of connectors

4

(assumed)

Connector Size & Type

16d Common Wire Nail

(assumed)

Existing Connection Capacity

648

lbs (Note: nail capacity = 162 lbs per next page)

RETROFIT REQ'D

Connection Retrofit (if applies)

of connectors

2

(top and bottom)

Connector Size & Type

Simpson A34

Base Capacity (F_1 , $C_d = 1.15^*$)

892

lbs

C_r , repetitive member factor

1.15

Increase in Connection Capacity

2051.6

lbs

Total Connection Capacity

2699.6

lbs

OK

* - linear interpolation between 1.00 and 1.25 values, below:

Model No.	Type of Connection	Fasteners (in.)	Direction of Load	DF/SP Allowable Loads		
				Floor (100)	Roof (125)	(160)
A34	[1]	(8) 0.131 x 1 1/2	F ₁	395	480	545
			F ₂ ^a	395	430	430
	[1]	(8) #9 x 1 1/2 SD	F ₁	640	640	640
			F ₂	495	495	495
	[1]	(8) #9 x 1 1/2 SD	Uplift	240	240	240

