VECTOR
ENGINEERS

UTAH OFFICES
Sandy
Layton
St. George

2

17-16440 - REV- 01- RS

Project Number: U2001-0820-171

July 14, 2017

Blue Raven Solar, LLC
1220 S. 630 E., Suite 430
American Fork, UT 84003
ATTENTION: Scott Gurney

REFERENCE: **Brian Van Horn Residence: 4734 Northeast 78th Place, Portland, OR 97218**
**Solar Panel Installation**

Dear Mr. Gurney:

Per your request, we have reviewed the attached layout relating to the installation of solar panels at the above-referenced site.

- Roof material: Composite / Asphalt Shingles
- Roof structure: 2x4 @ rafters 24" O.C. with knee wall above bearing wall

**Based upon our review, it is our conclusion that the installation of solar panels on the existing roof will require the roof structure of this house to be strengthened. This can be accomplished by attaching new 2x4 DFL#2 rafters to the existing roof rafters. Connect the new 2x4's to the existing rafters using 16d sinkers at 12 in O.C., staggered. For installation purposes, the sistered rafters may be cut as needed and installed on either side of the existing rafters with a minimum 6'-0" lap length. Refer to the attached detail.**

The design of supporting members and connections is by the manufacturer and/or installer. The adopted building code in this jurisdiction is the 2014 Oregon Structural Specialty Code and ASCE 7-10. Appropriate design parameters which must be used in the design of the supporting members and connections are listed below:

- Roof snow load: 20 psf (verify with local building code)
- Design wind speed for risk category II structures: 120 mph (3-sec gust)
- Wind exposure: Category C

The addition of the solar panels increases the dead load and the snow load for this house due to the relatively low slope of the roof. Due to this increase in design loads, an analysis of the roof trusses was performed. The analysis is attached. Regarding seismic loads, we conclude that any additional forces will be small. With an assumed roof dead load of 13 psf, solar panel dead load of 3 psf, and affected roof area of 40% (maximum), the additional dead load (and consequential seismic load) will be 19.0%. This calculation conservatively neglects the weight of wall dead load. Because the increase is less than 10%, this alteration meets the requirements of the exception in Section 3403.4 of the 2012 International Building Code.

During design and installation, particular attention must be paid to the maximum allowable spacing of attachments and the location of solar panels relative to roof edges. The use of solar panel support span tables provided by the manufacturer is allowed only where the building type, site conditions, and solar panel configuration match the description of the span tables. Attachments to existing roof trusses or rafters must be staggered so as not to overload any existing structural member. Waterproofing around the roof penetrations is the responsibility of others. Electrical engineering is beyond our scope. All work performed must be in accordance with accepted industry-wide methods and applicable safety standards. Vector Structural Engineering assumes no responsibility for improper installation of the solar panels.

Please note that a representative of Vector Structural Engineering has not physically observed the roof framing of this home. Our conclusions are based upon the assumption that all structural roof components and other supporting elements are in good condition and are sized and spaced such that they can resist standard roof loads.

Very truly yours,

VECTOR STRUCTURAL ENGINEERING, LLC

STRUCTURAL
REGISTERED PROFESSIONAL ENGINEER
78187PE

OREGON
MAY 16, 2006
ROGER ALWORTH
EXPIRES 12/31/2017

Roger Alworth, S.E.
Project Manager

July 14, 2017

RTA/dgd

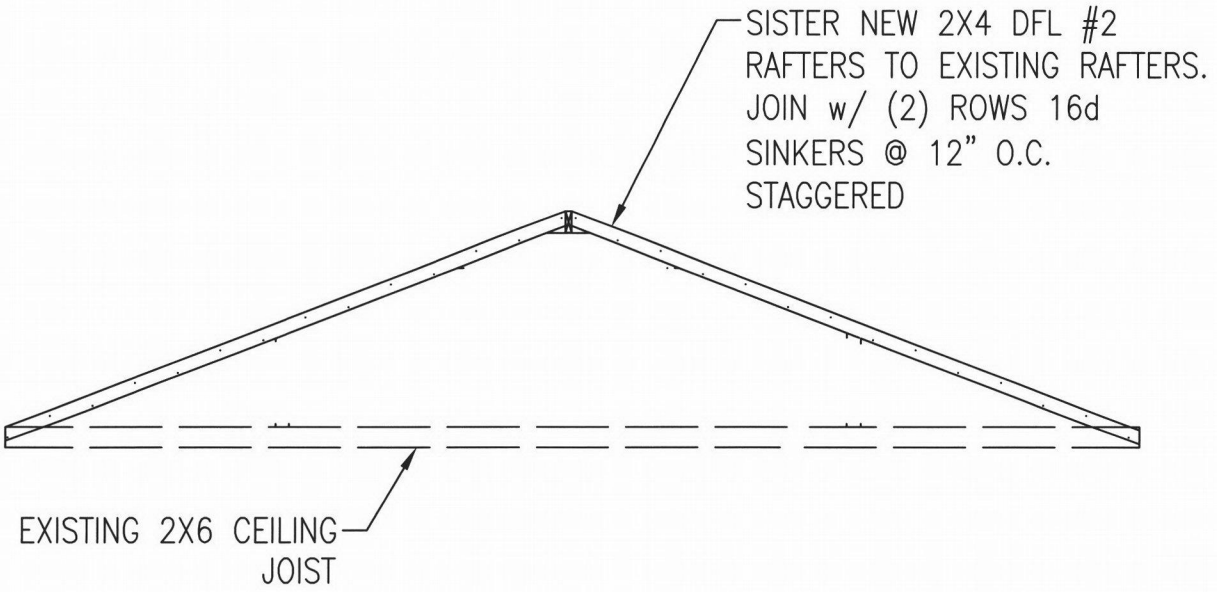
VECTOR ENGINEERS

JOB NO. U2001-0820-171

DATE 04/21/2017

PROJECT Brian Van Horn SHEET ____ OF ____

SUBJECT ROOF RETROFIT DESIGNED DGD CHECKED AMW




STRUCTURAL REGISTERED PROFESSIONAL ENGINEER
78187PE
OREGON
MAY 16, 2006
ROGER ALWORTH
EXPIRES 12/31/2017

May 12, 2017

NOTES:
ALL NEW MEMBERS TO BE DFL #2 OR BETTER.
EXISTING RAFTERS THAT ARE SPLIT OR HAVE DEEP NOTCHES SHALL BE REPLACED OR SISTERED TO AN ADDITIONAL RAFTER
CONSULT ENGINEER WHERE CONDITIONS DIFFER FROM THAT SHOWN
ALL RAFTERS UNDER SOLAR PANELS ARE TO BE RETROFIT AS SHOWN

9138 S. State Street #101 (801) 990-1775
Sandy, Utah 84070 (801) 990-1776 FAX
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VECTOR ENGINEERS

**JOB NO.:** U2001-0820-171

**PROJECT:** BRIAN VAN HORN RESIDENCE **SUBJECT:** WIND PRESSURE

**Components and Cladding Wind Calculations**

Label: Solar Panel Array Note: Calculations per ASCE 7-10

## SITE-SPECIFIC WIND PARAMETERS:

| | |
|---|---|
| Basic Wind Speed [mph]: | 120 |
| Exposure Category: | C |
| Risk Category: | II |

Notes:

## ADDITIONAL INPUT & CALCULATIONS:

| | | | |
|---|---|---|---|
| Height of roof, h [ft]: | 24 | (Approximate) | |
| Comp/Cladding Location: | Gable/Hip Roofs 7° < θ ≤ 27° | | |
| Enclosure Classification: | Enclosed Buildings | | |
| Zone 1 $GC_p$: | 0.9 | Figure 30.4-2B | (enter largest abs. value) |
| Zone 2 $GC_p$: | 1.7 | | (enter largest abs. value) |
| Zone 3 $GC_p$: | 2.6 | | (enter largest abs. value) |
| α: | 9.5 | Table 26.9-1 | |
| $z_g$ [ft]: | 900 | Table 26.9-1 | |
| $K_h$: | 0.937 | Table 30.3-1 | |
| $K_{zt}$: | 1 | Equation 26.8-1 | |
| $K_d$: | 0.85 | Table 26.6-1 | |
| Velocity Pressure, $q_h$ [psf]: | 29.4 | Equation 30.3-1 | |
| $GC_{pi}$: | 0 | Table 26.11-1 | (largest abs. value) |

## OUTPUT:

$$p = q_h\left[\left(GC_p\right) - \left(GC_{pi}\right)\right]$$

| | | |
|---|---|---|
| Zone 1 Pressure, p [psf]: | 26.43 | psf (1.0W, Interior Zones*) |
| Zone 2 Pressure, p [psf]: | 49.92 | psf (1.0W, End Zones*) |
| Zone 3 Pressure, p [psf]: | 76.35 | psf (1.0W, Corner Zones* within a) |
| | | (*a=assumed=3') |

VECTOR ENGINEERS

**JOB NO.:** U2001-0820-171

**PROJECT:** BRIAN VAN HORN RESIDENCE **SUBJECT:** CONNECTION CAPACITY

## Lag Screw Connection

**Capacity:**

| | | |
|---|---|---|
| Lag Screw Size: | 5/16 | |
| $C_d$: | 1.6 | |
| Embedment: | 2.5 | in |
| Grade: | SPF (G = 0.42) | |
| Capacity: | 205 | lbs/in. emb. |
| Number of Screws: | 1 | |
| Total Capacity: | 820 | lbs |

**Demand:**

| | Pressure (0.6 Wind) (psf) | Max Spacing (ft) | Max. Trib. Area ($ft^2$) | Max. Uplift Force (lbs) |
|---|---|---|---|---|
| Zone 1: | 15.9 | 4 | 12 | 190 |
| Zone 2: | 30.0 | 4 | 12 | 359 |
| Zone 3: | 45.8 | 4 | 12 | 550 |

Demand< Capacity: **CONNECTION OKAY**

VECTOR ENGINEERS

**JOB NO.:** U2001-0820-171

**PROJECT:** BRIAN VAN HORN RESIDENCE **SUBJECT:** GRAVITY LOADS

CALCULATE ESTIMATED GRAVITY LOADS

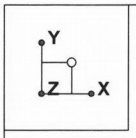
| **DEAD LOAD (D)** | | | Increase due to pitch | Original loading | |
|---|---|---|---|---|---|
| Roof Pitch/12 | | 5.9 | | | |
| Composite/Asphalt Shingles | | 4.2 | 1.06 | 4.00 | psf |
| 1/2" Plywood | | 1.1 | 1.06 | 1.00 | psf |
| Framing - Accounted for in RISA 3D | | | | | |
| M, E & Misc | | 1.0 | psf | | |
| | DL | 6.3 | psf (2 ft trib. = 12.6 plf D on rafter) | | |
| | PV Array DL | 3.0 | psf | | |

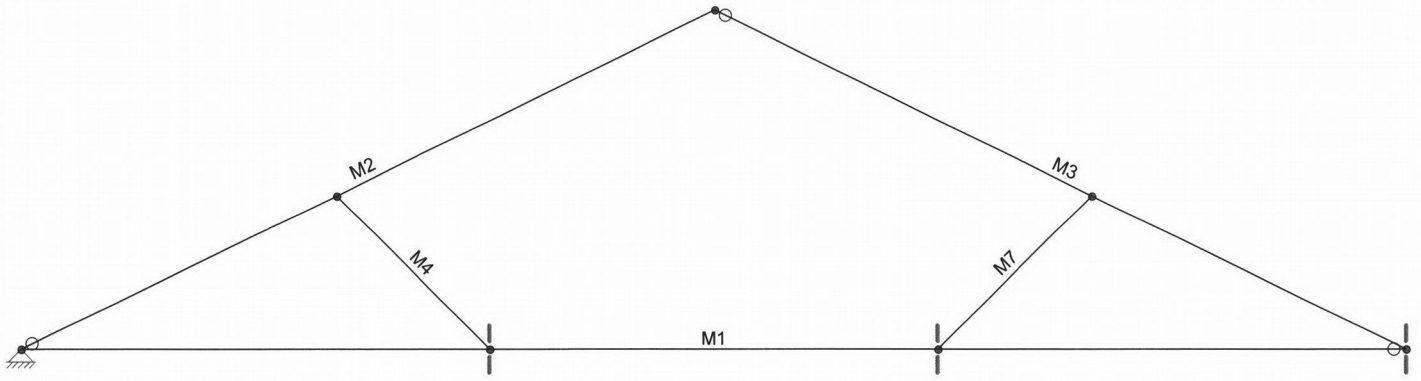
| **Ceiling Joist:** | | | |
|---|---|---|---|
| Insulation | 0.80 | psf | |
| 1/2" Gypsum Clg. | 2.20 | psf | |
| M, E & Misc | 1.00 | psf | |
| | 4.00 | psf (1.333 ft trib. = | 5.332) |

**ROOF LIVE LOAD (Lr)**

| | | |
|---|---|---|
| Existing Design Roof Live Load [psf] | 20 | ASCE 7-10, Table 4-1 |
| Roof Live Load With PV Array [psf] | 0 | 2015 IBC, Section 1607.12.5 |

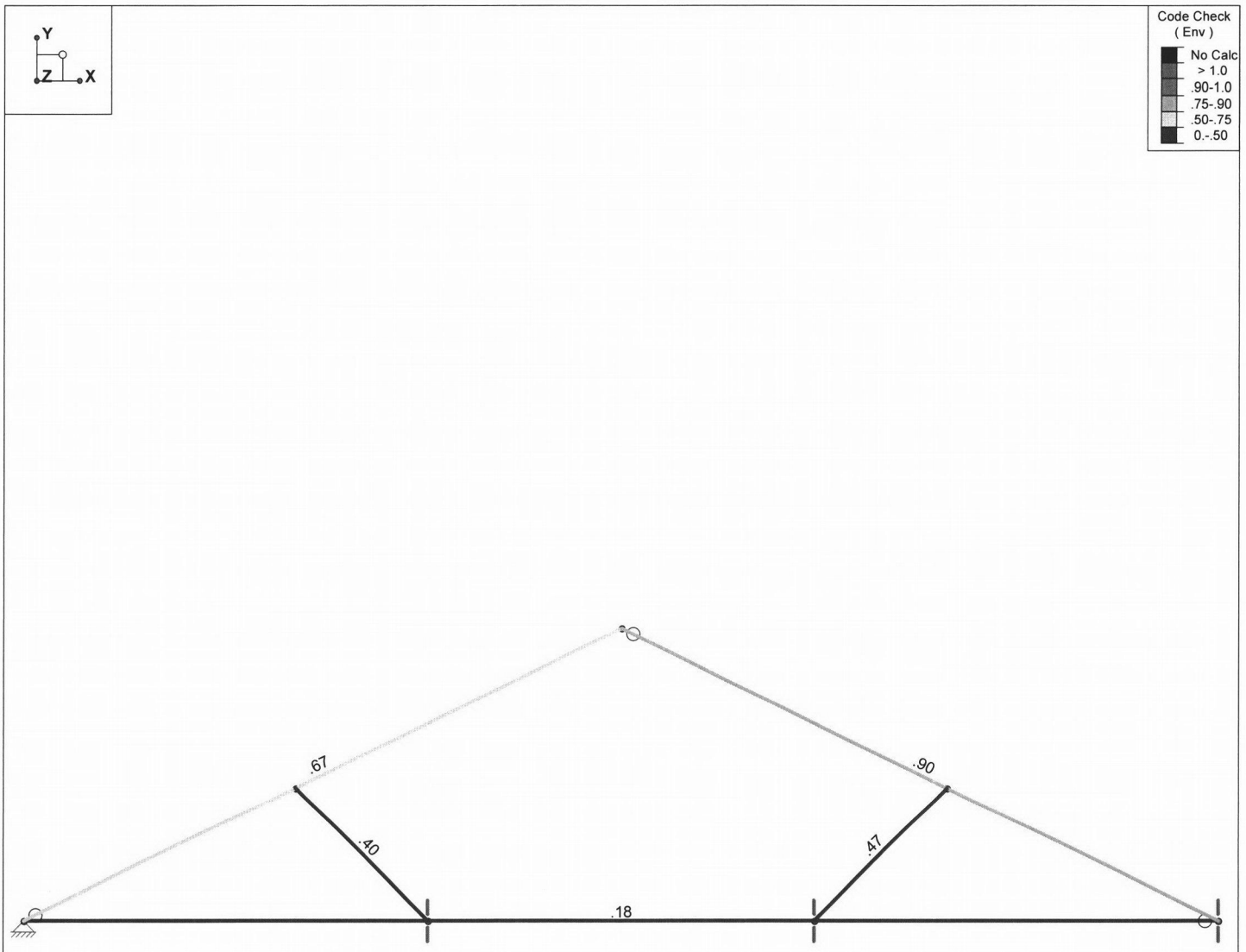
| **SNOW LOAD (S):** | Existing | With PV Array | |
|---|---|---|---|
| Roof Slope (:12): | 5.9 | 5.9 | |
| Roof Slope [°]: | 26 | 26 | |
| Snow Ground Load, $p_g$ [psf]: | 20 | 20 | ASCE 7-10, Section 7.2 |
| Terrain Category: | C | C | ASCE 7-10, Table 7-2 |
| Exposure of Roof: | Fully Exposed | Fully Exposed | ASCE 7-10, Table 7-2 |
| Exposure Factor, $C_e$: | 0.9 | 0.9 | ASCE 7-10, Table 7-2 |
| Thermal Factor, $C_t$: | 1.1 | 1.1 | ASCE 7-10, Table 7-3 |
| Risk Category: | II | II | ASCE 7-10, Table 1.5-1 |
| Importance Factor, $I_S$: | 1.0 | 1.0 | ASCE 7-10, Table 1.5-2 |
| Flat Roof Snow Load, $p_f$ [psf]: | 14 | 14 | ASCE 7-10, Equation 7.3-1 |
| Minimum Roof Snow Load, $p_m$ [psf]: | 20 | 20 | ASCE 7-10, Section 7.3.4 |
| Design Snow Load, S [psf]: | 20 | 20 | |




Envelope Only Solution

| | | |
|---|---|---|
| Vector Structural Engineers | Brian Van Horn Model | SK - 8 |
| DGD | | Apr 21, 2017 at 3:57 PM |
| U2001-0820-171 | | truss.r3d |




Member Code Checks Displayed (Enveloped)
Envelope Only Solution

| | | |
|---|---|---|
| Vector Structural Engineers | Brian Van Horn Model | SK - 7 |
| DGD | | Apr 21, 2017 at 3:57 PM |
| U2001-0820-171 | | truss.r3d |

## (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 |
| Include Warping? | Yes |
| Trans Load Btwn Intersecting Wood Wall? | Yes |
| Area Load Mesh (in^2) | 144 |
| Merge Tolerance (in) | .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) | 24 |
| Eigensolution Convergence Tol. (1.E-) | 4 |
| Vertical Axis | Y |
| Global Member Orientation Plane | XZ |
| Static Solver | Sparse Accelerated |
| Dynamic Solver | Accelerated Solver |

| | |
|---|---|
| Hot Rolled Steel Code | AISC 14th(360-10): ASD |
| Adjust Stiffness? | Yes(Iterative) |
| RISAConnection Code | AISC 14th(360-10): ASD |
| Cold Formed Steel Code | AISI S100-12: ASD |
| Wood Code | AWC NDS-12: ASD |
| Wood Temperature | < 100F |
| Concrete Code | ACI 318-11 |
| Masonry Code | ACI 530-13: ASD |
| Aluminum Code | AA ADM1-10: ASD - Building |

| | |
|---|---|
| Number of Shear Regions | 4 |
| Region Spacing Increment (in) | 4 |
| Biaxial Column Method | Exact Integration |
| Parme Beta Factor (PCA) | .65 |
| Concrete Stress Block | Rectangular |
| Use Cracked Sections? | Yes |
| Use Cracked Sections Slab? | 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 |

## (Global) Model Settings, Continued

| | |
|---|---|
| Seismic Code | ASCE 7-10 |
| Seismic Base Elevation (ft) | Not Entered |
| Add Base Weight? | Yes |
| Ct X | .02 |
| Ct Z | .02 |
| T X (sec) | Not Entered |
| T Z (sec) | Not Entered |
| R X | 3 |
| R Z | 3 |
| Ct Exp. X | .75 |
| Ct Exp. Z | .75 |
| SD1 | 1 |
| SDS | 1 |
| S1 | 1 |
| TL (sec) | 5 |
| Risk Cat | I or II |
| Drift Cat | Other |
| Om Z | 1 |
| Om X | 1 |
| Cd Z | 1 |
| Cd X | 1 |
| Rho Z | 1 |
| Rho X | 1 |
| | |

## 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 | .3 | .3 | .035 |
| 2 | SP | Solid Sawn | Visually Gr... | Southern Pine | No.1 | | 1 | .3 | .3 | .035 |
| 3 | HF | Solid Sawn | Visually Gr... | Hem-Fir | Stud | | 1 | .3 | .3 | .035 |
| 4 | 1X | Custom | N/A | DF#2 | na | | 1 | .3 | .3 | .035 |
| 5 | Cedar #2 | Solid Sawn | Visually Gr... | Western Cedars | No.2 | | 1 | .3 | .3 | .035 |

## Wood Section Sets

| | Label | Shape | Type | Design List | Material | Design Rules | A [in2] | Iyy [in4] | Izz [in4] | J [in4] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Top Chord | 2-2X4 | Beam | Rectangular | DF | Typical | 10.5 | 7.875 | 10.719 | 15.255 |
| 2 | Bottom Chord | 2X6 | Beam | Rectangular | DF | Typical | 8.25 | 1.547 | 20.797 | 5.125 |
| 3 | Web | 2X4 | VBrace | Rectangular | DF | Typical | 5.25 | .984 | 5.359 | 2.877 |

## Joint Coordinates and Temperatures

| | Label | X [ft] | Y [ft] | Z [ft] | Temp [F] | Detach From Diap... |
|---|---|---|---|---|---|---|
| 1 | N3 | 31.1667 | 0 | 0 | 0 | |
| 2 | N2 | 15.583333 | 7.6 | 0 | 0 | |
| 3 | N1 | 0 | 0 | 0 | 0 | |
| 4 | N5 | 10.538 | 0 | 0 | 0 | |
| 5 | N6 | 20.628 | 0 | 0 | 0 | |
| 6 | N7 | 7.08333 | 3.454544 | 0 | 0 | |
| 7 | N8 | 24.08333 | 3.454556 | 0 | 0 | |
| 8 | N10A | 0 | 0 | 0 | 0 | |

## Member Distributed Loads (BLC 1 : Roof Dead)

| | Member Label | Direction | Start Magnitude[lb/ft,... | End Magnitude[lb/ft,F... | Start Location[ft,%] | End Location[ft,%] |
|---|---|---|---|---|---|---|
| 1 | M1 | y | -5.333 | -5.333 | 0 | 0 |
| 2 | M2 | y | -12.6 | -12.6 | 0 | 0 |
| 3 | M3 | y | -12.6 | -12.6 | 0 | 0 |

## Member Distributed Loads (BLC 2 : Roof Live)

| | Member Label | Direction | Start Magnitude[lb/ft,... | End Magnitude[lb/ft,F... | Start Location[ft,%] | End Location[ft,%] |
|---|---|---|---|---|---|---|
| 1 | M2 | Y | -40 | -40 | 0 | 0 |
| 2 | M3 | Y | -40 | -40 | 0 | 3 |

## Member Distributed Loads (BLC 3 : Panel Dead)

| | Member Label | Direction | Start Magnitude[lb/ft,... | End Magnitude[lb/ft,F... | Start Location[ft,%] | End Location[ft,%] |
|---|---|---|---|---|---|---|
| 1 | M3 | Y | -12 | -12 | 3 | 0 |

## Member Distributed Loads (BLC 4 : Wind)

| | Member Label | Direction | Start Magnitude[lb/ft,... | End Magnitude[lb/ft,F... | Start Location[ft,%] | End Location[ft,%] |
|---|---|---|---|---|---|---|
| 1 | M2 | y | 50.86 | 50.86 | 0 | 0 |
| 2 | M3 | y | 50.86 | 50.86 | 0 | 0 |

## Member Distributed Loads (BLC 5 : Snow Unbalanced)

| | Member Label | Direction | Start Magnitude[lb/ft,... | End Magnitude[lb/ft,F... | Start Location[ft,%] | End Location[ft,%] |
|---|---|---|---|---|---|---|
| 1 | M3 | y | 0 | 0 | 0 | 0 |

## Member Distributed Loads (BLC 6 : Snow)

| | Member Label | Direction | Start Magnitude[lb/ft,... | End Magnitude[lb/ft,F... | Start Location[ft,%] | End Location[ft,%] |
|---|---|---|---|---|---|---|
| 1 | M2 | y | -40 | -40 | 0 | 0 |
| 2 | M3 | y | -40 | -40 | 0 | 0 |

## Basic Load Cases

| | BLC Description | Category | X Gravity | Y Gravity | Z Gravity | Joint | Point | Distributed | Area(Me... | Surface(P... |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Roof Dead | DL | | -1 | | | | 3 | | |
| 2 | Roof Live | RLL | | | | | | 2 | | |
| 3 | Panel Dead | DL | | | | | | 1 | | |
| 4 | Wind | WL | | | | | | 2 | | |
| 5 | Snow Unbalanced | OL1 | | | | | | 1 | | |
| 6 | Snow | SL | | | | | | 2 | | |

## 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... |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 DL | Yes | Y | | DL | 1 | | | | | | | | | | | | | | | | | | | | |
| 2 | 1.0 DL + 1.. | Yes | Y | | DL | 1 | SL | 1 | | | | | | | | | | | | | | | | | | |
| 3 | 1.0 DL + .... | Yes | Y | | DL | 1 | WL | .45 | RLL | .75 | | | | | | | | | | | | | | | | |
| 4 | 1.0 DL + 1.. | | Y | | DL | 1 | OL1 | 1 | | | | | | | | | | | | | | | | | | |

## Envelope Member Section Forces

| | Member | Sec | | Axial[lb] | LC | y Shear[lb] | LC | z Shear[lb] | LC | Torque[lb-ft] | LC | y-y Momen... | LC | z-z Momen... | LC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M1 | 1 | max | -164.767 | 1 | 32.555 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 2 | | | min | -503.796 | 2 | 31.235 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 3 | | 2 | max | -164.767 | 1 | -24.622 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -20.621 | 1 |
| 4 | | | min | -503.796 | 2 | -25.942 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | -30.903 | 2 |
| 5 | | 3 | max | -44.311 | 1 | .321 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | -4.693 | 2 |
| 6 | | | min | -212.26 | 3 | -.244 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -14.4 | 1 |
| 7 | | 4 | max | -243.537 | 3 | 25.943 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | -20.614 | 3 |
| 8 | | | min | -583.754 | 2 | 24.523 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -31.673 | 2 |
| 9 | | 5 | max | -243.537 | 3 | -31.234 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 10 | | | min | -583.754 | 2 | -32.654 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 11 | M2 | 1 | max | 635.609 | 2 | 154.033 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 12 | | | min | 203.566 | 1 | 41.524 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 13 | | 2 | max | 630.76 | 2 | -23.032 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | -40.068 | 1 |
| 14 | | | min | 198.717 | 1 | -83.902 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -151.96 | 2 |
| 15 | | 3 | max | 437.975 | 2 | 275.658 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 327.014 | 2 |
| 16 | | | min | 138.984 | 1 | 74.673 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 87.697 | 1 |
| 17 | | 4 | max | 433.126 | 2 | 37.723 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -96.061 | 1 |
| 18 | | | min | 134.135 | 1 | 10.116 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | -352.153 | 2 |
| 19 | | 5 | max | 428.277 | 2 | -54.44 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 20 | | | min | 115.423 | 3 | -200.212 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 21 | M3 | 1 | max | 421.506 | 2 | 214.102 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 22 | | | min | 122.506 | 1 | 48.321 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 23 | | 2 | max | 433.375 | 2 | -10.606 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | -45.643 | 3 |
| 24 | | | min | 134.375 | 1 | -38.227 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -402.752 | 2 |
| 25 | | 3 | max | 461.024 | 2 | -24.422 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | 379.919 | 2 |
| 26 | | | min | 162.024 | 1 | -322.912 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 33.981 | 3 |
| 27 | | 4 | max | 712.247 | 2 | 99.203 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | .24 | 3 |
| 28 | | | min | 246.229 | 3 | 6.107 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | -186.952 | 2 |
| 29 | | 5 | max | 739.896 | 2 | -5.997 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 30 | | | min | 273.878 | 3 | -185.482 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 31 | M4 | 1 | max | 626.125 | 2 | -.95 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | -15.907 | 1 |
| 32 | | | min | 171.288 | 1 | -16.961 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -70.55 | 2 |
| 33 | | 2 | max | 627.227 | 2 | -2.052 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | -14.074 | 1 |
| 34 | | | min | 172.39 | 1 | -18.063 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -49.161 | 2 |
| 35 | | 3 | max | 628.329 | 2 | -3.154 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | -10.895 | 1 |
| 36 | | | min | 173.492 | 1 | -19.165 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -26.426 | 2 |
| 37 | | 4 | max | 629.431 | 2 | -4.256 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | -2.345 | 2 |
| 38 | | | min | 174.594 | 1 | -20.267 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -6.369 | 1 |
| 39 | | 5 | max | 630.533 | 2 | -5.358 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 23.082 | 2 |
| 40 | | | min | 175.696 | 1 | -21.369 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -.498 | 1 |
| 41 | M7 | 1 | max | 745.51 | 2 | 23.381 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 26.534 | 2 |
| 42 | | | min | 49.269 | 3 | 5.046 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | -.752 | 3 |
| 43 | | 2 | max | 744.408 | 2 | 22.279 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -1.353 | 2 |
| 44 | | | min | 48.167 | 3 | 3.944 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | -6.243 | 3 |
| 45 | | 3 | max | 743.306 | 2 | 21.177 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -10.387 | 3 |
| 46 | | | min | 47.065 | 3 | 2.842 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | -27.894 | 2 |
| 47 | | 4 | max | 742.204 | 2 | 20.074 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -13.185 | 3 |
| 48 | | | min | 45.963 | 3 | 1.739 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | -53.089 | 2 |
| 49 | | 5 | max | 741.102 | 2 | 18.972 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | -14.636 | 3 |
| 50 | | | min | 44.861 | 3 | .637 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | -76.936 | 2 |

## Envelope Wood Code Checks

| | Member | Shape | Code | ...Loc[ft] | LC | Shear... | Loc[ft] | Dir | LC | Fc' [ksi] | Ft' [ksi] | Fb1' [... | Fb2' [... | Fv' [ksi] | RB | CL | CP | Eqn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M1 | 2X6 | .181 | 20.4... | 2 | .051 | 10.3... | y | 1 | .833 | .86 | .734 | 1.779 | .162 | 30.236 | .474 | .488 | 3.9-3 |
| 2 | M2 | 2-2X4 | .666 | 7.947 | 2 | .218 | 7.947 | y | 2 | .43 | .992 | 1.774 | 1.964 | .207 | 6.643 | .994 | .241 | 3.9-3 |
| 3 | M3 | 2-2X4 | .896 | 9.391 | 2 | .256 | 9.391 | y | 2 | .43 | .992 | 1.544 | 1.708 | .207 | 6.643 | .995 | .241 | 3.9-3 |
| 4 | M4 | 2X4 | .397 | 4.886 | 2 | .029 | 4.886 | y | 2 | .302 | .992 | 1.533 | 1.708 | .207 | 9.55 | .988 | .169 | 3.6.3 |
| 5 | M7 | 2X4 | .470 | 0 | 2 | .032 | 0 | y | 2 | .302 | .992 | 1.533 | 1.708 | .207 | 9.55 | .988 | .169 | 3.6.3 |