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STRUCTURAL CALCULATIONS, NOTES, & SPECIFICATIONS

PREPARED FOR:

PROJECT TYPE:

K2 Systems Crossrail Solar Ground Mount - California

DESIGNER:

K2 Systems LLC
2835 La Mirada Dr Suite A
Vista, CA 92081

PROJECT ENGINEER:

Pedro Asuncion-Velasco

PROJECT MANAGER:

Joel. J. Neal, P.E., LEED AP

T&S Job No. 21492

Date Signed: 09.24.2021

Valid Through December 31,2022
Subject to Annual Review and Reissuancex

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Job No.: *21492*
Job Name: *CA Solar Ground Mount - K2*

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Summary Letter

Date:	September 24, 2021
To:	Ryan Estrada Product Development Engineer K2 Systems LLC
From:	Pedro Asuncion-Velasco Taylor & Syfan Consulting Engineers, Inc.
Project:	K2 Systems Ground Mount System - California
T&S Job No.:	21492
Subject:	Summary Letter for K2 Systems Ground Mount System

INTRODUCTION

This Project Summary Letter is in reference to the Structural Calculation Packet for the K2 Systems Ground Mount System, dated September 24, 2021. The calculations have been performed in accordance with the 2019 *California Building Code* (CBC). The 2019 CBC references the 2016 *Minimum Design Loads for Buildings and Other Structures*, by the American Society of Civil Engineers (ASCE), referred to as ASCE 7-16. The system has been designed to withstand code-prescribed forces due to the self-weight of the racking system, weight of the solar panels, snow loads, wind loads, and seismic loads.

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SUMMARY CHARTS & LOADS

The attached pages of this summary contain charts relating the solar array's overall size and tilt angle with varying wind speeds and snow loads. Along with the Structural Notes & Specifications included herein, these charts may be used as a quick reference for looking up maximum allowed span conditions on the array location and site conditions; however, varying site and loading conditions must be determined by a registered professional engineer who can evaluate the exact topographic conditions for the specific site and exact loading conditions for that array prior to construction. Array span charts are only valid for the various site-specific conditions noted for which they were designed.

SITE-SPECIFIC ANALYSIS

Each racking configuration summarized and labeled within the following chart has been analyzed. Because there are many different possible configurations, a common case has been provided in this report as an example calculation. A registered, professional engineer is required to verify the site conditions and local code requirements to ensure the values listed herein are applicable to the site and unique project before construction. Taylor & Syfan may provide these services upon request.

Note that further analysis may be required if the location of the solar panel installation or configuration corresponds to any of the following criteria (but not limited to):

- The pitch of the solar panels (solar panel pitch) exceeds 35 degrees above the horizontal.
- A topographic factor applies to the location. Topographic factors apply, for general purposes, when the structure is on the upper one-half of a hill, or

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escarpment (mesa or bluff). For complete descriptions of topographic factors, please refer to ASCE 7-16 Section 26.8.2.

- The site specific ground snow load is greater than 50 psf.
- The site specific design wind speed is greater than 130 mph (3 second gust speed). Note that ASCE 7-16 uses a Mean Recurrence Interval (MRI) of 300 years and this design wind speed should not be compared to those provided in previous versions of ASCE 7.
- Soil conditions other than those described in the Structural Specifications.
- Adjacent to a body of water or other flat surface (such as salt flats) that exceeds 5,000 ft. (Exposure "D" per ASCE 7-16 26.7.2)
- A combination of loads and/or site conditions applies that is not addressed in the attached span and foundation charts.
- Risk Category II, III or IV.
- Seismic Design Category "F."

If one or more of these factors applies to the project location, please contact Taylor & Syfan, and we will be able to analyze the site conditions and recommend a custom engineered configuration for each specific site. A registered professional engineer must address site-specific features and factors, for wind speeds greater than 130 mph (3 sec. gust), for sites is in a wind borne debris region (as defined by ASCE 7-16 Section 26.12.3.1) or Special Wind Region (per ASCE 7-16 Figure 26.5-1A). These charts are for estimation purposes only. Sites with topographic factors shall have a licensed engineer calculate the exact design factors prior to construction. (Taylor & Syfan may be retained for this evaluation; however, they or another registered structural engineer should evaluate the site.)

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The Risk Category was assigned as Category I based on the following assumed conditions:

- The open nature of the ground mount construction and confined (fenced-in) nature of the site qualify the installation as 'uninhabitable' and therefore, the installation "represents a low risk to human life in event of failure." (CBC Table 1.5-1)
- Failure of the ground mount would not represent a loss of functionality to any receiving facilities or disrupt daily civilian life, in addition to the lower chance of complete structural failure due to the redundant nature of the array.
- The Client is willing to accept the risk accompanying a lower wind speed, which represents a lower Mean Reoccurrence Interval (MRI) than a higher Risk Category assignment (300 yr. vs 700 yr. MRI, etc.).

The seismic forces used in these calculation charts are based on values for Seismic Design Category "E" and assume Site Class D. These values incorporate the full range of short period spectral accelerations present in California as outlined in the CBC Figure 1613.2.5.

The ground snow load in these calculations assumes a value of 50 psf or less. Where ground snow loads exceed this value, a registered professional engineer shall evaluate the site specific ground snow loads and design prior to construction.

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Summary Letter

REFERENCES AND LIMITATIONS

Note that all sizes, material specifications, and weights of the racking components have been provided by K2 Systems LLC and are assumed to be accurate and correct. Installation must be in accordance with K2 Systems LLC's drawings and specifications. K2 Systems LLC shall notify Taylor & Syfan regarding any inaccuracies or changes in the materials, specifications, or details.

All waterproofing, ice effects, corrosion protection, module (panel) connections, modules, electrical components, flood effects, egress and access pathways, fire protection, setbacks, drainage issues, and all non-structural issues are the responsibility of K2 Systems LLC's customer, known as the contractor, professional solar installer, or owner. This summary letter discusses the structural adequacy of the solar racking system itself only and does not investigate or validate the adequacy of the panels or panel attachments. It is also the responsibility of K2 Systems LLC's customer to verify the site specific design forces (wind speed, topography, ground snow load, etc.) before using the charts contained in this document. Construction of any and all structures is under the jurisdiction of the local building official and building enforcement agency, which shall review and approve all projects prior to commencement of construction.

Please feel free to contact us with any questions or concerns. Thank you.

Sincerely,
Taylor & Syfan Consulting Engineers, Inc.

Pedro Asuncion-Velasco
Project Engineer

Project: **21492 – CA Solar Ground Mount – K2 Systems**

See Appendix A for Manufacturer Details & Specifications.

INSTALLATION DIMENSIONS

G	Wind Speed	Snow	Tie-Brace	Pipe Data		A*	A1**	*Concrete Depth (A)*		*Concrete Depth (A1)*	
TILT ANGLE	ASCE 7-16 (mph)	Ground Snow Load	Required?	Pipe Size	Pipe Specification	Post Spacing	Post Spacing w/ V-Brace	*Front*	*Back*	*Front*	*Back*
20°	85	0 psf	Yes	1.5”	Sch. 40	7'-9”	11'-9”	2'-0”	4'-0”	2'-6”	5'-0”
			Yes		Sch. 80	8'-9”	13'-6”	2'-0”	4'-0”	2'-6”	5'-0”
			Yes	2”	Sch. 40	9'-9”	15'-0”	2'-0”	4'-0”	2'-3”	5'-0”
			Yes		Sch. 80	10'-9”	16'-0”	2'-0”	4'-3”	2'-9”	5'-3”
20°	**85**	**0 psf**	**Yes**	**1.5”**	**Sch. 40**	**--**	**17’-0” *****	**--**	**--**	**3'-0”**	**5'-6”**
30° - 35°	90	30 psf	Yes	1.5”	Sch. 40	5'-6”	9'-0”	2'-0”	4'-6”	3'-0”	6’-0”
			Yes		Sch. 80	6'-3”	10'-9”	3'-0”	5'-0”	3'-0”	6’-0”
			Yes	2”	Sch. 40	7'-6”	12'-0”	2'-3”	5'-6”	3'-3”	7’-0”
			Yes		Sch. 80	9'-0”	13'-6”	2'-6”	6’-0”	3'-9”	7’-0”
30° - 35°	90	50 psf	Yes	1.5”	Sch. 40	5'-3”	9'-0”	2'-3”	5'-0”	3'-3”	6’-0”
			Yes		Sch. 80	5'-9”	9'-9”	2'-3”	5'-0”	3'-6”	6’-6”
			Yes	2”	Sch. 40	7'-0”	11'-0”	2'-6”	5'-3”	3'-9”	7’-0”
			Yes		Sch. 80	8'-0”	12'-6”	2'-9”	5'-6”	4'-6”	7’-0”
30° - 35°	95	30 psf	Yes	1.5”	Sch. 40	5'-6”	8'-3”	3'-0”	6'-0”	3'-6”	7'-3”
			Yes		Sch. 80	5'-9”	8'-3”	3'-0”	6'-0”	3'-6”	7'-3”
			Yes	2”	Sch. 40	7'-0”	9'-0”	3'-0”	6'-6”	3'-6”	7'-6”
			Yes		Sch. 80	8'-0”	10'-6”	3'-0”	7'-0”	3'-6”	8'-0”
30° - 35°	95	50 psf	Yes	1.5”	Sch. 40	4'-6”	6'-3”	3'-0”	6'-0”	3'-3”	6'-6”
			Yes		Sch. 80	5'-6”	7'-3”	3'-0”	6'-0”	3'-3”	7'-0”
			Yes	2”	Sch. 40	6'-0”	8'-9”	3'-0”	6'-0”	3'-6”	7'-6”
			Yes		Sch. 80	7'-0”	11'-0”	3'-0”	6'-6”	4'-9”	8'-3”

NOTES:

* Spacing “A” Indicates East-West Spacing for Arrays without V-Braces

** Spacing “A1” Indicates East-West Spacing for Arrays with V-Braces

***Increased Span Assumes Modified Bracing Support (See Page A3) and ¼” TekScrews with Hollaendar Fittings. See Page A8 for Installation Example. Construction Drawings and Attachment Details are per K2 Systems LLC.

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STRUCTURAL SPECIFICATIONS

GENERAL

1. Do not scale drawings. Contractor shall use dimensions on plans to lay out array, foundations and other elements. If dimensional questions occur, K2 Systems LLC must be consulted.

2. All construction and materials shall comply and be installed in accordance with all the requirements of all legally constituted public authorities having jurisdiction, including all county, government, and local ordinances, and the Safety Orders of the State Industrial Accident Commission, OSHA.

3. The Contractor shall be responsible for shoring and providing bracing during construction and/or erection to support all loads to which the structure may be subjected.

4. The Engineer will not be responsible for and will not have control or charge of construction means, methods, techniques, sequences, or procedures, or for safety precautions and programs in connection with the construction delineated by these plans. It should be understood that the contractor or his/her agent(s) shall supervise and direct all work and shall be solely and completely responsible for all construction means, methods, techniques, sequences, procedures, and conditions on the job site, including safety of all persons and property during the entire period of construction. Periodic observations by Taylor & Syfan Consulting Engineers Incorporated (or "Taylor & Syfan" typ.) personnel or representatives are not intended to include verification of dimensions or review the adequacy of the contractors safety measures on or near the construction site.

5. No deviations are allowed from the structural details, specifications, or notes without the written approval of the Engineer. Approval by Building Enforcement Agency, Inspector, Special Inspector, or any other party does not constitute authority to deviate from plans or specifications. All plan changes or addenda are subject to approval of the Building Enforcement Agency. Prior to construction, the Building Official shall review and approve the structural specifications, calculations, details, notes and design methodology contained herein. The processing of changes, assembly of permit documents, and acquisition of permits is the responsibility of the Contractor.

6. Special Inspectors shall obtain Building Enforcement Agency clearance prior to any work commencement. Copies of the inspection report(s) to be filed by the special inspector(s) shall be given to the Engineer. The Contractor is responsible for scheduling, coordination, and expenses involved in any and all inspections.

7. Taylor & Syfan's drawings are prepared to convey only the specific structural aspects of each detail. Additionally, impact loads or other effects from flying debris are not included. Non-structural information, including but not limited to fenestrations, fire-resistance, corrosion protection, foundations, insulation, finishes, panels, panel attachments, waterproofing, ice effects, drainage and flashing may not be included on the structural plans. Taylor & Syfan is not responsible for non-structural information. The Contractor shall obtain all non-structural information from K2 Systems LLC and Others.

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STRUCTURAL SPECIFICATIONS

8. The Building Inspector shall inspect and approve all construction for conformance to the construction documents and building code. Additionally, structural observation by Taylor & Syfan or another structural engineer is recommended to verify general conformance.

9. All construction projects require inspection and maintenance following completion. Operation, inspection, and maintenance are the sole responsibility of the Owner. The Engineer shall have no responsibility for any failures due to deviance from or neglect of the proper installation procedures, or for any failures by the Owner of Others to properly operate, inspect, or maintain the project. Ensure, and notify the Owner, that workers, equipment, storage, and other loading are not to be applied on the PV modules or racking throughout the life of the structure. Also, vegetation and debris shall be kept down to prevent snow build-up from affecting the system. In the event that the array or a portion thereof is displaced, due to seismic shaking, wind loads, or other reasons, the Owner shall re-position the array into its original design location.

10. Crossrail 80 PV Mounting Rail, Universal Pipe L-Brackets, Hollaender brace fittings, tie-braces, V-braces, pipe couplers, T-fittings, T-bolts, hex flange nuts, U-bolts, H-nuts, set screws, mid-clamps, end-clamps, modules, splice connectors, and module clamps are per K2 Systems LLC.

11.

MATERIAL REQUIREMENTS

1. Taylor & Syfan must be notified if the equipment or existing conditions are found to differ from what has been referenced or assumed in K2 Systems LLC's plans or the "Structural Calculations, Notes, & Specifications" in drawings dated 09/24/2021.

2. Cold-formed metal, other steel, and hardware exposed to weather, soil, or moisture shall be hot-dip galvanized, stainless steel, or have other corrosion protection appropriate for the installed environment specified by K2 Systems LLC. Finishing requirements for exposed steel and hardware are by others. Combining the aluminum connection hardware with the stainless steel hardware in a moist environment may promote corrosion between the two materials. Protection/isolation of differing metals is by others.

3. Pipe sections shall conform to ASTM A53 Grades B, Type E or S. "Sch. 40" indicates Standard Weight and "Sch. 80" indicates Extra Strong.

4. Embedment into soil is contingent upon the following: soil shall be firm, well graded, free of deleterious materials, non-expansive, not subject to erosion, free from foreign bodies and anything that hinders interaction between the pile and the soil surface. Where existing conditions do not match preceding qualifications, pile must be deepened such that embedment starts at competent soil.

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STRUCTURAL SPECIFICATIONS

CONCRETE & ANCHORAGE REQUIREMENTS

1. Soils values are per Table 1806.2 of the 2019 California Building Code (CBC) for Soil Type 4 (SW, SP, SM, SC, GM, & GC) minimum.

2. Concrete shall have a strength of 2500 psi at 28 days, a maximum slump of 5", a maximum W/C ratio of 0.45, and 6% +/- 1.5% air entrainment except where required by code, or specified by the local authority having jurisdiction. In an area requiring special freeze/thaw protection, concrete shall have a strength of 4500 psi at 28 days, a maximum slump of 5", a maximum W/C ratio of 0.45, and 6% +/- 1.5% air entrainment. A licensed professional engineer shall determine the Concrete Exposure Classes for the site and adjust the concrete mix specification as required. Special Inspection is not required, except where specified herein, on the plans, or by the Building Department.

3. Reinforcing steel shall be to ASTM A615, deformed, clean, and free of rust. Bars shall be 60 grade minimum (unless specified otherwise).

4. Aggregates shall be per ASTM C33. Maximum size 1½" for footings and 1" for all other work. Reduce maximum aggregate size as required to conform to ACI 318 Section 3.3.2. Coarse aggregate shall be crushed rock.

5. Reinforcing clearances for foundations shall be 3" min. when against earth and 2" min. when against a formed surface UNO. Other reinforcing clearances shall be 1 1/2" minimum UNO.

6. Removal of forms (formwork) supporting vertical surfaces shall be after 2 days min. and supporting beams or girders shall be after 15 days minimum.

7. Prevent surface and ground water from entering excavated shafts. Dewater excavated shafts before concreting. Conduct water to site drainage facilities. "Tremie Method" may be used, per Geotechnical recommendations. Place concrete in a dry shaft, unless placement underwater or by slurry displacement is approved by Engineer.

8. Excavate shafts for drilled foundation elements to indicated elevations. Excavate bottom of drilled shaft to level plane and remove loose material from bottom of excavation. Do not excavate shafts deeper than elevations indicated, unless approved by Engineer.

9. Excavate shafts for closely spaced drilled foundations and those occurring in fragile or sand strata, only after adjacent drilled foundations are filled with concrete and allowed to set. Contact Engineer if temporary casings are required.

10. Back-filling soil around piles is not allowed without prior approval & direction of soils engineer.

11. Screed concrete at cutoff elevation level. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

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12. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by excavations.

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WIND & SNOW

LOADS

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2019 CBC Solar Panel Wind Analysis - Version 1.1

Project: **21492 – CA Solar Ground Mount – K2 Systems**

Basic Wind Speed (V): ***85*** mph

Design Assumptions:
Surface Roughness Category: C (See ASCE 26.7.2)
No Topographic Effect (See ASCE 26.8.2)
Wind Forces Calculated by Main Wind Force-Resisting System for Open Structures (See ASCE 27.3.2)
Net Pressure Coefficient, C_N, from ASCE Figure 27.3-4 for Monoslope Free Roofs with a 45 Degree Max. Slope
15 ft Max. Height of Solar Panel Structure
Analysis for Ground Mount Panels Only

Velocity Pressure (q)

V (mph)	Kd	Ke	--	Kz	Kzt	q (psf)
85	**0.85**	**1.00**	**1.00**	**0.85**	**1.00**	**13.36**

Panel Data

Joist Wind Trib
2.75 ft

Design Pressure (p)

Panel Angle	Load Case	Wind Direction	G	C_{NW}	C_{NL}	p_W (psf)	p_L (psf)	w_W (plf)	w_L (plf)
15°	*A*	*0°*	*0.85*	*-1.1*	*-1.5*	*-12.5*	*-17.0*	*-34.4*	*-46.9*
15°	*B*	*0°*	*0.85*	*-1.9*	*0.0*	*-21.6*	*0.0*	*-59.4*	*0.0*
15°	*A*	*180°*	*0.85*	*1.3*	*1.6*	*14.8*	*18.2*	*40.6*	*50.0*
15°	*B*	*180°*	*0.85*	*1.2*	*-0.3*	*13.6*	*-3.4*	*37.5*	*-9.4*
20°	**A**	**0°**	**0.85**	**-1.3**	**-1.6**	**-15.1**	**-18.2**	**-41.6**	**-50.0**
20°	**B**	**0°**	**0.85**	**-2.1**	**-0.2**	**-23.9**	**-1.9**	**-65.6**	**-5.2**
20°	**A**	**180°**	**0.85**	**1.6**	**1.8**	**17.8**	**20.1**	**48.9**	**55.2**
20°	**B**	**180°**	**0.85**	**1.7**	**0.1**	**18.9**	**1.5**	**52.1**	**4.2**
30°	*A*	*0°*	*0.85*	*-1.8*	*-1.8*	*-20.4*	*-20.4*	*-56.2*	*-56.2*
30°	*B*	*0°*	*0.85*	*-2.5*	*-0.5*	*-28.4*	*-5.7*	*-78.1*	*-15.6*
30°	*A*	*180°*	*0.85*	*2.1*	*2.1*	*23.9*	*23.9*	*65.6*	*65.6*
30°	*B*	*180°*	*0.85*	*2.6*	*1.0*	*29.5*	*11.4*	*81.2*	*31.2*

*Note: C_{NW} and C_{NL} are Worst Case for Either **Clear OR Obstructed** Wind Flow*

Note: Values in grey were used for interpolation of the 20-degree wind pressure values.

Symbols and Notation
V = Basic Wind Speed (mph) per ASCE (see Figure 26.5-1A)
Kd = Wind Directionality Factor (per ASCE Table 26.6-1)
Ke = Ground Elevation Factor (per ASCE Section 26.9)
Kz = Velocity pressure exposure coefficient evaluated at height z (per ASCE Section 27.3.1)
Kzt = Topographic factor as defined in ASCE Section 26.8
q = velocity pressure in (psf) (q = 0.00256*Kz*Kzt*Kd*V^2 per ASCE 27.3.2)
p_W = Windward Design Pressure (psf) ($p = q*G*C_N$ per ACSC 27.4-3)
p_L = Leeward Design Pressure (psf) ($p = q*G*C_N$ per ACSC 27.4-3)
G = Guest effect factor
C_{NW} = Windward Net Pressure Coefficient for open buildings (See Figure 27.4-4)
C_{NL} = Leeward Net Pressure Coefficient for open buildings (See Figure 27.4-4)

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2019 CBC Solar Panel Wind Analysis - Version 1.1

Project: **21492 – CA Solar Ground Mount – K2 Systems**

Basic Wind Speed (V): ***90*** mph

Design Assumptions:
Surface Roughness Category: C (See ASCE 26.7.2)
No Topographic Effect (See ASCE 26.8.2)
Wind Forces Calculated by Main Wind Force-Resisting System for Open Structures (See ASCE 27.3.2)
Net Pressure Coefficient, C_N, from ASCE Figure 27.3-4 for Monoslope Free Roofs with a 45 Degree Max. Slope
15 ft Max. Height of Solar Panel Structure
Analysis for Ground Mount Panels Only

Velocity Pressure (q)

V (mph)	Kd	Ke	--	Kz	Kzt	q (psf)
90	**0.85**	**1.00**	**1.00**	**0.85**	**1.00**	**14.98**

Panel Data

Joist Wind Trib	
2.75	**ft**

Design Pressure (p)

Panel Angle	Load Case	Wind Direction	G	C_{NW}	C_{NL}	p_W (psf)	p_L (psf)	w_W (plf)	w_L (plf)
30°	**A**	**0°**	**0.85**	**-1.8**	**-1.8**	**-22.9**	**48.5**	**-63.0**	**133.5**
30°	**B**	**0°**	**0.85**	**-2.5**	**-0.5**	**-31.8**	**18.7**	**-87.5**	**51.5**
30°	**A**	**180°**	**0.85**	**2.1**	**2.1**	**26.7**	**66.1**	**73.5**	**181.7**
30°	**B**	**180°**	**0.85**	**2.6**	**1.0**	**33.1**	**39.0**	**91.1**	**107.1**
35°	**A**	**0°**	**0.85**	**-1.7**	**-1.8**	**-22.1**	**46.7**	**-60.7**	**128.5**
35°	**B**	**0°**	**0.85**	**-2.4**	**-0.6**	**-31.0**	**20.7**	**-85.2**	**56.8**
35°	**A**	**180°**	**0.85**	**2.1**	**2.2**	**27.2**	**71.4**	**74.7**	**196.3**
35°	**B**	**180°**	**0.85**	**2.4**	**0.8**	**31.0**	**29.2**	**85.2**	**80.2**

*Note: C_{NW} and C_{NL} are Worst Case for Either **Clear OR Obstructed** Wind Flow*

Symbols and Notation
V = Basic Wind Speed (mph) per ASCE (See per Figure 26.5-1A)
Kd = Wind Directionality Factor (per table 26.6-1)
Ke = Ground Elevation Factor (per ASCE Section 26.9)
Kz = Velocity pressure exposure coefficient evaluated at height z (per ASCE Section 27.3.1)
Kzt = Topographic factor as defined in ASCE Section 26.8
q = velocity pressure in (psf) (q = 0.00256*Kz*Kzt*Kd*V^2 per ASCE 27.3.2)
p_W = Windward Design Pressure (psf) ($p = q*G*C_N$ per ACSC 27.4-3)
p_L = Leeward Design Pressure (psf) ($p = q*G*C_N$ per ACSC 27.4-3)
G = Guest effect factor
C_{NW} = Windward Net Pressure Coefficient for open buildings (See Figure 27.4-4)
C_{NL} = Leeward Net Pressure Coefficient for open buildings (See Figure 27.4-4)

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2019 CBC Solar Panel Wind Analysis - Version 1.1

Project: **21492 – CA Solar Ground Mount – K2 Systems**

Basic Wind Speed (V): ***95*** mph

Design Assumptions:
Surface Roughness Category: C (See ASCE 26.7.2)
No Topographic Effect (See ASCE 26.8.2)
Wind Forces Calculated by Main Wind Force-Resisting System for Open Structures (See ASCE 27.4.3)
Net Pressure Coefficient, C_N, from ASCE Figure 27.4-4 for Monoslope Free Roofs with a 45 Degree Max. Slope.
15 ft Max. Height of Solar Panel Structure
Analysis for Ground Mount Panels Only

Velocity Pressure (q)

V (mph)	Kd	Ke	--	Kz	Kzt	q (psf)
95	**0.85**	**1.00**	**1.00**	**0.85**	**1.00**	**16.69**

Panel Data

Joist Wind Trib	
2.75	**ft**

Design Pressure (p)

Panel Angle	Load Case	Wind Direction	G	C_{NW}	C_{NL}	p_W (psf)	p_L (psf)	w_W (plf)	w_L (plf)
30°	**A**	**0°**	**0.85**	**-1.8**	**-1.8**	**-25.5**	**-25.5**	**-70.2**	**-70.2**
30°	**B**	**0°**	**0.85**	**-2.5**	**-0.5**	**-35.5**	**-7.1**	**-97.5**	**-19.5**
30°	**A**	**180°**	**0.85**	**2.1**	**2.1**	**29.8**	**29.8**	**81.9**	**81.9**
30°	**B**	**180°**	**0.85**	**2.6**	**1.0**	**36.9**	**14.2**	**101.4**	**39.0**
35°	**A**	**0°**	**0.85**	**-1.7**	**-1.8**	**-24.6**	**-25.5**	**-67.6**	**-70.2**
35°	**B**	**0°**	**0.85**	**-2.4**	**-0.6**	**-34.5**	**-8.0**	**-94.9**	**-22.1**
35°	**A**	**180°**	**0.85**	**2.1**	**2.2**	**30.3**	**31.7**	**83.2**	**87.1**
35°	**B**	**180°**	**0.85**	**2.4**	**0.8**	**34.5**	**11.4**	**94.9**	**31.2**

*Note: C_{NW} and C_{NL} are Worst Case for Either **Clear OR Obstructed** Wind Flow*

Symbols and Notation
V = Basic Wind Speed (mph) per ASCE (See per Figure 26.5-1A)
Kd = Wind Directionality Factor (per table 26.6-1)
Ke = Ground Elevation Factor (per ASCE Section 26.9)
Kz = Velocity pressure exposure coefficient evaluated at height z (per ASCE Section 27.3.1)
Kzt = Topographic factor as defined in ASCE Section 26.8
q = velocity pressure in (psf) (q = 0.00256*Kz*Kzt*Kd*V^2 per ASCE 27.3.2)
p_W = Windward Design Pressure (psf) ($p = q*G*C_N$ per ACSC 27.4-3)
p_L = Leeward Design Pressure (psf) ($p = q*G*C_N$ per ACSC 27.4-3)
G = Guest effect factor
C_{NW} = Windward Net Pressure Coefficient for open buildings (See Figure 27.4-4)
C_{NL} = Leeward Net Pressure Coefficient for open buildings (See Figure 27.4-4)

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2019 CBC Solar Panel Wind Analysis - Version 1.1

Project: **21492 – CA Solar Ground Mount – K2 Systems**

SNOW LOAD CALCULATIONS PER ASCE 7-16 CH. 7

Ground Snow Load, Pg

LC1 = *0* *psf*
LC2 = *30* *psf*
LC3 = *50* *psf*

Flat Roof Snow Load, Pf

Pf = 0.7 Ce Ct I Pg *Eq. 7-1*

	30 deg.	*35 deg.*	
C_e	0.90	0.90	*Table 7.3-1*
C_t	1.20	1.20	*Table 7.3-2*
I_s	0.80	0.80	*Table 1.5-2*

Sloped Roof Snow Load, Ps

Ps = Cs Pf *Eq. 7-2*

	30 deg.	*35 deg.*	
Cs	0.73	0.6	*Figure 7-2c*

Panel Data	
Rail Trib. Width	
2.75	**ft**

PV Snow Load (psf)		
pg (psf)	Tilt	
	30 deg.	*35 deg.*
0	0.00	0.00
30	18.92	16.59
50	31.54	27.65

PV Snow Load (plf)		
pg (psf)	Tilt	
	30 deg.	*35 deg.*
0	0.00	0.00
30	52.03	45.62
50	86.72	76.03

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Project: **21492 - CA Solar Ground Mount - K2**

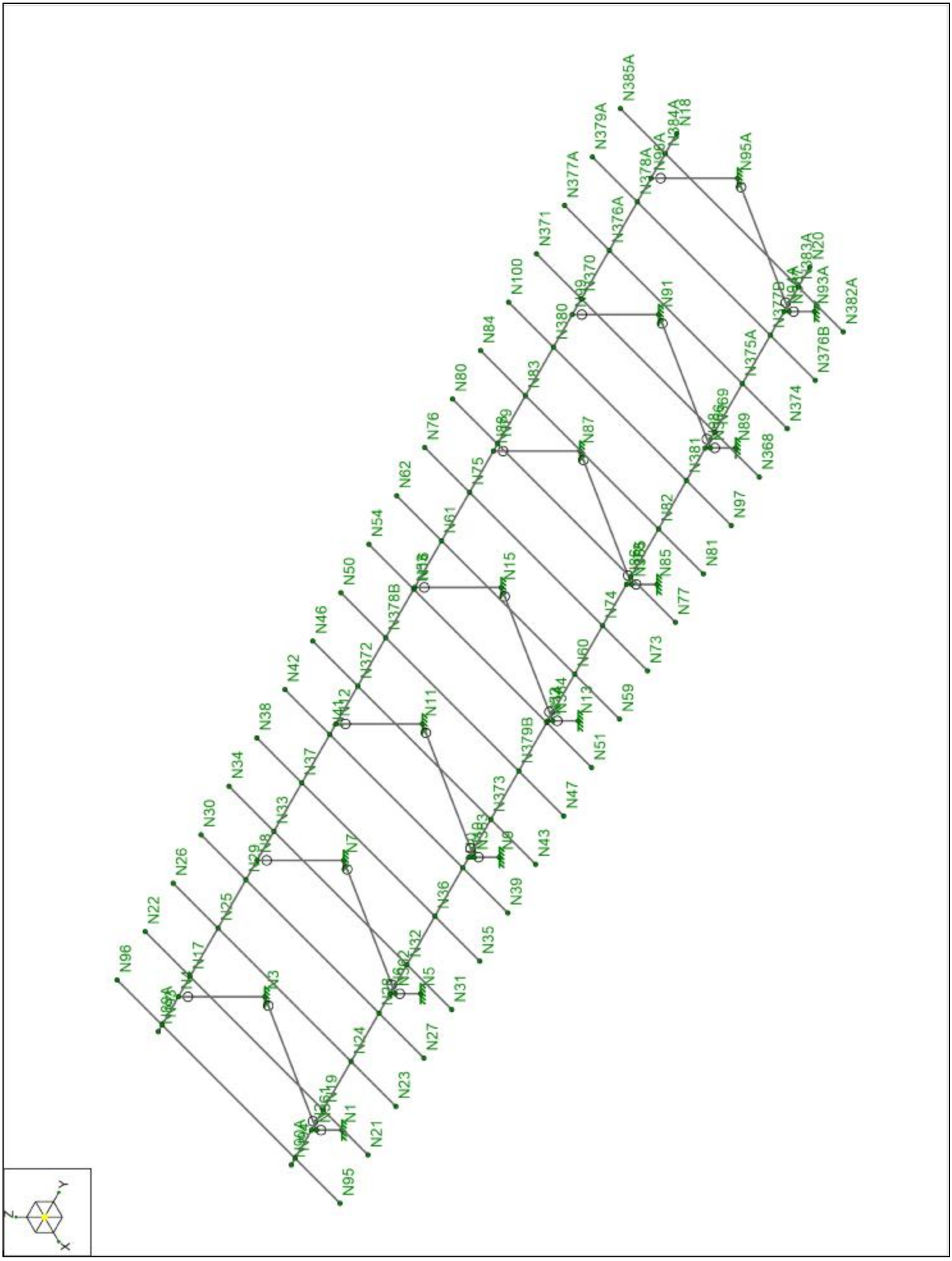
EXAMPLE RISA AND FOUNDATION ANALYSIS

Parameters for Example

Tilt: ***20*** Degrees
Wind Speed: ***85*** MPH (3-sec. Gust)
Exposure Category fiCfl

Snow Load: 0 psf

1.5flØ Sch. 40 Pipe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N371
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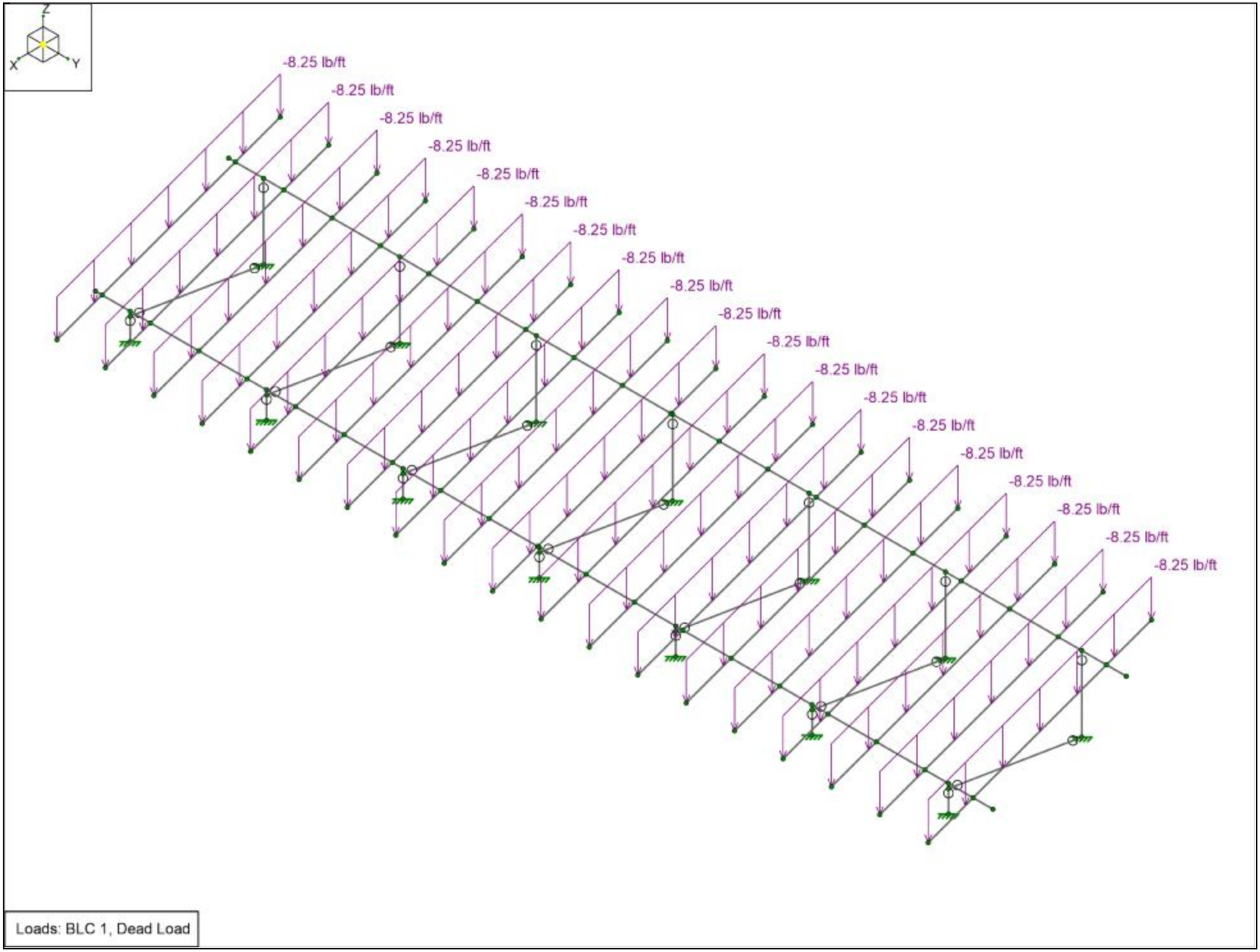
N382A
N84
N380
N91
N376B
N80
N83
N375A
N374
N76
N87
N89
N368
N62
N75
N381
N97
N54
N61
N82
N81
N50
N85
N77
N46
N378B
N15
N74
N73
N42
N372
N60
N38
N11
N59
N34
N37
N13
N51
N379B
N30
N33
N47
N373
N26
N43
N39
N22
N25
N36
N35
N96
N17
N32
N31
N5
N27
N24
N23
N19
N1
N21
N95
Y
Z
X


Z
X
Y
-8.25 lb/ft
-8.25 lb/ft
-8.25 lb/ft
-8.25 lb/ft
-8.25 lb/ft
-8.25 lb/ft
-8.25 lb/ft
-8.25 lb/ft
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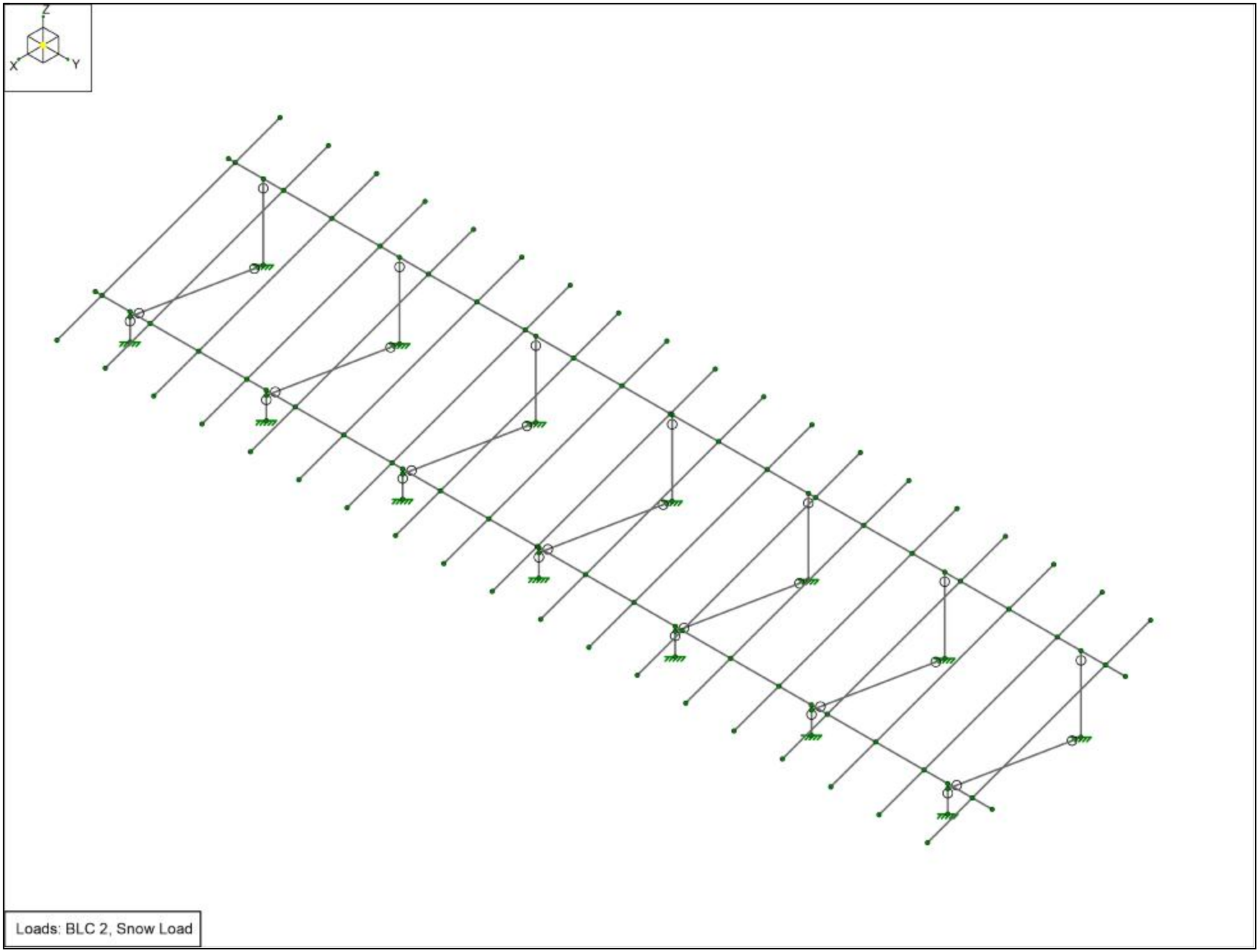
-8.25 lb/ft
-8.25 lb/ft
-8.25 lb/ft
-8.25 lb/ft
-8.25 lb/ft
-8.25 lb/ft
Loads: BLC 1, Dead Load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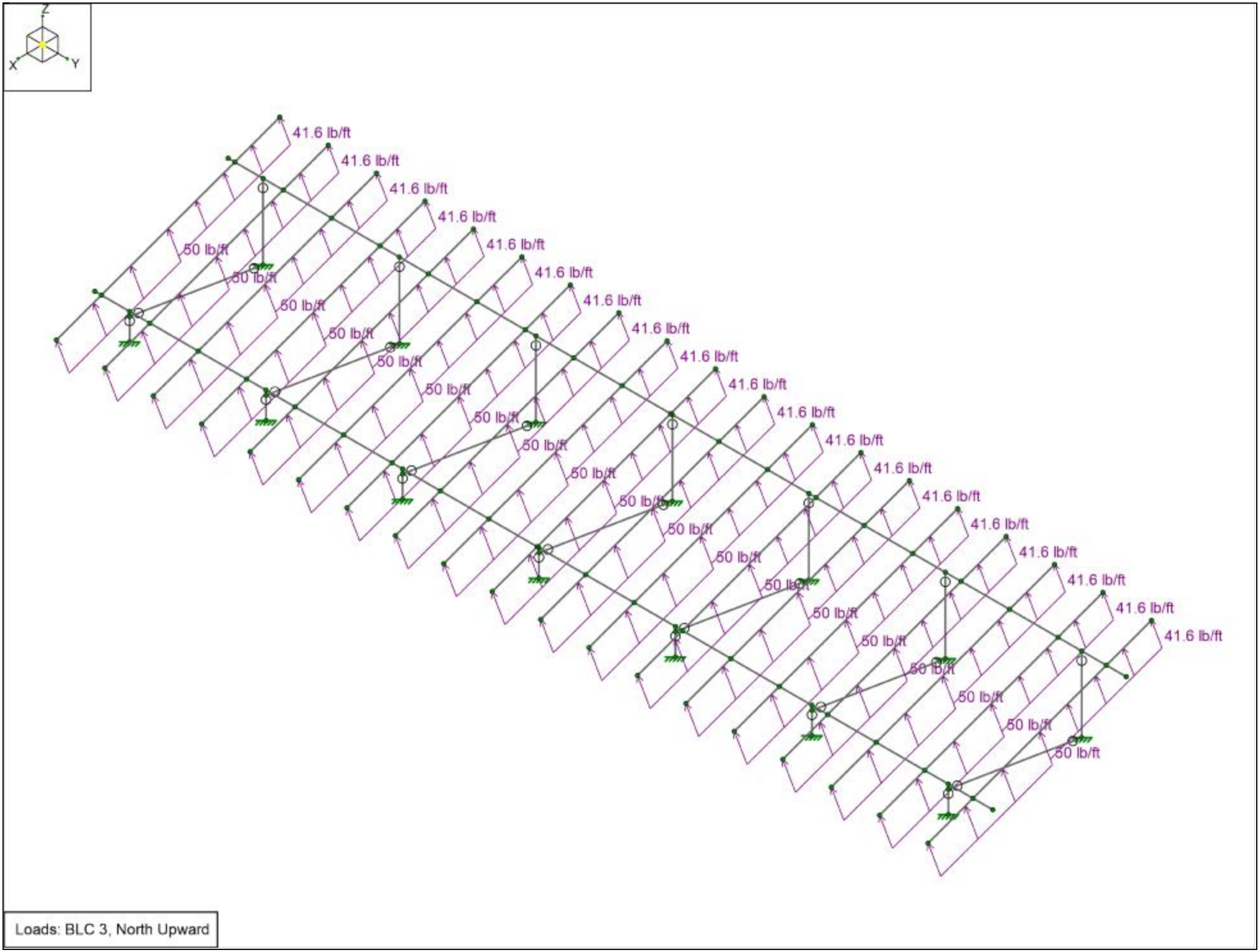
X
Y
Loads: BLC 2, Snow Load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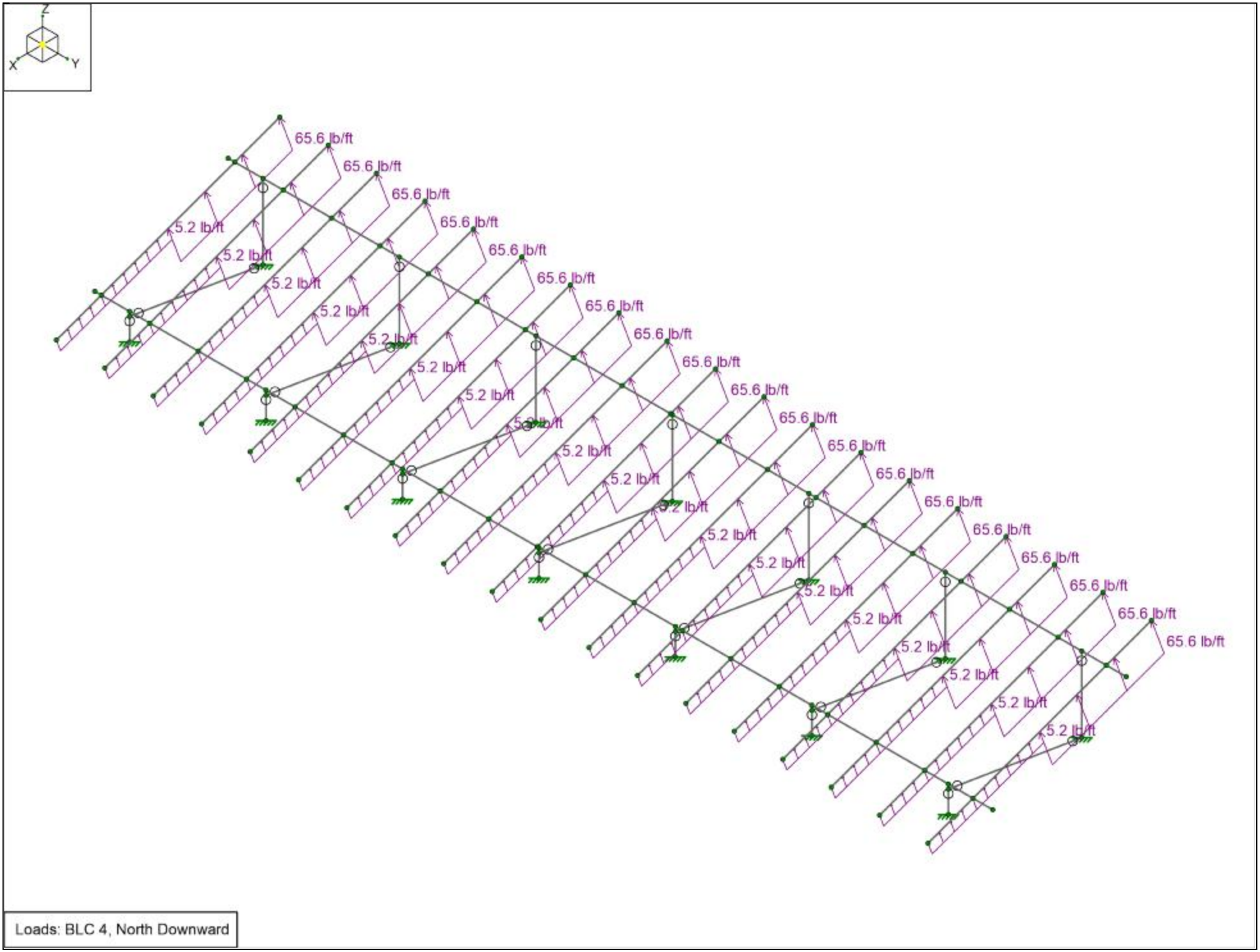
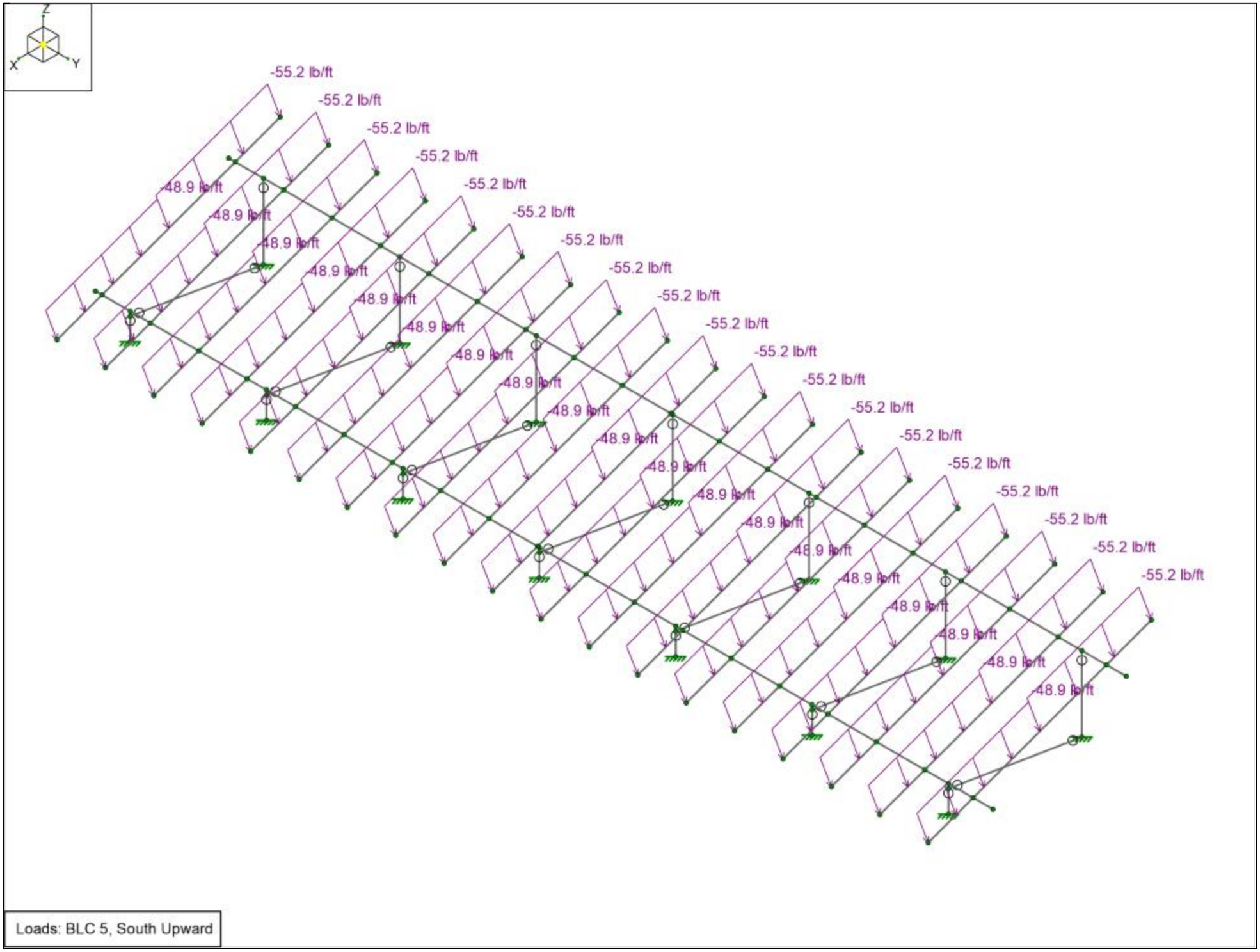
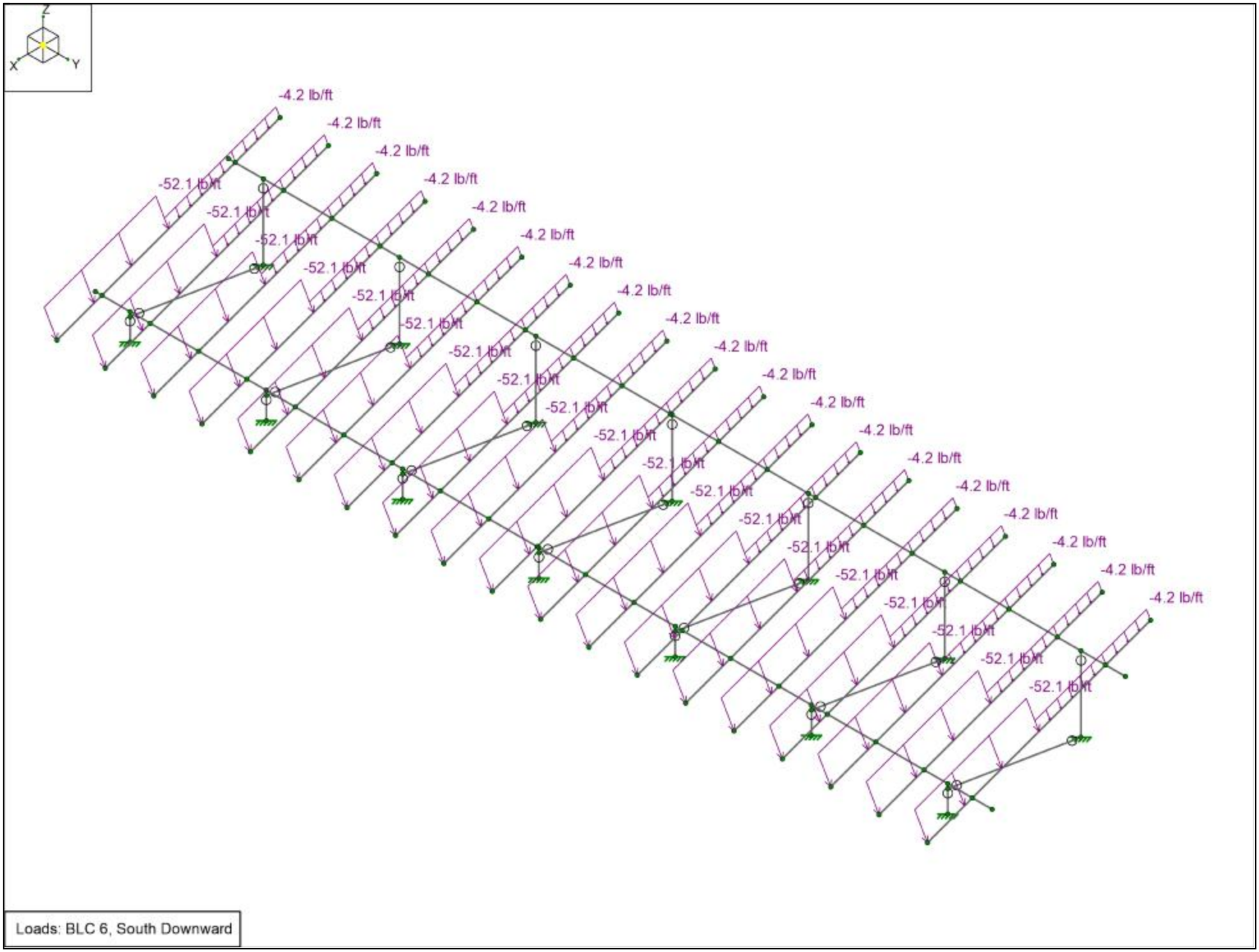
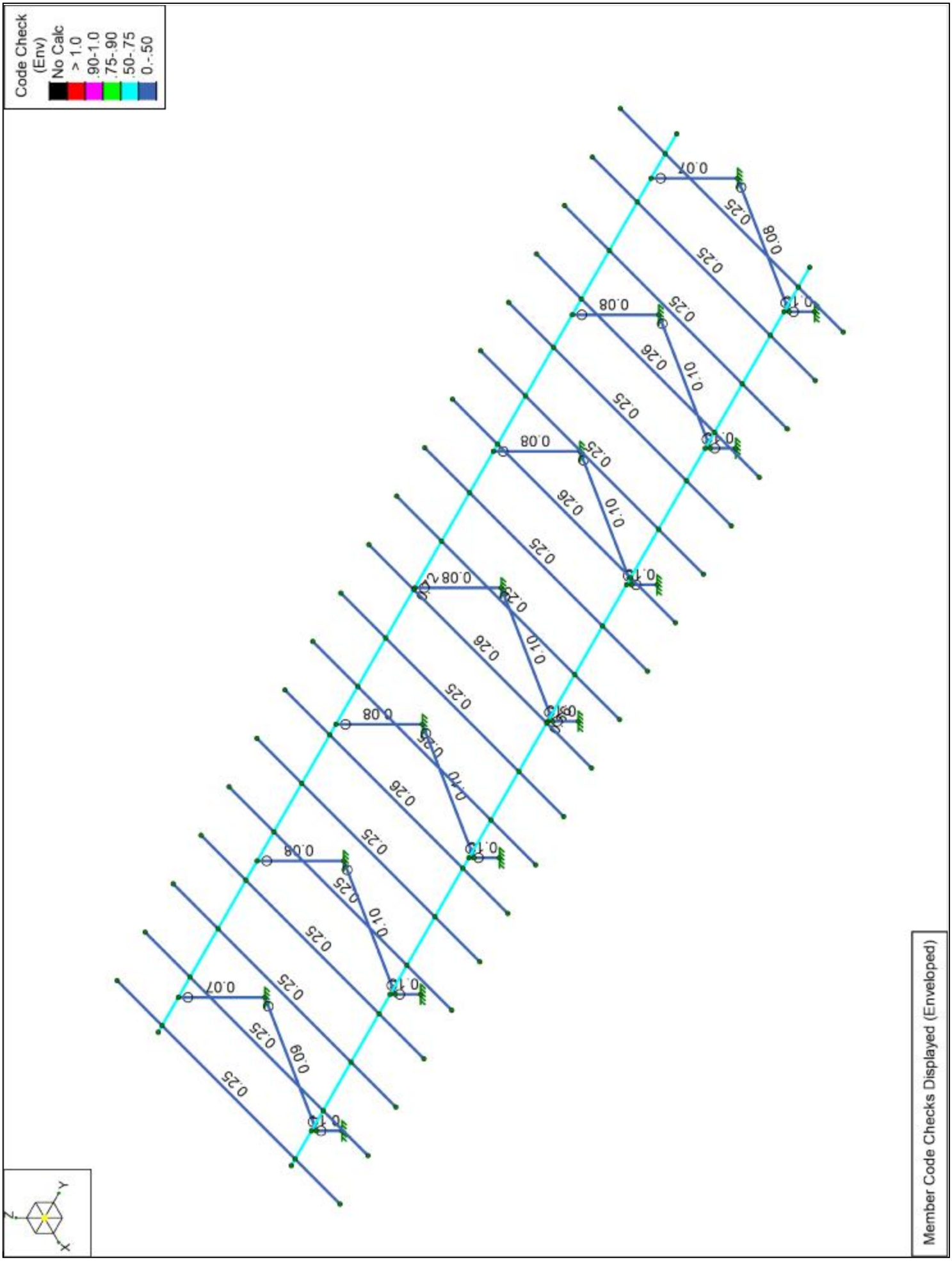
X
Y
41.6 lb/ft
50 lb/ft
Loads: BLC 3, North Upward


Z
X
Y
65.6 lb/ft
5.2 lb/ft
Loads: BLC 4, North Downward


Z
X
Y
-55.2 lb/ft
-48.9 lb/ft
Loads: BLC 5, South Upward


Z
X
Y
-4.2 lb/ft
-52.1 lb/ft
Loads: BLC 6, South Downward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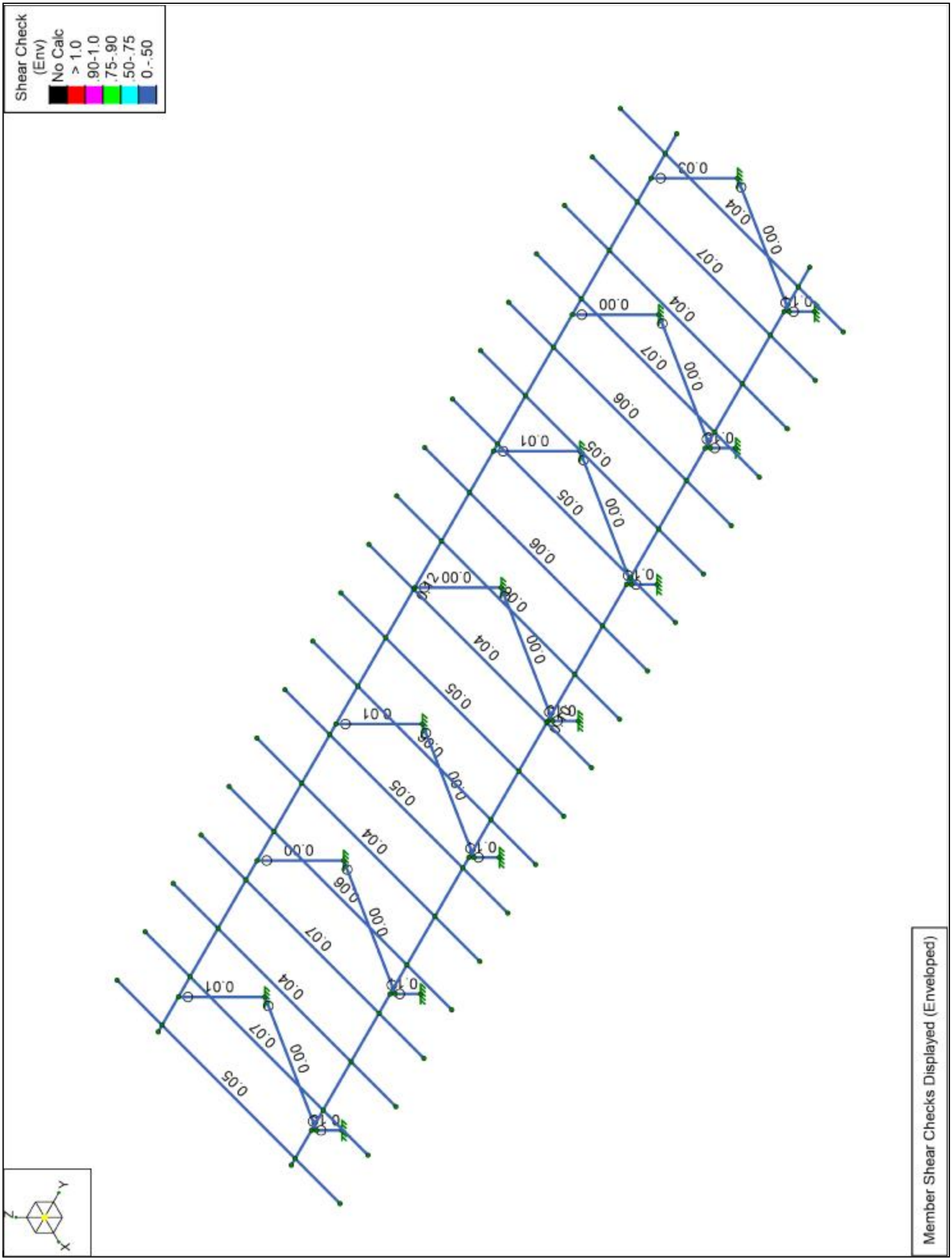
.90-1.0
.75-.90
.50-.75
0.-.50
Member Code Checks Displayed (Enveloped)
Y
Z
X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(Env)
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.75-.90
.50-.75
0.-.50
Member Shear Checks Displayed (Enveloped)
Y
Z
X

Company :
Designer : PAV
Job Number :
Model Name :

Checked By : JJN

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e⁵°F⁻¹]	Density [lb/ft³]	Yield [psi]	Ry	Fu [psi]	Rt
1	A36 Gr.36	29000	11154	0.3	0.65	490	36000	1.5	58000	1.2
2	A992	29000	11154	0.3	0.65	490	50000	1.1	58000	1.2
3	Pipe - 35ksi	29000	11154	0.3	0.65	490	35000	1.5	58000	1.2
4	T6061 Alum.	10600	4077	0.3	1.29	173	36000	1.5	58000	1.2

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in²]	Iyy [in⁴]	Izz [in⁴]	J [in⁴]
1	Pipe 1.5	PIPE_1.5	VBrace	Pipe	Pipe - 35ksi	Typical	0.749	0.293	0.293	0.586
2	Pipe 2.0	PIPE_2.0	VBrace	Pipe	Pipe - 35ksi	Typical	1.02	0.627	0.627	1.25
3	Pipe 1.5X	PIPE_1.5X	VBrace	Pipe	Pipe - 35ksi	Typical	1	0.372	0.372	0.744
4	Pipe 2.0X	PIPE_2.0X	VBrace	Pipe	Pipe - 35ksi	Typical	1.4	0.827	0.827	1.65

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Distributed
1	Dead Load	DL			-1	19
2	Snow Load	SL				19
3	North Upward	WL				38
4	North Downward	WL				38
5	South Upward	WL				38
6	South Downward	WL				38
7	Earthquake X-direction	ELX	0.8			
8	Earthquake Y-direction	ELY		0.8		

Load Combinations

	Description	Solve	PDelta	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	IBC 16-8	Yes	Y	DL	1	NL	1										
2	IBC 16-9	Yes	Y	DL	1	LL	1	LLS	1	NL	1						
3	IBC 16-10 (a)	Yes	Y	DL	1	NL	1										
4	IBC 16-10 (b)	Yes	Y	DL	1	SL	1	SLN	1	NL	1						
5	IBC 16-11 (b)	Yes	Y	DL	1	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75	NL	1		
6	IBC 16-12 (a)	Yes	Y	DL	1	3	0.6	NL	1								
7	IBC 16-13 (a)	Yes	Y	DL	1	3	0.45	LL	0.75	LLS	0.75	NL	1				
8	IBC 16-13 (b)	Yes	Y	DL	1	3	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75	NL	1
9	IBC 16-15	Yes	Y	DL	0.6	3	0.6	NL	1								
10	IBC 16-12 (a)	Yes	Y	DL	1	4	0.6	NL	1								
11	IBC 16-13 (a)	Yes	Y	DL	1	4	0.45	LL	0.75	LLS	0.75	NL	1				
12	IBC 16-13 (b)	Yes	Y	DL	1	4	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75	NL	1
13	IBC 16-15	Yes	Y	DL	0.6	4	0.6	NL	1								
14	IBC 16-12 (a)	Yes	Y	DL	1	5	0.6	NL	1								
15	IBC 16-13 (a)	Yes	Y	DL	1	5	0.45	LL	0.75	LLS	0.75	NL	1				
16	IBC 16-13 (b)	Yes	Y	DL	1	5	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75	NL	1
17	IBC 16-15	Yes	Y	DL	0.6	5	0.6	NL	1								
18	IBC 16-12 (a)	Yes	Y	DL	1	6	0.6	NL	1								
19	IBC 16-13 (a)	Yes	Y	DL	1	6	0.45	LL	0.75	LLS	0.75	NL	1				
20	IBC 16-13 (b)	Yes	Y	DL	1	6	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75	NL	1
21	IBC 16-15	Yes	Y	DL	0.6	6	0.6	NL	1								
22	IBC 16-12 (b) (a)	Yes	Y	DL	1	EL	0.7										
23	IBC 16-12 (b) (b)	Yes	Y	DL	1	EL	-0.7										
24	IBC 16-14 (a) (a)	Yes	Y	DL	1	EL	0.525	LL	0.75	LLS	0.75						
25	IBC 16-14 (a) (b)	Yes	Y	DL	1	EL	-0.525	LL	0.75	LLS	0.75						
26	IBC 16-14 (b) (a)	Yes	Y	DL	1	EL	0.525	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75		
27	IBC 16-14 (b) (b)	Yes	Y	DL	1	EL	-0.525	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75		
28	IBC 16-16 (a)	Yes	Y	DL	0.6	EL	0.7										
29	IBC 16-16 (b)	Yes	Y	DL	0.6	EL	-0.7										

Load Combination Design

	Description	CD	Service	Hot Rolled	Cold Formed	Wood	Concrete	Masonry	Aluminum	Stainless	Connection
1	IBC 16-8	0.9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	IBC 16-9		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	IBC 16-10 (a)	1.25	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	IBC 16-10 (b)	1.15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	IBC 16-11 (b)	1.15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	IBC 16-12 (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7	IBC 16-13 (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8	IBC 16-13 (b)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9	IBC 16-15	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10	IBC 16-12 (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11	IBC 16-13 (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
12	IBC 16-13 (b)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13	IBC 16-15	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	IBC 16-12 (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15	IBC 16-13 (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	IBC 16-13 (b)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
17	IBC 16-15	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18	IBC 16-12 (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
19	IBC 16-13 (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
20	IBC 16-13 (b)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
21	IBC 16-15	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
22	IBC 16-12 (b) (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
23	IBC 16-12 (b) (b)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
24	IBC 16-14 (a) (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
25	IBC 16-14 (a) (b)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
26	IBC 16-14 (b) (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
27	IBC 16-14 (b) (b)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
28	IBC 16-16 (a)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
29	IBC 16-16 (b)	1.6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Envelope Node Reactions

	Node Label		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-ft]	LC	MY [lb-ft]	LC	MZ [lb-ft]	LC
1	N1	max	78.248	6	0.947	14	604.945	18	0.356	9	20.838	9	22.388	9
2		min	-89.528	14	-0.625	9	-220.435	9	-0.569	14	-24.071	14	-32.803	14
3	N3	max	443.54	17	0.073	14	858.355	14	0.625	9	20.89	14	4.715	13
4		min	-390.867	6	-0.011	9	-559.287	13	-1.225	14	-21.847	10	-7.917	14
5	N5	max	90.149	9	0.154	9	714.318	18	0.054	18	24.032	9	15.496	14
6		min	-104.054	14	-0.292	14	-261.21	9	-0.003	9	-27.987	14	-9.316	9
7	N7	max	514.038	14	0.073	14	1013.701	14	0.055	17	20.692	14	1.499	10
8		min	-449.786	9	-0.012	9	-654.264	13	-0.27	10	-21.041	13	0.505	17
9	N9	max	89.931	6	0.304	13	695.268	18	0.126	14	23.954	9	16.245	14
10		min	-103.146	14	-0.358	14	-251.011	9	-0.08	13	-27.73	14	-15.001	13
11	N11	max	508.22	17	0.076	14	986.554	14	0.08	17	12.483	14	5.434	10
12		min	-447.126	6	-0.013	9	-642.437	13	-0.426	10	-12.088	13	-3.701	17
13	N13	max	91.206	9	0.099	13	701.409	18	0.11	14	24.305	9	4.925	14
14		min	-105.046	14	-0.159	14	-252.5	9	-0.042	13	-28.236	14	-4.186	13
15	N15	max	516.207	14	0.079	14	998.45	14	-0.014	9	5.905	14	1.603	10
16		min	-452.162	9	-0.015	9	-649.057	13	-0.28	14	-4.857	9	-0.954	17
17	N85	max	90.298	6	0.196	17	693.738	18	0.07	10	24.045	9	12.505	13
18		min	-103.478	14	-0.248	10	-248.913	9	0.014	17	-27.815	14	-12.93	14
19	N87	max	509.322	17	0.082	14	984.336	14	0.336	13	9.093	14	3.628	17
20		min	-448.297	6	-0.018	9	-641.989	13	-0.742	14	-8.33	13	-5.009	10
21	N89	max	91.206	9	0.416	14	721.616	18	0.097	6	24.316	9	15.133	9
22		min	-105.561	14	-0.303	9	-265.625	9	-0.027	17	-28.391	14	-24.72	14
23	N91	max	520.905	14	0.084	14	1026.926	14	0.455	9	18.169	14	-0.659	9
24		min	-454.54	9	-0.019	9	-662.454	13	-1.049	14	-18.293	13	-2.267	18
25	N93A	max	75.036	6	0.787	9	583.089	18	0.857	14	19.972	9	41.99	14
26		min	-85.592	14	-1.305	14	-209.09	9	-0.432	9	-23.016	14	-28.965	9
27	N95A	max	424.632	17	0.092	14	824.596	14	0.658	17	21.664	14	15.938	14

Envelope Node Reactions (Continued)

Node Label			X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-ft]	LC	MY [lb-ft]	LC	MZ [lb-ft]	LC
28		min	-375.115	6	-0.02	9	-534.452	13	-0.669	6	-22.667	10	-11.569	13
29	Totals:	max	2739.717	14	0	9	10797.159	14						
30		min	-2410.741	9	0	14	-4661.963	9						

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Project: **21492 – CA Solar Ground Mount – K2 Systems**

Maximum Envelope Solution from RISA

	Axial	Uplift	Moment (y)	Shear (x)
Front	**722 lb**	**-266 lb**	**-28 ft-lb**	**-106 lb**
Back	**1,027 lb**	**-662 lb**	**-23 ft-lb**	**521 lb**

	Joint		X		Y		Z		Mx		My		Mz	
	N1	max	78.25	6	0.95	14	604.95	18	0.36	9	20.84	9	22.39	9
		min	-89.53	14	-0.63	9	-220.44	9	-0.57	14	-24.07	14	-32.8	14
B	N3	max	443.54	17	0.07	14	858.36	14	0.63	9	20.89	14	4.72	13
		min	-390.87	6	-0.01	9	-559.29	13	-1.23	14	-21.85	10	-7.92	14
	N5	max	90.15	9	0.15	9	714.32	18	0.05	18	24.03	9	15.5	14
		min	-104.05	14	-0.29	14	-261.21	9	0	9	-27.99	14	-9.32	9
B	N7	max	514.04	14	0.07	14	1013.7	14	0.06	17	20.69	14	1.5	10
		min	-449.79	9	-0.01	9	-654.26	13	-0.27	10	-21.04	13	0.51	17
	N9	max	89.93	6	0.3	13	695.27	18	0.13	14	23.95	9	16.25	14
		min	-103.15	14	-0.36	14	-251.01	9	-0.08	13	-27.73	14	-15	13
B	N11	max	508.22	17	0.08	14	986.55	14	0.08	17	12.48	14	5.43	10
		min	-447.13	6	-0.01	9	-642.44	13	-0.43	10	-12.09	13	-3.7	17
	N13	max	91.21	9	0.1	13	701.41	18	0.11	14	24.31	9	4.93	14
		min	-105.05	14	-0.16	14	-252.5	9	-0.04	13	-28.24	14	-4.19	13
B	N15	max	516.21	14	0.08	14	998.45	14	-0.01	9	5.91	14	1.6	10
		min	-452.16	9	-0.02	9	-649.06	13	-0.28	14	-4.86	9	-0.95	17
	N85	max	90.3	6	0.2	17	693.74	18	0.07	10	24.05	9	12.51	13
		min	-103.48	14	-0.25	10	-248.91	9	0.01	17	-27.82	14	-12.93	14
B	N87	max	509.32	17	0.08	14	984.34	14	0.34	13	9.09	14	3.63	17
		min	-448.3	6	-0.02	9	-641.99	13	-0.74	14	-8.33	13	-5.01	10
	N89	max	91.21	9	0.42	14	721.62	18	0.1	6	24.32	9	15.13	9
		min	-105.56	14	-0.3	9	-265.63	9	-0.03	17	-28.39	14	-24.72	14
B	N91	max	520.91	14	0.08	14	1026.93	14	0.46	9	18.17	14	-0.66	9
		min	-454.54	9	-0.02	9	-662.45	13	-1.05	14	-18.29	13	-2.27	18
	N93A	max	75.04	6	0.79	9	583.09	18	0.86	14	19.97	9	41.99	14
		min	-85.59	14	-1.31	14	-209.09	9	-0.43	9	-23.02	14	-28.97	9
B	N95A	max	424.63	17	0.09	14	824.6	14	0.66	17	21.66	14	15.94	14
		min	-375.12	6	-0.02	9	-534.45	13	-0.67	6	-22.67	10	-11.57	13

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www.TaylorSyfan.com

INNOVATIVE STRUCTURAL DESIGNS

800.579.3881
800.617.2235 fax

Page:
Job No:
Engr:

Friction Pile Design
Version 12.35 - 2015 IBC

INPUT DATA:

Name: Pipe1.5_F_Full

V = 0.11 kips @ H = 0.00 ft above grade

M = 0.03 ft-kips @ H = 0.00 ft above grade

Axial = 0.72 kips

Creep = 0.00 plf/ft for D = 0.00 ft of soil

Pile is unconstrained

1.33x Short-term Stress Increase

2x Isolated Pile Increase

Pile Width = 12.00 inches

Passive = 150.00 psf/ft to a Maximum = 1500.00 psf

Friction = 250.00 psf/ft End Bearing = 2000.00 psf

SOLUTION:

Required Embedment Depths into Firm Soils:

Axial = 0.92 ft Lateral = 2.00

Required = 2.00 ft total embedment

Soil Pressures:

S1 = 266.67 psf at D/3

S3 = 4000.00 psf at full depth

Moments:

M = 0.10 ft-kips unfactored

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Project: **21492 – CA Solar Ground Mount – K2 Systems**

PILE UPLIFT CALCULATION *(FRONT PILE)*

SYSTEM INFORMATION

Pile Diameter	**12**	**inches**
Depth of Pile	**2**	**feet**
Distance Discounted	**1**	**feet**
Skin Friction	**250**	**psf/ft**
Concrete Density	**150**	**pcf**

LOADING INFORMATION

Uplift Demand *(ASD Level)*	**266**	**pounds**

UPLIFT CAPACITY

From Skin Friction

*Skin friction = Allowed Skin Friction * Circumference * Allowed Pile Depth*

785 **pounds**

From Concrete Weight

141 **pounds** *Concrete weight = 0.6 * Concrete Density * Pile Area * Full Pile Height*

TOTAL UPLIFT RESISTANCE

927 **pounds**

Pile Design is Acceptable for Uplift Demand

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www.TaylorSyfan.com

INNOVATIVE STRUCTURAL DESIGNS

800.579.3881
800.617.2235 fax

Page:
Job No:
Engr:

Friction Pile Design
Version 12.35 - 2015 IBC

INPUT DATA:

Name: Pipe1.5_B_Full

V = 0.52 kips @ H = 0.00 ft above grade

M = 0.02 ft-kips @ H = 0.00 ft above grade

Axial = 1.03 kips

Creep = 0.00 plf/ft for D = 0.00 ft of soil

Pile is unconstrained

1.33x Short-term Stress Increase

2x Isolated Pile Increase

Pile Width = 12.00 inches

Passive = 150.00 psf/ft to a Maximum = 1500.00 psf

Friction = 250.00 psf/ft End Bearing = 2000.00 psf

SOLUTION:

Required Embedment Depths into Firm Soils:

Axial = 1.00 ft Lateral = 3.00

Required = 3.00 ft total embedment

Soil Pressures:

S1 = 400.00 psf at D/3

S3 = 4000.00 psf at full depth

Moments:

M = 0.54 ft-kips unfactored

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Project: **21492 – CA Solar Ground Mount – K2 Systems**

PILE UPLIFT CALCULATION *(BACK PILE)*

SYSTEM INFORMATION

Pile Diameter	**12**	**inches**
Depth of Pile	**3**	**feet**
Distance Discounted	**1**	**feet**
Skin Friction	**250**	**psf/ft**
Concrete Density	**150**	**pcf**

LOADING INFORMATION

Uplift Demand *(ASD Level)*	**662**	**pounds**

UPLIFT CAPACITY

From Skin Friction

*Skin friction = Allowed Skin Friction * Circumference * Allowed Pile Depth*

1571 **pounds**

From Concrete Weight

212 **pounds** *Concrete weight = 0.6 * Concrete Density * Pile Area * Full Pile Height*

TOTAL UPLIFT RESISTANCE

1783 **pounds**

Pile Design is Acceptable for Uplift Demand

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Project: **21492 - CA Solar Ground Mount - K2**

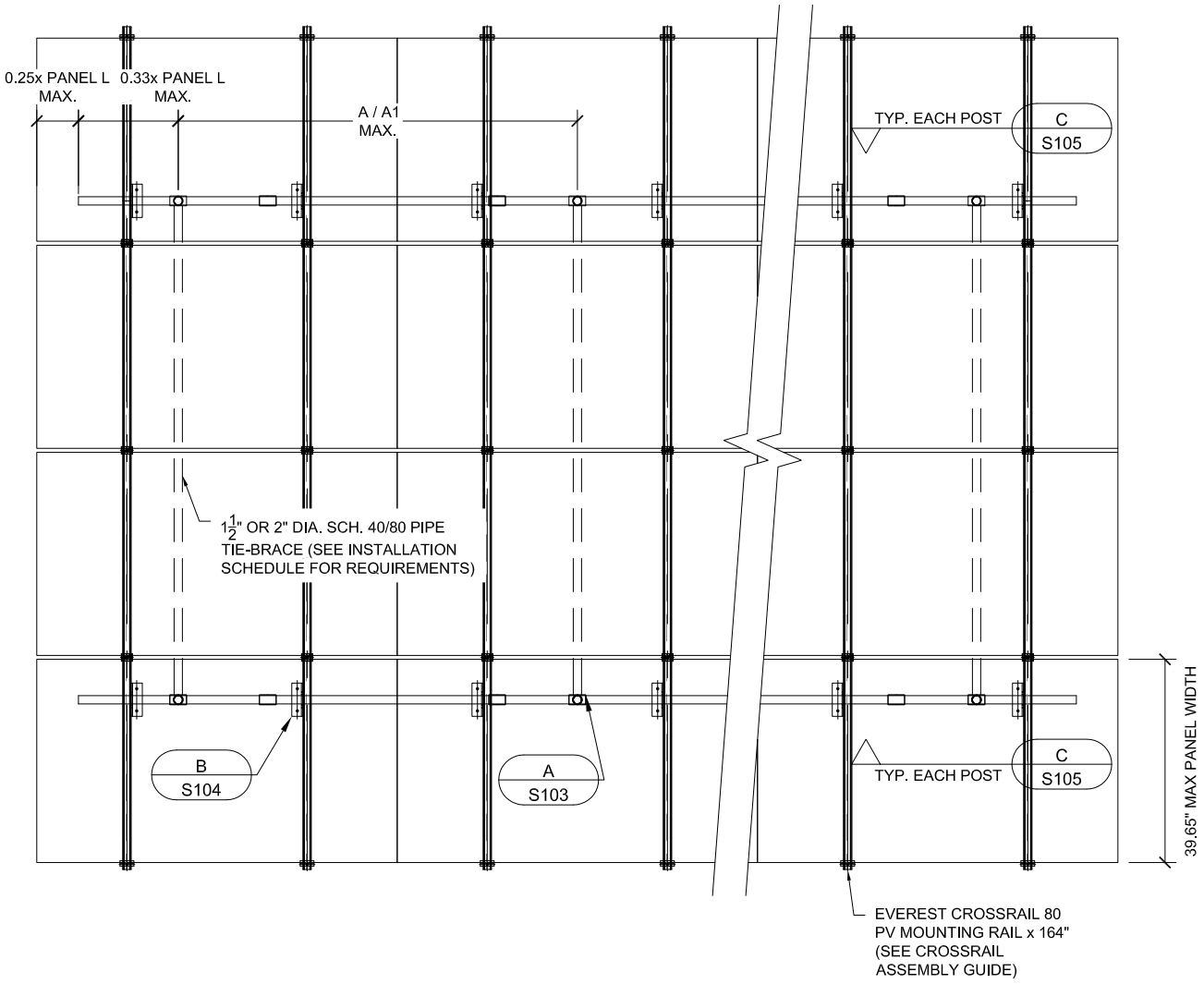
APPENDIX A

(Reference Documents from Everest Solar Systems)

For Reference Only

NOTE
REFER TO CROSSRAIL ASSEMBLY GUIDE FOR RAIL TO PV PANEL CONNECTION

NOTE
PIPE COUPLERS ALLOWED FOR *HORIZONTAL* PIPE RUNS ONLY.



1 CROSSRAIL GROUND MOUNT LAYOUT (PLAN VIEW)
NO SCALE

NOTE
REFER TO STRUCTURAL CALCULATIONS, NOTES, & DETAILS BY TAYLOR & SYFAN DATED 2019 FOR ADD'L SPECIFICACTIONS & REQUIREMENTS.

TITLE

EVEREST solar systems

Everest Solar Systems, LLC
3809 Ocean Ranch Blvd. Suite 111
Oceanside, CA 92056

DATA SHEET: CROSSRAIL GROUND MOUNT PLAN

S100

PART NUMBER: N/A

ALL DIMENSIONS FT. & INCHES

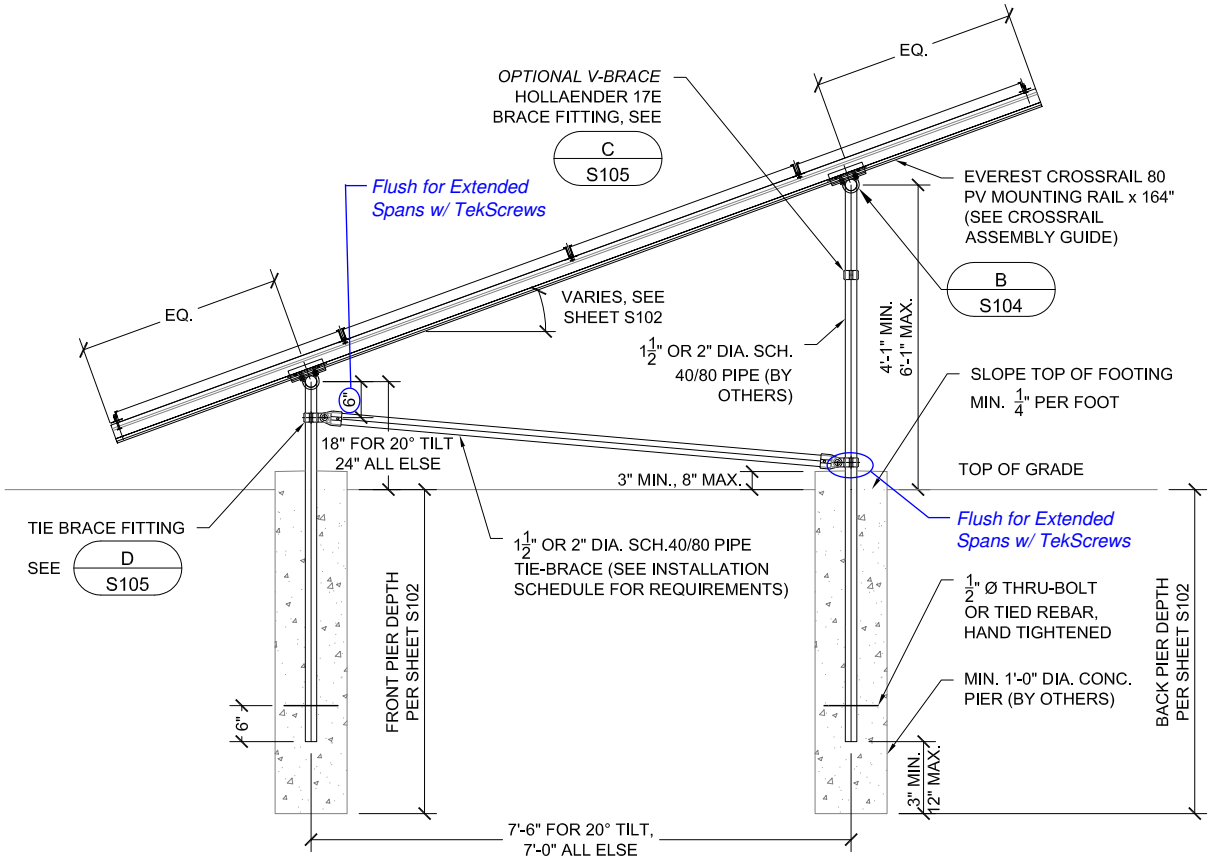
Created	PAC	20160320	MATERIAL:	VARIES	K2 REFERENCE NUMBER: N/A	
Revision	6		FINISH:	VARIES	SCALE: NTS	SERIES:

SHEET 1 OF 1

For Reference Only

NOTE
REFER TO CROSSRAIL ASSEMBLY GUIDE FOR RAIL TO PV PANEL CONNECTION

NOTE
PIPE COUPLERS ALLOWED FOR *HORIZONTAL* PIPE RUNS ONLY.



1 CROSSRAIL GROUND MOUNT LAYOUT (ELEVATION VIEW)
NO SCALE

NOTE
REFER TO STRUCTURAL CALCULATIONS, NOTES, & DETAILS BY TAYLOR & SYFAN DATED 2019 FOR ADD'L SPECIFICACTIONS & REQUIREMENTS.

TITLE

EVEREST solar systems

Everest Solar Systems, LLC
3809 Ocean Ranch Blvd. Suite 111
Oceanside, CA 92056

DATA SHEET:
CROSSRAIL GROUND MOUNT ELEVATION

S101

PART NUMBER: N/A

ALL DIMENSIONS FT. & INCHES

Created	PAC	20160320	MATERIAL:	VARIES	K2 REFERENCE NUMBER: N/A	
Revision	6		FINISH:	VARIES	SCALE: NTS	SERIES:

SHEET 1 OF 1

For Reference Only

INSTALLATION DIMENSIONS											
G	Wind Speed*	Snow*	Tie-Brace	Pipe Data		A	A1	CONCRETE DEPTH (A)		CONCRETE DEPTH (A1)	
TILT ANGLE	ASCE 7-05 / 7-10 (mph)	Ground Snow Load	Required?	Pipe Size	Pipe Specifcation	Post Spacing	Post Spacing w/ V-Brace	Front	Back	Front	Back
20˚	85 / 100	0 psf	Yes	1.5"	Sch. 40	7'-9"	11'-9"	2'-0"	4'-0"	2'-4"	5'-0"
			Yes		*Sch. 80*	*8'-9"*	*13'-6"*	*2'-0"*	*4'-0"*	*2'-4"*	*5'-0"*
			Yes	2"	Sch. 40	9'-9"	15'-0"	2'-0"	4'-0"	2'-3"	5'-0"
			Yes		*Sch. 80*	*10'-9"*	*16'-0"*	*2'-0"*	*4'-3"*	*2'-9"*	*5'-3"*
30˚-35˚	90 / 105	30 psf	Yes	1.5"	Sch. 40	5'-6"	9'-0"	2'-0"	4'-4"	3'-0"	6'-0"
			Yes		*Sch. 80*	*6'-3"*	*10'-9"*	*3'-0"*	*5'-0"*	*3'-0"*	*6'-0"*
			Ye						5'-4"	3'-3"	7'-0"
			Ye						*6'-0"*	*3'-9"*	*7'-0"*
30˚-35˚	90 / 105	50 psf	Ye						5'-0"	3'-3"	6'-0"
			Ye						*5'-0"*	*3'-3"*	*6'-0"*
			Ye						5'-0"	3'-4"	6'-4"
			Ye						*5'-3"*	*3'-9"*	*7'-0"*
30˚-35˚	105 / 130	30 psf	Yes	1.5"	Sch. 40	5'-6"	8'-3"	3'-0"	6'-0"	3'-6"	7'-3"
			Yes		*Sch. 80*	*5'-9"*	*8'-3"*	*3'-0"*	*6'-0"*	*3'-6"*	*7'-3"*
			Yes	2"	Sch. 40	7'-0"	9'-0"	3'-0"	6'-6"	3'-4"	7'-6"
			Yes		*Sch. 80*	*8'-0"*	*10'-6"*	*3'-0"*	*7'-0"*	*3'-6"*	*8'-0"*
30˚-35˚	105 / 130	50 psf	Yes	1.5"	Sch. 40	4'-6"	6'-3"	3'-0"	6'-0"	3'-3"	6'-6"
			Yes		*Sch. 80*	*5'-6"*	*7'-3"*	*3'-0"*	*6'-0"*	*3'-3"*	*7'-0"*
			Yes	2"	Sch. 40	6'-0"	8'-9"	3'-0"	6'-0"	3'-4"	7'-4"
			Yes		*Sch. 80*	*7'-0"*	*11'-0"*	*3'-0"*	*6'-6"*	*4'-8"*	*8'-3"*

For Reference Only,
Do Not Use

* TO BE VERIFIED BY A REGISTERED PROFESIONAL ENGINEER OR BUILDING OFFICIAL

NOTE
REFER TO STRUCTURAL CALCULATIONS, NOTES, & DETAILS BY TAYLOR & SYFAN DATED 2019 FOR ADD'L SPECIFICACTIONS & REQUIREMENTS.

TITLE

EVEREST solar systems

Everest Solar Systems, LLC
3809 Ocean Ranch Blvd. Suite 111
Oceanside, CA 92056

DATA SHEET:
CROSSRAIL GROUND MOUNT
INSTALLATION SCHEDULE

PART NUMBER: N/A

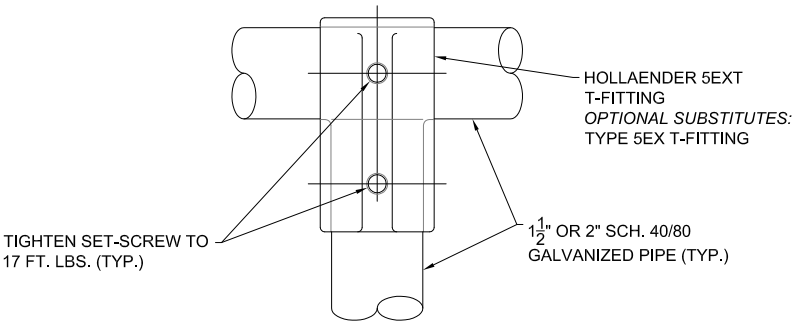
S102

ALL DIMENSIONS FT. & INCHES

Created	PAC	20160320	MATERIAL:	VARIES	K2 REFERENCE NUMBER: N/A	
Revision	6		FINISH:	VARIES	SCALE: NTS	SERIES:

SHEET 1 OF 1

For Reference Only



A GROUND MOUNT T-FITTING
NO SCALE

NOTE
REFER TO MANUF. SPECIFCATIONS FOR FITTINGS & 3D PARTY ACCESSORIES

NOTE
REFER TO STRUCTURAL CALCULATIONS, NOTES, & DETAILS BY TAYLOR & SYFAN DATED 2019 FOR ADD'L SPECIFICACTIONS & REQUIREMENTS.

TITLE

EVEREST solar systems

Everest Solar Systems, LLC
3809 Ocean Ranch Blvd. Suite 111
Oceanside, CA 92056

DATA SHEET:
CROSSRAIL GROUND MOUNT PARTS

PART NUMBER: N/A

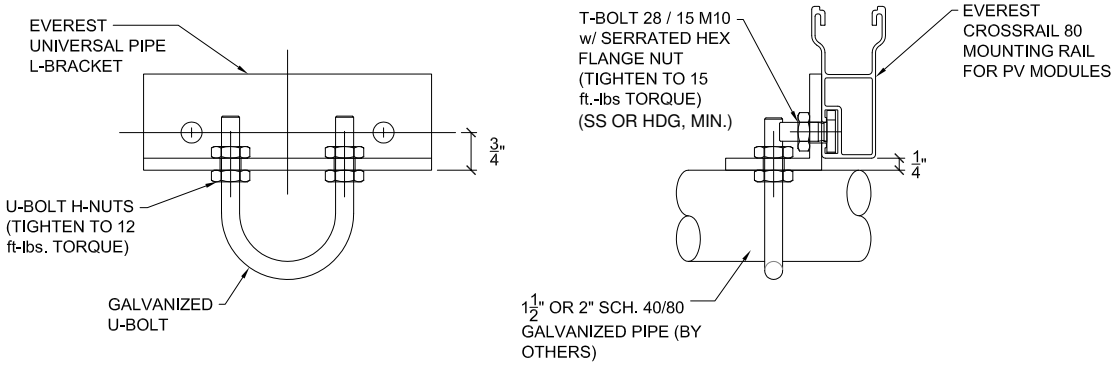
S103

ALL DIMENSIONS FT. & INCHES

Created	PAC	20160320	MATERIAL:	VARIES	K2 REFERENCE NUMBER:	N/A
Revision	6		FINISH:	VARIES	SCALE: NTS	SERIES: PARTS

SHEET 1 OF 1

For Reference Only



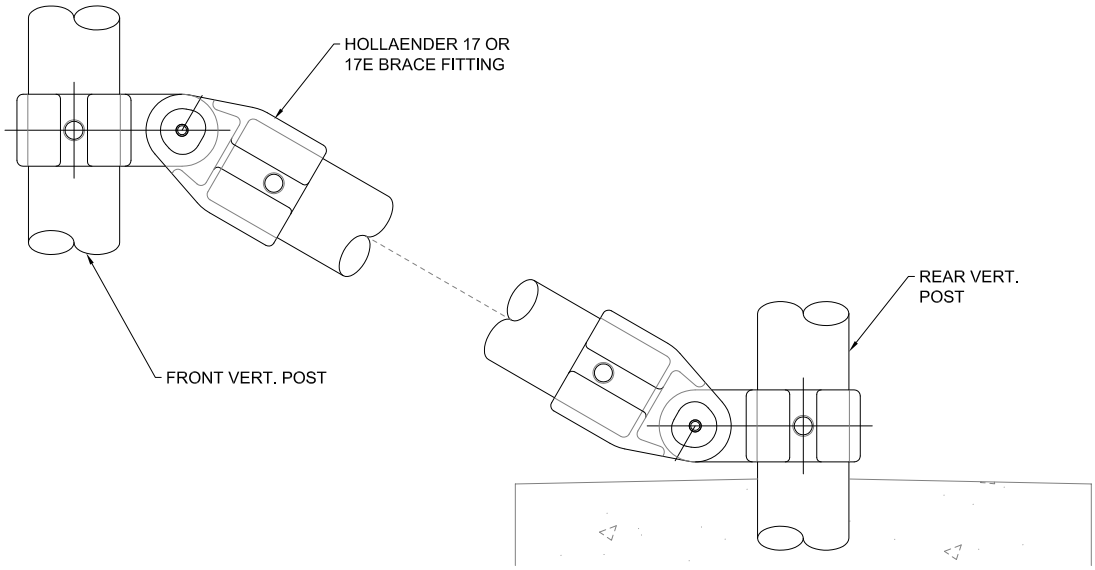
B EVEREST 1.5" PIPE L-BRACKET
NO SCALE

NOTE
REFER TO MANUF. SPECIFCATIONS FOR FITTINGS & 3D PARTY ACCESSORIES

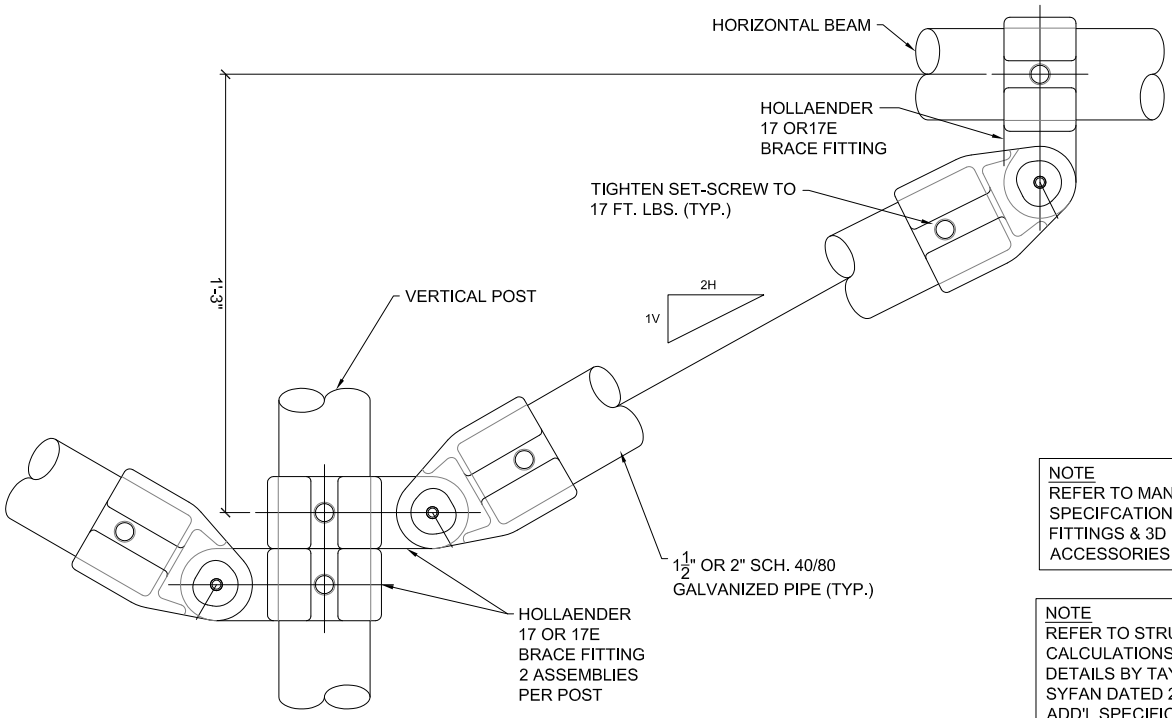
NOTE
REFER TO STRUCTURAL CALCULATIONS, NOTES, & DETAILS BY TAYLOR & SYFAN DATED 2019 FOR ADD'L SPECIFICACTIONS & REQUIREMENTS.

TITLE	EVEREST solar systems	Everest Solar Systems, LLC 3809 Ocean Ranch Blvd. Suite 111 Oceanside, CA 92056		DATA SHEET: CROSSRAIL GROUND MOUNT PARTS PART NUMBER: N/A	S104 ALL DIMENSIONS FT. & INCHES
	Created PAC	20160320	MATERIAL: VARIES	K2 REFERENCE NUMBER: N/A	
	Revision 6		FINISH: VARIES	SCALE: NTS SERIES: PARTS	SHEET 1 OF 1

For Reference Only



D TIE BRACE CONNECTIONS
NO SCALE

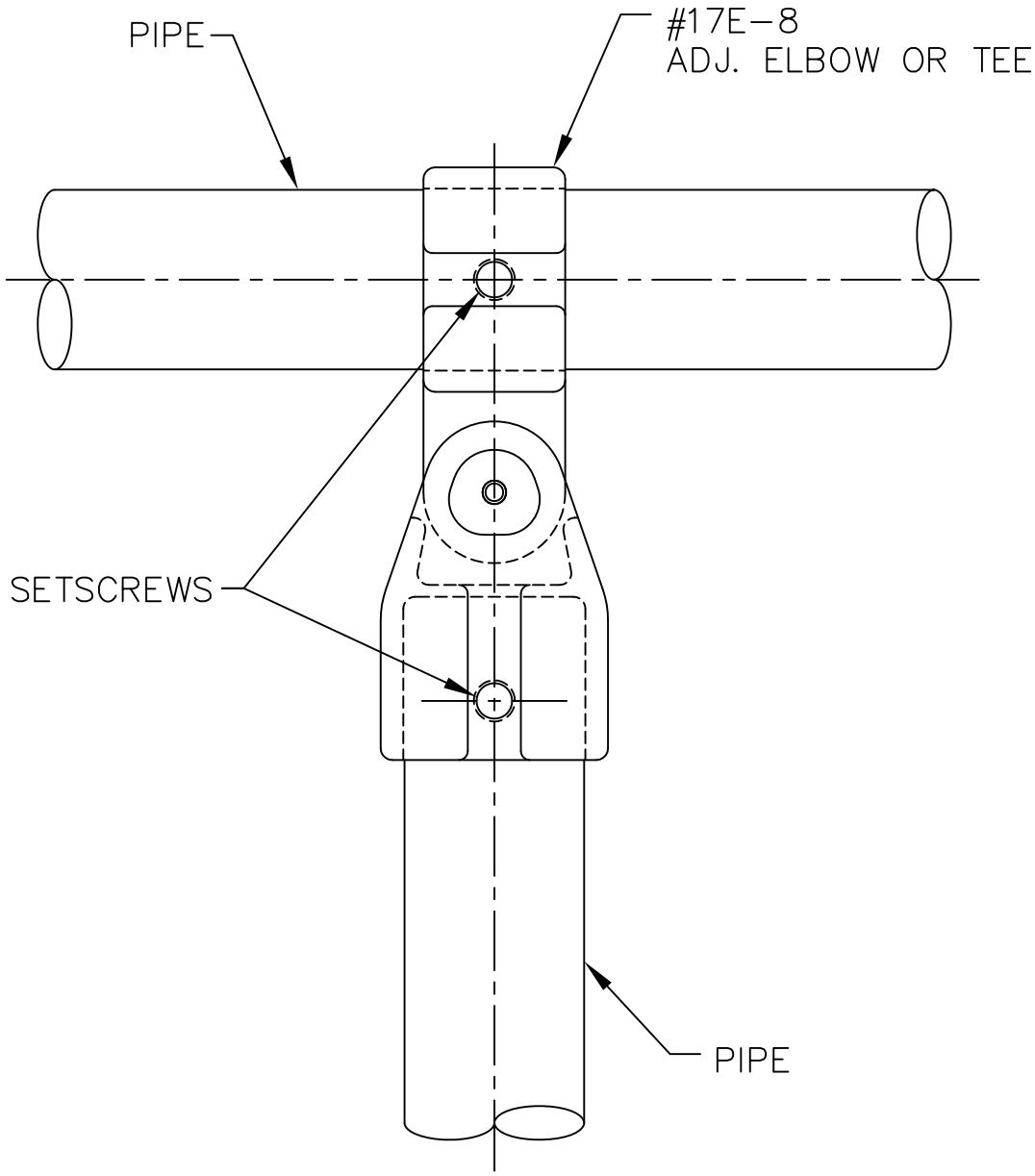


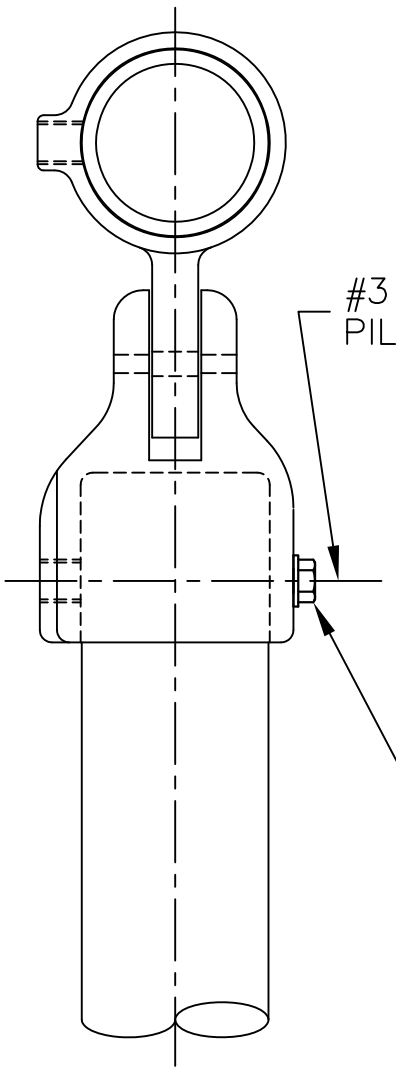
NOTE
REFER TO MANUF. SPECIFCATIONS FOR FITTINGS & 3D PARTY ACCESSORIES

NOTE
REFER TO STRUCTURAL CALCULATIONS, NOTES, & DETAILS BY TAYLOR & SYFAN DATED 2019 FOR ADD'L SPECIFICACTIONS & REQUIREMENTS.

C OPTIONAL V-BRACE (TYP. EACH POST)
NO SCALE

TITLE	EVEREST solar systems	Everest Solar Systems, LLC 3809 Ocean Ranch Blvd. Suite 111 Oceanside, CA 92056		DATA SHEET: CROSSRAIL GROUND MOUNT PARTS PART NUMBER: N/A		S105 ALL DIMENSIONS FT. & INCHES
	Created PAC	20160320	MATERIAL: VARIES	K2 REFERENCE NUMBER: N/A		
	Revision 6		FINISH: VARIES	SCALE: NTS	SERIES: PARTS	SHEET 1 OF 1





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A8 of A8

NO.	REVISIONS	DATE	APPROVED
0	RELEASED FOR APPROVAL	05-01-17	BW

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CINCINNATI, OH 45215-6399
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WWW.HOLLAENDER.COM

DRAWN BY: GG	APPROVED BY: BW	DATE: 05-01-17	
PROJECT NO.: N/A		SCALE: NTS	
FINISH: NOTED		DRAWING NO.: 10502-S	
MATERIAL: ALUMINUM		SHEET 1 OF 1	