iROOFA®

Instant Roof Framing Analysis

www.iroofa.solar

*tel: 540.313.5317 - email: info@iRooFA.solar*

# STRUCTURAL ANALYSIS

for the

# ROOFTOP PV SOLAR INSTALLATION

Project: Rusty Berry, 151 Nw Chadley Ln, Lake City, FL 32055

Prepared for:

Lunex Power

4721 N Grady Ave - Tampa, FL 33614

## Calculation Report Index

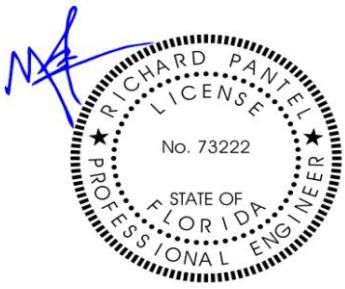

| Pages | Description | | |
|---|---|---|---|
| 1 | Cover | 2-5 | Loading Summary |
| | *Roof Structural Calculations for PV Solar Installation* | | |
| 6-9 | Location: MP 1 | | |
| 10-10 | Snow Loading Calculations | | |
| 11-12 | Truss FEA Calculations | | |


Project No: 66.433040, Rev. 0

Report Date: 04/01/2026

Report Prepared by:

*This item has been digitally signed and sealed by Richard Pantel, P.E. on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.*




Richard Pantel, P.E.
FL License No. 73222
Sealed 04/01/2026

Richard Pantel Digitally signed by Richard Pantel
Date: 2026.04.01 16:35:37 -05'00'

*V260401*
*ID.ec24 17:15*

# Loading Summary

| Exposure and Occupancy Categories | | |
|---|---|---|
| B | | *Exposure Category (ASCE 7-22 Table 26.7.3, Page 274)* |
| II | | *Building Use Occupancy / Risk Category (ASCE 7-22 Table 1.5-1, Page 5)* |

| Wind Loading: | | | |
|---|---|---|---|
| v | 119 | *mph* | *Value overridden from ASCE Hazards default* |
| qz | 21.57 | *psf* | *Velocity qz, calculated at height z* |

| Snow Loading | | | |
|---|---|---|---|
| pg | 4.21 | *psf* | *Ground Snow Load pg (Value overridden from ASCE Hazards default)* |
| *Total Snow Load* | | | |
| ps | 4.21 | *psf* | *Effective snow load on roof and modules* |

| Module Data | | | |
|---|---|---|---|
| Q Cells: Q.TRON BLK M-G2.C+ 430W | | | |
| Dimensions | *mm* | *ft* | *in* |
| *Length* | 1,722 | 5.65 | 67.80 |
| *Width* | 1,134 | 3.72 | 44.65 |
| *Area (m^2, ft^2)* | 2.0 | 21.02 | |
| Weight | kg | lb | psf load |
| *Module* | 21.20 | 46.74 | 2.22 |

| Roof Panel (Cladding) Loading Summary | | Module Loading Summary | | | |
|---|---|---|---|---|---|
| *Support Point Loads* | | *Upward* | *Upward* | *Upward* | *Downward* |
| Roof Zones | | 1,2e | 2n,2r,3e | 3r | All |
| Net load per module | *lb* | -44 | -73 | -89 | 46 |

*Positive values indicate net downward force*

**Primary Stanchion: Sunmodo K50563-001 MRB (Wood Deck)**

| StanchionFastener Pull-out and Spacing Calculations | | | |
|---|---|---|---|
| Framing spacing | *ft* | 2.00 | |
| Rails / Module | *ea* | 2 | |
| Max proposed stanchion span | *ft* | 3.00 | |
| # fasteners per stanchion | | 4 | |
| Bolt thread embedment depth | *in* | 0.50 | |
| Safety Factor | | 1.10 | |
| Pull-out for 1/4 threaded fasteners | *lb/in* | 186 | *lb per inch of embedment* |
| Factored max fastener uplift capacity | *lb* | 338 | |
| Fastener details *Material* Stainless | *Size* | 1/4 | *Predrill hole 0.12" dia or use self tapping* |
| Max stanchion uplift capacity | *lb* | 595 | |
| Max support point uplift capacity | *lb* | 338 | |

| **Roof Zones** | | *1,2e* | *2n,2r,3e* | *3r* |
|---|---|---|---|---|
| Net lift per module | *lb* | 44 | 73 | 89 |
| Min tot bolt thread embedment depth rq'd | *in* | 0.07 | 0.11 | 0.13 |
| Net uplift pressure 7. 0.60D - 0.6W | *psf* | -7.83 | -13.01 | -15.67 |
| Allowable lift area / support point | *sf* | 43.12 | 25.97 | 21.55 |
| Max rail span per support spacing | *ft* | 3.00 | 3.00 | 3.00 |
| **Landscape Modules** | | | | |
| Length along rafter | *ft* | 3.72 | | |
| Lift calc'ed max stanchion EW spacing | *ft* | > 6 | > 6 | > 6 |
| Max stanchion EW spacing | *ft* | 3.00 | 3.00 | 3.00 |
| Maximum module area / support point | *sf* | 5.58 | 5.58 | 5.58 |
| Factored lift per support point | *lb* | -44 | -73 | -87 |
| **Portrait Modules** | | | | |

| | | | | |
|---|---|---|---|---|
| Length along rafter | *ft* | 5.65 | | |
| Lift calc'ed max stanchion EW spacing | *ft* | > 6 | > 6 | 6.00 |
| Max stanchion EW spacing | *ft* | 3.00 | 3.00 | 3.00 |
| Maximum module area / support point | *sf* | 8.47 | 8.47 | 8.47 |
| Factored lift per support point | *lb* | -66 | -110 | -133 |

| **Plywood Nailing Calculations** | | | | |
|---|---|---|---|---|
| Nail Size | *Gauge* | *Shank Dia* | *Length* | *W* |
| 8D | 10 | 0.134 | 2.5 | 54 |
| 10D | 9 | 0.148 | 3 | 59 |
| Load Duration Factor - Wind | 1.6 | | | |
| AWC 11.3.1 W'=W*Cd*Cm*Ct*Ceg*LD | | | | |
| 8D withdrawl force @ 2" penetration (lb) | 138 | | | |
| 10D withdrawl force @ 2.5" penetration (lb) | 189 | | | |
| | | *1,2e* | *2n,2r,3e* | *3r* |
| # 8D's Req'd / stanchion in Landscape | *ea* | 0.32 | 0.53 | 0.63 |
| # 10D's Req'd / stanchion in Landscape | *ea* | 0.23 | 0.38 | 0.46 |
| # 8D's Req'd / stanchion in Portrait | *ea* | 0.48 | 0.80 | 0.96 |
| # 10D's Req'd / stanchion in Portrait | *ea* | 0.35 | 0.58 | 0.70 |

Stanchion support threaded fastener sizes are indicated in the Module Loading Summary table above. Lift forces were determined from GCp and other coefficients contained in the ASCE nomographs

## Conclusions

We were asked to review the roof of Rusty Berry, located at 151 Nw Chadley Ln, Lake City, FL, by Lunex Power, to determine its suitability to support a PV solar system installation.

Building design plans were used in the preparation of the roof structural calculations combined with the PV solar module locations shown on the PV solar roof layout design prepared by Lunex Power. Loads are calculated to combine the existing building and environmental loads with the proposed new PV array loads.

The Unirac NXT Umount Rail racking and Sunmodo K50563-001 MRB (Wood Deck) stanchions were selected for this project by Lunex Power. The racking and support stanchions shall be placed as shown on their plans, dated 04/01/2026, and shall be fastened to the roof deck using fastener sizes indicated in this report. Rack support spacing shall be no more than that shown above. Note that support points for alternating rows shall share the same truss cavity. Intermediate rows shall move the support points laterally to the next truss cavity.


***Google Location Map***

***Framing Summary***

| | Ex. Framing | Total Ex DL |
|---|---|---|
| MP 1: Truss @ 24" OC | 0.79 psf | 4.38 psf |

** Wood species used in these calculations assumes spruce, pine or fir, #2 grade.*

Based upon the attached calculations and in accordance with the 2023 FBC Section R324.4 and the FBC's reference to 2021 IBC Section 1607.12.5.2, the existing roof's framing system is capable of supporting the additional loading for the proposed PV solar system along with the existing building and environmental loads. No supplemental roof framing structural supports are required. No further structural alterations or modifications are needed to support the system..

*Fastener notes: 1) Install fasteners with head and where required, washer, flush to material surface (no gap). Do not over-torque.*

***References and Codes:***

1) *ASCE 7-22 Minimum Design Loads for Buildings and Other Structures*
2) *2021 IBC*
3) *2023 FBC*
4) *American Wood Council, NDS 2018,Table 12.2A, 12.3.3A.*
5) *American Wood Council, Wood Structural Design, 1992, Figure 6.*

***Roof Structural Calculations for PV Solar Installation*** **Array AR-1**
***Location: MP 1*** ***Roof shape: Gable***
***Member: Truss top chord - Total Length 27 ft, Unsupported 27 ft***

| Geometric Data | | | |
|---|---|---|---|
| Θ | *deg.* | 25.0 | *Angle of roof plane from horizontal, in degrees* |
| ω | *deg.* | 0.0 | *Angle the solar panel makes with the roof surface* |
| L | *ft.* | 40.50 | *Length of roof plane, in feet (meters)* |
| W | *ft.* | 25.50 | *Plan view width of roof plane, in feet (meters)* |
| h | *ft.* | 16.18 | *Average height of roof above grade, in feet (meters)* |

| *Roof Wind Zone Width* | | | |
|---|---|---|---|
| | use, a = | 3.00 | *ft* |

| Wind Velocity Pressure, $q_z$ evaluated at the height z | | | | | | |
|---|---|---|---|---|---|---|
| $q_z$= | 21.57 | *psf* | *Vasd* $q_z$= | 13.17 | *psf* | Basic wind pressure |
| V= | 119 | mph | | | | |

| Framing Data | | |
|---|---|---|
| Wood type | US Spruce | |
| Wood source, moisture content | White 0.12% | |
| # Framing Members / Support | | 1 |
| Rafter / Truss OC | *in* | 24.00 |
| Member Total Length | *ft* | 27.00 |

| | |
|---|---|
| 2 | # Rafters / Rack Support Width |
| 2.00 | Rack Support Spacing (ft) |
| 36.00 | Max. Rack Support Spacing (in) |
| 4 | Max # of mod's / Truss top chord |

| **Member Properties** | | **Member** |
|---|---|---|
| Name | | (1) 2x4 |
| Repetitive Member Factor (Cr) | | 1.15 |

** Mem properties based upon field measurements*

| Truss top chord |
|---|

| Module Data | | | |
|---|---|---|---|
| Weight | kg | lb | psf load |
| *Module* | 21.20 | 46.74 | 2.22 |
| *4 Stanchions* | 0.45 | 1.0 | 0.05 |

| **Existing Dead Loads** | *Units* | *Value* | *Description* |
|---|---|---|---|
| Roof Deck & Surface Material* | *psf* | 3.59 | *Truss members' self weight added to FEA analysis* |
| Sum Existing DL Roof Loads | *psf* | 4.38 | |

** Roof surface: Standing Seam Metal, Steel, 24 Gauge, 12-Inc*

| Rack Support Spacing and Loading | | | | |
|---|---|---|---|---|
| Across rafters | *ft* | 2.0 | | |
| Along rafter slope | *ft* | 5.6 | | |
| Area / support point | *sf* | 5.6 | | |
| Uphill gap between modules | *in* | 1.0 | 0.08 | *ft* |

| | | | |
|---|---|---|---|
| Member Total Length | *ft* | 27.00 | |
| Maximum member free span | *ft* | 27.00 | Truss top chord span |

**ASCE 7-22** **Method for Calculating Uplift on PV Modules**

Notation
Lp = Panel chord length.
p = uplift wind pressure
γa = Solar panel pressure equalization factor, defined in Fig. 29.4-8.
γE = Array edge factor as defined in Section 29.4.4.
θ = Angle of plane of roof from horizontal, in degrees.

**29.4.4 Rooftop Solar Panels Parallel to the Roof Surface on Buildings of All Heights and Roof Slopes.**

Θ >= 7 deg TRUE

| | |
|---|---|
| Min.d1: Exposed | **FALSE** |
| Max.d1: Exposed | **TRUE** |
| 1.5(Lp) = | 5.58 |
| γE = | 1.5 |
| γa = | 0.67 |

***Use EXPOSED for uplift calculations***

$p = qh(GCp)\ (\gamma_E)\ (\gamma_a)$ (lb/ft2) (29.4-7)

| Zones | 1,2e | 2n,2r,3e | 3r |
|---|---|---|---|
| GCp | -1.49 | -2.14 | -2.47 |
| p, Windload (psf) | -19.70 | -28.32 | -32.77 |

Downward, Zones All Zones
GCp 0.47

| ASCE 7-22 Chapter 2 Combinations of Loads, Table 2.4, Page 8 (in psf) | | | | |
|---|---|---|---|---|
| Zones | 1,2e | 2n,2r,3e | 3r | All Zones |
| 2.2 SYMBOLS AND NOTATION | *Module Upward* | *Module Upward* | *Module Upward* | *Downward* |
| D = dead load of PV Module + Stanchion | 2.27 | 2.27 | 2.27 | 2.27 |
| S = snow load | 4.21 | 4.21 | 4.21 | 4.21 |
| W = Vasd Windload | -19.70 | -28.32 | -32.77 | 6.24 |

| ***2.4 Combining Nominal Loads Using Allowable Stress Design (in psf)*** | | | | |
|---|---|---|---|---|
| 2.4.1 Basic Combinations. Loads listed herein shall be considered to act in the following combinations; whichever produces the most unfavorable effect in the building, foundation, or structural member being considered. Effects of one or more loads not acting shall be considered. | | | | |
| *Combination Formulae* | *Upward* | *Upward* | *Upward* | *Downward* |
| **Use this loading combination for DOWNWARD for Proposed PV Dead Load** | | | | |
| 6. D + 0.75L - 0.75(0.60W) + 0.75(Lr or S or R) | 6.48 | 6.48 | 6.48 | 9.29 |
| Module Support point load (lb) | 37 | 37 | 37 | 52 |
| Cr Factored Module Support point load (lb) | 32 | 32 | 32 | 46 |

| **Use this loading combination for UPWARD for Proposed PV Dead Load** | | | | |
|---|---|---|---|---|
| 7. 0.60D - 0.6W | -7.83 | -13.01 | -15.67 | 6.65 |
| Module Support point load (lb) | -44 | -73 | -89 | 38 |

**DOWNWARD**

*Presume loading directly over member.*

| ***Combined Dead and Wind Pressure Downward Loading*** | | | | | |
|---|---|---|---|---|---|
| | Truss top chord span | | | | |
| PV Module Row | Point load loc's from Left support | Point Load #'s | Module Support Point Load | Comment | Module Orientation |
| | *ft from left* | | *lb* | | |
| 1 | 1.00 | | 46 | | Portrait |
| 1 | 6.65 | | | Support placed on adjoining truss | Portrait |
| 2 | 6.73 | | | Support placed on adjoining truss | Portrait |
| 2 | 12.38 | | 46 | | Portrait |
| 3 | 12.47 | | 46 | | Portrait |
| 3 | 18.12 | | | Support placed on adjoining truss | Portrait |
| 4 | 18.20 | | | Support placed on adjoining truss | Portrait |
| 4 | 23.85 | | 46 | | Portrait |

## Truss Data and Loading for MP 1

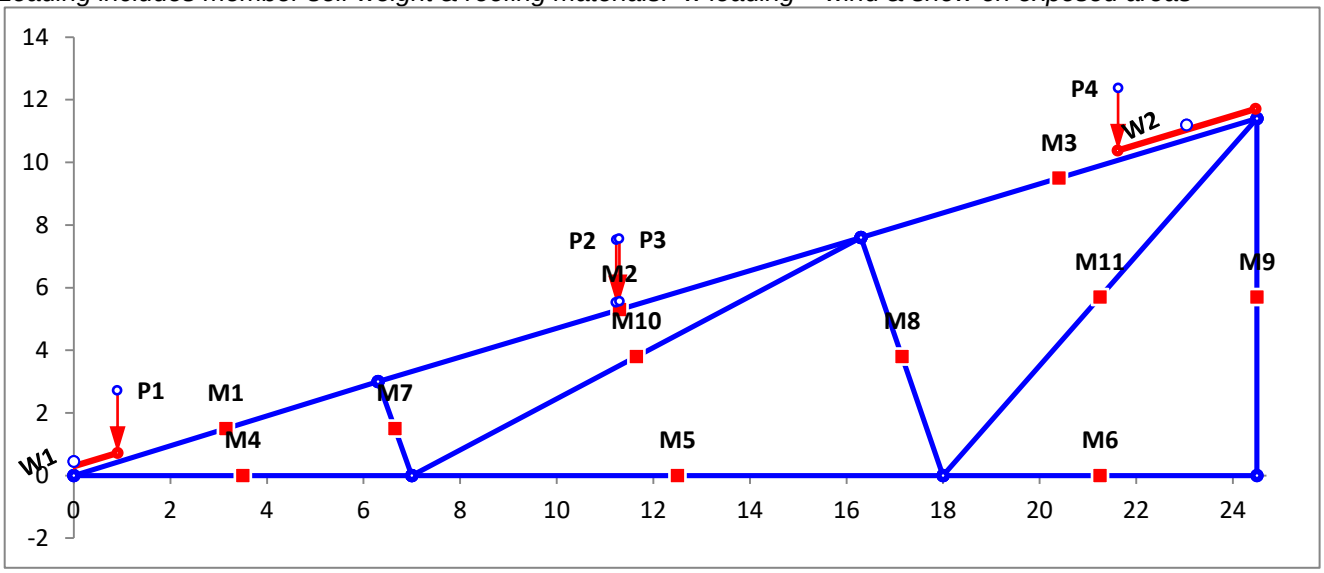
| | |
|---|---|
| Roof slope (degrees) | 25.00 |
| Top ridge height above floor plane | 11.41 |

| | | |
|---|---|---|
| | Length of roof plane | 27.00 |
| | Length of floor plane | 24.50 |

### Truss Segments

| *Roof Plane* | | *Floor Plane* | | *Diagonals* | | *Diagonals* | |
|---|---|---|---|---|---|---|---|
| Mem # | *Mem Type* | Mem # | *Mem Type* | Mem # | *Mem Type* | Mem # | *Mem Type* |
| 1 | 2x4 | 4 | 2x4 | 7 | 2x4 | 10 | 2x4 |
| 2 | 2x4 | 5 | 2x4 | 8 | 2x4 | 11 | 2x4 |
| 3 | 2x4 | 6 | 2x4 | 9 | 2x4 | | |

** Loading includes member self weight & roofing materials. w loading = wind & snow on exposed areas*



**Snow Loading Analysis**

where:

| | | | |
|---|---|---|---|
| | | Fully Exposed | Exposure category |
| **Ce** | = | 0.9 | Exposure Factor, Ce (ASCE 7-22 Table 7.3-1, Page 61) |
| **Ct** | = | 1.0 | Thermal Factor, Ct (ASCE 7-22 Table 7.3-2, Page 61) |
| **Is** | = | 1.0 | Snow Importance Factor, Is (ASCE 7-22 Table 1.5-2, Page 5) |
| $p_g$ | = | 4.21 | Ground Snow Load pg (Value overridden from ASCE Hazards default) |

$p_f$ = **0.7CeCtIsPg** Flat Roof Snow Load, pf (ASCE 7-22 Table 7.3-1, Page 61)

$p_f$ = **2.65** psf

but where Pf is not less than the following:

Minimum Snow Load pm (ASCE 7-22 Table 7.3.4, Page 62)

$p_m$ = **4.21** When Pg <=20 psf, then use Pf = Pg x Is

$p_f$ = **4.21** psf. Resultant Snow pressure to be used with Roof slope factor below

$p_s$ = $C_s p_f$ Sloped Roof Snow Load ps (ASCE 7-22 Table 7.4, Page 61)

Roof Type Warm Roofs

*Roof slope factor Cs for Warm Roofs, where Ct = 1.0*

Roof surface condition = Slippery Roof

$C_s$ = 1.00 Roof Slope Factor, Cs (ASCE 7-22 Table 7.4-1a, Page 62)

**Total Snow Load**

| | | | | |
|---|---|---|---|---|
| $p_s$ | = | **4.21** | **psf** | Roof snow load |

# FEA Calculation Results for Roof Plane MP 1 for Lunex Power Client RUSTY BERRY

***IDSPL - 2D Frame Analysis of a 2D frame subject to distributed loads, point loads and moments***

| Equilibrium check | FX | FY | 0.00295 |
|---|---|---|---|
| Total applied forces | 0.00 | 1192 | |
| Total output reactions | 0.00 | -1192 | |
| Output error | 4.20E-13 | -3.64E-12 | |

| | Shear | Ax |
|---|---|---|
| Max (psi) | 3 | 148 |
| Allowable (psi) | 115 | 5,610 |
| # of segments/beam | | 1 |

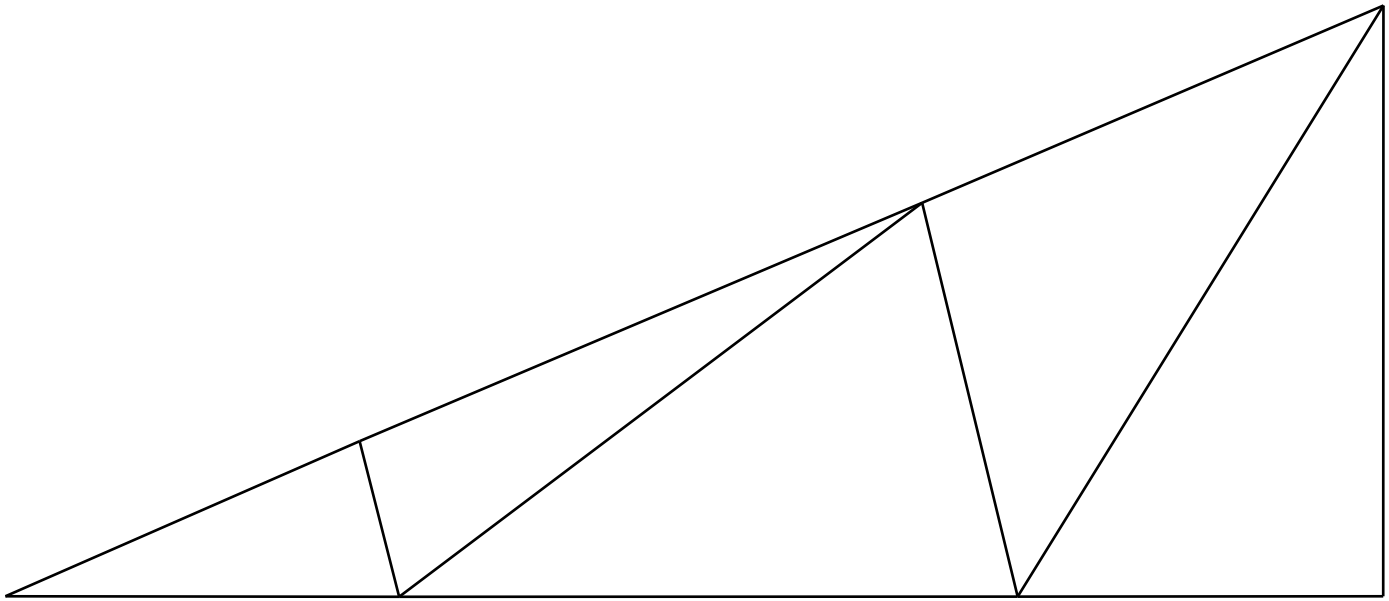
| Maximum Deflections | |
|---|---|
| -1.53E-03 | -4.67E-03 |

** vertical deflections do not take into account any supporting intermediate walls*

| Node Results | | | Beam End Results | | | |
|---|---|---|---|---|---|---|
| Direction | Deflection | Reaction | Beam | Shear | Axial | BM |
| DX1 | 0.00E+00 | 0 | 1-1 | -31 | 756 | 0 |
| DY1 | 0.00E+00 | -415 | 1-2 | 84 | 701 | 0 |
| RZ1 | 0.00E+00 | 0 | 2-1 | -33 | 723 | 0 |
| DX2 | -1.52E-03 | 0 | 2-2 | 145 | 641 | 0 |
| DY2 | 4.47E-03 | 0 | 3-1 | -159 | 391 | 0 |
| RZ2 | 0.00E+00 | 0 | 3-2 | 237 | 208 | 0 |
| DX3 | -2.69E-04 | 0 | 4-1 | -62 | -669 | 0 |
| DY3 | 3.74E-03 | 0 | 4-2 | 66 | -669 | 0 |
| RZ3 | 0.00E+00 | 0 | 5-1 | 0 | -392 | 0 |
| DX4 | 1.37E-03 | 0 | 5-2 | 0 | -392 | 0 |
| DY4 | 9.15E-04 | 0 | 6-1 | 0 | 0 | 0 |
| RZ4 | 0.00E+00 | 0 | 6-2 | 0 | 0 | 0 |
| DX5 | -4.98E-04 | 0 | 7-1 | 0 | 117 | 0 |
| DY5 | 4.67E-03 | 0 | 7-2 | -1 | 109 | 0 |
| RZ5 | 0.00E+00 | 0 | 8-1 | 2 | 486 | 0 |
| DX6 | -9.57E-04 | 0 | 8-2 | -6 | 449 | 0 |
| DY6 | 3.18E-03 | 0 | 9-1 | 0 | 778 | 0 |
| RZ6 | 0.00E+00 | 0 | 9-2 | 0 | 701 | 0 |
| DX7 | -9.57E-04 | 0 | 10-1 | -20 | -308 | 0 |
| DY7 | 0.00E+00 | -778 | 10-2 | 45 | -362 | 0 |
| RZ7 | 0.00E+00 | 0 | 11-1 | -15 | -555 | 0 |
| Rel1-3 | 7.035E-04 | 0 | 11-2 | 34 | -641 | 0 |
| Rel1-6 | 8.179E-04 | 0 | | | | |
| Rel2-3 | -8.528E-05 | 0 | | | | |
| Rel2-6 | 7.848E-05 | 0 | | | | |

| Beam | X | Shear | Mom | Axial | DX | DY | RZ |
|---|---|---|---|---|---|---|---|
| 1 | 0.00 | -31 | 0 | 756 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 1 | 6.98 | 41 | 186 | 722 | -1.53E-03 | -4.47E-03 | 7.18E-04 |
| 2 | 0.00 | -33 | 0 | 723 | -1.52E-03 | -4.47E-03 | 0.00E+00 |
| 2 | 11.01 | 76 | 301 | 673 | -2.83E-04 | -3.73E-03 | -4.15E-05 |
| 3 | 0.00 | -159 | 0 | 391 | -2.69E-04 | -3.74E-03 | 0.00E+00 |
| 3 | 9.04 | 73 | 1014 | 283 | 1.33E-03 | -8.94E-04 | -3.12E-05 |
| 4 | 0.00 | -62 | 0 | -669 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 4 | 7.00 | 19 | 207 | -669 | -4.98E-04 | -4.67E-03 | 7.38E-04 |
| 5 | 0.00 | 0 | 0 | -392 | -4.98E-04 | -4.67E-03 | 0.00E+00 |
| 5 | 11.00 | 0 | 0 | -392 | -9.57E-04 | -3.18E-03 | -1.36E-04 |
| 6 | 0.00 | 0 | 0 | 0 | -9.57E-04 | -3.18E-03 | 0.00E+00 |
| 6 | 6.50 | 0 | 0 | 0 | -9.57E-04 | -4.34E-19 | -4.89E-04 |
| 7 | 0.00 | 0 | 0 | 117 | -4.98E-04 | -4.67E-03 | 0.00E+00 |
| 7 | 3.08 | -1 | 0 | 112 | -1.52E-03 | -4.47E-03 | 3.38E-04 |
| 8 | 0.00 | 2 | 0 | 486 | -9.57E-04 | -3.18E-03 | 0.00E+00 |
| 8 | 7.79 | -4 | -1 | 456 | -2.69E-04 | -3.74E-03 | -1.00E-04 |
| 9 | 0.00 | 0 | 0 | 778 | -9.57E-04 | 0.00E+00 | 0.00E+00 |
| 9 | 11.40 | 0 | 0 | 712 | 1.37E-03 | -9.15E-04 | -2.05E-04 |
| 10 | 0.00 | -20 | 0 | -308 | -4.98E-04 | -4.67E-03 | 0.00E+00 |
| 10 | 12.01 | 36 | 5 | -354 | -2.70E-04 | -3.74E-03 | -1.07E-04 |
| 11 | 0.00 | -15 | 0 | -555 | -9.57E-04 | -3.18E-03 | 0.00E+00 |
| 11 | 13.12 | 28 | 3 | -630 | 1.37E-03 | -9.15E-04 | -2.72E-04 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

* vertical deflections do not take into account any supporting intermediate walls



**Scaled 2X Deflected Truss Plot**
**Roof Plane MP 1 for Lunex Power Client RUSTY BERRY**